HIMALAYAN FOSSILS.

VOL. III, PART 2.

TRIAS, BRACHIOPODA AND LAMELLIBRANCHIATA.

ALPHABETICAL LIST OF THE SPECIES OF BRACHIOPODA AND LAMELLIBRANCHIATA DESCRIBED.

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TRIAS BRACHIOPODA AND LAMELLIBRANCHIATA.

BY

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WITH 12 LITHOGRAPHIC PLATES.

The following descriptions are based upon a portion of those fossils of the trias of the Himálayas which have been entrusted to Prof. E. Suess, of Vienna, for purposes of palæontological investigation, by the Directors of the Geological Survey of India, Messrs. W. King and C. L. Griesbach. With the exception of those fossils belonging to F. Stoliczka's earlier collections, they have all been found by Mr. C. L. Griesbach himself. To these may be added the remnants of Brachiopoda and Lamellibranchiata collected by Dr. C. Diener in the year 1892 in the triassic region of the Himálayas. It was originally intended that the rare Gastropods should also be examined, but when their number had somewhat increased through the collections made by Dr. Diener, especially those from the triassic limestone of Tibet, I thought it advisable to offer them for investigation to our well-known authority, E. Kittl, Curator in the Imperial Museum, Vienna. But at that time the first plate for the present work had already been drawn, and upon it was figured a species of the genus Bellerophon, which must therefore also be treated of in the text. The sign 'etc.' added to the running title of the plates, refers therefore only to this one fossil. The descriptions of the remaining Gastropods by E. Kittl will follow. In accordance with a wish expressed by Mr. C. L. Griesbach, the Director, the descriptions of the species were disposed according to the chronological succession of the formations, and the arrangement of the plates, as far as it was possible, was effected in such a manner that fossils from the same formation were included in the

same plate. The descriptions begin with the species belonging to the oldest triassic deposits of the Himálayas. With reference to the divisions of these deposits attention should be drawn to the important work of Mr. C. L. Griesbach, *viz.*, "Geology of the Central Himálayas", in the Memoirs of the Geological Survey of India, Vol. XXIII., 1891, and also to the more recent contributions of Dr. C. Diener, "Ergebnisse einer geologischen Expedition in den Central Himálaya von Tohar, Hundés und Painkhanda," in the Denkschriften der Kais. Akademie der Wissenschaften in Wien, Band LXII., 1895.

I. BRACHIOPODA AND LAMELLIBRANCHIATA FROM THE LOWER TRIAS (BUNTSANDSTEIN, OR WERFEN-SLATE BEDS) OF THE HIMÁLAYAS.

a. *From the Lower or Otoceras Horizon.*

From the lowest fossil-bearing beds of trias of the Himálayas, the so-called Otoceras Beds (according to Dr. C. Diener's more restricted term), Mr. C. L. Griesbach ("Geology of the Central Himálayas," page 146) has already enumerated, besides Bellerophon, sp., the following species of lamellibranchiata :—*Posidonomya angusta*, Hauer, var., *Avicula Venetiana*, Hauer, var., *Gervillia mytiloides*, Schloth., *Modiola triquetra*, Seeb., *Myophoria ovata*, Schaur.

All the specimens mentioned by Griesbach under the above names are before me, and besides these also another series from these beds collected by Diener.

Taking this material as a criterion, the lamellibranchiate fauna of this horizon proves to be poor and wanting in variety, as besides the predominant genus *Posidonomya*, conspicuous by the number, as well as the size, of its species, all the remaining species appear to occur restricted in number and small as individuals. It is interesting to find a Bellerophon associated with these lamellibranchs, and equally so is the isolated occurrence of a brachiopod of the family of the Rhynchonellidæ, which latter is yet unknown in such low triassic deposits of the Alpine trias of Europe.

Pseudomonotis Griesbachi, nov. spec., Pl. I., Figs. 1–4.

By far the most frequent and remarkable species among the bivalves of this fauna belongs to that group of the Aviculidæ which plays so important a part in the Alpine Werfen slates, and which was united at first to Posidonomya, later to Avicula, and is now customarily placed in Pseudomonotis, on the authority of F. Teller. *Pseudomonotis* (*Posidonomya*) *Clarai*, Buch, sp., is taken as the type of this group of the lower triassic Aviculidæ.

The present Indian form is remarkably large, very unsymmetrical, more or less oblique, with very unequal valves, of which the left one is considerably inflated and the right one almost flat and lid-like.

The inflation of the left valve is by far the strongest in the region of the umbo, while farther from the latter it becomes much more flat. The umbo itself projects considerably beyond the hinge-line of this valve; the hinge-line is long and straight, and divided into two very unequal parts owing to the position of the umbo, which is pushed far towards the anterior end. The anterior part of the hinge-line forms about a quarter of its total length. This anterior portion of the hinge-line of the inflated left valve is not generally formed into a well-developed wing or ear, but in well-preserved specimens (*e.g.* enlarged figure, Pl. I., Fig. 1) a slight incurvature in the lines of growth at its margin can be perceived.

The Indian form does not possess a true incurvature in this region, such as that which R. Lepsius (Südwesttirol, Tab. I, Fig. 1*b*) indicates in the anterior ear of the left valve of a very closely related species from the Alpine Werfen slates, but I doubt whether this can be attributed to the Alpine form, and I am very much inclined to refer the figure mentioned above to the inner side of a right valve, supposing that the drawing is really true to nature, and that the incurvature is not accidental. Whilst Lepsius, as I presume, thus wrongly attributes a byssal sinus also to the left valve of one of these forms, A. Tommasi (Palæontographia Italica, Vol. I., 1895), has lately come to a diametrically opposite conclusion, for he denies the existence of a byssal ear also for the right valve of such a form (cf. Verhandl. der geol. R. Anstalt, 1897, p. 105.)

The right or 'lid-valve' of these lower triassic species possesses in fact an unusually distinct, very deep byssal sinus, which almost separates the feebly developed anterior ear from the rest of the shell. This can also be said of the Asiatic form to be described in these pages. The umbo of the right valve hardly projects above the straight hinge-line, the umbonal region is not at all elevated in front, but up to a third of its height it is either quite flat, or even a little depressed; farther below, however, this valve appears also slightly convex. The ear of the anterior side (byssal ear) possesses a steeply sloping outer margin, on which the crowded lamellar lines of growth overlap; the incurvature of all the lines of growth into the byssal sinus is very distinctly perceptible.

The surface of both valves appears almost smooth, as the striæ of growth are reduced to a merely inconspicuous concentric sculpture, while a true radial sculpture scarcely exists. The striation of growth is strongest near the hinge-line, appears generally to be a little more distinctly marked on the right valve than on the left, and rarely assumes the character of very indistinct ridges (Fig. 1.); and it occurs mostly only in the form of slightly elevated, irregularly distributed, concentric lines. Such regular fine concentric ornamentation as characterises the Alpine form designated by W. Salomon as *Pseudomonotis ovata*, Schaur., spec., seems to occur only quite exceptionally in the Asiatic one. In the Asiatic form the radial ornamentation, which at the utmost consists of quite faint radiations only observable when the light falls suitably upon them, is still more indistinct than the concentric ornamentation. The angle which the hinge-line makes with the vertical axis varies a little, that is, there are examples of this species of which some are shaped more obliquely (Pl. I, Figs. 2, 3,) and others less so (Figs. 1—4).

The Pseudomonotis here described from the lowest triassic deposits of the Himálayas is very closely related to certain Alpine forms. Among these the most remote relationship is with *Pseudomonotis Clarai*, whose sculpture, well-marked in typical specimens, and consisting of concentric ridges and radial ribs, is almost entirely absent in the present species. But the form described by F. von Hauer as *Pseudomonotis* (*Posidonomya*) *aurita*, sp., which other authors would unite with *Ps. Clarai*, shows a very perceptible dying out of that sculpture, and becomes thus much more like our form. This is still more applicable to those specimens for which Salomon has again employed the old name *Ps. ovata*, Schaur., and in which the radial sculpture is almost or completely wanting. If one considers with Salomon the figures 6, 7 and 9, of F. von Hauer's *Ps. aurita*, sp., as types, and places these in *Ps. Clarai*, or only near this species, the difference between the Asiatic form and *Ps. Clarai* can be estimated to a certain extent by the almost complete absence of a true radial ribbing in the former. Notwithstanding their great resemblance the Asiatic form could then also be distinguished from Salomon's Alpine *Ps. ovata* by the faintness and irregularity of its concentric sculpture. If it was desired to agree with Salomon in uniting the present species with *Ps. ovata*, Schaur., which could be effected by making only a slight extension of the species, it would be advisible to test the validity of the name introduced by Salomon, for it cannot be denied that the name is by no means free from objection. The very specimen figured by Schauroth, originally as var. *ovata*, does not agree very well with the newer figure of Salomon's species, and it is not at all certain that both authors understood exactly the same species under this name. Salomon's reference to Schauroth's name seems thus to have no strong justification. A. Tommasi describes apparently identical Alpine forms, such as those given by Salomon, as *Posidonomya Haueri*, and he unites with this species, as a synonym, Salomon's *Pseudomonotis ovata*, Schaur., sp., which he could not have done if he had been convinced that Schauroth's original form was really identical with Salomon's. On the other hand, Tommasi's species is certainly not a Posidonomya, but a Pseudomonotis. The mutual relationship of the species as expressed in their nomenclature becomes more and more confused, so much so that it is already getting very difficult to choose a perfectly suitable name for each of them from among those already in use; unless one unites all of them together under the oldest of these names, *viz.*, "*Pseudomonotis Clarai.*"[1] It will not therefore be possible before a fresh investigation of these forms is made on the basis of ample material, fully to explain their specific relationship, and to regulate their names accordingly. Before this can be effected it seems to me most advisable, as none of the existing specific names is quite applicable to the Indian form, to name it anew, and to designate it, in honour of its discoverer, *Pseudomonotis Griesbachi*. But with reference to its characteristics, it must again be emphasized that its sculpture is very feebly developed, whereby it is distinguished, not only very markedly from the strongly ornamented

[1] The name *Posidonomya angusta*, used at the time by Mr. C. L. Griesbach, is to be traced back to older designations in the collection of the k. k. geol. Reichsanstalt, in which the name, occurring through an evident error, according to Catullo. (cf. F. V. Hauer, l. c, p. 12) had by chance escaped correction. This name cannot therefore be employed.

Ps. Clarai and its radially ribbed allied forms, but also, though in a somewhat less degree, from the forms designated at present as *Pseudomonotis ovata*, Schaur. (Sal.), or *Posidonomya Haueri*, Tom. Single individuals of the Asiatic form may, however, be very closely related to the last-named European forms. The smoothness of the surface of the shell, *i.e.*, the vanishing of the sculpture, is the most important feature of the Asiatic form, in contrast to its Alpine congeners, of which not one can be regarded with so much right as really smooth-shelled as *Pseudomonotis Griesbachi*. The latter is the most abundant and most characteristic species among the few bivalves known as yet at the base of the triassic deposits of the Himálayas, and especially in the lowest division, the so-called Otoceras beds. In the limestones of these beds, which are mostly dark, it is often preserved with its shell which is glossy black and shines like velvet.

The localities at present known of *Pseudomonotis Griesbachi* are :—The Shalshal Cliff, near Rimkin-Paiar, where the species was first discovered by Mr. C. L. Griesbach, the Director of the Geological Survey of India, and later also collected by Dr. C. Diener, and from which place the specimens figured were derived.

Some fragments, which certainly belong to this species, come from the neighbourhood of Kiunglung, South-West of the Niti Pass.

A small number, mostly fragments, of particularly large specimens are from the hills to the south of Kuling in Spiti.

Some of these specimens possess the remarkably fine and regularly concentric striation that occurs in *Pseudomonotis ovata*, Schaur. (Salomon). They have also been found by Griesbach. Their matrix only varies a little from that in which *Ps. Griesbachi* occurs in the Shalshal Cliff. It is therefore possible that *Ps. Griesbachi*, and a species perhaps not separable from *Ps. ovata*, Schaur. (Salomon), occur associated in the Himálayas. This association would be of great interest, not only for the definite establishment of the relationship, already very close, between them, but also for stratigraphical comparison.

Pseudomonotis Painkhandana, nov. spec., Pl. I., Fig. 5.

Associated with the more abundant form described above under the name of *Pseudomonotis Griesbachi*, there occurs an isolated form of Pseudomonotis, which is much smaller, less oblique, vertically elongated, and cannot be specifically united, without reservation, to the former. Small specimens of the inflated left valve of *Pseudomonotis Griesbachi*, when compared with equal-sized specimens of the second species, taken at the same height, give a ratio of length (breadth) of about 4 : 3, which, as the illustration shows, implies very differently-shaped outlines. I should have liked to call this form *Ps. angusta*, if this name had not already been employed for *Ps. Griesbachi*. The left valve, the only one at present known, is highly inflated, recalling a little in its form Lingula, or certain species of Discina, but of course inequilateral, with a hinge-line very short anteriorly and about three times as long posteriorly. The umbo is strongly inflated and projects above the straight hinge-line.

The ornamentation of the surface of the shell is the same as in *Ps. Griesbachi*, to which it is, doubtless, very closely related, differing only from the latter in its narrow shape.

Among its Alpine congeners such a remarkably narrow form is, so far as I know, yet unknown, and for this reason it deserves to be distinguished by a special name.

Locality.—In the dark Otoceras beds of the lowest trias in the section of the Shalshal Cliff, near Rimkin-Paiar.

Avicula, aff. Venetianæ, Hauer, Pl. I, Fig. 8.

Besides the typical Pseudomonotis species of the Clarai Group there is in the Alpine Buntsandstein formations or Werfen slates a second Avicula type, widely distributed, which is represented by Aviculopecten-like forms, such as *Avicula Venetiana*, Hauer, auct. (general name), *Pecten Fuchsi*, Hauer, *Avicula striatoplicata*, Hauer, *Avicula inæquicostata*, Benecke, and others, forms whose mutual relations as species are only in part very insufficiently established. This Avicula type occurs also in the Otoceras beds of the Himálayas, from which Griesbach himself has already cited *Avicula Venetiana*, var.

In most of the forms belonging to this species only the left valve is as yet known, and this is also the case with the Asiatic form of this group under description. Its left valve is much inflated and only slightly oblique, with an umbo only a little pushed out of the median line. The hinge-line is straight, the umbo projecting above it, the former having on each side an ear (or wing), of which the posterior one is broader than the anterior, but appears rather indistinctly differentiated from the rest of the shell, while the narrower anterior ear is separated from the latter by a well-marked radial furrow. This radial furrow corresponds to a slight emargination between the anterior ear and the rest of the shell at the anterior margin, in which the lines of growth bend distinctly arch-like inwards. Nothing like this is to be noticed near the posterior ear.

The entire surface of the shell, including the two ears, is ornamented with numerous radial ribs, the greater number of which originate near the umbo, while farther out others insert themselves, so that finally three different degrees of strength or systems of such ribs occur, whose alternation is by no means distinguished by special regularity. The sides of the shell and the ears are more evenly and finally ribbed than the central area of the shell. Through the lines of growth crossing this area the stronger ribs become here and there rough, especially towards the lower margin. The shell itself is tolerably thick at the umbo. The cast possesses less distinctly marked, smooth ribs.

Among the related Alpine species, of which there are sufficient representatives, *Avicula inæquivalvis*, Benecke, the originals of which, thanks to the kindness of Professor Benecke, I am in a position to compare, might be regarded as the nearest to the present species. But the southern Alpine species is already dichotomously and more distinctly ribbed nearer to the umbo, and moreover possesses in the left

valve a more strongly defined anterior ear, which is traversed in the centre by a radial swelling. The posterior ear might have been just as wide and as little defined as it is in the Indian species, as it can be distinctly recognised in Benecke's original specimen, Fig. 5. *Avicula Venetiana*, Hauer, known for a longer time, is unfortunately represented by such badly preserved forms among Hauer's original specimens that an exact comparison of them with related forms appears almost impossible. It may, therefore, be easily understood that this species has gradually become a general type, and that different authors have in the course of time indicated and recorded various forms as *Avicula Venetiana*, Hauer. The original *Avicula Venetiana*, Hauer, is, in any case, a form closely related to the species described above and the one referred to as Benecke's. In the less sharply defined, dichotomous ribbing, the original of Hauer's *Venetiana* (Fig. 3) stands, it would seem, even nearer the Indian form than Benecke's species. This original species of Hauer's indicates also that the anterior wing is ear-like, and the front margin correspondingly emarginate, while the posterior wing almost merges into the rest of the shell. Hauer's illustration, it is true, wrongly shows a distinctly defined posterior ear. Still more markedly schematic are Hauer's illustrations, Figs. 1 and 2, with respect to the ribbing. I consider all the specimens figured by Hauer, including Fig. 2*a*, to be left valves. The one ear of Fig. 2*a* (the lower one in the drawing) is not present in the original. I am disposed to think that *Avicula Venetiana* also possessed a flat, right or lid valve, which seems to be very seldom found. If this should be regarded as strange and improbable, the recognised fact may be pointed out that in the Werfen slates whole layers are found with weathered specimens of *Pseudomonotis Clarai*, all of which turn in the same manner the inflated left valve outwards, whilst the small flat, right valve only very seldom appears in such layers. These forms, which are mostly in colonies, appear to have been buried in the rock as they lived, attached to one another by the byssus. In this manner the flat right valve was probably still further pressed into the larger opposite valve, and thus generally escapes observation. The same may also be said of related Aviculidæ, that is, of those with similiarly unequal valves. Who has not been struck with the rare occurrence of the right valve of the Rhætic *Avicula contorta*, Portl.? Perhaps still more rare is the right valve of *Cassianella decussata*, occurring in hundreds of specimens in the St. Cassian beds and the case is exactly the same with the rest of the species of Cassianella.

From a lower triassic deposit of the island of Russkij in the Amoor region, closely related to the Werfen slates and the Otoceras beds, I have before me some slabs collected by Iwanow, which are entirely covered with confusedly scattered inflated valves of an *Avicula*, ex. aff. *Venetiana*, Hauer, which is likewise closely related to *Avicula inaequicostata*, Ben., putting aside its somewhat finer and closer ribbing. Among these numerous inflated valves, there is only one single specimen of a flat right valve, with well-developed byssal ear, of distinctly marked Aviculid type, and provided with crowded ribbing which does not differ essentially from the ribbing of the other inflated valves. I cannot regard this single valve as anything more than the right valve, unknown until now, of an Avicula of the type of

Avicula Venetiana, that is, as the right valve of an inflated form occurring associated with it. A similar case will be mentioned further on in *Pseudomonotis himaica*. I find also that Benecke is inclined to suppose that the right valve of his *Avicula inæquivalvis* may have been flat, or less inflated than the left one.

Locality.—Collected in the section of the Shalshal Cliff by Messrs. Griesbach and Diener. Griesbach's older specimens bear the following note :—"Three miles south of Rimkin-Paiar, East slope of Kurguthidar, No. 2." Among the specimens brought home by Diener there is one associated with *Pseudomonotis Griesbachi*, both imbedded in the same fragment of rock.

Gervillia (?), spec. indet., Pl. I., Figs. 6, 7.

A rather poor and small Gervillia (?) of a somewhat variable outline, which does not appear to be so closely related to any of the known triassic species as to the permian *Gervillia* (*Bakewellia*) *antiqua*, Münst., as it is figured, for example, in King, Pl. XIV., Figs. 31, 33. It is a stumpy form with a strongly inflated left valve and a very flat right one. Among triassic species it has the greatest resemblance to *Gervillia costata* and *G. subcostata* (Credner, Zeitschr. der Deutsch. geol. Gesell., 1851, Tab. VI. Figs. 3, 4). But as even the generic position of the Asiatic form cannot be completely verified it would be useless to carry the comparison further.

Locality.—It appears to be not very rare in the thinly-bedded strata of the Otoceras beds in the Shalshal section near Rimkin-Paiar, associated with *Pseudomonotis Griesbachi* (the specimens collected by Griesbach are labelled with the following locality :—"Three miles south of Rimkin-Paiar, east slope of Kurguthidar").

Myophoria (?) spec. indet., Pl. I., Figs. 9, 10.

These fossils—as is the case with the Gervillia (?) mentioned above—have somewhat greater similiarity with certain permian species of Schizodus than with the forms of the lower triassic group of *Myophoria ovata*, which are so extensively distributed in the Alpine Werfen Slates. Unfortunately, the scarcity of the specimens does not allow of the exposure of the hinge, so a more minute investigation into their relationship is impracticable.

In their shape those Alpine forms which are named "Tapes subundata, Schaur.," from Recoaro, seem to be the most closely related ; but they are considerably longer (wider) than the Indian form.

Locality.—At the Shalshal Cliff, near Rimkin-Paiar (Kurguthidar, east slope) very sparingly, with *Pseudomonotis Griesbachi*, and the above-mentioned Gervillia. The same form seems also to occur near Kiunglung in the vicinity of the Niti Pass.

Nucula (?) spec. Pl. I., Fig. 11.

A form, quite uncertain as to its genus and which is therefore only mentioned here as Nucula with a query, because of its somewhat recalling by its shape certain

species of Nucula. As it is impossible to expose the hinge in the single specimen available, no further comparison can be entered into.

Locality.—In the Otoceras beds with *Pseudomonotis Griesbachi* near Rimkin-Paiar.

Remarks.—In the beginning of this memoir all lamellibranchs referred to by Griesbach (see ante, p. 2.) from the Otoceras beds (his "lower beds") have been enumerated, with the exception of his *Modiola triquetra*, Seeb., the determination of which is based upon a very badly-preserved fossil, which is therefore better left unnoticed. A brachiopod and a Bellerophon (cf. Introduction, p. 2.) from the same horizon will be described.

Rhynchonella (Norella) procreatrix, nov. sp., Pl. I., Fig. 12.

This Rhynchonella, the oldest among the "reversed" species of Rhynchonella (Norella, m., Abhandlung der k. k. geol. Reichsanst. XIV., p. 315) yet known, is a small slightly inflated form, of which young forms of about 4—5 mm. in length are still quite smooth, without ribs, and scarcely possess any indication of a sinus on the *small* valve, while in larger specimens, of above 5 mm. in length, a slight undulation of the front, besides a broad and shallow sinus in the small valve, are developed. The number of the little folds amounts to nine, of which the three middle ones occupy the tongue-like depression of the front of the shell. The test is fibrous, the beak is well-formed and Rhynchonella-like, with dental plates; a median septum appears to be wanting in the small valve.

The species is distinguished from all species of Norella hitherto described, including the ribbed *Norella Rosaliæ*, Salomon, by its broad and flat form.

In the later triassic deposits of the Himálayas related forms seem to be widely distributed. The species itself is of considerable interest as one of the oldest triassic species of Brachiopoda, for it is known that the Alpine Werfen Slates have yielded so far only a few hingeless brachiopods of the genera Lingula and Discina.

Locality.—In the Otoceras beds with *Pseudomonotis Griesbachi*, in isolated specimens, north-west of Kiunglung, south-west of the Niti Pass. Judging from an impression in the rock this species may also occur in the corresponding horizon of the Shalshal Section, near Rimkin-Paiar.

Bellerophon cf. Vacekı, nov. sp., Pl. I., Figs. 15 (13, 14).

The first specimens of Bellerophon of the Alpine trias were, as far as I know, discovered by Mr. M. Vacek, and in very low horizons of the Werfen Slates on each side of the Etsch, south of Botzen, on the Mendelstrasse, and near Montan (Verhandl. der k. k. geol. Reichsanst., 1882, p. 44, also 1894, p. 435). Specimens of Bellerophon were found later in a horizon very nearly agreeing, judging by the matrix, with that of the Werfen Slates, by Mr. G. von Bukowski, in the Spizza region of southern Dalmatia; they belong, however, to a species different from the specimens from southern Tyrol (Verhandl. der k. k. geol. Reichsanst 1895, p. 134).

Mr. Griesbach reported already in the year 1891 (Vol. XXIII., of the Memoirs of the Geological Survey of India, p. 146), the occurrence of species of Bellerophon in his lower triassic Otoceras beds, and since then they have also been known from a similar horizon in the region of the Amur in Eastern Asia, so that they may now be regarded as widely-spread, though rare, palæozoic stragglers in the fauna of the lowest beds of the trias.

The species of Bellerophon of the lower Werfen Slates of the valley of the Etsch and those of the Otoceras beds of the Himálayas seem to be specifically identical, or, in any case, so closely related to one another that, considering their state of preservation, they cannot be specifically separated with certainty.

They are small smooth strongly-inflated symmetrical shells, with rather deep median emargination, a narrow umbilicus closed by a callus, and faintly-marked striæ of growth. The only difference, though a very insignificant one, that I observed in the Asiatic form, as compared with the European, consists in the presence of a slight spiral depression which surrounds the umbilicus and sometimes forms a faint keel around it. I therefore designate the Asiatic form as *Bellerophon* cf. *Vaceki*, and figure two forms of the Alpine species, hitherto undescribed, for comparison with it.

Locality.—In the horizon of the Otoceras beds of the Shalshal Section, near Rimkin-Paiar, containing *Pseudomonotis Griesbachi*, very isolated. More abundant and in larger forms, as it seems, in the same horizon, north-west of Kiunglung in the vicinity of the Niti Pass. Found by Griesbach in both localities.

b. From the Upper or Subrobustus-Horizon.

The upper part of Griesbach's original Otoceras beds has recently been distinguished by Dr. C. Diener as the Subrobustus-Horizon. Besides cephalopoda only a few lamellibranchs have as yet been found. They are as follow :—

PSEUDOMONOTIS (? AVICULA) HIMAICA, nov. sp., Pl. I., Figs. 16—21.

A very inequilateral and inequivalved shell, therefore very oblique, with a ribbed surface. The left valve is greatly inflated and possesses a remarkably long straight hinge-line, and a beak strongly inclined forward and projecting above the hinge-margin. The posterior hinge-margin seems to be not at all marked off from the rest of the shell, while the anterior is of an incompletely ear- or wing-like form. There is scarcely any indication of an emargination on the anterior margin, or of curvature in the lines of growth in the place below that part which is to be regarded as the anterior ear.

The right valve is very slightly inflated, nearly flat; its beak does not project beyond the hinge-margin; anteriorly the latter is developed into the form of a byssal ear, and almost entirely marked off from the rest of the shell by the deep notch.

With the exception of the almost smooth beak, both valves are ornamented with numerous, nearly equally strong, slightly raised, blunt, and proportionally broad ribs, which reach the hinge-margin on both sides. In the middle of the shell the ribs widen out here and there at irregular distances, and in some places take between them one or several much finer ribs, or include between them only faintly impressed, longitudinally-furrowed, flat spaces. A regular alternation of ribs, differing in strength, does not take place. The ribs are here and there a little bent in their course, and sometimes also pushed out of it by stronger interruptions caused by the lines of growth. Extremely faint, close-set, and regular striæ of growth cross the ribs. In respect to their ornamentation there is no essential difference between the two valves. The byssal ear may be without ribs.

Whether it is better to place this species in Pseudomonotis or in Avicula, must be left undiscussed. Certain species of Avicula described by F. Teller from the triassic deposits of northern Siberia resemble this species, but they are less oblique and inequilateral. *Monotis ovalis*, Whiteaves (Contributions to Canadian Palæontology, Vol. I., Part II., 1889, p. 133, Pl. XVII., Fig. 4) from the trias of British Columbia, seems really to be very much like our species, but according to the description its hinge-margin appears to be shorter, its beak not lying so far forward, and the ribs are indicated as particularly broad, being in the median pallial margin even broader than the spaces between them, which is not the case with our species. At any rate *Monotis ovalis*, of which only the left valve is known, may be the nearest to our species, supposing, of course, that that species is *not* a Monotis.

Locality.—Collected by Dr. Diener in the Shalshal section, near Rimkin-Paiar, in a light gray limestone which, from its horizon, belongs to the beds indicated by Dr. Diener as the Subrobustus beds succeeding the true Octoceras beds containing *Pseudomonotis Griesbachi.*

As a great number of left valves in different stages of growth (Figs. 16-20), and one right valve (Fig 21), could be got out of the few fragments of rock obtained, the species seem to be very abundant in these beds. Associated with it I only found a second bivalve, the description of which is here subjoined.

Pseudomonotis decidens, nov. sp. Pl. I., Figs. 22—24.

This Pseudomonotis may be regarded as a depauperated, irregularly-formed descendant of the older *Pseudomonotis Griesbachi* described above. Two of the three specimens, all left valves, possess an irregularly formed beak (Figs. 22, 24), which irregularity occurs in differing degrees among them, and in such a manner as to make it difficult to trace it to a distortion produced later in the rocks. More regular specimens (Fig. 23) resemble very closely *Pseudomonotis Griesbachi*, but they remain, however, narrower, and are, on the other hand, more oblique than the form described above as *Pseudomonotis Painkhandana* associated with *Pseudomonotis Griesbachi.*

Locality.—Occurring with *Pseudomonotis* (? *Avicula*) *himaica* already described, in light gray limestone of the Subrobustus beds of the Shalshal section near Rimkin-Paiar.

11.—BRACHIOPODA AND LAMELLIBRANCHIATA FROM THE MIDDLE TRIAS (MUSCHELKALK) OF THE HIMÁLAYAS.

The Muschelkalk has yielded a larger number of species than the lower trias of the Himálayas. It is well known that of late the trias has often been divided only into lower and upper, and the Muschelkalk reckoned to be in the lower. If, however, one starts from the old and original three-fold division of this formation and thus admits the existence of a middle trias, it is natural for the Muschelkalk to stand for the latter. The more so if one gives a considerable upward range to the Alpine Muschelkalk as is now done. It is only in this sense that we here speak of the middle trias.

(*a*). *Brachiopoda and Lamellibranchiata from the principal complex of the Muschelkalk of the Himálayas, including the beds with* Rhynchonella Griesbachi, *m.* (*Rh. semiplecta, Münst., var., according to Griesbach*), *and with* SPIRIFERINA STRACHEYI, Salter.

In this part will be described not only those species which originate in the principal complex of the Muschelkalk of the Himálayas, but especially also those numerous species which have been found in those beds in which brachiopoda predominate. Griesbach has already distinguished them as a special horizon (*Rhynchonella semiplecta*-horizon), at the base of this complex, and Diener has recently assigned them to the horizon of *Sibirites Prahlada*, whose characteristic fossil, however, according to the discoveries yet made, is *Spiriferina Stracheyi*, Salter. The question as to whether the beds with *Rhynchonella Griesbachi* are really exactly of the same age as those containing *Spiriferina Stracheyi* will be discussed later on. The longest known brachiopods of the trias of the Himálayas, already partly described by Salter and Blanford, as well as by Stoliczka, belong, as will be shown, to the beds with *Spiriferina Stracheyi*. They seem to form a persistent, widely-distributed assemblage of species in those deposits.

RHYNCHONELLA GRIESBACHI, Pl. 11., Figs. 1—7.

Rhynchonella semiplecta, Münst., var., according to Griesbach, "Geology of the Central Himálayas," Mem. Geol. Surv. of India, Vol. XXIII., pp. 70, 143.

Rhynchonella Griesbachi, nov, sp. (Bittn.), according to C. Diener, Ergebnisse einer geolog. Expedition in d. Central Himálaya in Denkschr. d. kais. Akad. d. Wissensch. LXII. Wien, 1895, p. 571 (39).

It has already been remarked (by Diener) in the paper above-cited that this "Rhynchonella semiplecta, *var.*" has nothing in common with the St. Cassian species of that name, but that this name refers to a species of the Alpine Muschelkalk which was formerly very often indicated, especially by Stur, as *Rhynchonella semiplecta*, cf. This I have named *Rhynchonella trinodosi* (Abhandl. der k. k. geol. Reichsanst., XIV, p. 13), with which species it certainly has some resemblance, without, however,

being identical with it. As Mr. C. L. Griesbach was the first to refer to this species, I have done myself the pleasure of naming it in honour of him.

Rhynchonella Griesbachi, of which there are nine specimens from the locality, three miles south of Rimkin-Pair, where Griesbach first found it, is rather a variable form. Its test is almost smooth, only provided at the front with slight folds; the large valve projects in front in the shape of a rather broad, well-developed tongue-like lobe without, however, at the same time forming a distinctly marked sinus. Consequently the small valve is also very moderately inflated in the median area. The line of junction of the valves (commissure) at the lobe has from two to four folds; in the shallow sinus of the large valve, however, there are from one to three little folds which here, as well as on the inflated part of the small valve, are very slightly indicated and are very short. They are arranged mostly symmetrically, rarely unsymmetrically, but never, even approximately, so strong as in *Rhynchonella trinodosi*, or so long as in the species from the Olenek delta in Siberia, which is closely related to *Rhynchonella trinodosi*, and is described and figured in Mém. de l'Acad. impér. des Sciences de St. Pétersbourg, VII. Série, Tom. XXXIII, 1888, p. 139, Tab. XX. The Virginian *Rhynchonella Halli*, Gabb (Journ. Acad. Nat. Sci. Philadelphia, IV., 1858-66, p. 308, tab. 48, fig. 29) stands very near to *Rhynchonella trinodosi*.

Besides the little folds on the frontal lobe there are a few similar folds on each side of the shell. The greater number of the specimens possess an almost circular contour, and only a few (e.g. Fig. 5.) prove to be somewhat elongated. A very strong septum, almost attaining half the length of the shell, developes itself in the median line of the small valve, and under the beak of the large valve there are strong dental plates, arranged almost parallel to one another and of considerable length. The septum of the small valve projects far into the interior of the valve (Fig. 7).

The European *Rhynchonella trinodosi* has not nearly such long dental plates in the large valve, and the median septum of the small valve is also in this species much less strongly developed and is shorter and thinner.

Locality of Rhynchonella Griesbachi.—In Bed 121 of the Shalshal section worked out by Griesbach, three miles south of Rimkin-Paiar, in the "Earthy Limestone," which, according to Griesbach, forms the base of the Muschelkalk series. This section of the Shalshal Cliffs, studied by Griesbach, is, according to Dr. C. Diener, l. c., p. 543 (11), not locally identical with the section of the Shalshal Cliffs, which Diener himself, in company with Griesbach, had the opportunity to investigate later. I lay stress upon this, because the brachiopoda, which I obtained from different localities, presumably of the horizon of *Rhynchonella Griesbachi*, can by no means of themselves permit of the conclusion that they belong to one and the same horizon. It seems, moreover, very remarkable that in the material originally collected by Griesbach, besides the more abundant *Rhynchonella Griesbachi*, there occur, but more rarely, only two brachiopods which are entirely wanting in the material collected by Dr. Diener; while on the other hand, the large species of Spiriferina, Spirigera and Terebratula, which predominate in Diener's collection, must be wanting in Griesbech's original locality, as they would surely not have been overlooked by Griesbach, beside the three insignificant species which he had

collected there. The typical form in the brachiopod fauna of his horizon with *Sibirites Prahlada*, exhaustively studied by Diener, which horizon he regards as equivalent to Griesbach's Rhynchonella beds at the base of the Muschelkalk, is by no means *Rhynchonella Griesbachi*, but *Spiriferina Stracheyi*, Salter. On the other hand, *Rhynchonella Griesbachi* has not yet been found to occur in those beds, worked out by Diener, with *Spiriferina Stracheyi*, as it appears, but seems to be represented in them by another and much rarer species. This species will immediately be described under the name of *Rhynchonella Dieneri*.

RHYNCHONELLA DIENERI, nov. sp., Pl. II., Figs. 8, 9.

Only two specimens of it are known; it is considerably broader and shallower than *Rhynchonella Griesbachi*, possesses a more strongly marked sinus in the large, a correspondingly stronger inflation in the small, valve, as well as a higher, that is, more prominent frontal tongue or lobe. The ribbing is, as in *Rhynchonella Griesbachi*, confined to the frontal region, and is similarly indistinctly developed. Both specimens have three small folds in the sinus of the large valve and a few small folds on the contiguous lateral margins. The septum of the small valve appears to be considerably less strongly developed than in *R. Griesbachi*. In its total habit *R. Dieneri* reminds one far more of the true *R. semiplecta* of St. Cassian, and also of *R. productifrons*, m., from the 'marbles' of the Schreyeralm (Muschelkalk), than of *R. Griesbachi*. *R. productifrons* is however provided with numerous little folds on the lateral margin; while *R. projectifrons*, m., from the Schreyeralm, is almost completely smooth. *R. semiplecta*, Münst., of the St. Cassian beds, possesses a narrower frontal lobe in proportion to its total breadth, which lobe is, moreover, generally quite, or almost quite without folds. Still more widely different is the small St. Cassian *R. semicostata*, Münst., especially in its more strong projecting large valve, which is provided with a very slightly developed sinus.

Locality.—Two specimens collected by Diener on the 27th August, 1892, in the section of the Shalshal Cliffs, near Rimkin-Paiar, in the horizon with *Spiriferina Stracheyi*.

Added to these two species of Rhynchonella described above there is yet a third form which is represented only by one specimen, namely,

RHYNCHONELLA CF. TRINODOSI, Bittn., Pl. II., Fig. 10.

Rhynchonella cf. *trinodosi*, according to Diener, l. c., p. 571 (39).

This specimen is so closely related to the Alpine *R. trinodosi* that I would not on this ground separate it from that species. The specimen reaches a size which it only rarely does in the Alpine species; its frontal lobe is proportionally broad and has two folds, which is only exceptionally the case with *Rhynchonella trinodosi* (cf. Abhandl. der k. k. geol. Reichsanst., XIV., tab. XXXII., Figs. 22, 29). The large valve is remarkably strongly inflated, especially in the region of the beak; the septum of the small valve is thin and moderately long. This form could best be united with *R. trinodosi*, var. *latelinguata* from Wengen in South Tyrol (l. c., Fig. 29) which I have differentiated. It comes, in any case, much nearer to the species

of the Alpine Muschelkalk just mentioned than to the two Asiatic species already described.

Locality.—South-east of Muth in Spiti, collected by Griesbach. A single loose specimen obtained from a dark coloured limestone.

Very closely related to the Rhynchonella just mentioned is the form already described by F. Stoliczka.

RHYNCHONELLA MUTABILIS, Stol., Pl. II., Figs. 11, 12, 13.

Rhynchonella mutabilis., Stol., Mem. Geol. Survey of India, Vol. V., p. 40, pl. III., Figs. 5—9.

The dimensions of this species exceed those of the form just mentioned as *Rhynchonella* cf. *trinodosi* so greatly that young forms of *Rhynchonella mutabilis* of the same size as the specimen from Muth, must have been still more completely smooth, that is, without ribs. For the rest, both are so closely related to each other that the specimen from Muth, indicated as *R.* cf. *trinodosi*, could as well be regarded as a small collateral form of *R. mutabilis*, or *Rhynchonella mutabilis* as a gigantic form of the Alpine *R. trinodosi.* It resembles in particular those forms of *Rhynchonella trinodosi* which, having a high frontal lobe, possess two folds in the sinus of the large valve, and therefore a frontal lobe with three folds, as for instance, the specimen which I have figured (l.c., tab. XXXII, Fig. 28). For the greater number of the specimens before me of *R. mutabilis*, that is five out of seven, possess two folds in the sinus, which in *R. trinodosi* occurs only exceptionally and may therefore point to a more intimate connection between the isolated form from Muth and *R. mutabilis*, than between the former and *R. trinodosi.* The folds in *R. mutabilis* are rather long and high, and sharp-edged at the line of junction of the valves; the septum and dental-plate are inconspicuous and not nearly so strongly developed as in *R. Griesbachi.*

Stoliczka compares his *R. mutabilis* with *R. semiplecta* from St. Cassian, which it, however, only very slightly resembles. From the liassic *R. variabilis*, Schloth., and related forms (as *e.g.*, *R. austriaca*, Suess) it is distinguished by the fact that its ribs do not begin at the beak; and from all triassic species grouped round *R. trinodosi*, m., by its much greater size. Gabb's *Rhynchonella lingulata* from the trias of California is perhaps closely related to it.

Locality.—According to Stoliczka in the lower (?) trias of Lilang on the Lingti River in Spiti. The rock from which the specimens are derived is a dark limestone. Whether the geological horizon of the species under description is the same as that from which the fauna likewise occurring at Lilang, with *Spiriferina Stracheyi* comes, must be left undecided for the present.

A number of other species of Rhynchonella, which will now be described, belong to types different from those already dealt with.

RHYNCHONELLA (?) SALTERIANA, Stol., Pl. II, Figs. 14, 15.

Rhynchonella Salteriana, Stoliczka, in Mem. Geol. Survey of India, Vol. V., p. 41, pl. III., Fig. 11 (*See* Fig. 12).

Under this name Stoliczka unites two forms, one of which, Fig. 12, comes from a light-coloured limestone of uncertain age, of the Austrian Salzkammergut (neigh-

bourhood of Ichl, Hallstatt and Aussee). As it differs widely from the original *Rhynchonella Salteriana*, represented by Fig. 11, it is not necessary to bestow any further attention upon it.

Of *Rhynchonella Salteriana*, Stol., I have, besides Stoliczka's original, Fig. 11, a second specimen which was collected by Dr. Diener in the Shalshal section, near Rimkin-Paiar. Both specimens agree specifically on all points, and prove that one is dealing with a well characterised species, which is very well described by Stoliczka but very inadequately figured.

Rhynchonella Salteriana is a form with an oval outline, with close ribbing, proceeding from the beak. The median part of the frontal area is a little raised, corresponding to a low but distinct median lobe of the small valve. In this median lobe there are seven ribs; six, therefore, of them belong to the median part of the large valve, which scarcely possesses even the indication of a sinus. In one of the two specimens, one of the two outermost of these middle ribs is doubled, and this duplication agrees in position with a fine intercalated rib in the corresponding furrow of the large valve. Each of the lateral areas of the shell possesses from five to six ribs, which gradually become weaker. The ribs are bluntly rounded. The frontal area is thick, the lateral margins appear flattened, or even somewhat hollowed out and also smooth. The beak of the small valve is broad, flat, and medianly somewhat sunk-in; the beak of the large valve is strongly incurved, and so closely pressed against the beak of the small valve that no kind of opening can be observed in it. Stoliczka's drawing, Fig. 11, is here completed according to its analogy with Fig. 12, an undoubted Rhynchonella, wrongly considered identical, and also the description (p. 41) of this beak is taken from that Rhynchonella, and not from the original of Fig. 11. The latter indeed possesses a beak closely pressed against that of the small valve, one side of which shows a dental plate, exposed by weathering. The second specimen of this species has a perfectly-preserved beak, whose form strongly recalls that of the beak of the palæozoic genera of Rhynchonellidæ, Rhynchotrema, Hall, and Anastrophia, Hall. Unfortunately with the slender material representing this Asiatic species hitherto available it has been impossible to learn anything respecting its internal structure. The shell appears to be fibrous, but I cannot make out that it is punctate.

There is no species known in the Alpine trias which could be compared with *Rhynchonella Salteriana* even in the slightest degree. The form is quite isolated among all the brachiopoda of the trias. It does not appear to me perfectly clear that it is necessarily a Rhynchonella or even a Rhynchonellid, and I cannot help thinking that it may be a 'spire-bearer.' A certain resemblance which it bears to *Spirigera* (?) *Nœtlingii*, nov. sp., to be dealt with later in the Appendix, strengthens me in this suspicion. I have therefore put a query to the generic name of *Rhynchonella Salteriana*.

Locality.—Stoliczka's original comes from Lilang on the Lingti river in Spiti; the second specimen was collected by Diener in the upper Muschelkalk near Rimkin-Paiar. The species, though rare, seems thus to be widely distributed.

Remarks.—*Rhynchonella Salteriana*, Stol., cited by Griesbach in his "Geology

of the Central Himálayas," Mem. G. S. I., Vol. XXIII., p. 143, as occurring associated with *Rhynchonella semiplecta*, var. (*R. Griesbachi*, m.), does not belong to this species, but is a new Retzia, which will be described later on as *Retzia himaica*, m.

Rhynchonella Theobaldiana, Stol., Pl. V., Fig. 15.

Rhynchonella Theobaldiana, Stoliczka, l. c., p. 41, Pl. III., Fig. 10.

This species, which is represented only by the specimen described by Stoliczka, is in more than one respect doubtful; and it is even a question as to which horizon it comes from.

The specimen is greatly distorted and crushed. The large valve is pushed into the small one near the frontal area, so that a deep sinus with acute lateral margin results, which certainly was not there originally, as the fissures in the shell on each side show. The median part of the small valve is also pushed in near the frontal area, showing here a kind of irregular folding. The beak is medianly cleft, and possesses thick lateral parts, beside a narrow thin-shelled median area at the back. Were the specimen not so compressed, and were it not from its shape a Rhynchonella-beak, one would be inclined to regard the specimen as a greatly crushed form of *Spirigera Stoliczkai*; but on a closer comparison, it does not seem to belong to it, but to be actually a smooth Rhynchonella, whose natural outline one might imagine to have been considerably wider than the compressed specimen shows. A circumstance which argues very strongly in favour of its Rhynchonella nature is the following. Between the median part of the small valve, that is, the broad frontal lobe, and the sides of this valve, runs on each side a sigmoidal furrow-like depression, which is scarcely developed in this manner in smooth species of Spirigera, but is generally present in Rhynchonella. The specimen would have been better left undescribed, but as the name exists, it must, for the present at least, be retained. Perhaps bettter specimens may be found one day, and also information obtained at the same time as to the stratigraphical horizon to which this form belongs.

Locality.—Found, according to Stoliczka, at Muth, in the Pin Valley, in Spiti.

Rhynchonella (Norella) Kingi, nov. sp., Pl. II., Fig. 16.

A Norella, *N. procreatrix*, has already been described above (p. 9) from the Otoceras beds of the lower trias. In the horizon of *Rhynchonella Griesbachi*, m., at the base of the Muschelkalk of the Himálayas, a Norella was also found. Judging from the only specimen as yet known, the species is more elongated, narrower, and at the same time thicker, that is, more inflated than *Norella procreatrix*; the sinus of the small valve begins nearer to the beak; for the rest it is very near to that older species, and has, like it, a small number of faint folds at the frontal margin. In the present specimen there are eight or nine of such folds (three of which belong to the frontal sinus), not taking into account the scarcely perceptible sinuosities of the lateral margins further outside. The beak

is small and pointed, its edges rather sharp; the lines of junction of the valves are blunt, the front is thick. The shell is distinctly coarsely fibrous. Among the species of Norella of the Alpine trias there is scarcely one species that is particularly closely related to *N. Kingi*. *R. Rosaliæ*, Salomon, from the Marmolata might be taken as the most closely related form; it possesses, however, no lateral folds, but a deeper sinus.

Salter and Blanford in their Palæontology of Niti (Pl. IX, Fig. II) figure a species as *Rhynchonella retrocita*, Suess, which bears a certain resemblance to *Norella Kingi*, but should, according to the illustration, possess much finer and closer marginal folds. Stoliczka has already pointed out that this Niti species cannot be the Alpine *R. retrocita*, Suess, which moreover has since (Abhandl. d. geol. Reichanst., XIV., p. 208) been recognised as a Terebratulid, and has obtained the generic name of Nucleatula.

Locality.—Associated with the more abundant *Rhynchonella Griesbachi*, m., at the base of the Muschelkalk, in the section of the Shalshal Cliffs, three miles south of Rimkin-Paiar, investigated by Griesbach. A single specimen collected by him.

SPIRIFERINA STRACHEYI, Salter, Pl. IV., Figs. 3—14.

Spirifer Stracheyi, Salter, Palæontology of Niti, p. 72, pl. IX., Fig. 13.
Spiriferina Stracheyi, Salter, according to Stoliczka, l. c., p. 38.

Salter was the first to mention this species as coming from the Niti Pass (Rajhoti Pass, according to Stoliczka); Stoliczka himself having known it from Lilang in Spiti. Diener brought home numerous specimens of it from Rimkin-Paiar, where it appears to be one of the most abundant forms in certain deposits of the Muschelkalk of the Shalshal Cliffs section; in any case it is the most remarkable brachiopod of that horizon, which Diener has indicated as the horizon of *Sibirites Prahlada*. Besides these forms from Rimkin-Paiar, I have also before me specimens from Lilang mentioned by Stoliczka, in addition to two specimens from Rajhoti, the first locality of this species, so that an exact comparison and a trustworthy identification of all these discoveries is practicable. *Spiriferina Stracheyi* is rather closely related to the well-known *Spiriferina fragilis* of the European Muschelkalk; in larger forms, however, it acquires a very extraordinary appearance for a mesozoic Spiriferina by the extension of the angles of the hinge-line into wing-like points, which recalls very vividly many palæozoic types of the so-called winged Spiriferidæ. This peculiarity was pointed out by the first describer of the species. The younger specimens of *Spiriferina Stracheyi* (cf. Pl. IV, Figs. 3, 12) already possess a wide hinge-line with very broad and rather high area, so that the greatest breadth of the shell in them occurs already in the hinge-line. Beginning with a certain size a further very pronounced growth in breadth results, whereby the hinge-line is drawn out into pointed wings. At first sight these specimens with the extraordinarily pointed wings might be regarded as a distinct species which also finds expression in my previous observations upon Diener's work (l. c., p. 571 (39)),

mentioned in the introduction. More minute examination, however, shows that one has to deal here only with one form, which also agrees with Stoliczka's view, l. c., p. 38. The great variability of forms in the Spiriferidæ is a well-known fact, and for illustration of this one may compare, among others, the work of Gosselet which has recently appeared, *viz.* Étude sur les variations du *Spirifer Verneuili* (Mém. de la Soc. Géol. du Nord, tom. IV., I. Lille, 1894). The median line of the valves in *Spiriferina Stracheyi* is occupied either by a rapidly widening sinus, or a lobe, which is undivided; on each side of it follow in younger forms five to six ribs, which, as growth proceeds, have some less distinct ribs added to them towards the outer side. The wing-like extensions of the sides remain always quite indistinctly ribbed; sometimes distinct folds are seen at their outer margins. The semi-circular lateral margin of the younger specimens is modified in the older forms by the development of the wings in a corresponding manner, and acquires with the full development of the points of the wings (Fig. 9) a slight emargination beneath them. The ribbing as a whole is feebly developed. The test, especially near the beak, is considerably thickened, and in the manner characteristic of the Spiriferidæ marked wart-like throughout. The striation of growth is in general weakly developed, and irregular; though in some larger specimens it becomes stronger and closer towards the frontal margin.

The hinge-area of the species is very wide and also of considerable height, almost level, and horizontally striated; the beak only moderately incurved. The inner structure of the beak is tripartite, but in such wise that at the incurved point the three septa are completely fused together by a callosity of the shell (Figs. 6, 7, 13) and only a little farther down do they become free and separated from one another (Figs. 4, 5). The dental plates as well as the median septum reach very far on the outer side of the beak (Fig. 11), and the median septum projects internally up to the middle of the shell (Fig. 8). However similar the younger forms of this species may be to the European Muschelkalk form, *Spiriferina fragilis*, Schloth., sp., the Asiatic species differs so considerably in adult forms from the Alpine species just named, and from all related to it, that a closer comparison of their characters seems to be superfluous. But the younger specimens of *Spiriferina Stracheyi* are also recognizable by their wide hinge-line, and especially by the remarkably quick widening of the median area of the valves. But that, with regard to this feature, forms having a greater similarity occur in the Muschelkalk of the Alps, the species, *viz. Spiriferina fragilis*, Schloth., var. *latesinuata*, Phil., and *Spiriferina Possarti*, Phil., recently made known by Dr. E. Philippi (Zeitschr. d. Deutsch, geol. Gesell. 1895) show. Forms, similar to the adult ones of *Speriferina Stracheyi* have, however, as yet never been found in European triassic deposits, and even the best developed specimens of *Spiriferina fragilis* from the German Muschelkalk never possess, to my knowledge, such strikingly wing-like extensions of the hinge-line as those of *Spiriferina Stracheyi*, which give to this species the habit that so vividly recalls the palæozoic Spiriferidæ. As an example, the great resemblance to *Spiriferina octoplicata*, Sow., according to Davidson, in Quart. Journ. XVIII., 1862, Pl. I, Fig. 13 (likewise an Indian form) may be

pointed out; also *Spiriferina alata*, Schloth., sp. from the permian deposits (fide King) is extremely like *Spiriferina Stracheyi*.

Moreover, we shall see that other forms, still more closely related to *Spiriferina fragilis*, are also not foreign to the Muschelkalk of the Himálayas, and these will be compared further on under *Spiriferina lilangensis*, Stol. Stoliczka himself refers to *Spiriferina* cf. *fragilis*, Schloth., from Muth in the Pin Valley. The specimen in question is however, an undeterminable fragment of a form with more numerous ribs than *Spiriferina fragilis* ever possesses.

Locality of Spiriferina Stracheyi.—The original locality of this species is, according to Salter and Blanford, the Niti Pass, which, according to Stoliczka, would be equivalent to the Rajhoti Pass. Stoliczka himself records the species from Lilang on the Lingti river, in Spiti. A greater number was collected by Diener in the Shalshal section, near Rimkin-Paiar, in those beds which Diener designates as the horizon of *Sibirites Prahlada*, which, however, might more suitably be called the horizon of *Spiriferina Stracheyi* in reference to their typical and most widely distributed form.

For the illustration of this species given on Plate IV., specimens from all the three localities were chosen.

Spiriferina lilangensis, Stol., Pl. IV., Fig. 2.

Spirifer (*Spiriferina*) *Lilangensis*, Stoliczka, l.c., p. 38, Pl. III, Fig 4.

Stoliczka's original specimen is before me; it comes from Lilang in Spiti. It is easily and markedly distinguished from the younger, narrower forms of *Spiriferina Stracheyi*, Salter, described above, by its much narrower hinge-line, which does not coincide with the greatest breadth of the shell but falls short of it, occupying about two-thirds of it; further by a narrower and shallower sinus, and consequently by a less elevated median lobe, as well as by a somewhat larger number of lateral ribs (7-8). The hinge-area is in proportion to its lesser breadth tolerably high, the beak slightly incurved, internally probably tripartite, and very likely, as in *S. Stracheyi*, filled with a callosity of the shell at its extremity. The surface of the shell is comparatively coarse-grained. *Spiriferina lilangensis* is distinguished from the Alpine forms of *Spiriferina fragilis*, to which it is otherwise remarkably similar, by the conspicuous coarse graining. Besides which its hinge-area is perhaps still narrower than that of *Spiriferina fragilis* generally is, and its ribbing appears to be somewhat more crowded; it might therefore be advisable to retain also this form under the name given to it by Stoliczka. Stoliczka himself compares it, on the ground of its shape, with the Rhætic *Spiriferina Emmrichii*, Suess, to which it bears, however, only a very remote resemblance, as the absence of ribs in its sinus shows.

Locality.—According to Stoliczka, near Lilang, on the Lingti River, Spiti.

Remarks.—*Spiriferina lilangensis*, Stol., var., referred to by Griesbach in his "Geology of the Central Himálayas," p. 143, from Bed 3 of his upper trias of the

Shalshal section, is not identical with this species. This species will be described below as *Spiriferina shalshalensis*, nov. sp.

Spiriferina (Mentzelia) Kœveskalliensis, (Suess) Boeckh, Pl. IV., Figs. 15, 16.

Spiriferina Kœveskalliensis, Suess, Stur, Verhandl. der k. k. Reichsanst., 1865, p. 245 *et seq.*
Spirifer Spitiensis, Stoliczka. Mém. Geol. Surv. of India, Vol. V, 1866, p. 39, Pl. III, Fig. 5.
Spiriferina Kœveskalliensis, Suess. Boeckh. Geol. Verhältn. d. südlichen Bakony, 1873, p. 175, Pl. XI, Figs. 22, 23 (first illustrations of *Spiriferina Kœveskalliensis*, Suess).
Spiriferina (Mentzelia) Kœveskalliensis (Suess) Boeckh. Bittner, Brachiop. d. alp. Trias, 1890, p. 26, Pl. 34, Figs. 29—34.
Spiriferina (Mentzelia) cf. *Spitiensis*, Stol., sp. W. Salomon "Marmolata," 1895, p. 87, Pl. II., Figs. 7—15.
Spiriferina (Mentzelia) Kœveskalliensis (Suess). E. Philippi "Grignagebirge," Zeitschr. d. Deutsch. geol. Gesell., 1896, p. 720 (including the var. *Spitiensis*, Stol.)

With reference to the two species, namely, *Spiriferina (Mentzelia) Kœveskalliensis* and *Spiriferina (Mentzelia Spitiensis*, there is no complete agreement as to their relationship, as may be judged by the above citations. The Himálayan species was based by Stoliczka principally upon a specimen which is distinguished by a beak remarkably thick, and strongly incurved; it partly projecting over and covering the narrow low and inconspicuous hinge-area. This specimen is represented in Fig. 16. Stoliczka himself remarks that he knew a second specimen from the same locality, whose hinge-area is more distinctly developed and whose beak is less strongly bent over than in his original specimen. The latter is indeed remarkable for the extraordinary development of its beak. The foregoing is also proved by the fact that there are two more specimens from the Himálayas before me which in this respect are not essentially distinguishable from the European *Mentzelia Kœveskalliensis*, a species very widely distributed in the Alpine Muschelkalk deposits, using this term in its widest sense. One of these specimens (figured on Pl. IV., Fig. 15) possesses just the flat, somewhat contracted shape of *Mentzelia Kœveskalliensis*, var. *microrhyncha*, from the Muschelkalk of Wengen in South Tyrol, figured in Brach. d. alp. Trias, Tab. 34, Fig. 34; only there is a somewhat greater thickening of the beak than in the Wengen specimen, which produces an approximation towards Stoliczka's original. Finally, the second specimen (fragment of the large valve) possesses a much higher and flatter hinge-area, just like that of the common European *Mentzelia Kœveskalliensis*, and can therefore in no way be separated from it specifically. It seems therefore to me most advisable to regard *S. Spitiensis* merely as a sub-species, or variety of *S. Kœveskalliensis*, in accordance with Philippi's views in his paper cited above. This would then represent among the finely ribbed species of Mentzelia pretty nearly the same type as is illustrated by forms such as var. *acrorhyncha*, or var. *judicarica* among the many shaped varieties of the smooth *Mentzelia Mentzelii* (cf. Brach. d. alp. Trias, Tab. 34, Figs. 20, 26).

Locality.—The species is now known by four specimens from the Muschelkalk of the Himálayas at the following places, *viz.*, the original specimen of Stoliczka's *S. Spitiensis* at Lilang on the Lingti River, in Spiti; Dr. Diener brought a similar specimen, which however, is almost entirely a cast, from the "Upper" Muschelkalk of Rimkin-Paiar; and Mr. C. L. Griesbach, the Director of the Geological

Survey of India, collected a specimen on the western slope of the Silakank Pass from the lower trias, Bed 122, that is, from the Ammonite Division of the Muschelkalk. It is somewhat crushed, but otherwise, especially in its outline, well preserved; and lastly, another specimen, that is, a fragment of a large valve, was found by Dr. Diener in the Bambanag section, in the beds lying between the Otoceras beds (evidently in the wider sense) and the Muschelkalk. This, as mentioned above, is nearest to the more abundant form of the European *M. Kæveskalliensis.*

Remarks.—Stoliczka raises the question (l. c., p. 39) as to the relation which Salter's *Spirifer Oldhami* bears to *S. Spitiensis.* Among the specimens which I have examined there is none which could be compared with this remarkably thick form, which according to Salter's description may rather belong to the smooth-shelled species.

RETZIA HIMAICA, nov. sp., Pl. IV., Figs. 17, 18.

From the same horizon (Bed 121) from which the above-described *Rhynchonella Griesbachi* comes, I have before me three specimens of a beautiful ribbed brachiopod, which doubtless belongs in its wider original sense to the genus Retzia. These specimens were also collected by Griesbach. They possess only a superficial resemblance to *Rhynchonella Salteriana,* Stol., under which designation they were formerly referred to. This name is, however, already marked with a query on the original label.

The outline of *Retzia himaica* is broad oval, or, almost elliptical, completely rounded; the beak is slightly incurved, and possesses a terminal opening beneath which a very low, but rather broad, Retzia-like area can be made out with tolerable distinctness. The hinge-line of the small valve is provided with little ears on both sides of the inconspicuous beak; they are, however, only slightly marked out from the rest of the surface of the shell. About ten or eleven ribs (and of these 9 to 10 being on the small valve) traverse the surface of the shell. Among these there is *no* median rib in the small valve specially marked, either by being elevated or depressed in contrast to the lateral ribs, as is distinctly the case, one way or the other, in most of the species of Retzia of the Alpine trias. The shell itself is distinctly punctate. A slight polishing of one of the specimens sufficed to prove the existence of spiral cones which are very loosely coiled and consist of at most 4 to 5 whorls.

Though the structure of the beak and the region of the area in this species combined with a punctate shell and spiral cones, prove to be quite sufficient to place this form in the genus Retzia in its widest sense, yet it differs by reason of the slight development of its area and the hardly marked median rib of the small valve so greatly from all known species of Retzia of the Alpine trias (putting aside *Retzia pachygaster,* Laube, which represents quite a divergent type) that the question may arise whether it would not be better to place it in one of the related genera of the Retzia group. So long, however, as its internal structure is incompletely known, this cannot be decided even with an approach to certainty. It is

not even yet settled whether the species of Retzia of the Alpine trias can remain in this genus in the narrower sense. We shall moreover see later on that such Alpine forms of Retzia are also richly represented in the upper trias of the Himálayas.

Locality.—Three specimens from "Bed 121 of the Lower Trias," three miles south of Rimkin-Paiar, associated with the more abundant *Rhynchonella Griesbachi*, m., collected by Griesbach. As a third species which has been hitherto known in this small fauna of the "Lower Muschelkalk", the more rare *Rhynchonella* (*Norella*) *Kingi* was mentioned above.

SPIRIGERA (ATHYRIS, auct.) STOLICZKAI, nov. sp., Pl. III. Figs. 1—17.

Athyris (*Spirigera*) *Strohmayeri* (Suess), Salter and Blanford: Palæontology of Niti, p. 70, Pl. 9, Fig. 10.
Athyris Strohmayeri (Suess), Stoliczka, l.c., p. 43.
Spirigera, nov. sp., Diener, l.c., p. 39.

The Spirigera from the trias of the Himálayas here to be discussed is not in the remotest degree identical with *Spirigera Strohmayeri* of the Noric Hallstatt Limestone, though it may be so outwardly in individual specimens (cf. Brach. d. Alpinen Trias, Tab. XV., Figs. 9—25). Both species belong even to quite distinct subgenera of Spirigera; *Spirigera Strohmayeri* is a diplospire form, while *S. Stoliczkai* belongs to the haplospire species of Spirigera.

The variability of this species is also very considerable; there are broader and narrower, thicker and flatter forms of it. The development of the sinus and the corresponding lobe also vary to a great extent. Young forms (e.g., Fig. 1.) in which the sinus is wanting have an appearance as if there were no definite characters marking them; in older specimens the breadth and depth of the developing sinus correspond mostly with the breadth and thickness of the individual, so that broader and flatter forms (e.g., Figs. 4, 6, 10, 13) generally possess a broader and flatter sinus with a correspondingly less prominent lobe, the narrower and thicker specimens (Figs. 5, 11, 14) having, on the other hand, a narrower sinus and a more strongly elevated lobe.

The greater number of the specimens under description are in the condition of casts in which the shell is preserved only at the beaks (Figs. 2, 3, 13). Only exceptionally is there a specimen with completely preserved shell (e.g., Fig. 7), which possesses tolerably regular, fine striæ of growth upon its intact surface. The substance of the shell itself is fibrous, but shows only here and there in a very incomplete manner that convergence of the fibres in the median line which is peculiar to most of the triassic species of Spirigera. The shell is strongly thickened in the umbonal region, especially at the sides, while the median part, particularly that of the large valve, does not possess this thickenin . A kind of incomplete median septal thickening (Figs. 2, 15) which, however, does not seem to be constantly present, shows itself sometimes on the small valve; but here also the sides of the beak are always provided with very strong, firmly attached shell (Figs. 2, 3). At the beak of the large valve the median area between the

strongly developed dental plates has always a thin shell in striking contrast to the very massive shell of both lateral areas outside the dental plates. This structure is very conspicuous in cross sections (*vide* Figs. 8, 9, 15). These thick-shelled lateral parts of the beak sometimes break off (Fig. 11); and they have in some specimens special cavities (Fig. 9). The structure of the beak here referred to is in itself sufficient to distinguish this species very strikingly from the Hallstatt one, *viz.*, *Spirigera Strohmayeri*, Suess, with its enormously thickened beak, whose greatest thickness of shell lies in the median line (type of the sub-genus Pexidella, m.—Brach. d. Alpinen Trias, p. 244, Tab. XV. Figs. 22, 23, 24). The Hallstatt species has also no dental plates in the beak, which again are very strongly developed in *Spirigera Stoliczkai*, and fuse at the point of the beak with its lateral walls (Fig. 8). These extend rather far down at the outer side of the beak (Fig. 11) as in Dielasma among the Terebratulidæ, which is noteworthy, because a typical Dielasma species occurs very frequently associated with *S. Stoliczkai*, viz., *Dielasma himálayanum*, n. sp., to be described later on. The cardinal process of the small valve is very strong and is hollowed out from the interior of the valve (Figs. 9, 16). The spiral cones consist of a very large number of whorls; that is, there may be ten or even more of them; they are haplospire; a weathered specimen (Fig. 17) shows very distinctly close to the first whorl of the principal lamella the accessory lamella which accompanies the former for a short distance. Muscular and vascular impressions are sometimes also noticeable in well-preserved casts; they are richly branched in the direction of the front of the shell and produce an indistinct striation on the cast (Fig. 10). *Spirigera Stoliczkai* distinctly differs from all known triassic species. The differences between it and the Alpine species, *viz.*, *S. Strohmayeri*, Suess, formerly regarded as identical with it, have just been specially pointed out.

Locality.—One of the most abundant species in the horizon in which *Spiriferina Stracheyi*, Salter, is found and with which it occurs everywhere in association. It is recorded from Rimkin-Paiar where it was collected by Diener in two different places at the Shalshal Cliffs. From Lilang on the Lingti River in Spiti, from whence come the specimens mentioned by Stoliczka, and according to him this species also comes from other places in Spiti, that is, Dranghar, Kuling, Khar, and so on.

The specimens found by Strachey at the Rajhoti Pass, in Niti, recorded by Salter as *Spirigera Strohmayeri*, Suess, would, in harmony with Stoliczka's views, also be identical with the form here newly described as *S. Stoliczkai*, for Stoliczka himself unites that species with his *S. Strohmayeri*, from Lilang. This is also probable for the reason that the rest of the brachiopods assigned to this fauna occur also at Rajhoti. Salter's illustration ("Palæontology of Niti," Fig. 10) agrees very well with the smaller specimens (Figs. 5, 12, 14) of our *Spirigera Stoliczkai* here figured.

Both Salter and Stoliczka record *Spirigera Deslongchampsi*, Suess, a second species from the Noric Hallstatt Limestone, from the same localities in which *Spirigera Stoliczkai* occurs. *Spirigera Deslongchampsi* is also figured by Salter

(Fig. 8); but this illustration is by no means sufficient to establish the occurrence of the species here mentioned. Stoliczka records a single specimen of *Spirigera Deslongchampsi* from Lilang, in Spiti, which shows the spirals on one side weathered out. I can scarcely doubt that he had in his mind the specimen figured on Pl. III, Fig. 17, which I assign with full certainty to *Spirigera Stoliczkai*. The occurrence of a form indentical with, or even closely related to, *Spirigera Deslongchampsi* in the horizon of *Spiriferina Stracheyi* is therefore not to be regarded as in any way proved. It may, however, be pointed out that *S. Stoliczkai* stands, as a haplospire species, considerably nearer to *Spirigera Deslongchampsi*, which is probably also haplospire, than to the widely differing diplospire *Pexidella Strohmayeri* in which most of the specimens were formerly placed. It is of course to be expected that in course of time other species of Spirigera will be found in the middle trias of the Himálayas, as has been the case with the Alps. From Lara in Spiti there comes already a much compressed form of a Spirigera which may possibly have belonged to another species. The complete absence of the type of the ribbed *Spirigera trigonella*, so generally distributed in the European Muschelkalk deposits is very remarkable.

Terebratula (Dielasma) Himalayana, nov. sp., Pl. V., Figs. 1—8, 10, 11.

Waldheimia Stoppanii, Suess, Salter and Blanford, Palæontology of Niti, p. 71, Pl. IX., Figs. 6, 7.
Waldheimia Stoppanii, Suess, Stoliczka, l.c., p. 44.

In the Muschelkalk with *Spiriferina Stracheyi* there occurs, besides this typical form and in addition to *Spirigera Stoliczkai* described above, a third abundant species, a Terebratulid which has hitherto been assigned to *Waldheimia Stoppanii*, Suess, although it is not in any special degree externally like this species of the Lombardic-Esino Limestone. Also in the internal structure, at least in that of the hinge and umbonal region, the two forms differ considerably from each other, as already proved by the absence of dental plates in the Esino species, which in this respect connects it with *Cœnothyris vulgaris* of the Muschelkalk, while the Himálayan species shows by its particularly strongly developed dental plates that it belongs to Dielasma. A simple comparison of the "cardinal" sections of both species based upon the figures, Pl. V., Figs. 3, 8 (of *Dielasma Himalayanum*) and Pl. V., Fig. 9 (of *Cœnothyris vulgaris*, from an Alpine locality) makes the great differences between the two groups in this respect apparent. The cardinal section of *Waldheimia Stoppanii*, Suess, from Esino, agrees perfectly with that of *Cœnothyris vulgaris*, as I had an opportunity of convincing myself by means of specimens in the Kaiserlichen Hofmuseum in Vienna. The assignment of the species from Esino to *Cœnothyris*, which was hitherto by no means assured, might now be the most suitable, considering the relationship of the two species.

Externally also the two species, *Dielasma Himalayanum* and *Cœnothyris Stoppanii*, are very different. Even the largest forms of *Dielasma Himalayanum* hitherto known, such as those represented on Pl. V., Figs. 6, 7, 11, possess only a slightly elevated frontal lobe, whose median area is scarcely ever bordered by

strongly marked slopes, or, on the large valve, even by distinct sinuses. In contrast to this, even much smaller specimens of *Cœnothyris Stoppanii*, Suess, sp. from Esino sow a sharply marked lateral bordering of the elevated frontal area, which mostly goes so far that this median area is put into relief by two parallel hollows bordering it. The illustrations in Stoppani's Petrifications d'Esino, Pl. 23, show this very well. The strongly diverging dental plates running down on the outer side of the beak in the species from the Himálayas show a further striking and differentiating character when compared with the Terebratula from Esino. The indentification of these species with each other cannot therefore be thought of.

Dielasma Himalayanum, however, is essentially distinguished from the Muschelkalk precursor of the Esino species, the well-known *Cœnothyris vulgaris*, although it resembles this species externally more closely than it does the species from Esino. Cœnothyris is also wanting, as is known, in the dental plates extending to the wall of the beak, which are so strongly developed in *Dielasma Himalayanum*. There is, however, a form generally united as a variety with *Terebratula vulgaris*, viz., *Terebratula Ecki*, Frantzen (in the German Wellenkalk), which, as I have already shown in Abhandl. der geol. Reichsanst., Band XIV., p. 5, possesses dental plates in the beak; and as it could be assigned to Dielasma on this ground, it must be employed as an object for comparison with *Dielasma Himalayanum*. Through the kindness of Prof. Eb. Fraas in Stuttgart our collection acquired a number of specimens of the south German species, *Terebratula Ecki*, from the Lower Wellendolomit from Rohrdorf, near Nagold. Some of these specimens were cut across and the cardinal sections show, in accordance with the observation, previously published, that this form closely resembles *Cœnothyris vulgaris*, especially in the junction of the dental groove supports of the umbo of the small valve, and that the dental plates in the beak, in spite of their penetrating the outer wall, are nevertheless very thin and short. In this respect also *Terebratula Ecki* is very closely related to *Cœnothyris vulgaris*, and the question may be raised whether it would not be better to put it in Cœnothyris, if one should be inclined to attribute a higher systematic value to the distinction between Cœnothyris and Dielasma. In the opinion of W. Waagen, Cœnothyris is essentially a mere variation of Dielasma, with dental plates becoming rudimentary with age; while Douvillé regards the septum of the small valve as the decisive feature, a feature which, however, considering H. Zugmayer's researches on *Terebratula gregaria*, ought not to be over-rated. At the best *Cœnothyris* might represent a small triassic collateral branch of the older type of Dielasma in which, while a quick reduction of the dental plates occurs, the septal structure of the small valve is preserved unchanged. Forms like *Terebratula Ecki* thus offer some difficulty, but they are perhaps still best united with Cœnothyris. One might then perhaps be justified in recognizing in the Rhætic forms *Terebratula gregaria*, and *T. pyriformis*, Suess (*Rhætina*, subgen. Waagen), as represented in Cœnothyris .

Terebratula Himalayana varies externally within certain limits. There are broader and narrower forms, and also the breadth of the frontal lobe somewhat

varies. The shell is smooth with only indistinct fine and close concentric striations sometimes provided on the sides with very weak and irregular radial ribbing, which is here and there seen even on the casts. The shell structure is punctate.

The median septum of the small valve and the very strong and long dental plates at the outer side of the beak are quite perceptible on the cast; the rest of the impressions and elevations on the cast are of a very variable nature, and are differently developed in the different specimens. The side parts of the beak beside the dental-plate lamellæ easily break off.

Terebratula Himalayana strikingly recalls certain permian species, which also belong to the group Dielasma, as, for instance, *Epithyris elongata*, Schloth.

Locality.—In the horizons with *Spiriferina Stracheyi*, and *Spirigera Stoliczkai*, collected by Dr. Diener at Rimkin-Paiar at two different places. A specimen which was found on the 27th August, 1892, at Rimkin-Paiar, is recorded as coming from the "Upper Muschelkalk"; it cannot be separated from the other forms of this species (Fig. 7); the horizon containing *Spiriferina Stracheyi* is known to be regarded by Diener as "Lower Muschelkalk."

Not rare at Lilang on the Lingti River in Spiti.

Rajhoti Pass (according to Stoliczka), where it was collected by Strachey. The *Waldheimia Stoppanii* figured in the "Palæontology of Niti," certainly belongs here, as may once more be pointed out.

Kali River valley, from which comes one specimen, collected by Griesbach.

* * * *

I should like here to add to *Terebratula* (*Dielasma*) *Himalayana* some other species of *Terebratula* hitherto only obtained in isolated specimens from different localities; they being distinguishable only in slight details from that abundant and very widely distributed species. To the latter belongs first of all the figured specimens (Pl. V., Fig. 12) which come from the upper Muschelkalk of Rimkin-Paiar. This was assigned by Diener, l.c., p. 39, in accordance with my view, to *Terebratula* cf. *vulgaris*, Schloth., and in this specimen also I could only convince myself later of the existence of dental plates. They are, it is true, considerably weaker and shorter than in *Dielasma Himlayanum*, the frontal area being broad and scarcely perceptibly raised in its whole breadth; a fine radial ribbing is very distinctly visible on the sides.

A second specimen, figured on Pl. V., Fig. 13, comes from a dark limestone of the horizon of Ptychites, south-east of Muth in Spiti, and was brought home by Griesbach. This specimen is extremely like the poor forms of the Alpine species, *Terebratula vulgaris*, but it also has penetrating, and even rather long, though very thin, dental plates in the beak. Its frontal area is only imperceptibly raised anteriorly. I content myself here with drawing attention to those forms occupying evidently a higher horizon than the typical *Terebratula Himalayana* (which evidently finds its habitat in the older Muschelkalk deposits) and distinguishing them by the name of *Terebratula* (*Dielasma*) cf. *Himalayana*. They might perhaps

be regarded as "stragglers" of this species, perhaps as intermediate forms between it and the European species of Cœnothyris. As to their relationship with *Terebratula Ecki*, Frantzen, no decision can be arrived at without further and fuller material.

TEREBRATULA (CŒNOTHYRIS) cf. VULGARIS, Schloth., sp., Pl. V., Fig. 14.

A single specimen of a Terebratula from the trias of the Himálayas is before me, which may be referred with some probability to the most abundant species of the European Muschelkalk, so far as is possible to judge from external features; it stands at any rate very near it. It comes from Lilang in Spiti, and has been assigned, evidently in consequence of some mistake, to *Athyris Deslongchampsi*, Suess, which form Stoliczka records only in one solitary specimen from Lilang and which in all probability is identical with the specimen of *Spirigera Stoliczkai* figured here on Pl. III, Fig. 17. That the form illustrated on Pl. V., Fig. 14, is not a Spirigera is explained by the punctate shell structure. The frontal area is elevated just as it is in the large specimens of *Terebratula vulgaris*, and the umbonal region of the small valve flattened; the septum, however, is not very distinct; and dental plates in the beak are certainly not present. The preservation is unfortunately very imperfect; nevertheless this specimen deserves special notice.

Locality.—Lilang, on the Lingti River in Spiti. Gümbel records *Terebratula vulgaris* from a black limestone from Balamsáli, near Dánkhar in Spiti.

AULACOTHYRIS LILANGENSIS, nov. sp., Pl. VI., Fig. 1.

Rhynchonella retrocita, Suess, var. *angusta*, Stoliczka, l.c., p. 24, Tab. III, Fig. 13.

It has already been pointed out in the Abhandl. d. k.k. geol. Reichsanstalt XIV. Band, p. 209, that Stoliczka's *Rhynchonella retrocita*, var. *angusta* only possessed a slight resemblance to the Hallstatt species of this name, which, as could also be shown, belongs to the Centronella group of the Terebratulidæ, and for which the genus Nucleatula was established (Verhandl. d. geol. Reichsanstalt, 1888, p. 126).

Stoliczka's species belongs, on the other hand, to Aulacothyris; the varietal name "angusta" given to it by Stoliczka cannot therefore be retained as a specific name for it, as this name has already been long occupied by the well-known Muschelkalk species *Waldheima angusta*, Schloth., sp., also a typical Aulacothyris.

There is only one specimen of *Aulacothyris Lilangensis* known at present, that is, Stoliczka's original specimen, cited above. It represents a strikingly flat form, that is, compressed from valve to valve, with the large valve rounded-carinate in the median line, and the small valve, widely and flatly sinuated, especially towards the frontal area, the depression of the small valve beginning already near the umbo. The shell is smooth, with the exception of very indistinct traces of radial ribbing, which appear on the sides. A sharply-marked median

septum is present on the small valve, but only visible on the umbo, where the shell has undergone exfoliation; as to its length, nothing can be said. The small beak possesses dental plates which are far apart, divergent and extending to the shell-wall. The edges of the beak project very little.

From the numerous species of Aulacothyris hitherto known from the Alpine trias, only *A. conspicua* from the Hungarian locality Dernö, described by me, is allied to this species, but only in its flatter forms, such as have been figured in Brach. d. Alp. Trias, Abhandl. d. geol. Reichsanstalt, XIV. Tab. XXVI., Fig. 5.

Locality.—Lilang, on the Lingti River in Spiti; but whether from the Muschelkalk proper is questionable.

Remarks 1.—Stoliczka refers occasionally to Fig. 9 on Pl. IX., in the "Palæontology of Niti," concerning which figure nothing is however mentioned in the text. In fact it is possible that this Figure 9 might represent a species at least related to *A. Lilangensis.* What appears to be referred to and figured in the "Palæontology of Niti," p. 71, Pl. IX., Fig. 11, as *Rhynchonella retrocita* Suess, belongs just as little to that Hallstatt species as does *Aulacothyris Lilangensis,* here described. Stoliczka has already expressed his doubts in this respect, l. c., p. 43. This form, which is unknown to me, might rather represent a Norella, similar to *Norella Kingi* described above. Such forms seem to occur more generally distributed in the trias of the Himálayas in different horizons.

2.—From the whole region of those Muschelkalk deposits from which the above-described brachiopods come, there are no remnants at all of lamellibranchs, which, on the ground of their preservation would be suitable for description and illustration. It may however be pointed out here that a few lamellibranchs from these, or related deposits, have been described by C. W. Gümbel. Stoliczka records species of lamellibranchs which might have come from these deposits.

b. Brachiopoda and Lamellibranchiata from the Transition-Horizon between the principal complex of the Muschelkalk and the overlying complex of the so-called "Daonella-beds," and also from the Horizon of Daonella indica (designated by Diener as the Aonoides-beds).

If I assign the beds from which the species now to be described are derived still to the middle trias, or the Muschelkalk, I have several reasons for so doing. First, the equivalents of the Ladinic series of the Alpine trias must lie just in this place in the regular and unbroken succession of beds, which, according to all accounts, is said to exist here. Secondly, Dr. Diener, when on the spot, assigned these beds still to the Muschelkalk in accordance with their position. And thirdly, the "chorological interpretation" by means of which E. v. Mojsisovics would like to allocate these formations to his Aonoides zone is by no means so convincing that the possibility may seem to be excluded thereby of their being assigned to a lower and hence a Ladinic horizon. Mojsisovics has been obliged to adopt the expedient of dividing the Aonoides zone in order to make his argument more plausible, and in doing this he reverts to that older view in which the Aonoides zone was not looked upon as equivalent to the Lunz-Raibler beds, but older than these. These reasons

seem to me quite sufficient to link the beds here in question more closely to the principal Muschekalk complex of the Himálayas than to the overlying so-called Daonella-beds, which, however, so far as could be judged hitherto mostly contain Halobia from the group of *Halobia rugosa*, while species of true Daonella seem to be confined almost, if not entirely, to the transition formations which are here to be discussed.

AULACOTHYRIS NILANGENSIS, nov. sp., Pl. VI., Figs. 3—7.

This is one of the species of Aulacothyris, hitherto known from the triassic deposits, which seem to be without any defined and distinctive characteristics. Outline oval, rounded, or a little inclined to be five-sided; the thickness of the shell rather considerable. The lines of junction of the valves lie in one plane; the frontal outline is level, not in the least bent down in the manner of the greater number of species of Aulacothyris; the small valve possesses a trace of a median sinus near the frontal outline. The rather coarsely punctate shell shows near the frontal area mostly strong concentric lines of growth. In the small valve there is a strong median septum, reaching half its length; in the beak there are dental plates which are near to one another and extend to the shell-wall. The last two features decidedly suggest that the form belongs to Aulacothyris, though the presence of the Waldheima loop in the interior could not be proved.

There is not a single one among the numerous species of Aulacothyris in the Alpine trias which could be placed particularly near to *A. Nilangensis*. Only a few of them, especially *A. pulchella*, m., from the Noric Hallstatt limestones, have not a depressed frontal area. Perhaps the most closely related to the Asiatic species are certain forms of *Aulacothyris dualis*, m., from the Carnic Hallstatt limestones, but these also become larger and develop a median depression in the small valve, in consequence of which the frontal outline bends down.

Locality.—In the moderately thick beds immediately overlying the chief mass of the Muschelkalk with *Ptychites*, regarded by Dr. C. Diener as the representative of the Aonoides zone, these beds being divided into the lower crinoidal limestone, and an overlying Halobian bed. This Halobian bed is the horizon of *Daonella indica*, n. sp., which will be described further on. From this horizon of *Daonella indica*, and, moreover, from fragments of the Daonella rock itself, which Dr. Diener has brought from Rimkin-Paiar, are derived the two specimens of *Aulacothyris Nilangensis* figured on Pl. VI., Figs. 3, 4. More frequently I got the same species from a bed of dark colour entirely filled with *Daonella indica*. This bed recalls in every respect the rock of the Shalshal section, previously mentioned, and from which a slab of considerable size from the pass situated between Hop Gádh and Dogkwa Aúr meadow, N. E. from Tsang Chok Lá (Hundés), was brought home by Mr. C. L. Griesbach. It is recorded as belonging to the Daonella horizon (Black Limestone) of the upper trias. In all probability one has here to deal with that division of beds, mentioned above, lying at the base of the whole immense mass of the "Daonella beds," forming the uppermost part of the

Muschekalk. In breaking up that slab in order to get better preserved specimens of Daonella, there were also obtained a great number of mostly small brachiopods, the most abundant of which was the species of *Aulacothyris Nilangensis*, just described. There are about fifteen specimens from this locality, three of which have been figured on Pl. VI. Figs. 5, 6, 7, and of these one is a strikingly elongated form. This plate also contains the remaining species of the small brachiopod fauna from the horizon of *Doanella indica*. The latter will be described further on.

SPIRIGERA HUNICA, nov. sp., Pl. VI., Figs. 8—13.

This species which occurs associated with *Aulacothyris Nilangensis* in the horizon of *Daonella indica*, though bearing every resemblance in outline to *Spirigera Stoliczkai*, already described from the Muschelkalk, is narrower than that species, and is distinguished from the narrowest forms of it by its broader frontal lobe, with which is associated a weaker or obsolete median depression of the large valve next to the frontal lobe. In the formation of the beak the two species are also widely distinguished. While in *Spirigera Stoliczkai* (Pl. III. Figs. 8, 9) the sides of the beak, outside the dental plates, are thick-walled and the back of the beak between the dental plates only possesses a thin shell, the opposite is the case in *Spirigera hunica*, that is to say, the median part of the beak is thickened and its sides thin-shelled. In *S. hunica* dental plates extending to the shell-wall are present. The median umbonal area of the small valve is likewise thick-shelled and forms a kind of broad and flat septum which easily breaks off leaving a shallow furrow in the cast. The shell is minutely fibrous, without any trace of punctation, which combined with the presence of a terminal opening in the incurved beak proves incontestably the Spirigera nature of the species, though, owing to lack of material, the spiral cones in it could not be shown to exist. Thus for the present it is not possible to decide with which group of Alpine Spirigera this species is to be united; though, judging by the external features, it might stand nearest to Pexidella.

Locality.—A single loose specimen was collected by Griesbach in the "Daonella beds," on the road from Hop Gádh to Dogkwa Aúr encamping ground in Tibet. This (figured on Pl. VI. Fig. 13) certainly comes from the horizon of *Daonella indica*, from which, besides numerous forms of *Aulacothyris Nilangensis*, also the smaller specimens figured on Pl. VI. Figs. 10, 11, were obtained. I should like also to leave for the present Fig. 12, Pl. VI. in this species, though the specimen is considerably broader than those mentioned before. The smaller forms, Pl. VI. Figs. 8, 9, on the other hand, are to my mind very doubtful as to their position. They have the appearance of Aulacothyris, but have no septum, the shell is not punctate, and they show the structure of the beak of the larger forms as described above. They are perhaps young forms of *Spirigera hunica*.

A single large valve of this species, also from the horizon of *Daonella indica* from the Shalshal section, near Rimkin-Paiar.

RHYNCHONELLA (NORELLA) KINGI, nov. sp., Pl. VI., Figs. 14, 15, 16.

Species of Norella, with folds on the front margin, occur in the trias of the Himálayas already in the deep-seated layers with *Pseudomonotis Griesbachi* of the Otoceras beds (cf. above, *Rhynchonella* (*Norella*) *procreatrix*). A similar form, also from the horizon of *Norella Griesbachi*, was described as *Norella Kingi*, and figured on Pl. II., Fig. 16. From the horizon of the *Daonella indica*—on the upper boundary of the Muschelkalk—there are again similar species of Norella present, which can not even be separated specifically from the above-described *Norella Kingi*. They are very pretty little shells of a nut-like shape, which represent among the Rhynchonellidæ the same typical form as the Aulacothyris species do among the Terebratulidæ. The shell, which shows a distinct fibrous structure, is smooth, provided with delicate striæ of growth, and only ornamented on the front margin and on its contiguous sides with short, weak little folds, whose number is not at all constant. Some specimens show only two of them on the front margin, others as many as four; still more variable in number and strength are the lateral folds. The sinus of the small valve is broad and shallow, and the median part of the large valve forms a broadly-rounded back, while the sides are a little flattened. The beak is small and pointed; its margins are rather sharply marked and slightly hollowed, or overhanging. The shell appears to be somewhat thick on the sides of the beak, whilst a median band on the back of it is thin-shelled. Short dental plates extending to the wall of the umbonal region separate these three regions, and their presence is often the cause of the breaking off of the lateral portions. The specimen of *Norella Kingi*, already described from the horizon of *Rhynchonella Griesbachi*, evidently possesses this structure of the beak. It is scarcely to be distinguished from the specimen figured on Pl. VI. Fig. 15, but if anything, it is a little more inflated. Its similarity to *Norella Rosaliæ*, Sal., has been pointed out above.

Locality.—In the horizon of *Daonella indica*, associated with *Aulacothyris Nilangensis*, in the Shalshal Cliff, near Rimkin-Paiar, obtained from rock specimens of his "Halobia-beds" of the "Aonoides horizon;" collected by Diener on the 27th and 28th August, 1892.

Very near to this form stands a second, which occurs in the same beds *viz*;—

RHYNCHONELLA (NORELLA) TIBETICA, nov. sp., Pl. VI., Figs. 2, 17, 18.

This is distinguished from *Norella Kingi* only by the absence of the fine folds on the frontal margin, although they agree in size; it is, therefore, nothing but a perfectly smooth sub-species of *Norella Kingi*, to which it could be united as *var. tibetica*. Also the figured specimen (Pl. V. Fig. 2), in which I was able only at a later period to expose completely the fine Rhynchonella beak, belongs here; it connects by the character of its outline the two original specimens, Fig. 17 and Fig. 18.

Locality.—Associated with *Norella Kingi* in the horizon of *Daonella indica* in the beds immediately overlying the Hauptmuschelkalk (Diener's "Halobia-bed" of the "Aonoides zone") in the section of the Shalshal Cliffs, near Rimkin-Paiar; one specimen, figured Pl. VI. Fig. 2.

From the horizon of *Daonella indica*, near Dogkwa Aúr, in the Hop-Gádh district, Tibet; from whence come the two specimens, Pl. VI., Figs. 17, 18.

Rhynchonella Rimkinensis, nov. sp., Pl. VI., Fig. 19.

A narrow but tolerably thick Rhynchonella, with high, vertically flattened, lateral hinge-margins, and broadly-expanded frontal lobe in the large valve; to this lobe belong four short little folds; and the rest of the shell is smooth and unornamented. The beak is a pointed small Rhynchonella beak, with distinct triangular opening under it; that this form belongs to Rhynchonella thus admitting of no uncertainty. Among the forms of the Alpine trias, the narrow smooth *Rhynchonella intercurrens*, m., is perhaps most closely related to this species, without being, however, specifically identical with it; for apart from the entire absence of ribs, the flattening of the umbonal lateral margins exists in a much slighter degree in *Rhynchonella intercurrens*. In this respect the new species comes nearer to *R. halophila*, m., a form likewise without ribs, but which, however, possesses, as a rule, a very sligtly inflated small valve, while in *R. Rimkinensis* both valves are equally strongly inflated. *Rhynchonella halorica*, m., is again distinguished by the absence of the frontal lobe, the line of junction of the valves lying completely in *one* plane. In any case it is to the Hallstatt species that *R. Rimkinensis* is nearest in relationship.

Locality.—In a bed of grey crinoidal limestone immediately *under* the beds of *Daonella indica*, in the section of the Shalshal Cliffs, near Rimkin-Paiar. One specimen collected by Diener. There is only the cast of a small Myoconcha, sp., from this bed, which is figured on Pl. VII., Fig. 21.

Discina, sp., Pl. VI, Fig. 20.

Two specimens of a small Discina were also found in the horizon of *Daonella indica* in association with brachiopods in the rock-specimens from Dogkwa Aúr.

To the illustrations of the brachiopods from the horizon of *Daonella indica*,—the horizon forming the boundary between the Muschelkalk and the upper triassic deposits,—the descriptions of the lamellibranchs coming (with certainty, or, in all probability) from this horizon and exclusively belonging to the genus Daonella will be added later on (Pl. VII, in part).

Daonella cf. Lommeli, Wissm., sp., Pl. VII., Figs. 1, 2.

Daonella Lommeli, Wissm., sp. E. v. Mojsisovics, in Abhandl. d. k. k. geol. Reichsanstalt, VII. Bd. Heft 2, 1874, p. 19, Tab. II., Figs. 13, 14 (with the older literature).

Halobia Lommeli, Wissm., sp. A. Rothpletz: Die Perm-Triasund Juraformation auf Timor und Rotti; in Palæontographica, 39 Bd., 1692, p. 93, Tab. XIV., Figs. 11, 12 (6 ?).

Daonella (or *Halobia*) *Lommeli* has for some time, as is well known, been recorded also from the trias of the Himálayas. E. v. Mojsisovics has however already pointed out (l. c., p. 4) that these records refer either directly to different specific forms, or that they are not sufficiently well established. Whether Stoliczka's very decidedly expressed statements (l. c., p. 44) upon the occurrence of this species in Spiti actually referred to it had to remain undecided for Mojsisovics, for Stoliczka neither figured nor described those specimens. Stoliczka alludes in his references to the literature on the subject to the form designated in the "Palæontology of Niti" as *Halobia Lommeli*, and this considerably reduces the weight that one could attach to his statements regarding it. It appears to me, judging by the specimens which I have before me and which were collected by Stoliczka in Spiti, for instance, from Khar, Kuling, and so on, and which are likewise named (probably by Stoliczka himself) *Halobia Lommeli* (Pl. VII., Figs. 11, 12, belong to it), that neither Stoliczka nor Strachey knew the true *Halobia Lommeli* from the Himálayas. Strachey as well as Stoliczka may have obtained their specimens, which they regarded as *Halobia Lommeli*, from that deposit of Daonella which has already so often been indicated as the horizon of *Daonella indica*, so widely distributed and so remarkable, as it would seem, in the triassic deposits of the Himálayas. The form, figured in the "Palæontology of Niti," can at least with certainty be assigned to the species to be described further on, and also the greater number of those specimens named *Halobia Lommeli* by Stoliczka may be attributed, not to this species, but likewise to *Daonella indica*.

Dr. Rothpletz makes mention in his work, cited above, of *Halobia Lommeli* from Rotti Island in the Indian Archipelago. His illustration of this species (l. c., Tab. XIV, Fig. 6), supposing that it is a faithful one, would however by no means demonstrate the correctness of his determination, for it shows undoubtedly the absence of the dichotomy of the ribs, so striking in that species.

I might be permitted here to make a long digression. According to A. Rothpletz (l. c., p. 94), *Halobia Lommeli* may also occur in the Hallstatt Limestone. This statement rests upon the fact that Rothpletz declares *Halobia Hærnesi*, Mojs., to be identical with *H. Lommeli*, which however is decidedly an error. *Halobia Hærnesi* is distinguished specifically from Daonella Lommeli by the form of its ear. This is twice as wide as that portion of the shell which may be regarded in *D. Lommeli* as corresponding to the ear, and well developed, strongly projecting above the surface of the shell, and divided by a radial furrow into a narrower upper (outer), and a lower (inner) radial portion which is more than twice as broad as the upper, and moreover strongly convex; this latter being again sub-divided into three parts by two furrows which are placed on its sides. Nothing of this complicated ornamentation of the ear is to be found in *Daonella Lommeli*. The illustration of *Halobia Hærnesi*, Mojsisovics, (l.c. Tab. V. Fig. 3), shows the character of the ear pretty faithfully, and the description of the species

contains nothing whereby its identity with *Daonella Lommeli* could be judged, as is the case, on the other hand, with Rothpletz's.[1]

The statements concerning the occurrence of *Daonella Lommeli* elsewhere than in the Alps may thus be taken on the whole with a certain reservation. As to the presence of this species in the trias of the Himálayas, it could be shown that exact data have hitherto been in no way forthcoming.

It seems to have been reserved for Mr. Griesbach to make a discovery which may result in establishing the occurrence of *Daonella Lommeli* also in the trias of the Himálayas. The discovery was made in the district south-east of Muth in Spiti in the complex of the so-called Daonella beds (which, according to Griesbach, begin, as is well known, immediately above the Muschelkalk with *Ptychites Gerardi*), and consists of a specimen of rock, of a dark, somewhat dolomitic, very argillaceous and fissile limestone, the surfaces of its rather even layers being, as it were, sprinkled over with numerous minute particles of white mica. A similar rock cannot be duplicated in the rock-material from the trias of the Himálayas which is before me. On one of the surfaces of this rock lie, side by side, the two valves figured on Pl. VII., Figs. 1 and 2, which undoubtedly belong to *one* species, a very young form with a completely preserved outline, and a larger one whose umbo and anterior hinge-margin are wanting. Both valves are right valves, both are natural casts of the inner side of the shell, because their radial furrows appear as ribs upon them. They have been drawn from plaster casts. As nothing is preserved of the thin shell, the casts give an exact picture of the surface. The outlines agree best with those of *Daonella Lommeli*, with that remarkably beautiful specimen, for instance, from Wengen, which Mojsisovics illustrates, l. c., Pl. II., Fig. 13. The shell has, at the fusion of the posterior with the lower margin, as also in the two Indian specimens, a more decided diagonal extension than the illustration indicates; the figure of the larger specimen, specially at this point, is much too schematic in the way in which it is rounded. The ribbing of these Indian forms agrees also perfectly with that of the South Alpine specimens and can be affirmed to be completely identical. The number of the strongest or primary furrows amounts to from 14 to 15, which is also the case with most of the Alpine specimens, and the splitting of the ribs is very regularly dichotomous, a chief characteristic of *D. Lom-*

[1] There is as little identity between *Halobia Hærnesi*, Mojs., and *Daonella Lommeli*, as there is to all appearance between the Rotti specimen assigned by Rothpletz (l.c. Tab. XIV, Fig. 18) to *Halobia Cassiana*, and the true *D. Cassiana*, Mojs. In *D. Cassiana*, as well as in *D. Richthofeni* there remain only small portions near the hinge-margins free of ribs, so that these species, so to speak, connect the two groups of *D. Moussoni* and *D. Tyrolensis*. If one appealed to Mojsisovics' Tab. I., Figs. 2—5, as authoritative, Figures 2 and 3 of which represent *D. Cassiana*, but Figures 4 and 5 *D. styriaca*, both from the Hallstatt Limestone of the Rothelstein, the objection could be raised that the differences given by Mojsisovics in the number of ribs are not tenable, for in his *D. Cassiana*, Fig. 2, about 35 ribs may be counted, whilst his *D. styriaca*, Fig. 5, possesses about 45 ribs, although, according to his own statement, *D. styriaca* should only have half the number of ribs possessed by *D. Cassiana*, a difference which at the same time, is given as the only one existing between the two species. The Carnic Hallstatt forms of Rothelstein, which Mojsisovics separates into the two species, *viz.*, *D. styriaca* and *D. Cassiana*, not only merge into each other, but are simply specifically inseparable and Mojsisovics' specimens, Tab. I, Figs. 2, 3, belong to *D. styriaca*. In fact it was possible to expose the rudimentary ear just as it occurs in *D. styriaca*, in the specimen, Fig. 2, so that there can be no doubt that Mojsisovics' Hallstatt species, *D. Cassiana*, is nothing but *D. styriaca*. The statement as to the occurrence of *D. Cassiana* in the Hallstatt Limestone seems thus at present insufficiently vouched for. Rothpletz's statement about *Halobia Cassiana*, referred to above, must also be estimated from this standpoint.

meli, by which means the strikingly bundle-like ribbing in this species is produced. The secondary furrows also arise in the Indian specimens already near the umbo; the young specimens (Fig. 1) appear therefore more closely ribbed than is the case with many Alpine specimens of similar size, which often show only the primary furrows. But this feature is not general in the Alpine fossils; for the specimens from Wengen, from Mundevilla, in the Abteythale, and in other places in South Tyrol, possess the same close ribbing as the two Asiatic species. Also the varying strength of the ribs in any given shell is developed in the same manner as in the European specimens; the strongest and deepest radial furrows are in the middle and in the region of the posterior, diagonal extension of the shell; in the latter position they are, at the same time, the most crowded; and towards the anterior hinge-margin they become gradually, but towards the posterior proportionally rapidly weaker. The broadest and most regular bundles of ribs are tripartite by furrows of the second, third and fourth order, thus containing 8 ribs between two primary furrows. Where numbers like 6 or 10 occur, the division does not take place simultaneously, the complete dichotomy, however, prevailing. It is, moreover, only natural that an irregularity once occurring in the division of a bundle of ribs should augment with the growth of the shell.

After a minute comparison of Alpine specimens from different localities, I cannot doubt that in the two forms figured on Pl. VII., Figs. 1 and 2, from Muth, in Spiti, the true *Daonella Lommeli*, from the trias of the Himálayas, is really for the first time before me. If, nevertheless, I have named these still with some reservation, the reason for this is to be sought only in the scanty material hitherto representing the Indian form.

A short time ago A. Rothpletz declared the generic name "Daonella" to be superfluous, and said that it would be sufficient to distinguish special groups within the genus Halobia, to which the species of Daonella were again to be assigned. The two chief groups which were then again to be distinguished would certainly be that of true Halobia and that of Daonella; and therefore it would perhaps be simpler to retain the already existing name for that group, which would not prevent the definition of the two genera and their limitations with respect to each other from being perhaps somewhat modified in course of time. Rothpletz puts perhaps a somewhat exaggerated value upon the indication of an ear-like formation, which is found in some species of Daonella, particularly in *D. Lommeli*, as an argument for the reunion of the two genera, whose intimate relationship has not however been called in question by anybody. In making the following remarks I refer to the description which Rothpletz has given on the matter (l. c., p. 93). Large specimens of *Daonella Lommeli* from Corfara, which lie flattened in the rock, possess, beside the anterior hinge-margin, a narrow space, free from ribs and consequently from furrows. This space is generally somewhat concave or depressed, and is bordered at the hinge-margin itself by a distinct rim, from which the shell towards the outer side falls steeply away, or rather sinks into the rock. In Rothpletz, p. 93, Figs. 1 and 2, this rim might easily be taken for the outermost rib, bordered by a furrow on the inner side, but such a rib does not exist in reality. One can recognize the bordering of the little ear-area towards the outside in *Daonella*

Lommeli as a rim, and this only a very indistinctly pronounced one, which is remarkably perceptible, especially in the uncrushed specimens, Tab. II, Fig. 13 of Mojsisovics. This rim corresponds at the same time with a curvature of the hinge-margin towards the inner side, that is, in other words, of the hinge-margin of one valve towards that of the other valve, by which a kind of groove or cavity is created, in which probably lay the ligament, as is also assumed by Rothpletz. The little ear-area itself remains also in large specimens of *D. Lommeli* very narrow; measured at thirty mm. distance from the umbo it is scarcely four mm. wide, and this corresponds with valves sixty mm. in height. The inflation of the little ear-area does not in the least project beyond the neighbouring shell surface, and thus its area does not appear distinctly defined from the rest of the shell, and is not further sub-divided. There is not the slightest emargination on the anterior margin of the shell, between the latter and the little ear-area; the striæ of growth continue completely uniform across this area, and there is not a trace of an incurvature of the striæ which generally marks a byssal opening. The "ear" of Daonella is therefore, properly speaking, scarcely to be recognized as such. But if it is hardly possible to speak of a true ear in *Daonella Lommeli*, it is still less so in species such as *D. Taramelii*, *D. Cassiana* and others. It is possible, and it is not denied here, that there are forms about which one may actually remain doubtful as to whether to place them, on the basis of the generic diagnoses hitherto employed, in Daonella or in Halobia (such a form, for instance, being *Daonella styriaca*, Mojs.). But where in nature do we not have transition forms, and where are there sharply separated generic groups of related organisms? The greater number of species of Halobia incontestably possess a formation of the ear at the anterior hinge-margin, which is distinguished essentially from the very incomplete character of the little ear-area of *Daonella Lommeli* and related species.

The ear in Halobia is almost without exception more or less strongly raised above the adjacent shell surface, and is sharply and distinctly marked out from it, it thus being semiconical in shape. It is often characterized at the border by an emargination, almost always sub-divided by radial furrows, and falls into at least two divisions, of which the inner often shows by the striæ of growth being directed inwards that it corresponds with the byssal opening. Among the species with flatter ears *Halobia rugosa* (and its related forms from Balia in Asia Minor, cf. Jahrb. d. geol. Reichsanst., 1891, p. 100, 1895, Tab. XI., Figs. 10, 11), *Halobia austriaca*, Mojs., and *H. Halorica*, Mojs., as well as *H. insignis*, Gemm., have these inwardly directed striæ of growth of the byssal opening very distinctly developed; and in a geater number of closely related forms their existence may be assumed on account of this relationship. In other groups, especially in those of *H. plicosa* and *H. distincta*, in which they could not hitherto be observed, the formation of the ear itself is such that these groups can at once be placed in Halobia without these striæ being present. The characteristics of the genera Daonella and Halobia given at that time (l. c., p. 6) by Mojsisovics might therefore be altered to the following effect: for Daonella they would be, instead of "without ears,"—

"Without distinctly defined ear, or, with very incompletely developed ear, or better, little

ear-area, not raised above the surface of the adjacent shell, not sub-divided, not provided with an emargination and byssal opening;"

for Halobia, on the other hand :—

"With a distinctly marked anterior ear, raised above the shell surface, of semi-conical shape, sub-divided by radial furrows, and often provided with a true byssal opening."

For the reasons just mentioned the genus Daonella, Mojs., can, I think, be retained, and consequently I have allocated the species here in question, in opposition to Rothpletz's procedure, to *Daonella Lommeli*, Wissm., sp.

Locality of Daonella Lommeli.—South-eastward from Muth, in the Pin Valley, Spiti, in a rock which has already been described. Perhaps we have here in this quite isolated occurrence an indication that the Ladinic deposits (cf. Diener, l. c., p. 49), hitherto missing in the trias of the Himálayas, are really present in it, though perhaps only in insignificant development and thickness, much in the same way in which they occur in the north-east Kalkalpen; they thus having met with less attention. They should, therefore, be looked for in the upper portions, that is, on the upper boundary of the Muschelkalk deposits of the Himálayas, especially, I may add, at that place where the widely-extended beds with *Daonella indica* occur, which possibly likewise fall into the Ladinic group of beds as already mentioned.

Daonella Spitiensis, nov. sp., Pl. VII., Fig. 3.

A Daonella of quite unusual habit. It possesses the beautifully rounded outline of *Daonella Moussoni*, Mer., sp., but not its distinct, though fine, radial grooving. A right valve, the only specimen before me, is very slightly inflated, its hinge-margin straight, the umbo markedly directed forwards. The surface is covered with about thirty very slightly raised radial ribs, which, however, are not separated by the usually distinct furrows, but only by very indistinct, slight, radial depressions, so that the whole ribbing is only obscurely indicated. The illustration renders this kind of ribbing too strongly marked. Here and there one of the chief ribs undergoes subdivision. The striæ of growth are, if possible, still more indistinctly marked.

No species is known to me which I could compare with *D. Spitiensis*. The unusual ribbing distinguishes it from all species hitherto described. The two species from the Bakonyerwald, *viz.*, *D. Bæckhi* and *D. obsoleta*, Mojs., which one might be inclined to compare it with, are distinguished by their longer hinge-line as well as by their almost still less distinct radial sculpture. In its outline *D. Spitiensis* stands extremely near to *D. Moussoni* of the Lombardic Muschelkalk, as already mentioned. As upper triassic forms, which might be comparable with it, are yet unknown, it might well be supposed that *D. Spitiensis* is perhaps a Muschelkalk species, that is, that it is derived from the horizon of *Daonella indica*, as is the case with the greater number of species of Daonella which have hitherto come under my notice from Spiti.

Locality.—In compact black limestone, with rusty brown, earthy, weathered

surface, from Kuling in the Pin Valley, Spiti, brought thence by Stoliczka, and designated "Halobia Lommeli."

Daonella indica, nov. sp., Pl. VII., Figs. 4—11.

Monotis (Halobia) Lommeli, Wissm., Strachey's Palæontology of Niti, p. 68, Tab. 9., Fig. 1.
Halobia Lommeli, Wissm., Stoliczka, l. c., p. 44 (the greater part).
Daonella, nov. sp. Mojsisovics, Abhandlungen der geol. Reichsanstalt, VII. ½, 1874, p. 35 (4).

The form newly established here as *Daonella indica* in contrast to the other species of Daonella hitherto known from the trias of the Himálayas, is a species not only occurring in large numbers of individuals in beds, but also, as it seems, in a special horizon and widely distributed.

The outline of this species is rounded, the height greater than its breadth, the hinge-margin straight, the umbo projects little above it and lies somewhat excentrically, or almost in the middle of the hinge-margin. There is no anterior Halobian ear present; the radial sculpture begins, in fact, close to the hinge-margin, without leaving a space differently sculptured, or otherwise characterized as 'ear.' The form is, therefore, to be placed in Daonella. Both the ribs and the radial furrows begin already very near the umbo in a great number, about thirty to forty; only a very small umbonal part remaining free from them. At a very slight distance from the umbo, the greater number of the ribs are divided. The secondary furrows, however, do not attain the full strength and depth of the primary furrows up to the margins, whereby the greater part of the ribs, at least in the centre of the shell, appear continuously and very regularly bifurcated. Only very exceptionally a tripartite rib occurs here and there, and is then, as a rule, unsymmetrical, that is, one of the two secondary furrows begins much sooner than the other, or, in other words, one of these two furrows is a tertiary one, or a furrow of the third order. Near the hinge-margins the ribs are often single, or at least they do not bifurcate so generally and so regularly as the middle ones, without, on the other hand, differing from them essentially in breadth. The striation of growth is marked only in a very slight degree.

There are a number of Alpine species which must be compared with *Daonella indica*. First, there are the two St. Cassian species, *viz.*, *D. Cassiana* and *D. Richthofeni*, which, especially the latter, demand such comparison. In *Daonella Richthofeni*, however, the ribs bifurcate already nearer the umbo, and they are, therefore, at the same distance from it, much more numerous than in *Daonella indica*. In *D. Richthofeni* as well as in *D. Cassiana*, an irregularity of the ribs, that is, a bifurcation of them towards the margin, is scarcely indicated at all, for the secondary furrows quickly assume the strength of the primary ones. Finally, both of the St. Cassian species belong to those species of Daonella the ribbing of which gradually dies away near the hinge-margins on both sides, while *D. indica* belongs to that group in which the ribbing reaches the hinge-margins almost in full strength, without leaving a perceptible space free from ribs. This group would, according to Mojsisovics' classification (l.c., p. 7), be that of *Daonella Tyrolensis*, in which,

moreover, the primary furrows are distinctly differentiated by their strength from the weaker secondary furrows, without producing by further progress of the bifurcation of the ribs a bundle-like grouping of the latter, as in the *Lommeli* group. The species of the *Tyrolensis* group which are here collated are *D. Tyrolensis* itself, with its accessory form *D. badiotica*, Mojs., further *D. Parthanensis*, Schafh., sp., which is unfortunately very insufficiently known.

Daonella Tyrolensis., Mojs., is less oblique, almost equilateral, considerably higher, its umbo is more decidedly central, and its ribbing distinguished by a frequently occurring *regular tripartite* character. What is said of this species can also be said of *D. badiotica*, which is only a little more oblique than *D. Tyrolensis*, but is otherwise scarcely specifically distinguishable from it. There remains therefore for comparison with *D. indica* only *D. Parthanensis*, one of the most imperfectly known species of all hitherto described. Recently the opinion has been expressed (Rothpletz, Salomon) to the effect that the identity of *D. Parthanensis* and *D. Tyrolensis* is established. Were this really the case the foregoing remarks about the differences between *D. indica* and *D. Tyrolensis* could also be applied to *D. Parthanensis.* Supposing that *D. Parthanensis*, so insufficiently known, were nevertheless differentiated from *D. Tyrolensis*, as is possible, to judge by the ribbing of both, *D. Parthanensis* would always be distinguished from *D. indica* by the fact that the former possesses strikingly broader ribs near the anterior hinge-margin than in the centre, a distinction in the ribbing which does not exist in *D. indica.* Nevertheless it is indisputable that *D. indica* stands very near to *D. Parthanensis*,[1] but a fair comparison cannot at present be made between *D. Parthanensis* and the former on account of the very insufficient material hitherto available. Strictly speaking, *D. Parthanensis* ought to have been annulled long ago as a species, as neither the older nor the later describers have been able to put forth a correct interpretation of this "species."

Locality of Daonella indica.—The species is widely distributed in the trias deposits of the Himálayas. I have before me specimens of it from a number of places: Shalshal section near Rimkin-Paiar, from a bed which Diener, when on the spot, took to be the top of the Muschelkalk complex, but later attributed to the Aonoides beds. The rock is quite filled with confusedly embedded shells of this Daonella, which are unfortunately mostly broken, and contains small brachiopods, isolated and scattered among them, which have already been described.

Griesbach evidently collected the same rock with Daonella fragments further to the south-east of the mountains, opposite to the Ralphu glacier on the left side of the Lissar Valley. It seems to be more widely distributed to the north-west of the first-named locality.

First may be mentioned the large slab of Daonella rock brought home by Griesbach, from the pass leading to the Dogkwa Aúr meadow in Hóp Gádh, north-east from Tsang Chok Lá, from which slab not only the greater part of the brachiopod fauna, figured on Pl. VI. is derived, but from which also the

[1] Compare on this subject, Th. Skuphos in Geogn. Jahresheften des kön. bayr. Oberbergamtes IV., 1891, p. 51 (Sep.), Tab. Figs. 3, 4, 5, and further, W. Solomon, in his work on the Marmolata, Palæontographica, 1895, p. 154.

original specimens of most of the illustrations of *Daonella indica* on Pl. VII, (Figs. 4–9) are taken. This rock is also quite filled with shells of Daonella, which however are here also in a very fragmentary condition.

Ganes-Ganga (perhaps identical with the locality Gunes-Gunga in Strachey?); to this locality belong probably the specimens figured in the "Palæontology of Niti." The rock is identical with that of the localities named above.

Stoliczka mentions beds of rock in Spiti which consist almost entirely of the shells of *Halobia Lommeli*. This statement may also point to *Daonella indica*, as Stoliczka has determined other specimens of *D. indica* to be *Halobia Lommeli*, as already mentioned. To this belong the large specimens from Khar in the Pin Valley, of which the best preserved is figured on Pl. VII, Fig. 11.

A form lies before me, perhaps different from *D. indica*, to which possibly Stoliczka's remark might refer, *viz.*, that *Halobia Lommeli* occurs in beds almost made up of this species. This form comes from Kuling in the Pin Valley, and is illustrated on Pl. VII., Fig. 12. It is distinguished from *D. indica*, so far as the rather deficient preservation permits of recognition, by a somewhat different outline, the umbo lying more to the one side, and above all by considerably wider and much more irregular ribbing.

III.—BRACHIOPODA AND LAMELLIBRANCHIATA FROM UPPER TRIAS (THE KEUPER FORMATION) OF THE HIMÁLAYAS.

The upper triassic or Keuper deposits succeeding the Muschelkalk deposits (taken in the preceding pages as somewhat extended upwards) are divided, according to Griesbach, into two great natural groups, as in the Alps—a lower one, poor, for the greater part at least, in limestone, and an upper one, rich in limestone. Griesbach only indicates the lower of the two specially as upper triassic, while he admits the upper to be rhætic (according to F. v. Hauer's precedent). It comprises, therefore, at all events, not only the equivalents of the Kössen beds, which, however, at least in the material that I have investigated, cannot be proved, but specially those thick Limestone and Dolomite masses of the uppermost trias which are to be regarded as the representatives of the Main Dolomite and Dachstein Limestone horizon of the Alps. The lower group, poor in limestone (the upper trias in Griesbach's restricted sense of the term) is, on the other hand, again separated into two divisions, a *lower*, comprising the Daonella beds, with the overlying Tropites beds, and an *upper*, consisting of beds rich in certain brachiopods, with a large Spiriferina, and overlaid by an upper Mergel horizon, bearing bivalves, which is succeeded by the Main Dolomite. Part of the Daonella beds, and particularly their lower layers with true species of Daonella (more especially *Daonella indica*) may perhaps be better assigned to the upper Muschelkalk (Ladinic group of it) as has been done in the foregoing pages for reasons there given; the chief complex of the Daonella beds might more correctly be indicated as the "Horizon of Halobiæ from the group of *Halobia rugosa*," or, as "Horison of Halobia comata, nov. sp.," for the greater number of the species of

Daonella in this group of beds seem to belong actually to the Halobia group just named.

(*a*) *Species from the Lower Division of the upper triassic deposits of the Himálayas.*

(*a*^{1}) *From the Horizon of Halobia comata and the overlying Tropites-beds of Griesbach (Hauerites and Halorites beds of Diener).*

SPIRIFERINA SHALSHALENSIS, nov. sp., Pl. IV, Fig. 1.

A Spiriferina with straight, elongated, high, semi-conical, large valve, whose umbo is only slightly incurved, with broad and very high area and proportionally narrow pseudodeltidium. The median sinus of the large valve is moderately broad, but of considerable depth ; on each side of it as many as nine ribs may be counted, which become gradually weaker, those nearest the sinus, however, being much elevated and separated by deep intervals. On the rather flat small valve rises a high though not very wide median lobe, which has on each side of it folds seven to eight in number. The shell is thin and thickly dotted over with wart-like elevations. Nothing can be affirmed as to the inner structure of the beak from this single specimen. The shape of this species most clearly recalls the forms of the Hirsuta group (cf. Abhandl. der k. k. geol. Reichsanstalt, XIV., p. 292, Tab. XXXV) but nearly all the species of this group are distinguished by the presence of ribs in the sinus as well as on the lobe. The only exception to this is to be found in *Spiriferina Seebachi*, Proesch.; it is, however, easily differentiated from the form here described by its extraordinarily shallow sinus and its weakly marked ribs. Besides the species of the Hirsuta group there are only left for comparison *Spiriferina manca*, m., and the very similar *Spiriferina Beneckei*, Phil. (not to be confounded with *Spiriferina Peneckei*, m.). Both species of the European Muschelkalk are, however, distinguished by their uncommonly broad sinus, and *Spiriferina manca* also by less numerous and less distinct ribs.

Locality.—A single specimen, collected by Griesbach and recorded as *Spiriferina Lilangensis*, Stol., var., l. c., p. 143. It comes from the Shalshal section near Rimkin Paiar, from Bed 3 of the "Upper Trias Series," or from Bed 125 of the entire succession of beds; it can therefore no longer belong to the Muschelkalk, but certainly to the upper trias, and it must be assigned to the group of the so-called Daonella beds, or more correctly to the horizon of "the species of Halobia of the group of *Halobia rugosa*."

RETZIA SCHWAGERI, Bittn., var. ASIATICA, nov. Pl. VIII, Figs. 1, 2, 3.

Retzia Schwageri is one of the most widely distributed species of Retzia of the Alpine trias, in which it ranges from the Muschelkalk to the Dachsteinkalk (cf. Abhandl. d. geol. Reichsanst., XIV. Bd., p. 295). This type of Retzia is now also found in the trias of the Himálayas, in which it seems frequently to occur just in the horizon between the Muschelkalk and the equivalent of the Dachsteinkalk. The

specimens from the so-called "Daonella-beds" will here be next dealt with. The small valve of these forms possesses a median rib, not very strikingly marked, but nevertheless recognizable as such; at each side of the median rib there are four ribs, the outer of which are distinctly curved. The frontal margin is truncated in the middle, a position corresponding to that of the median rib. On the large valve there are, on each side of the median furrow, which is only a little broader and deeper than the lateral furrows, five ribs, between the last of which and the small area there still remains a space without ribs, of slight extent, which corresponds with the little ear on both sides of the umbo of the small valve. All the ribs begin at the umbo, or rather at the beak of the valves. They are narrow and rounded, and the intervals between them flat and of slight depth. The beautifully punctate shell is rather thick and exfoliates so easily that almost all the specimens before me are casts. They are, in the manner peculiar to these species of Retzia, ornamented in a more complicated way than the surface of the shell; the ribs and furrows, namely, are more strongly marked on them, and they stand out more distinctly from one another because true radial ridges occur at the boundaries of the ribs towards the flat intervals, while, at the same time, a fine secondary longitudinal ribbing is seen at the sides of each rib. This ribbing augments towards the margin with the increase of growth, and develops very markedly, especially on the curved outer side of the shorter ribs (which diverge from the median line), and continues from the last traces of the primary ribbing to the little ears of the small valve, as well as the corresponding portions of the large valve. The inner side of the test naturally possesses the same sculpture (cf. Pl. VIII, Fig. 3; here a fragment of the shell from the inner side is rendered on an enlarged scale). The inner side of these species of Retzia thus show, foreshadowed as it were, that complex ornamentation which the latest of the species of Retzia hitherto known, *viz.*, the large *Retzia superba*, Suess, sp. of the Kössen beds, also possesses on the surface of its shell. The beak and area are small, slightly incurved; the opening is terminal.

Though this form stands near the European types of *Retzia Swageri*, especially its upper triassic var. *fastosa*, m., nevertheless it cannot be united therewith without reservation on account of the invariably larger number of its ribs. It is true that the older forms from the so-called "Daonella beds" here first referred to are also, with respect to the ribbing, only very slightly different from the Alpine *Retzia fastosa*, but the form occurring in the younger beds with *Spiriferina Griesbachi*, which cannot possibly be separated from its precursor in the "Daonella beds," is invariably distinguished by the number of ribs from the European *R. fastosa*. It seems to me now more to the purpose to designate the Retzia of the "Daonella beds" as var. *asiatica*, although with respect to the ribbing it begins to be distinguished only very slightly from *R. fastosa*. The consideration of its dimensions makes it especially advisable to separate it from *R. fastosa* of the Alpine Dachsteinkalk which remains much smaller, becoming thereby thicker.

A separation in the European Muschelkalk of *Retzia Schwageri* into a type poor in ribs and another with abundant ribs is already proposed (cf. Abhandl.

der geol. Reichsanst., XIV, p. 21, Tab. 36, Figs. 1—4). New material from the Bakonyerwald has shown me that both types occur together in larger numbers of individuals, so that I should now separate the more numerously ribbed form illustrated in Fig. 3. from the chief form as var. *baconica*. W. Salomon in his description of the Marmolata refers (p. 99) to this more numerously ribbed species, *R. Schwageri*, of the Hungarian Muschelkalk, in establishing his *Retzia Taramellii*, and he is inclined to regard the latter as derived from it. Indeed *R. Taramellii*, Sal., might also belong to the extensive series of forms of *R. Schwageri*. With a further progress in the knowledge of the forms belonging hereto, and their mutual relationships, many a name will become superfluous which is necessary for their understanding to-day.

Locality.—From the so-called "Daonella beds," or more correctly the "horizon with species of Halobia of the group of Halobia rugosa," from two different places: from Lauka encamping ground, figured Pl. VIII, Figs. 2, 3, and from the Bambanag section, Pl. VIII, Fig. 1.

Rhynchonella Laucana, nov. sp., Pl. VIII, Figs. 5, 6.

A large smooth Rhynchonella, with deep median sinus on the large valve, and high frontal tongue, to which a narrow median lobe on the small valve corresponds. The surface of the shell is provided with fine though somewhat irregular striæ of growth. The beak is small and is not sufficiently preserved in the two specimens under description; in the one specimen the strong crura are conspicuous in the weathered umbo of the small valve. The shell is thick, especially in the umbonal portion.

Rhychonella Laucana stands extremely near a species of the Hallstatt Limestone. This is the *Rhynchonella regilla* described by me (Abhandl. d. geol. Reichsanst., XIV, p. 226, Tab. XIII, Figs. 23, 24), which belongs probably to the Carnic Hallstatt Limestone. *R. regilla*, however, possesses a considerably higher and somewhat broader frontal tongue, whereby also its outline has been influenced and the shape as a whole has acquired a markedly different habit.

Locality.—Two specimens collected by Diener at Lauka in the upper Girthi valley; from the so-called "Daonella beds," which may be more correctly designated as the "Horizon of the species of Halobia of the group of H. rugosa."

Rhynchonella Bambanagensis, nov. sp., Pl. VIII, Fig. 4.

A specimen of a Rhynchonella of a broad rounded form, with about fifteen to sixteen ribs, which appear distinctly only at some distance from the umbones. The umbo of the small valve with very indistinct, fine, and close ribbing, somewhat similar to that of the species of so-called Rimosæ. The lateral ribs bend very strongly outwards, the front is unsymmetrical, with a one-sided elevation, oblique and provided with four or five ribs, a number however which cannot be affirmed with certainty, because a sharp lateral demarcation of the frontal elevation

is only present on one side. On the other side the lateral ribs are somewhat close-set, and one or other of them is bifurcated. The frontal view (Fig. 4, upper one) is represented a little too symmetrical. The beak of the specimen is broken off and shows internally indistinct dental plates extending to the shell-wall.

There are only a few species of Rhynchonella in the Alpine trias of the vague undefined character here described. Among the specimens with numerous ribs of the variable *R. Concordiæ*, m., of the Salzburg Dachsteinkalk some are found which are very similar, but the ribs of these Alpine species begin in full strength at the umbones. The greater number of the specimens of *R. Concordiæ* possess much fewer ribs. The latter feature obtains in the single specimen hitherto known of *Rhynchonella hecuba*, m., from the so-called Zlambach beds.

Rhynchonella levantina, m., from the upper trias of Balia in Asia Minor (Jahrb. d. geol. Reichsanst., 1891, p. 107) is on the whole narrower, and the ribs originate in it nearer the umbo.

Locality.—Found by Diener in the Hauerites beds (No. 6) of the Bambanag section (compare his work above cited, p. 25). A form, scarcely differing specifically, also occurs in the younger beds of this section with *Spiriferina Griesbachi* (No. 8), which will be dealt with further on.

Halobia fascigera, nov. sp., Pl. VII., Fig. 15.

Specimens of Halobia in great numbers are also before me from the so-called "Daonella beds" (excluding their lowest division, which has already been referred to as the horizon of *Daonella indica*). They belong for the most part to species from the group of *Halobia fallax* and *Halobia rugosa*; but unfortunately, like all fossils of this group of beds, they leave much to be desired in respect to their preservation, and only a few of them can therefore be taken into account.

To these belong, in the first place, the form represented on Pl VII, Fig. 15, of a species which is not to be found among the species of the Rugosa group hitherto described. Its form is proportionally high, that is, its height is scarcely perceptibly exceeded by its length, and it is thus markedly oblique. The umbonal half of the shell—the figured form is a left valve—is pretty high and regularly inflated, the marginal half (taken in the radial direction), on the other hand, quite flat; at the boundary of these two divisions of the shell lies the remarkable interruption of the striæ of growth, which is developed in all species of the Rugosa group. The umbo is very feebly developed and scarcely projects above the straight hinge-line; the ear, on the other hand, is very wide, raised above the adjacent shell, and consists of a narrow and flat outer division and a radial inner one which is twice as wide and strongly elevated. The radial sculpture, particularly that of the median portion of the shell, begins very near the umbo, so that only a very limited umbonal space remains free from it. The radial furrows are deep and distinct; between the primary ones, which are somewhat close-set (in the central area of the shell in a space of about 10 mm. there being about nine of such primary furrows), finer, but

likewise very distinct secondary, and between these again tertiary, furrows are intercalated, so that a bundle-like ribbing arises, quite analogous to that of *Daonella Lommeli*, but closer and less distinctly marked, and confined to the middle of the shell; while, towards the anterior the primary ribs divide once, or only at a great distance from the umbo tertiary furrows also occur. Towards the posterior, however, the whole of the ribbing seems to become more indistinct, and towards the hinge-margin gradually dies out. Near the inner margin of the ear a few finer ribs are crowded together. The complicated division, or bundle-like arrangement of the middle ribs already occurs in the umbonal portion, lying above the larger interruption of growth. The sharp angle caused by the interruption of growth comes out most distinctly in the middle ribs. The ribs are moreover more or less markedly undulating throughout their whole extent, and scarcely decrease in strength towards the pallial margin. The wrinkling of growth is particularly strong on the umbonal part of the shell, but only weakly developed on the flat lower portion of the shell; also the umbonal part of the ear is coarsely wrinkled. *Halobia fascigera* may be sufficiently distinguished from all the species of the Rugosa group hitherto described. Not a single one of these species possesses the distinct bundle-like sculpture of the ribbing, but all those species in which the umbonal part is ribbed show a more or less simple, uniformly strong, radial furrowing, which only in a few forms, *e.g.*, *H. fluxa*, *H. Zitteli*, is as strongly developed as in *H. fascigera*, or perhaps still more strongly so; in the greater number of species, however, it remains much finer. The specific name is taken from the bundle-like ribbing of the form.

Locality.—Collected by Diener in the lower layers of the so-called "Daonella beds," or rather the horizon of Halobia of the Rugosa group, in the Bambanag section of the Girthi Valley. The bed from which the species is derived is indicated as Nos. 1 and 2; this indication corresponds perhaps with the numbers 5*a* and 5*b*, Diener, l. c., p. 24. The form may therefore have its habitat in the deepest layers of this horizon.

HALOBIA COMATA, NOV. sp., Pl. VII., Fig. 13.

A tolerably well-preserved right valve of a form which, though approximately equal in outline, is at once distinguished from *Halobia fascigera* just described by its extremely indistinct, almost obsolete, ribbing. While *H. fascigera* belongs to the most coarsely and distinctly ribbed species of this group, *H. comata* is, in respect of its ribbing, most closely related to *H. rugosa*, it coming in fact so near it that incompletely preserved specimens of the two species may be easily confounded. But the umbonal part of the shell of *H. comata* is not as in *H. rugosa* quite without ribs, though likewise finely ribbed. The ribs of *H. comata* begin already near the umbo. They are close-set, very small, and undulating; a specially marked concentric angle in the ribs, between the umbonal and the pallial portion of the shell does not exist, at least in the specimen under description. Here and there a single rib stands out a little more prominently; at the posterior margin there is an almost smooth narrow space on which the striæ of growth converge more

strongly towards the umbo. A similar structure of the posterior hinge-margin moreover occurs in *H. rugosa*, *H. Neumayri*, and other species of this group; it is almost the same as what has been designated as the 'ear' at the anterior hinge-margin of *Daonella Lommeli*. The anterior ear of the specimen of *H. comata* under description is not preserved; only the extreme part of the lower margin of it is still there and their position proves that this species also possessed a very broad anterior ear.

Locality.—In the so-called Daonella beds, or rather the horizon of the species of Halobia of the Rugosa group in the Bambanag section of the Girthi Valley. The bed in which this form occurs is indicated by Diener as No. 4, the species is therefore geologically younger than *H. fascigera*.

The present species seems to occur also farther to the north-west in the Niti region. It will be the subject of further comparison below.

Remarks on Halobia comata.—On the ground of the material being insufficiently preserved, I should not like to separate the Halobia figured on Pl. VII., Fig. 14, from this species for the present. It is a weathered umbonal fragment, with both the valves, of which the two anterior ears are rather well preserved, and though the finer details are, it is true, not recognizable, their great width is remarkable. The umbo is finely ribbed, the ribbing indistinct and nearly obsolete as in *H. comata*. From the specimen of the latter species represented in Fig. 13, Figure 14, could only be distinguished by its more elongated outline and consequently lesser height; but these particular proportions appear to be in no way constant in some species of Halobia, and as, moreover, distortion may have come into play in the present case, I refrain from giving the specimen represented in Figure 14 a special name and unite it as *Halobia* cf. *comata* with the species described above. This specimen is, according to Diener, still younger than the original of Figure 13; it comes from No. 6 of the division of beds of the Bambanag section in the Girthi Valley, which may perhaps be the 'Hauerites beds' at the upper boundary of the so-called 'Daonella beds,' the true beds with species of Halobia of the Rugosa group. Thus we see that in the whole thickness of those 'Daonella beds,' argillaceous for the greater part, species of Halobia of the Rugosa group occur, a circumstance of rather considerable stratigraphical importance, as, in all probability, this horizon, with species of Halobia from the Rugosa group, represents, or at least includes, the lower group of beds, poor in limestone, of the Alpine trias, in which *Halobia rugosa* itself has its habitat, and consequently the Lunz Raibl beds.

There occur, however, in this complex of beds also species of Halobia of other types, which have hitherto been only found in fragments. To them belong the specimen figured on Pl. VII., *viz.*, Fig. 16, a left valve with an unmistakable beginning of an anterior ear, which may however have been flat. The specimen comes from the Shalshal section (upper trias, Bed 8), near Rimkin-Paiar, was collected by Griesbach and referred to as *Daonella Tyrolensis*. As this reference is found in Griesbach, l. c., 143, the specimen may have come from the upper part of the Daonella beds. This form has little in common with *Daonella Tyrolensis*; but it is also decidedly different from *Halobia rarestriata*, Mojs., which must be

specially pointed out, because Griesbach records this species also from other places. There may, on the other hand, be a relationship rather to the group of *Daonella* (? Halobia) *styriaca*, Mojs., but the preservation of the specimen is unfortunately not sufficiently perfect to enable one to pursue the inquiry further.

Remarks upon Halobia comata, 2.—A faintly sculptured Halobia, which I cannot distinguish with certainty from *Halobia comata*, but which as far as its state of preservation allows of an examination, is a cast on a slab of black limestone. This was collected by Griesbach north-west of Kiunglung, south-west of the Niti Pass, in the horizon of his 'Daonella beds' (cf. Griesbach, l.c., p. 123). The specimen proves that the species of Halobia of the Rugosa group in this horizon are widely distributed in the trias of the Himálayas.

The *Halobia* cf. *comata* of this compact black limestone of Kiunglung attains considerable dimensions; a second, still larger specimen that probably also belongs here may measure more than 90 mm. in length. Its wide anterior ear is recognizable, while the first-mentioned species shows the slight ribbing of the umbonal part, which distinguishes *Halobia comata* from *H. rugosa*.

From the same specimen of rock comes a small ribbed Lima, which will be described further on. A small Lingula of peculiar outline seems to be more abundant in it, but unfortunately no form suitable for illustration could be freed from the rock.

Avicula (?) Girthiana, nov. sp. Pl. VII., Figs., 17, 18, 19.

A small Avicula-like form, which deserves mention on account of its good state of preservation. The very small shells are considerably oblique, strongly inflated and provided with prominent, concentric undulations of growth, between which a faint striation of growth is visible. There is scarcely any difference in the amount of inflation of the two valves. The hinge-line, beyond which the beak projects, is short but straight; the angles formed by the junction of the hinge-line and lateral margins are rounded. The anterior ear is not sharply marked off from the rest of the shell, but it is distinctly developed and proportionally large, and separated from the remainder of the shell by its lesser inflation and a perceptible emargination of the anterior margin, to which also a slight curvature of the striæ of growth corresponds. The posterior wing is, on the other hand, only indicated by a slight flattening of the shell along the hinge-margin. I should have taken this Aviculid of so undefined and vague a character for a young form of one of the large species of Halobia occurring in these beds, if it did not possess the rather distinct, proportionally large anterior ear, tolerably sharply marked by the emargination of the anterior border, as this does not to my knowledge exist in any of the young forms of Halobia. One had to consider, in the first place, the species of Halobia of the Rugosa group, not only on account of the smooth shell, but also on account of the occurrence of such species in the 'Daonella beds.' A comparison with well-preserved young forms of the Alpine *Halobia rugosa* has shown that in *Avicula Girthiana* we are not dealing with young specimens of related species

of Halobia, as in these the ear is scarcely recognizably indicated, and, above all, does not appear to be separated from the rest of the shell by the emargination of the anterior side.

These young forms of *Halobia rugosa* are, moreover, far less oblique than *Avicula Girthiana*. Young specimens of the Indian species of Halobia of the group of Rugosa might well stand so near Alpine forms related to them that a comparison between these and *A. Girthiana* would give the same result.

Locality.—In the horizon of the species of Halobia of the Rugosa group ('Daonella beds') of the Bambanag section in the Girthi Valley (Beds Nos. 3-5 of Section 2) collected by Diener. In a larger specimen of the black argillaceous limestone this small species is represented by numerous forms with glossy black, sometimes velvety, shell, without being in association with other species.

Cassianella (spec. plur. indet.), Pl. VIII., Figs. 7, 8, 9.

The genus Cassianella, known to be one of the most important typical forms of the Alpine trias, appears to occur, and not rarely, also in the upper trias of the Himálayas, especially in the division of beds dealt with in this chapter, up to the strata with *Spiriferina Griesbachi*. Griesbach refers (l. c., p. 142) to a Cassianella from Bed 22 of the upper trias of Rimkin-Paiar (East), as ? *Opis globata*, Dtm. The specimen is a cast, figured on Pl. VIII, Fig. 9. It extremely resembles in its shape certain of the most abundant species of Cassianella of St. Cassian, especially *C. gryphæata* and *C. tenuistria*, Münst. It shows very distinctly the presence of the single faint radial rib before the commencement of the slope of the posterior side, as found in the typical *C. tenuistria* (cf. Abhandl. der k.k. geol. Reichsanst., Bd. XVIII., Heft 1, p. 58). The state of preservation of the Indian specimen precludes a more minute comparison.

In Diener's collections from the Bambanag section there are also several species of Cassianella in a very imperfect state of preservation, two specimens from which (Pl. VIII., Figs. 7, 8) are figured. They are also for the greater part casts, with only here and there remnants of the shell adhering. The latter is in the form represented in Fig. 7, rather thick, and appears to have only possessed faint striæ of growth remotely placed. The back of the shell is narrow and high, the posterior slope, on the other hand, elongated. The specimen, Fig. 8, seems broader and more regularly rounded, and possesses more crowded striæ of growth. Neither of these specimens allows of the slight keel-like rib of the first-mentioned form being recognized; both show very distinctly the sharp incision which, in the cast, separates the umbo from the plug-shapped infilling of the anterior wing, a very characteristic structure in the genus Cassianella. The three figured specimens seem to represent forms related to three different species, which would point to a rich representation of this genus in the upper trias of the Himálayas.

It is well known that the first Cassianella from the trias of the Himálayas was made known by Gümbel (Sitzungsb. der königl. bayr. Akad. d. Wissensch. 1865, II, p. 361, Fig. 13). This species, *viz.*, *Cassianella grypostoma*, Gümb., which is regarded as coming from the so-called 'Spiti sandstone' and is, therefore, lower triassic, is

compared by Gümbel himself with the St. Cassian *C. planidorsata*, and indeed possesses a marked flattening of the back, a character not exhibited by one of the specimens here mentioned, is moreover much less oblique than any of those specimens and belongs, therefore, almost certainly to a different type.

There will further on be named and described another Cassianella which originates in the horizon with *Spiriferina Griesbachi* and represents the type of the ribbed species of Cassianella.

Locality.—In the horizon of the species of Halobia of the Rugosa group (the so-called 'Daonella beds') in the Shalshal Cliff, as well as in the Bambanag section.

Lima, spec. indet., Pl. VII., Fig. 20.

A small ribbed Lima of a somewhat broad shape, with a steeply sloping anterior and a gradually flattening posterior side. Ribs to the number of about sixteen, more strongly marked anteriorly, gradually dying out posteriorly, moderately wide, flat and separated by intervals of the same width as themselves. The sloping, level, anterior area without ribbing; the anterior ear rudimentary, the posterior ear faintly wing-like, without being distinctly marked off from the shell. The species is probably related to the widely spread Muschelkalk form *Lima striata*, Goldf., which extends upwards into the Ladinic limestone of the Alps (Esino, Marmolata).

Locality.—South-west of the Niti Pass, North-west of Kiunglung, in compact black limestone beds which bear on their surface the above-named *Halobia* cf. *comata* (p. 47), and in the interior of the rock there occur besides the rare Lima more abundant fragments of a small peculiarly shaped Lingula, from which unfortunately no specimen, suitable for description, could be obtained.

Lima, spec. indet., Pl. VIII., Fig. 11.

A small Lima, whose cast shows 12 or 13 rather high and strong ribs, and whose shell is more inflated than that of the species just mentioned from Kiunglung, while its anterior slope appears less sharply marked off from the ribbed area of the shell. The specimen is moreover much too imperfectly preserved for a more minute description and comparison of it to be given, and it is only mentioned here to show that more or less similar small ribbed species of Lima occur in very different horizons of the upper trias of the Himálayas.

Locality.—In the Halorites (Tropites) beds of the Bambanag section collected by Diener.

Lima serraticosta, nov. sp., Pl. VIII., Figs. 12, 13.

This form belongs perhaps rather to Lima than to Pecten. In favour of this view are its oblique shape, the steep slope of one (anterior ?) side, and the apparently slight development of the ears. The proportionately thick shell is raised at intervals so as to form seven high roof-like ribs, on whose blunt edges the striæ of growth, elsewhere very fine and crowded, become elevated into rows of small blunt

tubercles which give a serrated appearance to the ribs. The three middle and strongest ribs only possess one row of such serrations on their crests, the weaker ribs, succeeding on each side outwardly, show on the other hand besides the chief row on the crest, one or two weaker rows of a similar kind, which rise constantly on the *outer* side of each rib. The posterior of the three middle ribs also possesses a trace of a similar accessory row of serrations near the lower margin of the shell, and here it also lies on the outward side.

Nothing definite can be affirmed as to the shape of the ears in consequence of their imperfect preservation; the posterior ear appears to be sharply marked off from the shell. The cast of this thick-shelled species is distinguished by the fact that on it (Fig. 13) the ribs stand out much more clearly from the furrows than is the case on the surface of the shell itself.

I know of no species which could be closely compared with this form, which generically remains, it is true, somewhat uncertain. Its striking shape justified, I think, a description of it so far as it was possible to make out.

Locality.—Collected by Diener in the so-called 'Tropites beds' of the Bambanag section (II). An identical, or at least very closely related form seems also to occur in still higher beds, as the cast (Pl. X., Fig. 26) shows. The latter is derived from the so-called 'Corbis-zone' of Griesbach, or Diener's Sagenites beds, succeeding the horizon of *Spiriferina Griesbachi*, likewise from the Bambanag section (II). The typical bivalve of the Sagenites beds occurs, however, also below the beds with *Spiriferina Griesbachi*, as will be shown further on (cf. *Anodontophora Griesbachi*).

(a²) *From the Horizon of Spiriferina Griesbachi, and the Sagenites beds succeeding them.*

Spiriferina Griesbachi, nov. sp., Pl. IX., Figs. 1—13.

Spiriferina Griesbachi, m., Diener, l. c., p. 26.

The most abundant species of the brachiopod-bearing latest horizon of the trias of the Himálayas as yet known may bear the name of Mr. C. L. Griesbach, the Director of the Geological Survey of India, who was the first to assign this form to its stratigraphical horizon, and who already recognised that it differed from *Spiriferina Lilangensis*, Stol., for which reason it was designated by him *S. Lilangensis*, var.

Spiriferina Griesbachi is a large and remarkable Spiriferina with very variable development of the beak and the area of the large valve, distinguished specially by its broad sinus, in which there is a single weak median rib, to which corresponds a median furrow in the small valve, and by which its median lobe is rendered bipartite.

The area, at least in the specimens from the Bambanag section on which our description is based, is mostly very high (Fig. 4), but in the same bed there are also specimens with considerably lower area (Fig. 7). The curvature of the beak above the area is considerable in specimens of the latter kind, while in

specimens with very high area the beak is almost straight, and a slight curvature takes place only at the apex. The lateral margins of the area are blunt. On each side of the very broad sinus of the large valve there are from 7 to 10 ribs, which are low and flat and the outermost of which seems more or less to be completely obliterated, so that between the ribs and the margin of the area there remains still a space without ribs, or almost without them.

The lobe of the small valve rises considerably above the lateral parts; its median furrow begins only at a certain distance from the umbo. The shell-structure is a roughly punctate one.

The dental plates are in the interior of the apex of the beak fused as by a callus with the median septum, and only become free further down; they extend to the wall of the shell and reach pretty far down at the outer side of the beak, but not so far as the median septum itself (Fig. 4).

Only one Spiriferina of the trias is known to me, which seems to be closely related to *Spiriferina Griesbachi*, viz., *Spiriferina Moscai*, m., from Balia-Maaden, in Asia Minor (Jahrb. der k. k. Reichsanst., 1892, p. 80, Tab. IV., Fig. 8). Though the specimens of *S. Moscai*, hitherto known, are imperfectly preserved, yet they admit of being distinguished from *S. Griesbachi* by the fact that the sinus is narrower and shallower, and that the median rib lying in it, as well as the lateral ribs, are stronger than in *S. Griesbachi*; and the number of its lateral ribs is also smaller. From the Alpine trias no species is yet known to me which could be compared with these two species of Spiriferina of the Asiatic trias.

Locality of Spiriferina Griesbachi.—In the Bambanag section of the Girthi Valley, near Martoli Encamping Ground, very abundant in Bed No. 8, which was named after this species as the Horizon of *Spiriferina Griesbachi*. Griesbach's Spiriferina Horizon, with Spiriferina Lilangensis, var., is evidently the same horizon.

Remarks on Spiriferina Griesbachi.—Only after I had communicated the remarks on the brachiopods of the horizon of *Spiriferina Griesbachi* to Dr. C. Diener, published in his work, p. 26, my attention was drawn to the two species, *viz*, *Spirifer tibeticus* and *Spirifer altivagus*, included by F. Stoliczka in his (carboniferous) Kuling Series (Stoliczka, l. c., p. 28, Tab. III., Figs. 1—3). These two species, which were collected by Dr. Gerard in Spiti, can by no means, however, even on the ground of Stoliczka's views, be regarded with certainty as carboniferous forms; it is, moreover, not at all improbable, on account of their close relationship to *Spiriferina Griesbachi*, that they also originate in triassic deposits Stoliczka already knew that his *Spirifer tibeticus* was a Spiriferina, and *Spirifer altivagus* is so closely related to the former species that it is simply to be regarded as a variety of *Spiriferina tibetica*, Stol., sp. These two presumably carboniferous species have been figured again for comparison with *Spiriferina Griesbachi*, on Pl. IX., Figs. 14, 15, 16, and I believe I can affirm with confidence, after careful investigation, that I am unable to find any more essential distinction between them and *Spiriferina Griesbachi* than that the ribbing is somewhat stronger and more sharply marked. The outlines which are partly different, as a comparison of Fig. 4

with Figs. 14 and 15, makes evident, cannot be regarded as distinctive, as they depend upon the varying height of the area or rather upon the degree of incurvature of the beak, and if one compares Figure 4 (*Spiriferina Griesbachi*) with Fig. 16 (*Spiriferina altivaga*), a form with likewise very high area, one will at once appreciate the small value of that distinction. There are, moreover, specimens of *Spiriferina Griesbachi* with low area and stronger incurved beak (Fig. 7) which are scarcely to be distinguished in this respect from *Spiriferina tibetica* (Fig. 14).

Stoliczka also mentions a loose specimen from the neighbourhood of Kibber, in Spiti. This is also before me, but its matrix is not a carboniferous slate as Stoliczka states, but a marly limestone, strongly effervescing with hydrochloric acid, and exactly the same as a large specimen of rock collected by Griesbach on the western slope of the Manirang Pass[1] in Spiti, and which contains numerous specimens of Spiriferina of the same type and in the same state of preservation as the specimen from Kibber. I would therefore regard these two rock-specimens as coming from one and the same bed. The rock-specimen from the Manirang Pass (cf. Griesbach's "Geology of the Central Himalayas," p. 220) was regarded as rhætic, and we are thereby reminded that Griesbach had already considered the Main Dolomite group as rhætic; it bears the museum number H. 13. 86, and is quite filled with a large Spiriferina which, on a cursory comparison, possesses a certain resemblance to the liassic *Rhynchonella austriaca*, Suess, but is in fact completely identical with *Spiriferina tibetica*, Stol., sp. The specimens figured on Pl. IX., Figs. 8—13, were derived from the locality of the Manirang Pass. I cannot of course form an opinion as to the stratigraphical position of this rock-specimen with Spiriferina from the Manirang Pass, probably found loose, but would it not be quite justifiable from all that is known concerning the distribution of the brachiopod horizon of *Spiriferina Stracheyi* to assume that here in the Manirang Pass in Spiti there is nothing more than the exact horizon of *Spiriferina Griesbachi* in the Bambanag section to be dealt with? But before this is decided, before full assurance is reached regarding the horizon and locality of the 'Carboniferous' *Spiriferina tibetica* from Spiti, and the certainly identical rhætic form from the Manirang Pass, and from Kibber, it will always be advisable in any case to separate *Spiriferina tibetica* from *Spiriferina Griesbachi*, however slight the differences between the two forms may appear, considering the material available. Should, however, the specific identity of both be fully established on the strength of their occurrence in the same beds, it would perhaps be advisable to raise the question whether the name *Spiriferina Griesbachi* should not be retained for this species, as it was assigned to a species of which the exact horizon was determined and has even been applied to designate the horizon itself. The forms *Spiriferina tibetica*, and *S. altivaga*, Stol., doubtful as to their horizon, might then be united as varieties of *Spiriferina Griesbachi*.

[1] From the locality Manirang, Spiti, there is also a small specimen of a peculiar tufi-like dark coloured rock, with some imperfectly preserved specimens of a smooth Pecten, which, judging by the structure of its shell, might be identical with *Pecten filosus*, Hauer, of the Alpine Raibl. and Cardita beds (Torer beds, Opponitz beds, at the base of the Main Dolomite).

Spirifera Vihiana, Davidson (Quart. Journ., 1866, Vol. XXII., p. 41, pl. XXII., p. 4), very closely related to *Spiriferina Griesbachi* and *S. tibetica* may also be referred to here ; it comes from the vicinity of Vihi in Kashmir, and is regarded as carboniferous. That similar forms already occur in the devonian is shown in Oehlert's work " Fossiles dèvoniens de Santa Lucia (Espagne)" in Bull. Soc. Gèol. de France, 3 sèr., XXIV., 1896, p. 814, Figs. Tab. XXVIII.

Retzia Schwageri, Bittn., var. Asiatica, nov. Pl X., Figs. 16—20.

A Retzia from the somewhat older horizon of *Halobia comata* has already been mentioned under the above name (see p. 42). *Retzia Schwageri*, var. *Asiatica*, regarded as typical, belongs to the most abundant species of the horizon of *Spiriferina Griesbachi*. It is perhaps, at least in the Bambanag section, more abundant than *Spiriferina Griesbachi* itself, but is less striking on account of its smaller size. I have more than 20 specimens before me which were got from the few fragments of the Spiriferina rock brought home by Diener. They show all stages of growth, and their length varies from 2·5 mm. up to 13 mm., and even more. They are distinguished from the somewhat older form of the ' Daonella beds ' and from the *R. fastosa* of the European Dachsteinkalk, by a constantly larger number of ribs, as already mentioned above (p. 43). Already in the smallest individuals five lateral ribs are to be recognised on each side of the small valve, and in larger specimens there are always six present. For the rest they completely agree with the upper triassic forms of this type. Most of the larger forms are of considerable thickness, and they may therefore be regarded as full grown. A certain variability in the outline, characteristic also of this species, is very well shown in the illustrations, Figs. 18, 19, 20. This variability does not overstep certain limits, as it is also known to be the case in other triassic species of this genus. Something has already been said about its relationship with European forms (p. 44).

Locality.—Not rare in the beds with *Spiriferina Griesbachi*, m., of the Bambanag section in the Girthi Valley. Related or identical forms seem to be quite generally distributed in the group of beds, chiefly marly, between the Muschelkalk and the Main Dolomite horizon of the Himálayan trias.

Spirigera Dieneri, nov. sp., Pl. X., Figs. 1—14.

Spirigera Dieneri, nov. sp., Diener, l. c., p. 26.

As a third abundant and characteristic species in the beds with *Spiriferina Griesbachi* may be mentioned *Spirigera Dieneri*, a form which is distinguished by a certain strikingly characteristic habit from the above-mentioned species of Spirigera from the older triassic formation of the Himálayas, which appear so vague and undefined. This form is also before me in the different stages of growth ; the smallest forms scarcely measuring 3 mm. in length, while the largest reach a length of more than 15 mm. Even the smallest individuals are very stiking

forms with a distinct longitudinal furrow in the middle of the large, as well as in that of the small, valve. Within the space of 5 mm. the median furrow of the small valve dies out, while that of the large valve developes into a median sinus which widens and deepens continuously, and, in the largest specimen finally forms a triangular frontal tongue, deepened in the centre, to which, on the small valve, a median lobe corresponds, so that in these largest forms the large valve retains its original bipartite character, while the small valve gradually assumes a distinct tripartite shape, by which the median furrow of its umbonal portion generally remains quite distinctly preserved. The development of the external form of the shell is thus in *Spirigera Dieneri* very similar to that of *Spirigera eurycolpa*, m., from the Alpine Dachsteinkalk (Abhandl. d. geol. Reichsanst., XIV, p. 273, Pl. XXIX., Figs. 7—14). It is almost superfluous to remark that *Spirigera Dieneri* also possesses a very considerable variability; there being among specimens of equal size, including the most abundant type, strikingly narrow (Fig. 6), as well as strikingly wide forms (Fig. 8). These variations do not however extend to a greater degree than one is accustomed to meet with in related forms (for example in the abundant *Spirifera Strohmayeri*, Suess, of the Noric Hallstatt Limestone; Abhandl. d. geol. Reichsanst., XIV., Pl. XV).

The shell of *Spirigera Dieneri* is rather thin, and most specimens are for the greater part preserved as casts. Only the umbo of the small valves, and the sides of the beak are thicker-shelled. In this respect *S. Dieneri* is thus united with the older *S. Stoliczkai*, with which it has also in common strong dental plates in the beak extending to the shell-wall. *Spirigera Dieneri* also possesses haplospire spiral cones; it consequently belongs to the true Spirigera species. Forms with diplospire structure are not yet known among the few species hitherto described of Spirigera of the Himaláyan trias.

From the above-mentioned *Spirigera eurycolpa*, m., of the European Dachsteinkalk, *Spirigera Dieneri* is distinguished not only by its much smaller size, but also by the quicker disappearance of the median furrow in its small valve with increasing growth; the two species are by no means closely related to each other. The same may be affirmed with regard to *Spirigera pachyrhyncha*, m., of the Hallstatt Limestone, which may, moreover, probably be reckoned as belonging to the diplospire group or sub-genus Pexidella, m. This species is also wanting in the much-deepened sinus of the large valve, and the median lobe of the small valve is only indicated near the front margin, so that the small valve does not appear to have such a distinctly tripartite character as that of *S. Dieneri*. On the other hand *S. Dieneri* seems to approach very closely to the palæozoic forms (carboniferous) of Spirigera of the sub-genus Seminula (*S. subtilita*, Hall, *S. trinuclea*, Hall).

Locality.— Not rare in the horizon of *Spiriferina Griesbachi* in the Bambanag section, near Martoli Encamping Ground in the Girthi Valley.

Amphiclina, sp. Pl. X., Fig. 15.

A minute shell which certainly belongs to a species of the genus Amphiclina; it has the undefined form of *A. Lunzensis*, m., or *A. austriaca*, m. It represents, at

present, the only form of this genus which is yet known from non-European triassic deposits. I have lately had occasion to describe an Amphiclinodonta from the trias of Balia Maaden in Asia Minor (Jahrb. d. geol. Reichsanst., 1895, p. 252). When one reflects how little we knew, and that not very long ago, about the species of Amphiclina. so generally distributed in the Alpine trias (cf. Abhandl. d. geol. Reichsanst., Band XIV), one may be allowed, at the first discovery of an Amphiclina in the upper trias of the Himálayas, to indulge in the hope that these insignificant but interesting brachiopods may also be found there more abundantly.

Locality.—In the beds with *Spiriferina Griesbachi* in the Bambanag section of the Girthi Valley.

Rhynchonella Bambanagensis, nov. sp., Pl. IX., Fig 18.

A Rhynchonella from the Hauerites beds of the Bambanag section has already been described above as *Rhynchonella Bambanagensis*, (p. 44). A form closely related to it, which may well be regarded as specifically identical, taking into account the poorness of the material at hand, is represented by three specimens, also from the somewhat younger beds with *Spiriferina Griesbachi* in the Bambanag section. The specimen figured (Pl. IX., Fig. 18) is distinguished from the single form from the Hauerites beds (Pl. VIII., Fig. 4) only by a ribbing beginning somewhat nearer the umbones, and by a symmetrical frontal area, to whose elevated part the five middle ones of the 14 to 16 ribs of the small valve belong.

In this specimen, however, one side (the right side), as in the specimen from the Hauerites beds, is in the front view, so to speak, somewhat aborted, and here, as there, a rib is inserted at a distance from the umbo on this side. One of the two other specimens from the beds of *Spiriferina Griesbachi* also possesses an asymmetrical frontal area exactly like the figured specimen from the Hauerites beds. The last specimen is again a symmetrical one, with six ribs in the middle of the elevated frontal area. The beak is a short, pointed, Rhynchonella beak, with delicate dental plates, extending to the wall of the shell. As to the mutual relationship of the species, mention has already been made (p. 45). Forms, also symmetrical, of *Rhynchonella levantina*, m., there referred to, are distinguished from the Indian species by considerably smaller width. The symmetrical form of *Rhynchonella Bambanagensis*, on the other hand, vividly recalls *Rhynchonella Mentzeli* of the Alpine Muschelkalk, which however, shows a stronger ribbing arising from the umbones themselves.

Locality.—In the beds with *Spiriferina Griesbachi* in the Bambanag section of the Girthi Valley.

Rhynchonella Martoliana, nov. sp., Pl. IX., Fig. 17.

A single specimen of a Rhynchonella, unfortunately badly preserved, of the remarkable winged type of the Alpine Muschelkalk species, *Rhynchonella vivida*, m., and *R. volitans*, m. (Abhandl. d. k. k. geol. Reichsanst., XIV., pp. 10, 47, Pl. 31, 32).

The large valve of this species possesses two middle ribs and four or five lateral ribs which are very fine at the apex of the beak whence they arise. The median lobe of the small valve must therefore have had three ribs. The middle ribs as well as the lateral ones originate at the beak. They are not, so to speak, excluded from the back of the beak by the union of the inner lateral ribs above the median sinus. In connection with this the median sinus of the large valve in *R. Martoliana* is only indicated near the umbo by a slight depression, and the profile contour runs from the beak up to this in a strongly convex arch, while in the Muschelkalk species mentioned above the median depression of the large valve begins quite near the beak. This dfference is not clearly enough defined in the illustration (Fig. 17). The lateral parts of the valve are in the same manner widened into wing-like forms, and thinned out, as in *Rhynchonella volitans*. The beak is, in connection with the outer contour of its median line, somewhat curved forward. The present description of this single fragment suffices at the same time to permit of its dissimilarity to the Alpine Muschelkalk species with which it has been compared coming into prominence. A species of this type is not yet known to me from the upper Alpine trias.

Locality.—In the beds with *Spiriferina Griesbachi* of the Bambanag section, near the Martoli Meadows in the Girthi Valley.

AULACOTHYRIS JOHARENSIS, nov. sp., Pl. IX., Figs. 19, 20.

An *Aulacothyris Nilangensis* of a very indefinite shape, from the horizon of *Daonella indica*, has been described above (p. 30). In the beds with *Spiriferina Griesbachi* a very similar species occurs, which can only be distinguished from the older species by unimportant features.

The oval shell of this younger species, inclined to be somewhat pentagonal in shape, seems to possess a finely punctate shell-structure, and while the median septum of *Aulacothyris Nilangensis* appears as a strong, thick, but somewhat indistinctly defined streak, in *Aulacothyris Joharensis* it is, for an equal length, a very fine but extremely distinct, dark line. This septum, as well as the slightly divergent dental plates in the beak extending to the shell-wall, indicate also that this form is, in spite of its little characteristic shape, a true Aulacothyris. Its beak is small, depressed, and only slightly hollowed out under its rounded lateral margins. The surface is smooth; coarse concentric striæ of growth, which occur in nearly all specimens of *Aulacothyris Nilangensis* are wanting in this species. Traces of very fine striæ of growth appear only here and there (these have been represented a little too coarse in the illustration). Otherwise this species stands, as already stated, very near the older *Aulacothyris Nilangensis*, and is distinguished also in a similar manner to this from the known species of the Alpine trias.

Locality.—In a few specimens from the beds with *Spiriferina Griesbachi* of the Bambanag section, near Martoli Encamping Ground in the Girthi Valley.

CASSIANELLA PULCHELLA, nov. sp., Pl. VIII., Fig. 10.

A very elegant small Cassianella of a broad shape and with a moderately inflated left valve, the only valve known. It belongs to the forms with fine radial ribbing. The central inflation of the shell is broadly-rounded and bears posteriorly, in the same position as in the St. Cassain species *C. tenuistria*, a single remarkable slender radial rib, a kind of keel. Moreover, the entire central inflation in front of this keel, as also the slope of the shell behind the keel up to the saddle-like depression in front of the weakly-developed posterior wing, is covered with numerous very fine radial ribs, which are about 15 or more in number, in front of the keel, and about the same number behind the keel. The small ribs situated in front of the keel are very feebly developed and differ little from each other in strength; in some specimens the most anterior group of these is a little more strongly raised, while the succeeding ones become weaker, so that here and there in the middle of the shell, in the front of the keel-like rib, a very slight radial depression is formed, which becomes only preceptible through the projection of the keel-like rib. The small ribs behind the latter are more crowded and somewhat stronger than those in front of this principal rib, especially the ribs nearest to the keel being generally the strongest in the whole shell, though they do not attain to the strength of the keel-like rib. In a few individuals a differentiation makes itself apparent among them, for those lying immediately above the posterior slope appear the strongest.

In the best preserved specimens three weak ribs succeed behind the keel, and after these two remarkably strong ones, which enclose a thin intervening rib and come next to the keel in point of strength. This differentiation of the posterior ribs is less striking in the remaining specimens before me, but it always exists. The posterior wing is only free from ribs at its narrow border, while on the more strongly defined anterior wing, which, however, is not well preserved in any of the specimens, the striation of growth seems to predominate over the ribbing. It is true the striation of growth is, over the rest of the shell, everywhere distinct, but not so strongly developed as to produce an actual reticulation of the surface. The radial striation, however weak it is in itself, predominates. One could most properly speak of a net-like sculpture on this posterior slope of the shell, where the striation of growth also becomes somewhat stronger. *Cassianella pulchella* is evidently a species closely related to *Cassianella speciosa*, Mer., from the Kössen beds of the Alps, and may perhaps be regarded as the precursor of that species, which scarcely possesses nearer relationship among the older Alpine species of Cassianella. But, apart from the very different size of the two species, the keel-like rib would never stand out in so remarkable a manner in *C. speciosa;* moreover, the posterior wing of the Kössen species is almost quite free from ribs.

Locality.—In the beds with *Spiriferina Griesbachi* of the Bambanag section in the Girthi Valley. From the rock specimens brought home by Diener, four specimens, left valves throughout, could be obtained. Right valves even of the most abundant species of Cassianella of the Alpine trias are, as is known, very rarely found.

LIMA CUMAUNICA, nov. sp., Pl. X., Fig. 25.

A small neat species, narrower and perhaps also a little more oblique than the two forms illustrated on Pl. VII., Fig. 20 and Pl. VIII., Fig. 11, derived from older beds. The surface bears about 15 ribs, which do not extend to the anterior, steeply sloping somewhat hollowed portion of the shell, while towards the posterior they die out without previously becoming much weaker and leave a narrow space along the hinge-margin free. They are simple, broadly rounded or flattened, not roof-shaped, separated by intervals which are narrower than the ribs themselves. The striæ of growth are scarcely perceptible. The anterior ear is distinctly developed, while the posterior forms a kind of wing which is almost as steeply sloping as the anterior part of the shell.

This small species seems also to be a straggler of the Striata-group of the Muschelkalk; it is distinguished from certain forms of the Alpine trias (*e.g.*, *L. Telleri*, m., from the Esino Limestone, *L. paulula* from the Cardita beds) by its narrower shape as well as by its less numerous ribs, which quickly die out towards the posterior part of the shell.

Locality.—From the beds with *Spiriferina Griesbachi* of the Bambanag section in the Girthi valley, in two tolerably well preserved valves.

PECTEN BIFORMATUS, nov. sp., Pl. X., Figs. 23, 24.

A small Pecten with quite peculiar sculpture. The surface is ribbed, the ribs are arranged in bundles, that is they arise out of a three- to four-fold division, from a few (9-10) principal ribs, so that at the margin of the valves 30 ribs can be counted, of which the middle ones are mostly arranged regularly in bundles of four, the lateral ones, however, being less regularly grouped. The posterior part of the shell, the steep slope towards the scarcely distinctly defined posterior ear, is differently ornamented, for from the last strong radial rib radiates a weak ribbing or striation towards the posterior margin in the manner of a quill with feathers on one side. This ribbing varies in strength in different individuals, in some it being only very faint, indicated as a kind of irregular wrinkling, in others more regular, stronger, and even deepening towards the margin. Here and there it is even interrupted by traces of a radial furrowing. The byssal ear of the right valves is likewise radially ribbed. The above remarks are applicable in the first place to the right valve. The left valve forms in its sculpture the 'negative,' so to speak, of the right valve, for, while in the right valve the furrowing dominates everything, the ribs represent the more conspicuous element in the left. There are thus in the right valve bundles of ribs between the strong furrows; in the left valve, however, between the principal ribs there are furrows subdivided by secondary ribs. The sculpture of the right valve appears therefore deepened or grooved, that of the left valve raised. The entire inflation of the left valve is also somewhat stronger than that of the right valve, so that in this species the lower and upper valves are markedly different. This distinction however is unfortunately not sufficiently expressed in the illustration of this species, the figure of the left valve (24) more

specially leaving much to be desired. The sculpture of the left valve resembles indeed very closely that of the left valve of *Pecten interruptus* figured beside it (Fig. 22). The strong radial ribbing of the anterior ear is also not sufficiently indicated in Fig. 24. The striæ of growth in *Pecten biformatus* are only slightly marked.

I know of no species which could be compared in the peculiar sculpture of the shell with the form here described, which seems only to attain a very small size.

Locality.—Apparently not rare in the beds with *Spiriferina Griesbachi* of the Bambanag section, for seven, mostly fragmentary separate valves, among which both valves are represented, were obtained from the rock-specimens brought home by Diener.

PECTEN INTERRUPTUS, nov. sp., Pl. X., Fig. 22.

With *Pecten biformatus* occurs a second larger species of Pecten, of which, however, only a single partially preserved valve (apparently the left) is available, which possesses a ribbing quite similar to that of the left valve of *P. biformatus*, that is, a number of slender principal ribs, in the intervals of which several systems of finer accessory ribs are inserted ; the fine transverse striation, however, of the posterior portion of the shell is wanting in this larger species, and also the two ears are almost equally strongly defined, and apparently smooth or without ribs. The place where the shell merges into the ears is marked on each side by narrow but steep, almost furrow-like, deepened slopes. The figured form possesses a striking interruption of growth in the middle of the shell, beyond which the ribbing certainly continues, but is considerably weaker ; the contrast, however, is too strongly expressed in the illustration.

The species recalls *Pecten Landranus*, m., from the Alpine trias (Abhandl. d. geol. Reichsanst., XVIII., Heft I., p. 166, Pl. 19, Fig. 21) without, however, being identical with it.

Locality.—Collected by Diener in the beds with *Spiriferina Griesbachi* in the Bambanag section.

ANODONTOPHORA[1] GRIESBACHI, nov. sp., Pl. VIII., Figs. 14, 15, 16.

This shell, very similar in fact to the greatly lengthened form of the genus Gonodon,[2] Schafh. (*Schafhautlia*, Cossm., Corbis, auct.), widely distributed in the Alpine triassic deposits, proves, by its thin shell and further on account of the want of teeth, the non-existence of a pallial sinus, and its non-gaping shell, as most probably belonging to that group of forms to which has been applied hitherto the generic name Anoplophora, Sandb., which has however been recently replaced by M. Cossmann by the term Anodontophora.

[1] Anodontophora is proposed by M. Cossmann in his Revue critique de Paléozoologie, Nr. 2, Avril, 1897, as a substitute for Sandberger's generic name Anoplophora, already long preoccupied.

[2] Also Gonodon, Schafh., belongs, according to M. Cossmann, to preoccupied names. He proposes, as cited above, the generic term Schafhautlia.

This tolerably large bivalve is before me both as shells and as casts, and appears not to be rare in the uppermost marly layers of the series of beds devoloped between the Muschelkalk and the Main Dolomite, which were therefore formerly designated by Griesbach as the Corbis beds, because the form was first determined as *Corbis Mellingii*, Hauer, var., which seems to be very intelligible from what has just been said. Other specimens from Griesbach's collections bear, however, the designation 'Anoplophora Fassænsis, Wissm., spec.,' which comes already very near the true relationship, for among the species of Anodontophora (Anoplophora) of the European trias this very species stands doubtless nearest to the species under description. According to Dr. Diener's collections *A. Griesbachi* occurs also already lower down in the 'Tropites beds,' and seems also not to be absent in the beds with *Spiriferina Griesbachi*.

The specimens from the black limestones of the 'Tropites beds' are preserved with their test (Figs. 14, 15). This is very thin in proportion to the size of the shell, and covered with numerous fine and distinct striæ of growth, which become crowded and stronger towards the pallial margin, and are sometimes accompanied by a few stronger interruptions of growth. A radial sculpture does not exist. The outline, a little sub-angular, is very well rendered in the illustrations; the umbo projects pretty considerably, without being particularly strong; it is only shifted from the middle towards the anterior, or is almost medianly situated; its incurvature towards the anterior is inconsiderable; a distinctly defined lunule is wanting. The umbones might touch one another, as there remains only a very slight interval between them in the casts. The test is, moreover, only thin near the umbones, and a slight filing (Fig. 15) was sufficient to prove that a strong hinge-plate with tooth structure did not exist.

The smooth casts of this species from the marly layers of the younger Sageni-tes beds (Fig. 16), which, towards the pallial margin, mostly show some strong concentric undulations, also prove the non-existence of a hinge and also furnish evidence that the shell nowhere gaped. The muscular impressions are tolerably distinct for the thin shell; a pallial sinus is not perceptible.

As already mentioned, the lower triassic *Anodontophora* (*Anoplophora*) *Fassænsis*, Wissm., sp., is the only species with which *Anodontophora Griesbachi* shows any great resemblance, but it must here be pointed out that the lower triassic species of C. W. Gümbel is also recorded and figured from Spiti.

Locality of Anodontophora Griesbachi.—Several specimens collected by Diener from the 'Tropites beds' of the Bambanag section, besides *Lima serrati-costa*, described above.

An unquestionable specimen in Diener's collections is designated as also being derived from the 'Brachiopod beds' (*i.e.*, the beds with *Spiriferina Griesbachi*) of the Shalshal section.

Most abundantly perhaps in Diener's still younger 'Sagenites beds,' in the section of the Shalshal Cliffs, where this species was first found by Griesbach. It also possesses a certain vertical distribution in the upper layers of the marly series of beds among the Main Dolomite equivalents. This distribution seems also to be

common to several other species of bivalves and brachiopods (e.g., *Lima Serraticosta*, *Retzia asiatica*, *Rhynchonella Bambanagensis*), judging by their association.

Remarks.—The few other bivalves occurring in the Sagenites beds, besides the above (a smooth Pecten, a finely ribbed Lima, etc.,) are represented by specimens so imperfectly preserved that we must abstain from a closer inquiry of them.

(b) *Species from the Upper Division of the upper triassic Deposits of the Himálayas (from the Dolomites and Megalodonta-bearing Limestones.)*

MEGALODON CULTRIDENS, nov. sp., Pl. XI., Fig. 1.

Among the few species of Megalodon lying before me from the uppermost trias of the Himálayas there is one specimen especially noteworthy; it is for the most part a cast with the umbo of the right valve particularly well-preserved. Parts of the umbones, together with the very thick-shelled portions, lying in front of and between the umbones, are also present as test. As the rock, a gray friable dolomite, was very easily removed from the lunular cavity, and thereby it was seen that the fragments of the two valves were separated by a layer of rock penetrating between them, an attempt was made to isolate the two hinges and this succeeded surprisingly well. It is true that the points and edges of the hinge-teeth on the right side remained adherent to the rock of the opposite side, and on account of their brittle, crystalline condition could not be freed from it, but after they had been completely removed a plaster cast of the right hinge was taken from the mould thus obtained. The exposure of the hinge of the left valve, hidden by a thin dolomite coating, was then made, and its uncommonly high and acute teeth were found to be preserved in the most complete manner.

The teeth of the left valve are three in number. They run almost parallel to one another as remarkably high and acute ridges (Fig. 1 c (left) 1 d), which leave very deep furrows between them. The two anterior teeth (Fig. 1 d is viewed from the lunule) are almost equally high, and stand near each other, while the hindmost tooth, which is at the same time the lowest and shortest, leaves a larger space between itself and the preceding one. The edges of these hinge-teeth are sharp, almost cutting; their greatest height is inclined towards the umbo, and from thence they rapidly slope towards the anterior, that is, the upper hinge-contour; the foremost is bent into an angle at its highest point with a tendency of its edge to become double. All the three teeth agree in being gradually curved in their course outwards and towards the anterior. The posteriorly lying portion of the thick but narrow hinge-plate, which is remarkably extended in the direction of the height (it—the hinge-plate—is perfectly preserved in the region of the teeth, also in its inner side), is almost completely level, and only towards its anterior margin some fold-like indistinct elevations are visible which run almost parallel to the upper, anterior parts of the dentition. Immediately backwards from the hinder hinge-tooth runs a flat furrow which cannot be regarded as a tooth-groove, as in the right hinge scarcely any perceptible ridge corresponds to it, so that here the groove for

the third, left tooth, is actually hollowed out of the hinge-plate. In front of the third tooth of the left valve there lies a very large, wide and deep tooth-groove for the hindmost tooth of the right valve, whose point inserts itself immediately in front of the point of the third left tooth, into the deepest cavity of this large tooth-groove (in a position which is faithfully rendered in the illustration), while the groove itself, gradually flattening, reaches the anterior margin of the hinge-plate. In the lower, that is, posterior part of this groove, which likewise becomes shallower and at the same time narrower, indistinct secondary ridges are perceptible at its base. The grooving between the two anterior teeth of the left valve, however narrow and deep it may appear in consequence of the height of these teeth, does not cut with its base into the body of the hinge-plate itself, as the posterior tooth-groove does. It is only the case again with the anterior hinge-groove, lying in front of the foremost tooth. It is at least as deep as the posterior groove, but it could not be completely laid bare on account of the very brittle condition of the shell at this place, if the specimen had to be preserved.

We have thus to indicate as elements of the left valve, three teeth and a groove lying in *front* of each tooth; the middle one of these grooves, which is hollowed out between the two narrow and high anterior teeth, does not sink into the mass of the hinge-plate, as is the case with the anterior and posterior tooth-grooves. To these two deep or principal tooth-grooves of the left valve correspond the two chief teeth of the right valve, which are much less trenchant, acute and high, but are broader and more massively-developed than those of the left valve, and which leave between them an enormously wide and deeply hollowed-out space, which represents the common hinge-groove for the two anterior knife-like teeth of the left valve, which in a certain degree fit, as a double-tooth cleft by a median groove, into this wide cavity, in which, besides a great number of secondary tooth-ridges, those deepest hollows, which correspond to the highest points of the teeth on the left side, are very distinctly marked. These conditions are very correctly rendered in the drawing. To the two anterior sharp tooth-ridges, or knife-like teeth of the left valve, thus corresponds actually a very large common groove, in the hinge of the right valve. As a sub-division occurs in this groove through the rising of low secondary tooth-ledges, so the posterior tooth of the right valve divides towards the inside, and the ridge of the anterior tooth of this valve gives off (towards the anterior and below) to distinct, lower, accessory ridges. Through the tendency of the hinge-teeth to cleave and sub-divide, the development of the two narrow and sharp knife-like teeth of the left valve is perhaps to be explained in this species. The furrow between these two teeth, however narrow and deep it is, nevertheless does not cut into the body of the hinge-plate, as a true hinge-groove ought to, and to which no real hinge-tooth of the right valve corresponds, while the two knife-like teeth separated by it only possess a common hinge-groove in the right valve. To this wide and deep tooth-groove an enormous hinge-tooth of the left valve ought to correspond; instead of this the two anterior knife-like teeth appear, which by a great economy of shell-material might perhaps perform the same service even in a superior degree.

The question now arises whether this unusual hinge-structure occurring in

Megalodon cultridens can be brought into harmony with that of the remaining species of Megalodon known, in the first place, with the upper triassic species of the Alps. This question can be immediately answered in the affirmative on the basis of comparison with the original specimens of the south Alpine forms, viz., *Megalodon Tofanæ*, and *M. Damesi*, described by R. Hœrnes (Denkschrift. der Wiener kais. Akad. d. Wissensch., 40 Band, 1880).

The agreement of the hinge-elements in these south Alpine species of Megalodon with those of *M. cultridens* is, in spite of their very different appearance at first sight, very complete, so that there can be no doubt as to the perfect analogy of the structure of the hinge in all these species. A comparison may especially be made with the illustrations of R. Hœrnes (Tab. II., Fig. 2 d, e; Tab. III, Fig. 1a, b; 2a, b). These south Alpine specimens show the following hinge-structure. In the left valve a posterior, rather feebly developed hinge-tooth, to which a posterior groove, only slightly excavated, corresponds in the right valve; in front in the left valve a deep and rather wide groove for the strong posterior tooth of the right valve seems to be often longitudinally furrowed in the centre. In front of this principal tooth of the right valve lies a remarkable tooth-groove of extraordinary breadth, which is very characteristic, especially in the specimen, Tab. II., Fig. 2e. To this groove corresponds in the left valve the entire hinge-area between the two tooth-grooves of this valve, which area consists in several forms of a distinct posterior tooth ledge and of an anterior tooth protuberance, which are separated from each other by a furrow which does not cut into the body of the hinge-plate. R. Hœrnes only takes the anterior protuberance for a hinge-tooth; in his original figures (Tab. II., Fig. 2, and Tab. III., Fig. 3) the posterior ledge of this hinge-area is, however, as strongly raised, or perhaps still more strongly (III., 3) raised than the posterior hinge-tooth of the same valve; this may, therefore, in connection with the tooth protuberance lying before it, certainly be regarded as a double tooth, or more correctly as a bifid tooth, which, from its position, completely corresponds to the two knife-like teeth of the left valve of *Megalodon cultridens* and fits exactly like this into a common large tooth-groove of the right valve. In front of this anterior tooth-structure of the left valve there is besides the anterior tooth-groove of this valve, which is destined to receive the anterior strong tooth protuberance of the right valve. The similarity of the hinge-formation between *Megalodon Tofanæ*, and *Megalodon Damesi*, R. Hœrn., on the one hand and *Megalodon cultridens*, nov. sp., on the other, is therefore so far-reaching that their differences must be confined to the more or less strong developement of the separate hinge-elements. These forms, it is true, represent extremes in this respect, for the tooth-structure in the two Alpine species, compared with that of the Asiatic form, appears actually as if stunted in growth. The hinge-formula of these species of Megalodon would, therefore, be the following:—

$$\begin{array}{ll} \text{L:} & 10\hat{1}0, \\ \text{R:} & 0101 \end{array}$$

from which it is to be remarked that the compound tooth $\hat{1}$ represents a type other than the cleft tooth $\hat{1}$ of Trigonia, Mactra, and others, and would, therefore, be better

indicated by a different sign, as perhaps ï. The anterior muscular impression lies also in *Megalodon cultridens* in a deep and narrow indentation which separates the hinge-plate from the anterior border of the shell. The lunule in front of the umbones is only slightly excavated, and not very distinctly bordered towards the outside by a slight radial furrow. The ligamental area between the umbo and the hinge-plate is distinctly developed. The test at the umbo and hinge-areas is very thick, as is illustrated in Fig I b, which represents the right valve from the exterior with the inner rock wedge of the infilling of the umbo. The interior of the umbo possesses several ridges and furrows, which run far down from the apex (Figs. 1, 1a, 1b). These are wanting in the cast of *Megalodon Tofanæ* figured by R. Hœrnes (Tab. II., Fig. 1), except the furrow lying far backwards at the outer side, becoming very strong below, which is present in that south Alpine specimen. The striation of growth on the outer side is fine and crowded, arranged in irregularly distributed, concentric swellings; it runs uninterruptedly through the slight radial furrow in front of the lunule, scarcely deflected, into the lunular and ligamental area. The latter is separated by a perceptible ridge from the area behind the umbones, which area is again bordered by a sharper angular ridge of the shell, upwards and outwards. The lower portions of the shell are not present, but Fig. 1 may represent their outline (in the cast) with approximate correctness. In specimens with the test the thick-shelled umbones would almost or completely touch one another. The species, on account of its hinge-structure, is not to be united with any of the hitherto-known species of Megalodon.

Locality.—The only specimen hitherto known comes evidently from F. Stoliczka's collections; the vicinity of Lingti Sumdo (Tibet ?) is given as the locality.

Megalodon Ladakhensis, nov. sp., Pl. XII., Fig. 2.

Megalodon cf. *gryphoides*, Gumb., R. Lydekker, Mem. Geol. Survey of India, Vol. XXII., 1883, p. 164, Pl. IV., Figs. 1—4.

As *Megalodon* cf. *gryphoides*, Gumb, R. Lydekker has already figured a form of a Megalodon not very well preserved, which is distinguished from all species yet known by the striking breadth of the umbonal half, looked at in profile (cf. Pl. XII., fig. 2a). The specimen is slightly inequivalve, the left valve perceptibly larger than the right one; the umbo strongly incurved, lying far towards the anterior; the lunule in front of the umbo small, indistinctly defined, but deeply excavated; the area behind the umbones very large, forming a deep re-entering angle which is almost a right angle. The ligamental groove seems to have been large.

This form, with all allowance for its bad condition is not to be united with any species as yet known. It is especially to be noted that there is no species known whose umbonal half would widen so unusully quickly, a circumstance which gives a very extraordinary outline to the shell. To this must be added the abnormally large and deep area as a second striking feature, which, combined with the one first mentioned, sharply separates the Asiatic form from *Megalodon gryphoides*,

Gumb., compared with it. Forms of *Megalodon triqueter*, auct., with broad umbones might rather be compared, but in these also the contour of the lateral view differs very much, and the area is only very slightly excavated. In the latter respect *Megalodon scutatus*, Schafh., and certain specimens of the South Alpine forms, described by R. Hœrnes, stand nearer, but these forms do not even approximately reach the breadth of the upper half of the shell, which altogether possesses a more or less triangular lateral outline. The almost four-sided, stumpy shape of the lateral view of the Asiatic form distinguishes it best from all species of this genus hitherto described.

Locality.—According to Lydekker from a dark limestone from Shargol, in Ladakh. Stoliczka records *Megalodon triqueter* from Spiti and Rupshu in his well-known work, p. 64. Nothing of this species is to be found in the material which has come into my hands. As *Dicerocardium Himalayense*, Stol., next to be dealt with, bears the Museum number $\frac{H\ 47}{471}$, and the above described *Megalodon Ladakhensis*, on the other hand, the number $\frac{H\ 47}{472}$, it seems as if this Megalodon was likewise found by Stoliczka. It is perhaps identical with a specimen mentioned by Stoliczka from the Para Valley.

Dicerocardium Himalayense, Stol., Pl. XII., Fig. 1.

Dicerocardium Himalayense, Stol., l. c., p. 63, Pl. VII.

This species has already been described and very well figured by Stoliczka. He has in one respect succeeded even better in the illustration than is the case with the one here given from the same specimen, for it represents the roughness of the shell surface more distinctly, while the present illustration appears much too smooth and polished. On the other hand, the front view (Fig. 1) in Stoliczka makes the roof like blunt back, which runs from umbo to umbo in an arch across the anterior sides so little conspicuous, that this view could as readily be taken for the back view but for the striation of growth being more distinctly represented. This anterior ridge, running from umbo to umbo, is in *Dicerocardium Himalayense* not developed as an actual inflation in the manner that it is in the two closely related Alpine species, *Dicerocardium Jani* and *D. Curionii*, Stopp. It is very strongly marked in these two species, specially in *D. Curionii*, which is otherwise in its outline nearer to the Indian species, as pointed out by Stoliczka. This anterior ridge gets stronger at the two umbones also in *Dicerocardium Himalayense*, and the bundle-like striation of growth crossing over this ridge rises upon it into separate strong knobs. The section of the broken-off umbo (Fig. 1d) shows best the enormous thickness of the hinge-side of the umbo.

Locality.—According to Stoliczka, east of the village of Chiote in North-western Spiti, from the so-called Para Limestone. Similar forms, among them perhaps specifically different ones, are according to Stoliczka extremely abundant in this horizon through the whole of north Spiti and south Rupshu.

IV.—APPENDIX: SPECIES FROM BEDS THE AGE OF WHICH IS NOT PRECISELY KNOWN.

MYOPHORIA, ex. aff. OVATÆ, Goldf., Pl. I., Figs. 25—29.

Deposits having a facies of the Alpine Werfen slates are yet unknown from the southern chain of the Himálayas. Long ago (Sitzungsb. der Münchener Akad. d. Wissensch., 1865, II., I., p. 348) Gümbel, on the other hand, from the material brought home by the brothers Schlagintweit, made probable, on petrographical grounds, the occurrence of characteristic Werfen beds in Spiti (Tibet). A small number of species from the sandstone of Balamsali, near Dankhar, have been described and figured by him. Perhaps to this, or to a related horizon, belongs a rock of a peculiar impure calcareo-arenaceous character, that is before me in several fragments, containing bivalves contorted in different directions, and coming from the Dras Valley in Kashmir. It is evidently the same occurrence which Stoliczka mentions in Memoirs, G. S. I., V., p. 349, and from which he names *Megalodon columbella*, Hœrn. The original label of the locality has this designation, but only indicates the rock briefly as 'Trias.' The bivalves contained in it are, however, not Megalodon, but Myophoria from the Group of *Myophoria ovata*, Goldf., which in the Alpine trias, especially in the lower horizons, abound in the Werfen slates. The exposure of the hinge hardly allows any doubt as to their generic position. They are thick-shelled forms, of considerable size, with a strong keel on the posterior side, but so much distorted throughout in the different directions that a correct determination of the original outline is difficult. Specimens like those represented in Fig. 25, or Fig. 29, may come nearest to the original form. The surface of the shell is smooth, its substance dark-coloured. The hinge was exposed on several left valves, and in spite of the distortion, admits of the Myophoria hinge being recognised. The large triangular tooth somewhat emarginate, seems to lie a little more towards the anterior than is usual; in consequence of this the principal groove in front of it is more weakly developed, and the groove behind it more strongly so than usual, the anterior tooth being only slightly indicated but recognisable. Strong, almost tooth-like, is the ligamental support (Fig. 29*a*). In a second much-rolled fragment of an umbo (Fig. 28), only the posterior tooth-groove is distinct, the anterior only very slightly indicated (quite omitted in the illustration). A hinge of the right valve was also afterwards exposed; it shows a well developed posterior rounded tooth, and a less distinct anterior conical tooth, between these two lying the deep groove for the principal tooth of the left valve. From these considerations it appears to me that the connection of this species with the Group of *Myophoria ovata*, Goldf., can scarcely be doubted, although on account of its bad state of preservation the species cannot be specifically united with any of the known species; it may in fact even be new.

There is also from the same rock a fragment of a ribbed shell that might possibly be referred to a ribbed Myophoria.

RHYNCHONELLA MIDDLEMISSII, nov. sp., Pl. VI., Fig. 21.

A single specimen of a small almost smooth Rhynchonella of a rather broad shape, with slightly folded margin. The large valve is somewhat more strongly inflated than the small one, and drawn out at the margin to a very short but broad frontal tongue, which possesses three very slightly indicated folds; and stands out from the lateral lines of junction of the valves through the medium of a somewhat stronger bend; two or three slight folds of the lateral lines of junction succeed on each side of it; all of them reach only a little distance on the surface of the valves, that is, they only begin very near the margin. The beak is pointed, its lateral margins are rather sharp, and a little hollowed out, without, however, forming the 'ears' or areas of Halorella. From the umbo of the small valve runs a slightly deepened median furrow (which might indicate the existence of a septum) almost for half the length of the valve. The test is rather coarsely fibrous; there can thus be no doubt as to the generic affinities of the species.

The habit of this species on the whole, especially also the presence of well-marked ears on both sides of the umbo of the small valve, point emphatically to its relationship with the Group Austriella, m., occurring so abundantly in the Alpine Hallstatt Limestones, amongst whose members it seems again to stand nearest to the typical form of this group, *viz.*, *Rhynchonella dilatata*, Suess.

Locality.—Present in one specimen from the red limestone of the Cliff of Chitichun, No. 1, Tibet. It is interesting that the first brachiopod of this occurrence in Tibet, so similar in facies to the Hallstatt Limestone, is a species which bears upon it so markedly the typical characters of the predominant Rhynchonella (Austriella). This seems to be a confirmation of that which has already been said in the Abhandlungen der k.k. geologischen Reichsanstalt, XIV., p. 250, about the striking dependence of these brachiopods upon the facies of the deposits enclosing them. The red marbles of the Chitichun Cliffs are, as is well known, referred to the Muschelkalk (cf. Diener, l.c., p. 64). The European Muschelkalk deposits nearest in facies (Marble of the Schreyeralm, and of Han Bulog) have not yet yielded any species of Rhynchonella which are so near the type of Austriella.

SPIRIGERA (?) NŒTLINGII, nov. sp., Pl. XI., Figs. 2, 3.

A very remarkable form, but unfortunately doubtful in many respects especially as regards its horizon and its systematic position. Its entire habit, especially the small beak, recalls a Rhynchonella, which it was also considered to be by its discoverer, F. Stoliczka. The bed from which it comes was regarded as liassic. As several specimens are present, which, however, are all more or less distorted by pressure, one of the broken ones was polished, and a spiral cone of at least fifteen whorls was immediately brought to light. Two fragments of the species prove likewise to be provided with spiral cones, which however, unfortunately, are torn loose from their connection with the crural processes and lie in a displaced

position in the interior of the shell, and about whose attachment no data could therefore be acquired; only so much being ascertained from the existence of spiral cones that this brachiopod could not be a Rhynchonellid, according to our present knowledge, but that it must be placed in the Spiriferidæ. In a species, presumably liassic, it was at first only to be supposed that it should belong to the genus Spiriferina; but a Spiriferina, moreover a liassic one, without any indication of an area, without distinct open deltidium, without the trace of a median septum in the large valve and without the wart-like dotted shell structure, so extraordinarily developed in these forms, would have been such an unusual occurrence that it was impossible to maintain this view. Though in some triassic Spiriferinæ, as for instance in *Mentzelia Fraasi*, m., even the greater number of those characteristic features appear to be reduced almost to complete obliteration, one of them nevertheless remains and suffices to make it recognisable externally as belonging to this genus. Its belonging to Spiriferina could not thus be thought of in the present case. It was thus first intended to place it in the genus Spirigera (Athyris., auct.) without regard to the circumstance that the youngest forms of this genus hitherto known occur in the rhætic formations of the uppermost trias, and that as yet a true Spirigera has never been found in the lias. Regarded as spirigera this species would be the youngest of its genus, supposing it to be really of liassic age. But its reference to Spirigera also is not to be held as proved. It is true that it distantly recalls *Spirigera Tricupii*, m., described from the trias of Balia in Asia Minor (Jahrb. d. geol. Reichsanst., 1892), but this resemblance is again outweighed by the very weak development of its beak, as well as by the circumstance that a sure proof of the existence of median convergent fibres in the test cannot be brought forward, while just these two external features in *Spirigera Tricupii* were decisive for its generic position, though its internal structure is not known. The proof afforded by the spiral cones is unfortunately not sufficient in *Spirigera* (?) *Noetlingii* for the purpose of a safe generic determination, as the attachment of these spiral cones, characteristic of Spirigera, is disturbed in all the polished specimens.

The shell in all the specimens which were before me was of a finely crystalline sugar-like substance, without a trace of punctures. Only in some forms the originally fibrous condition of the shell can here and there and especially at the thick-shelled sides of the beak, be recognised with certainty. The species is, therefore, certainly to be reckoned as belonging to the fibrous-shelled brachiopods, which would be again in favour of Spirigera. But the surface ornamentation of the shell again reminds one strongly of Spiriferina. There is a narrow shallow median sinus in the large valve, a corresponding rounded narrow frontal tongue, and a slightly-marked median lobe in the small valve. The ribbing is not very strong, but the ribs run from the umbo over the whole shell. From two to four ribs can be counted in the sinus, and from five to eight on each of the sides. Some specimens seem to have possessed still more numerous ribs whose number thus varies considerably. The breadth of the sinus and of the frontal tongue are also variable in a corresponding degree. In forms with fewer ribs these are proportionally stronger and more distinct than in specimens bearing more numerous ribs; in such specimens

the ribs sometimes die out almost entirely. They always remain low and rounded at the edges.

The beak is, as already mentioned, uncommonly small and delicate for a brachiopod with spires, and might most easily be mistaken for a Rhynchonella beak, the more so as the external appearance of the shell is that of a symmetrical Rhynchonella. It *appears*, however, that the beak possessed a terminal opening. Its margins are rounded, and an area similar to that of the Spiriferidæ is not even indicated. The beak shows when cut and polished thick-shelled lateral walls and a thin-shelled median portion, exactly as in *Spirigera Stoliczkai* (Pl. III., Fig. 8). A median septum in the large valve is wanting. By further grinding and polishing the lateral thickening of the beak is seen to be divided into the outer beak wall, in itself very strong, and in a likewise strong dental support extending to the shell-wall similar to the above-mentioned *Spirigera Stoliczkai* (Pl. III., Fig. 9). The internal structure of the beak is thus also emphatically opposed to the relegation of the species to Spiriferina, although it cannot, on the other hand, be brought forward as an argument for its Spirigera nature; but it does not militate *against* the latter. The points in favour of placing this species in the genus Spirigera nevertheless preponderate. Among the species of the Muschelkalk described above there exists a form generically somewhat uncertain, *viz.*, *Rhynchonella Salteriana*, Stol. (Pl. II., Figs 14, 15), about which it does not seem at all clear to me whether it possesses spiral cones or not. Should it possess such cones, this species might perhaps stand nearest to *Spirigera* (?) *Nœtlingii* just described, and probably even be united with it generically.

Locality.—Collected by Stoliczka in the 'Lias' of Nio Sumdo, Karnag, and determined by him to be a Rhynchonella. The remarks of Stoliczka in his 'Geoligical Observations in Western Tibet' (Mem. Geol. Survey of India, V., 1866, pp. 345, 346) refer without doubt to this species. As already mentioned, the geological age of this interesting brachiopod seems yet unsettled, and it might perhaps not be impossible to assume it to have originated in triassic or still older beds.

This form seems to occur in Panga-La (Pangpo-La, according to Stoliczka, l.c., p. 342, ff.), in Ladakh, as well as in Nio Sumdo in Karnag. It may be mentioned that among the specimens from Karnag there is also a Belemnite, but the rock containing it does not seem to be identical with the rock from which the brachiopod species comes.

V.—RETROSPECT AND CONCLUSION.

The species described in the foregoing pages are distributed in the different groups of beds of the trias of the Himálayas as follows:—

I.—SPECIES FROM THE LOWER TRIAS.

(THE BUNTSANDSTEIN OR WERFEN SLATES HORIZON.)

Ia.—From the Lower or Otoceras Horizon.

Pseudomonotis Griesbachi, nov. sp.

Pseudomonotis Painkhandana, nov. sp.
Avicula aff. Venetianæ, Hauer.
Gervillia (?) sp.
Myophoria (?) sp.
Nucula (?) sp.

RHYNCHONELLA (Norella) PROCREATRIX, nov. sp.

BELLEROPHON cf. Vaceki, nov. sp.

I. b.—From the Upper or Subrobustus Horizon.

Pseudomonotis (? Avicula) himaica, nov. sp.
Pseudomonotis decidens, nov. sp.

II.—SPECIES FROM THE MIDDLE TRIAS (THE MUSCHELKALK).

IIa. From the Hauptcomplex of the Muschelkalk, including the beds with Rhynchonella Griesbachi, m., and Spiriferina Stracheyi, Salt.

From the horizon of Rhynchonella Griesbachi :—
Rhynchonella Griesbachi, nov. sp.
Rhynchonella (Norella) Kingi, nov. sp.
Retzia himaica, nov. sp.

From the horizon of Spiriferina Stracheyi :—
Rhynchonella Dieneri, nov. sp.
Spiriferina Stracheyi, Salt.
Spirigera Stoliczka, nov. sp.
Terebratula (Dielasma) himalayana, nov. sp.

From the remaining mass of the Muschelkalk, without a more exact horizon being assigned:—
Rhynchonella cf. trinodosi, Bittn.
Rhynchonella mutabilis, Stol.
Rhynchonella (?) Salteriana, Stol.
Rhynchonella Theobaldiana, Stol.
Spiriferina Lilangensis, Stol.
Spiriferina (Mentzelia) Kœveskalliensis (Suess) Bœckh.
Terebratula (Dielasma) Himalayana, nov. sp.
Terebratula (Dielasma) aff. Himalayanæ, nov. sp.
Terebratula (Cœnothyris) cf. vulgaris, Schloth.
Aulacothyris Lilangensis, nov. sp.

IIb. From the Transition Horizon of Daonella indica, m., and chiefly from beds probably of Ladinic age.

From rock with Daonella Lommeli from Muth in Spiti :—
Daonella Lommeli, Wissm. sp.

From grey crinoidal limestone underlying the bed with Daonella indica :—
Rhynchonella Rimkinensis, nov. sp.
Myoconcha, sp.
From the horizon of Daonella indica :—
Daonella indica, nov. sp.
? Daonella aff. indicæ, nov. sp.
? Daonella Spitiensis, nov. sp.
Aulacothyris Nilangensis, nov. sp.
Spirigera hunica, nov. sp.
Rhynchonella (Norella) Kingi, nov. sp.
Rhynchonella (Norella) Tibetica, nov. sp.
Discina, sp.

III. SPECIES FROM THE UPPER TRIAS (KEUPER).

IIIa. From the Lower Division of the upper trias.

IIIa.[1] *From the horizon of Halobia comata, and the succeeding Tropites beds.*

From the horizon of Halobia comata :—
Spiriferina Shalshalensis, nov. sp.
Retzia Schwageri, Bittn., var. Asiatica, nov.
Rhynchonella Laucana, nov. sp.
Halobia fascigera, nov. sp.
Halobia comata, nov. sp.
Avicula (?) Girthiana, nov. sp.
Cassianella, pl. sp.
Lima, sp.
From the Tropites beds (Hauerites and Halorites beds):—
Rhynchonella Bambanagensis, nov. sp.
Halobia cf. comata, nov. sp.
Cassianella, sp.
Lima, sp.
Lima (?) serraticosta, nov. sp.
Anodontophora Griesbachi, nov. sp.

IIIa.[2] *From the horizon of Spiriferina Griesbachi and the succeeding Sagenites beds :—*

Spiriferina Griesbachi, nov. sp.
Retzia Schwageri, Bittn., var. Asiatica, nov.
Spirigera Dieneri, nov. sp.
Amphiclina, sp.
Rhynchonella Bambanagensis, nov. sp.
Rhynchonella Martoliana, nov. sp.

Aulacothyris Joharensis, nov. sp.
Cassianella pulchella, nov. sp.
Pecten biformatus, nov. sp.
Pecten interruptus, nov. sp.
Lima cumaunica, nov. sp.
Anodontophora Griesbachi, nov. sp.

11b. From the Upper Division of the upper trias :—

Megalodon cultridens, nov. sp.
Megalodon Ladakhensis, nov. sp.
Dicerocardium Himalayense, Stol.

IV. ADDENDUM:—

Myophoria, ex aff. ovatæ, Goldf.
Rhynchonella Middlemissii, nov. sp.
Spirigera (?) Nœtlingii, nov. sp.

The total number of the brachiopoda and lamellibranchiata of the trias of the Himálayas described in the foregoing pages does not thus amount to more than about 60 species, which fall to these classes in about equal proportions; this is a minimum number considering their richness in species which is already known in the Alpine trias and which is far from being exhausted. Our knowledge of the brachiopoda and lamellibranchiata of the trias of the Himálayas compared with this is at present in its infancy.

The few brachiopods of the trias of the Himálayas yet known are assigned to the genera Terebratula (with Dielasma and Cœnothyris), Aulacothyris, Rhynchonella (with Norella and Austriella), Spiriferina, Mentzelia, Spirigera (Athyris, auct.), Amphiclina, Retzia and Discina. The lamellibranchs belong to the genera Avicula, Pseudomonotis, Gervillia, Cassianella, Halobia, Daonella, Pecten, Lima, Myophoria, Megalodon, Dicerocardium and Anodontophora (Anoplophora). These are, without exception, also genera well-known and generally distributed in the Alpine trias. Species agreeing specifically with those of the Alpine trias are only sparingly represented. As such may be enumerated the Muschelkalk brachiopoda *Mentzelia Kœveskalliensis*, *Terebratula* (*Cœnothyris*) cf. *vulgaris*, and *Rhynchonella* cf. *trinodosi*, of which the two latter cannot however be identified with full certainty, because they occur only as a few forms. Besides these there is only *Daonella Lommeli* that can be named as undoubtedly identical with European species. Of forms closely related to European species the following may be added here :—*Pseudomonotis Griesbachi*, *Avicula* aff. *Venetianæ*, *Bellerophon* cf. *Vaceki*, *Retzia Schwageri* (var. *Asiatica*), and perhaps *Rhynchonella Laucana*. All the rest of the species, thus by far the greater number of them, may be regarded as well differentiated new species, from which the conclusion may be drawn that the brachiopoda and lamellibranchiata are, in their totality, considerably different from those of the Alpine trias. As a few strikingly deviating types,

which are known so far to be entirely absent from the Alpine trias, the following may be pointed out, namely, *Retzia himaica*, *Spiriferina Stracheyi*, *Spiriferina Griesbachi*, *Rhynchonella Salteriana* ; further, *Lima serraticosta*, *Pecten biformatus*, and perhaps also *Megalodon cultridens*. It is remarkable that the genus Spiriferina is represented among them by two species. One of them, *S. Griesbachi*, possesses relationship with a form in the trias of Asia Minor.

The separate faunæ of the trias of the Himálayas offer an opportunity for the following remarks :—

I*a*. The oldest of these faunæ, namely, that with *Pseudomonotis Griesbachi*, from the lowest Otoceras beds, is proportionally rich in characters which harmonise with those of European species. Its most important and abundant members, *viz.*, *Pseudomonotis Griesbachi* itself, together with *Avicula* aff. *Venetianae*, and *Bellerophon* cf. *Vaceki*, are extremely closely related to Alpine species of the Werfen Slates, or are even identical with them. Some of the forms which remain specifically undetermined (e.g., Gervillia, sp., Myophoria, sp.) seem to possess closer relationship to permian forms. The appearance of a small Rhynchonella from the group of Norellæ is new, while only hingeless brachiopods are known in the Alpine Werfen Slates.

I*b*. The bivalves of the Subrobustus beds have hitherto been restricted to two species, of which one appears to be only a straggler of the Pseudomonotidæ of the Otoceras beds, while the other stands probably in closer relationship to a species of the North American trias.

II*a*. The brachiopod fauna of the Muschelkalk (in the strict sense) is of greater interest. Among the species is one of the few identical with Alpine forms, *viz.*, *Mentzelia Kœveskalliensis*, and two others, namely, *Terebratula* cf. *vulgaris*, and *Rhynchonella* cf. *trinodosi*, are at least very near to Alpine species. To the group of *Rhynchonella trinodosi* also belong several other species of Rhynchonella of the Asiatic trias ; that is, *Rhynchonella Griesbachi*, *R. Dieneri*, *R. mutabilis*. The group of Norella extends from the lower trias to the Muschelkalk. Very characteristic is *Spiriferina Stracheyi* which, with *Spirigera Stoliczkai* and *Dielasma Himalayanum*, forms a small but widely distributed little fauna of its own, to which, perhaps, belong some other Muschelkalk brachiopods from Spiti, as the brachiopods of this horizon in the Himálayas are generally distinguished by a wider distribution. This is the case, for instance, with *Mentzelia Kœveskalliensis* mentioned above, which is known from no less than four localities, *viz.*, Lilang, Silakank Pass, Rimkin-Paiar and Bambang section ; it is further very striking in *Rhynchonella Salteriana*, one specimen of which comes from Lilang, in Spiti, while a second was collected in the Shalshal Cliff ; this obtains in a still greater degree in the little fauna mentioned above with *Spiriferina Stracheyi*, about which more will be said further on. It seems to result from this that the conditions of the facies and the succession of beds must remain extremely constant, extending over large areas in the regions of the Himálayan trias.

The stratigraphical relations of the fauna with *Spiriferina Stracheyi* to the fauna with *Rhynchonella Griesbachi* require a more minute elucidation, as

already referred to. From their purely palæontological characters one might be inclined to consider the fauna with *Spiriferina Stracheyi* to be older than the brachiopod fauna of the European Muschelkalk with *Terebratula vulgaris*, whose typical species has only been found very sparingly, if at all, in the Himálayas, while others of the most abundant species associated with it, such as *Spirigera trigonella* and *Mentzelia Mentzeli*, have hitherto been entirely wanting in the trias of the Himálayas. One thing may here be pointed out. Diener, in taking the chief mass of the (ptychites-bearing) Muschelkalk of the Himálayas as the "Upper" Muschelkalk in the older sense, emphasises the fact that the thin brachiopod-bearing beds at its base are to be regarded as representing the so-called Binodosus-zone of the Alps, or, in a word, as Lower Muschelkalk, by which it is overlooked that this "Binodosus-zone" lies proportionately high in the mass of the Alpine Muschelkalk, and that then a representative of the thick underlying Muschelkalk beds, poor in fossils, must be sought for actually in the Subrobustus beds of the Himálayas (*cf.* Verhandl. der geol. Reichsanst., 1897, p. 100).

As types as yet quite foreign among the brachiopods of the Muschelkalk of the Himálayas, *Retzia himaica* and *Rhynchonella* (?) *Salteriana* are put prominently forward.

II*b*. The isolated occurrence of *Daonella Lommeli* in Spiti, and the more widely distributed horizon of *Daonella indica* have already been indicated as presumable equivalents of the upper or Ladinic group of beds of the Alpine Muschelkalk. In the horizon of *Daonella indica* a brachiopod fauna, poor in species, also occurs, in which Norellæ especially predominate ; these began to appear already in the lowest Otoceras beds in the Himálayas.

III*a*. In this horizon, mostly composed of marly beds, especially in its lower division, the Halobiæ from the group of *Halobia rugosa* (*viz.*, *H. comata*, *H. fascigera*) are particularly striking. Among other associated species may be pointed out the not rare species of Cassianella, *Rhynchonella Laucana*, which comes near a Hallstatt species, and the vertically and horizontally distributed *Retzia Schwageri*. The latter, together with some other forms, (*e.g.*, *Rhynchonella Bambanagensis*, *Lima serraticosta*, *Anodontophora Griesbachi*), connects the lower with the upper division of this group of beds.

The small but characteristic fauna of *Spiriferina Griesbachi* and *Spirigera Dieneri*, which both possess a remarkably palæozoic habit, lies in the upper division of the group of beds III*a*. In this fauna the first Asiatic representative of the brachiopod family of the Koninckiidæ, namely, a small Amphiclina, so important in the Alpine trias, was also recorded, and, in addition to it, also peculiar, new, elegantly sculptured species of Cassianella and Pecten (*viz.*, *Cassianella pulchella*, *Pecten biformatus*). In the uppermost layers of this group of beds, the so-called Sagenites-beds of Diener, *Anodontophora Griesbachi*, seems to preponderate.

III*b*. The fauna of the thick uppermost limestone masses in the trias of the Himálayas is as yet very sparingly represented, a circumstance which may well be attributed chiefly to the inaccessibility of the mountain region composed of these masses. Only Megalodon and Dicerocardium are recorded as abundant, among

which *Dicerocardium Himalayense* stands very near its European congeners, while *Megalodon cultridens* is very strikingly distinguished by its strongly devoloped hinge-dentition from all Alpine species examined in connection with this feature. Very noteworthy is the absence of the genus belonging to the Rhynchonellidæ, *viz.*, Halorella, so abundant in the Alpine Dachsteinkalk. Stoliczka has, it is true, already mentioned a species of it from the uppermost trias deposits of the Himálayas, but this statement is founded, as I have convinced myself, upon incompletely preserved fragments of a many-ribbed Rhynchonella which cannot at all be regarded as Halorella. That species of Halorella may, however, also occur in the trias of the Himálayas, might be inferred with great probability from the circumstance that members of this genus have been found by Stoliczka in the Pamir region, as Prof. E. Suess has recently shown. What is said of Halorella may equally be applied to the important genus Monotis, as yet wanting in the trias of the Himálayas (cf. E. Suess, Beiträge zur Stratigraphie Centralasiens, etc., in Denkschr. der Kais. Akad. d. Wiss., Wien, 1894, LXI. Bd. p. 30-32).

III*c*. The uppermost division of the Alpine trias, namely, that of the Kössen beds, is not represented in the palæontological material before me. It is particularly desirable to point out those fossil-bearing horizons, or separate faunæ which deserve special attention by reason of their wide distribution within the triassic region of the Himálayas. They are as follow :—

1. *The lowest fauna of the Otoceras beds with Pseudomonotis Griesbachi,* occurring in the Shalshal Cliffs, at Kiunglung near the Niti Pass and at Kuling in Spiti.
2. *The fauna of the horizon with Spiriferina Stracheyi,* which appears to be extremely widely distributed. It is known in the Shalshal Cliffs near Rimkin-Paiar, in the Niti Pass (Rajhoti) and in numerous localities in Spiti (Lilang, Muth, Kuling, Khar, Drangkhar) and finally in the Kali River valley. The fauna with *Rhynchonella Griesbachi* is so far known only at Shalshal.
3. *The fauna of the horizon with Daonella indica* is proved to be in the Shalshal Cliffs, in the Lissar valley, at Dogkwa Aúr, in the Hop Gadh district, at Ganesganga, and may also occur at Kuling, Khar, and other localities in Spiti.
4. *The fauna of the horizon* with *Halobia comata* is known in the Bambanag section, and at Kiunglung in the vicinity of the Niti Pass.
5. *The fauna with Spiriferina Griesbachi* is known in the Bambanag section, and, supposing that *Spiriferina Tibetica,* Stol., belongs to it, also farther to the north-west in the Manirang Pass, as well as at Kibber and Kuling in Spiti. The rest of the species of this fauna have hitherto been found only in the Bambanag section.
6. *The Megalodon fauna* of the so-called " Para-limestone " may finally here be added. It is widely distributed in Spiti, Rupshu, Karnag, Ladakh, etc.

EXPLANATION OF THE PLATES.

PLATE I.

Figs. 1-4. PSEUDOMONOTIS GRIESBACHI, nov. sp., p. 2, from the Otoceras beds of the Shalshal section, near Rimkin-Paiar, *viz.* Figs. 1 and 2, the lef tor inflated valve (Fig. 2 with enlargement of the anterior ear), Figs. 3 and 4 the right or flat valve of this species.

Fig. 5. PSEUDOMONOTIS PAINKHANDANA, nov. sp., p. 5, from the Otoceras beds of the Shalshal section, near Rimkin-Paiar, left valve natural size, and twice enlarged.

Figs. 6, 7. GERVILLIA (?) SP. p. 8, from the Otoceras beds of the Shalshal section, near Rimkin-Paiar; left valves.

Fig. 8. AVICULA AFF. VENETIANÆ, Hauer, p. 6, from the Otoceras beds of the Shalshal section; a left valve, partly a cast.

Figs. 9, 10. MYOPHORIA (? SCHIZODUS) SP., p. 8, from the Otoceras beds of the Shalshal section; both valves.

Fig. 11. NUCULA (?) SP., p. 8, from the Otoceras beds of the Shalshal section.

„ 12. RHYNCHONELLA (NORELLA) PROCREATRIX, nov. sp., p. 9, from the Otoceras beds N.-W. of Kiunglung.

Figs. 13, 14. BELLEROPHON VACEKI, NOV. SP., p. 9, from the Lower Werfen slates of the Mendelstrasse in South Tyrol, Fig. 13, cast, Fig. 14, specimen with shell. Figured for comparison with :—

Fig. 15. BELLEROPHON CF. VACEKI, nov. sp., p. 9, from the Otoceras beds from the locality N.-W. from Kiunglung; a cast.

Figs. 16-21. PSEUDOMONOTIS (? AVICULA) HIMAICA, nov. sp., p. 10, from the Subrobustus-beds in the Shalshal section, near Rimkin-Paiar. Figs. 16-20 left valves, Fig. 21, a right valve.

„ 22-24. PSEUDOMONOTIS DECIDENS, nov. sp., p. 11, from the Subrobustus-beds of the Shalshal section; three left valves.

„ 25-28. MYOPHORIA, EX AFF. OVATÆ, Goldf., p. 67, from a triassic rock, of which the exact horizon is not known; from the Dras Valley in Kashmir. Figs. 25, 26, right valves, 27-29, left valves, 28 and 29*a*, the hinge of the left valve, 29*a*, better preserved; 28 in a rolled condition, and not quite correctly figured.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

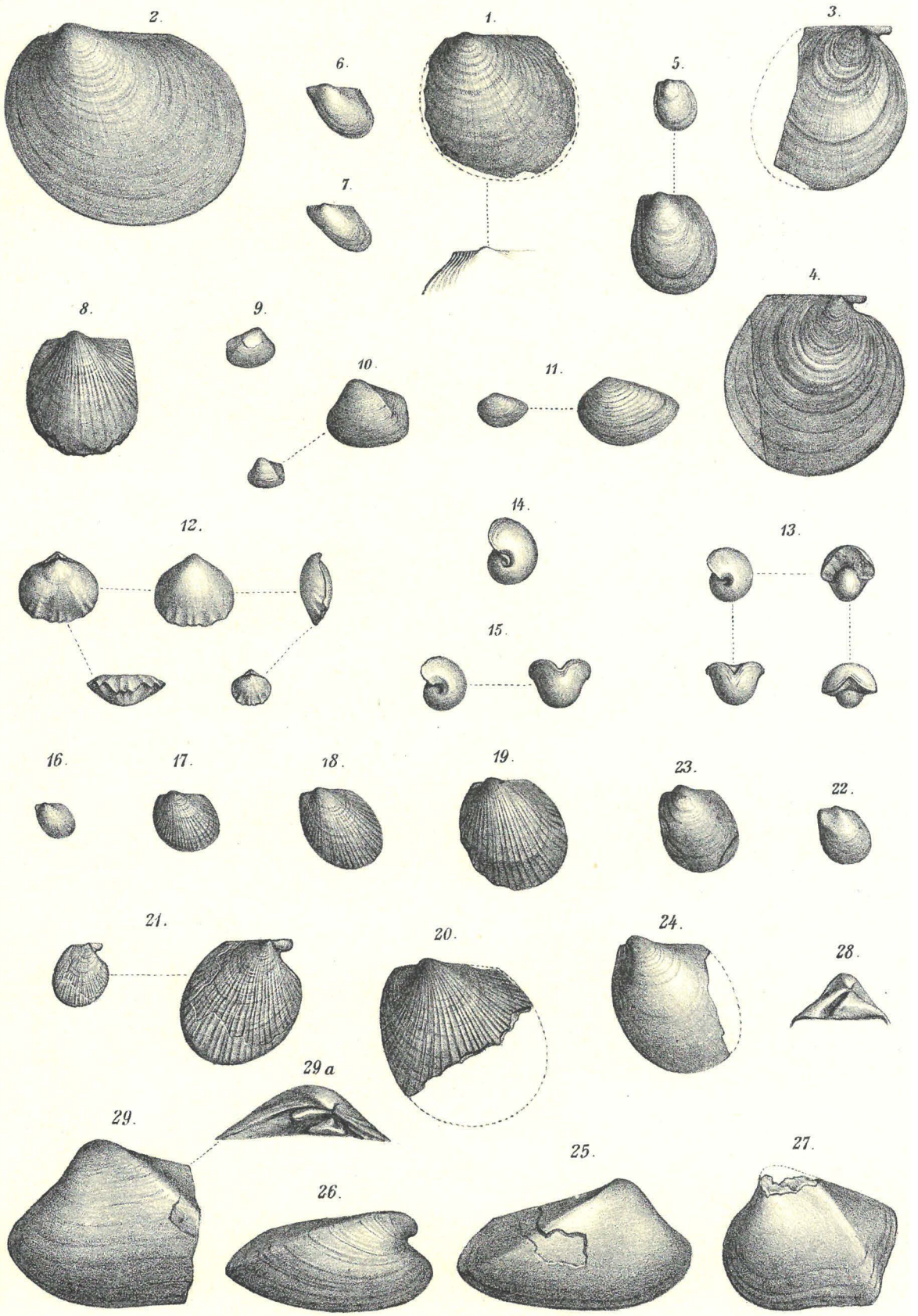


PLATE II.

Figs. 1-7. RHYNCHONELLA GRIESBACHI, NOV. SP., p. 12, from the Muschelkalk horizon of *Rhynchonella Griesbachi* in the Shalshal section, near Rimkin-Paiar. Figs. 1-5, different forms of this species; Fig. 6, a specimen with dental plates and septum of the left valve exposed; Fig. 7, with section of the umbones.

„ 8, 9. RHYNCHONELLA DIENERI, NOV. SP., p. 14, from the beds with *Spiriferina Stracheyi* in the Shalshal section, near Rimkin-Paiar.

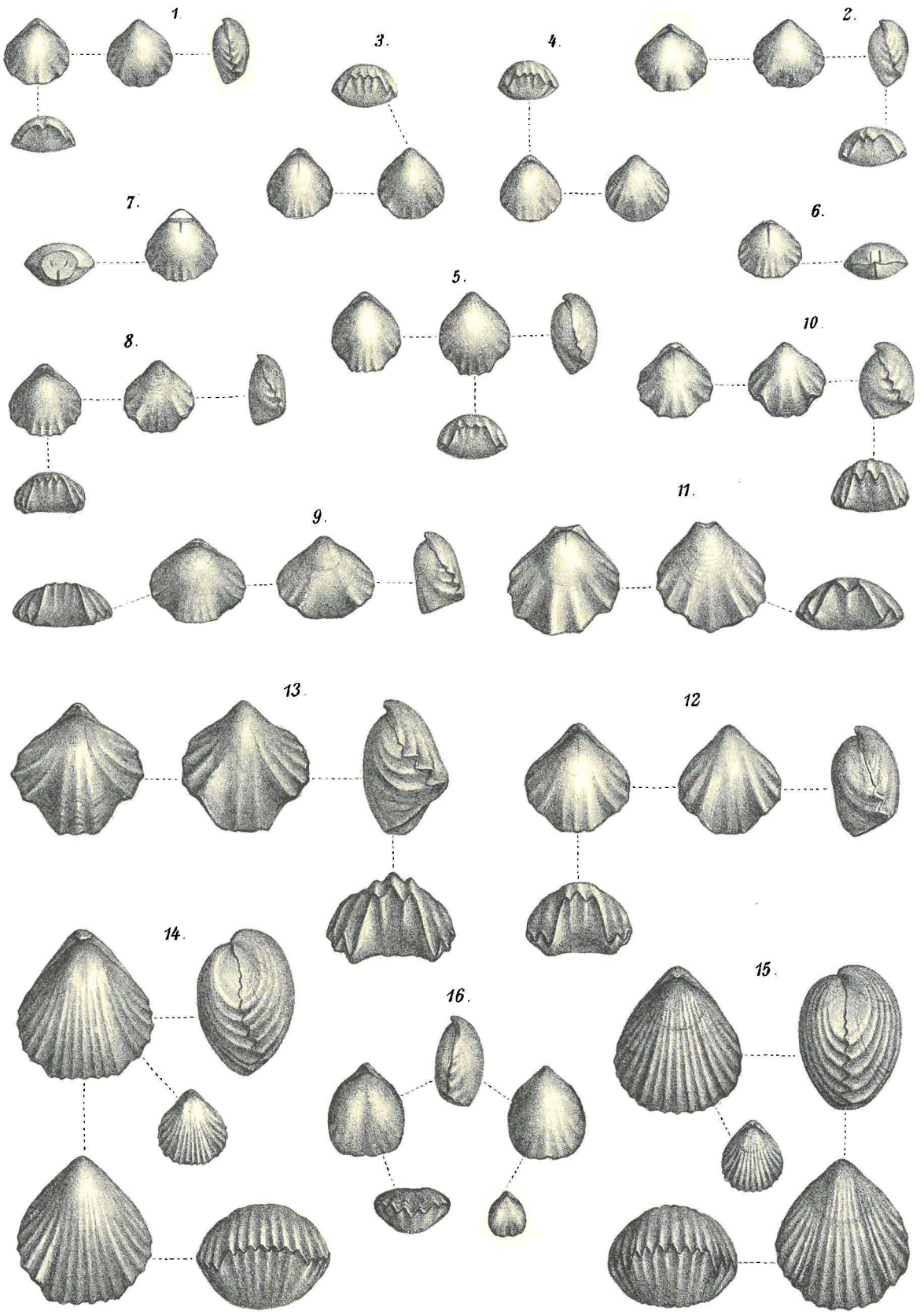
Fig. 10. RHYNCHONELLA, AFF. TRINODOSI, BITTN., p. 14, from the Muschelkalk of Muth in Spiti.

Figs. 11, 12, 13. RHYNCHONELA MUTABILIS, STOL., p. 15, from Lilang on the Lingti river in Spiti. The three figured forms are at the same time the originals of Stoliczka's figures of the species.

„ 14, 15. RHYNCHONELLA SALTERIANA, Stol., p. 15, Stoliczka's original specimen (Fig. 14 from Lilang on the Lingti river, the second specimen (Fig. 15) collected by Diener in the Upper Muschelkalk of the Shalshal section, near Rimkin-Paiar.

Fig. 16. RHYNCHONELLA (NORELLA) KINGI, NOV. SP., p. 17, from the horizon of *R. Griesbachi*, in the Shalshal section, near Rimkin-Paiar. Cf. Plate VI. Figs. 14, 15, 16.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE III.

Figs. 1-17. SPIRIGERA (ATHYRIS) STOLICZKAI, nov. sp., p. 23, in different stages of development, and from different localities.

„ 1-9. Specimens from the beds with SPIRIFERINA STRACHEYI, collected by Diener on the 27th August, 1892 at Rimkin-Paiar; Fig. 1, young specimen without sinus; Figs. 2-6, adult specimens of wider and narrower shape, for the most part casts; Fig. 7, a form with the shell; Figs. 8,9, cross-sections of the umbonal region, to show the dental plates and lateral thickenings of the beak, as well as the cavity in the umbo of the small valve.

„ 10, 11. Specimens from a second locality near Rimkin-Paiar, S. E. (collected by Diener on the 2nd September, 1892. Fig. 10, a broader and flatter, Fig. 11 a narrower, thicker, form; the latter with dental plates visible externally, and lateral thickenings of the beak partly broken off.

„ 12, 17. Specimens from Lilang in Spiti, collected by F. Stoliczka; among them Fig. 15, a cross-section with the dental plates disappearing downwards; Fig. 16, a longitudinal section with the hollow umbo of the small valve; Fig. 17, a weathered specimen with an exposed spiral cone, and the beak cut and polished to show the dental plates.

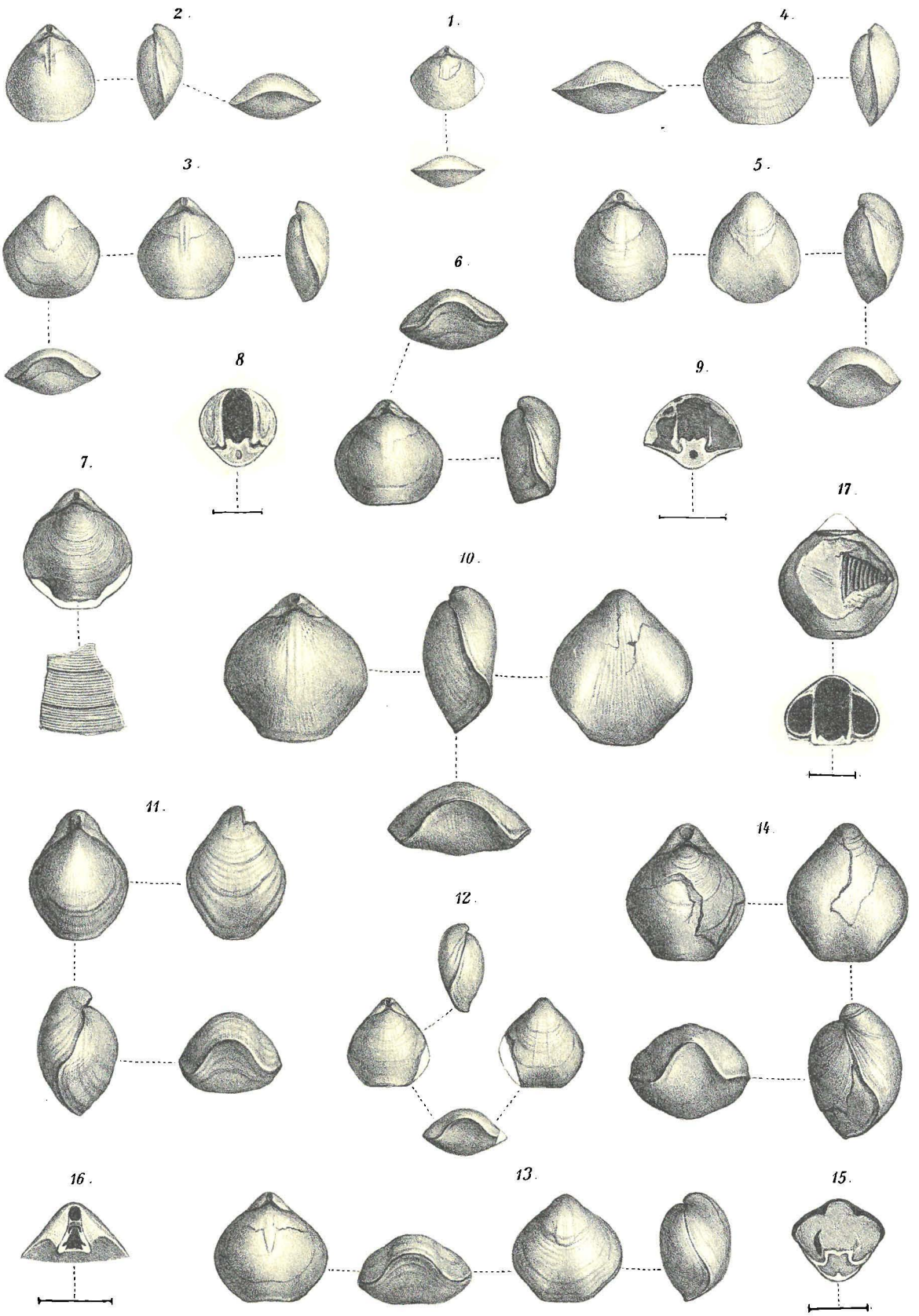

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PLATE IV.

Fig. 1. SPIRIFERINA SHALSHALENSIS nov. sp., p. 42, from the Shalshal section, near Rimkin Paiar, from the upper trias.

„ 2. SPIRIFERINA LILANGENSIS, Stol., p. 20, Stoliczka's original specimen, from Lilang in Spiti.

Figs. 3-14. SPIRIFERINA STRACHEYI, Salter, p. 18, the typical form of the horizon with *Spiriferina Stracheyi*; *viz.* Figs. 3-11 from Rimkin-Paiar. Fig. 3, a young specimen, still without the wing-like extensions (the front view is inaccurate, as the frontal lobe is drawn much too high, cf. Fig. 12); Fig. 4, with umbonal region cut and polished; Figs. 5-7, sections of the beaks of broader, older specimen; in Fig. 6,7 the beak only very slightly cut, in order to show the callosity at its apex; Fig. 8, a specimen with the median septum of the large valve broken through the centre; Fig. 9, a strongly winged form; Fig. 10, a specimen attached to the rock, with very well preserved area; Fig. 11, a cast of the large valve with the septal lamellæ. Figs. 12,13, forms from the Rajhoti Pass (the septa in the large valve in Fig. 13 drawn too short, cf. Fig. 11); Fig. 14, from Lilang, a little compressed and therefore appearing particularly wide.

„ 15, 16. SPIRIFERINA (MENTZELIA) KŒVESKALLIENSIS (Suess) Bœckh., p. 21, *viz.*, Fig. 15, var. *Microrhyncha*, Bittn., from Silakank; Fig. 16, *var. Spitiensis*, Stol., from Lilang (original of Stoliczka's *Spiriferina Spitiensis*).

„ 17, 18. RETZIA HIMAICA, nov. sp., p. 22, from the beds of *Rhyachonella Griesbachi*, m. in Rimkin-Paiar.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

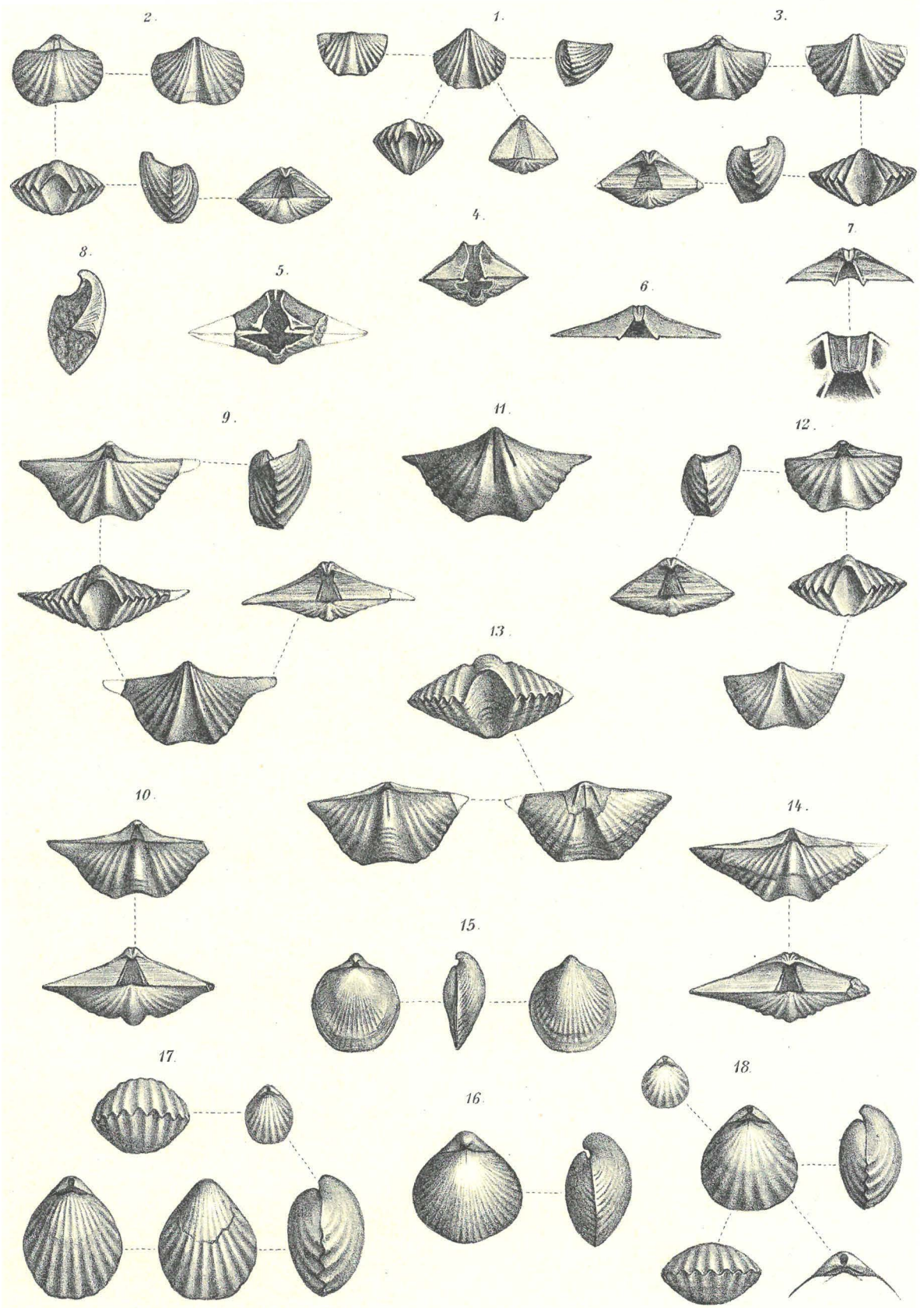


PLATE V.

Figs. 1-8, 10, 11. TEREBRATULA (DIELASMA) HIMALAYANA, nov. sp., p. 25 mostly from the horizon of *Spiriferina Stracheyi*. Figs. 1-3, from Rimkin-Paiar (collected by Diener, 26th August 1892), Fig. 1, a form with the shell with lateral striaton, Fig. 2, a cast, Fig. 3, a section through the cardinal area; Figs. 4, 5, 6, 8, from Rimkin-Paiar, S. E. (collected by Diener, 2nd September 1892), Fig. 4 with the shell preserved on the small valve, Figs. 5, 6, casts, Fig. 8, a section through the cardinal area (in Fig. 9 a section through the cardinal area of the Alpine *Coenothyris vulgaris* from a North Alpine locality added for comparison); Fig. 7 likewise from Rimkin-Paiar, but from the "Upper Muschelkalk" (collected 27th August, 1892); Figs. 10,11, from Lilang, on the Lingti River in Spiti.

„ 12, 13. TEREBRATULA AFF. HIMALAYANAE, nov. sp., p. 27, from the "Upper Muschelkalk," *viz.*, Fig. 12, from Rimkin-Paiar (collected 29th August 1892), Fig. 13, from S. E. of Muth, in Spiti.

Fig. 14. TEREBRATULA, cf. VULGARIS, Schloth., sp., p. 28, from Lilang, in Spiti.

„ 15. RHYNCHONELLA THEOBALDIANA, Stol. p. 17, Stoliczka's original specimen from Muth in the Pin Valley, Spiti.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

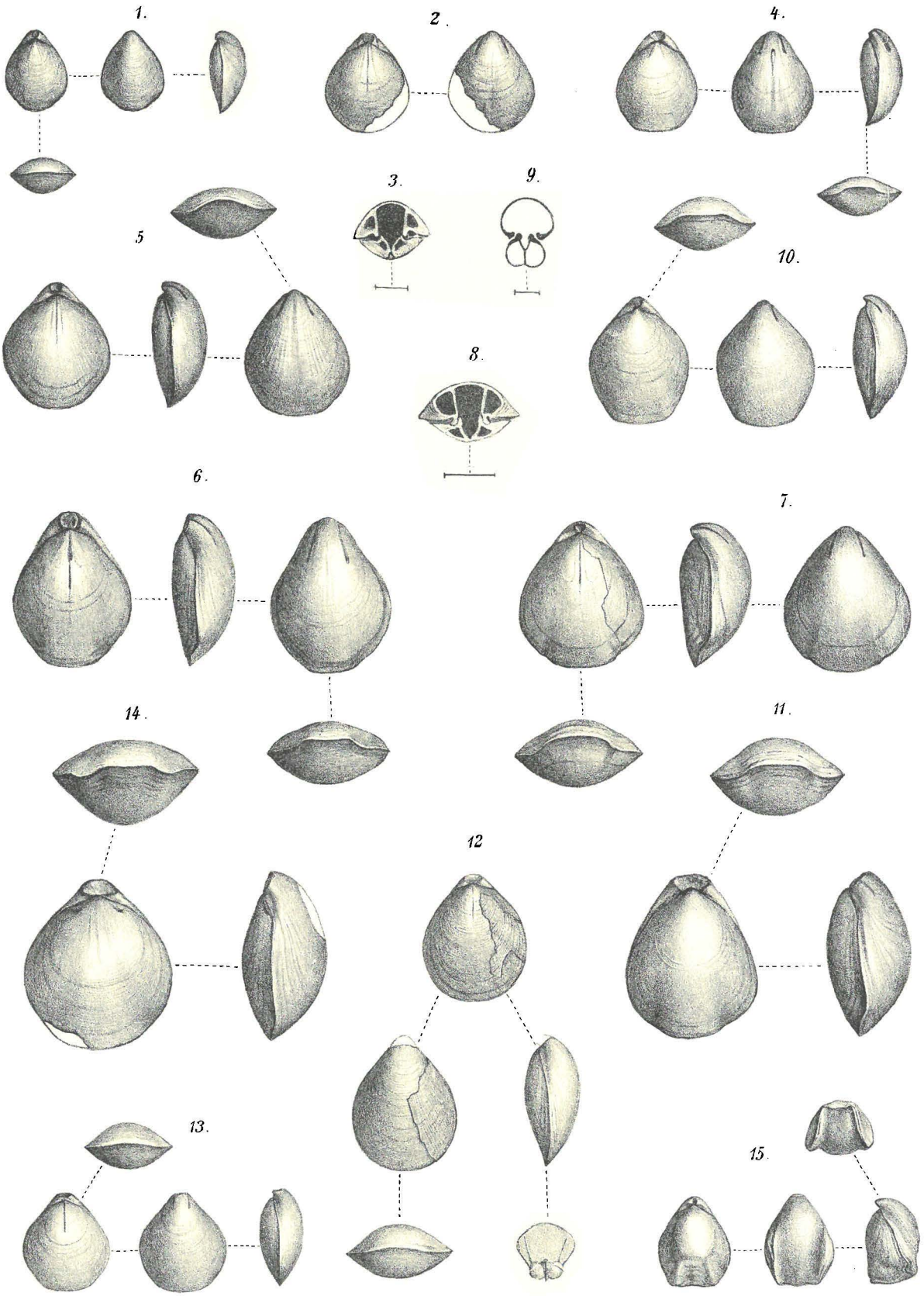


PLATE VI.

Fig. 1. AULACOTHYRIS LILANGENSIS, nov. sp., p. 28, from Lilang on the Lingti, Spiti; described and figured by Stoliczka as *Rhynchonella retrocita*, Suess, var. *angusta*, Stol. (Stoliczka's original specimen).

Figs. 2, 17, 18. RHYNCHONELLA (NORELLA) TIBETICA, nov. sp., p. 32, from the horizon of *Daonella indica*, m., at the upper boundary of the Muschelkalk complex. Fig. 2, from the Shalshal Cliff, near Rimkin-Paiar (the specimen was more completely developed only after it had been figured and then recognised as a Rhynchonella; it does not possess a Terebratula beak, as is shown in the figure); Figs. 17, 18, from Dogkwa Aúr in the Hop-Gadh district.

„ 3-7. AULACOTHYRIS NILANGENSIS, nov. sp., p. 30, from the horizon of *Daonella indica*, *viz.*, Figs. 3, 4, from the Shalshal section near Rimkin-Paiar, Figs. 5-7, from Dogkwa Aúr meadow in Hop-Gadh. The most abundant species of brachiopods in this horizon.

„ 8-13. SPIRIGERA HUNICA, nov. sp., p. 31, from the horizon of *Daonella indica* and *Aulacothyris Nilangensis*. Figs. 8, 9, smaller, doubtful specimens; Figs. 10, 11, larger specimens to be assigned with certainty to this species; the largest typical specimen hitherto known, represented in Fig. 13; Fig. 12, a wider, accessory form. All the specimens are from Dogkwa Aúr Encamping Ground, in the Hop-Gadh district, Tibet.

„ 14, 15, 16. RHYNCHONELLA (NORELLA) KINGI, nov. sp., p. 32, from the horizon with *Daonella Indica*, in the Shalshal Cliff, near Rimkin-Paiar (cf. also Pl. II, Fig. 16).

„ 17, 18. (See above, Fig. 2).

Fig. 19. RHYNCHONELLA RIMKINENSIS, nov. sp., p. 33, from the grey crinoidal limestone, immediately underlying the horizon of *Daonella indica* in the Shalshal section near Rimkin-Paiar.

„ 20. DISCINA, sp., p 33, from the horizon of *Daonella indica* from Dogkwa Aúr Encamping Ground, Tibet.

„ 21. RHYNCHONELLA MIDDLEMISSII, nov. sp., p. 68, from the red limestone of the Cliff of Chitichun in Tibet.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

PLATE VII.

Figs. 1, 2. DAONELLA CF. LOMMELI, Wissm. sp., p. 33, from S. E. of Muth in the Pin Valley, Spiti, collected by Griesbach, both forms from the same specimen of rock.

Fig. 3. DAONELLA SPITIENSIS, nov. sp., p. 38, from Kuling in the Pin Valley, Spiti.

Figs. 4-11. DAONELLA INDICA, nov. sp., p. 39, from the horizon of that name at the upper boundary of the Muschelkalk complex. Figs. 4-9, from Dogkwa Aúr Encamping Ground, in the Hop-Gadh district, Tibet; Fig. 10 from the Shalshal Cliff, near Rimkin-Paiar; Fig. 11 from Khar in the Pin Valley, Spiti.

Fig. 12. DAONELLA AFF. INDICA, nov. sp., p. 41, from Kuling in the Pin Valley, Spiti.

„ 13. HALOBIA COMATA, nov. sp., p. 46, from the so-called "Daonella-beds" of the Bambanag section in the Girthi Valley. The ribbing is shown a little too coarsely in the drawing.

„ 14. HALOBIA CF. COMATA, nov. sp., p. 47, from the same locality as Fig. 13, but from younger beds in the section.

„ 15. HALOBIA FASCIGERA, nov. sp., p. 45, from the lower beds of the so-called "Daonella beds" of the Bambanag section in the Girthi Valley. The bundle-like arrangement of the ribs is not brought out with sufficient distinctness in the illustration.

„ 16. HALOBIA, spec., p. 47, from the higher beds of the so-called "Daonella beds" in the Shalshal section, near Rimkin-Paiar.

Figs. 17, 18, 19. AVICULA (?) GIRTHIANA, nov. sp., p. 48, from the so-called "Daonella beds" of the Bambanag section in the Girthi Valley.

Fig. 20. LIMA sp., p. 50, from a black limestone bed with *Halobia* cf. *comata*, nov. sp., from N. W. of Kiunglung.

„ 21. MYOCONCHA, sp., p. , from the crinoidal limestone beneath the beds with *Daonella indica*, in the Shalshal section, near Rimkin Paiar.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

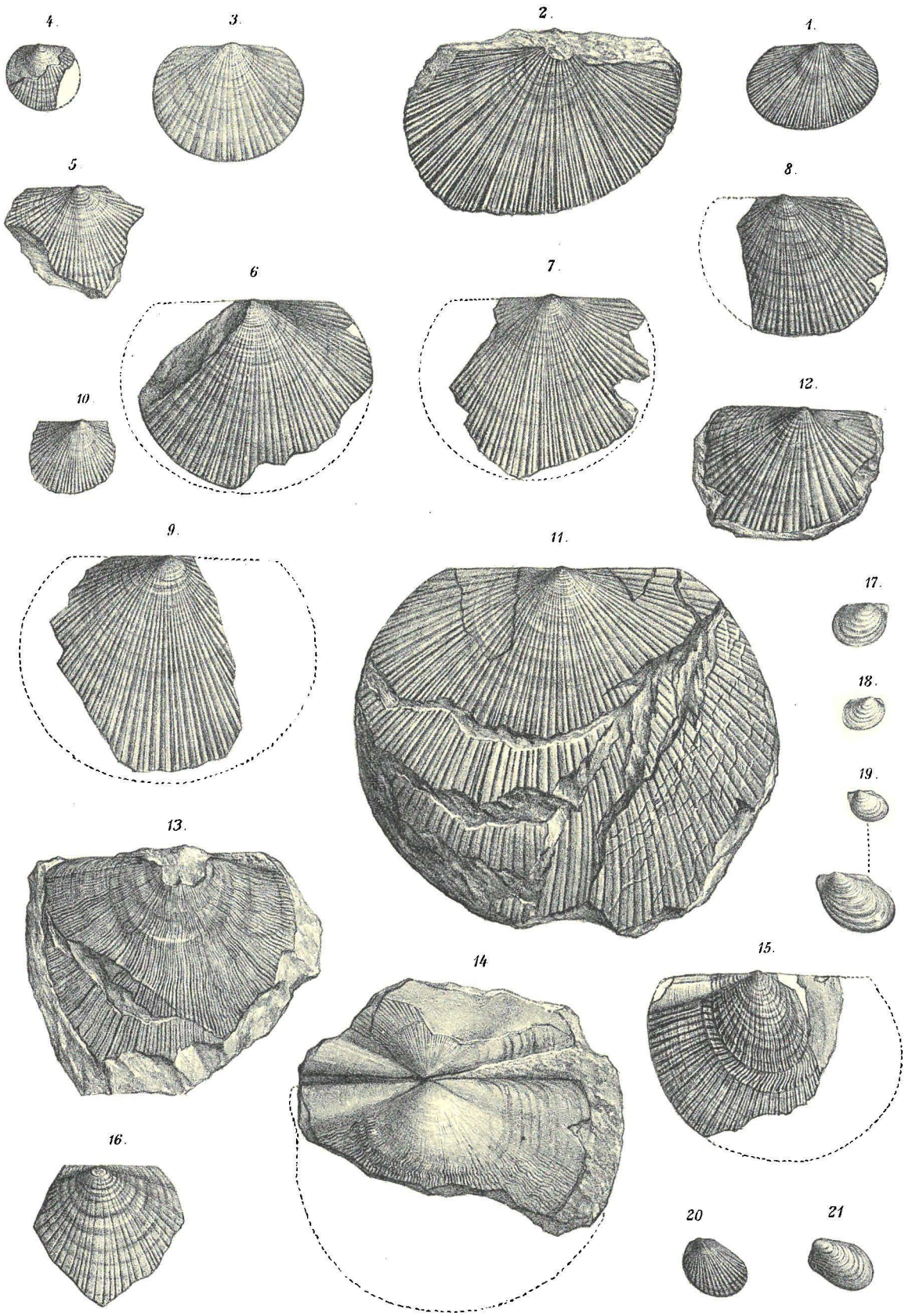


PLATE VIII.

Figs. 1-3. RETZIA SCHWAGERI, Bittn., var. Asiatica, nov., p. 42, from the complex of the "Daonella beds" of Lauka Encamping Ground (Figs. 2, 3), and from the Bambanag section (Fig. 1). Cf. also Pl. X, Figs. 16-21.

Fig. 4. RHYNCHONELLA BAMBANAGENSIS, nov. sp., p. 44, from the "Hauerites beds" of the Bambanag section. Cf. also Pl. IX, Fig. 18.

Figs. 5, 6. RHYNCHONELLA LAUCANA, nov. sp., p. 44, from the so-called "Daonella beds" of Lauka Encamping Ground, in the highest part of the Girthi Valley.

„ 7, 8, 9. CASSIANELLA, pl. sp., p. 49, *viz.* Figs. 7, 8, from the so-called "Daonella beds" of the Bambanag section; Fig. 9 from the Shalshal section, near Rimkin-Paiar.

Fig. 10. CASSIANELLA PULCHELLA, nov. sp., p. 58, from the horizon of *Spiriferina Griesbachi* of the Bambanag section.

„ 11. LIMA, sp., p. 50, from the Halorites beds in the Bambanag section of the Girthi Valley.

Figs. 12, 13. LIMA (?) SERRATICOSTA, nov. sp., p. 50, from the Halorites (Tropites) beds of the Bambanag section. Fig. 12, specimen with the shell; Fig. 13, cast; cf. also Pl. X, Fig. 26.

„ 4-16. ANODONTOPHORA (ANOPLOPHORA, auct.) GRIESBACHI, nov. sp. p. 60, *viz.* Figs. 14, 15, forms with the shell, from the Halorites (Tropites) beds of the Bambanag section; Fig. 16, a cast from the "Sagenites beds" overlying the horizon with *Spiriferina Griesbachi.*

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

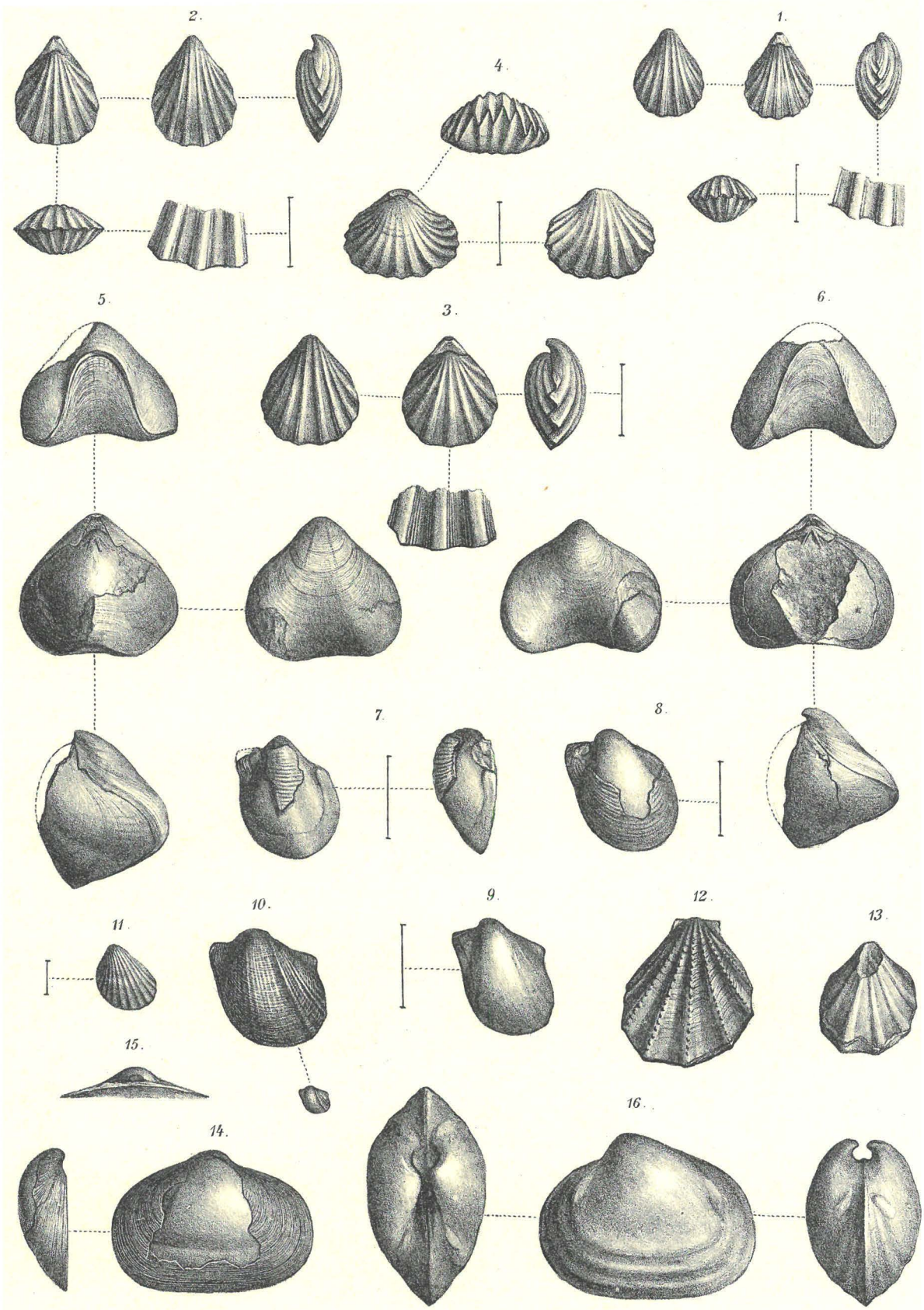


PLATE IX.

Figs. 1-7. SPIRIFERINA GRIESBACHI, nov. sp., p. 51, from the Bambanag section.

„ 8-13. SPIRIFERINA TIBETICA, Stol. p. , from the Manirang Pass in Spiti, *viz.*, Fig. 8, view of the area; Fig. 9, external view of a large valve; Fig. 10, section of the beak parallel to the area; Fig. 11, external section of the beak; Fig. 12, dental plates in the beak in complete preservation; Fig. 13, median septum of the beak.

„ 14, 15. SPIRIFERINA TIBETICA, Stol. sp., pp. 52, 53, Stoliczka's two original specimens.

Fig. 16. SPIRIFERINA ALTIVAGA, Stol. sp., p. 53, Stoliczka's original specimen.

„ 17. RHYNCHONELLA MARTOLIANA, nov. sp., p. 56, from the horizon of *Spiriferina Griesbachi* in the Bambanag section, near Martoli Encamping Ground.

„ 18. RHYNCHONELLA BAMBANAGENSIS, nov. sp., p. 56, from the horizon of *Spiriferina Griesbachi* in the Bambanag section (cf. also Pl. VIII, Fig. 4).

Figs. 19, 20. AULACOTHYRIS JOHARENSIS, nov. sp., p. 57, from the horizon of *Spiriferina Griesbachi* of the Bambanag section in the Girthi Valley.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

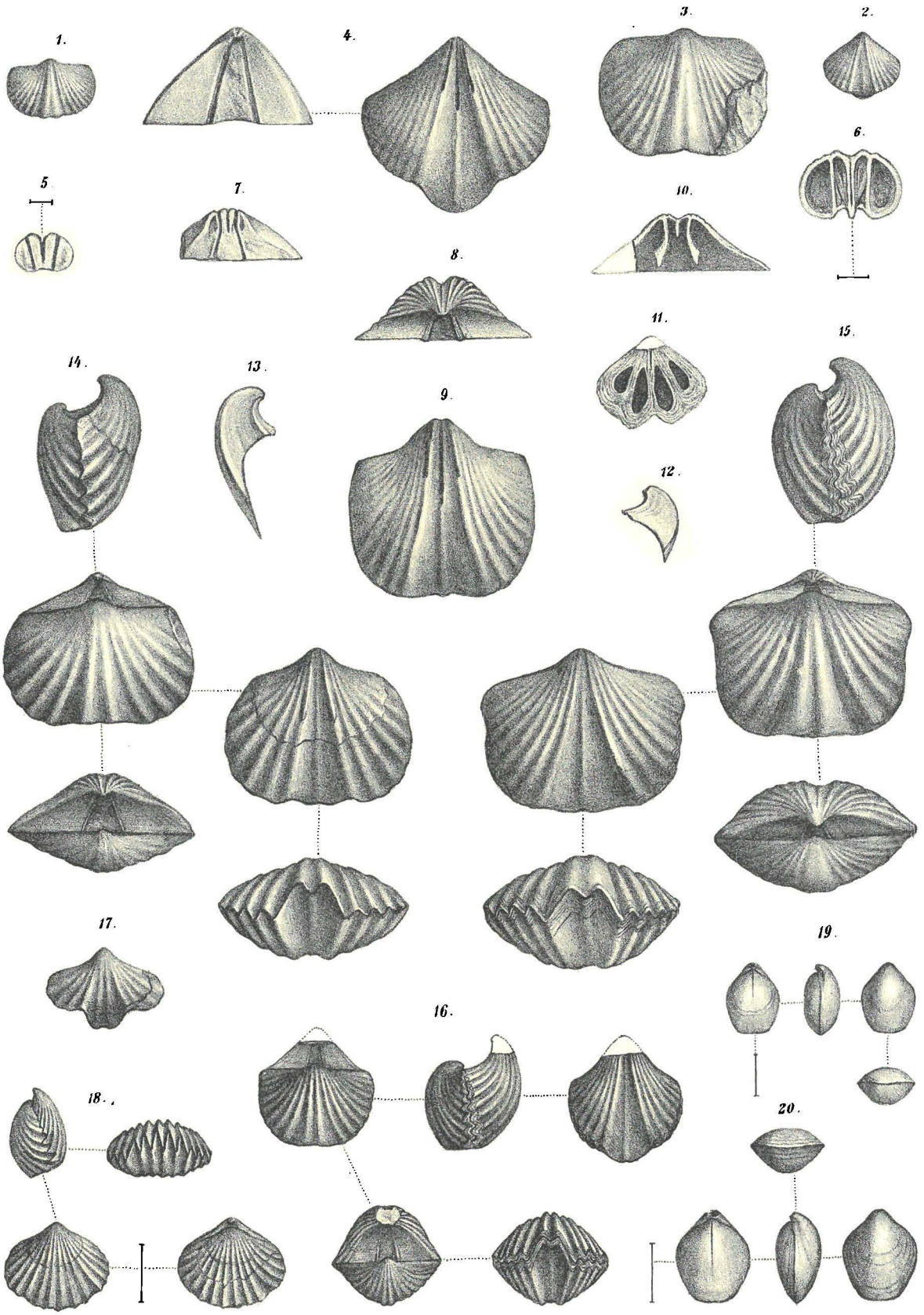


PLATE X.

Figs. 1-14. SPIRIGERA DIENERI, nov. sp., p. 54, from the horizon of *Spiriferina Griesbachi* of the Bambanag section; Figs. 1-11, the species in different stages of growth and varieties (Fig. 11 is enlarged one and a half times). Figs 12, 13, sections of the umbones; Fig. 14, section of the umbo of the small valve parallel to the line of junction of the two valves.

Fig. 15. AMPHICLINA, sp., p. 55, from the beds with *Spiriferina Griesbachi* of the Bambanag section.

Figs. 16-21. REIZIA SCHWAGERI, Bittn., VAR. ASIATICA, nov., p. 54 (cf also Pl. VIII, Figs. 1-3) from the beds with *Spiriferina Griesbachi* of the Bambanag section. Fig. 17, an abnormal specimen, Fig. 21, the region of the area enlarged.

Fig. 22. PECTEN INTERRUPTUS, nov. sp., p. 60, from the beds with *Spiriferina Griesbachi* of the Bambanag section.

Figs. 23, 24. PECTEN BIFORMATUS, nov. sp., p. 59, from the beds with *Spiriferina Griesbachi* of the Bambanag section. Both valves, but the drawing of the left valve (Fig. 24) is not quite correct.

Fig. 25. LIMA CUMAUNICA, nov., sp., p. 59, from the beds with *Spiriferina Griesbachi* of the Bambanag section.

„ 26. LIMA (?) SERRATICOSTA, nov. sp. (?), p. 51, from the "Sagenites beds" in the Bambanag section (cf. Pl. VIII, Figs. 12, 13).

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.

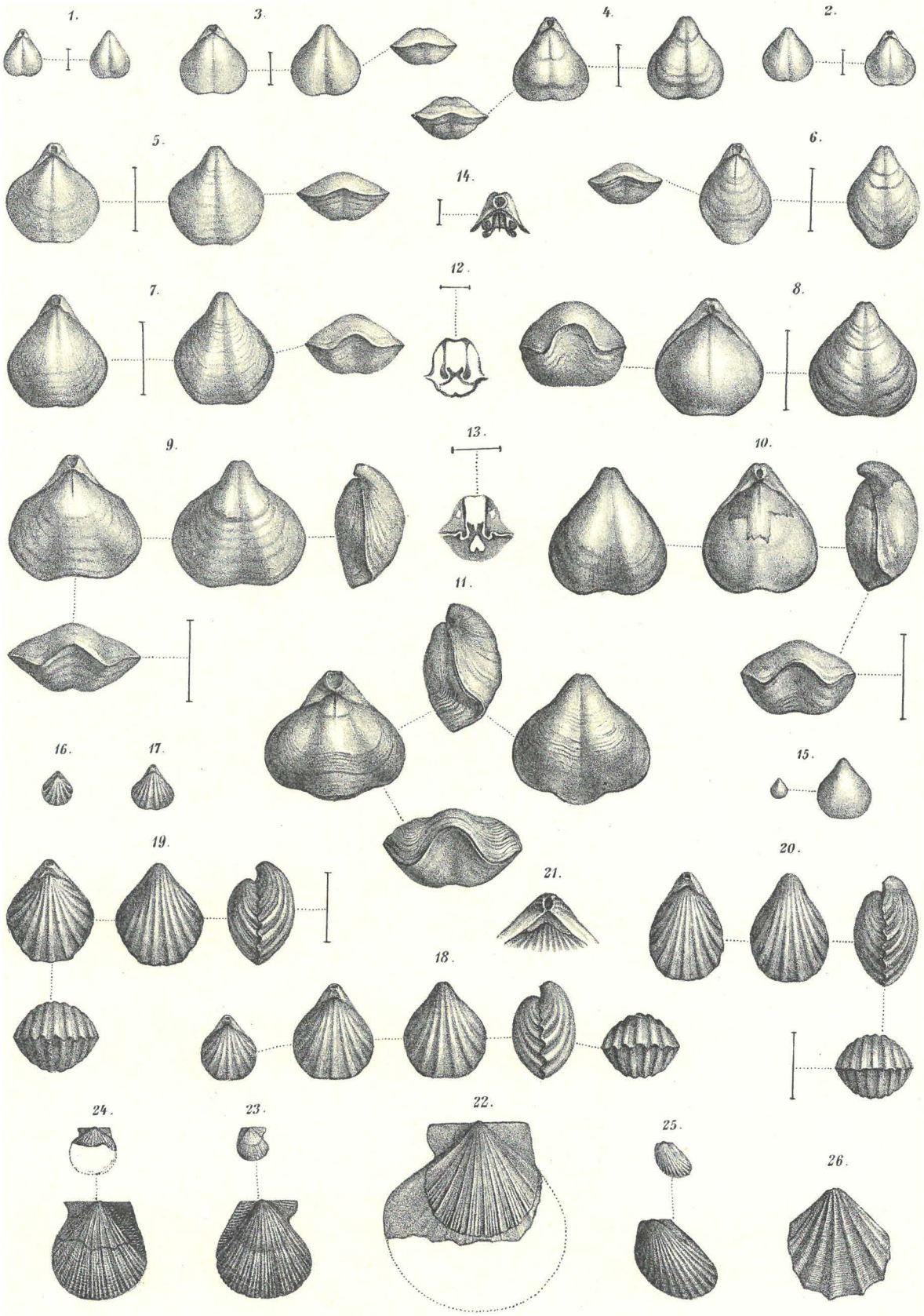
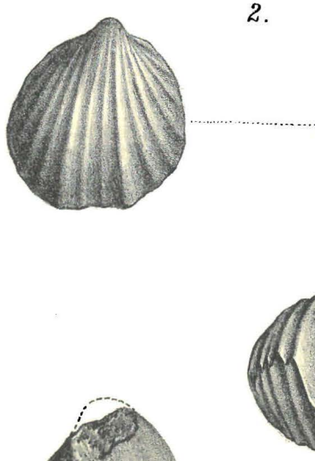


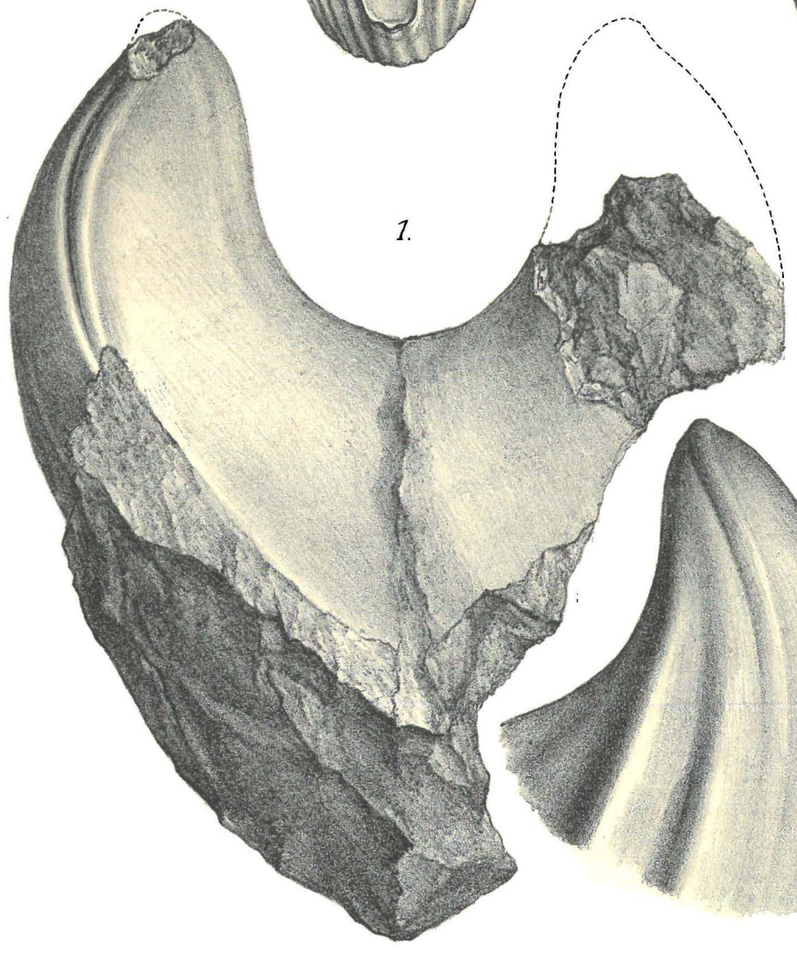
PLATE XI.

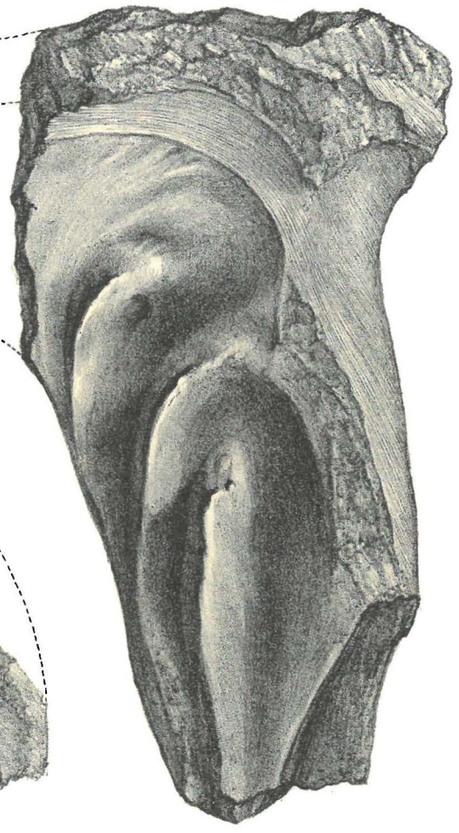
Fig. 1. MEGALODON CULTRIDENS, nov. sp., p. 62, from the vicinity of Lingti-Sumdo (Tibet ?). Fig. 1, the front view of the cast; 1^a the back view of the right umbo, 1^b lateral aspect of cast of the right umbo with the anterior part of the shell adherent to it; 1^c the hinge of the two valves, that of the right valve restored from a plaster cast of its mould; 1^d the hinge teeth of the left valve seen from the lunule. All the views from the same specimen.

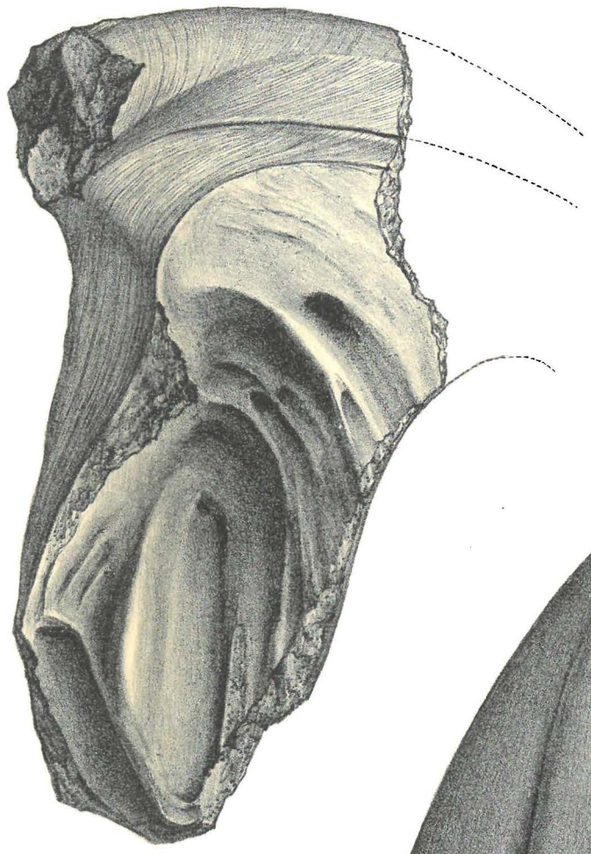
Figs. 2, 3. SPIRIGERA (?) NOETLINGII, nov. sp., p. 68, from beds of unknown age (presumably Lias) from Nio-Sumdo, in Karnag. Fig. 2, the front view is represented as revereed through a mistake on the part of the draughtsman. Fig. 3, cut and polished section with the arm spiral of one side, which is displaced in the shell.

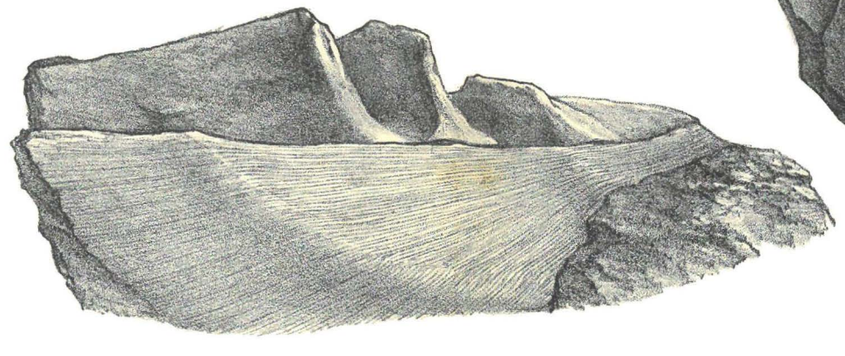
HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.











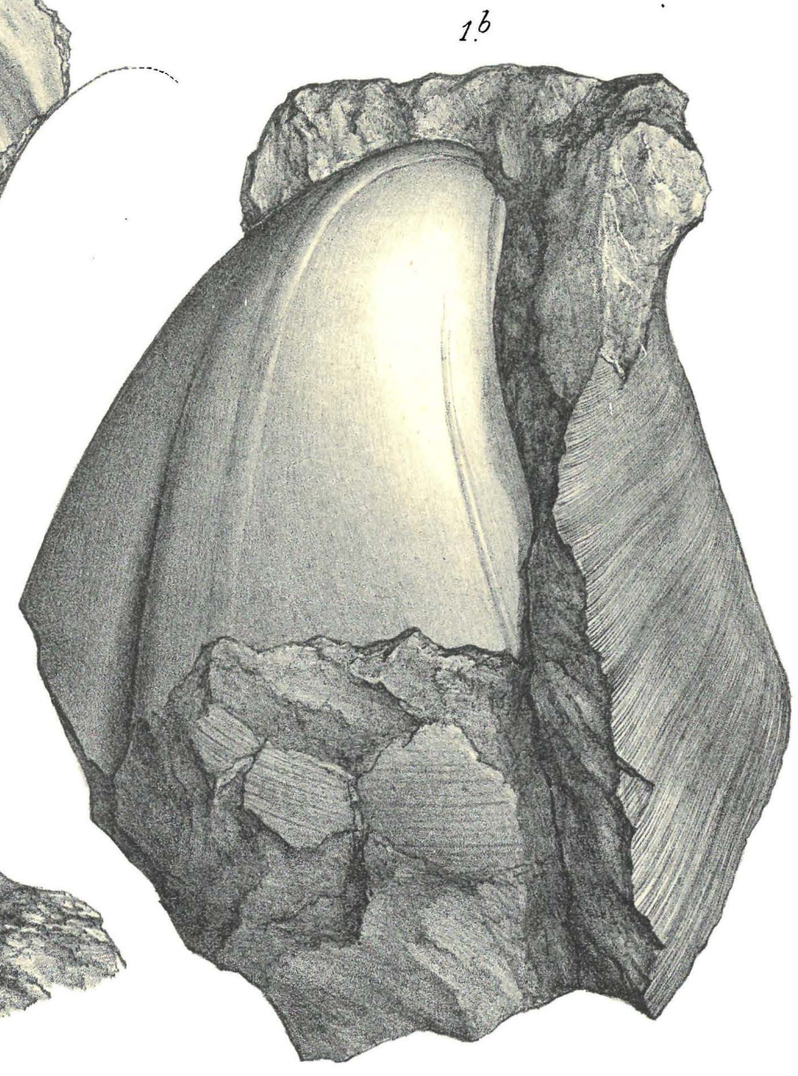


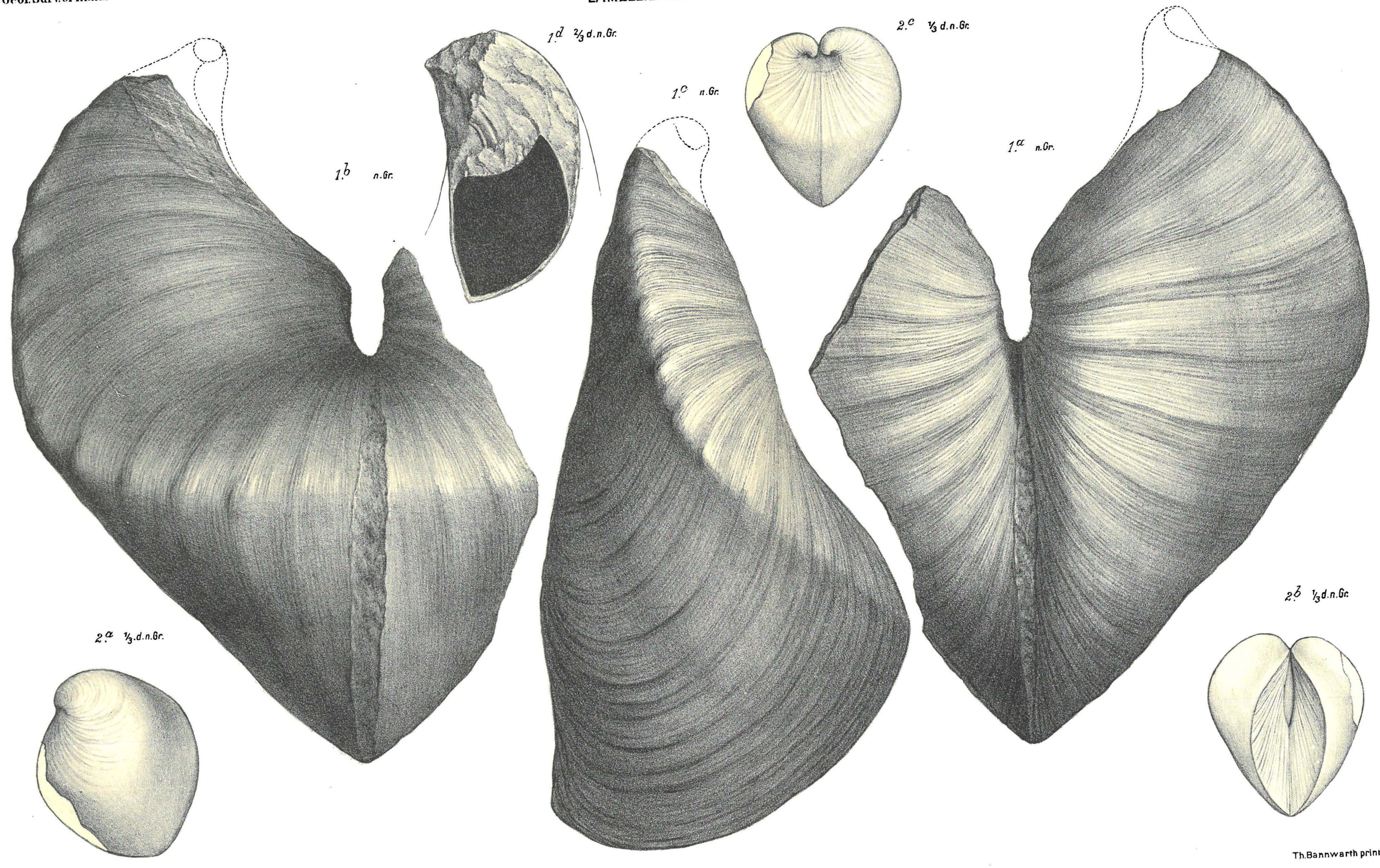
PLATE XII.

Fig. 1. DICERocARDIUM HIMÁLAYENSE, Stol., p. 66, from the so-called "Para limestone" from the village of Chiote in North-Western Spiti. Stoliczka's original specimen. Fig. 1^a, back view; 1^b, front view, 1^c, lateral view, 1^d, a portion of the left umbo broken off.

„ 2. MEGALODON LADAKHENSIS, nov. sp., p. 65, from Ladakh, or from Spiti. Original specimen of Lydekker's illustration on Pl. 4, in Mem. Geol. Surv. of India. Vol. XXII, here reduced to about one-third the natural size.

Geol. Surv. of India.

HIMALAYAN TRIAS BRACHIOPODA, LAMELLIBRANCHIATA ETC.



A. Swoboda del. et lith.

Th. Bannwarth print.