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ON THE CHARACTER OF THE BOUNDARY OF
PALAEOZOIC AND MESOZOIC NEAR DJULFA.¹⁾

BY A. A. Stoyanow.

Im Herbste, wenn man von dem Garten Abschied nimmt, werden noch die letzten Früchte gesammelt, welche da und dort vor dem herannahenden Winter die Reife erlangten.

Ed. Suess in Abich.

Ed. Suess in his preface to the third part of «Geologische Forschungen in den Kaukasischen Ländern» comparing all finished Abich's works dedicated to the Caucasus with a well arranged orchard, names these of his investigations, which he had merely in view, but had not accomplished, fruits fallen from the trees before the orchard was cleared, and ripening meanwhile, until in the drawing near autumn they will be gathered too.

As one of these after ripening fruits of Abich's orchard appears the question of the age of Palaeozoic deposits near Djulfa, the fauna of which after Suess's remark, consisting once of

¹⁾ First time reported in the form of a preliminary communication, December 29, 1909, (See the title) in the Diary of the XII-th Congress of Russian Naturalists and Physicians in Moscow, № 4, p. 142.

quite foreign species, has become now one of the most important comparable points for the Upper Palaeozoic of Central Asia and India.

Two questions have a particular lively interest in the history of development of the marine formations of the globe: the first—on the boundary of the Upper Carboniferous and Permian deposits, and the second on the boundary of the Palaeozoic and Mesozoic. Thus, each material having widened our representation of these boundaries, and admitted the concordance of the already existing facts, has drawn the attention of eminent specialists.

When after the classical monographies of A. P. Karpinsky, Th. N. Tschernyschew, W. Waagen, G. Gemmellaro, E. Schellwien, C. Diener, and other leading geologists, arose completely determinate representations of the general outlines of the Upper Palaeozoic Mediterranean, the fauna of Djulfa was no more isolated by its common character, but Abich's rather palaeontological monography ¹⁾ gave us no explanation about the correlations among the forms described by him, often so different in the degree of development of the leading morphological features, that the simultaneous existence of this whole fauna was acknowledged by some as impossible.

Frech and Arthaber, ²⁾ whose visit to Abich's section was but of short duration, had no time to gather this fauna in situ, and were quite unable to make a stratigraphical investigation in the place. These learned men brought to agreement with the contemporary state of science the whole material described by Abich, found some new forms, gave another interpretation to some of the ancient species, but for stratigraphical comparison they had at their disposal only these means, which other learned

¹⁾ Abich. Eine Bergkalkfauna aus der Araxesenge bei Djoulfa in Armenien.

²⁾ Frech und Arthaber. Ueber das Paläozoicum in Hocharmenien und Persien. Beiträge zur Paläont. und Geol. Österreich-Ungarns etc., Bd. XII, Heft IV.

authors possessed, having pronounced their ideas about the age of the deposits of Djulfa, i. e. the opinions on the common character of this fauna, and the method of statistical comparison.

Thus, the question on the bathrological correlations of the described specimens of Djulfa is again under doubt. Meanwhile, if on one side the fauna of Djulfa is closely connected in the ground-type of its development with the analogous fauna of India, on the other the comparative vicinity of Armenia to the classically studied districts of Europe, gives us the impulse to look within its boundaries for more stratigraphical grounds, owing to which one might join the European and Asiatic provinces of the above mentioned sea.

And reversely, the non-acquaintance with the stratigraphy of the Upper Palaeozoic of Djulfa has, for instance, caused the problematical dividing of Abich's section into lower beds with *Gastrioceras* and upper, «transitional beds» to Trias, with *Otoceras*.¹⁾ That undermined the significance of the having been received in that manner results of comparison of the marine deposits of India and Europe, disvaluing the well studied palaeontological material in stratigraphical inference, because each form allied to «Permian» of Djulfa did not substantially determine the age of the one or other of the treated horizons.

It must be remarked that though the Upper Palaeozoic fauna of India was excellently studied, still this study was not accompanied by careful stratigraphical investigations.

The speculative conclusions, the task of which was to bring closer the Upper Palaeozoic of Salt-Range and of the Himalayas, to the Palaeozoic of Europe, were also sometimes based on rather dubious principles.

In the given case one takes into consideration those methods

¹⁾ Waagen. Salt-Range Fossils, Vol. IV, Part 2, Geological Results, p. 215. Palaeontologia Indica, Ser. XIII.

of the determination of the question on the age of the Upper Palaeozoic formations of India, which were not based on the comparison of the fauna-representatives of India with identical or close species, the bathrological position of which is well known, but they were represented as experiments in order to determine the age of the divisions of the given system exclusively on the ground of the palaeontological habitus of the therein occurring forms, which yet had no analogues in the classical studied countries.

The inferences resting on such principles do not yield the required satisfaction, as it is righteously indicated by Th. N. Tschernyschew. ¹⁾

As an example, which besides has immediate relation to the hereinafter mentioned, I will indicate Diener's alteration of opinions on the age of the fauna of Chitichun № 1, having proceeded exclusively under the influence of Noetling's finding of *Xenodiscus carbonarius* Waag. in the middle division of Productus-limestone. ²⁾

In «The Permocarboniferous Fauna of Chitichun № 1» Diener has summed up his opinions on the age of this fauna in the following terms: ³⁾ «The Chitichun limestone is approximately homotaxial with the upper division of the middle Productus limestone (Virgal and Kálábagh beds) in the Salt-Range. It probably corresponds in age to the permocarboniferous horizon (Artinskian stage) in Russia, but the description of the brachiopods from the Fusulina limestone of Sicily must be awaited for, before it is possible to decide, whether it

¹⁾ Th. Tschernyschew. Die obercarbonischen Brachiopoden des Ural und des Timan, 1902, pp. 668 and 716.

²⁾ Noetling. Beiträge zur Geologie der Salt-Range etc. Neues Jahrbuch für Mineralogie etc., Beilage-Band XIV, 1901, p. 400.

³⁾ Diener. The Permocarboniferous Fauna of Chitichun № 1. Palaeontologia Indica, Ser. XV, Himalayan Fossils, Vol. 1, Part 3, p. 102, 1897.

does not hold a slightly higher position in the stratigraphical sequence, than the Artinskian deposits».

But in 1903, in the «Permian Fossils of the Central Himalayas, I.—Fossils from the Permian Limestone Crag of Chitichun № 1. (Hundes.)» ¹⁾ under the influence of Noetling's investigations, Diener declares that he considers the before mentioned position as erroneous. Pointing out that Rothpletz, Frech, Oldham and Suess adapted the Lower Productus-limestone to the Upper Carboniferous deposits, Diener writes: ²⁾

«In the meantime Tschernyshev called attention to the strongly marked affinities of the faunae of the middle Productus limestone and the Artinskian stage. On palaentological grounds he tried to prove that the entire middle Productus limestone ought to be synchronised with the Artinskian strata of Russia.

In admitting this homotaxis I merely followed the almost unanimous judgement of European geologists. The equivalence of the Chitichun limestone to the Virgal and Kalabagh-beds in the Salt-Range having been clearly demonstrated, the necessity of correlating it with the Artinskian stage of Russia was obvious».

Diener sets a high value on Noetling's discovery: ³⁾ — «The importance of this discovery consists in the fact that the famous Cephalopoda of permian age, which had first been described by Waagen, are not restricted to the upper Productus limestone, but that one of the most interesting species of triassic aspect, and with ceratitic sutures, has its main layer in the Kalabagh-beds of the middle Productus limestone. With this

¹⁾ Palaentologia Indica, Ser. XV, Himalayan Fossils, Vol. 1, Part 5, 1903.

²⁾ Diener, l. c. p. 54.

³⁾ Diener, l. c. p. 55.

discovery all the arguments in favour of a correlation of the middle *Productus* limestone with the Artinskian stage fall to the ground. Ammonites with ceratitic sutures are entirely absent in the Artinskian stage. Their presence points even more clearly to the younger horizons of the permian system, than does the first appearance of more highly developed ammonites to the permo-carboniferous stage».

In what relation the Ammoneae with the ceratito-like suture-line are to the forms of strict Permocarboniferous type in Abich's section, I will indicate lower.

The historical sum of opinions on the age of the fauna described by Abich was adduced by Frech and Arthaber ¹⁾ on the pages of their well known work. Here I will quote only those of them which I have reason to controvert.

After Abich the first who brought out this question was W. J. Möller, ²⁾ giving his opinion for the Lower Permian age (s. s.) of the fauna of Djulfa. The motive of such an affirmation, as Möller takes it, appeared the incorrect treaty of the majority of species found by Abich. The most important was the following alteration made by Möller in Abich's determinations of the species and genera.

ABICH.

MÖLLER.

Nautilus concavus Sow. = *Nautilus cornutus* Golovk.

Pr. intermedius Ab.

Pr. intermedius helicus Ab. } = *Pr. horridus* Sow.

Pr. spinoso-costatus Ab.

¹⁾ Frech and Arthaber, l. c. p. 291—292.

²⁾ Möller. Ueber die bathrologische Stellung des jüngeren paläozoischen Schichtensystems von Djoulfa in Armenien. Neues Jahrbuch für Mineralogie etc., 1879, p. 225.

$$\begin{array}{lcl}
 Pr. \textit{scabriculus} \text{ Martin} & \} & = Strophalosia \textit{horrescens} \text{ Vern.} \\
 Pr. \textit{Humboldti} \text{ d'Orb.} & \} & \\
 Pr. \textit{striatus} \text{ F. v. Waldh.} & \} & \\
 Pr. \textit{striatus} \text{ var. } \textit{sphaericus} & \} & = Pr. \textit{hemisphaerium} \text{ Kut.} \\
 \text{F. v. Waldh.} & \} & \\
 Pr. \textit{undatus} \text{ Defr.} & \} &
 \end{array}$$

Waagen, ¹⁾ after having ascertained common species for the Salt-Range and Djulfa, compared the fauna of the latter locality partly with the middle and upper division of the Middle Productus-limestone, but somewhat more with the Upper Productus-limestone. Drawing attention to the considerable difference of the degree of development of two groups of Djulfian Ammonoae, he assumed the representatives of the genus *Otoceras* as transitive forms from Upper Permian to Trias; but the presence of such a comparatively ancient genus as *Gastrioceras* in this fauna, besides the great quantity of its specimens, did not permit of attributing to all this fauna such a high bathrological position, particularly at the condition of its simultaneous existence ²⁾.

Therefore Waagen has admitted that Abich's section may be divided into the lower part with Brachiopoda and *Gastrioceras*, and the upper—transitive to Trias—with *Otoceras*. The latter as «passage beds» he adapted to *Otoceras* beds of the Himalayas. Considering the middle and upper division of Middle Productus-limestone for Lower Permian deposits (s.s.), Waagen assumed suppositively that the bathrological position of the Brachiopod-bearing beds of the Djulfian section should be somewhat higher, and partly corresponds already to the Upper Permian.

¹⁾ Waagen. Salt-Range Fossils, Geological Results, p. 214—215. Palaeontologia Indica, Ser. XIII.

²⁾ Abich. l. c. p. 11; Diener. The Cephalopoda of the Lower Trias, p. 171.

Acknowledging that some Djulfian forms are quite identical with the analogical species from the middle division of Middle Productus-limestone, yet in his «Tabular view», in the rubric «China and some other scattered Asiatic localities», in front of this division he has put a note of interrogation.

At last, Frech and Arthaber have given their opinion on this question in the following terms: «Heute aber können wir mit Sicherheit nur ein einziges Niveau annehmen, das wir über Artinsk und über Sosio stellen, das dem oberen Productus-Kalke der Salt-Range (Khundghat und Jabi beds) entspricht...» ¹⁾

They assume with Möller the presence of *Nautilus cornutus* Golovk. and *Productus hemisphaerium* Kut. in the fauna of Djulfa. Besides they consider *Productus Geinitzianus* Kon.—a species from German Zechstein—closely allied to *Productus scabriculus* (Martin) Abich and *Pr. intermedius* Ab., and point to a close connection of *Nautilus cornutus* Golovk. to *Nautilus Freieslebeni* Geinitz.

In order to explain the presence of such a form as *Gastrioceras Abichianum* Möll. in the section, they state the supposition that this genus has attained its maximum-development in the epoch of deposition of Calcare con Fusulina in Sosio, and there is nothing striking in the surviving of the representatives of this genus until the time of the deposition of the sediments of Djulfa.

And so are Frech's opinions in his composition «Die Dyas» — «Die Djulfaschichten enthalten hiernach die einzige besser bekannte Fauna der untern Neodyas in pelagischer Entwicklung». ²⁾

Thus, Frech separates rigorously the deposits of Djulfa from the Artinskian stage, Calcare con Fusulina in Sosio,

¹⁾ Frech and Arthaber, l. c. p. 295.

²⁾ Frech, die Dyas, p. 568.

the fauna of Chitichun № 1, and the Upper Palaeozoic deposits of Ajer mati on Timor, because all enumerated formations he considers to be Palaeodyassic ones. ¹⁾

In Frech's opinion the series of such original Brachiopoda as:

Scacchinella

Oldhamina

Tegulifera

Richthofenia

Lyttonia etc.

having been marked still in the Upper Carboniferous epoch, reached the highest development at the time of the deposition of the Lower Permian sediments (s. l.), but being very limited in their evolution in vertical direction, they become extinct once more.—«Die genannten auffallenden Formen sterben rasch wieder aus und fehlen z. B. im Djulfakalke vollständig, in dem auch keine Spur von Fusulinen mehr zu beobachten ist». ²⁾

By the initiative of Th. N. Tschernyschew, and owing to the cooperation of the Mineralogical Society, I succeeded in visiting the defile of the Araxes twice, and made closer acquaintance with Abich's section, than my honorable predecessors had chance to make.

Though the whole fauna gathered by me is not yet arranged, for instance, Pelecypoda and Coelenterata were as yet but fugitively examined, I cannot forbear imparting the interesting results received.

Before the stratigraphical outline I send here the description of some forms, important in stratigraphical respects.

¹⁾ Frech, l. c. zu Seite 493.

²⁾ Frech, l. c. p. 483.

Orthoceras lopingense n. sp.

Plate VII, figs. 2, 3.

1883. *Orthoceras* cnf. *cyclophorum* Waag. Kayser. Obercarbonische Fauna von Lo-ping. In v. Richthofen's «China», Bd. IV, p. 166, Taf. XIX, F. 6, 9, 10.

There were found by me specimens quite identical with the forms described by Kayser from Lo-ping as *Orthoceras* cnf. *cyclophorum* Waag. These forms differ vigorously from Waagen's mentioned species in the character of their transverse ribs, sharper and more angular. Each chamber of my species represents two truncated cones with common foundation which also appears as the transverse rib of the given chamber. Meanwhile Waagen remarks ¹⁾ in respect to the ribs of *Orthoceras cyclophorum*: «The rings are not angular, but rounded at their top».

In Kayser's excellent description: «...Bruchstücke... zeichnen sich durch ein sehr lang conisches, fast cylindrisches Gehäuse, kreisförmigen Querschnitt, sehr niedrige Kammern (gewöhnlich $\frac{1}{8}$ — $\frac{1}{4}$ so hoch als breit) mit schwach gebogenen Wänden und horizontalen, geradlinigen Suturen aus. Siphon dünn, etwas excentrisch. Die starken, gerundeten Ringwülste horizontal stehend. Die Schalenoberfläche scheint glatt zu sein»,—one can but mark out that the transversal ribs don't appear at all rounded, which is strikingly remarkable on the figures 6, 9, 10, plate XIX of his work. Kayser himself has stated the supposition that the specimens represented by him belong to different species. As it appears, the form corresponding to fig. 8, pl. XIX possesses more rounded transverse ribs.

¹⁾ Waagen, Salt-Range Fossils, I. Productus-limestone Fossils, i. Pisces-Cephalopoda, p. 68. Palaeontologia Indica, Ser. XIII.

With *Orthoceras transversum* Abich, ¹⁾ distinguished by elliptical transverse section, and less sharp ribs, this species is connected by a series of gradual transitions.

Nautilus hunicus Diener.

Plate VII, fig. 5.

1903. *Nautilus* (*Domatoceras?*) *hunicus* Diener, Permian Fossils of the Central Himalayas. Palaeontologia Indica, Ser. XV, Himalayan Fossils, Vol. I, Part 5, p. 5, Plate I, fig. 1.

I have at my disposal only the part of a whorl. The transverse section, the character of the exterior and lateral surfaces, and the ratio of height to width is quite the same as in the species described by Diener. The sutural lines are very poorly preserved. Diener ²⁾ pointed to essential differences of *N. hunicus* from the more involute *N. brahmanicus* Griesb. From other *Nautilidae*, found in Abich's section, this species differs perceivably. Diener points to ³⁾ the resemblance of *N. hunicus* with a form described by Arthaber ⁴⁾ as *Nautilus parallelus* Abich, but Arthaber's specimen differs from the Himalayan species in quite different ratios of height and width.

Popanoceras Tschernyschewi n. sp.

Plate VII, fig. 7.

The shell is discoidal, the lateral surface of its whorls is very gently convex, the siphonal surface is narrow, roundly

¹⁾ Abich, l. c. p. 26, Taf. 4, Fig. 7, 7a.

²⁾ Diener, l. c. p. 7.

³⁾ Diener, l. c. p. 7.

⁴⁾ Arthaber, l. c. p. 213, Taf. XVIII, Fig. 2 a-c.

stretched. That is one of the most compressed species of *Popanoceras*, and in this respect it may be compared, as far as one can judge by the drawings, with *Popanoceras scrobiculatum* Gemm. and *Pop. Moelleri* Gemm.,¹⁾ but differs in having a more elliptical transverse section. The whorls are strongly embracing, and there is a very narrow umbo. No traces of sculpture are observable.

By the character of the suture-line this form belongs to those *Popanoceras* in which the first lateral lobe is bipartite (i. e. in the meaning of which one ought to name bipartite the first lateral lobe in *Popanoceras Krasnopolskyi* Karp. by height of whorls of 6—7 mm. See A. P. Karpinsky—«Über die Ammoniten der Artinsk-Stufe etc.», Mém. Acad. d. Scienc. de St. Petersburg, 1889, S. 73, Taf. V, Fig. 10 k.), and the other lobes are trifid. A well preserved suture-line may be observed only in the youngest part of the last whorl, but it is clearly visible that the correlations of the elements of the suture-lines are quite equal in all its parts.

There are nine lateral lobes in all. The first lateral lobe is divided into two parts, from which the second in its base divides itself again into the chief vertical part and a lateral denticle. But on some suture-lines of this species one may remark also in the first part of the first lateral lobe «an arising bipartition» in the form of a lateral prominence. The other lateral lobes are trifid, but it is impossible to name any one of them strictly symmetrical. The saddles separating their exterior parts from the median ones are larger in their dimensions, than the saddles between the middle and inner parts. All parts of the lobes are lanceolate.

In the number of the lobes, and correlation of the parts

¹⁾ G. Gemmellaro. La Fauna dei Calcari con Fusulina, Tav. III, fig. 7, 8, 12, 14 e 24.

ornamenting them, this suture-line stands the nearest to the suture of *Stacheoceras mediterraneum* Gemm. ¹⁾ When examining the lateral lobes of this latter species, we also see that their external parts are separated from the median ones, by more expressed saddles, than the inner ones. There is observable a striking difference in the construction of the first lateral lobe which in *Stacheoceras mediterraneum* though bipartite, yet the part bearing the supplementary denticle is not the inner, but the external part of the lobe.

The difference between the suture-lines of these two species may also be observed in their general outlines, which in *Stacheoceras mediterraneum* Gemm. are much coarser.

By the expressiveness of the saddles and lobes, and by the lanceolate character of their parts, the suture-line of *Popanoceras Tschernyschewi* approaches more the suture-lines of *Stacheoceras Karpinskyi* Gemm., ²⁾ *Stacheoceras Trimurti* Diener, ³⁾ and *Arcestes tridens* Rothpletz. ⁴⁾

The similarity of the suture-lines of the Djulfian species and of *Stacheoceras Karpinskyi* Gemm. is also great in the meaning of the correlations of the particular parts of their lobes. Their first lateral lobes are of a quite identical construction. We see that the additional denticle is present in both species on the *internal* part of the two parts of these lobes. The other lateral lobes of *Stacheoceras Karpinskyi* have the construction of the same ground-type, but they are more unsymmetrical, and may be called bipartite.

When comparing the lobe elements of *Popanoceras Tscher-*

¹⁾ Gemmellaro, l. c. p. 29, Tav. IV, fig. 6; Tav. VII, fig. 13.

²⁾ Gemmellaro, l. c. p. 32, ^vTav. VIII, fig. 8.

³⁾ Diener. The Permocarboneous Fauna of Chitichun № 1. Palaeontologia Indica, Ser. XV, Himalayan Fossils, Vol. 1, Part 3, p. 9, Pl. I, fig. 1.

⁴⁾ Rothpletz. Die Perm-, Trias- und Jura-Formation auf Timor und Rotti im indischen Archipel. Palaeontographica Bd. 39—p. 87, Taf. IX, Fig. 4.

nyschewi with those of *Stacheoceras Trimurti*, we remark that the suture-line of the Himalayan species consists of ten lateral lobes; its first lateral lobe is strictly bipartite, the second unsymmetrically tripartite, and the others are symmetrically trifid. Examining the first lateral lobe of the other suture-line of this species, yielded by Diener,¹⁾ we see that each of its both parts has one denticle. In connection with this appearance we can by no means overlook the above mentioned inclination of the first lateral lobe of *Popanoceras Tschernyschewi* to form such a «twofold differentiation».

A closer confrontation of the suture-lines of the species described here, and these of *Arcestes tridens* Rothpletz²⁾ cannot be made in consequence of the tripartite character of absolutely all lobes of the Timor form.

We have still to examine the suture-lines of *Arcestes antiquus* Waag.³⁾ Evidently all lateral lobes (8 in number) of this species are trifid, and the first lateral lobe discovers the same correlation of its parts, as all the lateral lobes of *Popanoceras Tschernyschewi*, i. e. its median part is separated from the exterior one by a larger saddle, than from the inner one, and if we take into consideration the fact that these suture-lines were taken by Waagen at the very beginning of the last whorl, a certain similarity of them with the suture-line described here, cannot be disowned.

But I had the opportunity of examining some well preserved separate lobes also at the beginning of the last whorl of my species, and stating their complete identity with the lobes of the youngest part of the shell.

¹⁾ Diener, l. c. Pl. I, fig. 1e.

²⁾ Rothpletz, l. c. Taf. IX, Fig. 4b.

³⁾ Waagen. Salt-Range Fossils, i. Pisces-Cephalopoda, p. 28, Pl. I, fig. 10c. Palaeontologia Indica, Ser. XIII.

Dimensions.

Diameter	32,0 mm.
Height of the last whorl	18,8 »
Thickness of the last whorl	8,9 »
Height of the evolute part of the last whorl	9,0 »
Diameter of the umbo	3,9 »

Paratirolites nov. gen.

It is known that at the suture-line of typical representatives of the genus *Tirolites* Mojs. there is but one lateral lobe. Sometimes there is in some species an auxiliary lobe, which may become even denticulate, nevertheless it lies at the umbilical margin.

By Mojsisovics was ascertained the genus *Metatirolites*, the representative of which, *Ammonites foliaceus* Dittm.¹⁾ has this auxiliary lobe evidently fully developed, and the lateral saddle completely individualized.

Kittl has described²⁾ a form, having a second lateral lobe, lying already entirely on the lateral surface of the shell. The sculpture of this species—*Paraceratites prior*—possesses signs peculiar for *Tirolites* as well as for *Dinarites*, because its straight or slightly curved ribs have tubercles not only on the siphonal, but also on their umbilical ends.

Kittl pointing out that the majority of the known *Ceratites* have one or several auxiliary lobes, states these of them, which possess a simple suture-line, having not yet de-

¹⁾ Mojsisovics. Die Cephalopoden der Hallstätter Kalke. Abhandl. d. K. K. Geol. Reichsanst., Bd. VI. H. II, p. 590. Compare also *Tirolites* (*Metatirolites*) *foliaceus* Dittm. and *Tirolites pacificus* in Hyatt's and Smith's «The Triassic Cephalopod Genera of America»; U. S. Geol. Survey Profess. Paper № 40, pp. 160 and 159, Pl. LXXXII, fig. 8; Pl. XXI, f. 18; the species with a still very small second lateral lobe.

²⁾ Kittl. Die Cephalopoden der oberen Werfener Schichten von Muć in Dalmatien etc. Abhand. der K. K. Geol. Reichsanst., Bd. XX, Heft 1, p. 29.

veloped auxiliary elements, to detach from the typical *Ceratites* into a particular group—*Proceratites*.¹⁾

As for a ground-type of this genus or sub-genus Kittl point to *Xenodiscus carbonarius* Waag. and *Xenodiscus plicatus* Waag., as having only two lateral lobes; thus, we have to consider these two famous species as an ancestor-group. If the forms having the suture-line of the same simple character, receive the above mentioned sculptural peculiarity, they would be Kittl's *Paraceratites*.

According to Kittl's opinion in this group should be placed those representatives of *Ceratites*, the auxiliary lobes of which touch still the umbilical edge. The forms with still more developed lines should be *Ceratites* s. s.

On the same pages Kittl gives his opinion about the connection of his genus with *Tirolites*: — «Die Entwicklung der Lobenlinie bei den weiter vorgeschrittenen *Tirolites*-Formen, wobei ein zweiter Laterallobus unter der Naht zum Vorschein kommt und über die Nabelwand allmählich höher hinaufrückt, lässt Beziehungen zwischen diesen hochentwickelten *Tirolites* und unserem *Ceratites* vermuten. Doch auch diese beiden treten wahrscheinlich gleichzeitig auf. Jedenfalls zeigen aber die höherentwickelten *Tirolites*-Formen des oberen Werfener Schiefers die Tendenz, eine Lobenlinie auszubilden, wie sie *Ceratites prior* schon besitzt. Dazu kommt, dass *Ceratites prior* fast dieselbe kräftige Entwicklung der Randskulptur zeigt wie *Tirolites*».

Waagen pointed²⁾ still in 1879 to a certain similarity between *Xenodiscus* and *Tirolites*, but denoted that the representatives of the latter genus differ strongly in the absence of the second lateral lobe, and in the sculpture of the ribs which are, as a rule, more expressed on their siphonal part.

¹⁾ Kittl, l. c. p. 28.

²⁾ Waagen, l. c. p. 33.

Furthermore in 1897, Diener in his paper «The Cephalopoda of the Lower Trias», ¹⁾ when describing *Danubites nivalis*, then a new species (later described by Krafft and Diener as *Xenodiscus nivalis*, see lower), pointed out that the ribs on the young whorls of this form become observably thickened at the siphonal margin. An essential mark of distinction of such forms from the *Tirolites* of the group of «*Tirolites spinosus*» Mojs., excluding another character of the suture-line, appears the total absence of true tubercles or spines on the siphonal extremities of the ribs on the inner whorls of the shell.

In 1902 Schellwien describing *Xenodiscus tanguticus* ²⁾ underwent a certain difficulty in the systematization of this species, because of the distinctly expressed marginal tubercles, which set this species in connection with «*Tirolites spinosi*», its suture-line appeared just so as in the typical *Xenodiscus*.

At last I happened to meet at Djulfa a series of forms which almost did not differ from *Tirolites* in the form of the shell and character of the ribs, yet they had two lateral lobes.

After my opinion on the independent position of this group was already formulated, I read the memoir of Krafft and Diener, which then had just appeared, «Lower Triassic Cephalopoda from Spiti, Malla Johar, and Byans», ³⁾ and the therein alleged facts, created the possibility of my being definitely confirmed in my conviction.

Paratirolites differs from Diener's group of *Xenodiscus nivalis* in the presence of strongly expressed thickenings, tubercles and spines on the siphonal ends of the ribs of the last

¹⁾ Palaentologia Indica, Ser. XV, Himalayan Fossils, Vol. II, pp. 51—53.

²⁾ Schellwien. Trias, Perm und Carbon in China. Schriften der Phys. Oek. Ges. zu Königsberg, Bd. 43, p. 6, T. III, Fig. 2.

³⁾ Palaentologia Indica, Ser. XV, Vol. VI, Memoir № 1.

whorl, and a more robust character of the spines on the inner whorls of the shell; from the *Tirolites* of the group of «*T. spinosi*», in the more proportional distribution of ribs, and, for the most part, in their identical character on all whorls, and also in the presence of a second lateral lobe; from *Paraceratites*, in the presence of spines on the interior whorls, in the feeble character of the ribs in their umbilical part, and in having a more developed character of the second lateral lobe. One of the most important marks of all species of this genus, which I observed, is the very low position of the first lateral saddle.

But among the typical representatives of this genus, the species described by me below — as *Xenodiscus* (*Paratirolites*?) *Mojsisovicsi* — doubtless connects this genus with the forms from the group of *Xenodiscus nivalis* as well, as with Kittl's *Paraceratites*.

As to such forms—as *Xenodiscus tanguticus* Schellw. and *Xenodiscus asiaticus* Krafft—they stand evidently closer to *Paraceratites*, because the ribs of these two species have very perceptible thickenings on their umbilical extremities.

Whilst *Metatirolites* and *Californites* represent themselves as genera proceeding from *Tirolites*, ¹⁾ *Paratirolites* stands doubtless in direct dependence upon the group of *Xenodiscus nivalis*.

The latter group is characterized by Diener as follows: «A group, represented by one single species only—*Xenodiscus nivalis* Dien.—recalling the genus *Tirolites* Mojs., in which the marginal portions of the ribs are developed more strongly than the umbilical». ²⁾

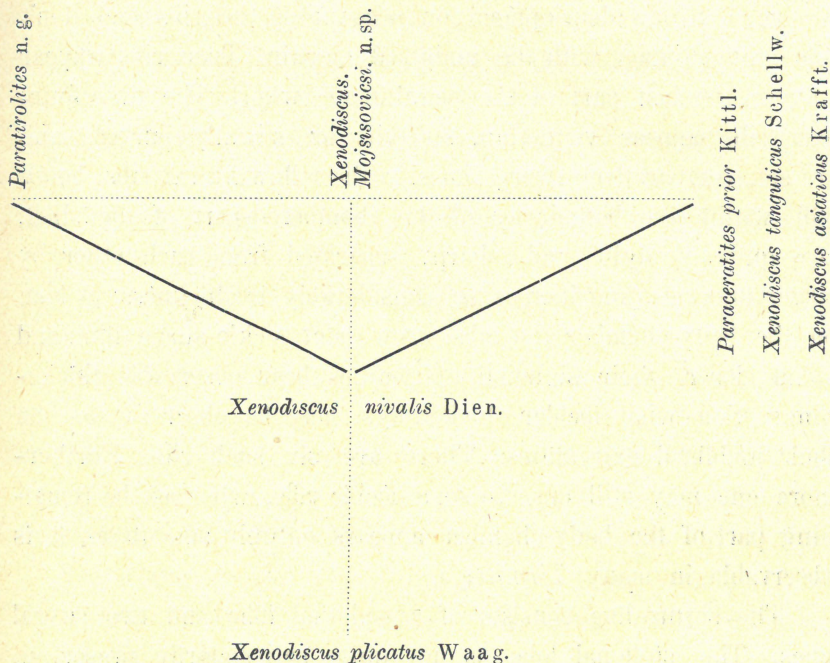
Transitional forms between *Xenodiscus* and *Paratirolites*

¹⁾ Hyatt and Smith. The Triassic Cephalopod Genera of America, pp. 160 and 180.

²⁾ Krafft and Diener, l. c. p 91.

should be those, in which one may already perceive the replacement of the oval transverse section, by the angular-oval, and perfectly perceivable thickening of the ribs on the periphery. One of such forms appears described below—as *Xenodiscus* aff. *Kapila* Dien.

The dependence between the indicated groups may be represented by the following scheme.



Xenodiscus (*Paratirolites*?) *Mojsisovicsi* n. sp.

Plate VIII, fig. 1.

? 1909. *Xenodiscus nivalis* Diener. Krafft and Diener. Lower Triassic Cephalopoda from Spiti, Malla Johar, and Byans. Palaeontologia Indica, Series XV, Vol. VI, Memoir № 1, p. 102, Pl. XXV, fig. 5.

The whorls of this species are only adjacent. Their lateral surface is flat, the exterior is flatly-convex. In the begin-

ning part of the last whorl the lateral surface goes gradually over into the exterior one, but in the younger part of the shell both meet under an angle. The transversal section is oval-quadrangular. On the inner whorls there are present very strongly expressed spines. These spines, situated usually in the typical *Tirolites* on the siphonal ends of the ribs, and more or less adjacent to the neighbouring whorls, here receive a strong development on account of the ribs, and don't come into contact with the umbilical margin. True ribs appear only in the last part of the penultimate whorl. The first fourteen ribs appear very thin, straight or slightly curved, and are set, comparatively, very densely; the following six ribs, being still within the boundaries of the chambered-part of the shell, are quite straight and sharp, separated from each other by larger intervals, and increasing considerably in thickness; at last, on the body-chamber the ribs grow bent sickle-shape like, and stand closer; their siphonal extremities bear observable thickenings. Somewhat feebler thickenings may be observed too, on their umbilical extremities. There are six such ribs. Furthermore one may still observe some feeble ribs, whereas the remaining part of the body-chamber appears entirely smooth as it is observable in many *Tirolites*.

The suture-line consists of a siphonal lobe and two lateral ones. The siphonal lobe is not quite satisfactorily preserved, but it can be seen that it is deep and consists of two branches, which are divided by a not very large siphonal saddle, and each of them is provided with two denticles. The exterior saddle is three times higher than the siphonal; it is broad, with quite intact and rounded margins. The first lateral lobe is narrower than the exterior saddle at one third of its width; it is almost as deep as the siphonal lobe, and bears seven denticles in its base. The first lateral saddle is twice narrower than the

exterior, and less high. The second lateral lobe is in dimensions equal to the first lateral saddle, and less deep in comparison with the first lateral lobe; it bears six denticles in its base. After the formation of this lobe, the suture-line rises strongly, and the second lateral saddle attains a height equal to about $\frac{4}{3}$ of the height of the external saddle, representing by itself the highest part of the suture-line. Afterwards the suture-line descends to the umbilical margin without forming the auxiliary lobe.

The denticles being in the base of the lateral lobes of this species are not so delicate, as is observable on the lobes of *Tirolites* Mojs., *Xenodiscus* Waag. and *Paraceratites* Kittl. They are vigorously expressed, and are of such a character, as may be observed on the denticles of the lateral lobes in *Stephanites superbus* Waag., *Flemingites compressus* Waag., and in some other species described in «Fossils from Ceratite Formation».

One must remark that the character and correlation of the ribs on the lateral surface of the chambered part of the species described here, resemble much the sculpture of the last whorl of that form, represented in «Lower Triassic Cephalopoda from Spiti etc.», Pl. XXV, f. 5a, which Krafft has referred to *Xenodiscus nivalis* Dien. But on the inner whorls of this latter form instead of vigorously expressed spines there are only nodular thickenings.

The thickening of some ribs of *Xenodiscus Mojsisovicsi* in their umbilical part connects this species with Kittl's *Paraceratites*.

Dimensions:

Diameter	64,0 m.m.
Height of the last whorl.	19,5 »
Diameter of the umbo	34,2 »
Length of the body-chamber.	180°.

Paratirolites Kittli n. sp.

Plate IX, figs. 1, 2.

Whorls only touching. Height only somewhat surpassing the width. Width hardly varying throughout the whole extent of the last whorl. Height varying very gradually. Umbo very broad. Lateral and exterior surfaces slightly convex. Transversal section roundly quadrangular. Ribs feebly commencing at the umbilical margin, but very rapidly increasing in strength, high, and sharp folds, comparatively short, ending at the siphonal margin in robust spines. On the interior whorls the spines are not in contact with the succeeding whorl. Already on the spines of the youngest part of the penultimate whorl one may discern that their siphonal portions are roundly conical, and the umbilical ends represent themselves as sharp crests rapidly falling toward the umbilical margin. All spines and ribs are distributed in remarkable regularity, and the relation between them is quite equal on all whorls of the shell. The intercostal spaces are slightly curved. The ribs of the described species might be to a certain degree compared with the ribs of the lateral surface of *Tirolites Haueri* Mojs., namely of those forms, which were described by Kittl ¹⁾ from Gornje Muć and Dolnje Muć, but in the last named species the ribs do not attain the umbilical margin, and their character and distribution are less correct and uniform.

The suture-line is not perfectly preserved, nevertheless their integral parts are clearly visible. All elements of the suture-line are the same as in the Triassic representatives of the genus *Xenodiscus*. The siphonal lobe is divided by a not high saddle into two narrow bidental parts. The exterior saddle is three

¹⁾ Kittl, l. c. Taf. IX, Fig. 9, 11, 13.

times higher than the siphonal; both lateral lobes are not uncharacteristical; their denticles are badly preserved. The first lateral saddle scarcely surpasses half the height of the exterior saddle. The second lateral saddle is considerably heigher than the first lateral. The suture-line ends in an auxiliary lobe, departing under the umbilical margin.

Dimensions.

Diameter	44,5 mm.
Height of the last whorl. .	13,5 »
Width of the last whorl. .	13,0 »
Diameter of the umbo. . .	20,0 »
Length of the body chamber	150°—180°.

Paratirolites Dieneri n. sp.

Plate VIII, fig. 2.

Regretably this interesting form is not preserved in its full shape. The shell is very flat, with a broad umbo; the lateral surface of the whorls is flat, the exterior flatly convex. The ribs fairly preserved on a part of the last whorl, commence very feebly at the umbilical margin; on the lateral surface they increase very little in thickness, and terminate at the siphonal margin by vigorously expressed spines.

These ribs are almost indiscernible from the ribs of *Tirolites rectangularis* Mojs.

The transverse section too, approaches the section of this species, but it recalls in a still higher degree the transverse section of *Xenodiscus asiaticus* Krafft ¹⁾ with the difference that in the outline of my form there are not so strikingly expressed thickenings, corresponding to the thickenings of the ribs at the umbilical margin of the Himalayan species.

¹⁾ Krafft and Diener, l. c. Pl. XXVI, f. 5b.

The suture-line, badly preserved, as it is, permits nevertheless the discernment of the following interesting particularities.

The siphonal lobe is divided by a not large saddle into two short parts, each supplied with two denticles. The exterior saddle is twice higher than the siphonal. It has the same width as the siphonal lobe. After the formation of the exterior saddle, the suture-line descends to the base of the first lateral lobe; having formed its base, the line rises again but very insignificantly, and yields a very broad, but not high swell, which represents the first lateral saddle. Afterwards the suture descends in order to form the second lateral lobe, which is like the first lobe, rises keenly and steeply upwards to the height of the exterior saddle, and after having described the second lateral saddle, takes the direction to the umbilical margin. Thus, the lateral lobes are separated one from another by a saddle of insignificant height, and from the siphonal and umbilical margins, by very high saddles.

These remarkable peculiarities may be traced on five successively situated suture-lines. In consequence of the weathered state of the chambered part of the lateral surface, it is impossible to decide, whether these lobes were supplied with denticles or not.

Whether the above mentioned peculiarities have any signification for the enlightenment of the genesis of the suture-line of true *Tirolites*, is, at the present time, difficult to say; but whether or not, it is a very remarkable apparition.

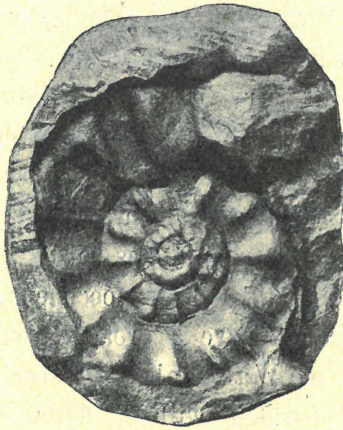
Dimensions.

Diameter	49,0 mm.
Height of the last whorl . . .	15,5 »
Width of the last whorl. . . .	10,5 »
Diameter of the umbo	21,8 »

Paratirolites (?) sp. ind.

Plaster cast. I leave under question the appurtenance of this form to this genus in consequence of the non-acquaintance of its suture-line, but the extremely correct and proportionally set ribs, and their quite equal character on all whorls of this shell, makes me report it to be a *Paratirolites*.

All ribs of this species commence very feebly at the umbilical margin, and gradually top up in the siphonal part by robust tubercles. The spaces between the ribs are proportionally equal on all whorls. The intercostal spaces are almost flat.



Such a constancy in the distribution of the ribs is observable on none of *Tirolites*, I know, although this peculiarity appears pretty often among some *Xenodiscus*.

Dimensions.

Diameter 43,0 mm.
Diameter of the umbo. 20,5 »

Xenodiscus radians Waagen.

Plate IX, fig. 5.

1895. *Gyronites radians* Waagen. Fossils from the Ceratite Formation. Palaeontologia Indica, Ser. XIII, Vol. II, p. 302, Pl. XXXVIII, figs. 6—8.

1909. *Xenodiscus radians* Waag. Krafft and Diener. Lower Triassic Cephalopoda from Spiti, Malla Johar, and Byans. Palaeontologia Indica, Series XV, Vol. VI, Memoir № 1, p. 93, Pl. XXV, figs. 1—3.

The writer's unique impediment for referring all analogical Djulfian specimens to this species, appeared the angular passage of the lateral surface of the youngest part of the whorl into the exterior, being observed on the majority of his forms, because we read in Waagen: ¹⁾—«The external part is broadly rounded and gradually passes into the sides of the whorls. The external part is very indistinctly flattened in young specimens, and shows very obtuse external edges».

But Krafft comparing *Xenodiscus rotula* Waag., with *Xenodiscus radians* Waag., indicates directly: ²⁾ — «Waagen states that *Xenodiscus rotula* has marginal edges in young stages, which disappear in older specimens, whereas *Xenodiscus radians* is said to have a broadly rounded external part. On re-examination of Waagen's type-specimens, I found that both species are provided with a flattened external part in young individuals, whereas in more advanced stages of growth the marginal edges become obtuse, without disappearing altogether».

The suture-lines are preserved only on the inner whorls of these specimens; they approach more the sutures of the forms

¹⁾ Waagen, l. c. p. 302.

²⁾ Krafft and Diener, l. c. p. 94.

described from the Salt-Range, but differing from them, perhaps, by an insignificantly smaller width of the first lateral saddles. In the fig. 6, Pl. IX, is represented a specimen the last whorl of which is much deformed, but the state of preservation of the sculpture and the suture-lines on the inner ones, shows all features corresponding to this species.

Xenodiscus cfr. *nivalis* Diener.

Plate IX, fig. 4.

1897. *Danubites nivalis* Diener. The Cephalopoda of the Lower Trias. Palaeontologia Indica, Ser. XV, Himalayan Fossils, Vol. II, Part I, p. 51.

1909. *Xenodiscus nivalis* Dien. Krafft and Diener. Lower Triassic Cephalopoda from Spiti, Malla Johar, and Byans. Palaeontologia Indica, Series XV, Vol. VI, Memoir № 1, p. 102, Pl. XXIV, figs. 1—2.

This form (there is only a plaster cast of the print) is, as it appears, identical with the specimens represented by Krafft and Diener in «Lower Triassic Cephalopoda from Spiti etc.», Pl. XXIV, fig. 1 and 2.

Another analogical print was found by Mr. Podgursky already on Persian territory 25 kilom. south of Djulfa in the defile of Daradyz. It was obtained for examination through the kindness of Professor C. I. Bogdanovich.

Xenodiscus aff. *Kapila* Dien.

Plate IX, fig. 3.

1897. *Danubites Kapila* Diener. The Cephalopoda of the Lower Trias. Palaeontologia Indica, Ser. XV, Himalayan Fossils, Vol. II, Part I, p. 50, Pl. XV, fig. 16.

1909. *Xenodiscus Kapila* Diener. Krafft and Diener. Lower Triassic Cephalopoda from Spiti, Malla Johar, and By-

ans. Palaeontologia Indica, Series XV, Vol. VI,
Memoir № 1, p. 99, Pl. XXIII, fig. 3, Pl.
XXVII, figs. 2, 3.

The basal properties of this form are the same as in *Xenodiscus Kapila* Dien. Just as there, we see here only adjacent whorls; on the young part of the last whorl the ribs too, are set denser, than in its beginning. But it is impossible to consider the Djulfa species as identical with *Xenodiscus Kapila* Dien. The described *Xenodiscus Kapila* have on the responsive young part of the last whorl considerably more ribs, than one may observe on my specimen. The other peculiarity of my form consists in the relation of the lateral surface to the exterior. Both surfaces meet at the end of the last whorl under an angle, forming an almost square transverse section.

The ribs situated at the beginning of the last whorl possess on their siphonal extremities observable thickenings. As an interesting detail one may point out that on some ribs of the youngest part of the last whorl, thickenings can be excellently traced not only on the siphonal, but also on the umbilical extremities of the ribs, as it is to be seen in the forms, approaching the type of Kittl's *Paraceratites*.

Diener too, points ¹⁾ to these two latter peculiarities for his specimens: — «The sculpture of the chambered part of the last whorl consists of perfectly straight, narrow, radial ribs, which originate near the umbilical margin, and are strongest a little below the middle of the height of the lateral parts. They are separated by intercostal intervals, which are twice to three times as broad as the ribs themselves. The latter become somewhat broader near the siphonal margin and terminate rather abruptly», but only in the Djulfian specimen these peculiarities are more conspicuously expressed.

¹⁾ Diener. The Cephalopoda of the Lower Trias, p. 51.

The suture-line possesses all elements peculiar to this genus. One must remark that the first lateral saddle is lower, than the exterior, and but a little lower than the second lateral. On the umbilical suture is visible the arising auxiliary lobe.

This species stands between *Xenodiscus* and the above described *Paratirolites*.

Stephanites sp. ind.

Plate VII, fig. 8.

This form, in the general character of the shell, the small umbo, and the vigorously developed spines, without any marks of ribs, may be easily acknowledged as affinitative to one of the species of the indicated group, for instance, *Stephanites corona* Waag. On the surface of the last whorl one can discern five spines, partly broken.

The suture-line is not preserved.

Stephanites (?) *Waageni* n. sp.

Plate VIII, fig. 3.

Waagen gives the following diagnosis of this genus: ²⁾ «The shells belonging to this genus are very strongly inflated with only few whorls. On the lateral parts there are very strong tubercles or thorns which are in no connection with any ribs. Otherwise, the shell is entirely smooth. The external part is smooth and broadly rounded....

The characters of the sutural line existing in this genus are only indicated by the peculiarity that the saddles are always broadly rounded and entire, and that the lobes are but little

²⁾ Waagen. Fossils from the Ceratite Formation, p. 100.

denticulated at the bottom, and that one large lateral lobe is always present. Thus, the sutural line appears absolutely ceratitic in its development».

The species described by me corresponds to the general conditions of this diagnosis, but differs by character of the thorns and some peculiarities of the suture-line. Of the two species, described by Waagen — *St. superbus* and *St. corona*, — this Djulfian species approaches more the first.

The external surface in *St. Waageni*, just as in both Indian species, is entirely smooth, but whilst at these latter the tubercles being on their lateral surface appear almost perfectly rounded, on my specimens they are represented by bulky, sharp pyramidally-coniform spines. These spines cut short by their round side towards the exterior surface, and lower more declivously in sharp crests towards the umbo. If we examine the tubercles of *Stephanites superbus*, we see that the fifth, eleventh and twelfth tubercles of this species, ¹⁾ counting from the beginning of the last whorl, have also inclination to distention, but none of them attains such a sharp conspicuously thorn-like form.

The suture-line has the following character.

The siphonal lobe is divided by a narrow, high saddle into two parts supplied with denticles. ²⁾ The exterior saddle perfectly intact and roundly-extended out, appears as the highest element of the whole suture-line. The first lateral lobe is very deep. It has the same depth as the siphonal lobe, by its width it surpasses somewhat that of the exterior saddle. Its sides are intact and parallel. It bears in its base seven den-

¹⁾ Waagen himself points to the distended character of some tubercles: «...lateral tubercles, which are quite rounded and very prominent on the greater part of the shell, but which become elongated, and less strongly elevated on the distal end of the body-chamber.», but simultaneously with the elongation these tubercles become lower, l. c. p. 101.

²⁾ They are badly preserved.

ticles. All first lateral lobes are situated on the outer side of the spines. The first lateral saddle is twice shorter than the exterior, and only insignificantly broader. They are all situated on the spines or between the two succeeding ones. The second lateral lobe has a somewhat smaller depth in comparison with the first; its sides are parallel, and the base bears six denticles. Finally, the second lateral saddle has almost the same height as the exterior. Auxiliary lobes are absent.

Waagen had no opportunity to investigate the siphonal lobe of his species. The comparison of the remaining part of the suture-line of Waagen's specimen with that of mine, shows the following difference: the second lateral saddle of *St. Waageni* is rather less high, than the exterior, but in consequence of the utterly small height of the first lateral saddle, the suture-line, on the lateral surface of the shell, makes the impression of a gigantic lobe, divided into two parts by an inconsiderable saddle. To this peculiarity of the suture-line of certain Ammonoites of the Lower Trias of Djulf, I have already referred before.

Furthermore one must remark that between the both lateral lobes of my species there is not such a difference in size as is observable in *St. superbus* Waag; the first lateral saddle which encompasses the base of the tubercles of the India-species, on my specimens embraces correspondingly the half height of the spines. Notwithstanding the affinity of the suture-line, which I described, to the suture-line of *Paratiroliites*, at the present time I would find it difficult to refer this species (there are at my disposal two specimens) to any other group of Ammonoites.

Balatonites (?) cfr. *euryomphalus* Benecke.

Plate VII, fig. 6.

1866. *Ceratites euryomphalus* Benecke. Ueber Trias und Jura in den Südalpen, S. 154, Taf. II, Fig. 1.

1882. *Balatonites euryomphalus* Benecke. Mojsisovics. Die Cephalopoden der mediterranen Triasprovinz, p. 84, Taf. VI, Fig. 6; Taf. XXXVIII, Fig. 6.

Owing to the damaged exterior surface of my specimen, it is impossible to get a true representation of the character of the keel, which existed here, a very important mark for the discernment of the species of *Balatonites*. From the form, described by Mojsisovics as *Balatonites euryomphalus* Benecke, this specimen differs in having somewhat sparser set ribs, and, as it appears, scarcely observable to the eye, being slightly less flat on the lateral surface of the shell.

The suture-line appears to be nearly related to that, which Mojsisovics has represented on Taf. VI, Fig. 6.

Dimensions.

Diameter.	36,4 mm.
Height of the last whorl. .	14,0 »
Width of the last whorl. .	11,8 »
Diameter of the umbo. . .	15,4 »

Notothyris nucleolus Kutorga.

Plate VI, fig. 1.

1842. *Spirifer nucleolus* Kutorga. Verhandl. d. Kais. Russ. Mineralog. Gesellschaft zu Petersburg, p. 23.
 1862. *Terebratula seminula* Moeller (pars). Geological and Palaeontological notes, p. 62.
 1902. *Notothyris nucleolus* Kut. Tschernyschew. Die obercarbonischen Brachiopoden des Ural und des Timan, p. 464, Taf. XLII, Fig. 8—13.

Th. N. Tschernyschew drew my attention to this, that amid the *Notothyris djoulfensis* Ab., collected by me in Abich's section, there are specimens approaching *Notothyris nucleolus* Kut. These two species are connected by a whole series of intermediate forms in the fauna of Djulfa, but being

set at the ends of this series, they differ conspicuously from each other.

The form described by me does not at all differ from the specimen from the Schwagerina limestone of Tastuba, represented on Pl. XLII, fig. 13, in «Die obercarbonischen Brachiopoden des Ural und des Timan».

N. nucleolus Kut. from Djulfa differs from *N. djoulfensis* Ab. in the general outline, which in the first species is more elongated-oval, in the second, more pentagonal, but the principal difference consists in the character of the sculpture.

The narrow sinus of the ventral valve of *N. nucleolus*, enclosed between two folds, is itself entirely free of folds, while the analogous sinus of *N. djoulfensis* is divided by one longitudinal fold, which is unconditionally present, and does not depend upon to what degree the sinus is developed.

Further, in the sinus of the dorsal valve of *N. nucleolus*, there is only one fold, corresponding to the sinus of the ventral valve. *N. djoulfensis* has in this place two folds, and it seldom occurs that the sinus of the dorsal valve of this species is itself strongly expressed. Besides the folds, limiting the sinuses of the ventral and dorsal valves, in *N. nucleolus* there is still but only one fold on each side of the sinus of both valves. In *N. djoulfensis* there are no fewer, than three folds on each side of the sinus.

I take the opportunity to exhibit two different varieties of *N. djoulfensis*, the most diffused in Abich's section: A.—a form with a very narrow sinus of the ventral valve and a clearly expressed sinus of the dorsal valve (Plate VI, fig. 3), and B.—with a broad sinus of the ventral valve and an almost unperceivable sinus of the dorsal valve (Plate VI, fig. 2).

Finally, I yield here C.—the original intermediate form, having in the sinus of the dorsal valve two folds, like *N.*

djoulfensis, and the sinus of the ventral valve quite devoid of the interior folds, like *N. nucleolus* (Plate VI, fig. 4).

All mentioned forms are from the same horizon.

Lyttonia sp. ind.

Plate VII, fig. 4.

The preserved dorsal valve of this species with its straight, rounded at the ends, lateral septa, resembles, to a certain extent, *Leptodus americanus* Girty.¹⁾ Its conspicuous peculiarity appears to be the size of the spaces dividing the lateral septa.

Each interval between both lateral septa is equal by its dimensions to one of them. The other mark, distinguishing this species from all Asiatic representatives of *Lyttonia* known to me, appears the extremely small length of these lateral septa.

These two peculiarities recall somewhat the character of the situation of the lateral septa of the Uralian *Keyserlingina*.²⁾

Richthofenia (?) sp. ind.

Plate VII, fig. 1.

This is a very small specimen. I succeeded in preparing only the surface of the large valve. In the outlines of the shell, and the character of sculpture, this form resembles *Richthofenia Lawrenciana* Kon.³⁾

¹⁾ Girty. The Guadalupian Fauna, p. 212, Pl. XXV, figs. 1 to 3a. U.S.G.S. Professional Paper 58.

²⁾ Tschernyschew. Die obercarbonischen Brachiopoden des Ural und des Timan, p. 473, Taf. XLII, Fig. 14—17.

³⁾ Waagen. Productus-limestone Fossils, p. 736, Pl. LXXXIII, figs. 3, 4, 5.

But considering that the representatives of *Tegulifera* ¹⁾ in adult state are almost undistinguishable from *Richthofenia* in exterior markings, I leave the appurtenance of my form to this genus under question.

Athyris cfr. *planosulcata* Phill.

Plate VI, figs. 5, 6, 8.

1902. *Athyris planosulcata* Phill. Tschernyschew. Die obercarbonischen Brachiopoden des Ural und des Timan, p. 512, Taf. XLIII, Fig. 7—10. ²⁾

In the lower horizons of Abich's section I found three specimens, almost undistinctive from the forms of the Schwagerina horizon of the Ural.

One must by no means confound these my specimens with that very broad form, which was described by Abich as *Spirigera plano-sulcata* Phill. ³⁾

Reticularia convexiuscula Gemmellaro.

Plate VI, figs. 11, 12.

1899. *Reticularia convexiuscula* Gemmellaro. La Fauna dei Calcari con Fusulina, p. 332, Tav. XXXIV, Fig. 30—36.

1899. *Reticularia convexiuscula* Gemmellaro. Semper. Ueber Convergenzerscheinungen bei fossilen Brachiopoden, p. 231, Taf. XVI, Fig. 10—12. Neues Jahrbuch für Mineralogie etc., Bd. I.

Arthaber in his work on the Upper Palaeozoic of Djulfa ⁴⁾ uttered the supposition that the forms, described by

¹⁾ Schellwien. Die Fauna der Troglfelschichten in den Karnischen Alpen etc., p. 59—62, Taf. VI, Fig. 5—13.

²⁾ See the synonymy l. c. p. 105.

³⁾ Abich, l. c. p. 63, Taf. 8, Fig. 4.

⁴⁾ Arthaber, l. c. p. 272.

Gemmellaro as *Reticularia convexiuscula*, are identical with *Reticularia indica* Waag. In «the Reticularian» horizon of Abich's section there is a colossal quantity of representatives of this genus. My researches have ascertained that *Reticularia convexiuscula* Gemm. is connected by a series of transitional forms with *R. pulcherrima* Gemm., as well as with *R. indica* Waag., but at Djulfa there also exists a pure, independent type of this species, distinguishable in original outlines of the shell, the nature of the area, and a very low position of the apex of the dorsal valve.

The described specimens are identical with the forms represented by Semper.

I observe hereby that *Reticularia* cfr. *pulcherrima* Gemm. described by Arthaber, ¹⁾ belongs in all probability to an independent species, because it differs from the true *R. pulcherrima* Gemm. not only in having a sharply limited area, but also in the more elongated, narrower outline of the whole shell.

Both these forms occur at Djulfa, and they are there too in a considerable quantity of specimens.

Pugnax cfr. *Uta* Marcou.

Plate VI. fig. 7, 9.

1894. *Pugnax Uta* Marcou. Hall and Clarke. Palaeontology of N. Y. Vol. VIII, Brachiopoda, Pl. LX, figs. 39—42.

1902. *Pugnax* sp. Tschernyschew. Die obercarbonischen Brachiopoden des Ural und des Timan, p. 484, Taf. XLIV, Fig. 7.

1903. *Pugnax Utah* Marcou. Girty. The Carboniferous Formations and Faunas of Colorado, p. 412, Pl. VII, figs. 14—14b. U. S. G. S. P. P. 16.

At my disposal there are two specimens from Abich's section, which differ from the forms mentioned in the description at

¹⁾ Arthaber, l. c. p. 268, Taf. XX, Fig. 13.

heading, that their folds, limiting the sinus of the ventral valve at its anterior part, are set somewhat more straightly and the ribs of the same valve at its apical part are very faintly expressed.

Camarophoria cfr. *solitaria* Gemmellaro.

Plate VI, fig. 10.

1899. *Camarophoria solitaria*. Gemmellaro. La Fauna dei Calcari con Fusulina, p. 269, Tav. XXVII, Fig. 26—29.

This form, I have found, is very similar to the unique example of Gemmellaro in its pentagonal outline and the sculpture of both valves, but differs from it in an extremely characteristical pseudo-area, smaller dimensions, thicker apexes, and a less convexity of the dorsal valve at its anterior part.

Abich, as well as Frech and Arthaber, did not fix the finding-place of the fossils gathered by them. Meanwhile as neighbouring hunters seldom come to this part of the defile, and also in consequence of the great many of strata outcropping here, uniformly inclining to NE, it is not easy to find this place.

If we examine the character of the left wall of the defile of the river Araxes, issuing from the frontier post Doroshinsky to the Upper Djulfian, we clearly see that the wall runs first at a more or less equal distance from the river-bank, but after that it curves, and without reaching the last post at a few kilometers, approaches the river by the steep, abrupt cape Karmür-Yarlagan (red escarpment), forming something like a semicircle.

Now, if in order to find the rock Sew-Kar (black stone), which we have already passed, we direct our steps towards it from Karmür-Yarlagan in a straight line, we must absolutely

cross four ridges of different preservation, consisting of steeply inclined fossil-bearing strata.

These strata, inclosed between the above mentioned escarpments, are nowhere more outcropping in this part of the defile. They are easily discernible from others at a short distance, because they alone incline to SW by the general inclination of all strata of the defile to NE, but if looking at them from the level of the Araxes, or from the patrol-way, it is very difficult to perceive this counter-inclination. Only by this fact can be explained Frech's and Arthaber's indication as to the inclination of these strata to NE.

This series of strata represents itself as a steeply inclining flank of the flexure; whereas the gently inclining flank of the lower gray marl, the Palaeozoic part of the section, is almost quite washed away, as for the upper red marl, Triassic beds, one may excellently trace the bending of the flexure and the gently sloping flank. All this runs under the whole mass of the canyon's strata inclining to the NE. ¹⁾

The strike of the steeply inclining strata of the section is on an average, NW 295° , the dip SW 205° under $< 65^{\circ} - 75^{\circ} - 88^{\circ}$; the bending of the flexure is compressed, and its gently sloping flank has the strike, at the beginning, SW 215° at the dip SE 125° , and afterwards it agrees gradually with the general position of the strata of the canyon, extending SE 130° , and inclining to NE 40° .

When investigating these sections step by step, one may successively discern in them the following series and horizons, counting from bottom to top:

Gray marl, of a thickness of nearly 25 m.

1. Zone of *Productus intermedius* Abich—2 m.

¹⁾ Their strike SEE 112, the dip NNE 22° , taken nearly the Doroshinsky post.

Here occur numerous specimens of:

Pr. intermedius Ab.

Pr. scabriculus (Mart.) Abich, N. B.

Orthothetes armeniacus Arth.

Orthothetes peregrinus Ab.

Marginifera helica Ab.

and *Productus*, described by Abich as *Productus Humboldti* d'Orb.

In this zone there are also numerous, evidently original representatives of *Camarophoria*. As to the unique or at least not numerous specimens, one must point to the following forms:

Camarophoria cfr. *solitaria* Gemm.

Pugnax cfr. *Uta* Marcou

Athyris cfr. *planosulcata* Phill.

Marginifera cfr. *ovalis* Waag.

I must remark that among the large number of specimens of *Pr. scabriculus* (Mart.) Abich and *Pr. Humboldti* (d'Orb.) Abich, I gathered, there is not one devoid of area, and absolutely all have very important particularities of the interior structure, which are not at all common amongst the genera of *Productus* and *Strophalosia*.

Besides, in respect to the form, described by Abich as *Productus Humboldti* d'Orb., there were stated different opinions in literature, which have caused, as it now turns out, some misunderstanding.

Waagen believed that Abich's specimen is identical with those forms from Salt-Range which were referred by himself to *Pr. Humboldti* d'Orb.

«The Indian specimens of *Prod. Humboldti* are absolutely identical with what has been described by Abich from Djoulfa

as belonging to the same species. Also at Djoulfa this species is apparently rare, as Geheimrath Abich possesses only a single specimen from there». ¹⁾

Rothpletz has found in Ajer mati an example, which he determined as belonging to the Djulfian and Indian species. Yet, he supposed that *Productus Humboldti* Waagen is not identical with *Pr. Humboldti* d'Orbigny; and allied the Timorian, Indian and Djulfian forms into a particular species—*Productus Waageni*. ²⁾

Arthaber, ³⁾ considering *Pr. Humboldti* (d'Orb) Waagen as only an insignificant variety of *Pr. Abichi*, accepted that the Djulfian and Timorian specimens belong to the same species—*Productus Waageni* Rothpl.

Leaving aside the question about the identity of the Timorian and Indian species on one hand, the Timorian and Djulfian on the other — I can now affirm that Waagen's *Pr. Humboldti* (d'Orb) and Abich's *Pr. Humboldti* (d'Orb)—are two different forms. I examined this question in the note: «On a new genus of Brachiopoda», which was edited recently. ⁴⁾ Not having the possibility of going into particulars here, I indicate that the peculiarities of the interior organization of the Djulfian forms, which Abich has described as *Pr. scabriculus* Martin and *Pr. Humboldti* d'Orbigny, lead me to range both these species into a particular genus to which I propose the name—*Tschernyschewia*.

2. Zone of *Notothyris djoulfensis* Ab.—1 m. This species occurs here in numerous specimens; *Notothyris nucleolus* Kut.

¹⁾ Waagen. *Productus-limestone*, p. 697.

²⁾ Rothpletz, l. c. p. 77.

³⁾ Arthaber, l. c. p. 250—254.

⁴⁾ Bulletin de l'Académie Impériale des Sciences de St.-Petersbourg.—1910, p. 853.

3. *Bryozoan* reef — 3 m. As far as I could remark, the Bryozoan reef consists of only one species, described by Abich as *Polypora fastuosa* Kon. ¹⁾ Here there is still occurring *Not. djoulfensis* Ab.

4. *Crinoidal* reef (*Poteriocrinus?*)—2,5 m. In this horizon we still meet with *Productus* (?) *scabriculus* (Mart.) Abich = *Tschernyschewia typica* mihi.

5. — 1 m. This is the zone of that *Productus*, which was referred by Abich ²⁾ to *Productus striatus* Fisch. v. Waldh. and *Pr. undatus* Defr.; and by Möller ³⁾ and Arthaber ⁴⁾ to *Productus hemisphaerium* Kut. This horizon, insignificant by thickness, is literally overfilled with representatives of this species, very inclined to varieties. From the immediate comparison of this *Productus* with the specimens of *Pr. hemisphaerium* Kut. preserved in the collections at the Academy of Sciences and the Geological Committee, I drew the conclusion that these species are not only non-identical, but do not even stand very near each another. As I have in view the description in detail of this species later, I will point here only to its ground-varieties:

a. Forms with a thick apex, are strongly inflated, with a very regularly coiled apical part of the ventral valve, the anterior part is lowering and elongated. By itself this form may be placed only in the group of «*Productus Cora*», namely in that sense, in which it was accepted by Schellwien. ⁵⁾

b. Forms with a very long and thin apex, strongly extending to the anterior margin.

c. Forms with a very small and short apex, semispherical,

¹⁾ Abich, l. c. p. 83.

²⁾ Abich, l. c. p. 35—38.

³⁾ Möller, l. c. p. 233.

⁴⁾ Arthaber, l. c. p. 256.

⁵⁾ Schellwien. Die Fauna der Trogkofelschichten etc., p. 41—43.

elongated, described by Abich as *Pr. striatus* Fisch. v. Waldh. var. *sphaericus*.¹⁾

All these forms pass one into another very gradually.

The ventral valves of decidedly all examples are provided with spines.

Within view of the fact that these forms belong to none of those species to which they were referred, and fully agreeing with Schellwien that the best for such kind of groups would be to designate it by a special term, I denominate this species, characterizing in a most accomplished manner the determinate horizon of Abich's section, — *Productus djulfensis* n. sp.²⁾

In the same horizon the following species were still met with: *Orthis indica* Waag., there were found all varieties of this species represented in «Productus-limestone Fossils»; *Lyttonia* sp. n., *Richthofenia* (?) sp. ind., *Tegulifera* sp. n., *Scacchinella* sp. ind., and *Marginifera spinosocostata* Ab.

When reading Abich's memoir, one is astounded at the large quantity of forms of this latter genus, unperceivedly passing one into another; quite another picture we receive, when gathering in situ. The *Bryozoan* and *Crinoidal* reefs divide the strata with *Marginifera* in such a manner that *Marginifera helica* Ab. is lower than these reefs, and *M. spinosocostata* Ab. — higher. It is singular that the whole typical *M. helica* is confined in the zones of *Pr. intermedius* Ab. and *Notothyris djoulfensis*

¹⁾ Abich, l. c. p. 36, Taf. 8, Fig. 1.

²⁾ That what Arthaber held for the ventral valve of this species, proves to be, following my investigations, a complete individual with very thin valves, and a very small visceral space. The casts, described by Arthaber, represent by themselves the print not of the ventral valve, but this of the external surface of the dorsal one. The apex of the ventral valve bears about five strong folds, by which the animal was adherent to foreign bodies, and an impression as the result of this adherence. This species might be supposed to be a close ally of that admirable fossil, which is well known as *Productus (Etheridgina) compectens* Etheridge.

Ab.; in the horizon of *M. spinosocostata* there occur only those, which are more or less closely allied to the typical *M. helica*, forms, which Abich considered as varieties, and characterized in the division—«Formen von unbestimmter Stellung». ¹⁾

6. — 1,5 m. *Spirigera protea* Ab., *Orthothes eusarcos* Ab., and one specimen of *Strophalosia*, which is apparently a new species.

7. *Cephalopoda*-zone—3 m.

Otoceras trochoides Ab.

Gastrioceras Abichianum Moell.

Orthoceras transversum Ab.

Orth. oblique-annulatum Waag.

Orth. cribrosum Gein.

Orthoceras bicinctum Ab.

Orth. lopingense n. sp.

Nautilus hunicus Dien., described by Abich *Nautilidae*, and among the Brachiopoda—*Spirigera protea* Ab.

Otoceras trochoides Ab. occurs here in numerous specimens, the other *Otoceras* described by Abich, and the very closely resembling them new forms, are, comparatively, more rarely met with.

They are all intimately allied one to another.

Nautilus cornutus Golovk. I did not meet here at all; Arthaber ²⁾ agreeing with Möller, considered Abich's *N. concavus* (Sow.) as *N. cornutus* Golovk., and expressed already his personal supposition that the forms described by Abich as *N. excentricus* Eichw. and *N. proginquus* Ab., represent by themselves only different stages of growth of the same *Nautilus*.

In my mind, the grounds offered by Möller ³⁾ in order to

¹⁾ Abich, l. c. p. 47.

²⁾ Arthaber, l. c. p. 211.

³⁾ Möller, l. c. p. 230.

consider *N. concavus*, Abich's original, identical with the species described by Golovkinsky, are very insufficient.

Arthaber himself, when elaborating his material, had no opportunity to reexamine Abich's collection, ¹⁾ and how risky it is to compare the material with the drawings, representing badly preserved fragments, is to be seen from, for instance, that *N. convergens* Ab. taken by Arthaber for a form identical with *N. parallelus* Ab., after the investigation of prof. N. N. Yakowlew turned out to be very close to *Discites nikitowkensis* Yakowl. ²⁾

M. K. Tzwetaev considers ³⁾ the *Nautilidae* described by Abich as extremely close to some Russian Upper-Carboniferous species, in particular she does not agree with Möller's opinion on the identity of *N. concavus* (Sow.) Abich with *N. cornutus* Golovk., and accounts the first form to be closer to *N. globatus* Sowerby.

This point of view of the Russian learned authoress finds its full support in my collections; in the number of the Djulfian *Nautilidae*, being at my disposal, there are forms hardly discernible from *Discites* (*Discitoceras*) *planotergatus* M' Coy.

I must also remark that among the Djulfian *Nautilidae*, which I met with, there are forms well preserved, possessing funnel-shaped branches, running, as it is observable in many *Otoceras*, from the umbonal margin perpendicularly to the lateral surface of the whorl.

At first appearance one may take such a form for a species close to *N. Seebachianus* Gein. But when examining it attentively, it turns out to be of a quite independent group.

We cannot leave unmentioned this circumstance that such

¹⁾ Arthaber, l. c. p. 291.

²⁾ Yakowlew. Die Fauna einiger oberpalaeozoischer Ablagerungen Russlands, p. 87, 1899.

³⁾ M. Tzwetaev. Cephalopodes de la section supérieure du calcaire carbonifère de la Russie centrale, p. 41—58.

original and evidently uncharacteristical morphologic markings appear in the Ammoneae as well as in the Nautilidae in the same geological moment.

8.—*Reticularian* horizon—10 m.

Are found here in enormous numbers of specimens:

Reticularia indica Waag.

R. pulcherrima Gemm.

R. convexiuscula Gemm.

R. Waageni Lóczy

Besides these *Reticulariae* there occur: *Spirigera protea* Ab. and *Gastrioceras Abichianum* Moell.

Here ends the series of the gray marl, and further follows:

9. Red marl—15 m. in which are discernible two parts:

a) lower division with *Crinoidea* (*Cyathocrinus?*) and *Gastrioceras Abichianum* Moell.,

and b) upper division, only with *G. Abichianum*.

In the lower division I have found a badly preserved specimen of *Otoceras*, nearer indeterminable, and, as higher in the whole strata of the section I met with no more representatives of this genus, one has to adopt this horizon for the upper limit of its diffusion.

10. White marl — 10 m. There are no fossils discovered in this horizon.

11. Red marl—3,5 m.

Gastrioceras Abichianum Moell.

Popanoceras Tschernyschewi n. sp.

The *Gastrioceras Abichianum* occurring here differ in their small dimensions.

This horizon appears as the upper boundary of the Djulfian Palaeozoic.

We see already from this palaeontological list that there are no serious reasons to consider this series of strata as Upper Permian or even lower boundary of Neodyas.

Abich was much more cautious, than his learned successors, and, being a very penetrating investigator, he expressed himself about the forms similar to Permian of the fauna discovered by him, as follows:—«Die Formenverwandschaft, die das vorstehende Bild zwischen dem armenischen *Nautilus concavus* und dem *N. cornutus* erkennen lässt, stellt den ersteren in die Kategorie der zweideutigen Arten und ist gleichwertig mit derjenigen, die den *Goniatites striatus* dem *uralicus*, den *Productus intermedius* dem *timanicus* und eine weitere Anzahl von Bergkalk-Brachiopoden, entsprechenden permischen Arten nahe brachte», ¹⁾ i. e. among these forms there is only a coarse similarity: they are similar each to another, so to say, at the first glimpse.

Nautilus concavus too, does not stand closer to *N. cornutus* Golovk., than *Gastrioceras Abichianum* Moell. to *Agathiceras uralicum* Karp., than *Productus intermedius* Ab. to *Productus timanicus* Stuck.

One must believe that the latter two species of north-eastern Russia are taken for Permian (s. s.) no more by anybody at present.

Still the late Waagen has stated the supposition that *Productus scabriculus* (Mart.) Abich is not identical with *Strophalosia horrescens*, now I can affirm this without further appeal.

One has to hold to analogical opinions also as to other Abich's species, the names of which Möller has changed into Permian ones.

As the most interesting result of my journey to the Ara-

¹⁾ Abich, l. c. p. 124.

xes one ought to consider the elucidation of the relations of the beds with *Gastrioceras* to the *Otoceras*-bearing beds.

As it is visible from the above stated, *Gastrioceras Abichianum* Moell. occurs for the first time in the zone of *Otoceras trochoides* Ab., passes through the zone of *Reticularia*, and rises still 28 m. above the horizon, in which was met the last representative of *Otoceras*.

It is quite comprehensible, why Waagen held *Gastrioceras Abichianum* Moell. for the leading species of the lower portion of Abich's section; it was known to him that the representatives of this genus belong to the Artinskian stage, that Djulfian *Otoceras* possess a ceratite-like suture-line, and *Otoceras*-beds were held at this time for the boundary between the Upper-Permian and Lower Trias, by the Indian Geologists.

Now, if we do not even touch the deposits of Djulfa, the fact of the presence of *Medlicottia (Episageceras) Dalailamae* Dien. in the *Otoceras*-beds makes the question of the age of these latter strata much more complicated, than one might have believed at the time of the edition of Waagen's monography.

We see that such original forms as *Lyttonia* and *Richthofenia*, so much important for the elucidation of the boundaries of the Upper Palaeozoic Mediterranean sea, lived in each case at the time of the deposition of the Brachiopod-part of Abich's section. In respect to Frech's pointing out to the absence of even traces of *Fusulina* in the Upper Palaeozoic of Djulfa, one must but remark that till now it is quite unknown, what namely represent by themselves the strata, which appear underlying in regard to the described deposits, though in the main one has to expect their being-present only there. ¹⁾

¹⁾ It is impossible to neglect the indication of still another rather annoying mistake, which has become property of the widely spread literature. As I have said above, Arthaber (l. c. p. 254) considered the Djulfian *Pr. scabriculus*

In determining the age of the Upper Palaeozoic deposits of Djulfa, we have above all to mark out the Permocarbo-
niferous (s.s.) character of a few brachiopods existing in
the lowest portion of the section. In the zones of *Pr. inter-*
medius Ab. and *Notothyris djoulfensis* Ab., the already mentioned
forms are met with:

Notothyris nucleolus Kut.

Athyris cfr. *planosulcata* Phill.

Pugnax cfr. *Uta* Marcou

They are very close to the species described partly from the
Schwagerina limestone, partly from the Artinskian deposits.

Th. N. Tschernyschew marks out ¹⁾ a close similarity
of *Marginifera juresanensis* from Schwagerina limestone, de-
scribed by him, to *Marginifera spinosocostata* var. *ciliata*
Arthaber.

Among the *Orthis*, I found, some specimens by exterior
markings are undiscernible from *Orthis* (*Schizophoria*) *juresanen-*
sis Tschern. of Schwagerina limestone. The *Camarophoria*
cfr. *solitaria* Gemmellaro, present here, is similar to the species
of the limestone of Sosio. If even assuming with Schell-
wien ²⁾ and Diener, ³⁾ that the «Calcare con Fusulina» of
Sosio may be divided into considerably varying in faunian re-
lation: into the lower part—«Calcare compatto», and the
upper «Calcare grossolano», — yet it could not be de-

(Mart.) Abich as close to *Productus Geinitzianus* var. *Geranus* Eisel, and for
stronger conviction, he represented a specimen of this latter species from
Trebnitz on Pl. XXI, fig. 1, of his work. Meanwhile Kayser in «Lehrbuch der
geologischen Formationskunde» speaks (l. c. p. 258) about this form as of coming
one from Djulfa, and uses it, on a par with *N. cornutus* and *Pr. hemisphae-*
rium, for proving the homotaxis of the described deposits with Zechstein.

¹⁾ Tschernyschew, l. c. p. 653.

²⁾ Schellwien, l. c. p. 121.

³⁾ Diener. Permian Fossils of the Central Himalayas, p. 57.

cided, from what part derives *Camarophoria solitaria* Gemm., because in Gemmellaro's text is said that his unique specimen was found in «Calcare compatto», but in the plate it is determined as proceeding from «Calcare grossolano». ¹⁾

Yet the deciding significance of the question on the age of the Palaeozoic part of this section has the fauna of its upper horizons. From the above stated is visible that the whole fauna described by Abich is covered succesively with the Reticularian horizon, and with the zone of *Gastrioceras Abichianum* Moell. and *Popanoceras Tshernyschewi* n. sp. Among *Reticulariae* two species — *R. pulcherrima* and *R. convexiuscula*—are indiscernible from those described and represented by Gemmellaro and Semper; the occurring in the topmost zone representatives of *Gastrioceras Abichianum* Moeller are to such a degree similar to *Gastrioceras sosiense* Gemm. in the size of the shell and outlines of the suture-line, that these two forms can be discerned only in the character of the sculpture and the dimensions of the umbo.

As I have already above indicated, *Popanoceras Tshernyschewi* is allied to *Stacheoceras mediterraneum* Gemm. and *Stacheoceras Karpinskyi* Gemm. in the character of the suture-line. When examining the fauna of these upper strata, it is not difficult to perceive, that being less abundant in varieties of species, it appears to be very close to the fauna of «Calcare con Fusulina» of Sosio by its type.

If in agreement with A. P. Karpinsky ²⁾ we treat the fauna of Sosio as «a somewhat younger one, but extremely near the Artinskian», one may consider homotaxial with the Artinskian stage, or with the immediately succeeding deposits, that portion of Abich's section—underlying the horizon with *Reti-*

¹⁾ Gemmellaro, l. c. p. 269, Tav. XXVII, fig. 26—29.

²⁾ Karpinsky, l. c. p. 91.

culariae—in which one may discern that the strata with characteristic Brachiopoda are subordinate to the Cephalopoda-zone, containing for the first time the appearing of *Gastrioceras* in the section.

The presence in the section of *Otoceras*—forms with ceratite-like suture-line—appearing simultaneously with *Gastrioceras*, and disappearing much earlier, may be explained one'self as well, as the presence of complicated *Arcestitidae* in the fauna of Sosio. ¹⁾

In the résumé of all the above stated, one may assume Abich's position of which he speaks in «Nachschrift» of his work: ²⁾—«...das ganze fragliche armenische Schichtensystem, dem oberen Kohlenkalk angehörig, eine Grenzbildung zwischen der carbonischen und der permischen Formation darstellt», i. e. paraphrasing this conformably to the contemporary scientific terminology, one must refer the Palaeozoic portion of the Djulfian series of strata to the Permocarboniferous (s. l.) or to Palaeodyas.

As in Djulfa some solidly fixed horizons are characterized by fossils diffused also in Salt-Range, one may make comparisons between the treated deposits, basing them on the correlations of these zones.

An important circumstance in this sense appears this, that the vertical diffusion of the leading fossils at Djulfa is very insignificant, yet its boundaries are outlined very distinctly.

As for instance, the thickness of layers comprising:

Productus scabriculus (Martin) Abich = *Tschernyschewia typica* mihi, is equal to 8,5 m.

Notothyris djoulfensis Ab.—5 m.

Orthoceras oblique-annulatum Waag.—3 m.

Reticularia indica Waag.—10 m.

¹⁾ Karpinsky, l. c. p. 91.

²⁾ Abich, l. c. p. 124.

Comparing with these bases the diffusion of the three latter forms in Productus-limestone, we see that all specimens of the *Notothyris djoulfensis* Ab. are included in the layers of Kálabágh; *Reticularia indica* Waag. is present in Virgal and Kálabágh-beds, the presence of this form in Upper Productus-limestone is left by Waagen under question;

Orthoceras oblique-annulatum Waag. was found in Kund-Ghat-beds.

Joining hereto *Orthis indica* Waag. and *Arcestes antiquus* Waag., a form to a certain extent close to *Popanoceras Tschernyschewi* in the character of its suture-line, we find that the first species is diffused from Amb to Kálabágh-beds, the second is met in the layers of Kund-Ghat.

In regard to the list of the forms, common to the deposits of Djulfa and Productus-limestone, alleged by Frech and Arthaber, ¹⁾ I must remark that *Pr. mytiloides* Waag. and *Uncinulus jabiensis* Waag. I did not find at Djulfa; nor even have I met with *Favosites jabiensis* Waag. and Wentz. at my review of Coelenterata, moreover Waagen has marked out these forms for Productus-limestone as «very rare». With respect to *Macrocheilus avellanoides* Kon. and *Spiriferina cristata* Schloth., though these forms extend to Jabi-beds, yet they are already occurring—the first, beginning from Virgal—and the second from Amb-beds.

Amplexus Abichi Waag. and Wentz. is peculiar to Jabi as well as to Kund-Ghat-beds.

According to the stated considerations, I believe one can only with strained meaning ²⁾ agree with Frech's and Arthaber's opinion that in the Palaeozoic of Djulfa one ought to

¹⁾ Arthaber, l. c. p. 290—296.

²⁾ For instance, *Orthis indica* Waag. was not met with by Waagen in Kund-Ghat-beds.

consider a homologue exclusively of the Upper Productus-limestone. In the contrary, the correlations of the zones in which are found:

Notothyris djoulfensis Ab.

Orthis indica Waag.

Reticularia indica Waag.

and also all other bases, indicate quite decidedly that these deposits correspond to the space of Kálabágh — Kund-Ghat beds. Whether Abich's section encroaches also the upper strata of Virgal, is difficult to say, because all Djulfian species common to this division occur also in Kálabágh-beds.

I point to this that in Salt-Range not one of the species of *Lyttonia* goes over into the Upper Productus-limestone,¹⁾ but the specimen, I found, belongs in all probability to a new species.

Thus, grounding exclusively on positive reasons, we have to assume that the Upper Palaeozoic of Djulfa is rather intimately allied to the Fusulina-limestone of Sosio on one hand, as well as to the boundary between the middle and upper divisions of the Productus-limestone on the other hand. As it is known, Th. N. Tschernyschew on grounds of the comparison in detail of the Brachiopoda of Timan-Ural and Salt-Range has found²⁾ that the Artinskian deposits of Russia correspond to the Kálabágh-beds, and partly to Upper Productus-limestone. On this wise, whether we compare our deposits with Productus-limestone or with Calcare con Fusulina, or relying on the few motives, immediately with the Artinskian deposits of Russia, we come in all cases to the same conclusion that, as it was already above stated, they are either simulta-

¹⁾ According to Waagen.

²⁾ Th. N. Tschernyschew. Die obercarbonischen Brachiopoden des Ural und des Timan, pp. 719 and 727.

neous with Artinskian or succeed immediately. Of course, I will not say at all thereby that in a short time one might raise the question about the referring of the deposits of Djulfa to CPg or to CPc of the Russian Geological map, but at present we have the possibility to affirm that these deposits represent by themselves Permocarbiniferous, Palaeodiyas or Lower Permian, in a wide sense of this comprehension.

In consequence of the elucidated comparatively very low bathrological position of *Otoceras* of Djulfa, I cannot agree with that great signification of the finding of *Xenodiscus carbonarius* Waag. in Middle Productus-limestone, which Noetling¹⁾ and Diener²⁾ attribute to this fact.

Th. N. Tschernyschew calling attention to the finding of Ammoneae with a ceratite-like suture-line in the Lower-Carboniferous deposits of America, indicates how incautiously it would be to judge about the age of any deposits relying exclusively on such grounds.³⁾

In the beginning of this short description it was pointed out how Diener, having assumed, after a careful study of the material, the Permocarbiniferous age of the fauna of Chitichun № 1, afterwards changed radically his opinion exclusively on the account of the presence of *Xenodiscus carbonarius* Waag. in the studied deposits.

Meanwhile, examining the other forms, which Diener has described there, we see that they belong wholly to the Mediterranean sea of the Upper Palaeozoic, to the Permocarbiniferous, partly even to the Upper Carboniferous deposits of Europe, and taken by themselves they can by no means be referred to Neodiyas.

¹⁾ Noetling. Beiträge zur Geologie der Salt-Range etc. Neues Jahrbuch f. Min. etc., Beilageband XIV, 1901, pp. 369—471.

²⁾ Diener. Permian Fossils of the Central Himalayas, pp. 50—59.

³⁾ Tschernyschew, l. c. p. 720.

Now we can somewhat complete the list of the forms common to Djulfa and to some Upper Palaeozoic deposits of Asia.

With Chitichun № 1, excluding those which Diener has already indicated:

Reticularia Waageni Lóczy (*R. cfr. lineata* Mart.)?

Reticularia pulcherrima Gemm.

Uncinulus jabiensis Waag.¹⁾

Amplexus coralloides var. *Abichi* Waag and Wentz.

the deposits of Djulfa have still one allied species of *Nautilus hunicus* Dien, and as to the new common genera, they are *Lyttonia* and *Richthofenia* (?).

I have already pointed above to the connection of the suture-line of *Stacheoceras Trimurti* Dien. with this of *Popanoceras Tschernyschewi* n. sp.

As common with Djulfian ones by Diener are also indicated: ²⁾ *Marginifera helica* Ab. from Malla Sangcha and *Spirigera* cf. *protea* var. *alata* Ab. from Spiti. A great scientific signification would probably have the elucidation of strict stratigraphical relationship of the fauna of Productus shales of Byans, in which are met the representatives of such genera as:

Gastrioceras

Nomismoceras

Adrianites

to the fauna of «Pomarang» with the Permian Lamellibranchiata, and to the fauna containing the genera *Xenodiscus* and *Cyclolobus*. Of course, all these are faunas of different zones, and the complicated, but very important elaboration of their correlations belongs to the future.

¹⁾ According to Arthaber.

²⁾ Diener. Permian Fossils of the Central Himalayas, pp. 74 and 185.

As affinitive with the fauna of Djulfa, the Uppercarboniferous fossils of Lo-ping, revised by Fliegel,¹⁾ have the following species:

Marginifera helica Ab. var. *lopingensis* Fliegel

Reticularia Waageni Lóczy

now we must join to this, *Orthoceras lopingense* n. sp., found by me in the zone of *Otoceras trochoides*.²⁾ The common genera, new for Djulfa are:

Strophalosia

Lyttonia

Richthofenia.

Immediately higher than the zone of *Gastrioceras Abichianum* Moell. and *Popanoceras Tschernyschewi* n. sp. (designated above under № 11), there are following deposits in Abich's section:

12. White marl—1 m.

13. Red marl of the thickness of about 30 m.

At the very commencement of this series were observed imperceptible traces of fossils which might be referred but with the greatest cautiousness to the Cephalopoda.

In the uppermost part of this series of strata is discovered Triassic fauna. Here were met with:

Xenodiscus radians Waag.

Xenodiscus aff. *Kapila* Dien.

Xen. cfr. *nivalis* Dien.

Xenodiscus Mojsisovicsi n. sp.

¹⁾ Fliegel. Über obercarbonische Faunen aus Ost- und Südasien. Palaentographica, Bd. 48, pp. 129 and 131.

²⁾ The presence of *Orthoceras bicinctum* Ab. in Lo-ping has been indicated by Kayser long ago (Obercarbonische Fauna von Lo-ping, Richthofen's «China», Bd. IV, p. 167).

Stephanites sp. ind.

Stephanites Waageni n. sp.

Paratirolites Kittli n. sp.

Paratirolites Dieneri n. sp.

Balatonites (?) cfr. *euryomphalus* Benecke.

14. A series of beds of white marls and compact limestones—56 m.

15. Gray marls, a Pelecypoda bed—6 m.

From this horizon proceeds that Abich's specimen, which has been referred to *Avicula* cf. *Clarai* by Mojsisovics, and also some other species very close to the Werfian Pelecypoda.

The fauna here met with is in specific relation very poorly represented; it is at present in elaboration.

Higher goes the series of beds of white, gray and yellow marls, of spotted limestones and brown sandstones, of the thickness of about 200 f.

I have met here only obscure traces of fossils. The whole complex of strata is covered with Tertiary sandstones and conglomerates.

Triassic deposits were indicated in Abich's section 30 years ago by Mojsisovics, ¹⁾ who discovered in Abich's collection a print of Ammonites with spines on the interior whorls; this circumstance enabled him in reporting it to be a *Tirolites*, and Abich's form, *Pecten tortilis* Sem., as it was said above, has led him to believe that it belongs to *Avicula*, a very close form to *Avicula Clarai* Emmr.

Frech and Arthaber stated the assurance that the forms,

¹⁾ Mojsisovics. Zur Alterbestimmung der Sedimentär-Formationen der Araxes-Enge bei Djoulfa in Armenien. Verhandl. K. K. Geol. R. A. 1879, p. 171.

of which Mojsisovics wrote, cannot proceed from this section: «Die nach den Angaben Abich's im unmittelbaren Hangenden der Djulfakalke vermutheten Werfener Schichten mit *Tiro-lites*, *Pseudomonotis* etc. können im Süden, wo die Profilzeichnung dieselben angiebt, nicht liegen: Das Einfallen der Schichten ist vielmehr gerade umgekehrt nach Norden gerichtet, und nördlich von dem Fundpunkte der Versteinerungen beobachteten wir noch mindestens 100—200 m. mächtige palaeozoische Kalke»; ¹⁾ «Jedenfalls sind die Werfener Versteinerungen nicht dort zu suchen, wo sie das Abich'sche—offenbar aus dem Gedächtnis gezeichnete—Profil angibt. Das Einfallen der Schichten ist umgekehrt, wie es Abich beschreibt, so dass an dem Fundorte die Werfener Versteinerungen gerade das Liegende die Djulfa-Kalke bilden würden». ²⁾

These investigators have discovered, approximately 10 kilometers above the river Araxes, marlaceous limestones, the badly preserved fauna of which gave them the ground to suppose in these strata Chidru-beds; the higher lying quartzite they took for the finding-place of the Triassic forms described by Mojsisovics.

Noetling repeats latter erroneous judgment already in affirmative form. ³⁾

The above described representatives of the Lower Trias were found partly even in the summer of 1908. The connection between the Djulfian and Indian Lower Triassic faunas seemed to me still then indubitable. But now, after the edition of Krafft's and Diener's paper:—«Lower Triassic Cephalopoda from Spiti, Malla Johar, and Byans», there appears the possibility of accounting this connection as sufficiently complete.

¹⁾ Frech. Die Dyas, p. 568.

²⁾ Frech and Arthaber, l. c., p. 176.

³⁾ Noetling. Die asiatische Trias, Lethaea geognostica, Th. II, Das Mesozoicum, I. Bd., Trias, II Lief., p. 115.

The Lower Triassic deposits of India and Djulfa appear to be connected by the following forms:

Xenodiscus radians Waag.

Xen. aff. *Kapila* Dien.

Xen. cfr. *nivalis* Dien.

and two species of *Stephanites* ¹⁾

Xen. Kapila Dien. and *Xen. nivalis* Dien. were met with in the Himalayas only in Hedenstroemia beds. As to *Xenodiscus radians* Waag., ²⁾ this species was found, as Waagen shows, «in beds corresponding in age to the lower part of the Ceratite Sandstone», i. e. in the strata, corresponding to Hedenstroemia beds of the Himalayas. We must regret that this species was incautiously collected in the Himalayas, and bears the note: «Lower division (Otoceras beds?)». ³⁾

Krafft uttered doubt as to the possibility of finding this form in the lower part of Ceratite sandstone by Waagen: «According to the explanation of Pl. XXXVIII in Waagen's memoir, his type-specimens of *Xenodiscus rotula* and *X. radians* were collected from the lower region of the Ceratite Sandstone. The original labels of the specimens say «about region of ceratite sandstone». From this discrepancy doubt must arise as to whether the geological position of the two species has been satisfactorily ascertained». ⁴⁾

However, I am inclined to believe, on account of the position of this species in Djulfa, that the superiority in sense of correctness of the gathering and stratigraphical determination

¹⁾ When this chapter was already sent to be printed, O. W. Knyrko prepared an excellently preserved specimen of *Xenodiscus rotula* Waagen.

²⁾ Waagen. Fossils from Ceratite Formation, p. 303.

³⁾ Krafft and Diener, l. c. p. 95.

⁴⁾ Krafft and Diener, l. c. p. 95.

ought to be Waagen's, who indicates most decidedly the horizon to which this form should belong.

Besides it is not at all likely that *Xenodiscus radians* might simultaneously pertain to *Otoceras*—and *Hedenstroemia* beds.

The Djulfian *Stephanites* are very affinitive to the Indian species of the Upper Ceratite limestone.

Thus, in relation to India one must adapt the Triassic deposits of Djulfa to the upmost part of *Hedenstroemia*-beds of the Himalayas, and to the boundary between Ceratite sandstone and Upper Ceratite limestone in Salt-Range. This stands in perfect accord with Diener's and Noetling's bases, confronting the zone of *Sibirites* of Byans in the Himalayas with the zone of *Stephanites superbus* Waag. of Salt-Range.

The representatives of *Paratirolites* have for the Trias of Djulfa the same signification as for the analogous deposits of the Himalayas — *Tirolites injucundus* Krafft, *Xenodiscus asiaticus* Krafft and *Meekoceras pseudoplanulatum* Krafft.

The significancy of all these fossils of Djulfa and the Himalayas is very great, and has a double sense.

Firstly, they are the first indubitably Triassic forms in the deposits of the Asiatic parts of the Mediterranean sea, and secondly, they connect really the *Hedenstroemia* beds and the Trias of Djulfa with the Lower Trias of the Alpine region of this sea.

In some sort of contradiction to such an opinion might stand the presence of *Balatonites* (?) cfr. *euryomphalus* Beneck. in the Djulfian Trias, a form sufficiently similar to this, described by Mojsisovics.

As known, the normal position of this species is—the zone of *Ceratites trinodosus*; but a specimen very close to *Bal. euryomphalus*, described by Mojsisovics as *Balatonites* sp.

ind. aff. *euryomphalo*,¹⁾ proceeds from the zone of *Ceratites binodosus*, the *Balatonites* of Bogdo are referred to the zone of *Tirolites cassianus*, and *Balatonites punjabiensis* Waag. was found²⁾ by Waagen not higher than in the Upper Ceratite limestone.

As an analogical fact we must also indicate the finding of such a form as *Ceratites pumilio* Krafft in the Hedenstroemia-beds of the Himalayas.³⁾

Of course, I am far from the thought of affirming that Hedenstroemia-beds and the Trias of Djulfa were deposited simultaneously with any determinate division of the Werfian deposits; on the contrary, some considerations lead to the conclusion that at least the Cephalopoda-zone of the Werfian layers should represent somewhat younger formation.

One must remark that among the Cephalopoda, lying below the Hedenstroemia-beds, there were till now met no forms, which could be set into immediate connection with the fauna of the lowest Triassic deposits of Europe.

The base for estimation of *Otoceras*—*Meekoceras*—and Hedenstroemia-beds as Triassic depositions appeared their «Mesozoic» character; but it is impossible to demand simultaneously an existence of a complex of strata representing an uninterrupted deposition of sediments, as such appear after the opinion of some German Geologists the Upper Palaeozoic and Mesozoic deposits of Salt-Range and the Himalayas, and that at the same time there would be preserved the conditions for these artificial divisions, which are assumed in western Europe.

¹⁾ Mojsisovics. Die Cephalopoden der mediterranen Triasprovinz, pp. 84 and 90.

²⁾ Waagen. Fossils from the Ceratite Formation, p. 65. Compare also: Mojsisovics. Upper Triassic Cephalopoda Faunae of the Himalaya. Palaeontologia Indica, Ser. XV, Vol. III, Part. 1, p. 138.

³⁾ Krafft and Diener, l. c. p. 172.

For us it is important to elucidate, be it only in common view, in what homotaxial relation stand the deposits, we are examining, to the classical deposits of Europe.

Of what age must be the deposits inclosed between the strata with the first, indubitably Lower Triassic fossils and the strata with lower, Palaeodyassic formations, and where should be drawn the upper limit of the Palaeozoic deposits as well as the lower Mesozoic? Let us try to set this question thus: where could be stated, within the boundaries of the eastern parts of the Mediterranean sea, determinate points of stratigraphical equivalents of the classically studied regions, and how should be synochronized, basing exclusively on positive grounds, the fauna confined between these constants?

On the ground question, whether the interruption was or not in the deposition of the sediments between the Lower Permian and the Triassic deposits of Tethys, there are two sharp counter opinions.

Th. N. Tschernyschew ¹⁾ declared himself for the transgressive overlying of the Trias on the Upper Palaeozoic of the Salt-Range. In his lectures, read in the Mining-Institute, he points to the remarkable fact of the finding of allied *Anomodontia*, *Glossopteris*-flora, and fauna of the closed basins, in the northeastern Russia and South Africa, having been deposited at the time, which responds to the Upper Permian.

Yet in particular for the region of India, Vredenburg pointing to traces of weathering of the surface of the layers constituting the Otoceras beds, yields thereby a ponderous proof in favour of the Trias transgressively overlying them. ²⁾

In the meantime Noetling insists on the other hand, upon the uninterrupted shifting of these depositions in India, indica-

¹⁾ Tschernyschew, l. c. p. 726—727.

²⁾ Vredenburg. A Summary of the Geology of India, 1907, p. 44.

ting that the interruption between the layers containing faunian relics in Salt-Range, in some localities is only all in all equal to a few inches, ¹⁾ now in the Himalayas the Otoceras-beds are connected with Productus shales in the most intimate manner. ²⁾

Diener ³⁾ insists upon the connections of the Otoceras and Meekoceras beds.

It seems to me that these apparently quite different opinions might be made up, if we draw attention to one circumstance. If we observe in what relation stand each to another during the period of shifting of the Palaeozoic and Mesozoic, in the regions concerning us, not these strata in which is generally perceived any fauna, but those, which appear as horizons characterized by the presence of Cephalopoda, we shall see the following picture. The interruption in Djulfa between the horizon containing *Gastrioceras Abichianum* and *Popanoceras Tschernyschewi*, and the layers of the Lower Trias, is equal to 30 m., and that is the very interruption in the deposition of each fauna in general; in the Salt-Range the interruption between Cephalopoda-beds and Lower Ceratite limestone does not surpass 60 Eng. f., yet the interval between these horizons is pre-eminently occupied by representatives of *Bellerophon* or *Stachella*. Now in the Himalayas, apparently the favorable conditions for the existence of Cephalopoda do not change from the zone of *Cyclolobus Oldhami* to the very Hedenstroemia beds, whereas the interruption between the zones of *Ophiceras tibeticum* and *Prionolobus Noetlingi* ⁴⁾ is equal all in all to only 10 Engl. f.

Thus, moving from Djulfa towards Spiti we see that the

¹⁾ Noetling. Lethaea geognostica, Die asiatische Trias, p. 162.

²⁾ Noetling. Ueber das Alter der Otoceras-Schichten von Rimkin Paiar etc., p. 539—548.

³⁾ Krafft and Diener, l. c. p. 168—169.

⁴⁾ *Meekoceras Markhami* Diener (emend. Hayden and Diener).

«hiatus» between the Cephalopoda-bearing horizons grows more and more smaller, and while this interruption at Djulfa is not accompanied by any fauna, as far as I could perceive, in the Salt-Range still before the beginning of the complete interruption (one must estimate it at an average of about 15 Engl. f.) was observed a poor Gasteropoda-fauna, whereas in the Himalayas the Cephalopoda-life was replaced only by more developed Cephalopoda.

If we, getting our fragmentary informations from these three points, see neither the full discontinuation of the deposition of the lithological sediments on the West, on one side, nor the visible contact of the Cephalopoda faunas on the East, on the other—at any rate we have some reasons to suppose that in the eastern part of Tethys, after the deposition of the Upper-Palaeozoic layers, there existed the most favorable conditions for the permanent deposits of the deep-water facies, but these conditions changed gradually towards the western part. From this point of view we are able to explain the communication of the terrestrial fauna and flora of the continents of Africa and Europe, and the discontinuation of the development of the Cephalopoda at Djulfa and the Salt-Range, and affinitive features between the representatives of divers Cephalopoda-zones of the Himalayas, and at last, the more ancient character of the Hedenstroemia beds and the Triassic fauna of Djulfa in comparing with Campiler Schichten. By such an idea of the decrease of the basin of the Mediterranean-sea, which is documentarily expressed in the changement of the facial conditions, we have observed in the sections, we are able to conceive why there has been remarked impoverishment of the fauna, and further its entire absence in the intermediate strata of the Salt-Range and Djulfa, and why the *Otoceras* from the *Otoceras*-beds are much younger than the Djulfian species, and why reversedly, the Djulfian Trias commences with

the fauna of Hedenstroemia-beds, in the absence of Meekoceras and Otoceras beds, represented by unfossiliferous strata.

As to deposits of Salt-Range, they possess analogues of Meekoceras beds excellently expressed, but the Otoceras-beds are represented there only by a poor fauna of Gasteropoda. At present there is no more doubt about this gradual transgression of the Triassic Cephalopoda fauna from East to West. The question is now, to what age shall we refer the fauna and the unfossiliferous strata, confined between the Palaeodyassic deposits and those, which we have right to consider to be Lower Triassic.

Noetling ¹⁾ proposes to draw the lower boundary of the Trias of the Himalayas above the zone of *Ophiceras tibeticum* and under the zone of *Meekoceras Markhami*;—with such a position one may dispute in the sense that in the Meekoceras beds there are not at all forms which could be so or otherwise connected with the Cephalopoda of the Werfian fauna. On the other side Diener points to a striking faunian difference between Meekoceras and Hedenstroemia beds.—«The difference of the Cephalopod faunae of the two latter stages is very remarkable, only one single species extending from the lower into the higher stage». ²⁾

That gives some sort of reasons also from the formal side for drawing the lower boundary of the Trias immediately under the Hedenstroemia-beds.

But it is incomparably more difficult to say, in what horizons one may fix the upper boundary of the Palaeodyas of the Tethys.

Diener and Noetling seeing in the Productus-limestone an equivalent of the Permian deposits of western Europe, took

¹⁾ Noetling. Ueber das Alter der Otoceras-Schichten von Rimkin Pairar etc., p. 552—553.

²⁾ Krafft and Diener, l. c. p. 172.

Otoceras-beds for the intermediate strata between the Upper Permian and Triassic, but they have a strikingly different manner of considering the question of the precise age of these latter deposits.

Noetling taking Otoceras beds as still belonging to Permian, stated in defence of his opinion the following considerations: ¹⁾

a) The supposed stratigraphical diversity between Productus-shales and Otoceras-beds did not turn out evincible, and the Otoceras-beds are more connected with the Productus-shales, than with the higher lying strata.

b) The affirmation that the Cephalopoda of Triassic habitus appear for the first time in the Otoceras-beds is incorrect, because *Xenodiscus carbonarius* was found in the middle, and *Cyclolobus Oldhami* in the upper division of Productus-limestone.

c) The genus *Otoceras* is till now known only from the Permian deposits.

d) The suture-line of *Medlicottia Dalailamae* bears undoubtedly Permian character.

e) The historical priority: as soon as is discovered any new fauna, more ancient than the fauna of the lowest, classically ascertained horizons of the given system, the lower boundary of this latter ought not at all to be lowered.

Diener does nowadays agree with this Noetling's ²⁾ point of view. As a proof for the Triassic age of the Otoceras-beds he gives the following accounts:

a) An almost entire absence of Brachiopoda of the Palaeozoic type in the Otoceras-beds, and general character of their Cephalopoda fauna reveal in them Mesozoic deposits; the

¹⁾ Noetling. Ueber das Alter Otoceras-Schichten von Rimkin Paiair etc., p. 537.

²⁾ Krafft and Diener, l. c. p. 168—170.

prevailing majority of the species of these Cephalopoda is supplied with a ceratito-like suture-line.

b) On a level with the genera which are common to the Permian as well as to the Triassic deposits, there are also representatives known only from the Triassic deposits.

And as inference:

At the condition of the homotaxis of Hedenstroemia beds—Campiler Schichten, and Kuling shales with the Bellerophonkalk, the Otoceras-beds ought to correspond to Seiser Schichten.

Yet not one of these positions can be considered convincing in the sense of definition of the age of the Otoceras-beds.

The disappearance of the Brachiopoda is comprehensible, as there arose favorable conditions for the broad prevalence of the Cephalopoda. The contrast of two faunas does not yet make dependent the boundary between two systems, if there are not more positive arguments.

Nor are there any valid reasons to consider Kuling shales an equivalent of the Bellerophonkalk; in the contrary, if we draw attention to the fauna of Bellerophonkalk, we perceive that in the Palaeozoic which lies immediately below the Werfian layers on the West, there is observable the same astonishing apparition as on the East, i. e. in the given case in the Otoceras-beds; namely, as if the faunas of the Palaeozoic and Mesozoic were confounded in these two places. ¹⁾ It is as if we had to deal with this fact that the fauna of the basin of Tethys, at its transition from the Palaeozoic to Trias, in different

¹⁾ Frech. Die Dyas, p. 552; Diener. Ueber ein Vorkommen von Ammoniten und Orthoceren im südtirolischen Bellerophonkalk. Sitz. Ber. Kais. Acad. Wissenschaften Bd. 106, 1897.

regions has been subordinated to the same conditions of passing, moreover, were these conditions, apparently, simultaneous.

Thus, we have the same reason to range the *Otoceras*-beds to the upper lying strata as well as to the lower ones. To make use of these deposits for stratigraphical purposes, grounding only on the received facts, is till now impossible. Yet if in these considerations we try to adapt Noetling's opinions, and also assume that *Xenodiscus carbonarius* has «already» a Triassic habitus, ¹⁾ and *Medlicottia Dalailamae* has «still» a Permian one, ²⁾ in this case we may easily get on unsafe ground.

With certainty we can but affirm that the layers of Kálabágh—Kund-Ghat and the Upper Palaeozoic of Djulfa belong to the Palaeodyas. If now we draw attention to the fact that the layers of Kund-Ghat are covered with the zone of *Cyclolobus Oldhami*, and that this zone also lies in the base of the *Otoceras*-beds in the Himalayas on one side, on the other hand the representatives of *Medlicottia* of these latter deposits are younger, than the Artinskian and Sicilian, and the Himalayan *Otoceras* are younger than the Djulfian, one may see without anything further particular in this zone the conditional upper boundary of the Palaeodyas.

There is met with in Diener's work such an explanation of the faunian difference between the Lower Trias of the Alps and of the Himalayas: «... it is evident that the obstacles, preventing an exchange of Indian and Mediterranean Cephalopoda during the *Otoceras* and *Meekoceras* periods, were partly removed during the later period of the lower Trias, although there was probably no such open communication through the Tethys as in upper Triassic times, the influence of conside-

¹⁾ Noetling, l. c. p. 533.

²⁾ Noetling, l. c. p. 549.

rable isolation of the Alpine fauna becoming obvious from the scarcity of closely allied forms in the two regions». ¹⁾

It seems to me that if admitting transgression of the Cephalopoda fauna from East to West only during the period of the deposition of Hedenstroemia beds, the Otoceras and Meekoceras-beds, and also all that, which lies in Djulfa and the Salt-Range between the equivalents of Hedenstroemia beds and the Palaeodyas, must be considered synchronical to the Neodyas, i. e. to the Bellerophonkalk or Zechstein.

One may think that at this time, when after the Permian-carboniferous period in European Russia and Germany the peculiar Permian fauna began to develop, in India there were regions where was proceeding the uninterrupted development of the Cephalopoda, and only in the period somewhat earlier, than the deposition of the Werfian strata, there began to appear forms, common to the Trias of India and Europe.

We may consider Hedenstroemia-beds more ancient depositions than the Campiler Schichten because their fauna appears as an autochthonic one, and is overlying the deposits of the open sea, which contains syngenetical representatives, whilst the Cephalopoda fauna of Campiler Schichten has been deposited in near vicinity of closed basins and continental formations, and lies on strata, occupied with species far from being affinitive.

Of course, at the present judgment on the Upper Productus-limestone, considered equivalent to the Upper Permian, there was naturally a strong desire to examine all that lies immediately under the Hedenstroemia-beds as deposits corresponding to Seiser Schichten. Against my opinions one may object that according to Bittner almost all Pelecypoda from the Otoceras-beds have the Triassic habitus, and I have positively nothing against

¹⁾ Krafft and Diener, l. c. p. 172.

such objection, as there are many Cephalopoda from these deposits having also a Mesozoic character. ¹⁾

I do not intend to argue that all this fauna ought to possess a Permian mark; but the radical task of the stratigraphy consists in the elucidation of the question, which deposits ought to be considered simultaneous, and what dependence exists between the deposits of different times.

Moreover, at the comparatively little changeability of the Pelecypoda in time, there are to be determinate complexes of identical forms in order to prove the simultaneousness of these or those formations.

If we assume that between the Palaeodyassic, Neodyassic and Triassic deposits of India there was no interruption in the formation of the deposits of the open sea, though only sporadically, it is quite comprehensible that for the Cephalopoda fauna of the Himalayas, already at its precedent epoch, those types ought to have been marked there, which in subsequent time would have served sources for broad diffusion of the new species. Namely, partly simultaneously with the Artinskian fauna, partly immediately after it should have been deposited these Cephalopoda, the representatives of which we find in Sosio, Djulfa and the Salt-Range. *Xenodiscus carbonarius*, *Xen. plicatus*, as well as the Djulfian *Otoceras*, are visibly the basal groups in the development of the Cephalopoda, which gave the origin to a numerous quantity of forms confined between the Palaeodyassic and Triassic deposits of Tethys.

But in the main, whether the connection of the faunas of the *Otoceras*, *Meekoceras* and *Hedenstroemia*-beds will be pro-

¹⁾ M. D. Zalessky kindly communicated me that among the Upper Palaeozoic flora of Kusnezsk he stated a few forms quite indiscernible from some Mesozoic species (*Phoenicopsis* cfr. *angustifolia* Heer., *Czekanowskia* cfr. *rigida* Heer., *Gingko* sp. etc.); notwithstanding this fact cannot make these undoubtful Palaeozoic deposits Rhaetic.

ved, or will we have to own that in the regions till now known it is entirely incomprehensive, the situation of the things remains unchanged, because whether the process of the deposition of the sediments were continue in the given place, or was it temporary interrupted, so or otherwise, all that is included between these horizons, which we may consider only Palaeodiasic, and those, in which we can indicate undoubtedly the first representatives of the Lower Trias, at the condition of their conformable stratification, should be referred to the Upper Permian.

To agree entirely with Vredenburg in the sense that the Zechstein of Europe and the typical Upper Permian of Russia are not represented in India as such ones, I would consider it very difficult to attribute the Triassic age to the Lower Ceratite limestone, Ceratite marl and the Meekoceras beds. ¹⁾

Vredenburg's idea as to the bathological position of the Otoceras beds is evidently rather near that declared on these pages, — «The newest age that can be assigned to it is the top of the Lower Permian». ²⁾

Thus, I believe one ought to take for the chronological equivalent of the Neodias, within the boundaries of Tethys, the Bellerophonkalk, lying on the Grödener Schichten, but at the same time, here and there lithologically connected with the upper Fusulinian series of layers; ³⁾ the strata without fossils at Djulfa, being between the strata with *Popanoceras Tschernyschewi* and the zone of *Paratirolites*; all the space between the zone of *Cyclolobus Oldhami* and Ceratite-sandstone in the Salt-Range, and, at last, all deposits inclosed between the zone of *Cyclolobus Oldhami* and Hedenstroemia beds in the Himalayas.

¹⁾ Compare also: Caneva. Über die Bellerophonkalkfauna. Neues Jahrb. f. Min. etc., 1906, p. 52—60.

²⁾ Vredenburg, l. c. p. 44.

³⁾ Geyer. Ueber die geologischen Verhältnisse im Pontafeler Abschnitt der Karnischen Alpen. Jahrb. d. geol. R.-Anst., 1896.

About those deposits, which lie immediately under the Hedenstroemia beds one might speak as about Seiser Schichten, but only in the case, in which there were possibility to prove that the Hedenstroemia-beds and Campiler Schichten were being deposited at the same time. But the bases at our disposal speak in favour of the Lower Triassic transgression from the East to the West.

On account of the facts and considerations examined here, we see that Noetling's ¹⁾ positions: «Das Vorkommen von *Tirolites* bei Djulfa würde diese Schichten ohne Weiteres von der indischen Provinz trennen und in das Gebiet der alpinen Trias verweisen», and «Wir dürfen darum wohl mit grosser Wahrscheinlichkeit annehmen, dass zur Zeit der unteren Trias eine Barriere existirte, welche das Triasmeer des westlichen Asiens von der indochinesischen Provinz trennte und dass darum die Annahme einer grossen Meeresverbindung, welche sich von Centraleuropa bis nach Indien hin erstreckte, wenigstens für die untere Trias hinfällig ist», are entirely inacceptable.

After the principal positions of this very communication were reported in the session of the Mineralogical Society, March 23^d, p.p. in present year, I received № 11 «Comptes rendus» (March 14, 1910) in which were expounded the results of the visitation of the defile of the Araxes by Messieurs P. and N. Bonnet. In the lying side of Abich's section they discovered — as it was to be expected — the presence of *Fusulinella*; the other information, they alleged concerning Abich's section, substantially coincides with my observations.

St. Petersburg, June, 1910.

¹⁾ Noetling, Die asiatische Trias, p. 118—119.

Provisional Tabular Statement of Stratigraphy.

	Alpine Region.		NE of Russia.	Sosio.	Djulfa.	Salt-Range.	Himálayas.
Lower Triassic.	Campiler Schichten.		?				Niti limestone.
	Seiser Schichten.						
Upper Permian.	Bellerophonkalk.		Permian s. s.		Unfossiliferous beds?	Pelecypoda beds.	Zone of <i>Sibirites</i> . Hedenstroemia beds. Meekoceras beds. Otocer beds. ^{as} Productus shales.
						?	
						Zone of <i>Paratrolites</i> .	
						Upper Ceratite limestone.	
						Ceratite sandstone.	
						Ceratite marls.	
						Lower Ceratite limestone.	
						Unfossiliferous clay.	
Lower Permian.	Grödener Sandstein.	Canal-thal's dolomite.	Kungur stage.	Calcare con <i>Fusulina</i> .	Zones of <i>Gastrioceras</i> , <i>Otoceras</i> and Brachiopoda.	Chidru beds.	
						Jabi beds.	
Upper Carboniferous.	Troglkofelkalk.		Artinsk stage.			Khund Ghat beds.	
						Kálabách beds.	
						Virgal beds.	
						Katta beds.	
			Uralian.			Amb beds.	
	Auernig Schichten.						

Abich's Section in the Araxes Canyon.

Pelecypoda beds.

Unfossiliferous beds?

Zone of *Paratirolites Kittli*.

Unfossiliferous beds?

With <i>Gastrioceras</i> <i>Abichianum</i> .	{	Zone of <i>Popanoceras Tschernyschewi</i> .
		Crinoidea-bearing marls.
		Zone of <i>Reticularia Waageni</i> .
		Zone of <i>Otoceras trochoides</i> .
Without Cephalopoda.	{	Zone of <i>Productus djulfensis</i> .
		Crinoidal reef.
		Bryozoan reef.
		Zone of <i>Notothyris djoulfensis</i> .
	{	Zone of <i>Productus intermedius</i> .

Explanation of Plates.

PLATE VI.

Fig. 1. *Notothyris nucleolus* Kutorga; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view.

Figs. 2—3. *Notothyris djoulfensis* Abich; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view.

Fig. 4. *Notothyris* sp. ind.; intermediate form between *N. nucleolus* Kut. and *N. djoulfensis* Ab.; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view.

Figs. 5, 6, 8. *Athyris* cfr. *planosulcata* Phill; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view.

Figs. 7, 9. *Pugnax* cfr. *Uta* Marcou; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view.

Fig. 10. *Camarophoria* cfr. *solitaria* Gemmellaro; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view; *e*, portion with pseudo-area enlarged three times.

Figs. 11 — 12. *Reticularia convexiuscula* Gemmellaro; *a*, ventral view; *b*, lateral view; *c*, dorsal view; *d*, front view.

PLATE VII.

Fig. 1. *Richthofenia* (?) sp. ind.; specimen showing only the large valve; *a*, natural size; *b*, the same enlarged.

Figs. 2—3. *Orthoceras lopingense* n. sp.; two fragmentary specimens; *3b*, septum.

Fig. 4. *Lyttonia* sp. ind.; specimen only with dorsal valve.

Fig. 5. *Nautilus hunicus* Diener; fragmentary specimen; *a*, transverse section of the whorl; *b*, side view.

Fig. 6. *Balatonites* (?) cfr. *euryomphalus* Benecke; *a*, side view; *b*, back view; *c*, suture-line.

Fig. 7. *Popanoceras Tschernyschewi* n. sp.; *a*, side view; *b*, front view; *c*, back view; *e*, suture-line enlarged three times.

Fig. 8. *Stephanites* sp. ind.; *a*, side view; *b*, front view.

PLATE VIII.

Fig. 1. *Xenodiscus* (*Paratirolites* ?) *Mojsisovicsi* n. sp.; *a*, side view; *b*, back view; *c*, suture-line.

Fig. 2. *Paratirolites Dieneri* n. sp.; *a*, side view; *b*, front view; *c*, suture-line.

Fig. 3. *Stephanites* (?) *Waageni* n. sp.; fragmentary specimen; *a*, side view; *b*, back view; *c*, transverse section; *d*, suture-line.

PLATE IX.

Fig. 1. *Paratirolites Kittli* n. sp.; *a*, side view; *b*, back view; *c*, front view; *d*, suture-line.

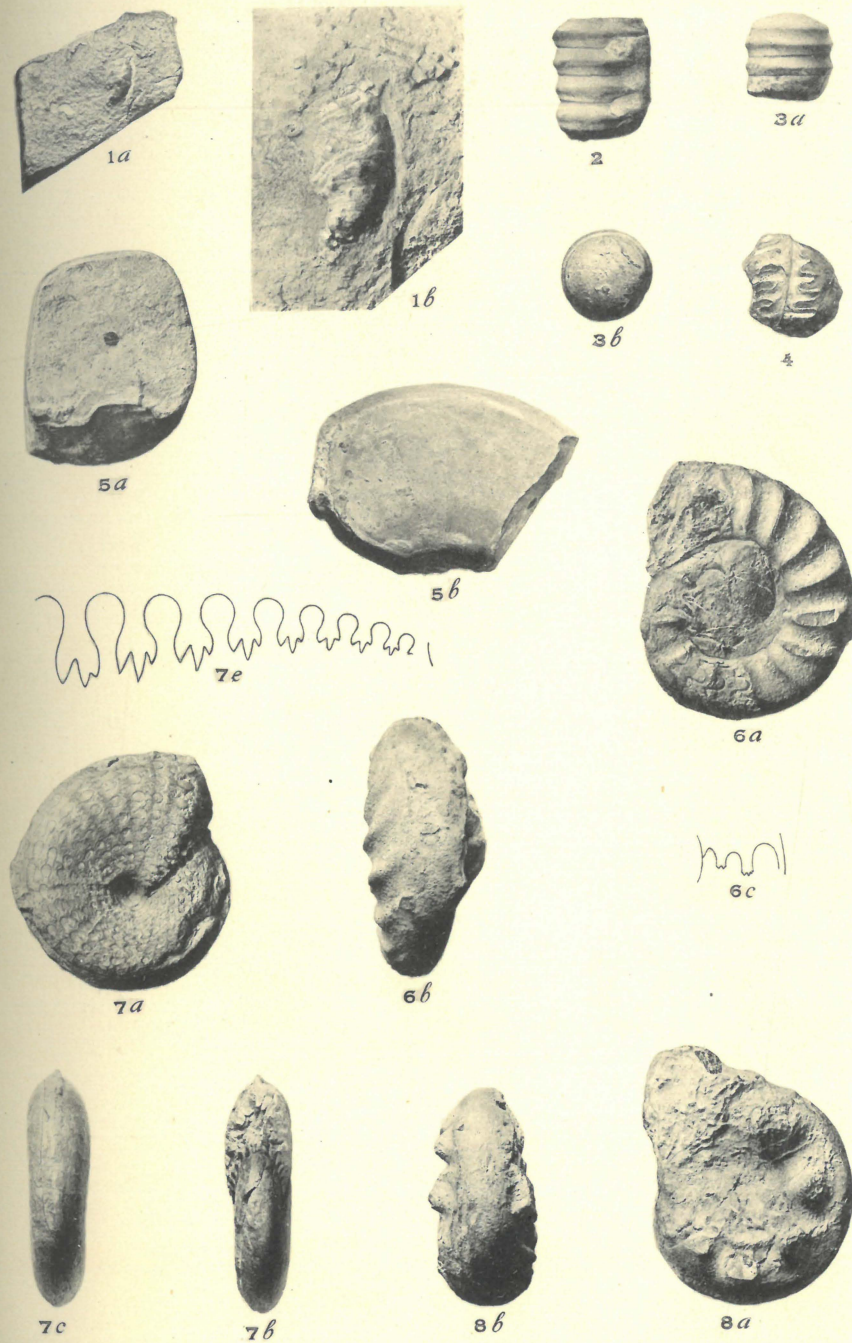
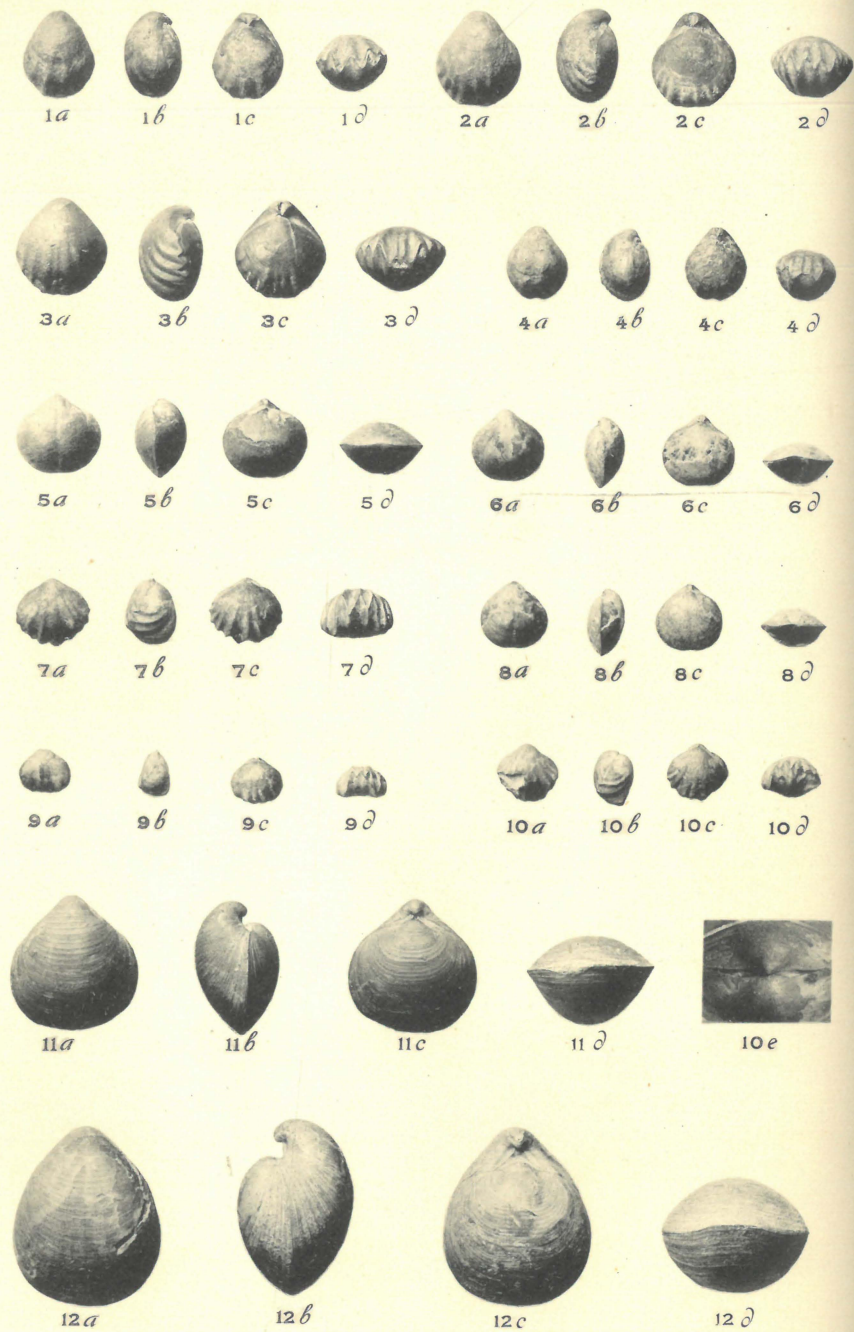
Fig. 2. *Paratirolites Kittli* n. sp.; side view.

Fig. 3. *Xenodiscus* aff. *Kapila* Diener; *a*, and *c*, side view; *b*, front view; *d*, suture-line.

Fig. 4. *Xenodiscus* cfr. *nivalis* Diener; plaster cast of a print; side view.

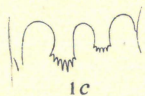
Fig. 5. *Xenodiscus radians* Waagen; *a*, side view; *b*, front view; *c*, back view.

Fig. 6. *Xenodiscus* sp. ind.; specimen very much deformed by pressure, side view.

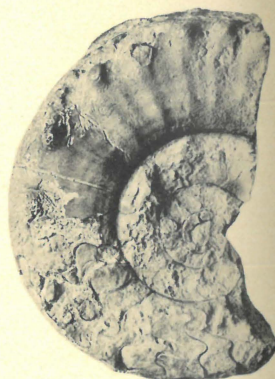




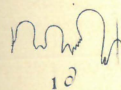
1a



1c



2a



1d



1b



1a



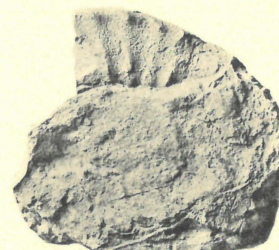
1b



2b



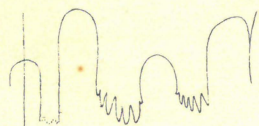
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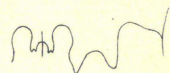
3c



1c



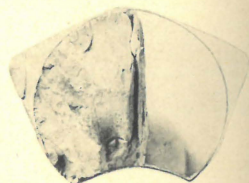
3d



2c



2c



3c



3a



3d



3b



4



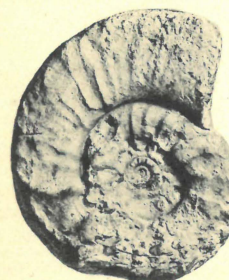
3a



3b



5b



5a



5c



6