Diener, Carl

Himálayan fossils

Vol. I, Part 2. Anthracolithic fossils of Kashmir and Spiti

Calcutta
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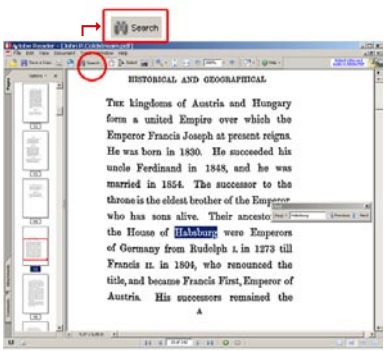

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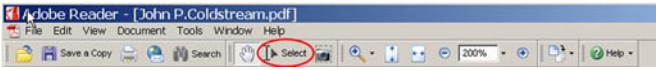

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HIMÁLAYAN FOSSILS.

VOL. I, PART 2.

ANTHRACOLITHIC FOSSILS OF KASHMIR AND SPITI.

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VOLUME I, PART 2.

ANTHRACOLITHIC FOSSILS OF KASHMIR AND SPITI.

BY

C. DIENER, PH.D.,

Professor of Geology at the University of Vienna.

WITH PLATES, I–VIII.

INTRODUCTION.

In the introduction to my monograph on the fauna of the permian Productus shales of Johár and Painkhánda it was proposed to devote a proper part of this volume to the description of the fossil contents of the Kuling shales of Spiti and of the Zewán or Barus beds of Kashmir, which have been considered to be of carboniferous age by previous authors.

Even then it seemed to me highly probable that representatives of both the carboniferous and permian systems were mixed together among the fossils contained in the Geological Survey's Himálayan collections from the upper palæozoic rocks of Kashmir and Spiti. This probability has been greatly strengthened by a closer examination of the fossil material entrusted to me for description. In my opinion the Kuling shales of Spiti, or more exactly, their lower portion underlying the triassic *Otoceras* stage, correspond stratigraphically to the Productus shales of Johár and Painkhánda, as has already been suggested by Griesbach, and must consequently be correlated with the permian system. In Kashmir this system seems to be likewise represented by black micaceous shales, observed by Lydekker on a ridge N.E. of Prongam Trál, whereas the large bulk of fossils from the Zewán or Barus beds are of upper carboniferous age, occupying, as it seems, the very highest stratigraphical position within the carboniferous system.

In spite of this it is impossible to fix the exact stratigraphical zone of every fossil in the Geological Survey's collections from the upper palæozoic rocks of Kashmir and Spiti. Notwithstanding the rather limited number of species, regarding which their geological age cannot be settled definitively at present, I deemed it preferable to let this uncertainty find an expression in the title of the present monograph. I have used the term "*Anthracolithic*" under which I understand both the carboniferous and permian fossils. This term, which I find very convenient,

considering the intimate stratigraphical and faunistic connection of the carboniferous, and permian systems of the Himálayas, was originally introduced by Waagen in the "Geological Results" of his Salt Range Fossils (Vol. IV, 1891, p. 241). I am glad to avail myself of it as one of the best denominations in our stratigraphical nomenclature, and I sincerely wish that it may be used more generally in geological literature than has been done hitherto.

Before entering into a detailed description of the anthracolithic fossils of Kashmir and Spiti, a few notes on the previous geological literature on the subject may be found useful.

The first reference to the existence of carboniferous rocks in the Himálayas was made by Dr. Hugh Falconer in 1838, who proved the carboniferous age of a limestone in the Kashmir Valley.[1]

In 1850 W. King[2] described the first anthracolithic fossil from the North-Western Himálaya, *Strophalosia Gerardi*, which had been collected by Dr. Gerard on the crest of a pass, leading from Ladakh into Bisáhir, at a height of 17,000 feet.

Among the fossils, picked up by Dr. Gerard in Spiti and entrusted by him to the Asiatic Society of Bengal in Calcutta, a large number was subsequently proved to be of anthracolithic age. One of the most common shells in his collection has been described as *Spirifera Rajah* by J. W. Salter[3] in 1865.

Although he never lost sight of its being a true carboniferous form, closely allied to *Spirifer Keilhavii*, von Buch, he erroneously inferred that it had been derived from the triassic beds of the Spiti-Pass. In an appendix to the same work, however, Mr. H. F. Blanford[4] correctly observed that *Spirifer Rajah* did not occur in the same bed with triassic ammonites described by himself in 1863,[5] but decidedly below them—"in beds, which other evidence combines to show, must be referred to the same general relative age, as the carboniferous of Europe."

Blanford's view regarding the stratigraphical position of the beds with *Spirifer Rajah* was fully confirmed by Dr. Ferdinand Stoliczka, who in 1864 had examined a number of geological sections in Spiti and Rupshu. Among the palæozoic rocks of Spiti three different series, the Babeh series, Muth series and Kuling series were distinguished by that learned author. The Babeh and Muth series he correlated to the silurian, the Kuling series to the carboniferous system of Europe. The prevalent rocks of the latter series he found to consist of "a dark brown crumbling shale and a light coloured, mostly whitish quartzite, generally speaking very difficult to distinguish from the top beds of the Muth series." The total thickness of these beds, considered by him to be carboniferous, he estimated to be from 100 to 400

[1] Palæontological Memoirs of *Hugh Falconer*, in "Official Report of Expedition to Kashmir and Little Tibet in 1837-38." Vol. I, p. 567.

[2] W. *King*, "A monograph of the permian fossils of England," London, 1850, p. 96, Pl. XIX, figs. 6, 7.

[3] J. W. *Salter* and H. F. *Blanford*, "Palæontology of Niti in the Northern Himálayas," Calcutta, 1865, p. 59.

[4] H. F. *Blanford*, ibidem, p. 111.

[5] H. F. *Blanford*, "On Dr. Gerard's collection of fossils from the Spiti valley in the Asiatic Society's Museum, Journal Asiat. Soc. of Bengal, 1863, No. 2, pp. 121—138.

feet. He records the following list of fossils, collected by himself and Dr. Gerard[1]:—

Spirifer Moosakheylensis, Davids.
„ *Keilhavii*, v. Buch (=*Sp. Rajah*, Salt.)
„ *tibeticus*, Stoliczka.
„ *altivagus*, Stol.
Productus Purdoni, Davids.
„ *semireticulatus*, Mart.
„ *longispinus*, Sow.
Avicula, sp.
Cardiomorpha, sp.
Aviculopecten, sp.
Orthoceras,? sp.

Among the species of *Lamellibranchiata* not a single one permits of a specific determination. A single indistinct cast has been identified as *Productus Purdoni* but it does not warrant a decided determination. The species mistaken for *P. semireticulatus* and for *P. longispinus* belongs to the subgenus *Marginifera*, Waagen, and is one of the leading fossils of the Kuling shales of Spiti and of the corresponding beds in Kashmir.

Whether *Spirifer tibeticus* and *Sp. altivagus* are really of anthracolithic age is very doubtful. The original geological position of the specimens collected by Dr. Gerard is not known. Stoliczka himself found only one loose specimen of *Spirifer tibeticus* near Kibber. On the other hand, *Spirifer tibeticus* is so closely allied to *Sp. Griesbachi*, Bittner,[2] of upper triassic age, that a distinction between them is very difficult. This question will be more fully discussed by Dr. Bittner in his memoir on the triassic Brachiopoda and Lamellibranchiata of the Himálayas (Palæontologia Indica, ser. XV, Vol. III, Pt. 2).

Stoliczka's notes on the stratigraphical sequence in Spiti have been partly corrected by R. D. Oldham and C. L. Griesbach. Oldham[3] in his interpretation of the Spiti sections inferred that Stoliczka's "Muth-quartzite" should be rather correlated with the carboniferous quartzite of Kashmir, than with the silurian system. Griesbach[4] confirmed this view and distinguished the following sequence of beds in the anthracolithic series of Spiti.

The dark unfossiliferous limestones, which rest on the flesh coloured quartzite series of upper silurian age and which probably correspond to the devonian system, are conformably overlaid by earthy, grey, crinoid-limestones from 600 to 800 feet in thickness. The red crinoid-limestone is overlaid by a fine-grained, white

[1] F. *Stoliczka*, "Geological sections across the Himálayan Mountains from Wangtu bridge on the River Sutlej to Sungdo on the Indus, etc.," Memoirs Geol. Surv. of India, Vol. V, Pt. I, pp. 25—29.

[2] C. *Diener*, "Ergebnisse einer Geologischen Expedition in den Central Himálaya, etc.," Denkschr, Kais. Akad. d. Wiss. Wien, math. nat. Cl., 1895, Bd. LXII, p. 558.

[3] R. D. *Oldham*, "Some notes on the geology of the N.W. Himálayas," Records, Geol. Surv. of India, Vol. XXI, 1888, pp. 151—153.

[4] C. L. *Griesbach*, Records of the Geol. Surv. of India, 1889, Vol. XXII, pp. 158—167, and "Geology of the Central Himálayas," Mem. Geol. Surv. of India, Vol. XXIII, 1891, pp. 212—223.

quartzite of about 500 feet in thickness, which Stoliczka originally included in his Muth series. This sequence of beds is exactly the same as in the Central Himálayas of Kumaon and Gurhwál. As in the eastern sections, the entire series is characterised by the scarcity of organic remains. In the Geological Survey's Himálayan collections this series is not represented by a single fossil which would permit of a specific determination. This remark, unfortunately, likewise applies to the next rock-group, a grey limestone which, Griesbach states, overlies the white quartzite conformably. It is a "hard, splintery, grey limestone, in flaggy beds of a total thickness of about 70 feet, which has yielded numerous fossils, though few in species. Amongst them are several *Producti*, *Athyris Royssii* and Corals. Its evident connection with the white quartzite and the character of the fossils define its upper carboniferous age."

It is very much to be regretted that Griesbach's collection does not contain fossils from this grey limestone exposed in the Pin river section near Muth, more especially so because this horizon seems to be absent in the Central Himálayas of Kumaon and Gurhwál and might perhaps be a representative of the Zewán or Barus beds of Kashmir.

The grey limestone near Muth is overlaid by Stoliczka's Kuling series. In this series two groups of a geologically different age have been included by that author. The upper portion has yielded the characteristic fossils of the *Otoceras* stage and consequently belongs to the scythian[1] series of the triassic system. The lower portion, consisting of dark, crumbling, often micaceous shales, alternating irregularly with sandstone-partings, Griesbach considers to be equivalent of the permian Productus shales of Johár and Painkhánda.

I am of opinion that the local denomination of "*Kuling shales*," given by Stoliczka, might advantageously be retained for these beds, owing to the claim of priority, although beds of lower triassic age had been originally included in Stoliczka's "Kuling series." But a restriction of the original name to the well defined horizon, included between the grey limestone of Muth and the *Otoceras* beds, is not contrary to the laws of stratigraphical nomenclature. Among more recent instances I only need mention the interpretation of the term "Partnach Schichten" by Skuphos, who restricts this name to the lower portion of Gümbel's Partnach beds and which has met with the unanimous approval of all Alpine geologists.

The existence of true anthracolithic rocks in the Kashmir Valley, which had been first supposed by Dr. Hugh Falconer in 1838, was definitely proved in a most important paper by Captain Godwin-Austen and Th. Davidson, an abstract of which appeared in 1864 in the Quarterly Journal of the Geological Society of London.[2] The original paper was, however, only published in 1866.[3] The sections of the fossiliferous rocks near Wasterwan, Barus, Loodoo and Khoonmoo, on the eastern

[1] *E. v. Mojsisovics, W. Waagen,* and *C. Diener.* "Entwurf einer Gliederung der pelagischen Sedimente des Trias Systems," Sitzungsber. kais. Akad d. Wissensch. Wien. math. nat. Cl. Bd. CIV., 1895, p. 1278.

[2] *Godwin-Austen,* "Geological notes on part of the N.-W. Himálayas," Quart. Journ. Geol. Soc. Vol. XX, 1864, pp. 383-387

[3] On the carboniferous rocks of the valley of Kashmir, with notes on the brachiopoda, collected by Captain Godwin-Austen in Tibet and Kashmir, by *Th. Davidson,* ibidem, Vol. XXII, 1866, pp. 29-45.

side of the Kashmir Valley, S. of Srinagar, were described in detail by Captain Godwin-Austen. The brachiopoda which were all obtained from the Kashmir Valley, and not partly from Little Tibet, as stated erroneously in his memoir, have been examined by Professor Davidson. The fauna described by this eminent author and considered as carboniferous, consists of the following forms, excluding those which were too badly preserved to permit of a specific determination :—

Terebratula (= *Dielasma* ?) *Austeniana*, Dav.
„ (*Dielasma*) *sacculus* ?, Mart.
Athyris subtilita, Hall.
Spirifer Rajah, Salter.
„ *Vihianus*, Davids.
„ *Kashmeriensis*, Davids.
„ *Moosakheylensis*, Davids.
„ *sp. ind.* (= *Lydekkeri*, Diener).
Rhynchonella pleurodon var. Davreuxiana, de Kon.
„ *Kashmeriensis*, Davids.
„ *Barusiensis* (misnamed : *Barumensis*), Davids.
Streptorhynchus crenistria, Phill. (= *Derbya cf. senilis*, Phill.)
Productus semireticulatus, Mart.
„ *Cora*, d'Orb.
„ *scabriculus*, Mart.
„ *Humboldti*, d'Orb. (?).
„ *longispinus*, Sow. (?).
„ *striatus*, Fischer, (?).
„ *spinulosus*, Sow.
„ (?) *laevis*, Davids.
Discina Kashmeriensis, Davids.
Chonetes Hardrensis var. Tibetensis, Davids. (recte *Kashmeriensis*, Lydekker).
Chonetes laevis, Davids.
„ *Austeniana*, Davids.
„ (*Spirifer*, Davids.) *Barusiensis*, Dav.

Altogether 25 species, of which 13 only, or about one half of this number, are also contained in the Geological Survey's Himálayan collections from Kashmir.

Professor Davidson sums up his views regarding the geological age of the beds from which these fossils were obtained, in the following remarks, (l. c. p. 40) :—

" Here again we find many of our common and widely spread European and American species, along with a few, that had not yet been noticed from other parts of the world, and which indicate that the carboniferous rocks of Tibet, Kashmir and the Punjab belong to one great formation."

Another very important paper on the geology of the anthracolithic region to the East of the Kashmir Valley was published by Dr. A. Verchère in 1866 and 1867.[1] He stated that the fossiliferous series is underlaid by slates, in which there

[1] A. *Verchère*, " Kashmir, the Western Himálaya and the " Afghan Mountains," Journal Asiatic Soc. of Bengal, Calcutta, 1866, Vol. XXXV, pt. 2, pp. 89-134, 159-203, 1867, Vol. XXXVI, pt. 2, pp. 201-229.

is an abundance of contemporaneous volcanic rock. The limestones and shales which rest on these volcanic rocks have been divided by Verchère into three divisions, called by him (in ascending order) Zeeawán beds, Weean beds and Kothair beds. The term "Zeeawán beds" is, however, taken in a wider sense than in Godwin-Austen's memoir, the Zewán beds having been restricted by the latter author to a distinct horizon of the anthracolithic series only, characterised by its abundance of *Fenestellæ*. Both the Zeeawán beds and Weean beds are considered to be carboniferous by Verchère, whereas the Kothair beds were placed by him in the triassic system.

The numerous fossils collected by Dr. Verchère in the anthracolithic series of Kashmir Valley have been studied partly by himself and partly by E. de Verneuil, but the results of these studies have, unfortunately, been published in a form which renders them almost useless.

The following species are quoted by Verchère from the Zewán beds :—

Nautilus Flemingianus, de Kon.
Terebratula (*Dielasma*) *sacculus*, Mart.
Spirifer Vercherei, de Verneuil.
,, *striatus*, Mart.
,, *Moosakheylensis*, Davids.
,, *Rajah*, Salter.
Spiriferina octoplicata var. transversa, Verch.
Athyris subtilita, Hall.
,, *Buddhista*, Verch.
cf. Royssii, Lev.
Retzia (*Eumetria*) *grandicosta*, Davids.
Orthis resupinata, Mart.
,, *sp. ind.*
Strophomena analoga, Phill.
Productus costatus, Sowerby.
,, *semireticulatus*, Mart.
,, *Cora*, d' Orb.
,, *Humboldti*, d' Orb.
,, *Purdoni*, Davids.
,, *longispinus*, Sow.
,, *Boliviensis*, d' Orb.
,, *aculeatus*, Mart.
Strophalosia (?) *arachnoidea*, Verch.
Fenestella Sykesii, de Kon.
,, *sp. ind.*
,, *megastoma*, de Kon.
Vincularia multangularis, ? Portl.
Disteichia ? *sp. ind.*
Acanthocladia sp. ind.
Retepora lepida, de Kon.
Alveolites septosa, ? Flem.

Both the descriptions and figures (Pl. I. to X. Journ. Asiat. Soc. of Bengal, Vol.

XXXVI, Pt. 2) are so unsatisfactory that I have only been able to identify such forms as are represented in Verchère's collection entrusted to me for examination by the Director of the Geological Survey of India. For the following species the identification seems to be pretty certain :—

Spiriferina cf. Kentuckensis, Shum.
Spirifer Moosakheylensis, Dav.
„ *Rajah*, Salter.
Athyris subtilita, Hall.
Retzia (*Eumetria*) *cf. grandicosta*, Dav.
Productus semireticulatus, Mart.
„ *Cora*, d' Orb.
„ *aculeatus*, Mart.

Orthis resupinata, Verch., is probably identical with *O. indica*, Waagen. *Athyris Buddhista* seems to be really a new species. *Spirifer Vercherei*, on the contrary, must be removed from the list of independent species, having been founded on strongly weathered waterworn specimens of *Sp. Rajah* only, which have lost the original details of their ornamentation.

There can be no doubt about the identity of Verchère's Zewán beds—I prefer to adopt the spelling of this name as given by Captain Godwin-Austen—with the anthracolithic rock-group, from which the brachiopoda, collected by Godwin-Austen and studied by Davidson, were obtained. The case is different with the Weean beds of Verchère. Neither from Verchère's description of the Kashmir sections, nor from his list of the fossil contents of this rock-group is it possible to make out whether they actually belong to the anthracolithic system or to one of the younger horizons in the stratigraphical sequence (Lydekker's "Supra-Kuling series").

The following species are quoted by Verchère from the Weean beds of Kashmir :—

Goniatites gangeticus, L. de Kon.
Nautilus clitellarius, ? Sow.
Solenopsis imbricata, de Kon.
„ *nov. sp.*
Cardinia Himalayana, Verch.
„ *ovalis*, ? Mart.
Cucullaea, sp.
Pecten, sp.
Aviculopecten dissimilis, Flem.
„ *ovatus*, Verch.
„ *ranus*, Verch.
„ *circularis*, Verch.
„ *sp. ind.*
„ *testudo*, Verch.
„ *gibbosus*, Verch.
Axinus, nov. sp.
Spiriferina Stracheyi, Salt.
Productus laevis, Davids.
Chonetes Barusiensis, Davids.

With the exception of the brachiopoda, all the type specimens quoted in the preceding list are contained in the Geological Survey's collection. Among them a single one only, *Goniatites gangeticus* from Banda, can be safely identified. It is identical with *Danubites nivalis*, Dien., one of the leading fossils of the Himálayan *Subrobustus* beds of lower triassic age. Attention has been drawn to this interesting fact in my memoir on the Cephalopoda of the lower trias (Vol. II, pt. I, of the present series). The rest of specimens are all undeterminable fragments, quite unfit for a specific determination. The Lamellibranchiata especially are so poorly preserved casts that it would be perfectly useless to have them figured. I can only say that it is absolutely impossible to derive from them any satisfactory conclusion as to the geological age of the strata in which they occur. Among the brachiopoda, *Spiriferina Stracheyi* points to a triassic age, this species having been found in the Lilang sries of Spiti by Stoliczka. Thus beds of triassic age have undoubtedly been included in the Weean group by Dr. Verchère, but it is impossbile to decide whether this group represents the lower trias only or may also include the topmost portion of the anthracolithic system, as was found to be the case with Stoliczka's Kuling series in Spiti.

Both Godwin-Austen's and Verchère's views of the stratigraphical sequence in the Kashmir sections were partly modified by Lydekker[1] from whose reports on the geological survey of the Kashmir, Ladakh and Chamba territories much valuable information may be obtained, although he was not able to establish a safe classification of the upper palæozoic and mesozoic rocks (his "Zanskar system"), based on palæontological evidence. Neither did he succeed in separating the triassic and anthracolithic systems, nor did he recognise the lower trias and the typical Kuling shales, although both of these horizons are certainly present in Kashmir, as was clearly proved by an examination of the fossils in the Geological Survey's Himálayan collection.

The most important additions to our knowledge of the anthracolithic system in Kashmir, for which we are indebted to Mr. Lydekker, are the following:—

The fossiliferous Zewán or Barus beds, the total thickness of which varies from 30 to 280 feet, rest conformably on a compact white quartzite, which is considered to be the equivalent of the carboniferous white quartzite of the Central Himálayas of Oldham and Griesbach. This quartzite is generally underlaid by massive amygdaloidal and other traps, which frequently, when the bottom quartzitic bed is less strongly developed, pass insensibly upwards into the fossiliferous strata. Although Lydekker hints at the possibility of these traps with their associated slates being at least partly of carboniferous age, he preferred to class them with his Panjal system, which corresponds to the older palæozoic rocks in other parts of the world. These slates, characterised by the abundance of contemporaneous volcanic rock, were found to be underlaid by conglomeratic slate, very similar to the Blaini conglomerate of the Simla sections, composed of subangular fragments and rounded pebbles of slates and quartzites imbedded in a matrix of fine-grained slate.

[1] *R. Lydekker*, "The geology of the Kashmir and Chamba territories and the British district of Khágán," Memoirs Geol. Surv. of India, Vol. XXII, 1883, Chapters VI, VII. I have not cited the previous papers of this author published in the Records of the Geol. Surv. of India, as their contents are embodied in the memoir quoted.

Whereas Lydekker considered this conglomerate, the glacial origin of which he advocated, to be of older palæozoic age, R. D. Oldham[1] compares the Kashmir conglomerate to the boulder bed of the Salt-Range and consequently refers it to the carboniferous system.

The following fossils from the anthracolithic rocks of Kashmir have been figured by Lydekker, but were not described in detail :—

Protoretepora ampla, Lonsdale.
Productus semireticulatus, Mart.
„ *Humboldti*, d'Orb.
Spirifer striatus, Mart.
Phillipsia cf. seminifera, Phill.

These determinations, which seem to have been chiefly quoted on the authority of Dr. Feistmantel, have been considerably modified by my revision of Lydekker's fossils. For the following three forms an identification can be established with certainty :—

Productus semireticulatus = *Marginifera himalayensis*, Diener.
„ *Humboldti* = *P. Abichi*, Waagen.
Spirifer striatus = *Sp. Lydekkeri*, Diener.

Mr. Lydekker was also the first to draw attention to the occurrence of the genus Lyttonia in the anthracolithic rocks of the Kashmir Valley.[2]

In 1891 Professor W. Waagen published the geological results of his examination of the Productus limestone fossils of the Salt-Range. In this memoir[3] he briefly discusses the brachiopoda of the Zewán or Barus beds of Kashmir described by Davidson. He remarks that the percentage of truly carboniferous forms, that is to say, of mountain limestone forms, is far largeramong them than in the fauna of the Amb beds (lower Productus limestone) of the Salt-Range, and that in the meantime slight affinities to Australian forms were indicated by the presence of *Spirifer Vihianus*, Dav., and *Sp. Kashmeriensis*, Davids.

Among the species quoted by Davidson, Waagen found only two identical with Salt-Range forms: *Athyris subtilita*=*Spirigerella Derbyi*, Waagen, and *Spirifer Musakheylensis*, Dav. To tnese species a third one, *Discinisca Kashmeriensis*, might perhaps be added, as its affinity to *D. Warthi*, Waag., amounts almost to identity. On the strength of this evidence Waagen came to the conclusion that "the Kashmir carboniferous strata should either be placed on a level with the lower speckled sandstone of the Salt-Range, or else they should be considered as intermediate in age between the latter and the lower Productus limestone or upper speckled sandstone."

There are several points on which I differ from the views of that learned author; these differences will be noticed in the descriptions of the Kashmir fossils in their proper places.

[1] A Manual of the Geology of India, 2nd Edition, by R. D. Oldham, Calcutta, 1893, p. 134.
[2] Records Geol. Surv. of India, Vol. XVII, 1889, p. 37.
[3] W. *Waagen*, Salt-Range fossils, Palæont. Indica, ser. XIII, Vol. IV, Geological Results, pp. 165, 166.

The material for the present memoir consists of the fossils collected in the Kuling shales of Spiti by Dr. Gerard, Stoliczka and C. L. Griesbach, of parts of the collections made by Captain Godwin-Austen, Dr. Verchère and Major Collet in Kashmir, and, last but not least, in the rich collections, brought together from the anthracolithic rocks of Ladakh and Kashmir by R. Lydekker, with the type specimens, figured in Vol. XXII, of the Memoirs of the Geological Survey of India.

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DESCRIPTION OF FOSSILS.

Class: CRUSTACEA.

Order: TRILOBITÆ.

Family: *PROETIDÆ*, Phillips.

Genus: PHILLIPSIA, Portlock.

1. Phillipsia sp. ind. aff. seminifera, Phillips. Pl. I, figs. 1, 2.

1883. *Phillipsia cf. seminifera*, Lydekker, Geology of the Kashmir and Chamba territories, etc. Mem. Geol. Surv. of India, Vol. XXII. Pl. II, figs. 5, 5*a*.

This species is represented in the Himálayan collection by two pygidia only, which are too fragmentary and too badly preserved to permit an exact determination. One of them (fig. 1) has been discovered and was compared with *Phillipsia seminifera*, Phill., by Lydekker; the other was not discovered, until the whole collection had been looked over several times, owing to the fact that it was crushed and partly covered by fragments of a *Spirifer*. After carefully cleaning it, however, it was found to be a *Phillipsia*, which I think may be safely referred to the same species as Lydekker's type specimen.

The pygidium figured by Lydekker, which is the better preserved of the two specimens available for description, is of a semi-elliptical shape, rather strongly convex and a little wider than long. The axis is considerably elevated above the lateral lobes. It is about one-third of the breadth of the entire tail-shield at its anterior border. Its posterior portion has been broken off, but from its preserved outlines we may judge that its extremity was rather prominent and distinctly obtuse.

In my second specimen (fig. 2) this character of the central axis may likewise be noticed. In the preserved portion of the axis five coalesced somites are shown. The lateral lobes consist of eight pleuræ, terminating within the narrow marginal space. Traces of tubercles may be seen both on the surface of the pleuræ and of the axial rings.

The measurements of this pygidium can only be given approximately, owing to its fragmentary and partly deformed condition. They are as follow:—

Length of the entire pygidium	10 mm.
Breadth „ „ „	cca. 12 „
Length of the axial lobe	8·5 „
Breadth „ „ „ at its anterior margin	4 „
Breadth of the smooth marginal space	1·5 „

The fragment of the second pygidium (fig. 2) shows eight somites in the axial, and six pleuræ in each of the corresponding lateral lobes. Traces of an indistinct granulation may likewise be noticed, both on the surface of the strongly marked lateral pleuræ and of the axial segments.

No measurements of this pygidium can be given on account of its imperfect state of preservation. The dimensions may be gathered in a general way from the figure. Its original outlines seem to have been altered considerably by crushing, especially so in a transverse direction.

Locality and geological position; number of specimens examined.—N. of Eishmakam, Lidar Valley, Kashmir, in a dark-blue limestone with numerous *Fenestellae;* Coll. Lydekker; 2.

Remarks.—Among the congeneric species from carboniferous rocks of European districts, *Phillipsia seminifera*, Phillips, has been correctly compared with the present form by Lydekker. The two species are certainly closely allied, though probably not identical. It is especially the figure of *Ph. seminifera* given by Woodward on Pl. V, fig. 5, of his monograph of the British carboniferous Trilobites (Palæontographical Society, London, 1883, Part I) which strongly resembles Lydekker's specimen. It is, however, not possible to fix the affinities between the European species and our Himálayan trilobite in a more positive way, as the state of preservation of the latter is too indifferent to warrant an exact determination.

Phillipsia seminifera has been mentioned by L. de Koninck (Recherches sur les fossiles paléozoiques de la Nouvelle Galles du Sud, 1876, p. 348) among the carboniferous fossils of Colocolo in New-South-Wales, but I am far from convinced of the correctness of this identification, especially regarding the pygidium figured by this author on Pl. XXIV, fig. 9*a* of his memoir.

An Australian species, which is probably closely allied to the present one, is *Griffithides dubius*, Etheridge (Quart. Journ. 1872, Vol. XXVIII, p. 338, Pl. XVIII, fig. 7) from the carboniferous rocks of the Don River in Queensland.

MOLLUSCA.

Class: LAMELLIBRANCHIATA.

There is no more difficult group among the anthracolithic fossils of Kashmir and Spiti than the Lamellibranchiata. Although this class is well represented, I have not met with one single complete specimen. Thus even the few identifications must necessarily remain uncertain. This will, I hope, explain why I deemed it preferable to indicate the described species which are probably new, as *sp. ind.* only, without adding a particular denomination. All the numerous specimens collected by Dr. Verchère have been purposely excluded from a special description, their fragmentary state of preservation rendering them absolutely unfit for determination.

I need hardly say that with such materials no idea of the real character of the fauna can be formed. No doubt, systematic researches at the proper localities will greatly add to our knowledge.

Order: ANISOMYARIA, Neumayr.

Family: *MYTILIDÆ*, Lam.

Genus: MODIOLA, Lamarck.

MODIOLA ? SP. IND. Pl. I. fig. 5.

The umbonal region having been broken off entirely, the fragment of a right valve is provisionally and with much hesitation referred to the genus *Modiola* on account of its external similarity with some types, figured by L. de Koninck on Pl. 28 of his "Faune du Calcaire Carbonifère de Belgique" (Annales du Musée Roy. d' hist. nat. T. XI. 5 ème ptie.). It especially reminds of *M. princeps* or of *M. fusiformis* by its obliquely elongated, slightly inflated shape, and by its numerous concentric striæ of growth, which are of somewhat irregular strength as in *M. Cordoliana*.

Locality and geological position; *number of specimens examined*.—Dark-blue micaceous shales with numerous *Fenestellæ*, near Eishmakam, Kashmir Valley; Coll. Lydekker; 1.

Family: *PECTINIDÆ*, Lamarck.

Genus: AVICULOPECTEN, M'Coy.

AVICULOPECTEN SP. IND. Pl. I. fig. 3.

The only known specimen of this species is a right valve with a nearly circular outline and a very indifferent sculpture. The valve is strongly inequilateral, flat, and about as long as high. The apex is anterior in its position, slightly prominent, limited on both sides by wings of unequal size, the posterior ear being considerably larger than the anterior one. It is on the strength of this character that I have considered this species as belonging to the genus *Aviculopecten*.

Both wings are marked off distinctly from the remainder of the shell. The marginal edges, which separate the apical region of the valve from the wings, slope very steeply towards the surface of the latter, although their general elevation above them is not considerable. The anterior margin projects far in front of the anterior wing and passes gradually into the ventral margin. The posterior margin is continuous, not sinuated at the commencement of the posterior wing. The hinge-line is only one-half the length of the antero-posterior diameter of the shell.

The whole valve is very flatly arched, its greatest thickness being situated about the middle of its height.

The surface is smooth with the exception of numerous and delicate concentric lines of growth. Traces of a few radiating costæ may be seen on the surface of the posterior wing.

The measurements are as follow :—

Entire length of the shell	21 mm.
„ height „ „ „	21 „
Length of the hinge-line	9 „
Thickness of the right valve	1·5 „
Apical angle without the wings	cca. 90°

Locality and geological position; number of specimens examined.—Dark-blue shales and limestone partings with *Fenestellæ*, near Eishmakam; Coll. Lydekker; 1.

Remarks.—A specific determination is impossible. In ornamentation it resembles *A. squamula*, Waagen (Salt Range Fossils, Pal. Ind., ser. XIII, Vol. I, Prod. Limest. Foss., p. 315, Pl. XXIV, fig. 5), but it differs from it radically owing to its strongly inequilateral outline. From *A. sibiricus*, Verneuil (Géologie de la Russie d' Europe, Vol. II. Paléontologie, p. 329, Pl. XXI, fig. 7) and *A. ellipticus*, Phill., it is also readily distinguished by this latter conspicuous character. There is also a distant similarity between it and *Avicula circularis*, Hall (Palæontology of Iowa, p. 522, Pl. VII, fig. 9) or *Streblopteria cellensis*, L. de Koninck (Faune du calcaire carb. de Belgique, p. 209, Pl. 39, fig. 14), although the Kashmir shell is certainly not a *Streblopteria*.

Genus: PECTEN, Klein.

Pecten sp. ind. Pl. I. fig. 4.

This species is represented by a single left valve only.

Outline transversely oval and very inequilateral. Apex anterior not very prominent, pointed. Two wings, of which the anterior is by far the larger. I based the determination as *Pecten* on this character, no other generic features being seen. Anterior wing flat, almost rectangular, separated from the anterior marginal edge of the valve by a furrow, bounded by a comparatively high perpendicular wall. Towards the posterior wing the shell is less steeply inclined, but the edge separating them is also distinctly defined. This wing is rather small and cut off obliquely, its posterior margin meeting the hinge-line at an obtuse angle. Hinge-line rather short, barely one-half the entire length of the shell.

The anterior margin forms a broad curve and projects only slightly in front of the anterior wing. It is continuous with the broadly arched ventral margin. The posterior margin passes into the ventral one in a kind of an obtusely rounded-off angle, from where it ascends in a nearly straight, oblique line, passing into the furrow which separates the posterior wing from the remainder of the shell.

The valve is moderately inflated, its greatest thickness being situated about the middle of its height.

The ornamentation consists of numerous extremely thin concentric striæ of growth, which are crossed by a system of radiating costæ. The latter are augmented in number towards the margins by intercalation. They are unequal in strength, roof-shaped and separated by valleys of unequal width, but stronger and thinner costæ do not alternate regularly. On the anterior wing a delicate radiating sculpture is likewise noticed. The posterior wing is entirely smooth.

The measurements are as follow :—

Entire length of the shell	15·5 mm.
„ height „ „ „	19 „
Length of the hinge-line	7 „
Thickness of the left valve	4 „
Apical angle without the wings	85°

Locality and geological position; number of specimens examined.—Dark-blue micaceous shales, associated with *Sperifer Lydekkeri* and *Fenestellæ*, Eishmakam, Kashmir Valley ; Coll. Lydekker ; 1.

Remarks.—The specimen is too fragmentary to determine its relationship to other congeneric forms. In the character of ornamentation it is not unlike *Pecten præcox*, Waagen (Salt Range Fossils, l. c., p. 318, Pl. XXIII, fig. 3), from the top beds of the upper Productus limestone, or some of the *Pectines* from the Bellerophon-limestone of the Comelico district described by Stache, but it radically differs from them by its strongly inequilateral shape.

Class: PTEROPODA?

Order: CONULARIDA, Waagen.

Family: *CONULARIDÆ*, Walcott.

Genus: CONULARIA, Miller.

Conularia tenuistriata, M'Coy. Pl. VII, fig. 6.

1847. *Conularia tenuistriata*, M'Coy, On the fossil botany and zoology of the rocks associated with the coal of Australia, Annals and Mag. of Nat. History, Vol. XX, p. 307, Pl. XVII, figs. 7, 8.

1877. *C. tenuistriata*, L. de Koninck, Recherches sur les foss. paléozoiques de la Nouvelle Galles du Sud., p. 310, Pl. XXIII, fig. 2.

1886. *C. tenuistriata*, Waagen, Records Geol. Surv. of India, Vol. XIX, Pt. I., p. 26 ; Pl. I, fig. 3.

1891. *C. tenuistriata*, Waagen, Salt Range Fossils, Pal. Ind., ser. XIII, Vol. IV, Geological Results, p. 125, Pl. V, figs. 2, 3.

A single fragment of this species was quite accidentally discovered when chiselling out a specimen of *Spirifer Lydekkeri* from a block of quartz-sandstone. I only succeeded in clearing two of the perfectly well preserved faces from the tough matrix and in developing the transverse section. Although incomplete, the specimen is, I think, sufficiently well preserved to permit of identification.

The fragment belongs to a young individual of a total length of about 60 mm., of which 29 mm. is preserved, whilst the apical portion was broken off. Apical angle very small, a little less than ten degrees, imparting to the shell a strongly elongated shape. Outline of the transverse section somewhat rhomboidal and inequilateral. The narrower side is nearly two-thirds the breadth of the broader one. Both the longer and narrower faces are distinctly impressed in the middle. The four corners of the pyramid are marked by narrow furrows, in which the ribs from both sides meet, being slightly bent backwards and alternating with each other. These transverse ribs, which ornament the four faces, meet in the middle of the latter under an obtuse angle and there mostly alternate. Very few only unite directly with each other and then form simply broken, upward curved lines. The ribs are very thin, smooth on their crests, and rather regularly distributed. From seventeen to twenty ribs are counted within a space of ten millimetres.

I have not observed any striation on the surface between the ribs.

I do not think that there can be any doubt about the identity of this fragment with the specimens from the *Conularia*-nodules of the Salt Range boulder-group, which have been described as *C. tenuistriata* by Waagen. Whether the specimens from the Salt Range ought to be identified with M'Coy's Australian species appears to me less certain. The latter seems to be distinguished by its strongly inequilateral transverse section, the narrow sides of which attain scarcely one half the length of the broader ones. The difference in the number of ribs in the Indian and Australian types has been satisfactorily explained by Waagen. In the small fragment figured by L. de Koninck (l. c. Pl. XXIII, fig. 2a) exactly the same number of ribs is counted within a space of 10 mm. as in the present specimen. If the difference in the shape of the transverse section should be thought a sufficient reason for distinguishing the Salt Range and Kashmir types from the Australian ones by a varietal denomination, the name *Conularia tenuistriata var. Indica* might be applied to them.

It cannot be identified with *C. laevigata*, Morris (in Strzelecki's Physical description of New South Wales, etc., p. 290, Pl. XVIII, fig. 9), on account of its considerably smaller apical angle, its rhomboidal, not rectangular, laterally impressed transverse section, and its more numerous ribs. From *C. Warthi*, Waagen, and its allies it is at once distinguished by its different sculpture.

Locality and geological position; number of specimens examined.—Quartz sandstone with *Spirifer Lydekkeri*, Ladakh Valley, Kashmir; Coll. Lydekker; 1.

Remarks.—The occurrence of this species in the quartzitic sandstones of the Ladakh Valley is of no small interest. Its importance is, however, diminished by the fact that the exact stratigraphical position of these sandstones in the anthracolithic system of the Himálayas is as little known as that of the *Conularia*-nodules in the Salt Range boulder bed, discovered by Dr. Warth in 1885.

Conularia tenuistriata has been quoted from the carboniferous sandstone of Murree by L. de Koninck, from the boulder bed of the Eastern Salt Range by Waagen and from the Gympie beds of Queensland with some hesitation by Etheridge, jun.

MOLLUSCOIDEA.

Class: BRACHIOPODA.

Order: TESTICARDINES, Bronn.

Suborder: APHANEROPEGMATA, Waagen.

Family: *PRODUCTIDÆ*, Grey.

Subfamily: PRODUCTINÆ, Waagen.

Genus: PRODUCTUS, Sowerby.

The *Productidæ* are the most numerous fossils from the anthracolithic rocks of Kashmir and Spiti. Four genera (*viz.* subgenera) of this family are represented among them. They are: *Productus, Marginifera, Strophalosia, Chonetes.* Among them the genus *Productus* takes the most important part, at least regarding the number of species, of which I count not less than eleven altogether. Three of them are to be attributed to the section of *Fimbriati*, two to the *Semireticulati* and *Spinosi*, one to the *Lineati, Undati, Caperati*, and *Irregulares*.

A classified list of the *Producti*, from Kashmir and Spiti, which I have been able to determine specifically, is drawn up in the following scheme :—

I. Section, LINEATI.

1. *Productus Cora*, d'Orbigny.

II. Section, UNDATI.

2. *Productus undatus*, Defrance.

III. Section, SEMIRETICULATI.

3. *Productus semireticulatus*, Martin.
4. *P. cf. longispinus*, Sowerby.

IV. Section, SPINOSI.

5. *Productus cf. scabriculus*, Martin.
6. *P. cf. spinulosus*, Sowerby.

V. Section, FIMBRIATI.

7. *Productus Abichi*, Waagen.
8. *P. pustulosus*, Phillips.
9. *P. punctatus*, Martin.

VI. Section, CAPERATI.

10. *Productus aculeatus*, Martin.

VII. Section, IRREGULARES.

11. *Productus mongolicus*, Diener.

In addition to these species a very remarkable one may be mentioned, which has been described and figured by Professor Davidson (Quart. Journ. Geol. Soc., London, Vol. XXII, 1866, p. 44, Pl. II, fig. 16) as *Productus laevis, nov. sp.* It was founded on a single ventral valve, "occurring in a coarse limestone in the Zéwan beds, valley of Kashmir, but less compact and of a lighter grey, than the bed, from which most of the species, found at Khoonmoo, were obtained."

Davidson's description of this species is as follows:—"Shell small, nearly circular; hinge-line slightly shorter than the greatest width of the shell; ventral valve evenly convex; ears small, surface smooth (?); length 3 lines, the width slightly exceeding the length."

This species is not represented in our collection. Without venturing a decided opinion on this subject, I do not think it superfluous to draw attention to the striking resemblance of *Productus laevis* to the triassic *Koninckina Leonhardi*, Wissm.,[1] from St. Cassian. As Professor Davidson himself asserts his specimen to have been found in a rock lithologically different from the limestone, from which the majority of brachiopoda collected by Captain Godwin-Austen had been obtained, the identity of *P. laevis* with a species of *Koninckina* is not impossible. In the upper triassic beds of the Bambanag Range (Kumaon) the presence of *Amphiclina*, a typical representative of the *Koninckinidæ*, has been proved by Dr. Bittner.[2]

On the other hand an identity of *Prod. laevis* with *Leptaena indica*, Waagen (Salt Range Fossils, Pal. Ind. ser. XIII, Vol. I, Prod. Limest. Foss., p. 609, Pl. LVIII, figs. 7—9) from the Katta beds of the middle Productus limestone is likewise possible as has been suggested by Waagen himself, although to me this solution of the question does not seem very probable. For Mr. Davidson should scarcely have placed, I think, his Kashmir species in the genus *Productus* had he been able to demonstrate the presence of an area in his specimen of a similar kind, as it is developed in *Leptaena indica*.

Besides these species *Productus Humboldti*, d'Orb., *P. Boliviensis*, d'Orb., *P. costatus*, Sow., *P. Purdoni*, Dav., have been quoted from the carboniferous rocks of Kashmir by Dr. Verchère. The last mentioned species has also been described from the Kuling shales of Spiti by Stoliczka, but it is absolutely impossible to venture on an identification of these forms, as the interpretation of species, as applied by Verchère, widely differs from that adopted in the present memoir.

[1] *A. Bittner*, Brachiopoden der Alpinen Trias, Abhandlgn. K. K. Geol. Reichs-Anst. Wien, Bd. XIV, Pl. XXX, figs. 45-50.

[2] *C. Diener*, Ergebnisse einer Geologischen Expedition in den Central Himalaya, Denkschr, Kais. Akad. d. wissenschaften, Wien. math. nat, Classe, Bd., LXII, 1895, p. 558.

I. Section: LINEATI.

1. Productus Cora, d'Orbigny, Pl. I, fig. 12.

1872. *Productus Cora*, d'Orbigny, Voyage dans l'Amérique Méridionale, T. III., 4 ème ptie., Paléontologie, p. 55, Pl. V, figs. 8, 9.

1866. *P. Cora*, Davidson, Quart. Journ. Geol. Soc., Vol. XXII, p. 73.

1867. *P. Cora*, Verchère, Kashmir, the Western Himálaya and the Afghan Mountains, Journ. Asiat. Soc. of Bengal, Vol. XXXV, Pt. II, pp. 202, 212.

For further synonyms my memoir on the Chitichun-fossils (Pt. III of the present volume) ought to be consulted.

Two ventral valves referable to this well-known species have been obtained by Lydekker from the carboniferous limestone of Barus in Kashmir. One of them is fairly complete and agrees very well with the figures and description of *P. Cora* given by Waagen in his monograph of the Salt Range Fossils (Pal. Ind., ser. XIII, Vol. I, Productus Limestone Fossils, p. 677, Pl. LXV, fig. 3; Pl. LXVII, figs. 1, 2). It is larger than any specimens from the permo-carboniferous limestone of Chitichun, No. I, and nearly equals in size the example figured by Waagen on Pl. LXVII, fig. 2.

It is considerably broader than long and provided with tolerably large asymmetrical wings. The curve of the valve is rather irregular, being somewhat flattened in the apical region. The apex is strongly curled inwards. The hinge-line corresponds to the greatest breadth of the shell. The trail is not preserved.

Not the slightest trace of a sinus is exhibited in the specimens, which consequently must be separated from the group of *Productus Neffedievi* and placed in the group of *P. corrugatus*, M'Coy. The latter species and *P. Cora* are very closely related to each other. According to Waagen their only difference consists in the general absence of spines on the surface of *P. corrugatus*. As a few irregularly scattered spines are exhibited on the surface of my type specimen, I deemed it preferable to identify it with d'Orbigny's species.

Apart from these few, irregularly scattered spines, the ornamentation consists of numerous, delicate, radiating striae, which are descending straight across the frontal region of the valve. A few indistinct concentric folds or wrinkles are developed on the wings.

Neither the dorsal valve, nor the internal characters are preserved.

The approximate measurements are as follow:—

Length of the shell in a straight line	16·5 mm.
„ „ „ „ along the curve	28 „
Breadth of the shell	23 „
Thickness of the ventral valve	12 „

Locality and geological position; number of specimens examined.—Barus, Kashmir Valley, in a dark blue limestone; Coll. Lydekker; 2. From the same locality three or four specimens were obtained by Capt. Godwin-Austen, which have been referred to this species by Professor Davidson (*vide antea*).

Remarks.—In identifying these specimens with *Productus Cora* I am taking this species in the circumscription attributed to it chiefly by Russian geologists. Further remarks on this subject as well as on the geological range of *P. Cora* will be found in the third part of this volume (pp. 16 and 17).

II. Section: UNDATI.

2. Productus undatus, Defrance. Pl. I, figs. 9, 10.

1826. *Productus undatus*, Defrance, Dictionnaire des sciences natur. Vol. XLIII, p. 354.
1842. *P. undatus*, L. de Koninck, Déscription des animaux foss. du terrain carbonif. de Belgique, p. 156, Pl. 12, fig. 2.
1844. *P. tortilis*, M'Coy, Synopsis of the characters of the carbon. fossils of Ireland, p. 116, Pl. XX, fig. 14.
1845. *P. undatus*, E. de Verneuil, Géologie de la Russie d'Europe, Vol. II., Paléontologie, p. 261, Pl. XV, fig. 15.
1847. *P. undatus*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*, p. 59, Pl. V, fig. 3.
1860. *P. undatus*, Davidson, Monogr. of the Scottish Carb. Brachiopoda, p. 41, Pl. IV, figs. 15-17.
1861. *P. undatus*, Davidson, Monogr. British Carbonif. Brachiopoda, p. 161, Pl. XXXIV, figs. 7-13.
1874. *P. undatus* (?) Toula, Kohlenkalk- und Zechstein-Fossilien aus dem Hornsund an der Südwestküste von Spitzbergen, Sitzgsber. Kais. Akad. d. Wissensch. Wien. math. nat. Cl. Bd., LXX, p. 9.
1876. *P. undatus*, Trautschold, Die Kalkbrüche von Miatschkowa, p. 55, Pl. V, fig. 2.
1876. *P. undatus*, L. de Koninck, Recherches sur les fossiles Paléozoiques de la Nouvelle Galles du Sud, p. 190, Pl. IX, fig. 4.
1883. *P. cf. undatus*, Stache, Fragmente einer afrikanischen Kohlenkalkfauna aus dem Gebiete der West-Sahara, Denkschr. Kais Akad. d. Wissensch, Wien. math. nat. Cl. Bd. 46, p. 404, Taf. VII, 21.
1883. *P. undatus*, Kayser, Obercarbonische Fauna von Loping, Richthofen's China, Bd., IV, p. 188, Taf. XXVI, figs. 12, 13.
1890. *P. undatus*, Foord, Notes on the Palæontology of Western Australia, Geological Magazine, London, new. ser., Decade. III, Vol. VII, p. 152, Pl. VII, fig. 6.
1892. *P. undatus*, Etheridge jun. in Jack and Etheridge, Geology and Palæontology of Queensland and New-Guinea, p. 254, Pl. 12, fig. 16.
1895. *P. undatus*, Tornquist, Das fossilführende Untercarbon am oestlichen Rossbergmassiv in den Süd-Vogesen, Th., I. Abhandlungen zur Geologischen Special-Karte von Elsass-Lothringen, Bd. V, Hft. 4, p. 70, Taf. XIV, figs. 9, 11.

Two casts of dorsal valves which have been collected by Lydekker in the carboniferous rocks near Eishmakam are referable to this characteristic and easily recognised species.

One of them is of an unusually large size, larger even than Kayser's type-specimens from Loping, whereas the second is an average-sized example, of nearly the same dimensions as L. de Koninck's type specimen from the Belgian Calcaire de Visé. Both of them are broader than long, making however exception of the trail, which is very well developed in the larger specimen (fig. 9).

Valve slightly concave, with a regularly excavated apex and with indistinctly defined auriculate expansions. No trace of a median fold is developed. The hinge-line is shorter than the greatest width of the shell.

The ornamentation is very characteristic and agrees in every respect with the figures and descriptions given by L. de Koninck and Davidson of the sculpture in their European type-specimens. The surface is covered by very numerous and

delicate radiating striæ, which are not continuous but interrupted by an equally delicate, concentric sculpture. The number of these radiating thread-like striæ is augmented by intercalation. The most prominent feature in the ornamentation of the shell is, however, the numerous concentric lamellæ or wrinkles of growth, which sharply imbricate and occur at irregular distances, but all over the surface of the valve, imparting to the latter a terrace-shaped appearance. The steeper, occasionally perpendicular slope of these undulating lamellæ is directed towards the apex. Only very few lamellæ can be traced across the entire valve. As a rule, either two separate wrinkles unite during their passage or are absorbed, whilst a new one is rising at some distance. In the trail this concentric, crumpled-like sculpture is but very indistinctly developed. In my two specimens it is altogether less strongly marked than in the Chinese specimens from Loping described by Professor Kayser.

No traces of spines or tubercles have been discovered.

On account of the variability of the outline of my larger type-specimen with its partially preserved trail, it appears barely practicable to give exact measurements. The drawing (fig. 9) will however give a sufficiently clear idea of its dimensions and features. The second specimen is not complete. Nevertheless the indication of its length, breadth and thickness may perhaps be of interest.

The measurements are as follow:—

Length of the dorsal valve	cca. 25 mm.
Breadth „ „ „ „	32 „
Depth „ „ „ „	2 „
Length of the hinge-line	cca. 28 „

Locality and geological position; number of specimens examined.—Dark blue limestone with *Fenestella*, North of Eishmakam, Kashmir Valley; Coll. Lydekker; 2.

Remarks.—*Productus undatus* is a comparatively rare but wide-spread species, both in lower and upper carboniferous rocks of the Eastern hemisphere. In Europe it is known from Belgium, where it occurs chiefly in the Calcaire de Visé, from Great Britain, from Central France, from Alsatia and from Russia, where it occurs in the Moscovian stage of Miatchkowa. It has been described by Stache from the lower carboniferous beds of the Western Sahara, by Kayser from the upper carboniferous deposits of Loping in China, by L. de Koninck from a carboniferous sandstone near the Paterson River in New South Wales, by Etheridge jun. from the Gympie beds of Queensland. Toula quotes the species as doubtful from the permo-carboniferous rocks of the Hornsund in Spitzbergen.

A. H. Foord figures a *Productus* from the carboniferous rocks of the Irwin river (Victoria district of Western Australia) which he considers to be identical with *P. undatus*. I am however not convinced of the absolute identity of the two forms. The Australian specimen differs from the typical shape of *P. undatus*, as it is described by L. de Koninck, by the larger number of its spines and reminds very strongly of *P. cancriniformis*, Tschernyschew (Mém. du Comité Géol. de la Russie, Vol. III, No. 4, St. Pétersbourg, 1889, p. 373, Pl. VII, figs. 32, 33). This spinose variety of *P. undatus* can barely be distinguished from *P. cancriniformis*, if one

has to deal with ventral valves only, the chief difference consisting in the shape of the dorsal valve, which is regularly concave in *P. undatus*, but distinctly geniculate in Tschernyschew's species.

The fragment from Djulfa in Armenia, considered first as identical with *P. undatus* by Abich (Geologische Forschungen in den Kaukasischen Lændern I. Theil, Eine Bergkalk-Fauna aus der Araxes-Enge bei Djoulfa, p. 31, Taf. V, fig. 10), but referred later to the permian *Productus hemisphærium*, Kutorga, both by Abich himself and by Val. von Moeller, has certainly nothing to do with the carboniferous species.

III. Section: SEMIRETICULATI.

3. Productus semireticulatus, Martin. Pl. I, fig. 14; Pl. II, fig. 10.

1809. *Anomites semireticulatus*, Martin, Petrificata Derbiensia, Pl. XXXII, figs. 1, 2; Pl. XXXIII, fig. 4.
1866. *Productus semireticulatus*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 36, Pl. I, fig. 6, p. 43, Pl. II, fig. 12.
1867. *Prod. semireticulatus*, Verchère, Journ. Asiatic Soc. of Bengal, Vol. XXXV, Pt. 2, pp. 201, 212.

For a more complete list of synonyms *vide* my monograph on the permo-carboniferous fauna of Chitichun No. I (Pt. 3 of this volume). To these synonyms the following ought to be added :—

1863. *P. semireticulatus*, Davidson, On the lower carboniferous brachiopoda of Nova Scotia, Quart. Journ. Geol. Soc., Vol. XIX, p. 174, Pl. IX, figs. 20, 21.
1896. *P. semireticulatus*, Julien, Le terrain carbonifère marin de la France Centrale, p. 65, Pl. I, figs. 1-4, 13, Pl. VII, figs. 4-6, Pl. XI, fig. 6, Pl. XII, fig. 8.
Nec P. semireticulatus, Stoliczka, Mem. Geol. Surv. of India, Vol. V, Pt. I, (1865) p. 29, *nec* Lydekker, ibid, Vol. XXII, Pl. II, fig. 1.

This well-known and far-spread species is not at all rare in the carboniferous rocks of Kashmir, but most of the specimens are in a rather inferior state of preservation. A small number of specimens is however sufficiently complete for identification.

Most of the specimens are of considerable size, some of them reaching 90 mm. in width. The ventral valves, which as a rule are entirely crushed or show no shelly substance, are provided with a distinctly developed sinus, which in some specimens is quite as deeply indented as in the Carinthian variety, described as *P. semireticulatus var. bathykolpos* by Schellwien (Palæontographica, Bd. 39, 1892, p. 22). Curiously enough, dorsal valves of this species are generally much better preserved than the ventral ones. A tolerably complete specimen of a dorsal valve of *P. semireticulatus* from Barus is represented on Pl. I, fig. 14. This specimen is provided with a long hinge-line, distinctly developed wings, and with a shallow median fold, becoming more prominent in the vicinity of the front only. The flat proximal portion, which is covered by the characteristic reticulate sculpture, meets the frontal portion at a right angle.

In one of the specimens (Pl. II, fig. 10) the internal structure of the ventral valve is clearly exhibited. In the deep valley between the coarsely striated

divaricator muscular scars the phylloid petal-shaped adductor, or occlusor impressions are situated. The proximal portion of the cast is separated from the hinge margin by deep furrows. The apex is smooth, crossed only by a low, distinctly produced ridge. The internal surface of the shell is covered by numerous coarse granulations.

The measurements of this cast are as follow:—

Length of the shell in a straight line	50	mm.
„ „ „ „ along the curve	82	„
Breadth of the shell	cca. 60	„
Thickness of the ventral valve	30	„

Locality and geological position; number of specimens examined.—Shaly limestone with *Fenestellæ*, Barus, Kashmir Valley; Coll. Godwin-Austen; 6; dark blue limestone with *Fenestellæ*, N. of Khúmmu, near Pampur; Coll. Lydekker; 5 (including the two figured type-specimens); Tangar, N.W. of Avantipur; Coll. Lydekker; 1.

The specimens described by Davidson were obtained from Barus and from Loodoo, W. of Wasterwan.

Remarks.—The fossils from Kashmir and Spiti which have been quoted as *Productus semireticulatus* by Stoliczka and Lydekker are different from Martin's species and must be classed among the subgenus *Marginifera*. They will be described hereafter as *Marg. himalayensis*.

4. Productus cf. longispinus, Sowerby. Pl. I, fig. 11.

1814. *Productus longispinus*, Sowerby, Mineral Conchol., Vol. I, p. 154, Pl. LXVIII, fig. 1.
1814. *P. Flemingi*, Sowerby, ibidem, fig. 2.
1814. *P. spinosus*, Sowerby, ibid. Pl. LXIX, fig. 2.
1823. *P. lobatus*, Sowerby, ibid. Vol. IV. p. 16, Pl. 318, figs. 2-6.
1836. *P. setosa*, Phillips, Geology of Yorkshire, Vol. II, Pl. VIII, figs. 9, 17.
1841. *P. lobatus*, L. von Buch, Abhandlgn. Königl. Akad. d. Wissensch. Berlin, I. Th. p. 32, Pl. II, fig. 17.
1843. *P. longispinus*, L. de Koninck, Descr. des animaux fossiles du Terrain carbon. de Belgique, p. 187, Pl. XII, fig. 11, Pl. XII, *bis*, fig. 2.
1845. *P. lobatus*, E. de Verneuil, Géologie de la Russie d'Europe, Vol. II, Paléontologie, p. 266, Pl. XVI, fig. 3, Pl. XVIII, fig. 8.
1846. *P. tubarius* (?) Graf Keyserling, Reise in das Petschoraland, p. 208, Pl. IV, fig. 6.
1847. *P. Flemingii*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*, p. 95, Pl. X, figs. 2, 3.
1860. *P. Flemingii*, Gruenewaldt, Beiträge zur Kenntniss der sedimentären Gebirgsformationen etc., Mém. de l'acad. impér. des sciences de St. Pétersbourg sér. VII, T. II, p. 123, Taf. III, fig. 4.
1861. *P. longispinus*, Davidson, Monograph British Carbon. Brachiopoda, p. 154, Pl. XXV, figs. 5—17.
1866. *P. Orbignyanus*, Geinitz, Carbonformation und Dyas in Nebraska, p. 56, Taf. IV, figs. 8—11.
1867. *P. lobatus var. paucicostatus*, Trautschold, Bull. soc. impér. des natur. de Moscou, T. XI. p. 37. Taf. V, fig. 2.
1870. *P. longispinus*, Rœmer, Geologie von Oberschlesien, p. 89, Taf. VIII, fig. 2.
1872. *P. longispinus* ? Meek, in Meek and Hayden, Final Report of the U. S. Geological Survey of Nebraska, p. 161, Pl. VIII fig. 6 (*non* Pl. VI, fig. 7).
1873. *P. Flemingii*, L. de Koninck, Monographie des fossiles carbonifères de Bleiberg, p. 24, Pl. I, fig. 14.
1874. *P. longispinus* (?) Toula, Kohlenkalk und Zechstein Fossilien aus dem Hornsund an der Südwest Küste von Spitzbergen, Sitzgsber. Kais. Akad. d. Wiss. Wien, LXX, Bd. math. nat. Cl. I. Abth. p. 10, fig. 7.

1876. *P. longispinus*, Trautschold, Die Kalkbrüche von Miatschkowa, p. 57, Taf. I, fig. 4.
1876. *P. sinuatus*, Trautschold, ibid. p. 61, Taf V, fig. 5.
1880. (?) *P. longispinus*, Roemer, Über eine Kohlenkalk Fauna der Wesküste von Sumatra, Palæontographica, XXVII. Bd. p. 5.
1883. *P. longispinus*, Kayser, Obercarbonische Fauna von Loping, Richthofen's China, Bd. IV, p. 183, Taf. XXVII, fig. 1, *non* 2—4.
1890. *P. longispinus*, Nikitin, Mém. Com. Géol de la Russie, Vol. V, No. 5, p. 159, Pl. 1, figs. 7-12.
1892. *P. longispinus*, Schellwien, Die Fauna des Karnischen Fusulinenkalks, Palæontographica, Bd. 39, p. 25, Taf. III, fig. 4-5, Taf. VIII, fig. 26.

The only specimen referable to this species consists of an incomplete ventral valve, which, however, agrees in every respect so perfectly with some British specimens from Yorkshire that I do not hesitate to identify it with the latter.

In my specimen the apical region is partly broken, but the rest corresponds exactly with Davidson's type-specimen from Yorkshire, figured on Pl. XXXV, fig. 7, of his monograph. The shell is slightly transverse, a little wider than long, evenly convex in a longitudinal direction, but in the transverse direction divided by a broad sinus, which flattens gradually towards the front. The lateral parts appear strongly depressed and descend in a very steep curve to the margin. The small auricular expansions are slightly curled.

There is not the least trace of any marginal ridge, which forms the distinguishing character of Waagen's subgenus *Marginifera*. This specimen certainly cannot therefore belong to the latter, the shell margin having been broken off in such a manner that the absence of a prominent shelly ridge within the wings warrants its separation from *Marginifera*. Having a large number of true *Margineferæ* from Chitichun No. I and from Kashmir at hand for comparison, I am fully convinced that this specimen belongs to the genus *Productus, s. s.*

The surface of the ventral valve is covered by numerous rounded longitudinal ribs which are of about equal width for their entire length and slightly converge towards the mesial sinus. This radiating sculpture is crossed by delicate concentric ribs in the visceral and apical portions. Some of the longitudinal ribs are dichotomous. Two points of attachment of broken-off spines may be observed in the vicinity of the mesial sinus.

Exact measurements of this specimen can barely be given on account of its incomplete state of preservation.

Locality and geological position ; number of specimens examined.—Dark blue limestone with *Fenestella*, Barus, Kashmir; Coll. Lydekker; 1.

Remarks.—It strongly resembles the delicately ribbed variety of *Productus gratiosus*, Waagen. This is also the case with the Yorkshire specimens of *P. longispinus*, as has already been remarked by Rothpletz (Palaentographica, Bd. 39, 1892, p. 76). This strong resemblance even induced L. de Koninck (Monogr. des foss. carb. de Bleiberg, p. 25) to class a typical representative of *P. gratiosus*, *P. semireticulatus*, Beyrich, from Timor (Abhandl. Koenigl. Akad. d. Wiss, Berlin, 1865, Taf. II, fig. 2) among the synonyms of *P. longispinus*. The differences, enumerated by Rothpletz, especially the more delicate ornamentation in the apical region and the less strongly developed wing in Sowerby's species appear however sufficient for a distinction of the two forms.

Davidson (Quart. Journ. Geol. Soc., Vol. XXII, p. 43) quotes *Productus longispinus* (?) from the grey limestone of Khoonmoo. It is however impossible to say whether he really had a true *P. longispinus* at hand, or rather a species of the subgenus *Marginifera*. He asserts that his specimen from Kashmir is identical with some specimens found in the Punjab. But the majority of the Punjab specimens considered as identical with Sowerby's species have been proved by Waagen to belong to *Marginifera* (especially to *M. typica*), although the true *P. longispinus* is certainly not altogether absent in the Salt Range.

Productus longispinus is a wide-spread species of a considerable horizontal and vertical range. It occurs in strata of lower and upper carboniferous age in Western Europe, in the Moscovian and Gshelian stage of Russia, in the upper carboniferous rocks of Loping and Sumatra (?) and in the Productus limestone of the Salt Range. Its occurrence in the coal-measures of North America is not yet beyond every doubt. The specimen considered as identical with *P. longispinus* by Meek and with *P. Orbignyanus* by Geinitz, is the only one which resembles some of Sowerby's types so very closely that their identity is probable. The case is different with the specimen figured by Meek on Pl. VI, fig. 7, of the final report on the Palæontology of Nebraska, which differs from *P. longispinus* by having an almost smooth shell. *P. longispinus*, Meek (Report of the geological exploration of the 40th parallel, Vol. IV, Palæont., p. 78, Pl. VIII, fig. 4) from Nevada is more gibbous and provided with larger costæ than the true *P. longispinus* from the British and Belgian mountain-limestone. *P. splendens*, Norwood and Pratten (Journ. Acad. of nat. sciences of Philadelphia, 2nd ser., Vol. III, p. 11, Pl. I, fig. 5), and *P. Wabashensis*, Norw. and Pratt. (ibid. p. 13, Pl. I, fig. 6) must according to Waagen be classed among the subgenus *Marginifera* although the latter species is considered to be directly identical with *P. longispinus* by Meek, who insists that the figures given by the two above-mentioned authors are quite defective and misleading. *Productus scitulus*, Meek and Worthen (Geological Survey of Illinois, 1866, Vol. II, Palæont., p. 280, Pl. XX, fig. 5) and *P. parvus*, Meek and Worthen (ibidem, p. 297, Pl. XXIII, fig. 4), which have been placed among the synonyms of *P. longispinus* by L. de Koninck (Fossiles carbonifères de Bleiberg, p. 25), ought to be maintained as proper species, especially *P. scitulus*, which is distinguished by its very delicate ornamentation. A similar remark applies to *P. capacii*, d'Orbigny (Voyage dans l'Amérique Méridionale, T. III, 4 ème ptie., Paléontologie, Pl. III, figs. 24—26) from Yarbichambi in South America. *P. longispinus*, White (Report upon the U. S. geograph. surv., West of the 100th Meridian, Vol. IV, Paleontology, 1877, Pt. II, p. 118, Pl. VIII, fig. 5) from Santa Fé (New Mexico) is probably a representative of Waagen's subgenus *Marginifera*, judging at least from the figure given by Prof. White.

Nor am I convinced of the identity of *P. longispinus* with the species described by Toula from the Hornsund in Spitzbergen; Toula's description, it is true, agrees very well with his identification of the two forms, but the figure does not strengthen this view. In this figure the concentric ornamentation is represented as quite indistinct in the apical portion of the ventral valve, whereas it continues

all over its visceral part in the shape of broad stripes, thus differing considerably from the delicate reticulation which is so conspicuous in Davidson's type specimens.

The specimen from the Nordfjord of Spitzbergen described as *P. longispinus var. setosa* by Toula (Permocarbon Fossilien von der Westkueste von Spitzbergen, Neues Jahrb. f. Mineral. 1875, p. 252, Taf. VIII, fig. 4) must, according to my humble opinion, be kept separate from the British species on account of its considerably less numerous and coarse ribs. Thus the presence of *P. longispinus* in the permo-carboniferous deposits of Spitzbergen has not yet been established with certainty.

Both L. de Koninck (Recherches sur les fossiles paléozoiques de la Nouvelle Galles du Sud, p. 191, Pl. XI, fig. 3) and R. Etheridge (Quart. Journ. Geol. Soc., 1872, Vol. XXVIII, p. 333, Pl. 18, fig. 9) mention the occurrence of *P. longispinus* in carboniferous beds of Australia. I think however that L. de Koninck's specimen from New South Wales can only be identified with Sowerby's species, if such wide interpretation of the latter is permitted. The specimen from the Don River in Queensland is a rather indifferently preserved cast of a dorsal valve. Its identification with *P. longispinus* has been questioned by Etheridge, jun. (Geology and Palæontology of Queensland and New Guinea, p. 255).

IV. Section: SPINOSI.

5. Productus cf. scabriculus, Martin. Pl. II, figs. 8, 9.

1809. *Anomites scabriculus*, Martin, Petrificata Derbiensia, p. 8, Pl. XXXVI, fig. 5.
1836. *Productus scabricula*, Phillips, Geology of Yorkshire, Vol. II, Pl. VIII, fig. 2.
1836. *P. quincuncialis*, Phillips, ibidem, Pl. VIII, fig. 8.
1843. *P. scabriculus*, L. de Koninck, Description des animaux fossiles du terrain carbon. de Belgique, p. 190, Pl. XI, fig. 3.
1845. *P. scabriculus*, E. de Verneuil, Géologie de la Russie d'Europe, Vol. II, Paléontologie, p. 271, Pl. XVI, fig. 5, Pl. XVIII, fig. 5.
1847. *P. scabriculus*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*, p. 111, Pl. XI, fig. 6.
1862. *P. scabriculus*, Davidson, Monogr. British Carb. Brachiopoda, p. 169, Pl. XLII, figs. 5-8.
1866. *P. scabriculus*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 43, Pl. II, fig. 13.
1873. *P. scabriculus*, L. de Koninck, Monographie des fossiles carbonifères de Bleiberg, p. 27, Taf. I, fig. 16.
1876. *P. scabriculus*, Trautschold, Die Kalkbrueche von Miatschkowa, p. 59, Taf. VI, fig. 1.
1876. *P. scabriculus* (?), L. de Koninck, Recherches sur les foss. paléozoiques de la Nouvelle Galles du Sud., p. 196.
1889. *P. scabriculus*, Tschernyschew, Mem. Com. Géol. St. Pétersbourg, Vol. III, No. 4, p. 371, Taf. VI, fig. 12.

This species is probably represented by two specimens. One of them is a ventral valve, whereas the second, smaller one represents a dorsal valve. Neither of them is sufficiently well preserved to permit identification.

The ventral valve (fig. 8) is medium sized, and in its dimensions and general shape agrees pretty well with Davidson's type-specimen of *P. scabriculus var. quincuncialis*, Phill., from Yorkshire (Pl. XLII, fig. 6). Much wider than long, tolerably inflated, provided with a hinge-line, which is inferior in length to the

greatest width of the shell, and with a broad, but not deeply excavated mesial sinus. The auriculated expansions are small and pointed.

Although this specimen is much crushed and its surface weathered, its ornamentation is still partially visible. It consists of numerous, radiating ribs, swelling out at short intervals into elongated, protracted tubercles, which exhibit an indistinctly quincuncial arrangement. Both the longitudinal ribs and the numerous tubercles covering them appear to be rather more delicate than in the majority of the British and Russian types of *P. scabriculus*, but in this respect agree well with the ornamentation exhibited by Davidson's specimens from Kashmir.

Traces of concentric wrinkles are very indistinctly marked.

The dorsal valve (fig. 9) is also much wider than long, slightly concave, provided with a short hinge-line and with a low median elevation, corresponding to the sinus in the opposite valve. Its surface is covered by numerous, elongated, radiating grooves, which, like the tubercles in the ventral valve, are arranged in a sort of irregular quincunx. This radial ornamentation is crossed by a concentric sculpture, which is most distinctly marked in the apical region and on the wings.

The measurements of the larger specimen (fig. 8) are as follow :—

Length of the ventral valve in a straight line	37 mm.
„ „ „ „ along the curve	cca. 60 „
Length of the hinge-line	cca. 36 „
Breadth of the ventral valve	46 „
Thickness „ „ „	19 „

The measurements of my second specimen (fig. 9) are as follow :—

Length of the dorsal valve	22·5 mm.
Breadth „ „ „	34 „
Length of the hinge-line	22 „

Locality and geological position; number of specimens examined.—Dark limestone with mica, Barus, Kashmir Valley; Coll. Lydekker; 2. The specimens referred to this species by Prof. Davidson were found at Barus and Khoonmoo.

Remarks.—On the whole the determination of the present specimens as *Productus scabriculus* cannot be far wrong and accords with the description of Prof. Davidson's specimen. *P. scabriculus* is a widespread species, which ranges from lower carboniferous into permo-carboniferous strata, but seems to be most common in beds of middle and upper carboniferous age. In Europe it has been found in the mountain-limestone of Great Britain and Belgium and in the lower carboniferous Noetscher Schichten of Bleiberg in Carinthia. In Russia it was found in the different stages of the carboniferous system and in the Artinskian strata of the Ural. L. de Koninck mentions the species from the carboniferous beds of New South Wales, but without giving any figure. Among the fossils collected by Drasche near the Nordfjord of Spitzbergen and described by Toula, there is a specimen of *Productus* which has been identified as *P. cf. scabriculus* (Permo-Carbon-Fossilien von der Westkueste von Spitzbergen, Neues Jahrb. f. Mineral., 1875, p. 252, Taf. VIII, fig. 6). This identification seems to me extremely doubtful, judging by the figure, which represents a *Productus* distinguished by the

presence of very coarse, irregular and mostly dichotomous ribs, and by the rarity of tubercles.

Some American shells, as *Productus asperus*, M'Chesney (Description of new species of fossils from the palæozoic rocks of the Western States, 1868, p. 34, Pl. I, fig. 7), *P. Wilberanus*, M'Chesney (ibidem, p. 36, Pl. I, fig. 8), *P. Rogersii*, Norwood and Pratten (Journ. Acad. of Natural Sciences, Philadelphia, Vol. III, 1854, p. 9, Pl. I, fig. 3), *P. symmetricus*, Meek (Final Report of the U. S. Geol. Surv. of Nebraska, p. 167, Pl. V, fig. 6), *P. Nebrascensis*, Owen (ibid., p. 165, Pl. II, fig. 2; Pl. IV, fig. 6; Pl. V, fig. 11), have been classed among the synonyms of the British species by L. de Koninck and looked upon as local varieties only. Leaving the question undecided whether these forms should be regarded as distinct species, which I consider preferable, or merely as variations of *P. scabriculus*, still the fact remains that the typical *P. scabriculus* is certainly absent in the coal-measures of North-America. The specimen from Pecos Village described and figured by Marcou (Geology of N. America, Zurich, 1858, p. 47, Pl. V, fig. c) is certainly different from Martin's species. The same remark applies to *P. scabriculus*, Abich (Geologische Forschungen in den Kaukasischen Ländern, I, Theil, Eine Bergkalk Fauna aus der Araxes-Enge bei Djoulfa, p. 33, Taf. V, fig. 3), which this author himself has excluded from the synonyms of the true *P. scabriculus* in his additional remarks and which has been made the prototype of another species, *P. Abichi*, by Waagen.

6. Productus cf. spinulosus, Sowerby. Pl. II, fig. 12.

1814. *Productus spinulosus*, Sowerby, Mineral Conch., Pl. LXVIII, figs. 5, 6.
1836. *P. granulosa*, Phillips, Geology of Yorkshire, Pl. VII, fig. 14.
1843. *P. Cancrini*, L. de Koninck, (*non* de Verneuil), Description des animaux foss. du terrain carbonifère de Belgique, Pl. IX, fig. 3.
1843. *P. papillatus*, L. de Koninck, ibidem, Pl. X, fig. 6, p. 201.
1847. *P. granulosus*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*, p. 135, Pl. XVI, fig. 7.
1862. *P. spinulosus*, Davidson, Monogr. British Carb. Brachiopoda, p. 175, Pl. XXXIV, figs. 18—21.
1866. *P. spinulosus*, ? Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, Pl. II, fig. 15.
1888. *P. granulosus*, Krotow, Geologische Forschungen am Westlichen Ural-Abhange in den Gebieten von Tscherdyn und Ssolikamssk, Mém. Com. Géol. St. Pétersbourg, Vol. VI, p. 408, Taf. I, figs. 14, 15.
1889. *P. spinulosus*, Tschernyschew, Mém. Com. Géol. St. Pétersbourg, Vol. III, No. 4, p. 281.

Among the carboniferous fossils obtained by Captain Godwin-Austen at Barus there is a single ventral valve, bearing much resemblance to this species. It is however too imperfectly preserved to permit of a decided identification.

The shell is small, transversely semicircular and regularly curved in both directions. Hinge-line shorter than the greatest width of the shell. The beak is not very involute and scarcely overhangs the hinge-margin. Ears very small. There is no indication of a distinct sinus, only a flat depression in the middle part of the front.

The ornamentation is indifferently preserved and can only be made out in the vicinity of the lateral and frontal margins . It seems to consist exclusively of small but numerous, subregular tubercles, without any regular quincuncial

arrangement, as in the variety, to which the term "*granulosus*" was originally applied.

Neither longitudinal ribs nor concentric striæ can be made out, but the specimen is too much weathered to state this with any degree of certainty.

In general shape and sculpture the specimen seems to agree better with *P. spinulosus* than with any other form of this genus. It also strongly resembles *P. opuntia*, Waagen (Salt Range Fossils, Pal. Ind., Ser. XIII, Vol. I, Prod. Limest. Foss., p. 707, Pl. LXXIX, figs. 1, 2) from the Cephalopoda (Jabi) beds of the upper division of the Productus Limestone, but I should not like to identify it with this species, which, according to Waagen's description, is always provided with a very strongly elevated median and apical part of the ventral valve. In this character, however, my specimen does not agree with the Indian shell. *Productus Wallacianus*, Derby (Bull. of the Cornell University, Ithaca, 1874, Vol. I, No. 2, p. 57, Pl. III, figs. 46—48, Pl. VI, fig. 5) from the coal-measures of Itaituba may also be compared with our specimen. Taking into consideration Derby's statement that *P. Wallacianus* chiefly differs from *P. spinulosus* by the absence of concentric wrinkles on the ears, this Brazilian species may perhaps be very closely related to our *Productus* from Kashmir, but the figures given by Derby are too bad to allow of a closer comparison.

The measurements of my specimen are as follow :—

Length of the shell in a straight line	12·5 mm.
„ „ „ „ along the curve	18 „
Greatest breadth of the shell	16 „
Length of the hinge-line	13 „
Thickness of the ventral valve	5 „
Distance of the apex from the frontal margin	12 „

The proportion between the last dimension and the entire length of the shell most clearly shows the difference between this specimen and Waagen's *P. opuntia*, in which the apical region is always highly elevated above the proper beak. The measurements of my specimen agree almost exactly with those of Sowerby's type-specimen of *P. spinulosus*, as figured in Davidson's monograph (Pl. XXXIV, fig. 18).

Locality and geological position; number of specimens examined.—Coarse grey, semi-crystalline limestone, Barus, Kashmir Valley; Coll. Godwin-Austen; 1. Two specimens referred with some doubt to *P. spinulosus* by Davidson were obtained from Khoonmoo.

Remarks.—*Productus spinulosus* has been quoted from the mountain limestone of Great Britain and Belgium by Davidson and L. de Koninck, from the upper-carboniferous rocks of the Ural Mountains by Krotow and from the Artinskian stage by Tschernyschew. The specimens considered as identical with *P. spinulosus* by Abich (Geologische Forschungen in den Kaukasischen Laendern, I. Theil, Eine Bergkalk Fauna aus der Araxes-Enge bei Djulfa, p. 51, Taf. V, fig. 9, Taf. IX, fig. 22) have been referred to *P. horridus* by Val. von Moeller.

V. Section: FIMBRIATI.

7. Productus Abichi, Waagen. Pl. I, fig. 8.

1883. *Productus Humboldti*, Lydekker, Geology of the Kashmir and Chamba territories, Memoirs Geol. Surv. of India, Vol. XXII, Pl. II, fig. 3.

1884. *P. Abichi*, Waagen, Salt Range Fossils, Palæont. Indica, Ser. XIII, Vol. I, Prod. Limest. Foss., p. 697, Pl. LXXIV, figs. 1—17.

For a complete list of synonyms I refer the reader to my memoir on the permo-carboniferous fauna of Chitichun No. I, (Pt. III of this vol.).

Of this beautifully sculptured *Productus* an excellently preserved ventral valve has been figured by Lydekker and considered identical with *P. Humboldti*, d'Orbigny. But its coarse sculpture and its less numerous, elongated tubercles which are mostly arranged in a rather regular quincunx, distinguish the present specimen from the true *P. Humboldti*. In general shape this specimen bears much resemblance to my type specimen of *Prod. Abichi* from the permo-carboniferous limestone of Chitichun No. I. (Pt. III of this volume, Pl. III, fig. 8), especially as regards the attenuated character of its apical region. It is however less inflated and provided with a very shallow median sinus only. In this respect it agrees best with the example figured by Waagen on Pl. LXXIX, fig. 4, of his monograph. The hinge-line is considerably shorter than the greatest breadth of the shell.

The ornamentation is exactly the same as in Waagen's type-specimen from the upper Productus limestone. The coarse, elongated, quincuncially arranged tubercles are crossed by concentric, delicate lines of growth. A narrow zone of roundish pustules is restricted to the immediate vicinity of the lateral and front margins only.

The measurements of this specimen are as follow :—

Length of the shell in a straight line	23·5 mm.
„ „ „ „ along the curve	33 „
Greatest breadth of the shell	28·5 „
Thickness of the ventral valve	8 „
Length of the hinge-line	20 „

The small size of this specimen makes its distinction from the closely allied *P. gangeticus*, Diener (Pt. IV of this volume, Pl. I, figs. 1—3, Pl. II, fig. 3), one of the leading species of the permian Productus shales of Painkhanda, an easy matter.

Locality and geological position; number of specimens examined.—Black limestone, summit of ridge N.E. of Prongam Trál, Kashmir; Coll. Lydekker; 1.

Remarks.—*Productus Abichi* is one of the most characteristic fossils of permo-carboniferous and permian rocks in Armenia, India and Timor. It has as yet never been found in beds of an older than permo-carboniferous age. At the locality, where it has been obtained by Lydekker, it is associated with *Marginifera himalayensis*, Diener, *Strophomena analoga*, Phill., and *Chonetes grandicosta*, Waagen.

The specimen from Khoonmoo, which has been referred to *P. Humboldti*

by Davidson (Quart. Journ. Geol. Soc., Vol. XXII, 1866, p. 43, Pl. II, fig. 14), does not permit an exact determination, on account of its fragmentary condition. But it seems at all events to be specifically different from *P. Abichi.*

8. Productus pustulosus, Phillips. Pl. I, fig. 13.

1836. *Productus pustulosa*, Phillips, Geology of Yorkshire, Vol. II, p. 216, Pl. VII, fig. 15.
1836. *P. ovalis*, Phillips, ibidem, p. 216, Pl. VIII, fig. 14.
1843. *P. punctatus*, L. de Koninck (*non* Martin), Déscription des animaux foss. du terrain carbon. de Belgique, p. 196, Pl. IX, fig. 6, Pl. XII, *bis* fig. 3.
1847. *P. pustulosus*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*, p. 118, Pl. XII, fig. 4, Pl. XIII, fig. 1, Pl. XVI, figs. 8—9.
1862. *P. pustulosus*, Davidson, Monogr. British Carb. Brachiopoda, p. 168, Pl. XLI, figs. 1—6, Pl. XLII, figs. 1—4.
1863. *P. pustulosus*, Roemer, Zeitschr. d. Deutsch. Geol. Ges. p. 591, Taf. XVI, fig. 3.
1870. *P. pustulosus*, Roemer, Geologie von Oberschlesien, p. 90, Taf. VIII, fig. 1.
1873. *P. pustulosus*, L. de Koninck, Monographie des fossiles carbonifères de Bleiberg en Carinthie, p. 29. The reference to Pl. I, fig. 21 is erroneous, no figure of this species being actually given in L. de Koninck's memoir.
1883. *P. pustulosus var. palliata*, Kayser, Obercarbonische Fauna von Loping, Richthofen's "China," Vol. IV, p. 186, Taf .XXVII, figs. 9—13.
1888. *P. cf. pustulosus* (?), Krotow, Geologische Forschungen am Westlichen Ural-Abhange, etc., Mém. Com. Géol. St. Pétersbourg, Vol. VI, p. 406.
1895. *P. pustulosus*, Tornquist, Das fossilfuhrende Untercarbon am östlichen Rossberg-Massiv in de Südvogesen, Abhandl. Geol. Spec. Karte von Elsass-Lothringen, Bd. V, Heft 4, p. 72, Taf. XIV, fig. 3.
1896. *P. pustulosus*, Julien, Le terrain carbonifère marin de la France Centrale, p. 67, Pl. VII, figs. 1—3, Pl. IX, fig. 1, Pl. X, fig. 2, Pl. XII, fig. 7, Pl. XIII, figs. 3, 4.

A very well preserved cast of a dorsal valve exhibits the characteristic shape and sculpture of this *Productus*, which, in its typical forms at least, may be easily distinguished from congeneric species by its peculiar ornamentation.

The shell is rotundate-square, nearly as long as wide, very flatly concave in the apical and visceral portions, but is distinctly geniculated, where the trail commences, exactly as in the Chinese variety, described as "*palliata*" by Kayser. It is divided by a broad but rather shallow median elevation which originates at some distance from the apex. The hinge line is a little shorter than the greatest width of the shell. The ears are broad and perfectly flat.

The surface of the cast is covered with numerous, tolerably regular, concentric wrinkles, crossing the radial ornamentation, which consists of coarse elongated pustules, distinctly arranged in quincunx. The immediate vicinity of the very apex is covered with closely packed granulations At a distance of 2 mm. from the apex the concentric wrinkles make their first appearance and gradually increase in strength towards the shell-margin.

The specimen does not seem to me distinguishable from the *var. palliata* of *P. pustulosus*, as it has been described by Kayser. It can scarcely be mistaken for a species of the group of *P. Humboldti*, d'Orb., on account of its much coarser ornamentation. From *P. punctatus*, Martin, it distinctly differs by the character and distribution of its tubercles. It is distinguished from *P. Buchianus*, de Kon., by its much larger size, from *Prod. Leuchtenbergensis*, de Kon., by the

concave shape of the dorsal valve, from *P. fimbriatus*, Sow., by the larger number of its concentric wrinkles.

Measurements of the specimen :—

Length of the dorsal valve	34 mm.
Breadth „ „ „ „	37 „
Depth „ „ „ „	7·5 „
Length of the hinge line	30 „

Locality and geological position; number of specimens examined.—Coarse grained, dark limestone, with a reddish weathered surface, containing remains of *Fenestellæ ;* Barus, Kashmir Valley ; Coll. Godwin-Austen ; 1.

Remarks.—Productus pustulosus is known from beds of lower carboniferous age in England, Ireland, Belgium, Central France, Alsatia, Silesia, Carinthia and Central Russia (?). A variety of this species has been described from Loping by Kayser. It differs from the typical form by the presence of a broad, distinctly marked off, geniculate trail. It is this upper carboniferous variety with which the type specimen from Kashmir ought to be identified.

The specimen from New Mexico considered as identical with *P. pustulosus* by Marcou (Geology of N. America, p. 48, Pl. VII, fig. 1), is distinguished from this species by the presence of a finely tuberculated zone in the vicinity of the anterior and lateral shell-margins.

P. pustulosus var. minutus, Abich (l. c. p. 37, Taf. V, fig. 10) from the permian rocks of Djulfa has been referred to *Strophalosia horrescens* by Val. von Moeller.

9. Productus punctatus, Martin. Pl. II, fig. 11.

1809. *Anomites punctatus*, Martin, Petrificata Derbiensia, p. 8, Pl. XXXVII, fig. 6 (figs. 7, 8 exclusis).
1811. *Trigonia rugosa*, Parkinson, Organic Remains, etc., Vol. III, p. 177, Pl. XII, fig. 11.
1822. *Anomites thecarius*, Schlotheim, Nachträge zur Versteinerungskunde, Vol. I, p. 63, Pl. XIV, fig. 1.
1823. *Productus punctatus*, Sowerby, Min. Conch., Vol. IV, p. 22, Pl. 323.
1836. *Producta punctata*, Phillips, Geology of Yorkshire, Vol. II, p. 215 ; Pl. VIII, fig. 10.
1837. *Leptaena sulcata*, Fischer von Waldheim, Oryctographie du Gouvernement de Moscow, p. 143, Pl. 23, fig. 2 (*non* Sowerby).
1841. *Productus punctatus*, L. v. Buch, Abhandlgn. koenigl. Akademie d. Wiss. Berlin I. Th. p. 34, Taf. II, figs. 10, 11.
1843. *P. punctatus*, L. de Koninck, Description des animaux foss. du terrain carbon. de Belgique, p. 196, Pl. VIII, fig. 4 ; Pl. X, fig. 2.
1845. *P. punctatus*, E. de Verneuil, Géologie de la Russie d'Europe, Vol. II. Paléontologie, p. 276, Pl. XVI, fig. 11.
1847. *P. punctatus*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*, p. 125, Pl. XII, fig. 2.
1854. *P. punctatus*, Shumard in R. Marcy's Exploration of the Red River of Louisiana, p. 188, Pl. I, fig. 5 ; Pl. II, fig. 1.
1858. *P. punctatus* (?), Marcou, Geology of North America, p. 48, Pl. VI, fig. 2.
1860. *P. tubulaspinus*, M'Chesney, Description of new species of fossils from the palæozoic rocks of the Western States, p. 37. Illustrations of the same : 1865, Pl. I, figs. 10, 11.
1862. *P. punctatus*, Davidson, Monogr. British carboniferous Brachiopoda, p. 172, Pl. XLIV, figs. 9-16.
1870. *P. punctatus*, Roemer, Geologie von Oberschlesien, p. 60, Pl. VII, fig. 2.

1872. *P. punctatus*, Meek, Final Report of the U. S. Geological Surv. of Nebraska, p. 169, Pl. II. fig. 6, Pl. IV, fig. 5.
1873. *P. punctatus*, L. de Koninck, Monographie des fossiles carbonifères de Bleiberg, p. 30, Pl. I, fig. 19.
1873. *P. punctatus*, Meek and Worthen, Geological Surv. of Illinois, Vol. V, p. 569, Pl. 25, fig. 13.
1875. *P. punctatus* (?), Toula, Eine Kohlenkalk-Fauna von den Barents Inseln. Sitzgber. Kais. Akad d. Wiss. Wien. math. nat. Cl. Bd. LXXI, I. Abth. p. 25.
1876. *P. punctatus* (?), L. de Koninck, Recherches sur les foss. paléozoiques de la Nouvelle Galles du Sud, p. 193, Pl. X, fig. 2.
1877. *P. punctatus*, White, Report upon the U. S. Geogr. Surveys W. of the one hundredth Meridian, Vol. IV, Palæontology, p. 114, Pl. VII, fig. 2.
1888. *P. punctatus*, Krotow, Mém. Com. Géol. St. Pétersbourg, Vol. VI, p. 406.
1889. *P. punctatus*, Tschernyschew, Mém. Com. Géol. St. Pétersbourg, Vol. III, No. 4, p. 373.
1890. *P. punctatus*, Nikitin, ibid. Vol. V, No. 5, p. 58.
1892. *P. punctatus*, Schellwien, Die Fauna des Karnischen Fusulinenkalks, Palæontographica, Bd. 39, p. 25, Taf. V, fig. 1.
1896. *P. punctatus*, Julien, Le terrain carbonifère marin de la France Centrale, p. 69, Pl. VII, fig. 9; Pl. XI, figs. 3, 4; Pl. XII, fig. 8; Pl. XIV, figs. 4, 5.

This beautiful and easily recognised species which in Western Europe is most frequently associated with *Productus pustulosus* is represented in the Geological Survey's Himálayan collection from Kashmir by two ventral valves, which, although partly injured by weathering, are sufficiently well preserved to warrant a certain identification.

My specimens are somewhat broader than long, moderately arched and provided with a distinct medial sinus, originating a short distance from the very apex and extending to the front. The hinge-line is shorter than the greatest width of the shell. The auriculate expansions are barely defined from the swell of the umbo.

The most characteristic feature of this species is its peculiar sculpture. I am entirely unable to detect any differences in the ornamentation of my specimens and Davidson's or L. de Koninck's type-specimens. My two specimens clearly exhibit the numerous concentric and regular bands, separated from each other by smoother interstices and thickly set with very numerous and delicate spines. The concentric ridges increase in size from the apex towards the front, but in my second specimen, which attains 38 mm. in length, they become again smaller in the vicinity of the margins.

The measurements of the figured specimen, which can only be given approximately, are as follow :—

Length of the ventral valve in a straight line	27 mm.
„ „ „ „ „ along the curve	37 „
Breadth of the ventral valve	30 „
Thickness „ „ „ „	6·5 „
Length of the hinge-line	27 „

Locality and geological position; number of specimens examined.—Dark blue shale with limestone partings, containing numerous *Fenestellæ* and indeterminable casts of *Strophalosiæ*, Barus, Kashmir Valley; 2.

Remarks.—*Productus punctatus* is a very characteristic species, which ranges through the entire carboniferous system into permo-carboniferous strata. In Europe it has been described from the mountain-limestone of Great Britain, Belgium,

Central France and Silesia, from the Noetscher Schichten of Bleiberg in Carinthia of lower carboniferous age, from the upper carboniferous *Fusulina* limestone of the Krone (Carnian Alps), from the Moscovian, Gshelian and Artinskian stage of Russia. In North America it likewise ranges through all the strata of the carboniferous period, from the sub-carboniferous beds of Iowa, Illinois and Missouri into the upper carboniferous coal measures of Nebraska.

A dorsal valve figured by L. de Koninck from the carboniferous rocks of New South Wales has been attributed to *P. punctatus* by this learned author. But judging from the figure the specimen is too incomplete to allow a safe identification.

VI. Section: CAPERATI.

10. Productus aculeatus, Martin. Pl. I, figs. 6, 7.

1809. *Anomites aculeatus*, Martin, Petrificata Derb. p. 8, Pl. XXXVII, figs. 9, 10.
1814. *Productus aculeatus*, Sowerby, Miner. Conch. Vol. I, p. 156, Pl. LXVIII, fig. 4.
1836. *Producta laxispina*, Phillips, Geology of Yorkshire, Pl. VIII, fig. 13.
1836. *P. spinulosa*, Phillips (*non* Sowerby), ibidem, Vol. II, Pl. VII, fig. 14.
1843. *P. gryphoides*, L. de Koninck (*ex parte*) Déscription des animaux foss. du terrain carbonif. de Belgique, p. 182, Pl. IX, fig. 1, Pl. XII, fig. 12.
1847. *P. aculeatus*, L. de Koninck ; Monographie des genres *Productus* et *Chonetes*, p. 144, Pl. XVI, fig. 6.
1861. *P. aculeatus*, Davidson, Monogr. British Carb. Brachiopoda, p. 166, Pl. XXXIII, figs. 16-20.
1867. *P. aculeatus*, Verchère, Kashmir, the Western Himálaya and the Afghan Mts. Journ. Asiatic Soc. of Bengal, Vol. XXXV, Pt. 2, pp. 203, 213.
1873. *P. aculeatus*, L. de Koninck, Monographie des fossiles carbonifères de Bleiberg en Carinthie, p. 35, Pl. I, fig. 20.
1875. *P. aculeatus*, Toula, Eine Kohlenkalk Fauna von den Barents-Inseln, Sitzungsber. Kais. Akad. d. Wiss. Wien, math. nat. Cl. Bd. LXXI, I Abth. p. 26, Taf. II, fig. 10.
1883. *P. aculeatus*, Kayser, Obercarbonische Fauna von Loping, Richthofen's China, Bd. IV., p. 185, Taf. XXVI, figs. 1-5.
1888. *P. aculeatus*, Krotow, Mém. Com. Géol. St. Pétersbourg, Vol. VI, p. 409, Taf. I. figs. 16, 17.
1892. *P. aculeatus*, Schellwien, Die Fauna des Karnischen Fusulinenkalks, Palæontographica, Bd. 39, p. 25, Taf. III, figs. 10, 11.

Among the few fossils of undoubtedly anthracolithic age which have been collected in the Kashmir valley by Dr. Verchère, a small species of *Productus* is most numerously represented, which agrees very well with *P. aculeatus*, Martin.

All my specimens are of moderate dimensions, nearly as broad as long, or of slightly elongated outline. The greatest width of the shell is nearly always situated nearer to the front margin than to the beak, thus imparting to my forms a somewhat trapezoid shape. The ventral valve is very strongly convex and provided with high, steeply curved, lateral parts. The hinge-line is considerably shorter than the greatest width of the shell and is overlaid by the attenuated, strongly involute apex. The ears are very small and not distinctly defined. No trace of a median sinus is developed in any of my specimens.

In the majority of my forms the sculpture consists of irregularly scattered tubercles, which in the anterior portion of the valve are occasionally transformed into longitudinal ribs. These radiating ribs are however never as numerous and

regular as in the Chinese variety described by Kayser, or in the specimen figured by Davidson on Pl. XXIII, fig. 19, of his monograph of the British carboniferous Brachiopoda.

Besides this peculiar sculpture a much more delicate concentric ornamentation is exhibited in the less weathered specimens.

No dorsal valve of this species is known to me. The measurements of one of my type specimens (fig. 7) are as follow :—

Length of the ventral valve in a straight line	15 mm.
„ „ „ „ „ along the curve	20 „
Breadth „ „ „ „	13 „
Thickness „ „ „	8 „
Length of the hinge-line	7 „

Locality and geological position ; number of specimens examined.—Coarse, dark grey limestone, Kashmir ; Coll. Verchère ; 8.

Remarks.—*Productus aculeatus* is a very variable species, under which many shapes differing considerably from Martin's type specimen have been united by various authors. My forms seem to hold an intermediate position between Martin's type, which almost entirely agrees with Toula's specimen from Hoefer Island, and the Chinese variety described by Kayser. The Carinthian variety figured by Schellwien is characterised by yet stronger ribs in the frontal portion of the ventral valve. The specimen from New South Wales, considered as identical with *P. aculeatus* by L. de Koninck (Recherches sur les foss. paléozoiques de la Nouvelle Galles du Sud. p. 204, Pl. XI, fig. 6.) seems to differ considerably from Martin's species by its uncommonly broad and strongly developed concentric laminæ.

Productus aculeatus is a characteristic species of the carboniferous period, being known from the mountain limestone of Belgium, Great Britain and Bleiberg in Carinthia, and from the upper carboniferous beds of the Carnian Alps, of Russia, Hoefer Island and China.

VII. Section: IRREGULARES.

11. Productus mongolicus, Diener. Pl. VI, figs. 7, 8.

1883. *Productus cf. Cora*, Kayser, Obercarbonische Fauna von Loping, Richthofen's China, Bd. IV, p. 184, Taf. XXVII, fig. 5.

1898. *P. mongolicus*, Diener, Himálayan Fossils, Palæont. Indica, ser. XV, Vol. I, Pt. 3. The permocarboniferous fauna of Chitichun No. 1, Pl. IV, figs. 8-10.

Two specimens from the anthracolithic rocks of Kashmir are referable to this characteristic and easily recognised species. One of them is a tolerably well preserved ventral valve, which, although somewhat deformed by crushing, exhibits all the leading features peculiar to the present species. It is of an elongately triangular shape, provided with an acuminated, involute apex, and, as far as I am able to judge, with very small, strongly depressed wings. The ornamentation is of exactly the same pattern as in my type specimens from the permo-carboniferous limestone-crag of Chitichun No. 1.

I think this specimen may be safely identified with *P. mongolicus*, not with the closely allied *P. compressus*, Waagen (Salt Range Fossils, Pal. Ind., ser. XIII, Vol. I, Prod. Limest. Foss., p. 710, Pl. LXXXI, figs. 1, 2) on account of its more strongly developed, concentric sculpture, which equally affects the median and lateral portions of the valve and on account of its lateral margins not being concealed below the strongly compressed lateral parts of the shell, as is the case with the Salt Range species, according to Waagen's description.

The measurements are approximately as follow:—

Length of the shell in a straight line	36 mm.
„ „ „ „ along the curve	41 „
Breadth of the shell	cca. 28 „
Thickness of the ventral valve	8 „

My second specimen is the cast of a large ventral valve, with a few fragments of the dorsal valve adhering to it. The distance between the two valves must have been very small, especially in the apical region. This specimen only differs from the previously described one by its larger size and greater flatness. I think there can be little doubt as to its identity with the present species.

Locality and geological position; number of specimens examined.—Dark, micaceous shales with limestone partings, containing numerous remains of *Bryozoa*, Barus, Kashmir valley; Coll. Godwin-Austen; 2.

Remarks.—*Productus mongolicus* has been described from the upper carboniferous beds of Loping in China by Kayser, and from the permo-carboniferous limestone of Chitichun No. 1 in Tibet by myself.

Subgenus: MARGINIFERA, Waagen.

1884. *Marginifera*, Waagen, Salt Range Fossils, Palæontologia Indica, ser. XIII, Vol. I, Prod. Limest. Foss., p. 713.

For a discussion of the subgeneric value of this group of *Producti*, *vide* my monograph of the Chitichun fossils (Pt. 3 of this volume, pp. 30 to 32).

1. MARGINIFERA HIMALAYENSIS, nov. sp. Pl. II, figs. 1-7; Pl. VI, figs. 1, 2.

1865. *P. semireticulatus*, Stoliczka, Geological sections across the Himálayan Mountains from Wangtu bridge on the River Sutlej to Sungdo on the Indus, Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 29.

1865. *P. longispinus*, Stoliczka, ibidem, p. 29.

1883. *P. semireticulatus*, Lydekker. The Geology of the Kashmir and Chamba Territories, Mem. Geol. Survey of India, Vol. XXII, Pl. II, fig. 2.

1895. *Marginifera cf. typica*, Diener, Ergebnisse einer Geologischen Expedition in den Central Himálaya von Johár, Hundés und Painkhánda, Denkschr. Kais. Akad. d. Wiss. math. nat. Cl. Bd. LXII, p. 595.

1898. *M. himalayensis*, Diener. The permocarb. fauna of Chitichun No. 1, Pal. Ind. ser. XV, Himálayan Foss., Vol. I, Pt. 3, p. 35.

This is the most common species of Stoliczka's "Kuling Shales" in Spiti and is met with in corresponding beds in Kashmir. The majority of specimens contained in the Geological Survey's Himálayan collection have been mistaken for *Productus*

semireticulatus by Stoliczka and Lydekker. With this species the present form has however scarcely anything in common but an external similarity in the sculpture of the dorsal valve. Its internal characters, on the contrary, prove it to be a typical representative of Waagen's subgenus *Marginifera* and to be most closely allied to *M. typica*, from which indeed it is distinguished by very subordinate characters only.

The present species varies considerably in its general shape and outlines. It is, as a rule, transversely oval or even transversely rectangular, but specimens of a subquadrate outline are also occasionally met with, and a few exceptional forms even exhibit an elongately oval shape.

The ventral valve is always very strongly inflated. Its visceral part is distinctly prominent above the hinge-line. It is either regularly curved in the longitudinal direction throughout its entire length from the apex to the front margin, or its apical region appears to be more or less flattened. In some specimens even a blunt geniculation sets in where the visceral and anterior portions of the valve unite. Close to the apex, almost at its point, a mesial sinus takes its origin and extends down to the front line. It is of variable width and depth, but is always distinctly developed. In some of my specimens it is extraordinarily deep and narrow, exactly of the same character as in the type specimen of *Productus gratiosus*, figured on Pl. III, fig. 7, of my monograph on the Chitichun brachiopoda (Pt. 3 of this volume). As a rule the mesial sinus is most deeply impressed in the visceral portion of the valve, but becomes more shallow towards the front. The beak is not much bent over, pointed, but not passing far within the hinge-line. The latter is straight and marks the greatest breadth of the shell. The wings are rather large and prominent, pointed at their extremities, somewhat triangular and strongly arched. They are defined by a sinuosity or furrow from each lateral margin. The lateral portions of the ventral valve are bent down in a very steep curve towards the wings. The lateral margins are rounded anteriorly from the sinuosity or furrow in advance of each wing, to the front, which is distinctly, though, as a rule, but slightly sinuous in the middle.

If the shell has been entirely preserved, the ornamentation consists of very numerous longitudinal striæ or costæ. The majority of the ribs remain quite regular for their entire length. Occasionally, however, two or three are united into a coarser one. The striæ or costæ are parallel and do not exhibit any tendency to converge towards the centre line of the mesial sinus, as it is the case in the typical form of *Marginifera typica*. In the apical region the delicate, radial plication is crossed by an equally delicate concentric sculpture, imparting to this portion of the shell an indistinctly reticulate appearance. The concentric striæ are always less numerous and separated by larger intervals than the radiating ones. Traces of spines are almost entirely absent.

Generally on somewhat worn-out examples the concentric striæ are so nearly obsolete that the radial plication only is exhibited. Specimens of this kind strongly remind of the figure of *Productus longispinus var. setosus*, given by Krotow in his memoir on the geological structure of the districts of Tscherdyn and

Ssolikamsk (Mém. Com. Géol. de la Russie, Vol. VI, St. Pétersbourg, 1888, Taf. I, figs. 12, 13). In specimens which are still more weathered the surface, at a first glance, presents the appearance of being entirely smooth. But even these specimens, like the one figured by Lydekker, almost always show the remains of either the concentric or radiating striæ on the more protected parts.

A small number of specimens which have been collected in the Kuling shales near Muth in Spiti by Dr. Ferdinand Stoliczka are distinguished by a slightly stronger ornamentation of their ventral valves than the rest of my forms. In these specimens (Pl. VI, figs. 1, 2), which clearly show the peculiar internal characters of the subgenus *Marginifera*, both the concentric and radiating plications are rather strongly developed. In the specimen, figured on Pl. VI, fig. 1, moreover, the radiating costæ standing next to the mesial sinus show a slight tendency to converge towards the latter. Regarding the small importance of these characters of difference, I do not think that these specimens ought to be considered as more than variations of the present species.

The dorsal valve is deeply concave and follows very closely the curve of the opposite one, thus leaving but very little room for the animal within. The visceral and anterior portions are very often separated by a strong geniculation. A broad, strongly elevated mesial ridge, corresponding to the sinus in the ventral valve, extends from the beak towards the front. The wings are flattened, but not distinctly marked off from the remainder of the valve. The sculpture is much more prominent than in the ventral valve. Both the apical and visceral portions are strongly reticulated, imparting to the casts of this valve an external similarity to small forms of *Productus semireticulatus*. In the trail this reticulated ornamentation is replaced by a delicate radial plication. The sculpture of the wings is more delicate than in the remainder of this valve. Traces of spines have but seldom been noticed.

The shelly substance of both valves is rather thin.

The measurements of one of my largest and most complete specimens (Pl. II, fig. 1) are as follow:—

Length of the shell in a straight line	22·5	mm.
„ „ „ „ along the curve	40	„
„ „ „ dorsal valve	19	„
Entire breadth of the shell	43	„
Thickness of the ventral valve	14	„
Distance of the two valves from each other	7	„
Breadth of the shell without the wings	30	„

The characteristic feature of the subgenus *Marginifera*, *viz.*, the prominent shelly ridge within the wings of the ventral valve, is clearly seen in Lydekker's type specimen of this species from Kashmir (Pl. II, fig. 5). The wing having been broken off on one side of this specimen, the peculiar crenulated ridge, as described and figured by Waagen, is exhibited. This internal ridge has also been noticed in several forms from the Kuling shales of Spiti collected by Dr. Stoliczka. In a large number of my specimens, moreover, the trail of the ventral valve is marked

off from the remainder of the shell by a distinct band or furrow, which corresponds to the internal ridges along the margins of the dorsal valve.

Of other internal characters of this species nothing is known to me.

Locality and geological position; number of specimens examined.—The Kuling shales of Spiti are very rich in specimens belonging to this species. Among the Geological Survey's Himálayan collection from Spiti the following localities are represented :—Kuling, Coll. Stoliczka, 35; Coll. Griesbach, 14; Khar, Coll. Stoliczka, 4; Coll. Griesbach, 18; Muth, Coll. Stoliczka, 8; Lilang, Coll. Stoliczka, 8. Six specimens have been collected by Dr. Gerard, but the exact locality from which they have been obtained is not known.

In Kashmir our species has been collected by Lydekker in shales with limestone partings of the same lithological character as the Kuling shales of Spiti. The specimens, 16 in number, were found on the western summit of a ridge N.E. of Prongam Tral, associated with *P. Abichi*, Waag., *Strophomena analoga*, Phil., and *Chonetes grandicosta*, Waagen.

It is not improbable that Dr. Verchère (l. c. p. 213) had this species in view when describing his specimens of *Productus longispinus* from Kashmir as differing from Davidson's types by "their well-defined, enrolled and horn-like ears."

Remarks.—The present species is very closely allied to *Marginifera typica*, Waagen (Salt Range Fossils, Pal. Ind., ser. XIII., Vol. I, Prod. Limest. Foss., p. 717, Pl. LXXVI, figs. 4-7, Pl. LXXVIII, fig. 1), and it was only after much consideration that I did not feel justified in identifying them altogether. If one had to deal with ventral valves only, it should, in some cases at least, be difficult to distinguish between them. This remark chiefly applies to the variety from Muth, which, by its coarser sculpture, approaches very closely the typical form of the Salt-Range species. The almost entire absence of spines, however, is a remarkable feature in all my specimens of *M. himalayensis*.

The most striking proof of the distinctness of the two species rests on the character of the dorsal valve which is much more strongly reticulated and provided with a very prominent median fold in *M. himalayensis*. Nor are the two remarkable rows of grooves present in the latter species, which in *M. typica* extend inside along the ridges, separating the wings from the remainder of the shell.

A closer comparison of the present species with other forms of the subgenus *Marginifera* seems hardly necessary, as the distinguishing characters are almost the same as have been indicated by Waagen as separating *M. typica* from the rest of congeneric species.

Genus: STROPHALOSIA, King.

The genus *Strophalosia* is not at all rare in the anthracolithic system of the Western Himálayas, but nearly all the specimens which I have examined are too fragmentary for specific determination.

The only Himálayan representative of this genus, the characters of which are

tolerably well known, is *Strophalosia Gerardi*, King (A monograph of the permian fossils of England, London, 1850, p. 96, Pl. XIX, figs. 6, 7). The forms on which this species has been founded by Prof. King were picked up by Dr. Gerard on the crest of a pass, leading from Ladakh into Bisâhir, at a height of 17,000 feet. This species, which is not represented among my fossil material, has been compared by Waagen to *Strophalosia plicosa* from the lower Productus limestone of the Salt-Range and has been identified recently with an Australian shell from the Bowen river coalfield in Queensland by R. Etheridge, jun. (Geology and Palæontology of Queensland and New Guinea, London, 1892, p. 260, Pl. XIII, fig. 18, Pl. XIV, fig. 18; Pl. XL, figs. 7, 8). Whether the two dorsal valves from the Zewan beds of Kashmir, described and figured by Dr. Verchère as *Strophalosia* (?) *arachnoidea* (Journ. Asiat. Soc. of Bengal, Vol. XXXV, Pt. 2, p. 213, Pl. IV, fig. 1a, 1b), really belong to this genus, is at least very doubtful.

Among the specimens of *Strophalosia*, contained in the Geological Survey's Himálayan collection, two species can be distinguished. One of them appears to be related to *St. costata*, Waagen, the other to *St. tenuispina*, Waagen.

1. Strophalosia sp. ind. aff. St. costata, Waagen. Pl. I, figs. 15, 16.

Besides a considerable number of very poorly preserved fragments, two incomplete ventral valves with partly preserved shell are referable to a species, which to me seems rather closely allied to *St. costata*, Waagen (Salt-Range Fossils, Pal. Ind., ser. XIII, Vol. I. Prod. Limest. Foss., p. 655; Pl. LXIII, figs. 7, 8; Pl. LXIV, fig. 1) from the lower Productus limestone (Amb beds) of the Salt-Range.

Both specimens are of transversely oval outline, but so much crushed as to appear strongly asymmetrical. The apex is too badly preserved to show the presence of point of attachment. Nor has it been possible to state the presence of an area with full certainty. A mesial sinus is but slightly indicated.

The most characteristic feature of these two ventral valves is their ornamentation. It consists of tolerably sharp, elevated, radiating ribs, which are not quite regular for their entire length and increase in number towards the front either by bifurcation or by intercalation of new costæ. At irregular intervals the ribs are strongly nodose and ornamented with spines. These spines are most numerous in the vicinity of the lateral margins near both extremities of the hinge-line. This coarse radiating sculpture is crossed by a very delicate concentric ornamentation.

The measurements of the smaller specimen (fig. 15) are approximately as follow:—

Length of the shell	21 mm.
Breadth „ „ „	22 „
Length of the hinge-line	15 „

Locality and geological position; *number of specimens examined*.—Dark blue, shaly limestone, with *Fenestella*, N. of Eishmakam, Kashmir Valley; Coll. Lydekker; 2.

Remarks.—Among the Indian representatives of this genus the present

species has probably its nearest ally in *Strophalosia costata*, Waagen. It is, however, distinguished from the latter by its considerably larger dimensions, by the absence of a strongly developed mesial sinus and by its more numerous spines.

2. STROPHALOSIA CF. (?) TENUISPINA, Waagen. Pl. I, fig. 17.

1887. *Strophalosia tenuispina*, Waagen, Salt-Range Fossils, Pal. Ind., ser. XIII, Vol. I. Productus Limestone Foss., p. 654, Pl. LXIV, figs. 2—7.

A single incomplete ventral valve of a *Strophalosia* so closely resembles this species from the lower Productus limestone of the Salt-Range that I can scarcely be far wrong in referring it to the latter as its nearest ally.

Its general outline is almost circular. The ventral valve, which alone is accessible to observation, is but moderately inflated, as in Waagen's type specimen, figured on Pl. LXIV, fig. 2 of his monograph and is very regularly curved in either direction. The apex being broken off, one of the most important characters for the identification of a *Strophalosia* is unfortunately missing.

The ornamentation is nearly the same as in the specimen figured by Waagen on Pl. LXIV, fig. 6 of his monograph. It consists of a comparatively small number of very thin, elongated spines, which are directed forward, firmly appressed to the surface of the valve, and arranged into approximately concentric rows. A few imbricating, concentric striæ of growth may be noticed besides this radiating sculpture.

I have not succeeded in cleaning the dorsal valve from the adhering matrix.

Exact measurements of this species cannot be given, as the materials at hand are too fragmentary. The figure will give, I hope, a sufficiently clear idea of its features.

Locality and Geological position; number of specimens examined.—Shaly, micaceous limestone with *Productus semireticulatus*, Barus, Kashmir Valley; Coll. Godwin-Austen; 1.

Remarks.—As this specimen is too imperfect to warrant a decided identification, its direct reference to *Strophalosia tenuispina* may have elements of doubt, but, on the other hand, I cannot satisfactorily compare it to any other among the congeneric species. Had it not been for the moderate inflation of the ventral valve and for the less numerous and more delicate spines, *S. plicata*, Waagen, might have put in a claim for a closer comparison.

In the Salt-Range *Strophalosia tenuispina* is restricted to the Chonetes-bed of the lower Productus limestone at Amb. The Barus beds of Kashmir with *P. semireticulatus* seem to hold a similar geological position.

Subfamily: CHONETINÆ, Waagen.

Genus: CHONETES, Fischer v. Waldh.

In the Himálayan collections of the Geological Survey from Kashmir and Spiti the genus *Chonetes* is represented by altogether four species. Among the

subdivisions or sections of this genus established by L. de Koninck and partly emendated by Waagen, they can be grouped in the following manner:—

I. Section: STRIATÆ.

1. *Chonetes cf. Lissarensis*, Diener.
2. *Chonetes Austeniana*, Davidson.

II. Section: GRANDICOSTATÆ.

3. *Chonetes grandicosta*, Waagen.
4. *Chonetes Barusiensis*, Davidson.

One of these species, *Chonetes cf. Lissarensis*, from the Kuling shales of Spiti, is probably identical with one of the most common leading fossils of the permian Productus shales of Johar, described by myself in the fourth part of this volume. *Chonetes grandicosta* had been previously discovered in the upper Productus-limestone by Waagen. The two remaining species are peculiar to the anthracolithic system of Kashmir. One of them, *Ch. Barusiensis*, had been originally classed among the genus *Spirifer* by Davidson. In placing it in the genus *Chonetes* I am following Waagen's opinion.

Besides *Chonetes Austeniana* and *Ch. Barusiensis* two more species of this genus have been described by Davidson in his memoir on the carboniferous fossils, collected by Captain Godwin-Austen in Kashmir. These are *Ch. lævis*, Davidson (Quart. Journ. Geol. Soc., London, Vol. XXII, 1866, p. 44, Pl. II, fig. 17) and *Ch. Hardrensis var. Tibetensis*, Davidson (ibid, p. 36, Pl. I, fig. 7). The latter denomination ought to be changed into "*Kashmeriensis*," according to Lydekker, because the specimens in question were obtained from Kashmir, not from Skardú in Little Tibet, as it had been first erroneously supposed.

Chonetes lævis is a small and rather indifferent species, with a nearly smooth surface. Waagen has compared it to *Ch. Ambiensis*, Waag., *Ch. rotundata*, Toula, and *Ch. planumbona*, Meek and Worthen. He even suggested its probable identity with *Ch. rotundata* from Hœfer Island. I think, however, that all these forms are specifically different from *Ch. lævis*. *Ch. rotundata*, Toula (Eine Kohlenkalk Fauna von den Barents-Inseln, Sitzungsber Kais. Akad. d. Wiss. Wien, 1875, math. nat. Cl. Bd. LXXI., p. 28, Taf. II. fig. 12, *non* 11) is much more strongly convex and not flattened towards the ears, which according to Davidson's description, is a prominent feature in the Himálayan form. *Ch. Ambiensis* Waagen (Salt-Range Fossils, Pal. Ind., ser. XIII., Vol. I. Prod., Limest. Foss., p. 618, Pl. LVIII, figs. 1-6) is also more strongly inflated and provided with a shorter hinge-line and with a prominent apex. From *Ch. planumbona*, Meek and Worthen (Geol. Surv. of Illinois, Vol. II. Palæont. p. 253, Pl. 18, fig. 1), *Ch. lævis* differs by similar characters.

The second species, *Chonetes Hardrensis var. Kashmeriensis*, belongs to a group of the carboniferous descendants of the devonian *Ch. Hardrensis*, Phill., of which *Ch. Laguessiana*, L. de Kon., is the prototype.

I. Section: STRIATÆ.

1. Chonetes cf. Lissarensis, Diener. Pl. VI, fig. 3.

1897. *Chonetes Lissarensis*, Diener, Himálayan Fossils, Pal. Ind., ser. XV, Vol. I, Pt. 4. The fauna of the permian Productus shales of Johár and Painkhánda, Pl. II, figs. 4, 6, p.

Among the fossils collected by Stoliczka in the Kuling shales of Spiti there is a single ventral valve of a *Chonetes*, which seemed to me indistinguishable from *Ch. Lissarensis*, one of the most typical species of the permian Productus shales of Johár.

Its outline is transversely trapezoidal, with rounded-off margins. It is very gently curved in the longitudinal direction. The hinge-line corresponds to the greatest width of the shell. The lateral parts are distinctly flattened and form slight triangular wings. The apex is very slightly developed and pointed. No spines have been noticed on the margins, which are limiting the area above. The mesial sinus is cut out very sharply and bordered by steep marginal walls. It is, however, neither deep nor wide, and disappears almost completely in the vicinity of the front. A narrow, sharp, median fold rises from the bottom of the sinus and is distinctly developed almost throughout its entire length. It is exactly of the same character as the majority of the specimens from the Productus shales of the Lissar Valley in Johár.

The specimen is a cast only. Its central portion is ornamented with very numerous and delicate striæ, covered with numerous puncta. In the marginal region the ornamentation is partly obscured by weathering, but in some places, especially in the vicinity of the wings, the presence of deep grooves is distinctly seen, which are directed towards the shell margin.

The measurements of this specimen are as follow:—

Entire length of the shell	9	mm.
„ breadth „ „ along the hinge-line	17	„
Thickness of the ventral valve	2	„
Apical angle, without the wings	cca. 120°	

Locality and geological position; number of specimens examined.—Kuling shales, associated with *Marginifera Himalayensis*, Kuling, Spiti; Coll. Stoliczka; 1.

Remarks.—This specimen can hardly be otherwise determined, I think, than as *Ch. Lissarensis*. If I do not venture on a direct identification, it is because the example is not complete and differences might perhaps be noticed, if the dorsal valve were preserved. A closer comparison with other forms of this group, *Ch. Vishnu*, Salter, *Ch. lobata*, Schellwien, *Ch. mesoloba*, Norw. and Pratt., seems hardly necessary.

Chonetes Lissarensis is a very common shell in the permian Productus shales of the Lissar Valley in Johár. Its presence in the Kuling shales of Spiti would therefore be of no slight importance, with regard to a determination of their exact stratigraphical position. The Kuling shales of Spiti, or, more exactly, their lower portion, which contains a palæozoic fauna and is overlaid by the triassic *Otoceras*

stage, have been correlated with the Productus shales of Johár and Painkhanda by Griesbach. The presence of *Ch. Lissarensis* in these beds would be strongly in favour of this view.

2. Chonetes Austeniana, Davidson. Pl. II, fig. 13.

1866. *Chonetes Austeniana*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 44, Pl. II, fig. 18.
1884. *Ch. Austeniana*, Waagen, Salt-Range Fossils, Palæont. Indica, ser. XIII., Vol. I, Prod. Limest. Foss., p. 633.

This species was introduced by Davidson from a single ventral valve, collected by Captain Godwin-Austen in the anthracolithic rocks of Kashmir. My materials for its description are unfortunately in no way more complete.

The only specimen, available for description, is a ventral valve of a transversely oval outline. It is moderately inflated and very regularly curved both in the longitudinal and in the transverse directions. There are no auricular expansions, although the lateral parts are slightly flattened near the extremities of the hinge-line, which corresponds to the greatest width of the shell. The apex is barely at all prominent, pointed, but not or only very little involute. At its very extremity a narrow, concave, median sinus originates and extends to the front, increasing gradually but very slowly in width and depth. On the lateral portion of the valve two obscure, rounded depressions of very small dimensions may be traced on each side of the mesial sinus. These depressions are more conspicuous than the broad, barely elevated folds, into which the lateral portions are divided by the former. Otherwise the surface is almost smooth. But this feature, I think, is only due to the weathering of the cast, because in some places a large number of rounded punctures is indistinctly visible, which are arranged into radiating striæ.

Neither the dorsal valve nor the internal characters of this species are known.

The measurements of my type specimen are as follow:—

Entire length of the shell	12·5	mm.
„ breadth „ „	16	„
„ thickness „ „	2·5	„
Apical angle of the ventral valve without the wings	120°	

Locality and geological position; number of specimens examined.—Coarse, grey limestone, made up almost entirely of undeterminable fragments of brachiopoda, Zewan beds, Barus, Kashmir Valley ; Coll. Godwin-Austen ; 1.

Remarks.—The present species has been classed by Waagen among the section of *grandicostatæ*, and I must state my reasons for not concurring in this view with that learned author. In its general characters *Ch. Austeniana* approaches more nearly the "*striatæ*" than any form of the "*grandicostatæ*," being characterised by a delicate, radiating striation, which is made up of a large number of regularly arranged punctures, whereas the traces of larger plications are rather obscure and restricted to the vicinity of the margins only. In this respect *Ch. Austeniana* cannot advantageously be compared to *Ch. semiovalis*, Waagen (l. c. p. 632, Pl. LXI, fig. 5) as has been suggested by Waagen. The latter species

undoubtedly belongs to the section of *grandicostatæ*, being distinguished by the presence of strong and moderately high, radiating ribs. I therefore should not think it advisable to unite *Ch. semiovalis* and *Ch. Austeniana* in the same group of forms.

Among the "*striatae*" *Chonetes Austeniana* may be considered as the prototype of a proper group, distinguished from the rest of congeneric species by the presence of a few, low depressions, affecting the lateral portions in the vicinity of the shell-margin.

II. Section: GRANDICOSTATÆ.

3. Chonetes grandicosta, Waagen. Pl. II, fig. 14.

1884. *Chonetes grandicosta*, Waagen, Salt Range Fossils, Palæont. Ind., ser. XIII, Vol. I, Prod. Limest. Foss., p. 638, Pl. LXI, figs. 6, 7.

The materials of this species in the Himálayan collection are very small, but the specimen is so characteristic that I think the determination can be made with sufficient accuracy.

The specimen serving for description is slightly inferior in size to Waagen's types, but perfectly agrees with them in all its characters. It is easily distinguished from all the rest of congeneric forms by its strongly inflated ventral valve, its deep mesial sinus, and its well developed, radiating folds.

The ventral valve, which alone is accessible to observation, is a little wider than long, strongly but rather regularly convex. The hinge-line corresponds to the greatest width of the shell. The apex is slightly prominent, pointed and incurved, thus concealing the area almost entirely. In the specimen at my disposal the largest portion of the area is covered up by the rocky matrix.

Transversely the valve appears impressed in the middle by the presence of a very deep and broad, mesial sinus, which originates in the apex and is limited on both sides by prominent, rounded folds. These folds descend rather abruptly towards the flattened, pointed wings, from which they are marked off very sharply.

The entire valve is covered by a radiating sculpture, which is most prominent on the two elevated folds. The sinus is ornamented in its bottom by delicate, longitudinal striæ only, whereas on the elevated folds regular costæ make their appearance, the highest among them forming the very crest of each fold. The wings are apparently devoid of a radial sculpture, but are ornamented with imbricating, transverse striæ of growth. This transverse sculpture is but very faintly indicated in the remaining portions of the valve.

Neither the dorsal valve nor the internal characters of this species are known to me.

The measurements of the present specimen are as follow:—

Entire length of the shell	8 mm.
„ breadth „ „ „ along the hinge-line	9 „
„ thickness „ „ „	4 „
Apical angle of the ventral valve, without the wings	cca. 80°

Locality and geological position; number of specimens examined.—Micaceous,

dark shales, with *Productus Abichi* and *Marginifera himalayensis*, western summit of a ridge N.E. of Prongam Trál, Kashmir ; Coll. Lydekker ; 1.

Remarks.—The only differences between this form and Waagen's type-specimens of *Chonetes grandicosta* are the somewhat more longitudinal shape and the smaller size of the former. In these characters it approaches more nearly *Ch. aequicosta*, Waagen (l. c. p. 639, Pl. LX, fig. 7), from which it differs however by its ornamentation and by its deeply impressed mesial sinus. The two above-mentioned points of difference are certainly too insignificant to forbid its identification with *Ch. grandicosta*.

In the Productus limestone of the Salt Range the present species is restricted to the Cephalopoda beds of Jabi.

4. Chonetes Barusiensis, Davidson. Pl. VI, fig. 4.

1866. *Spirifer Barusiensis*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 42, Pl. II, fig. 7.
1884. *Chonetes Barusiensis*, Waagen, Salt Range Foss., Pal. Ind. ser. XIII, Vol. I. Prod. Limest. Foss., p. 618.

Professor Davidson had only a single ventral valve of this species at his disposal, for which he introduced the present denomination. Nor are my materials in any way more complete. Thus our knowledge of the species necessarily must yet remain rather imperfect.

Davidson himself states his description of this shell, which he provisionally classed among the genus *Spirifer*, to be very incomplete. Waagen was the first to discover the close resemblance of *Spirifer Barusiensis* to the largely costate species of *Chonetes* from the *Productus* limestone of the Salt Range, and he consequently deemed it preferable to consider it as a ventral valve of a *Chonetes*. I fully agree with this opinion of that learned author.

Chonetes Barusiensis is of very small size and is easily distinguished from the rest of largely costate *Chonetes* by its transversely trapezoidal outline, being twice as broad as it is long. The greatest width of the shell corresponds to the hinge-line. The ventral valve is but very little inflated and equally curved in the longitudinal direction. A broad, rounded sinus originates in the very apex and extends to the front, increasing gradually in width and depth. The wings are large, flattened and pointed. The apex is not prominent. There are three folds within the mesial sinus and five on each of the two elevated parts of the valve on both sides of the sinus. The costæ within the sinus are less strongly developed than those on the elevated parts of the shell. The wings are devoid of any ornamentation.

Neither the dorsal valve nor the internal characters of this species are known to me.

The measurements of my type specimen are as follow :—

Entire length of the ventral valve	4 mm.
„ breadth „ „ „ „	8 „
„ thickness „ „ „ „	cca 1 „
Apical angle of the ventral valve, without the wings	cca. 100°

Locality and geological position ; number of specimens examined.—Dark shales

weathering in greenish and reddish colours, with *Protoretepora*, Barus, Kashmir Valley ; Coll. Godwin-Austen ; 1.

Remarks.— *Chonetes squamulifera*, Waagen(l. c. p. 634, Pl. LX, figs. 1 to 4) from the middle and upper Productus limestone of the Salt Range has been considered as the nearest ally to the present species by Waagen. The two forms are, however, readily distinguished by the smaller size and greater width of the Himálayan shell, by its flatness, its larger wings and its distinctly impressed sinus, which is limited off more sharply from the elevated parts of the ventral valve.

On account of its great flatness and of its large, pointed wings *Ch. deplanata*, Waagen, might put in a claim for a closer comparison.

Family : *LYTTONIIDÆ*, Zittel.

Sub-family : LYTTONIINÆ, Waagen.

Genus: LYTTONIA, Waagen.

LYTTONIA sp. ind. Pl. II, figs. 15, 16.

Among the fossil materials, collected in the anthracolithic rocks of Kashmir by Lydekker, there are several fragmentary casts of a *Lyttonia*, which is probably very closely related to *L. nobilis*, Waagen, or to *L. tenuis*, Waagen, but does, unfortunately, not allow a specific determination, on account of the fragmentary character of the forms available for observation.

The smaller of the two figured casts, corresponding to the cardinal portion of a ventral valve, exhibits thepeculiar triangular outline, which is common to all the species of this genus. The shelly substance has been entirely destroyed, but its characteristic, distinctly porous structure has been partly preserved on the cast. Both the strongly developed median septum and the numerous lateral septa are marked by deep furrows, which are corresponding to them in the casts. The surface of the latter is partly covered by the branches of *Protoretepora*.

The specimen, figured on Pl. II, fig. 16, seems to have attained very considerable dimensions, its width at the anterior border measuring about 60 mm.

The present species is perhaps identical with one of the congeneric forms from the Productus limestone of the Salt Range described by Waagen. With *Lyttonia Richthofeni*, Kayser (Obercarbonische Fauna von Loping, Richthofen's "China," IV. Bd., p. 161, Taf. XXI, figs. 9-11) it cannot be identified, because the median septum, which is very distinctly developed in my casts, seems to be entirely absent in the Chinese shell.

Locality and geological position ; number of specimens examined.—Dark shales with limestone partings, made up almost entirely of *Bryozoa*, especially of *Protoretepora*, Marble Pass, Kashmir ; Coll. Lydekker ; 4.

Remarks.—Lydekker (Records Geol. Surv. of India, 1884, Vol. XVII, p. 37) was the first to draw attention to the occurrence of *Lyttonia* in the anthracolithic

deposits of the Kashmir Valley. The presence of this genus is of considerable importance for a safe correlation of these beds, as it has hitherto never been discovered in older than upper carboniferous strata.

Family: *STROPHOMENIDÆ*, King.

Sub-family: STROPHOMENINÆ, Waagen.

Genus: STROPHOMENA, Blainville.

1. STROPHOMENA ANALOGA, Phillips. Pl. II, fig. 17.

1836. *Producta analoga*, Phillips, Geology of Yorkshire, Vol. II, p 215, Pl. II, fig. 10.
1840. *Leptæna distorta*, Sowerby, Miner. Conch., Vol. VII, Pl. 615, fig 2.
1843. *Leptæna depressa*, L. de Koninck, Description des animaux fossiles qui se trouvent dans le terrain carbonifère de Belgique, p. 215, Pl. XII, fig. 3.
1844. *Leptagonia multirugata*, M'Coy, Synopsis of the characters of the carb. foss. of Ireland, p. 118, Pl. XVIII, fig. 12.
1861. *Strophomena rhomboidalis var. analoga*, Davidson, Monogr. British Carb. Brachiopoda, p. 119, Pl. XXVIII, figs. —13.
1863. *Strophomena analoga*, Davidson, On the lower carboniferous brachiopoda of Nova Scotia, Quart. Journ. Geol. Soc., London, Vol. XIX, p. 173, Pl. IX, fig. 18.
1867. *Str. analoga*, Verchère, Kashmir, the Western Himalaya and the Afgan Mts. Journ. Asiat. Soc. of Bengal, Vol. 35, Pl. 2, p. 212, Pl. II, fig. 4.
1872. *St. rhomboidalis var. analoga*, Etheridge, Quart. Journ. Geol. Soc., Vol. XXVIII, pp. 331 and 333, Pl. XV, figs. 3 and ? 5, Pl. XVI, fig. 7, Pl. XVII, fig. 1.
1875. *St. depressa*, Toula, Eine Kohlenkalk Fauna von den Barents Inslen Sitzgsber. Kais Akad. d. Wiss. Wien, LXXI, Bd. math. nat. Cl. I, Abth p. 22 Taf. II, fig. 8.
1876. *Strophomena analoga*, L. de Koninck, Nouvelles Recherches sur les fossiles paléozoiques de la Nouvelle Galles du Sud, p. 208, Pl. IX, fig. 3, Pl. XI, fig. 7.
1872. *St. rhomboidalis var. analoga*, R. Etheridge jun. in Jack and Etheridge, Geology and Palæontology of Queensland and New Guinea, p. 245, Pl. XII, figs. 8, 9, Pl. LX, fig. 6.
1896. *St. analoga*, Julien, Le terrain carbonifère marin de la France Centrale p. 84, Pl. III, figs. 8, 9.

This species which by the majority of palæontologists has only been admitted as a variety of the silurian *Strophomena rhomboidalis*, Wahlenberg, is represented among the fossils collected by Lydekker, in the anthracolithic rocks of Kashmir, by a tolerably well preserved, though incomplete, ventral valve. Exactly at the place where we ought to expect the sudden geniculation in the convexity of the shell, the latter has been broken off in my specimen.

The ventral valve is of a subtrapizoidal outline, considerably wider than long, moderately curved in both directions, and provided with large, slightly depressed auricular expansions, which join the lateral borders in a very regular curve. The hinge-line corresponds to the greatest width of the shell. The apical region strongly reminds one of a *Productus*, but exhibits the trace of the characteristic perforation in the vicinity of the beak, peculiar to the genus *Strophomena*.

The geniculated portion of the valve having been broken off entirely, the surface of my specimen shows the reticulate ornamentation only, restricted to the posterior portion of complete forms. The longitudinal striæ are very numerous and somewhat irregular. The concentric wrinkles are more strongly marked.

Among them those wrinkles, which are situated in the vicinity of the apex, meet the cardinal border at right angles or are even slightly converging towards the beak, whilst those, which are situated on the visceral portion of the valve follow the marginal curves in their direction and are consequently turned outwardly towards the cardinal angles.

My specimen is too incomplete to allow exact measurements to be given.

Locality and geological position; *number of specimens examined.*—Shales with limestone partings containing *Productus Abichi*, *Chonetes grandicosta* and *Marginifera himalayensis*, western summit of a ridge North-East Prongam Trál, Kashmir; Coll. Lydekker; 1.

Remarks.—This species belongs to a series of forms, which ranging from silurian into permo-carboniferous deposits, are changing so slightly in their shape and sculpture that the majority of palæontologists are inclined to consider them as variations of a single species only. L. de Koninck (Recherches sur les foss. pal. de la Nouvelle Galles du Sud, p. 210), however, does not share in this view, but believes the carboniferous *St. analoga* to differ by a few though very subordinate constant characters from its silurian and devonian allies.

St. analoga, in L. de Koninck's circumscription of this species, is a form of a tolerably large geographical and geological distribution. It is known from the lower carboniferous deposits of western Europe and of Nova Scotia, from the upper carboniferous rocks of Queensland and of New South-Wales, and from the permo-carboniferous limestone of Barents' Island (North-West Nowaja Semla). With the specimens which have been collected from the last mentioned locality by Hœfer and described by Toula, Lydekker's example from Kashmir resembles most closely by the comparatively strong convexity of its ventral valve.

A very large form of a *Strophomena* has been figured by Dr. Verchère. But the author does not state whether it was obtained from the Zewan beds of Kashmir or from the Productus limestone of the Salt Range.

Sub-family: ORTHOTHETINÆ, Waagen.

Genus: DERBYIA, Waagen.

DERBYIA CF. SENILIS, Phillips. Pl. VI, figs. 5, 6.

1856. *Spirifer senilis*, Phillips, Geology of Yorkshire, Vol. II, Pl. IX, fig. 5.
1861. *Streptorhynchus crenistria var. senilis*, Davidson, Monograph British carboniferous Brachiopoda, p. 124, Pl. XXVII, figs. 2, 3, 4 Pl. XXX, figs. 13, 14 (*caeteris exclusis*).
1866. *Streptorhynchus crenistria*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 42, Pl. II, fig. 10.
1880. *Streptorynchus crenistria var. senilis* (?) Roemer Ueber eine Kohlenkalk-fauna von der Westkueste von Sumatra, Palæontographica, 27 Bd., p. 6.
1880. *Orthothetes crenistria var. senilis*, Etheridge jun., Proceed. Royal Pvs. Soc. of Edinburgh, p. 282, Pl. VII, figs. 12–15.
1883. *Orthothetes crenistria var. senilis*, Kayser, Obercarbonische Fauna von Loping, Richthofen's "China," IV, Bd., p. 178, Pl. XXIII, figs. 1—7.
1884. *Derbyia senilis*, Waagen, Salt Range Fossils, Pal. Ind., ser. XIII, Vol. I, Prod. Limest. Foss., p. 593.
1892. *Derbyia senilis*, Etheridge jun., Jack and Etheridge, Geology and Palæontology of Queensland and New Guinea, p. 246, Pl 12, figs. 1–6.

It is with great reserve only that I refer some of the numerous fragments from the carboniferous rocks of Kashmir which have been identified with *Orthothetes crenistria* by Davidson to the present species. As has been stated by Professor Waagen himself, a distinction of the different species which he introduced in his genus Derbyia is extremely difficult "as the forms are very variable and seemed to be linked together by more or less numerous transitional shapes." A specific distinction therefore becomes impossible, if one has to do with fragmentary specimens.

Among my materials of *Derbyia*, accepting Waagen's separation of this genus and *Orthothetes*, there is only one single, fairly complete dorsal valve. It is on account of its strong similarity to the British and Chinese types of *Derbyia senilis* that I refer a few fragments of ventral valves to the same genus, although no trace of the characters, which led Waagen to a generic distinction between *Streptorhynchus*, *Derbyia* and *Orthothetes*, has been preserved in any of my specimens.

The dorsal valve, which alone, among all the rest of fragments provisionally referred to this species, is fairly complete, appears to me to have a stronger affinity with *Derbyia senilis*, than with any of the species described from the Productus Limestone of the Salt Range by Waagen, or from the upper carboniferous limestone of the Krone by Schellwien. It agrees almost perfectly with the British specimen figured by Davidson on Pl. XXVII, fig. 3 of his monograph. It is moderately convex, but the regularity of the curve is slightly deformed by pressure. No distinct median furrow has been noticed. The hinge-line is considerably shorter than the greatest width of the shell. In this respect the present specimen is also most closely allied to the British form from Bolland and to the Chinese types from Loping, described by Kayser, but distinctly differs from all the Salt Range species of the group of *D. senilis*. Etheridge's type specimens of *D. senilis* from Queensland are likewise provided with a short hinge-line and therefore agree best with the Himálayan and Chinese types.

Towards both ends of the hinge-line the valve is somewhat flattened. Thus two small flattened wings are formed on each side. The frontal line seems to be nearly straight, not depressed in the middle.

The surface of this valve is ornamented with numerous radiating striæ of unequal strength. These striæ, the edges of which appear locally crenelated by the intersection of concentric wrinkles, are somewhat irregular, often flexuous and dichotomising.

The measurements of this specimen are as follow :—

Length of the dorsal valve	21·5 mm.
Breadth „ „ „	26 „
Thickness „ „ „	4 „
Length of the hinge-line	14 „

Whereas this specimen may be referred to *Derbyia senilis* with great probability, although I am not convinced of its identity with the latter species, the appurtenance of several other fragments to the genus *Derbyia* is much more doubtful. One of the more complete, which has been figured on Pl. VI, fig. 6 of this memoir, exhibits the peculiar semiconic shape of the valve and the step-like

interruptions in the sculpture "produced by two or three very large and irregular concentric undulations," which are among the leading features of *D. senilis*. These are however the only claims my fragment can put in for a comparison with the present species.

Locality and geological position; number of specimens examined.—Micaceous shales with *Spirifer Musakheylensis* and numerous *Bryozoa*, Barus; Coll. Godwin-Austen; 4.

Remarks.—The large list of synonyms given for *Streptorhynchus crenistria* by L. de Koninck cannot be accepted for the present species, if the latter is taken in the narrow circumscription, which has been proposed by Waagen. Following the interpretation of that learned author, none of the American or Spitzbergen forms of the genus can be united with *Derbyia senilis*.

The true *D. senilis* has hitherto only been described from the mountain limestone of Western Europe and from the upper carboniferous deposits of China, Australia and (?) Sumatra. Its presence in the permian rocks of Timor is as yet very doubtful.

Sub-order: HELICOPEGMATA, Waagen.

Family: *NUCLEOSPIRIDÆ*, Davidson.

Sub-family: RETZIINÆ, Waagen.

Sub-genus: EUMETRIA, Hall.

1. EUMETRIA CF. GRANDICOSTA, Davidson. Pl. VI, fig. 10.

1862. *Retzia radialis var. grandicosta*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XVIII, p. 28, Pl. I, fig. 5.

1863. *Retzia radialis*, Phill., *var. grandicosta*, Davidson, in L. de Koninck, Memoire sur les fossiles paléozoiques, recueillis dans l'Inde, p. 33, Pl. IX, fig. 5.

1867. *Retzia radialis var. grandicosta*, Verchère, Kashmir, the Western Himálaya and the Afghan Mts. Journ. Asiat. Soc. of Bengal, XXXVI, Pt. 2, No. 3, p. 211.

1882. *R. grandicosta*, Kayser, Obercarbonische Fauna von. Loping, Richthofen's "China," IV Bd., p. 176.

1884. *Eumetria grandicosta*, Waagen, Salt Range Foss., Pal. Ind., ser. XIII, Vol. I. Productus Limest-Foss., p. 491, Pl. XXXIV, figs. 6-12.

1890. *Retzia grandicosta*, Nikitin, Mém. Comité Géol. St. Pétersbourg, Vol. V, No. 5, p 68, Taf. III, figs. 9-11.

1892. *Retzia grandicosta*, Rothpletz, Die Perm-Trias und Juraformation auf Timor und Rotti, Palæontographica, 39 Bd., p. 83, Taf. X, fig. 11.

Two incomplete forms of a small brachiopod with a punctate shell structure and with radiating costæ have been obtained from the carboniferous rocks near Eishmakam by R. Lydekker. I think there can be but little doubt that the species is a representative of the genus *Retzia* or of its sub-genus *Eumetria*. It is not impossible that we are dealing here indeed with the widely distributed

Eumetria grandicosta, but the state of preservation of my specimens does not warrant a certain identification.

The more complete one of my two forms is a little longer than large, and provided with moderately and evenly convex valves. The beak of the ventral valve has unfortunately been broken off. Neither a sinus nor a median fold is developed in any of the two valves. Each valve bears about eight or ten prominent costæ, which are distinctly rounded on their tops. Their exact number cannot be made out, because the lateral portions of the shell are partly covered by the tough, adhering matrix, which I have not been able to remove.

In my second specimen consisting of a dorsal valve, nine ribs are counted. The median rib does not surpass the others in strength.

The shell is punctate.

The measurements of the figured specimen are, approximately, as follow:—

Length of the shell	cca. 7 mm.
„ „ „ dorsal valve	6 „
Breadth of the shell	5·5 „
Thickness of the two valves	2·5 „

The reference of this shell to *Eumetria grandicosta* is provisional only, although it seems to exhibit a stronger resemblance to this species than to the rest of congeneric forms. From *E. ulotrix*, de Koninck, or from *E. indica*, Waagen, it differs by the greater number and by the less prominent character of its costæ. In *Retzia radialis*, Phill., the number of ribs is, as a rule, larger, and in typical shapes at least a median sinus or corresponding fold is developed. With *Retzia pseudocardium*, Nikitin, a closer comparison is scarcely necessary. From *Retzia Mormonii*, Marcou, (Geology of North America, Pl. VI, fig. 11), it is distinguished by its less globose shell.

A similar remark applies to *Retzia compressa*, Meek (Palæontology of California, Vol. I, p. 14, Pl. II, fig. 7), which is, however, very closely allied to my Kashmir specimens and specially agrees with them perfectly well in size and number of ribs. It is therefore not impossible that a larger number of better preserved types of the present species might prove the latter to be rather a variety of *Retzia compressa* than of *Eumetria grandicosta*.

Locality and geological position; number of specimens examined.—Dark limestone, crowded with young individuals of indeterminable brachiopods, Eishmakam, Kashmir Valley; Coll. Lydekker; 2.

Remarks.—In the Salt Range *Eumetria grandicosta* is equally distributed throughout the entire thickness of the Productus limestone, with the only exception of the Chidru beds. It has been, moreover, described from the Gshelian stage of the carboniferous system in Central Russia by Nikitin and from the permian rocks of Timor by Rothpletz.

Retzia compressa is quoted from the anthracolithic rocks of California by Meek and from the upper carboniferous *Fusulina* limestone of Loping in China by Kayser.

Family : *ATHYRIDÆ*, Phillips.

Sub-family : ATHYRINÆ, Waagen.

Genus : ATHYRIS, M'Coy.

(SPIRIGERA, d'Orbigny.)

The family *Athyridæ* is represented among the brachiopoda from the anthracolithic rocks of Kashmir and Spiti by the genus *Athyris* only.

The sub-genus *Spirigerella*, Waagen, which is so largely represented in the Salt Range, is entirely absent from my fossil materials from the North-Western Himálayas. I must lay a special stress on this fact because Waagen himself supposed Davidson's and Verchère's *Athyris subtilita* from Kashmir to be identical with *Spirigerella Derbyi*, an identification in which this learned author has however been mistaken.

Among the representatives of the genus *Athyris* in the Geological Survey's Himálayan collection from Kashmir and Spiti the three following species can be distinguished :—

1. *Athyris Gerardi*, nov. sp.
2. *A. cf. expansa*, Phillips.
3. *A. subtilita*, Hall.

The first is restricted to the Kuling shales of Spiti, the two others have been obtained from the upper carboniferous beds of Kashmir.

Besides these three species *Athyris cf. Royssii*, Lev., and *A. Budhista* have been quoted from the Zewán beds of Kashmir by Dr. Verchère.

1. ATHYRIS GERARDI, nov. sp. Pl. VI, figs. 12, 13, 14.

1897. *Athyris Royssii*, Diener, *ex parte*, Himálayan Fossils, Palæontologia Indica, ser. XV, Vol. I, Pt. 4. The fauna of the permian Productus shales of Johár and Painkhánda, Pl. V, fig. 5 (*non* 7).

In my monograph of the brachiopoda obtained by Griesbach from the permian Productus shales of Johár and Painkhanda, I identified the present shell with *Athyris Royssii*, Leveillé, the materials then at my command not being sufficient to enable me to introduce a new species. A number of better preserved forms having subsequently turned up from Dr. Gerard's collections from the Kuling shales of Spiti, I was able to assure myself that they differ from *A. Royssii* by some constant features. The differences, which might be established between them, are of a similar character to those which induced Count A. de Keyserling (Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland, St. Petersburg, 1846, p. 237) to separate *A. Royssiana* from *A. Royssii*.

As leading features of this species the following ought to be considered. The shell attains a larger size than in any of the hitherto described forms of *Athyris*. The ventral valve is almost perfectly flat and the difference in the inflation of the

two valves is much more remarkable than in *A. Royssii* or in *A. Royssiana*. With the latter species the present one agrees in the presence of an uncommonly large apical angle, which in full-grown individuals attains about 150°, and in the small size of the beak, which barely overhangs the hinge-margin. A remarkable difference between the Himálayan and the Russian species exists, however, in the shape of the mesial sinus. In *A. Royssiana* the sinus is rather strongly developed and shaped into a highly prominent tongue, which is bordered by parallel margins. In *A. Gerardi* the sinus is but slightly impressed, in adolescent types of 15 mm. in length barely if at all perceptible, and in full grown individuals is always bordered by distinctly converging margins.

The only two specimens, which I have been able to secure from the Productus shales of Kiunglung near the Niti Pass, were in a rather imperfect state of preservation. I consequently failed in making out their characters of distinction with sufficient certainty so as to feel justified in separating them from *Athyris Royssii* (in a wider interpretation of this latter species than has been admitted by L. de Koninck). The specimen, figured on Pl. V, Fig. 7 of my above-quoted memoir, ought, however, to remain with *A. Royssii*. Its sub-pentagonal outline, the small size of its apical angle (100° only), and the presence of a well developed sinus are in favour of an identification with the latter species. I first thought this type to be linked to the true *A. Gerardi* by intermediate shapes, but this view I find no more tenable since numerous young forms of *A. Gerardi* from the Kuling Shales of Spiti have come to my knowledge, which, although approaching in their outline and in the size of the apical angle the specimen from Kiunglung are constantly differing from the latter by the greater flatness of their ventral valves and by the absence of any distinctly marked sinus. I consequently deemed it preferable to leave this specimen with *Athyris Royssii*.

The specimen from the Productus shales of the Chor Hoti, figured by Salter in the Palæontology of Niti (p. 53, Pl. V, fig. 13) ought, according to my humble opinion, likewise to be identified with *A. Royssii* rather than with the present species.

The measurements of a tolerably well preserved ventral valve are approximately as follow :—

Entire length of the shell	40 mm.
„ breadth „ „ „	52 „
Thickness of the ventral valve	3·5 „
Apical angle of „ „ „	145°

My largest specimen attains an approximate length of 45 mm., corresponding to a width of 60 mm.

Locality and Geological position; number of specimens examined.—Sandstone partings in the Kuling shales N. W. of Po, Spiti; Coll. Gerard; 7.

Remarks.—*Athyris Gerardi* must be added to the numerous elements peculiar to the fauna of the Productus shales, the large number of which imparts to the latter its characteristic aspect. The sandstone partings, in which this species occurs in the Kuling shales of Spiti, do not differ lithologically from the layers in which it has been found imbedded in Painkhánda, associated with *Spirifer Moosakheylensis*, *Sp. Nitiensis* and *Productus gangeticus*.

2. Athyris cf. expansa, Phillips. Pl. VI, fig. 11.

1836. *Spirigera expansa*, Phillips, Geology of Yorkshire, Vol. II, p. 220, Pl. X, fig. 18.
1840. *Atrypa expansa*, Sowerby, Mineral Conchology, Pl. DCXVII, fig. 1.
1840. *Atrypa fimbriata*, Sowerby (*non* Phillips), ibidem, fig. 4.
1857. *Athyris expansa*, Davidson, Monograph British carbon. Brachiopoda, p. 82, Pl. XVI, figs. 14, 16-18, Pl. XVII, figs. 1-5.
1888. *Athyris expansa*, Krotow, Mém comité géol. St. Pétersbourg, Vol. VI, p. 421.

A single, rather poorly preserved specimen may be provisionally referred to this species. It is very transversely elliptical, nearly twice as broad as long. The ventral valve, which alone is accessible to observation, is very evenly convex, but not strongly inflated. No trace of a mesial sinus has been noticed. The ornamentation of the shell consists of numerous, concentric lines of growth, which are occasionally intersected by an indistinct radiating sculpture.

The present specimen appears by its general shape and outline to be most closely allied to *Athyris expansa*. From *A. subexpansa*, Waagen, it is distinguished by the absence of any mesial sinus and of fringed lateral expansions.

The measurements of this specimen are approximately as follow:—

Entire length of the ventral valve	22	mm.
„ breadth „ „ „	40	„
„ thickness „ „ „	6	„
Apical angle of the ventral valve	cca. 140°	

Locality and Geological position; number of specimens examined.—Dark, micaceous shales N. of Khummú, near Pampur; Coll. Lydekker; 1.

Remarks.—*Athyris expansa*, Phill., has been quoted from the mountain limestone of England and Ireland by Davidson, and from the lower portion of the carboniferous limestone of Tscherdyn (Russia) by Krotow.

3. Athyris subtilita, Hall. Pl. VII, figs. 1-3.

1842. *Spirifer Royssii*, d'Orbigny, Voyage dans l'Amérique Méridionale, T. III, 4 ème ptie, Paléontologie, p. 76, Pl. III, figs. 17-19.
1852. *Terebratula subtilita*, Hall, in Howard Stansbury's Report of an exploration of the valley of the Great Salt Lake of Utah, Philadelphia, p. 409, Pl. IV, figs. 1, 2.
1855. *Terebratula subtilita*, Schiel, Pacific Railroad Report, Vol. II, p. 108, Pl. I, fig. 2.
1856. *T. subtilita*, Hall, ibidem, Vol. III, p. 101, Pl. II, fig. 4.
1857. *Terebratula subtilita*, Davidson, Monograph British Carb. Brachiopoda, p. 18, Pl. I, figs. 21, 22.
1857. *Athyris subtilita*, Davidson, ibidem, p. 86, Pl. XVII, figs. 8-10.
1858. *Terebratula subtilita*, Marcou, Geology of North America, p. 52, Pl. VI, fig. 9.
1858. *Terebratula subtilita*, Hall, Report on the Geological Survey of Iowa, Vol. I, Pt. 2, Palæont., p. 714.
1861. *Athyris subtilita*, Salter, Quart. Journ. Geol. Soc. London, Vol. XVII, p. 64, Pl. IV, fig. 4.
1863. *A. subtilita*, Davidson, ibidem, Vol. XIX, p. 170, Pl. IX, figs. 4, 5.
1866. *A. subtilita*, Davidson, ibidem, Vol. XXII, p. 40, Pl. II, fig. 2.
1866. *A. subtilita*, Geinitz, Carbonformation und Dyas in Nebraska, p. 40, Taf. III, figs. 7-9.
1867. *A. subtilita*, Verchère, Kashmir, the Western Himalaya and the Afghan Mts., Journ. Asiat. Soc. of Bengal, Calcutta, Vol. XXXVI, Pt. II, No. 3, pp. 203, 210, Pl. II, figs. 1, 1*a*.
1869. *Spirigera* (*Athyris*) *subtilita*, Toula, Ueber einige Fossilien des Kohlenkalkes von Bolivia, Sitzungsber. Kais. Akad. d. Wiss. Wien, math. nat., Cl. LIX. Bd., I. Abth. p. 6, fig. 5.

1872. *Athyris subtilita*, Meek, Final Report of the U. S. Geol. Surv. of Nebraska, Pt. II, p. 180, Pl. I fig. 12; Pl. V, fig. 9; Pl. VII, fig. 4.

1874. *A. subtilita*, Derby (*ex parte*), on the carboniferous brachiopoda of Itaitúba, Bull. Cornell University, Ithaca, Vol. I, No. 2, p. 7.

1875. *A. subtilita*, Toula, Eine Kohlenkalkfauna von den Barents Inseln, Sitzungsber. Kais. Akad. d Wiss. Wien, math. nat. Cl. Bd. LXXI, I. Abth. p. 20.

1877. *A. subtilita*, Meek, in Cl. King's Report of the U. S. Geological Exploration of the 40th parallel, Vol. IV, Palæontology, p. 83, Pl. VIII, fig. 6.

1877. *Spirigera subtilita*, White, in Wheeler's Report upon the U. S. Geological Surv., West of the one hundredth Meridian, Vol. IV, Palæontology, p. 141, Pl. X, fig. 6.

1884. *Spirigera subtilita*, White, XIII, Annual Report of the Geol. of Indiana, Pt. II, p. 136, Pl. XXXV, figs. 6-9.

1887. *Athyris subtilita*, L. de Koninck, Faune du calcaire carbonifère de la Belgique, 6 *ème* ptie, Annales du Musée Royal d' hist. nat. de Belgique, Bruxelles, T. XIV, p. 73, Pl. XVIII, figs. 1-4, 7-10, 12-28, Pl. XIX, figs. 47-56.

1897. *A. subtilita*, Perrin Smith, Marine Fossils from the coal-measures of Arkansas, Proceed. Amer. Philos. Soc., Vol. XXXV, No. 152, p. 31.

This species, which is one of the most abundant and widespread carboniferous brachiopoda, has been quoted from the Barus or Zewán beds of Kashmir by Prof. Davidson in 1866 and by Verchère in 1867. The correctness of this identification has been doubted by Waagen (Salt Range Foss., Pal. Indica, ser. XIII, Vol. IV, Geological Results, p. 165), who united the Himálayan species with *Spirigerella Derbyi*, Waag. This latter view has not, however, been confirmed by my subsequent examination of a considerable number of types, collected by Godwin-Austen, Verchère and Lydekker in the carboniferous strata of the Kashmir Valley. In none of these specimens is the beak of the ventral valve firmly appressed to the apex of the dorsal one, but always distinctly exhibits the moderately large foramen truncating its extremity. In the list of synonyms of *Spirigerella Derbyi*, given in my memoir on the permian Productus shales of Johár and Painkhánda (Pt. IV of the present volume), these Kashmir shells have been quoted on the authority of Waagen. This view I find, however, no more tenable.

My specimens agree almost perfectly with some of the best figures which have been published up to the present of the American types of *Athyris subtilita* by Geinitz and Meek, and of the European ones by L. de Koninck.

The ovoid shell is, as a rule, longer than wide, its greatest width being situated a little in advance of the middle. The ventral valve is somewhat tapering at the beak, which is prominent, distinctly incurved and always pierced by a moderately large foramen. In the majority of my Kashmir specimens the two valves are almost equally convex, but not very strongly inflated. As has been noticed by L. de Koninck in some Belgian types of *Athyris subtilita*, the inflation occasionally becomes so strong that they can barely at all be distinguished from *A. globularis*, Phill. Among my Himálayan specimens a similar shape never occurs. None of them is decidedly gibbous, not even in adult age. A mesial sinus is nearly always present, but indicated only by a low median impression, which originates in the visceral region of the shell and corresponds to an elevated convex curve in the front margin. A distinct tongue-shaped process, corresponding to this frontal wave, so conspicuous in *Spirigerella Derbyi*, Waagen, especially in the *var. acuteplicata*, is but rarely developed.

On the dorsal side of the ventral valve, laterally from the beak, a narrow false area extends to the end of the hinge-line. It is marked off from the remainder of the shell by indistinct ridges.

The dorsal valve is not quite equally curved in the transverse direction but is of a somewhat roof-shaped appearance, sloping from a broadly rounded median crest in moderately convex planes towards the lateral margins. The beak is strongly incurved under that of the opposite valve.

The surface is nearly smooth or covered with irregular, concentric striæ of growth only. In the majority of my specimens, however, the shell substance has been too strongly injured by weathering to allow anything of the minor details of its ornamentation being noticed.

The measurements of a fairly complete specimen (fig. 1) are as follow :—

Entire length of the shell	25·5 mm.
Length of the dorsal valve	23·5 „
Entire breadth of the shell	24 „
Thickness of both valves	15 „
Apical angle of the ventral valve	81°
„ „ „ dorsal „	96°

Of the internal structure nothing is to be made out in any of my specimens.

Locality and Geological position; number of specimens examined.—Coarse, grey limestone, north of Khummúu, near Pampur, Kashmir Valley; Coll. Lydekker, 9; Coll. Godwin-Austen, 5; Zawoor, Kashmir Valley, Zewán beds, Verchère.

Remarks.—*Athyris subtilita* is a very common and widespread species, ranging throughout the entire carboniferous system into permo-carboniferous and perhaps even into still higher permian deposits. It has been quoted from the United States of North America, from Nova Scotia, Bolivia, Brazil, Western Europe and Barents Island by various authors.

Meek advocates the identity of *Athyris subtilita*, Hall, with a shell from the upper coal-measures of Illinois, which had been described as *Terebratula argentea* by Shepard in 1838. The figure given by that author in the American Journal of Science (Vol. XXXIV, fig. 8) does not however agree with adult forms of *A. subtilita*. Shepard's original type not having been found up to present, its claims of priority to the name of that species are as yet very uncertain. Meek's question, whether the present shell ought not to be called *A. Peruviana*, because A. d'Orbigny figured it in 1847 under the name of *Terebratula Peruviana*, must also be answered in the negative. The name *Terebratula Peruviana* has been given erroneously in the Plate of d'Orbigny's monograph, whilst in the text it is applied to a very different species from devonian rocks (Voyage dans l'Amérique Méridionale, T. III, Paléont. p. 36, Pl. II, figs. 22-25).

Spirigera protea var. subtilita, Abich (Geologische Foruschungen in den Kaukasischen Laendern, I, Th. Eine Bergkalkfauna aus der Araxesenge bei Djulfa, p. 59, Taf. VIII, figs. 10, 11) has nothing to do with the true *Athyris subtilita*, as has been remarked by Val. von Moeller and by Rothpletz.

A species which is probably very closely allied to the present one has been described and figured as *Athyris Buddhista* by Dr. Verchère (l. c. p. 210, Pl. II,

figs. 2, 2*a*, 2*b*). This species, which has been collected in the Zewán beds of Kashmir, seems to differ from *A. subtilita* by its strongly attenuated apical region and by the presence of a sharp median fold in the dorsal valve. No specimen resembling Dr. Verchère's illustration has come to my notice. Provided this illustration be correct, *Athyris Buddhista* should be considered as an independent species.

Family: *SPIRIFERIDÆ*, d'Orbigny.

Subfamily: SUESSIINÆ, Waagen.

Genus: SPIRIFERINA, d'Orbigny.

1. SPIRIFERINA CF. KENTUCKENSIS, Shumard. Pl. V, figs. 11, 12.

1852. *Spirifer octoplicatus*, Hall, in Howard Stansbury's Report on the Exploration of the Valley of the Great Salt Lake in Utah, p. 409, Pl. XI, fig. 4.

1855. *Spirifer Kentuckensis*, Shumard, Geological Survey of Missouri, p. 203.

1856. *Spirifer Kentuckensis*, Hall, Pacific Railroad Report, Vol. III, p. 103, Pl. II, figs. 10, 11.

1866. *Spirifer laminosus*, Genitz (*non* M'Coy), Carbonformation und Dyas in Nebraska, p. 45, Taf. II, fig. 19.

1867. *Spirifera octoplicata var. transversa*, Verchère, Kashmir, the Western Himalaya and the Afghan Mts., Journ. Asiat. Soc. of Bengal, Calcutta, Vol. XXXVI, Pl. 2, p. 210, Pl. I, figs. 2, 2*a*, 2*b*.

1872. *Spiriferina Kentuckensis*, Meek, Palæontology of Eastern Nebraska in Final Rep. upon the U.S. Geol. Surv. of Nebraska, p. 185, Pl. VI, fig. 3, Pl. VIII, fig. 11.

1877. *Sp. Kentuckensis*, White, in Wheeler's Report upon U. S. Geological Surveys W. of the one hundredth Meridian, Vol. IV. Palæontology, p. 138, Pl. X, fig. 4.

Numerous casts and external impressions of dorsal valves of a strongly transverse *Spiriferina* have been collected in the Zewán beds of Kashmir both by Capt. Godwin-Austen and by Dr. Verchère. Curiously enough, dorsal valves only are represented among the materials available to me for examination. Some of them which are tolerably well preserved, though none is complete, closely resemble *Spiriferina Kentuckensis* from the North American coal-measures. I consequently thought it advisable to refer them provisionally to that species, although I do not venture on a direct identification, having regard to the absence of any ventral valves among my materials.

Among four better preserved dorsal valves two are quite as large as the specimen from the coal-measures of Nebraska, figured by Meek on Pl. VI, fig. 3 of his above-quoted memoir. They are very strongly transverse, of a sub-fusiform shape, terminating in slender attenuated ears. The hinge-line corresponds to the greatest width of the shell. On each side of the mesial fold from three to five simple prominent ribs are distributed. All the ribs are slightly rounded on their crests and separated from each other by deep V shaped valleys, which are sharply rounded at the bottom. The first plications on each side of the mesial fold are but slightly inferior in size to the latter.

The surface is ornamented with very numerous prominent and closely-crowded lines of growth. This concentric sculpture is so strong as to hide almost completely the granulated structure of the shell substance.

Of the ventral valve the impression of the beak and area only are preserved in one of my specimens (Pl. V, fig. 12). In this specimen the greatest width of the dorsal valve is 24 mm., corresponding to a length of 11 mm., and to a length of the entire shell of 13 mm.

Locality and Geological position; number of specimens examined.—Zewán beds, Kashmir Valley; shales and micaceous limestones with numerous *Bryozoa*, *Spirifer Musakheylensis*, *Derbyia cf. senilis*, etc.; Coll. Godwin-Austen, 4; Coll. Verchère, 2.

Remarks.—Among all the hitherto described species of *Spiriferina* there is only the present one to which my specimens from Kashmir may be advantageously compared. The sub-fusiform shape and the strong concentric ornamentation clearly distinguish them from *Spiriferina cristata*, Schloth., and *Sp. octoplicata*, Sow. They likewise differ by their sub-fusiform shape and long hinge-line from *Sp. insculpta*, Phill., and *Sp. ornata*, Waag., with which they have the distinct concentric ornamentation in common. The only European species, which my Kashmir forms resemble more closely, is *Sp. peracuta*, de Koninck (Faune du calcaire carbonifère de la Belgique, Annales du Musée Royal d' hist nat., T. XIV, 6 *ème* ptie., p. 101, Pl. XXII, figs. 56-61) from the mountain-limestone of Belgium and Ireland. A remarkable difference consists, however, in the larger size of the dorsal median fold in *Sp. peracuta* which, according to L. de Koninck's description, is twice as large as the neighbouring lateral ribs, whereas it scarcely surpasses them in size in my Himálayan shell.

Spiriferina laminosa, M'Coy, which has been erroneously identified with *Sp. Kentuckensis*, by Geinitz, is easily distinguished from the latter by its much larger size and the broad area of the ventral valve.

The shells described and figured as *Spiriferina octoplicata* var. *transversa* by Verchère, will probably fall within this species. I am led to this conclusion, which might scarcely be drawn from Verchère's exceedingly bad figures, by the examination of two specimens collected by that author in the Zewán beds of the Kashmir Valley.

As one of the chief characteristics of *Spiriferina Kentuckensis* lies in the shape of the sinus of the ventral valve, the reference of my specimens, which are dorsal valves only, to this American species, must yet remain provisional.

Spiriferina Kentuckensis is a common species in the carboniferous and permo-carboniferous strata of Kentucky, Illinois, Missouri, Iowa, Nebraska, Kansas, Utah, New-Mexico, Arizona and Texas, but does not descend into beds of sub-carboniferous

Sub-family: DELTHYRINAE, Waagen.

Genus: SPIRIFER, Sowerby.

The genus *Spirifer* is rather richly represented in the anthracolithic system of Kashmir and Spiti. Not less than ten species are counted among the materials examined by Prof. Davidson and myself, although one-half of this number only are

sufficiently complete to allow of a satisfactory diagnosis of their specific characters being given.

These species may be grouped most conveniently in the following manner :—

I. Group of Spirifer fasciger, Keyserl.
1. *Spirifer Musakheylensis*, Davidson.
2. *Sp. sp. ind., aff. Musakheylensis.*
3. *Sp. Nitiensis*, Diener.

II. Group of Spirifer trigonalis, Mart.
4. *Spirifer cf. Triangularis*, Martin.

III. Group of Spirifer pinguis, Sowerby.
5. *Spirifer Vihianus*, Davidson.

IV. Group of Spirifer Rajah, Salter.
6. *Spirifer Rajah*, Salter.
7. *Sp. sp. ind., aff. Rajah.*

V. Group of Spirifer Clarkei, de Kon.
8. *Spirifer Lydekkeri*, nov. sp.
9. *Sp. sp. ind. ex. aff. Lydekkeri.*

VI. Group of Spirifer Alatus, Schloth.
10. *Spirifer Kashmeriensis*, Davidson.

Of all these species eight are entirely restricted to the anthracolithic rocks of the Himálayas. Among them *Spirifer Lydekkeri* and its allies are of a special interest, on account of their relationship to the Australian *Sp. Clarkei*, whilst *Spirifer Rajah* exhibits a close affinity to Arctic types from Spitzbergen. Two species only occur also in the carboniferous system of Europe; these are *Sp. Musakheylensis* and *Sp. triangularis*, while a third one, *Sp. vihianus*, is very closely allied to the European *Sp. pinguis*.

I. Group of Spirifer fasciger, Keyserling.

1. Spirifer Musakheylensis, Davidson, Pl. V, figs. 3—7.

1862. *Spirifer Moosakheylensis*, Davidson, Quart. Jour. Geol. Soc., London, Vol. XVIII, p. 28, Pl. II, fig. 2.

To the list of synonyms, given in Part IV of the present volume, the following ought to be added :—

1867. *Sp. Moosakheylensis*, Verchère, Journ. Asiat. Soc. of Bengal, Vol. XXXVI, Pl. 2, p. 210, Pl. III., figs. 1, 1*a*.

1890. *Sp. Musakheylensis var. australis*, Foord, Notes on the Palæontology of Western Australia, Geol. Magazine, New ser, Decade III, Vol. VII, p. 147, Pl. VII, fig. 2.

This species is very common, both in the Zewán beds of Kashmir and in the Kuling shales of Spiti, but no complete specimen has been noticed among the materials available to me for examination, ventral and dorsal valves being nearly always met with separately.

To the detailed description of the specimens from the Productus shales of Johár and Painkhánda I have but little to add.

In spite of the great variability of the shapes there is not a single one among my specimens from the anthracolithic rocks of Kashmir and Spiti which agrees with either *Spirifer fasciger*, Keyserling, or with *Sp. tegulatus*, Trautschold. The folds, corresponding to the fasciculi of ribs, are invariably rounded but never provided with acute edges, as in Gruenewaldt's and Tschernyschew's type-specimens of *Sp. fasciger*. The lamellose character of the striæ of growth is distinctly developed in the majority of my forms, but the peculiar sculpture of *Sp. tegulatus*, reminding one of a tiled roof, has not been noticed in any of my Indian representatives of this group. Some of my specimens from the Kuling shales of Spiti agree perfectly well with the type from the Productus shales of Kuling, figured on Pl. V, fig. 1 of Pt. IV of the present volume by the unusually flat convexity of their folds.

The specimens from the Kuling shales of Spiti attain very considerable dimensions, the largest specimen collected by Dr. Gerard measuring about 60 mm. in length and 130 mm. in breadth.

Of the internal characters of the ventral valve of this species some information has been gathered by an examination of the casts figured on Pl. V, Figs. 5 and 7 of the present memoir. In the apical region the shell-substance is so extremely thickened that the dental plates and the outer walls of the valve are united into one solid shelly mass, on which the entire area rests. The muscular impressions are distinctly marked. On each side of them the internal surface of the shell is covered with numerous irregular grooves, which on the cast are exhibited as rounded granulations. The ornamentation of the cast is very simple, consisting of a few broad and flat wavy folds only, while the ribbing of the external shell-surface is completely absent.

Locality and Geological position; number of specimens examined.—Zewán beds, Kashmir Valley, Coll. Godwin-Austen, 6, Coll. Lydekker, 1; Kuling Shales, Spiti Valley, Coll. Gerard, 3, Coll. Stoliczka; Khar, Coll. Griesbach, 1.

Remarks.—The specimen from the carboniferous rocks of West Australia, described and figured as *Spirifer Musakheylensis var. Australis*, by Foord, does certainly belong to the present species. Foord, stating the close resemblance of the Australian fossil to Davidson's types, notes the only difference between them to be that "the ornaments of the Australian species are perhaps a little coarser than those of the Indian one, *i.e.*, the former has slightly larger and consequently fewer small ribs (comparing together individuals of the same size) than the latter and the imbricating lamellæ exhibit the same divergence of character. It seems however scarcely necessary to regard these slight differences as of more than varietal importance, especially if one takes into account the variations in any large assemblage of brachiopods, as Davidson himself has so often demonstrated in his plates".

That the Australian variety is included among the variations of the Himálayan *Sp. Musakheylensis*, is clearly evident from an examination of the specimen from the Productus shales of Kiunglung, figured on Pl. IV, Fig. 1, of my monograph of the fauna of the Productus shales (Pt. IV of the present volume).

This specimen exactly agrees with the Australian type of our species by its coarse ribs and lamellæ.[1]

2. Spirifer cf. Nitiensis, Diener. Pl. V, fig. 9.

1897. *Spirifer Nitiensis*, Diener, The Permian fauna of the Productus Shales of Johár and Painkhánda, Pal. Indica, ser. XV, Himálayan Fossils, Vol. I, Pt. 4, Pl. IV, figs. 4, 5.

The fragment of a ventral valve from the Kuling shales of Spiti agrees so perfectly well in its outline and ornamentation with this remarkable species that I do not hesitate to refer it to the latter, although its fragmentary condition may forbid a direct identification.

This fossil is almost of exactly the same size as my type specimen from Kiunglung (Pl. IV, fig. 5), though perhaps even a little more strongly transverse. It is moderately curved in the longitudinal, but quite flat in the transverse direction. Its tolerably broad, reclining, parallel-sided and vertically-striated area is overlooked by the little pointed beak. The ornamentation consists of numerous ribs of unequal strength, arranged into fasciculi, each of which is composed of a small number of ribs only. On the wings the fascicular arrangement of the ribs becomes gradually indistinct. All the ribs are flatly rounded at their crests.

Locality and Geological position; *number of specimens examined.*—Sandstone partings in the Kuling shales, with *Athyris Gerardi*, Po, Spiti Valley; Coll. Gerard; 1.

Remarks.—*Spirifer Nitiensis* is a very characteristic species of the permian Productus shales of Gurhwál. I know of no other species of the genus *Spirifer* to which the present fragment could be referred, its peculiar ornamentation combined with the strongly fusiform shape distinguishing it from all the rest of congeneric forms.

3. Spirifer sp. ind. aff. Musakheylensis. Pl. V, fig. 10.

This interesting species, which in the Geological Survey's Himálayan collection from Kashmir is represented unfortunately by a single ventral valve only, seems to hold an intermediate position between *Spirifer Musakheylensis*, Davidson, and *Sp. Joharensis*, Diener (Part IV of this volume, Pl. IV, Fig. 3) from the permian Productus shales of Johár, but is more closely allied to the former.

It chiefly differs from Davidson's species by its stronger folds which are highly prominent and composed of a small number of secondary ribs only. There are not more than three ribs present in each of the fasciculi in the vicinity of the sinus. Among them the median primary rib is a little stronger than the rest. The sinus not having been preserved in my fragment, I have not been able to state the pre-

[1] *P. S.*—After having sent this paper to Calcutta for the press I had an opportunity of studying the beautiful collections of the Comité géologique de la Russie at St. Petersburgh. Prof. Tschernyschew, to whom I am indebted for many valuable information regarding the carboniferous faunæ of the Ural Mts., was kind enough to show me a large number of specimens of *Spirifer fasciger*, Keyserl. By their examination I have been convinced of the insufficiency of the characters on which I thought a specific distinction of *Sp. Musakheylensis* and *Sp. fasciger* might be based; consequently I no longer object to Prof. Tschernyschew's view as to the identity of the two species. For the *var. tegulata*, Trautschold, a varietal rank ought, however, to be retained.

sence of a mesial fold, as it is developed in *Sp. Joharensis*. The radial ornamentation is crossed by raised striæ of growth as in *Sp. Musakheylensis*.

The present specimen is too fragmentary to allow of any exact measurements being taken.

Locality and Geological position; number of specimens examined.—Dark, shaly, micaceous limestones with *Spirifer Musakheylensis*, *Productus cf. undatus* and numerous Bryozoa, Barus, Kashmir Valley; Coll. Godwin-Austen; 1.

Remarks.—A species, which the present specimen most closely resembles, has been figured and described by Toula (Permo-Carbon-Fossilien von der Westkueste von Spitzbergen, Neues Jahrb. f. Mineralogie, 1875, p. 240, Taf. VII, Fig. 3) as a variety of *Sp. cameratus*, Morton. The Spitzbergen specimen from Axel Island for the loan of which I am indebted to Dr. Fuchs, Director of the Imperial Museum of Natural History in Vienna, is likewise distinguished from *Sp. cameratus* and from *Sp. Musakheylensis* by its strong folds, composed of a small number of secondary ribs only, as has been correctly remarked by Toula. Nevertheless I do not think that the Himálayan and Spitzbergen forms should be united in the same species, since the ribs composing the fasciculi are equally strong in the latter but different in size among one another in the former specimen.

The fragment, figured as *Spirifer sp. ind.* by Gruenewaldt (Beitraege zur Kenntniss der sedimentæren Gebirgsformationen etc. Mém. Acad. impér. des sciences de St. Pétersbourg, VII, ser. T. II, 1860, p. 99, Pl. V, fig. 4) might perhaps fall within the relationship of this species or of *Spirifer Joharensis*.

II. Group of SPIRIFER TRIGONALIS, Mart.

4. Spirifer cf. triangularis, Martin. Pl. V, fig. 5.

1809. *Conchiliolithes Anomites triangularis*, Martin, Petrif. Derb., p. 10, Pl. XXXVI, fig. 2.
1827. *Spirifer triangularis*, Sowerby, Miner. Conch. Great Brit., Vol. VI, p. 120, Pl. 562, figs. 5, 6.
1836. *Spirifer triangularis*, Phillips, Geology of Yorkshire, Vol. II, p. 217, Pl. IX, fig. 12.
1840. *Sp. triangularis*, L. v. Buch, Mém. Soc. Géol. de France, T. IV, p. 182, Pl. VIII, fig. 5.
1843. *Sp. triangularis*, L. de Koninck, Descr. des animaux foss. du terrain carbonif. de la Belgique, p. 234, Pl. XV, fig. 1.
1844. *Spirifera otiorhyncha*, M'Coy, Synopsis of the characters of the carbon. limestone foss. of Ireland, p. 133, Pl. XXI, fig. 2.
1854. *Sp. triangularis*, Semenow, Zeitschr. Deutsche Geol. Ges. Bd. VI, p. 330.
1854. *Spirifera otiorhyncha*, M'Coy, Descr. of British Palæozoic, Foss. in the Cambridge Museum, p. 418, Pl. III, fig. 27.
1857. *Sp. triangularis*, Davidson, Monogr. British Carb. Brachiopoda, pp. 27 and 233, Pl. V, figs. 16-24, Pl. L, figs. 10-17.
1887. *Sp. triangularis*, L. de Koninck, Faune du Calc. carbonifère de la Belgique, Annales du Musée Royal, d'hist. nat. de Belgique, T. XIV, 6 ème ptie., p. 124, Pl. XXIX, figs. 7-15.
1888. *Sp. triangularis*, Krotow, Mém. Com. Géol. de la Russie, St. Pétersbourg, Vol. VI, p. 418.

The existence of this as a Himálayan species depends upon a fragmentary dorsal valve, collected by Lydekker in a quartzitic sandstone near Eishmakam (Kashmir Valley). In shape it is very like some of the types figured by Davidson and L. de Koninck, but slightly surpasses them in size. It is about twice as broad

as long, although exact measurements cannot be given, both the wings and the frontal portion of the mesial fold having been broken off. The most prominent character in the present valve is its strongly elevated, sharp, mesial fold, which "assumes the shape of a single, produced and acutely angular, cuneiform ridge or rib." Along the lateral slope of this central ridge two very low secondary folds are distinctly indicated, such as have been figured by L. de Koninck in his type specimen from Visé (Pl. 29, fig. 7), or in Martin's original form, reproduced on Pl. V, Fig. 16 of Davidson's monograph.

On either side of the mesial fold from six to seven single, obtusely rounded ribs ornament the lateral portions of the valve. They gradually diminish in strength towards the wings. Those situated near the extremities of the latter are but very faintly marked.

My specimen having been partly injured by weathering, the delicate concentric ornamentation, which is peculiar to well preserved forms of *Spirifer triangularis* is but indistinctly marked. Nevertheless in a few spots it is sufficiently well indicated to allow its presence to be stated with full certainty.

Locality and Geological position; *number of specimens examined.*—Quartzitic sandstone of a rusty brown colour, near Eishmakam, Kashmir Valley; Coll. Lydekker; 1.

Remarks.—The present specimen, although very incomplete, so closely agrees with *Spirifer triangularis* in its general shape and sculpture, especially in the presence of a prominent, cuneiform, mesial ridge, that I cannot refer it to any other species of the group of *Sp. trigonalis.* It will at any rate tend to show the existence of this remarkable group in the anthracolithic rocks of the Kashmir Valley.

Spirifer triangularis has been quoted from the mountain-limestone of Great Britain, Ireland, Beligum and Silesia by various authors, and from the upper carboniferous strata of Central Russia by V. von Moeller and by Krotow.

III. Group of SPIRIFER PINGUIS, Sowerby.

5. Spirifer Vihianus, Davidson.

1866. *Spirifera Vihiana*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 41, Pl. II, fig. 4.
1891. *Sp. Vihiana*, Waagen, Salt Range Fossils, Pal. Ind., ser. XIII, Vol. IV, Geological Results, p. 166.

This beautiful species is, unfortunately, not represented in the Himálayan collection entrusted to me for examination, but the figure and description given by Prof. Davidson are so excellent that from them a very good idea of its character can be formed.

Davidson himself compared his new species to *Spirifer pinguis*, Sow., from which he found it to differ by its constant, well marked, median rib in the sinus of the ventral valve. The resemblance of *Sp. Vihianus* to this common British form is indeed a very close one, especially to such shapes of *Spirifer pinguis* as are characterised by the presence of a strongly marked, longitudinal groove in the mesial fold of the dorsal valve.

In the face of such features, Waagen's opinion "that *Spirifer Vihianus* apparently belongs to the same group of forms as *Spirifer duodecimcostatus*, M'Coy, and appears to differ from that form solely by its greater number of ribs," has hardly ever been admissible. It is certainly no more tenable, since M'Coy's Australian species has been proved to belong to the genus *Spiriferina* by Etheridge, jun. (Geology and Palæontology of Queensland and New Guinea, London, 1892, p. 234).

A species, which needs a closer comparison to *Sp. Vihianus*, has been described and figured as *Sp. Parryanus* by Toula (Permo-carbon-Fossilien von der Westkueste von Spitzbergen, Neues, Jahrb. f. Miner. 1875, p. 256, Taf. VII, fig. 8) from Hinlopen Straits in Spitzbergen. The name of this Spitzbergen shell must, however, be changed, since the priority of the denomination of *Sp. Parryanus* is claimed by a species from the devonian rocks of Iowa, described in 1858 by J. Hall (Report on Geological Survey of Iowa, Vol. I, Pt. 2, Palæontology, p. 509, Pt. IV, fig. 8). This species, for which I venture to propose the name of *Sp. Loveni*, seems to hold an intermediate position between *Sp. Vihianus* and the group of *Sp. Rajah*, Salter. With the former it agrees in the presence of a deep longitudinal groove in the mesial fold of the dorsal valve, with the latter in the tendency to develop secondary ribs, originating from the massive primary costæ. But in *Sp. Loveni* this tendency affects the two ribs bordering the mesial sinus and fold only, whereas in the two following costæ it is restricted to the immediate vicinity of the front margin. Whether the dorsal valve, marked erroneously as Fig. 7 instead of 8*d* on Pl. VII of Toula's memoir, actually belongs to the same species as the three ventral valves which by the kindness of Director Fuchs I have been able to examine, is yet doubtful, though highly probable. The reconstruction of the wings (not preserved) by the draughtsman is entirely misleading.

The specimens described by Davidson were obtained from the anthracolithic rocks of Barus in the Kashmir Valley.

IV. Group of SPIRIFER RAJAH, Salter.

6. Spirifer Rajah, Salter, Pl. IV., Figs. 1—7, Pl. V., Fig. 1.

1865. *Spirifer Rajah*, Salter, Palæontology of Niti, etc., pp. 59 and 111.
1865. *Sp. Keilhavii*, Stoliczka, Geological Sections across the Himalaya Mts. from Wangtu bridge on the river Sutlej to Sungdo on the Indus, etc., Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 27.
1866. *Sp. Rajah*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 40, Pl. II, fig. 3.
1867. *Sp. Vercherei*, de Verneuil, in Verchère: Kashmir, the Western Himálaya and the Afghan Mts., Journ. Asiatic Soc. of Bengal, Calcutta, Vol. 36, p. 205, Pl. I, figs. 1, 1*a*.
1867. *Sp. Rajah*, Verchère, ibidem, p. 210.

This elegant species, one of the most remarkable among the brachiopoda of the anthracolithic system in the Himálayas, is very variable in shape, dimensions and relative proportions. The shell is, as a rule, longitudinally oval, or square-shaped, sometimes sub-circular, as wide as long, very rarely even broader than long. The hinge-line is always shorter than the greatest width of the shell. The cardinal angles, which are but exceptionally preserved, are acutely rounded.

The ventral valve is considerably deeper than the opposite one, and strongly vaulted in the either direction. The beak is strongly incurved and prominent, in full-grown specimens (Pl. IV, Fig. 5) approaching very nearly the apex of the dorsal valve. The area is moderately broad, distinct, concave and divided in the middle by a proportionately large, triangular fissure of equal height and width. It exhibits in well-preserved specimens an indistinct horizontal striation. A deep mesial sinus extends from the extremity of the beak to the front. It is in general broadly rounded, but in a very small number of specimens, however, acutely so, at its bottom, and is invariably ornamented by a narrow, median, thread-like rib.

The sculpture is rather variable. The surface of this valve is ornamented with from twelve to twenty broadly rounded ribs, which become gradually indistinct in the vicinity of the cardinal angles, whilst those bordering the mesial sinus are the largest and most prominent. Each of these flat broadly-vaulted primary ribs is ornamented by a variable number of lower, secondary costæ. In some forms, as in Davidson's type specimen or in the types figured on Pl. IV, Figs. 1 and 7 of this memoir, these secondary costæ are of equal strength and equidistant throughout their entire length. In the majority of my specimens, however, one or two of the secondary costæ are again sub-divided into smaller ones of irregular strength and distance. The specimen figured on Pl. IV, Fig. 4, is a good instance of this shape. The manifold transitions between these two extreme shapes prove their specific identity; an opinion, which I have founded on the minute examination of more than fifty individuals.

If the shelly substance has been partly injured by weathering, the secondary costæ gradually disappear, the flat primary ribs remaining solely. On such weathered specimens *Spirifer Vercherei* has been founded, which must consequently be erased from the number of independent species. Among the forms collected by Dr. Verchère and contained in the Geological Survey's Himálayan collections, there are several which agree pretty well with the illustrations of *Sp. Vercherei* given by that author, but are certainly nothing else but strongly-weathered individuals of *Sp. Rajah*.

The dorsal valve is less strongly convex than the ventral one. It is almost equally curved in the longitudiual direction on its lateral parts and along the median fold. A narrow but distinctly developed hinge-area is noticed below the tolerably prominent apex. The mesial fold is considerably elevated and shaped into a single, acutely rounded crest. At some distance from the apex smaller lateral ribs are produced on either side, which in larger specimens become again sub-divided before reaching the front line. The lateral parts are likewise ornamented by rounded folds, simple at their origin, but soon producing on either side a smaller lateral rib, which is either single or dichotomous but always inferior in strength to the main rib. The intercostal depressions are regularly rounded.

In weathered specimens, in which the details of the sculpture are lost, the ornamentation consists of simple coarse radiating ribs only, as in the type figured as *Sp. Vercherei* by Verchère (*l. c.* Fig. 1*a*).

In perfectly preserved individuals the surface is marked on both valves with very delicate longitudinal striæ. The radiating sculpture is crossed by indistinct marks of growth of greater or lesser strength at irregular distances.

The internal characters of the ventral valve are well exhibited in several of my specimens. The hinge-teeth are supported by two large diverging dental plates, forming the walls of the triangular fissure and extending into the interior of the valve for some distance. Between them a large portion of the free space at the bottom of the shell is occupied by the muscular impressions. On each side of the muscular impressions the interior of the shell is covered by numerous coarse granulations.

The measurements of a pretty large specimen (Pl. IV, fig. 5.) are as follow :—

Entire length of the shell	65 mm.
Length of the dorsal valve	51 „
Greatest breadth of the shell	cca. 63 „
Length of the hinge-line	50 „
Thickness of both valves	43 „
Apical angle of the ventral valve	88°
„ „ „ „ dorsal „	125°

Locality and Geological position; number of specimens examined.—Kuling shales of Spiti, associated with *Marginifera Himalayensis*, Kuling, Coll. Gerard, 12, Coll. Stoliczka, 10, Coll. Griesbach, 3; Muth, Coll. Stoliczka, 2; Lilang, Coll. Stoliczka, 6; Spiti Valley (exact locality not known), Coll. Gerard, 9. All the forms from Kashmir, contained in the Geological Survey's Himálayan collection, are loose specimens. The majority, 21, have been obtained from Barus by Capt. Godwin-Austen. The exact locality, where the specimens collected by Dr. Verchère (6) and by Lydekker (9), were picked up, has not been given on the accompanying labels. It cannot therefore be made out with certainty whether the species actually occurs in the Zewán beds, or is restricted to the beds with *Productus Abichi* and *Marginifera Himalayensis*, corresponding to the Kuling shales of Spiti, although the section, published by Capt. Godwin-Austen on p. 33 of his memoir on the carboniferous rocks of the Kashmir Valley (Quart. Journ., Geol. Soc., London, Vol. XXII.) is strongly in favour of the former view.

Remarks.—*Spirifer Rajah* belongs to a very remarkable group of this genus, which is distinguished by the presence of coarse fasciculate ribs, and seems to exhibit a distant similarity to *Sp. integricosta*, Phill., among the mountain limestone forms of Western Europe. This group is represented by *Sp. Tasmaniensis*, Morris, in Australia, by *Sp. interplicatus*, Rothpletz, in Timor, by *Sp. Tibetanus*, *Sp. Rajah*, and a third yet very incompletely known species in the Himálayas, by *Sp. Keilhavii*, v. Buch., *Sp. Loveni*, Diener (=*Sp. Parryanus*, Toula) and *Sp. Wilczeki*, Toula, in Spitzbergen.

Among these species *Spirifer Keilhavii*, v. Buch (Ueber Spirifer Keilhavii über dessen Fundort und Verhæltnisszuähnlichen Formen, Abhandlgn. Kœnigl. Akad. d. Wissensch. Berlin, 1876, p. 65) seems to be most closely related to the present one. In general shape and sculpture they are indeed very similar, although points of difference forbidding their identification are not absent. These characters

chiefly consists in the absence of a median thread-like rib in the sinus of *Sp. Keilhavii*, and in the shape of the mesial fold of the dorsal valve. The latter is divided in the middle by a broad and shallow longitudinal depression or groove, whereas it is shaped into a sharply-rounded crest in *Sp. Rajah*.

Another species, which closely approaches the present one, is *Spirifer Tibetanus*, Diener (Pt. III, of this volume, Pl. VI, Figs. 1—7,) from the permo-carboniferous limestone crag of Chitichun No. I, in Hundés. It is, however, readily distinguished from *Sp. Rajah* by its short hinge-line and area, which is much more triangular and broader in proportion to its width. In its ornamentation *Sp. Tibetanus* chiefly resembles such shapes of *Sp. Rajah* as are characterised by the irregular strength of their secondary ribs (Pl. IV, Fig. 4), but the dichotomous character of the dorsal median fold in the Tibetan species has not been noticed in the present form.

Spirifer Loveni (=*Sp. Parryanus*, Toula, Neues, Jahrb. f, Min. 1875, p. 256, Taf. VII, fig. 8) seems to hold an intermediate position between *Sp. Rajah* and *Sp. Vihianus*, as has been explained more fully in the description of the latter species.

The similarity to *Spirifer Wilczeki*, Toula (Kohlenkalk-Fossilien von der Suedspitze von Spitzbergen, Sitzgsber, Kais. Akad. d. Wiss. Wien., LXVIII. Bd. p. 271, Taf. I, fig. 3), *Sp. Tasmaniensis*, Morris (in Strzelecki's Physical Description of New South Wales and Vandiemensland, p. 280, Pl. XV, figs. 3, 4) and *Sp. interplicatus*, Rothpletz (Die Perm-Trias-und Jura Form. auf Timor und Rotti, Palæontographica, 39, Bd. 1892, p. 78, Taf. IX, fig. 6) is a more distant one. Among these species *Spirifer Tasmaniensis*, as figured by Morris, L. von Buch and L. de Koninck, is certainly least closely related to *Sp. Rajah*, from which it differs by its strongly-transverse shape, the less prominent and differently sculptured dorsal median fold and by the longitudinal ornamentation of the sinus.

A species, which might also be compared to the group of forms as the prototype of which *Spirifer Rajah* ought to be considered, has been described and figured as *Sp. Waageni*, Tschernyschew (Mém. Comité Géol. S. Pétersbourg, Vol. III, No. 4, p. 368, Taf. V, fig. 2), but the fasciculate arrangement of the secondary ribs seems to be less distinctly developed in this Artinskian form.

It is rather remarkable that no representative of this group has as yet been met with in the Productus limestone of the Salt Range, whereas both *Sp. Rajah* and *Sp. tibetanus* are among the most common and characteristic types of brachiopoda in the anthracolithic rocks of the Himálayas.

No representative of this group has even been found in deposits of a lower carboniferous age.

7. Spirifer sp. ind. ex aff. Sp. Rajah, Pl. IV, Fig. 8.

A species which seems to be very closely allied to the preceding one, is represented among Dr. Gerard's collections from the Kuling shales of Spiti, although unfortunately, by an isolated dorsal valve only. This valve, which has been slightly

deformed by crushing, is somewhat square-shaped, wider than long, and provided with slightly-produced, attenuated wings, terminating in acutely rounded angles. The mesial fold is not strongly elevated above the general convexity of the valve, but nevertheless considerably surpasses in strength all the rest of the radiating ribs. The latter are of the same character as in weathered specimens of *Sp. Rajah*. The majority of them are single, but occasionally traces of the original secondary bifurcating costæ are still to be noticed. Concentric imbricating marks of growth are strongly developed.

The chief difference between this species and *Sp. Rajah* consists in the shape of the median fold. It is composed of a single rib at its origin, and continues so for some distance, when it becomes dichotomous. The two ribs, into which the original fold is thus splitting up, gradually increase in size towards the front, and are separated by a deep longitudinal valley, which is much more deeply excavated than the corresponding depression in *Sp. Keilhavii*, v. Buch.

The measurements of this valve are as follow :—

Entire length of the dorsal valve	35 mm.
„ breadth „ „ „	52 „
Apical angle „ „ „	cca. 115°

Locality and Geological position; number of specimens examined.—Kuling shales near Muth, Spiti; Coll. Gerard; 1.

Remarks.—If we set aside *Spirifer Rajah* and *Sp. Keilhavii*, there is a species from the anthracolithic rocks of Spitzbergen described by Toula (Kohlenkalk-Fossilien von der Suedspize von Spitzbergen, Sitzgsber. Kais. Akad. d. Wissensch Wien. Bd. LXVIII, p. 273, Taf. II, figs. 1, 2), to which the present one might be more especially compared. This species, of which the partly weathered dorsal valve only is known, agrees with my Himálayan specimen in the presence of a strongly dichotomous mesial rib, the two branches of which are separated by a deeply excavated valley.

V. Group of SPIRIFER CLARKEI, de Kon.

8. Spirifer Lydekkeri nov. sp., Pl. III, Figs. 1-4.

1866. *Spirifer sp. ind.*, Davidson, Quart. Journ., Geol. Soc., Vol. XXII, p. 36, Pl. I, fig. 4.
1883. *Sp. striatus.* Lydekker, Mem., Geol. Surv. of India, Vol. XXII, Pl. II, fig. 4.

No complete specimen of this interesting species has come to my knowledge, but besides a large number of well-preserved dorsal valves one internal cast and two decorticated external impressions of ventral valves have been discovered among the fossil materials collected by Lydekker. Thus a fairly clear idea of the characteristic features of the species may be formed from a comparison of the different specimens.

The shell is rather variable in its dimensions, though always strongly transverse, more than twice as wide as long, the hinge-line corresponding to the greatest breadth of the shell. The lateral margins of each valve rapidly converge towards the extremities of the hinge-line, being thus produced into attenuated little wings, termi-

nating in acute cardinal angles. Both valves are only moderately and almost equally convex.

I shall begin with the description of the dorsal valve which is more completely known to me. This valve is but little curved in either direction. Transversely it is slightly depressed in the vicinity of the small, attenuated and pointed wings, and is divided by a prominent, large, median fold. This median fold is considerably elevated above the general convexity of the valve, broadly rounded above, and without any trace of secondary ribs. On each side of the median fold the lateral parts of the valve are ornamented by a variable number of single, straight, radiating ribs, which become gradually obsolete in the vicinity of the wings. In the specimen figured on Pl. III, Fig. 2, about fifteen distinct ribs are counted on each side of the mesial ridge. In some forms they occur to the number of twenty. All the ribs are very regularly rounded above and separated by narrow rounded furrows which are far inferior to them in width.

If the test is entirely preserved, the surface of the valve is covered all over by closely disposed, concentric, undulating laminæ. But in the majority of my specimens this beautiful sculpture has been greatly injured or completely destroyed by weathering.

In casts devoid of their test, as in the form figured on Pl. III, Fig. 6, or in Lydekker's type specimen (Pl. III, Fig. 7) faint concentric marks of growth only are occasionally noticed.

In none of my numerous specimens has the apex been preserved. It has been either broken off or has been destroyed by weathering, thus partly exhibiting some of the internal characters of the valve. The Figures 6, 7, 10 will give a better idea of them than any particular description. I need only remark their strong similarity to the internal features exhibited by *Spirifer Lonsdalei*, as illustrated by Prof. Davidson (in Davidson-Suess, Classification der Brachiopoden, Wien, 1856, Pl. III, fig. 4). The impressions of the adductor muscles are especially well preserved in the specimen, Fig. 6*a*.

The measurements of two specimens, the larger of which has been collected in the dark-blue carboniferous rocks near Eishmakam, are as follow :—

	I. (Fig. 2*a*.)	II. (Fig. 6*a*.)
Entire length of the dorsal valve	43 mm.	31 mm.
„ breadth „ „ „ „	88 „	75 „
„ thickness „ „ „ „	10 „	10 „

The ventral valve of this species is represented among Lydekker's collection by an internal cast from Eishmakam, and by two external impressions from the Quartz sandstone of the Ladakh valley.

This valve is provided with a moderately deep, mesial sinus, regularly rounded at the bottom and devoid of any longitudinal sculpture. Its lateral borders are sharply rounded. The ornamentation of the lateral parts is of exactly the same pattern as in the opposite valve. In the specimen from Eishmakam the test has been partly preserved in the vicinity of the front line. It exhibits the concentric

lamellose condition, peculiar to complete forms of this species. The plaster-casts of the two external impressions, which have been reproduced in the Figures 5 and 9 of Pl. III, represent strongly crushed and deformed individuals, but show pretty well both the radiating sculpture of the surface and the shape of the rounded sinus strongly enlarged frontwards. Neither the apex nor the front line has been preserved. The anterior outline, as given in Fig. 5, ought not to be mistaken for the actual front of that specimen.

The cast from Eishmakam exhibits the two strong diverging dental plates extending to a distance of more than one-third the entire length of the valve.

The measurements of this specimen are as follow :—

Entire length of the ventral valve	37 mm.
„ breadth „ „ „ „	cca. 90 „
Width of the area	12 „
Apical angle	135°

Locality and Geological position ; number of specimens examined.—Dark-blue shales and limestones with numerous *Fenestellidæ*, N. of Eishmakam, Coll. Lydekker, 4 ; yellowish-grey quartz sandstone, reminding of the devonian Spiriferen-Sandstein of the Rhenish region in its lithological aspect, Ladakh Valley, Coll. Lydekker, 12.

The identity of the specimens from the Barus beds of Eishmakam and from the quartz sandstones of the Ladakh Valley does not seem to me in any way doubtful.

Remarks.—Among the carboniferous *Spiriferidæ* the present species seems to be most closely allied to *Spirifer Clarkei*, L. de Kon. (Recherches sur les fossiles Paléozoiques de la Nouvelle Galles du Sud, p. 236, Pl. XIII, fig. 2). The only essential difference between the two forms consists in the presence of small attenuated wings in *Sp. Lydekkeri*, whereas in *Sp. Clarkei* the lateral margins unite with the cardinal border in rounded angles without any proper wings being developed. If we set aside this difference, the two species agree very well in their general shape, in the presence of a wide, slightly raised, smooth mesial fold in the dorsal and of a moderately deep, smooth and rounded sinus in the ventral valve, in the character of their radiating sculpture, which is composed of numerous single rounded ribs, and in their beautiful laminose concentric ornamentation.

In the face of such features there can be but little doubt, I think, that our Himálayan species belongs to the same group of forms as the Australian *Spirifer Clarkei*.

There is quite a number of carboniferous and devonian species which show a more distant similarity to the present one, but there is none among them which might justly put in a claim for a closer comparison.

9. Spirifer sp. ind. ex aff. Sp. Lydekkeri, Pl. V, fig. 2.

This species is perhaps still more closely allied to *Spirifer Clarkei*, de Kon., than the preceding one, but my materials are too scanty to allow anything to be asserted more positively.

Among the Geological Survey's Himálayan collection the present species is represented by a single incomplete dorsal valve only, with parts of the area of the ventral valve adhering to the rocky matrix. It is less strongly transverse than *Sp. Lydekkeri*, considerably less than twice as wide as long, without any proper wings and, so far as can be made out from the indistinct outline of the shell, with rounded cardinal angles. Its sub-elliptical shape readily distinguishes this species from the preceding one, whereas in the ornamentation no difference can be noticed. The specimen being devoid of its test, concentric marks of growth are but very faintly indicated.

The measurements of this specimen are approximately as follow :—

Entire length of the valve	28 mm.
„ breadth „ „ „	cca. 40 „
„ thickness „ „ „	9 „

Locality and Geological position; *number of specimens examined*.—Yellowish grey quartz sandstone, associated with *Spirifer Lydekkeri*, Ladakh Valley, Kashmir ; Coll. Lydekker ; 1.

VI. Group of SPIRIFER ALATUS, Schloth.

10. Spirifer Kashmeriensis, Davidson.

1866. *Spirifera Kashmeriensis*, Davidson, Quart. Journ. Geol. Soc., London, Vol. XXII, p. 41, Pl. II, fig. 5.
1883. *Spirifer Kashmeriensis*, Waagen, Salt Range Foss., Pal. Ind., ser. XIII, Vol. I, Prod. Limest. Foss., p. 521.
1891. *Spirifer Kashmeriensis*, Waagen, ibidem, Vol. IV, Geological Results, p. 166.

The following is Davidson's description of this species :— "Shell transversely fusiform, hinge-line long and straight, the lateral margins becoming gradually attenuated. Ventral valve ornamented with about twenty simple ribs. The sinus deep and divided along the middle by a small, median, slightly projecting rib, which, commencing at a short distance from the beak, extends to the front. Length 7, width 18 lines."

Of this species a few ventral valves only from the Zewán beds of Barus and Khoonmoo were obtained by Captain Godwin-Austen and entrusted to Mr. Davidson for examination. My materials are still more incomplete, consisting of a single incomplete ventral valve, which I refer with some hesitation to *Sp. Kashmeriensis*. Thus our knowledge of the characters of this interesting form remains yet very limited.

Davidson compared *Spirifer Kashmeriensis* to the devonian *Sp. macropterus*, Goldf, on account of its very transverse spindle shape, but marked the presence of a median rib in the sinus as an easily recognisable point of difference. Waagen in 1883 believed the present species to be closely allied to *Sp. alatus*, but afterwards, rejecting his former opinion, placed it in the group of *Sp. vespertilio*, Sow., from which he assumed it to differ solely by its more numerous ribs.

There is a good deal of confusion about *Spirifer vespertilio*, Etheridge, jun., differing entirely from L. de Koninck and Waagen in the synonymy of that species. I believe, however, that Mr. Etheridge (Geology and Palæontology of Queensland, p. 23) is perfectly right in retaining Sowerby's original name for

the strongly transverse form, figured by Morris on Pl. XVII., Figs. 1 and 2, of his memoir in Count Strzelecki's "Physical description of New South Wales" and in proposing a new denomination, *Sp. Stutchburii*., for the species, figured by Morris on Pl. XVII., Fig. 3, and by L. de. Koninck on Pl. XIII., Figs. 4*b*, 4*c*, and Pl. XIV., Fig. 3, of his memoir on the palæozoic fossils of New South Wales. Waagen's shell from the *Conularia*-nodules of the Salt Range consequently ought to be identified with *Sp. Stutchburii*, not with *Sp. vespertilio*, if an identification may be based altogether on so fragmentary materials.

A third species of the group of *Spirifer vespertilio* is indicated by the form figured by L. de Koninck on Pl. XIII., Figs. 4, 4*a*, of his above-quoted memoir. This species approaches *Sp. Kashmeriensis* by the presence of a mesial fold in the sinus, but strongly differs from it by its sharp angular ribs. Neither in the true *Sp. vespertilio* nor in *Sp. Stutchburii* a mesial rib is developed in the bottom of the sinus. Nor does the shape of the sinus agree in any way with that exhibited in the Kashmir shell. To me, therefore, the affinity of the latter to the Australian group of *Sp. vespertilio* appears, to say the least, very uncertain.

The permian *Spirifer alatus*, Schloth., appears to me more closely allied to the present form than any of the above quoted species. In this respect I perfectly agree with the view expressed by Prof. Waagen in 1883, when he stated his specimens of *Sp. alatus* from the Amb beds of the Salt Range Productus limestone to differ from *Sp. Kashmeriensis* by some minor details only.

Subgenus : SYRINGOTHYRIS, Winchell.

SYRINGOTHYRIS CUSPIDATA, Martin, Pl. IV., Figs. 9, 10.

1796. *Anomites cuspidatus*, Martin, Transactions, Linnean Soc., Vol. IV., p. 44, Pl. III., figs. 1—4, 5, 6.
1809. *Conchyliolithus Anomites cuspidatus*, Martin, Petrificata Derbiensia, Vol. I., p. 10, Pl. XLVI. figs. 3, 4, Pl. XLVII, fig. 5.
1818. *Spirifer cuspidatus*, Sowerby, Mineral Conchology, Vol. II., p. 42, Pl. 120, figs. 1-3.
1825. *Sp. cuspidatus*, Sowerby, ibidem, Vol. V., p. 90, Pl. 461, fig. 2.
1836. *Spirifera cuspidata*, Phillips, Geology of Yorkshire, Vol. II., p. 216, Pl. IX., figs. 1—4.
1840. *Spirifer cuspidatus*, L. v. Buch, Mém. Soc. Géol. de France, T. I. V., p. 187, Pl. IX., fig. 13.
1843. *Sp. cuspidatus*, L. de Koninck, Descr. des animaux fossiles du terrain carbon. de Belgique, p. 243, Pl. XIV., fig. 1.
1857. *Spirifera cuspidata*, Davidson, Monograph British Carb. Brachiopoda, pp. 44 and 224, Pl. VIII, Figs. 9—24, Pl. IX., figs. 1, 2.
1877. *Spirifer cuspidatus* ? Meek, Report U. S. Exploration of the fortieth parallel, Vol. IV., Palæontology, p. 87, Pl. III, figs. 11, 11*a*.
1884. *Syringothyris cuspidata*, Walcott, Palæontology of the Eureka District, Monogr. U. S. Geol. Surv., Washington, Vol. VIII., p. 219.

A ventral and a dorsal valve, which, however, do not belong to the same individual, from Kuling, in Spiti, are referable to this common mountain limestone species. They agree perfectly with typical specimens of *Syringothyris cuspidata* from Tournay, which I have been able to procure for comparison.

The ventral valve, which is not complete and slightly distorted, exhibits the characteristic, transversely pyramidal shape of a medium-sized form of *S. cuspidata*. Its straight hinge-line is terminating in acutely rounded off cardinal angles. The arched triangular area is almost vertical, and curved slightly forward in the vicinity of the apex. The apical angle is obtuse. The narrow triangular fissure is nearly twice as high as broad. Of the flat, concave sinus the umbonal portion only has been preserved in my specimen, since the frontal portion of the valve, situated anteriorly to the hinge-line, has been broken off. The sculpture consists of single straight radiating ribs, of which from eighteen to twenty are counted on each side of the sinus.

The measurements of this specimen are as follow :—

Length of the hinge line	56 mm.
Width of the area	18 „
Width of the triangular fissure	18 „
Height of the triangular fissure	9·5 „
Apical angle of the ventral valve	110°

The specimen represented by the dorsal valve, figured on Pl. IV., Fig. 10, has been considerably larger than the preceding one. This valve is strongly transverse, moderately and rather regularly convex, with nearly acute cardinal angles and a barely prominent apex. The large smooth median fold is but little elevated above the general convexity of the shell. It is divided along its middle by an indistinct longitudinal depression, extending from the extremity of the apex to about one-half the length of the fold.

There are about twenty-two simple radiating ribs present on each side of the mesial fold.

The measurements of this specimen are as follow :—

Entire length of the dorsal valve	33·5 mm.
„ breadth „ „	72 „
„ thickness „ „	12 „
Apical angle „ „	cca. 135°

Locality and Geological position; number of specimens examined.—The two specimens were obtained near Kuling, in Spiti, by Dr. Stoliczka from a black crinoidal limestone, entirely different from any of the rocks which form part of the typical Kuling shales of Spiti or of the Productus shales in Johár and Painkhánda. There is some probability of this rock-specimen having been derived from the crinoid limestone horizon, which Griesbach has demonstrated to underlie the white quartzite of Spiti and which he correlates with the mountain limestone of Europe. If this probability could be proved, the presence of *Syringothyris cuspidata* would be strongly in favour of Griesbach's correlation, as neither in Europe nor in America this species has hitherto been ever met with in beds of an upper carboniferous age.

Sub-family: MARTINIINAE, Waagen.

Genus: MARTINIOPSIS, Waagen.

1883. *Martiniopsis*, Waagen, Salt Range Fossils, Pal. Ind., ser. xiii, Vol. I., Prod. Limest. Foss., p. 524.

MARTINIOPSIS (2) sp. ind. AFF. SUBRADIATA, Sowerby. Pl. VI., Fig. 9.

[Compare: *Spirifera subradiata*, Sowerby, Darwin's Geological Observations on the volcanic islands visited by H. M. ship Beagle, etc., 1844, p. 159.]

Spirifer subradiatus, Morris, in Strzelecki's Physical description of New South Wales and Vandiemensland, 1845, p. 281, Pl. XV., fig. 5, Pl. XVI., figs. 1—4.

Spirifer glaber, Dana, Geology, Wilkes' U. S. Exploring Expedition, etc., 1849, Vol. X., p. 683, Pl. I, fig. 6.

Spirifer glaber, L. de Koninck, Recherches sur les fossiles paléozoiques de la Nouvelle Galles du Sud, 1877, Pt. III, p. 227, Pl. XI., figs. 8, 9, Pl. XII., figs. 1a—c.

Spirifer Darwini, L. de Koninck (*non* Morris), ibidem, p. 230, Pl. X., fig. 11a, b, Pl. XI., fig. 10, 10a, Pl. XII., fig. 1.

Martiniopsis subradiata, Etheridge jun., in Jack and Etheridge, Geology and Palæontology of Queensland, and New Guinea, 1892, p. 238, Pl. XI., fig. 14.

It is with some hesitation that I introduce this name for a very fragmentary and somewhat crushed shell from the Zewán beds of the Kashmir Valley, but among the forms with which the present specimen could be compared, *Martiniopsis subradiata*, Sowerby, seemed to be the most similar one.

I consider this specimen to be the fragment of a ventral valve, with the internal cast partially exposed in its apical region. The sharp left border of the cast seems to correspond to the inner wall of a dental plate. The linguatiform impressions of the cardinal muscles are divided by a large double median septum. The median septum is more strongly developed than in any of the types of *Martiniopsis* figured by L. de Koninck. It must, however, be borne in mind that the present form if complete, would probably exceed in size even the type specimen of L. de Koninck's figure 10*a* on Pl. XI. of his memoirs on the palæozoic fossils of New South Wales.

My fragment is too incomplete to allow any exact reconstruction of its original outlines, but what can be made out of its general shape is not contradictory to an identification as a species of *Martiniopsis*, allied probably to *M. subradiata*. With this identification the sculpture of the shell surface agrees very well. It consists of a comparatively small number of strong concentric laminæ of growth which are crossed by a very faint radial ornamentation. A few obtuse radiating costæ are, however, more strongly marked. The shell structure exhibited in the vicinity of the front margin only is moderately punctate and fibrous.

Locality and Geological position; number of specimens examined.—Greenish shales of the Zewan beds, associated with *Protoretepora ampla*, Lonsd., Kashmir Valley; Coll. Verchère; 1.

Remarks.—It is to be regretted that the present specimen is too poorly preserved to allow a definite identification. Could I have satisfactorily proved its apper-

tenance to the group of *M. subradiata*, it might very justifiably have been quoted among the species indicating an affinity between the faunæ of the Himálayan Zewan beds and of the carboniferous rocks of Australia.

Sub-order: ANCISTROPEGMATA, Zittel.

Family: *RHYNCHONELLIDÆ*, Gray.

Sub-family: RHYNCHONELLINÆ, Waagen.

Genus: RHYNCHELLA Fisch. v. Waldh.

Three species of this genus have been described by Davidson from the collections of Captain Godwin-Austen made in the Zewan beds of Kashmir. Only one of them was identified with a European form by that learned author, whilst the two others were considered to be new. These three species are:—

1. *Rhynchonella pleurodon var. Davreuxiana*, de Kon (*Rh. triplex*, M'Coy).
2. „ *Barusiensis*, Davidson (l. c. p. 421, Pl. II, fig. 8. 1.)
3. „ *Kashmeriensis*, Davidson (l. c. p. 42, Pl. II. fig. 91.)

The genus seems to be extremely rare in the anthracolithic rocks of Kashmir. Only very few specimens were available to Prof. Davidson, who himself stated the study of a larger number of specimens to be necessary for arriving at a satisfactory conclusion regarding the affinities of his new species to the rest of congeneric forms. Unfortunately, however, I am not in a position to add anything to elucidate this point. Both in the quartz sandstone with *Conularia tenuistriata* and *Spirifer Lydekkeri* from the Ladakh Valley, collected by Lydekker, and in a slab of rock from the Zewan beds of Barus collected by Major Collet, a small number of *Rhynchonellidæ* have been discovered, but they are so badly preserved that I could not even decide whether they actually belong to either *Rhynchonella* or *Camarophoria*. In a sericitic slate from the Ladakh Valley very badly preserved specimens of *Rhynchonella* have likewise been noticed.

Sub-family: CAMAROPHORIINÆ, Waagen.

Genus: CAMAROPHORIA, King.

CAMAROPHORIA cf. PURDONI, Davidson. Pl. VII., Fig. 4.

1862. *Camarophoria Purdoni*, Davidson, Quart. Journ. Geological Soc., London, Vol. XVIII., p. 30, Pl. II, fig. 4.

For a complete list of synonyms I refer to my memoir on the fauna of the permo-carboniferous limestone crag of Chitichun No. I (Pt. 3 of this volume).

Two specimens from the anthracolithic rocks of Kashmir are referable to this species, with which I should have united them without the slightest hesitation had not their insufficient state of preservation prevented me from doing so.

In its general shape and outline the more complete specimen of the two agrees almost perfectly with moderately inflated forms of *Camarophoria Purdoni* from Chitichun No. I. This specimen, which has served as type for the illustration on Pl. VII. of this memoir, having been strongly injured by weathering, the exact number of ribs cannot be made out. One of the ribs in the median fold of the dorsal valve can be traced to the proximity of the apex. The two lateral portions of the shell are distinctly asymmetrical.

The measurements of this specimen are as follow :—

Entire length of the shell	31 mm.
Length of the dorsal valve	28 „
Entire breadth of the shell	32 „
Breadth of the median fold	16 „
Thickness of both valves	16 „
Apical angle of the ventral valve	80°
„ „ „ „ dorsal „	95°

The specimens under consideration are probably identical with *C. Purdoni*, but there are several species of this genus which so closely approach the latter form, especially *C. alpina*, Schellwien, from the upper carboniferous Fusulina limestone of Carinthia, that a direct identification is only possible if completely preserved forms were available.

Locality and Geological position ; number of specimens examined.—Black, micaceous shells, Kashmir, exact locality not known; Coll. Lydekker; 2.

From the character of the matrix adhering to the loose shells it appears doubtful whether they have been obtained from the Zewan beds or from the geologically younger shales with *Productus Abichi* and *Marginifera himalayensis* corresponding in age probably to the Kuling shales of Spiti.

Sub-order : ANCYLOPEGMATA, Zittel.

Family : *TEREBRATULIDÆ*, King.

Sub-family : TEREBRATULINÆ, Waagen.

Sub-genus : DIELASMA, King.

DIELASMA HASTATUM, Sowerby, Pl. VII., Fig. 5.

1824. *Terebratula hastata*, Sowerby, Mineral Conch. of Great Britain, Vol. V., p. 66, pl. 446, fig. 2, media (fig. 2, dextra et cateris exclusis).
1857. *T. hastata*, Davidson, Monograph British carb. Brachiopoda, p. 11, Pl. I., fig. 1 (cateris exclusis).
1876. *T. hastata*, Roemer, Lethaea Palæazoica I., Th. atlas, tab. XLIII., fig. 1.
1880. *T. sacculus var. hastata*, Davidson, Monogr. British Fossil Brachiopoda, supplement, Vol. IV., p. 269, Pl. XXX., fig. 17.
1887. *Dielasma hastatum*, L. de Koninck, Fauna du Calcaire carbonifere de la Belgique, p. 9, Pl. III., figs. 1—26, Pl. IV., figs. 9—22, *var.* figs. 23—25.

Among the fossil material collected by Lydekker in the anthracolithic rocks of the Kashmir valley, there is one single but perfectly complete specimen of *Dielasma*, which, I think, may be safely identified with *Dielasma hastatum*, even

if this latter species is accepted in the narrow circumscription proposed by L. de Koninck. In the genus *Dielasma* an interpretation of species has been introduced by that learned author, as has scarcely been adopted in any other group of brachiopoda, their distinction being based on very subordinate details to which in other genera of this class barely a varietal importance would have been accorded.[1] Of some of these species L. de Koninck himself candidly admits it to be solely a matter of taste, whether the difference be considered or not as sufficient for the distinction of separate species. If, notwithstanding this fact, I venture on a direct identification of the present specimen with *Dielasma hastatum* in the narrow circumscription proposed by L. de Koninck, it is on the ground of its agreeing entirely with some of the type specimens of that author from the mountain limestone of Belgium.

The shell is of a somewhat pyriform shape, elongated, truncated in the frontal region, and provided with a slightly arched frontal line. Its largest transverse diameter is situated a little anteriorly to the middle of its entire length.

The ventral valve is strongly inflated, especially so in the vicinity of the beak, gradually tapering towards the front line where a broadly excavated sinus is formed. This sinus originates in the middle of the entire length of the valve. The beak is thick, regularly curved, and slightly prominent beyond the apex of the dorsal valve. It is pierced by a large, longitudinally oval, oblique foramen. Its lateral portions are somewhat flattened, indistinct ridges extending down the beak on both sides of the foramen and limiting off a very ill-defined false area.

The dorsal valve is less strongly inflated than the opposite one, regularly vaulted in either direction, and provided with a shallow broad sinus, which is considerably less deep than the corresponding sinus in the ventral valve. The lateral margins of the two valves meet in a very flatly curved line, the convexity of which is turned towards the ventral valve. The front line is slightly raised in the opposite direction.

The surface of the shell is nearly smooth, ornamented by a few irregularly disposed, concentric striæ of growth only, which are restricted to the proximity of the front.

The measurements of this specimen are as follow :—

Entire length of the shell	29	mm.
„ „ „ „ smaller valve	25	„
„ breadth of the shell	21	„
Thickness of the shell	16	„
Apical angle of the ventral valve	cca 80°	
„ „ „ „ dorsal valve	„ 90°	

Locality and Geological position; number of specimens examined.—N. of Eishmakam, Kashmir Valley, obtained probably from the Zewan beds ; Coll. Lydekker ; 1.

[1] In strict contrast to this narrow interpretation of species stands L. de Koninck's identification of a *Dielasma* from Loping, described by Kayser (Obercarbonische Fauna von Loping, Richthofen, China, IV. Bd., p. 174, Taf. XXIII, fig. 9) with *D. normale*, L. de Kon. (l. c. p 21, Pl. VI., figs. 49—62). If these two forms are to be united, we may as well accept species of so monstrous an extension as *D. sacculus* in the interpretation of Davidson.

Remarks.—L. de Koninck insists on this species being restricted to the mountani limestone of Belgium and Ireland only, and does not admit its identity with permian forms described as varieties of *Dielasma hastatum* by Davidson and by Kirkby. It is, however, impossible to decide whether among the forms from upper carboniferous beds, quoted under that name by European and American authors, the true *D. hastatum* may be represented or not, as a very different definition of this species has been adopted by the majority of palæontologists and by L. de Koninck.

Order: INARTICULATA, Huxley.

Family: *DISCINIDÆ*, Gray.

Genus: DISCINA, Lamarck.

DISCINA KASHMERIENSIS, Davidson.

1866, *Discina Kashmeriensis*, Davidson, Quart. Journ., Geol. Soc., London, Vol. XXII., p. 45, Pl. II., fig. 19.

Two specimens of this interesting species were obtained by Captain Godwin-Austen in the Barus beds of Khoonmoo and described by Davidson. Waagen considers them to be very closely allied to *Discinisca Warthi* (Salt Range Fossils, Palæont. Indica, ser. XIII, Vol. IV., Geological Results, p. 134, Pl. V., figs. 12-15), from the *Conularia* nodules of the lower speckled sandstone in the Eastern Salt Range and to differ from the latter species solely by their larger dimensions and by their more strongly inflated upper valves.

No specimens of any *Discinidæ* have been discovered among the fossil material from Kashmir and Spiti entrusted to me for examination by the Director of the Geological Survey of India.

The genus *Discina* is of so scarce an occurrence in Asiatic deposits of an anthracolithic age that the presence of this Himálayan species in the carboniferous rocks of Kashmir is of some importance.

Class: BRYOZOA.

Although this class of fossils is very richly represented in the anthracolithic rocks of Kashmir, their examination is rendered exceedingly difficult by their unsatisfactory state of preservation. Not only they are, as a rule, found in the condition of impressions only, but even in the few cases, if the polyzoarium itself has been preserved, I have, with one single exception, either not succeeded in clearing the poriferous side from the matrix, or have found it so strongly injured from weathering that no definite information concerning the nature of the cells could be obtained. In the absence of this character I deemed it preferable to abstain from a specific identification of my specimens and to be rather content with comparing them with such species as I thought to be probably their nearest allies. In one single case only did I dare to make an exception from this

treatment of my materials. This species is *Protoretepora ampla*, Lonsdale. The examination of some excellently preserved impressions from the Zewán beds of Kashmir revealed to me the nature and arrangement of the cells, agreeing perfectly with those exhibited in the Australian types of this remarkable form.

Thus the present monograph does not give an adequate idea of the rich fauna of *Bryozoa* contained in the anthracolithic system of the North-Western Himálayas. No doubt a systematic search of the localities mentioned will bring to light a much larger number of species than those here described.

Order: GYMNOLÆMATA, Allen.

Sub-order: CYCLOSTOMATA, Busk.

Family: *FENESTELLIDÆ*, King.

Sub-family: FENESTELLINÆ, Waagen.

Genus: FENESTELLA, Lonsdale.

1. Fenestella sp. ind. aff. F. fossula, Lonsdale. Pl. VII., Fig. 8; Pl. VIII., Fig. 4.

[Compare: *Fenestella fossula*, Lonsdale, in Darwin's Geol. Observations on Volcanic islands, 1844, p. 166, and in Count Strzelecki's Physical Description of New South Wales, etc., 1845, p. 269, T. IX., fig. 1.]
Fenestella fossula, Etheridge, Quart. Journ., Geol. Soc., London, Vol. XXVIII., 1872, p. 332, Pl. 25, fig. 1.
Fenestella fossula, Etheridge jun., in Jack and Etheridge, Geology and Palæontology of Queensland, etc., [p. 217, Pl. IX., figs. 4, 5].

A number of specimens of a *Fenestella* from the Zewán beds of the Kashmir valley appear to be very closely allied, if not actually identical with the present species. But as the poriferous side is not sufficiently well preserved to allow the character and arrangement of the cells to be studied, I dare not venture on a direct identification. Since a very narrow circumscription of the single species of this genus has been adopted by Stuckenberg in his monograph of the Russian carboniferous corals and Bryozoa, a specific determination of *Fenestellæ* is barely any more possible if one has not to deal with perfectly preserved specimens. Being not in this happy position, I must be satisfied with referring my forms to *Fenestella fossula* as their probably nearest ally.

All my specimens are characterised by their very regular structure and by their densely retiform appearance, being composed of very delicate and slender dissepiments and interstices. The branches are of equal thickness throughout their entire extent and are not frequently divided dichotomously. They are not swollen at the point of division. They are considerably thinner and bifurcate less frequently than in *F. plebeia*, M'Coy. The interstices form together with the dissepiments rectangular fenestrules, bordered by nearly straight bars, and provided with ovally rounded off corners. Within the space of 5 mm. there can be counted generally 10 meshes or fenestrules in the direction of the extension of the branches, and 14 in the transverse direction.

On the non-poriferous side the branches are flatly vaulted. Whether they have been ornamented by a longitudinal striation or not I am not able to decide, as in none of my numerous forms the surface has been perfectly well preserved. Of the poriferous side very little is known to me. Traces of a median keel are occasionally noticed in the hollow spaces left in the cast by the impression of the branches.

The species attains considerably large dimensions, one of my specimens, though incomplete, reaching a length of 100 mm. and a width of 90 mm.

In the specimen, figured on Pl. VII, Fig. 8, the natural colouring of the species, a dark Indian red, seems to have been preserved.

Locality and Geological position; number of specimens examined.—Numerous forms of this species have been collected in the Zewán or Barus beds of the Kashmir Valley by Major Collet, of the Ladakh Valley and at Eishmakam by Lydekker, near Barus by Captain Godwin-Austen.

Remarks.—The dense arrangement of the very thin, but rarely dichotomising branches is a good character of this species which very closely approaches *Fenestella fossula*, Lonsd., from the carboniferous rocks of New South Wales, Tasmania and Queensland. In its general shape it agrees especially well with the specimen from Gympie figured by Etheridge, sen., in Volume XXVIII of the Quarterly Journal.

Waagen united together *Fenestella fossula* with *F. veneris*, Fisch., and *F. jabiensis*, Waag., in a special group of forms, distinguished from the rest of congeneric species by a different aspect of the two faces of the colony, "on the poriferous side the fenestrules appearing more or less rectangular, while on the other side they appear oval or nearly circular." This peculiarity is however not mentioned by Etheridge, jun., in his minute description of Lonsdale's species in the "Palæontology of Queensland and New Guinea" (p. 217).

2. Fenestella sp. aff. f. internata, *Lonsdale*.

Pl. VII., Fig. 9; Pl. VIII, Fig. 3.

[Compare *Fenestella internata*, Lonsdale, in Darwin's Geological Observ. on Volcanic Islands, etc., 1844, p. 165.]

F. internata, Lonsdale, in Strzelecki's Physical Description of New South Wales, etc., 1845, p. 269, Pl. IX, fig. 2.

F. internata, Dana, in Wilkes, U. S. Exploring Expedition, Geology, 1849, p. 710, Pl. X, fig. 13.

F. internata, Etheridge, jun., in Jack and Etheridge, Geology and Palæontology of Queensland, etc., 1892, p. 218, Pl. IX, figs. 6-7.]

Although among my materials this species is more numerously represented than the preceding one, I have seen it only in the condition of impressions in which the casts of the fenestrules and the hollow spaces left by the removed dissepiments and branches have been preserved. Thus the determination of the species remains yet more uncertain, being necessarily based on a general resemblance of my specimens to *Fenestella internata* only.

The present species exhibits the same densely retiform appearance, the rarely dichotomising branches, the regular arrangement of the straight interstices and

disepiments enclosing rectangularly oval fenestrules as has been noticed in *F fossula*. It chiefly differs from the latter in being of a larger habit. Within the space of 5 mm. there can generally be counted 5 to 6 fenestrules in the direction of the extension of the branches, and 7 to 8 in the transverse direction.

Locality and Geological position; number of specimens examined.—I have examined about twelve specimens of this species which were obtained at different localities from the Zewán beds of the Kashmir and Ladakh Valley, by Captain Godwin-Austen, Major Collet and Lydekker.

Subfamily: POLYPORINÆ, Waagen.

Genus: PROTORETEPORA, de Koninck.

PROTORETEPORA AMPLA, Lonsdale, Pl. VII, Fig. 10; Pl. VIII, Figs. 1, 2.

1844. *Fenestella ampla*, Lonsdale, in Darwin's Geolog. Observ. on Volcanic Islands, etc., p. 163.
1845. *F. ampla*, Lonsdale, in Strzelecki's Physical Descr. of New South Wales, etc., p. 268, Pl. IX., figs. 3.
1849. *F. ampla*, Dana in Wilkes, U. S. Exploring ExPedition, Geology, p. 10, Pl. XI, figs. 1, 1a.
1876. *Polypora ampla*, Etheridge, jun., Transactions Royal Soc. Victoria, Vol. XII, p. 66, fig. 1.
1883. *Protoretepora ampla*, Lydekker, Geology of the Kashmir and Chamba territories, etc., Mem. Geol. Survey of India, Vol. XXII, Pl. II, fig. 1.
1892. *P. ampla*, Etheridge, jun., in Jack and Etheridge, Geology and Palæontology of Queensland, etc., p. 221.

1876/77. P. a. Koninck, Foss. foliq. New South Wales &c. Pl. VIII f. 5.

This is the only species of *Bryozoa* contained in the Geological Survey's collections from Kashmir which is represented by sufficiently well preserved forms to warrant a certain identification. Mr. Etheridge, jun., has fully discussed the value of the generic name *Protoretepora* and redefined it. I have also relied on his arguments in adopting the present species in a narrower circumscription than had been introduced by L. de Koninck.

My specimens agree perfectly well with the Australian *Protoretepora ampla*, if the latter is accepted in the interpretation proposed by Etheridge, jun., excluding the *var. Koninckii* and *var. Woodsi*. They form very large funnel or cup-shaped colonies with often strongly contorted or crumpled expansions. The largest among them seems to have attained at least 160 mm. in length and 180 mm in width. The cell-bearing face of the polyzoarium is internal. The interstices are tolerably straight and bifurcating at moderately long intervals. They are broad, flatly arched and expanding previous to bifurcation. The dissepiments are only one-half to one-third the length of the interstices, from which they are, however, not very distinctly defined. The numerous elongate oval fenestrules are arranged radially in regular rows, some of which can be traced from the very root to the margins of the colony. There are generally four fenestrules within the space of 10 mm. along the longitudinal direction.

On the poriferous face of the colony the interstitial interspaces between the fenestrules are occupied by from five to eight rows of circular cell-apertures. The dissepiments as well as the interstices are celluliferous

The outer surface has been too much injured in my specimens by weathering to allow its ornamentation to be studied in detail.

Locality and Geological position; number of specimens examined.—This remarkable species is not at all rare in the Zewán beds of the Kashmir Valley. The chief localities where it has been collected by Verchère, Captain Godwin-Austen and Lydekker are the following: Mandakpál, N. W. of Wasterwan, Leitipur, S. E. of Srinagar, Pailgam, Barus, Marbal Pass (associated with *Lyttonia sp. ind.*).

Remarks.—The identity of the Kashmir specimens with the typical *Protoretepora ampla* from the anthracolithic rocks of Tasmania and Queensland has been advocated by Lydekker on the authority of Dr. Feistmantel and fully confirmed by my examination of his materials. It is of no small geological importance, pointing as it does, to slight Australian affinities in the carboniferous fauna of Kashmir in a more direct way than the rest of similar indications.

Family: *THAMNISCIDÆ*, King.

Genus: ACANTHOCLADIA, King.

ACANTHOCLADIA SP. IND. Pl. VII, Fig. 7.

It is with considerable hesitation that I refer a single, incomplete and badly preserved specimen from Loodoo to this genus.

The arborescent colony consists of a primary branch, from which a few secondary branches take their origin, bifurcating at long intervals, but being never connected by dissepiments. All the branches are situated in one plane. The majority of them are ornamented either on both sides or on one side only with numerous little branchlets, which are narrower than the principal stems, very short, pointed and nearly parallel to each other.

Although the poriferous face is exposed in my specimen, the character and arrangement of the cellules cannot be made out with certainty on account of its unsatisfactory state of preservation.

Locality and Geological position; number of specimens examined.—Loodoo Vihi Valley, Kashmir, Zewán beds; Coll. Godwin-Austen; 1.

FAUNISTIC RESULTS.

Among the faunæ of the anthracolithic system in the Himálayas of Kashmir and Spiti described in the present memoir, the fauna of the Kuling shales of Spiti is the geologically youngest in age. It comprises the following forms, being rather poor in species, though rich in individuals:—

1. *Marginifera himalayensis*, Diener.
2. *Chonetes cf. Lissarensis*, Diener.
3. *Athyris Gerardi*, Diener.
4. *Spirifer Rajah*, Salter.
5. „ *sp. ind. aff. Rajah.*
6. „ *Musakheylensis*, Davids.
7. „ *cf. Nitiensis*, Diener.

So far as numbers go, *Marginifera himalayensis*, Diener—a species very closely allied to *M. typica*, Waagen—and *Spirifer Rajah*, Salt., play the principal part. The class of Lamellibranchiata is represented by a few very poorly preserved fragments only, which do not allow a specific determination. The state of preservation of the brachiopoda is also, as a rule, rather indifferent. There is barely one single fairly complete form among the numerous specimens collected by Dr. Gerard, Stoliczka and Griesbach.

Griesbach correlated the Kuling shales of Spiti (*sensu stricto*) with the permian Productus shales of Johár and Painkhanda. The palæontological evidence afforded by the examination of the fossil materials handed over to me is certainly not adverse to this correlation, which was chiefly based on stratigraphical and lithological characters. Out of seven species of brachiopoda composing the fauna of the Kuling shales of Spiti, four are probably identical with forms from thepermian Productus shales of the Central Himálayas. These four species are :—

Chonetes cf. Lissarensis, Dien.
Athyris Gerardi, Dien.
Spirifer Musakheylensis, Davids.
„ *cf. Nitiensis*, Dien.

Three of these species are restricted exclusively to the Productus shales of the Himálayas and do not occur in any other deposits. Among the three remaining forms, forming part of the brachiopod-fauna of the Kuling shales of Spiti also, not a single one occurs outside the sedimentary belt of the Himálayas. Thus the affinity of the present fauna to that of the permian Productus shales is undoubtedly more strongly marked than to the faunæ of any non-Indian strata of anthracolithic age. To this evidence it may be added that *Athyris Gerardi* and *Spirifer cf. Nitiensis* have been obtained from sandstone partings intercalated in the black micaceous Kuling shales, which lithologically agree so perfectly well with similar intercalations of sandstone partings in the Productus shales of Kiunglung that the specimens in the collection could not be separated without the labels attached to them.

An astonishing fact which must not be overlooked is the total absence of the two chief leading fossils of the Kuling shales of Spiti, *Marginifera himalayensis* and *Spirifer Rajah* in the Productus shales of Johár and Painkhánda. This fact, it is true, strongly diminishes in its importance if we bear in mind that the leading fossils of the Productus shales themselves are very unequally distributed at different localities. *Chonetes Lissarensis*, e. g., which is most abundant in the Productus shales of Johár, whole rock-specimens being made up of its shells only, is entirely absent in Painkhánda. On the other hand, *Productus cancriniformis*, which is very common in the Niti district, has not been found in the Productus shales of Johár.

This rather unequal distribution of species throughout the Himálayan Productus shales does not however exclude the possibility of another explanation of the absence of *Marginifera himalayensis* and *Spirifer Rajah* in the eastern portion of the Central Himálayas. To this explanation a passage in Griesbach's

description of the sequence of anthracolithic rocks in the Niti area (Geology of the Central Himálayas, Mem. Geol. Surv. of India, Vol. XXIII, p. 120) gives a clue. In his description Griesbach makes reference to the development of a calcareous thick-bedded dark-grey sandstone, intermediate between the carboniferous white quartzite and the Productus shales of a ravine at the foot of the Niti pass. This dark-grey sandstone he found full of brachiopoda, which he identified with *Productus semireticulatus*. "I have compared"—he further adds—"both the specimens and the matrix with specimens contained in the Geological Survey Museum, which had been collected at Kuling by Dr. Stoliczka; both are so close in form and lithological character that they might easily have come from the same locality."

Among the materials handed over to me for examination no fossils from this rock group are unfortunately represented. Could the presence of *Marginifera himalayensis*—corresponding to Griesbach's *Productus semireticulatus*—in the calcareous sandstones from the foot of the Niti Pass satisfactorily be proved, this evidence might point to the probability of a correlation of these sandstones with part of the Kuling shales of Spiti characterised by the presence of *M. himalayensis* and *Spirifer Rajah*. Nor is the possibility excluded that these beds are slightly lower in their position within the Kuling shales than the main mass of the latter from which the species identical with forms peculiar to the Himálayan Productus shales have been derived. I have hinted at this possibility to draw the attention of future observers to this question, as it may easily be decided by collecting more extensive fossil materials, according to single geological horizons. To say more on the poor evidence of a few vague palæontological indications only, which are not supported by a thorough knowledge of the actual stratigraphical sequence, would far transgress the limits of sound geological reasoning.

My recent examination of the anthracolithic fossils of Kashmir collected by Captain Godwin-Austen, Verchère, Major Collet and Lydekker, has led me to recognize two fairly well differentiated faunæ among them. The geologically younger fauna is represented by a small set of brachiopoda, collected by R. Lydekker in a dark micaceous shale with occasional intercalations of sandstone on the summit of a ridge north-east of Prongam Trál. The species composing this faunula are the following :—

Productus Abichi, Waagen.
Marginifera himalayensis, Dien.
Chonetes grandicosta, Waagen.
Strophomena analoga, Phill.

So far as a correlation of horizon may be based on so small a number of fossils, all the evidence goes to prove that the rocks from Prongam Trál correspond in age to the Kuling shales of Spiti. The few slabs of rock from this locality, contained in the Geological Survey's collections, are full of *Marginifera himalayensis* and exactly agree in their lithological character with specimens from the Kuling shales, collected by Stoliczka and Griesbach. Each of the three remaining species is represented in Lydekker's collection by one single individual only. Among them

Strophomena analoga is an ubiquitous form of a tolerably wide geographical and geological distribution, ranging throughout the entire carboniferous system into permian strata. *Productus Abichi* and *Chonetes grandicosta* decidedly point to a permian age. *Productus Abichi* is among the most characteristic permian species of the Salt Range, of Armenia and Timor. *Chonetes grandicosta* has as yet not been discovered outside the upper Productus limestone of the Salt Range.

In considering these facts it appeared to me that from a *palæontological* point of view a correlation of the shales with *Marginifera himalayensis* from Prongam Trál with the Kuling shales of Spiti will best express our present state of knowledge regarding their true stratigraphical position. This view is corroborated by the fact that none of the few fossils from this locality is identical with a species from the Zewán beds of Barus, Khoonmoo or Eishmakam. Stratigraphical evidence to ascertain this correlation of the Prongam Trál beds with the Kuling shales of Spiti is, however, unfortunately wanting. In Lydekker's report on the geology of the Kashmir district no reference is made to the position of those beds, which he probably failed altogether to distinguish from the rest of anthracolithic rocks.

Provided the correlation of the Prongam Trál beds in Kashmir and of the Kuling shales in Spiti with the Productus shales of Johár and Painkhánda be correct—a view which, I suppose, will better express the facts hitherto known than any other—the permian system appears to play an important part in the anthracolithic series of the Himálayas and to represent a distinct horizon of great geographical distribution.

The richest of all the anthracolithic faunæ described in the present memoir is contained in the Zewán or Barus beds of the Kashmir Valley. This fauna, to which attention has first been drawn by the valuable memoirs of Godwin-Austen and Davidson, is composed of the following species:—

TRILOBITÆ.

1. *Phillipsia sp. ind. aff. seminifera*, Phill.

LAMELLIBRANCHIATA.

2. *Modiola sp. ind.* (?)
3. *Aviculopecten nov. sp. ind.*
4. *Pecten nov. sp. ind.*

BRACHIOPODA.

5. *Productus Cora*, d'Orb.
6. „ *undatus*, Defr.
7. „ *semireticulatus*, Mart.
8. „ *cf. longispinus*, Sow.
9. „ *cf. scabriculus*, Mart.
10. „ *cf. spinulosus*, Sow.
11. „ *pustulosus*, Phill.
12. „ *punctatus*, Mart.
13. „ *aculeatus*, Mart.
14. „ *mongolicus*, Diener.

15. *Strophalosia sp. ind., aff. costata,* Waag.
16. „ *cf.* (?) *tenuispina,* Waag.
17. *Chonetes lævis,* Davids.
18. „ *Hardrensis var. Kashmeriensis,* Dav.
19. „ *Austeniana,* Davids.
20. „ *Barusiensis,* Davids.
21. *Lyttonia sp. ind.*
22. *Derbyia cf. senilis,* Phill.
23. *Eumetria cf. grandicosta,* Davids. (*an compressa,* Meek ?).
24. *Athyris subtilita,* Hall.
25. „ *Buddhista,* Verchère.
26. „ *cf. expansa,* Phill.
27. *Spiriferina cf. Kentuckensis,* Shum.
28. *Spirifer Musakheylensis,* Davids.
29. „ *sp. ind., aff. Musakheylensis.*
30. „ *Rajah,* Salter.
31. „ *cf. triangularis,* Mart.
32. *Spirifer Lydekkeri,* Diener.
33. „ *Kashmeriensis,* Davids.
34. „ *Vihianus,* Davids.
35. *Martiniopsis* (?) *sp. ind., aff. subradiata,* Sow.
36. *Rhynchonella triplex,* M'Coy.
37. „ *Barusiensis,* Davids.
38. „ *Kashmeriensis,* Davids.
(?) 39. *Camarophoria cf. Purdoni,* Davids.
40. *Dielasma hastatum,* Sow.
41. *Discina Kashmeriensis,* Davids.

Bryozoa.

42. *Fenestella sp., aff. fossula,* Lonsdale.
43. „ *sp., aff. internata,* Lonsd.
44. *Protoretepora ampla,* Lonsd.
45. *Acanthocladia* sp. ind.

I have not been able to ascertain if *Camarophoria cf. Purdoni* ought not to have been included rather in the list of fossils from Prongam Trál than in the present one.

The fossils of the Zewan beds are contained in variously coloured shales, sandstones and limestones, but are as a rule rather indifferently preserved. This fact will explain the large number of species marked in the preceding list as "*sp. ind.*" or as "*cf.*" only.

In this list are contained 45 species altogether, of which, however, barely more than 30 could be identified with tolerable certainty. Among them brachiopoda by far predominate, both in number of species and individuals, composing with 37 species five-sixths of the entire fauna. Although this proportion may be partly due to the circumstance that among the Lamellibranchiata and Bryozoa available for examination very few specimens only were found worthy of a

specific description, the predominance of brachiopoda over the other classes of organic remains may be considered a well-established fact.

Judging by its general zoological character, the fauna of the Zewán or Barus beds can only be looked upon as of upper carboniferous age. Leaving out such forms as are either restricted to the Zewán beds only or specifically undeterminable, the remaining species may be divided into two groups. The first group is represented by species which occur both in the mountain-limestone and in deposits of an upper carboniferous age. The second group, which from a palæontological point of view is much more important, is composed of such species as are restricted to younger carboniferous strata but are absent in the mountain-limestone of lower carboniferous age. These species are :—

Productus mongolicus, Diener.
Strophalosia cf. (?) *tenuispina*, Waag.
Chonetes Barusiensis, Dav.
Lyttonia sp ind.
Eumetria cf. grandicosta, Davids.
Spiriferina cf. Kentuckensis, Shum.
Spirifer Musakheylensis, Davids.
„ *Rajah*, Salt.
Camarophoria cf. Purdoni, Davids.
Protoretepora ampla, Lonsd.

The frequent occurrence of *Strophalosiæ*, the presence of the strange genus *Lyttonia*, of the group of *Chonetes grandicostatæ*, of *Spirifer Musakheylensis* and of a group of *Spirifer*, distinguished by coarse fasciculate ribs (*Sp. Rajah*) are characters of such high importance that in the face of them a correlation of the Zewán beds with the upper carboniferous series of other countries can hardly be questioned. To this may yet be added another fact, pointing in the same direction, and this is the absence of any species in the whole list which has hitherto only been met with in strata of a lower carboniferous age.

Though the question as to the age of the Zewán beds may thus be settled in a general way, it is hardly possible to decide to which particular horizon of the upper carboniferous series in the standard stratigraphic scale these beds may correspond. In elucidating this point it will be necessary to deal first with the relations which exist between the fauna of the Zewán beds and the faunæ of anthracolithic deposits of other countries.

A tolerably large percentage of species, at least 16 out of the 45 species, quoted in the preceding list, are peculiar to the fauna of the Zewán beds. The majority among them are, however, closely allied to carboniferous forms, as has been indicated in the special descriptions. Nevertheless one-third of the entire Zewán fauna appears to be made up of species which have not been found hitherto outside the Kashmir territory. But their importance from a stratigraphic point of view is considerably lessened by the fact that one of them only, *Spirifer*

Lydekkeri, is among the chief leading fossils of the Zewán beds. All the rest of leading fossils are well known anthracolithic species, *viz.* :—

Productus semireticulatus, Mart.
Derbyia cf. senilis, Phill.
Athyris subtilita, Hall.
Spiriferina cf. Kentuckensis, Shum.
Spirifer Musakheylensis, Davids.
„ *Rajah*, Salt.
Protoretepora ampla, Lonsd.

One of the most striking features of the Zewán fauna is their comparatively slight affinity to any of the faunæ of the Salt Range Productus limestone. Five species only are identical, three of which have not been quite safely determined. These species are the following :—

Productus Cora, d'Orb.
„ *semireticulatus*, Mart.
„ *cf. longispinus*, Sow.
Spirifer Musakheylensis, Davids.
Camarophoria cf. Purdoni, Davids.

An affinity to the fauna of the Productus limestone of the Salt Range is further indicated by a small number of forms, which are very closely allied to Salt Range species. Such species are : —

Strophalosia sp. ind., aff. costata, Waag.
„ *cf.* (?) *tenuispina*, Waag.
Lyttonia sp. ind.
Eumetria cf. (?) *grandicosta*, Davids.
Discina Kashmeriensis, Davids.

These are rather slight affinities only. Much more close are the relations to the carboniferous deposits of Europe. Chiefly the list of *Producti* from the Zewán beds contains a large number of European carboniferous forms. Ten species are directly identical, but the number of species probably identical is increased to 17, if such forms are included as are marked in the above quoted list as "*cf.*" only. The species pointing to European affinities are the following :—

Productus Cora, d'Orb.
„ *undatus*, Defrance.
„ *semireticulatus*, Mart.
„ *cf. longispinus*, Sow.
„ *cf. scabriculus*, Mart.
„ *cf. spinulosus*, Sow.
„ *pustulosus*, Phill.
„ *punctatus*, Mart.
„ *aculeatus*, Mart.
Derbyia cf. senilis, Phill.
Athyris subtilita, Hall.
„ *cf. expansa*, Phill.

Spirifer cf. triangularis, Mart.
„ *Musakheylensis*, Davids.
Rhynchonella triplex, M'Coy.
Camarophoria cf. Purdoni, Davids.
Dielasma hastatum, Sow.

This predominance of European carboniferous types is a very remarkable fact. It is the more astonishing if we take into consideration that very close relations exist between the faunæ of Chitichun No. I and of the Salt Range Productus limestone, more than one-half of the entire brachiopod fauna of Chitichun No. I being composed of identical species.

There are similar relations between the faunæ of the Zewán beds of Kashmir and of Loping in China, as between the former and the faunæ of European carboniferous deposits. Seven or eight species are probably identical, and the number of very closely allied forms is still larger. The fauna of the Zewán beds certainly bears a greater similarity to that of Loping than to any of the Salt Range faunæ, though the latter region is geographically less distant.

A third element in the faunæ of the Zewán beds is constituted by a few forms which point to an affinity with the carboniferous fauna of Australia. These Australian affinities are indicated by the following species :—

Spirifer Lydekkeri, Dien.
Martiniopsis (?) *sp. ind., aff. subradiata*, Sow.
Protoretepora ampla, Lonsd.
Fenestella sp. ind., aff. fossula, Lonsd.
„ *sp. ind., aff. internata*, Lonsd.

Among these five species *Protoretepora ampla* only is actually identical with an Australian carboniferous type. *Spirifer Lydekkeri* is very closely allied to *Sp. Clarkei*, de Kon. The determination of the specimen, figured on Pl. VI, Fig. 9, of the present memoir, as *Martiniopsis*, is not beyond all doubt. The two species of *Fenestellæ* may probably have their nearest allies in the carboniferous rocks of Australia, but their exact identification is impossible, owing to the unsatisfactory state of preservation of my materials available for examination.

Another Himálayan species identical with an Australian form is *Strophalosia Gerardi*, King, but the geological age of the beds in which the Himálayan type specimen was collected by Dr. Gerard is unfortunately unknown.

The faunistic affinities between the Zewán beds of Kashmir and the carboniferous deposits of Australia, as indicated by the above-mentioned fossils, appear therefore to be very slight only. They are certainly less strongly marked than the Australian affinities of the fauna contained in the *Conularia* nodules and in the *Eurydesma* sandstones of the Salt Range. Nevertheless I consider them to be of no small geological importance, because similar affinities are entirely absent in the Productus limestone.

A correlation of the Zewán beds with the lower speckled sandstone of the Salt Range has been advocated by Waagen. Although Davidson's description of the brachiopoda, collected by Godwin-Austen, was only available to him as a base for

correlation, he justly noticed the predominance of European carboniferous types in the Kashmir fauna, and correctly inferred that the Zewán beds should be placed rather high in the carboniferous series, "that they should either be placed on a level with the lower speckled sandstone of the Salt Range, or else they should be considered as intermediate in age between the latter beds and the lower Productus limestone (Amb beds)."[1]

The remarkable palæontological separation of the faunæ of the Zewán and Amb beds is indeed no evidence in favour of a correlation of these two rock-groups. So far as the testimony of fossils in the correlation of the faunæ of two distant regions can be relied on to the extent and with the precision which our ability to interpret them will permit, the predominance of European and the slight admixture of Australian types point to a geological horizon slightly lower in age than the Amb beds. A correlation with the lower speckled sandstone is nevertheless yet far from being established safely. Only by obtaining new and abundant materials and giving them an exhaustive study could the problem of the relations existing between the Kashmir and Salt Range anthracolithic faunæ be practically solved.

The question whether the Zewán beds should be placed on a level with the Moscovian or Gshelian stages of the carboniferous system in Europe, is likewise an open one. Those who try to establish a natural classification of Himálayan rocks will probably come to the conclusion that the minor divisions of the carboniferous system, which are thoroughly adapted to the stratigraphic order in Eastern Europe, cannot be recognized in the carboniferous series of extra-peninsular India. I seriously doubt that the sub-divisions of the upper carboniferous strata, which are locally distinguishable in the Ural or in Central Russia, are satisfactory for purposes of correlation in the Indian province. All attempts to establish a correlation of the Zewán beds with any of these sub-divisions on biological evidence will prove forced and artificial.

There is yet one horizon among the anthracolithic series of the North-Western Himálayas, to which, upon the scanty palæontological data available, an upper carboniferous age must probably be attributed. This horizon is represented by a quartz-sandstone, collected in the Ladakh Valley by Lydekker, and containing the following fossils :—

Productus sp. ind.
Spirifer Lydekkeri, Dien.
Sp. ind. aff. Lydekkeri.
Conularia tenuistriata, M'Coy.

Neither the stratigraphic position of this sandstone nor the locality is mentioned in Lydekker's memoir. The assemblage of species strongly exhibits an affinity to Australian carboniferous types. Especially the presence of *Conularia tenuistriata*, occurring also in the boulder group of the Salt Range, points in this direction.

A horizon lower in age than all those hitherto mentioned is perhaps indicated by the specimen of a crinoidal limestone collected by Stoliczka near Kuling in Spiti.

1 *W. Waagen*, Salt Range Fossils, *l. c.* Vol. IV, Geological Results, p. 166.

This rock specimen yielded two forms of *Syringothyris cuspidata*, Mart., a very common mountain limestone form in Western Europe. There is some probability of the specimen having been derived from the crinoid limestone horizon, which Griesbach has proved to form the base of the carboniferous series in the Central Himálayas, and which he correlated with the lower carboniferous beds of the European standard.

This is all I am able to say with regard to the faunistic features of the anthracolithic series in Kashmir and Spiti. My indications are rather vague, I regret to say, and the results of my studies less certain than I could have wished. But it must be borne in mind that in many instances the exact stratigraphic position of the fossils entrusted to me for examination was not known, and that it would require a personal study of the anthracolithic deposits *in situ* and the collection of extensive materials, exactly to single geological horizons, to obtain safer results. I can only express my earnest hope that the interesting problems connected with the stratigraphy of the anthracolithic system in the North-Western Himálayas may be solved in time by a detailed survey of the Kashmir Valley. If the details of both stratigraphy and palæontology in this district are worked out with sufficient minuteness, they may not only permit fuller correlations with the anthracolithic system in other parts of the world, but may probably lead to the solution of one of the most important problems in the natural history of the anthracolithic epoch, *i.e.*, of the relations between the carboniferous deposits of Europe and of Australia.

PLATE I.

Figs. 1, 2. PHILLIPSIA, sp. ind. aff., SEMINIFERA, Phill.
Two pygidia from the Zewán beds, N. of Eishmakam, Kashmir Valley; coll. Lydekker.
1*a*, 2*a* natural size; 1*b*, 2*b* twice enlarged.

Fig. 3. AVICULOPECTEN, sp. ind.
Right valve from the Zewán beds of Eishmakam, Kashmir Valley; coll. Lydekker.

Fig. 4. PECTEN, sp. ind.
Left valve from the same locality; coll. Lydekker.

Fig. 5. MODIOLA (?) sp. ind.
Right valve from the same locality; coll. Lydekker.

Figs. 6, 7. PRODUCTUS ACULEATUS, Martin.
Zewán beds, Kashmir Valley; coll. Verchère.
6*a*, 7 ventral view 6*b* lateral view.

Fig. 8. PRODUCTUS ABICHI, Waagen.
Summit of a ridge N. E. Prongam Trál, Kashmir; coll. Lydekker.
8*a* ventral view, 8*b* lateral view.

Figs. 9, 10. PRODUCTUS UNDATUS, Defrance.
Two casts of dorsal valves from the Zewán beds, N. of Eishmakam, Kashmir Valley; coll. Lydekker.

Fig. 11. PRODUCTUS cf. LONGISPINUS, Sow.
Incomplete ventral valve from the Zewán beds of Barus, Kashmir Valley; coll. Lydekker.
11*a* ventral view, 11*b* front view, 11*c* lateral view.

Fig. 12. PRODUCTUS CORA, d'Orb.
Ventral valve, Zewán beds, Barus, Kashmir Valley; coll. Lydekker.
12*a* ventral view, 12*b* apical view, 12*c* lateral view.

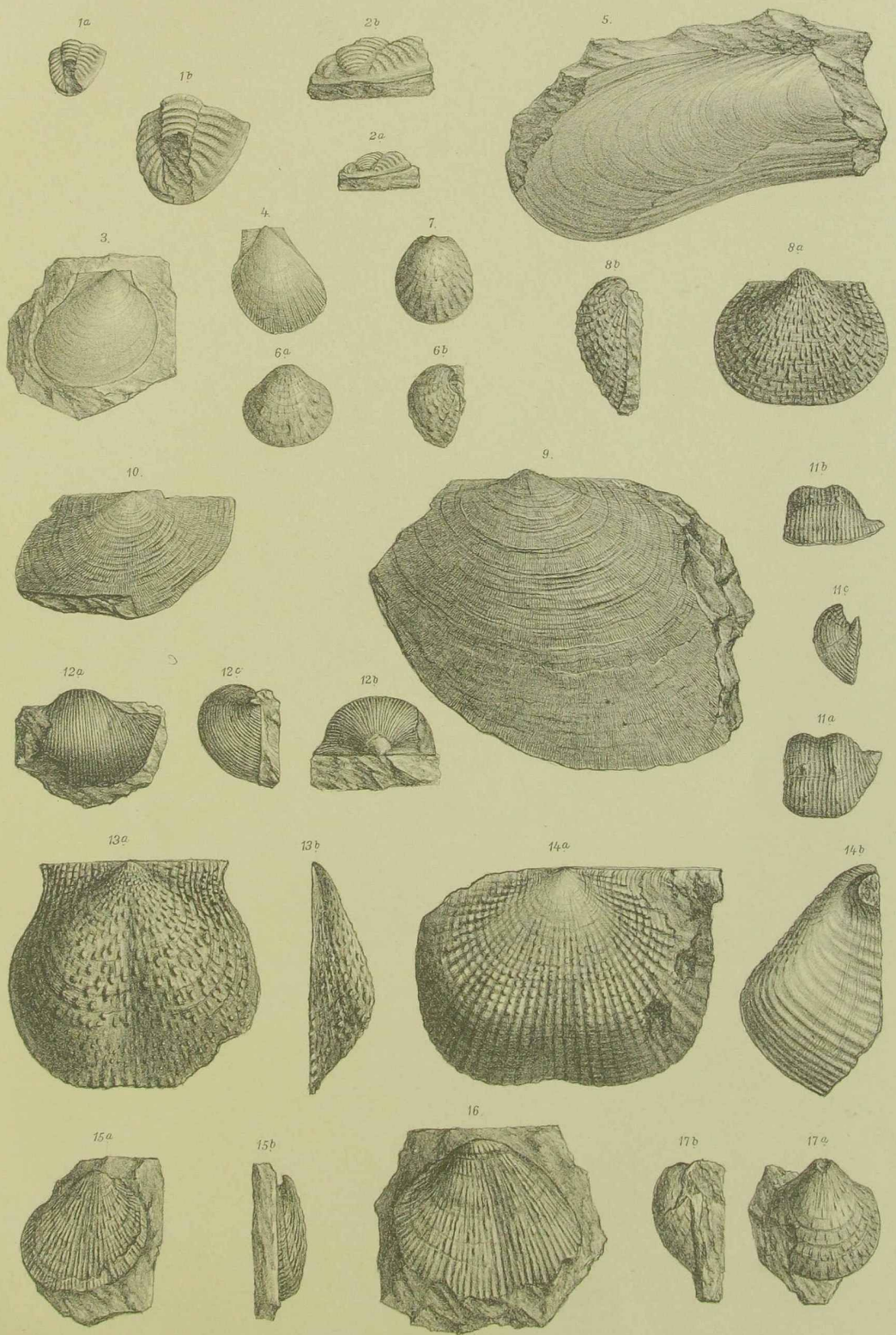
Fig. 13. PRODUCTUS PUSTULOSUS, Phill.
Cast of a dorsal valve from the Zewán beds of Barus, Kashmir Valley; coll. Godwin-Austen.
13*a* dorsal view, 13*b* lateral view.

Fig. 14. PRODUCTUS SEMIRETICULATUS, Martin.
Cast of a dorsal valve from the Zewán beds, N. of Khoonmoo, near Pampur; coll. Lydekker.
14*a* dorsal view, 14*b* lateral view.

Figs. 15, 16. STROPHALOSIA, sp. ind. aff., S. COSTATA, Waagen.
Two ventral valves from the Zewán beds, N. of Eishmakam, Kashmir Valley; coll. Lydekker.
15*a*, 16 ventral view, 15*b* lateral view.

Fig. 17. STROPHALOSIA cf. (?) TENUISPINA, Waagen.
Ventral valve from the Zewán beds of Barus, Kashmir Valley; coll. Godwin-Austen.
17*a* ventral view, 17*b* lateral view.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE II.

Figs. 1—7. MARGINIFERA HIMALAYENSIS, Diener.

1, ventral valve, with cast of dorsal valve partly visible, from Kuling, Spiti; coll. Griesbach.

1*a* ventral view, 1*b* lateral view, 1*c* apical view.

2, 3, ventral valves, from Khar, Spiti; coll. Griesbach.

2*a*, 3*a* ventral view, 2*b*, 3*b* front view, 3*c* apical view.

4, cast of dorsal valve, from Khar, Spiti; coll. Griesbach.

4*a* dorsal view, 4*b* apical view.

5, ventral valve from W. summit of ridge, N. E. Prongam Trál, Kashmir; coll. Lydekker.

5*a* ventral view, 5*b* lateral view, 5*c* apical view.

6, cast of a dorsal valve from the same locality; coll. Lydekker.

6*a* dorsal view, 6*b* lateral view, 6*c* apical view.

7, tolerably complete specimen, with both valves preserved, from the Kuling shales of the Spiti Valley; coll. Gerard.

7*a* ventral view, 7*b* dorsal view.

Figs. 8, 9. PRODUCTUS cf. SCABRICULUS, Martin.

8, ventral valve, 9, dorsal valve, both from the Zewán beds of Barus, Kashmir Valley; coll. Lydekker.

Fig. 10. PRODUCTUS SEMIRETICULATUS, Martin.

Internal cast of a ventral valve, Zewán beds, N. of Khoonmoo, near Pampur, Kashmir; coll. Lydekker.

Fig. 11. PRODUCTUS PUNCTATUS, Martin.

Ventral valve from the Zewán beds of Barus, Kashmir.

Fig. 12. PRODUCTUS cf. SPINULOSUS, Sowerby.

Ventral valve from the Zewán beds of Barus, Kashmir Valley; coll. Godwin-Austen.

12*a* ventral view, 12*b* lateral view.

Fig. 13. CHONETES AUSTENIANA, Davidson.

Ventral valve from the Zewán beds of Barus, Kashmir Valley; coll. Godwin-Austen.

13*a* ventral view, 13*b* lateral view, 13*c* apical view.

Fig. 14. CHONETES GRANDICOSTA, Waagen.

Ventral valve, from the summit of ridge, N.E. Prongam Trál, Kashmir; coll. Lydekker.

14*a* ventral view, 14*b* lateral view, 14*c* front view, 14*d* apical view.

Figs. 15, 16. LYTTONIA sp. ind.

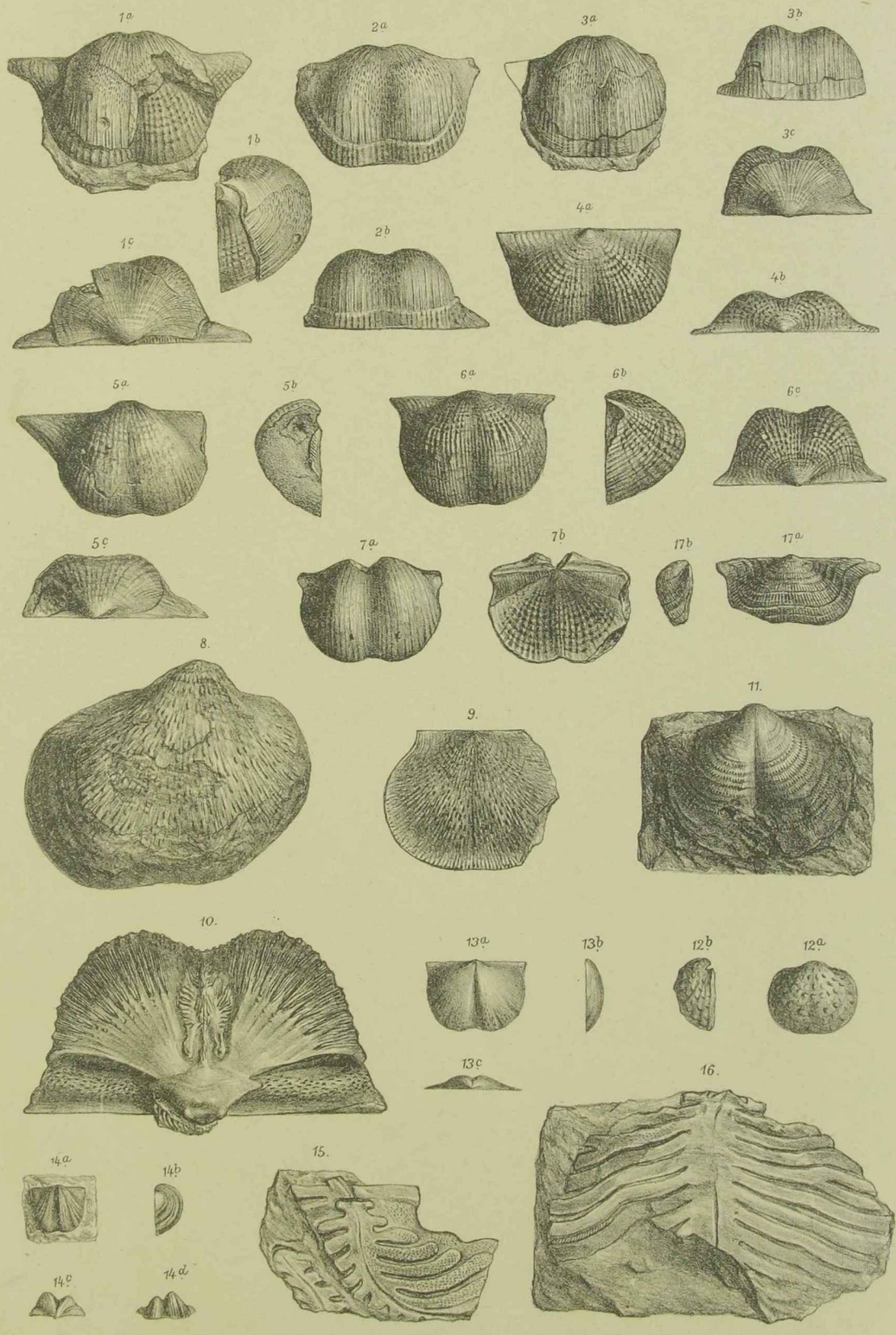
Two casts from the Zewán beds of the Marbal Pass, Kashmir; coll. Lydekker.

Fig. 17. STROPHOMENA ANALOGA, Phillips.

Ventral valve, from W. summit of ridge, N.E. Prongam Trál, Kashmir; coll. Lydekker.

17*a* ventral view, 17*b* lateral view.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE III.

Figs. 1—4. Spirifer Lydekkeri, Diener.
From the Zewán beds, N. of Eishmakam, Kashmir Valley ; coll. Lydekker.

Figs. 5—11. From a quartz-sandstone of the Ladakh Valley (exact locality unknown) ; coll. Lydekker.

1, 2*a*, 3 dorsal valves.
2*b* cardinal region, slightly enlarged.

4, internal cast of a ventral valve, with impressions of cardinal teeth.
4*a* ventral view, 4*b* apical view.

5, 9, plaster-casts of external impressions of two ventral valves. Frontal region not preserved.

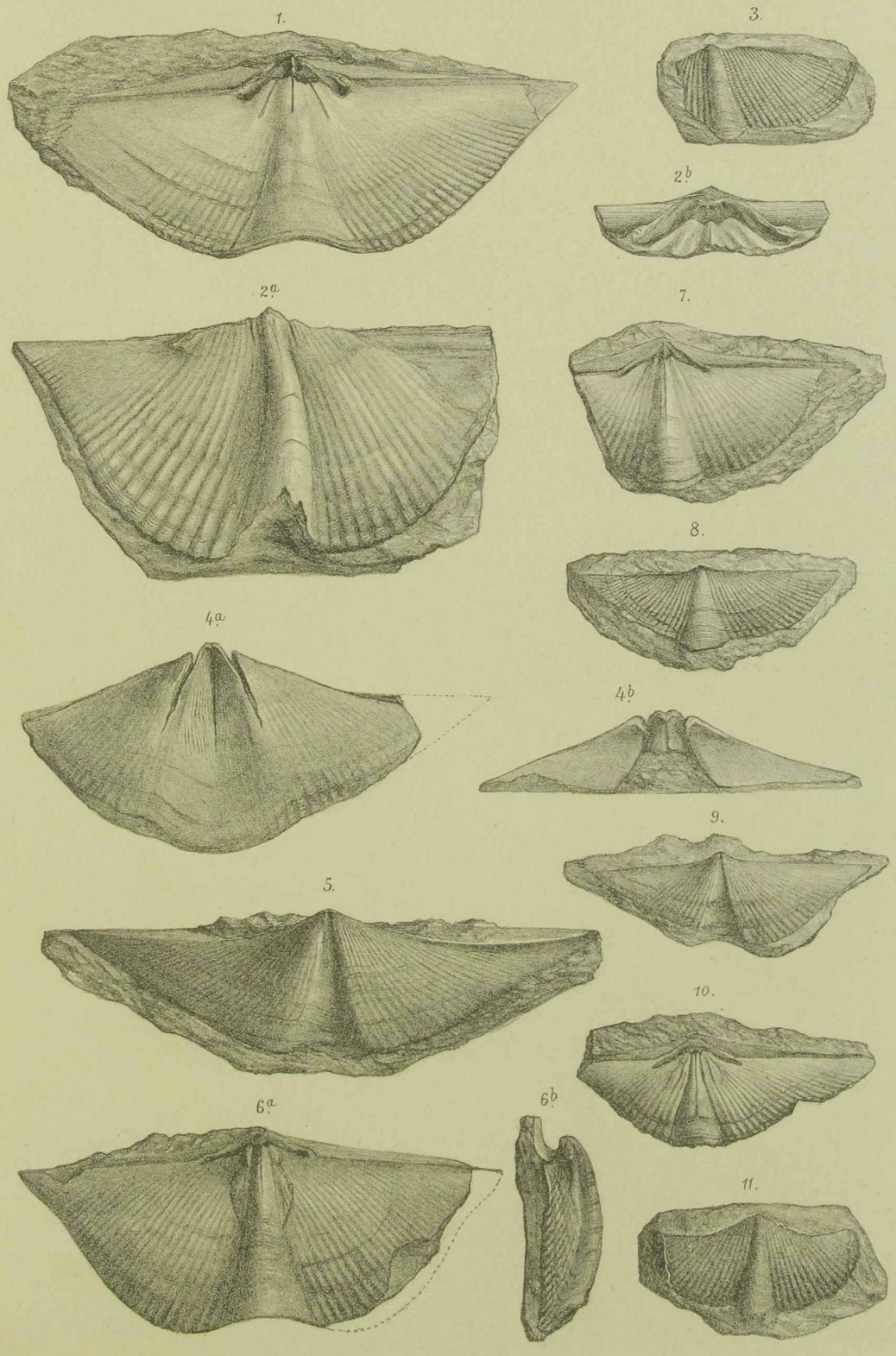
6, dorsal valve.
6*a* dorsal view, 6*b* lateral view.

7, dorsal valve, with cardinal region of ventral valve adhering, Lydekker's type-specimen (Mem. Geol. Surv. of India, Vol. XXII, Pl. II, Fig. 4).

8, 11, plaster-casts of external impressions of two dorsal valves.

10, dorsal valve with muscular impressions preserved.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE IV.

Figs. 1—7. Spirifer Rajah, Salter.

1, ventral valve, from Barus, Kashmir Valley; coll. Godwin-Austen.

2, dorsal view of a specimen from the Spiti Valley; coll. Gerard.

3, internal cast of a ventral valve, from the Spiti Valley; coll. Gerard.

4, ventral valve, from Kuling, Spiti; coll. Griesbach.

5, largest specimen, known to me, from Kuling, Spiti; coll. Griesbach.
5*a* dorsal view, 5*b* lateral view.

6, internal side of a ventral valve, from the Spiti Valley; coll. Stoliczka.

7, ventral valve, from the Spiti Valley; coll. Gerard.

Fig. 8. Spirifer sp. ind., ex aff. Sp. Rajah.

Dorsal valve from Muth, Spiti; coll. Gerard.

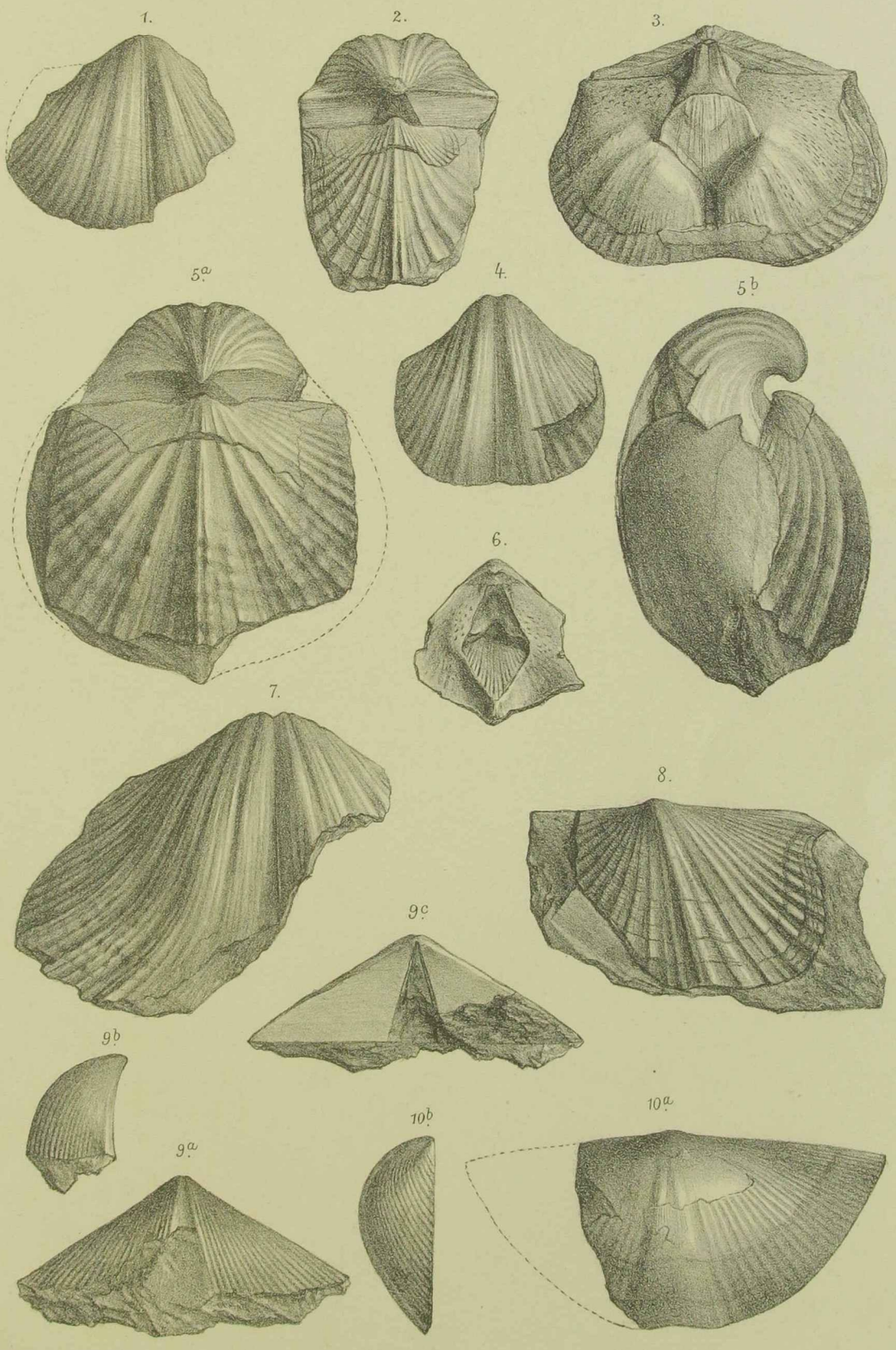
Figs. 9, 10. Syringothyris cuspidata, Martin.

Two specimens from a black, crinoidal limestone, Kuling, Spiti; coll. Stoliczka.

9, ventral valve.
9*a* ventral view, 9*b* lateral view, 9*c* apical view.

10, dorsal valve.
10*a* dorsal view, 10*b* lateral view.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE V.

Fig. 1. SPIRIFER RAJAH, Salter.
Dorsal view of a specimen from the Spiti Valley ; coll. Gerard.

Fig. 2. SPIRIFER sp. ind., ex aff. LYDEKKERI, Diener.
Dorsal valve from a quartz-sandstone of the Ladakh Valley, Kashmir ; coll. Lydekker.

Figs. 3—7. SPIRIFER MUSAKHEYLENSIS, Davids.
3, dorsal valve from Muth, Spiti ; coll. Stoliczka.
4, ventral valve from the Spiti Valley ; coll. Gerard.
5, ventral valve from Khar, Spiti ; coll. Griesbach.
6, ventral valve from the Zewán beds, Kashmir Valley ; coll. Godwin-Austen.
7, internal cast of a ventral valve from the Spiti Valley ; coll. Godwin-Austen.

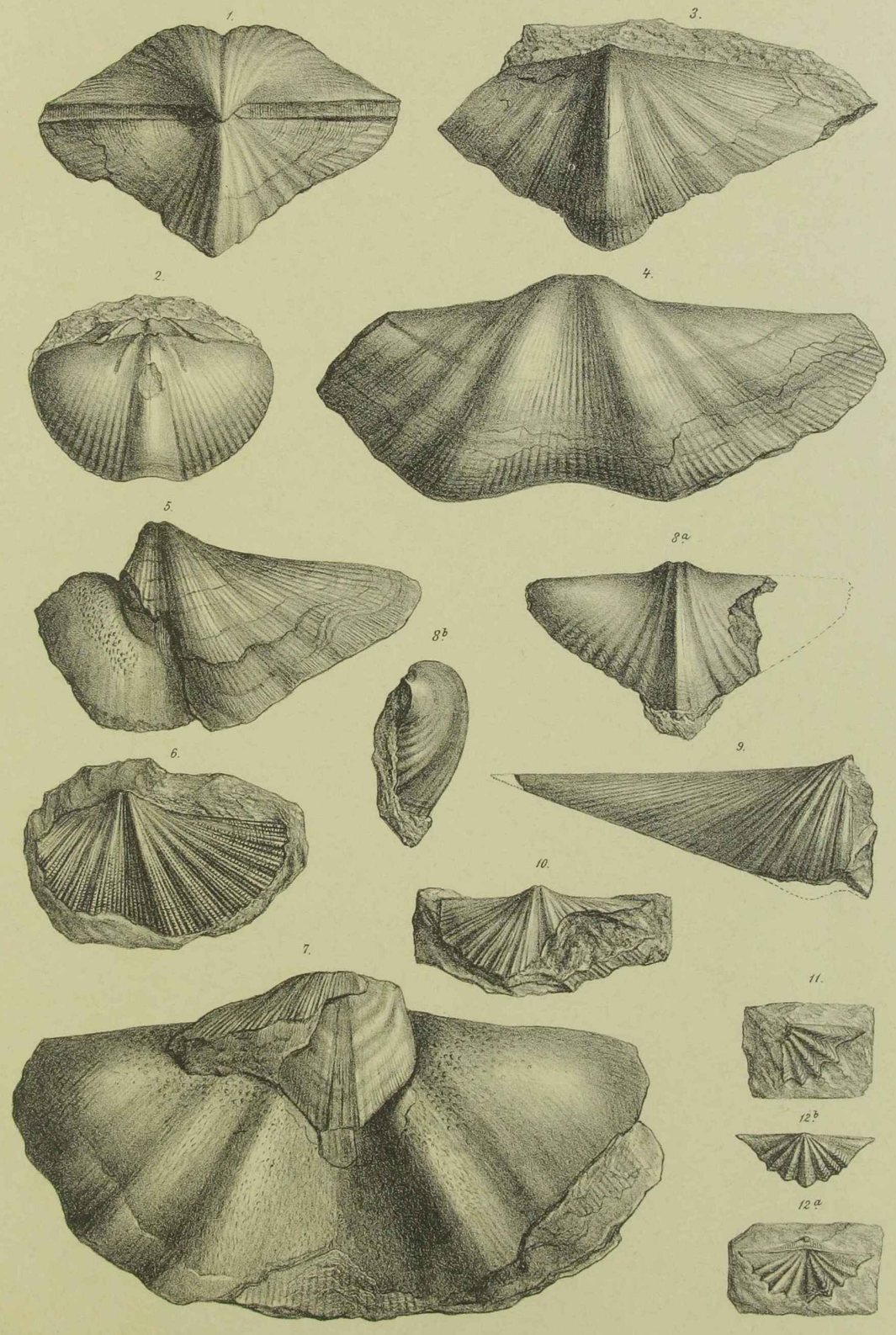
Fig. 8. SPIRIFER cf. TRIANGULARIS, Martin.
Fragment of a dorsal valve, from the Zewán beds of Eishmakam, Kashmir ; coll. Lydekker.

Fig. 9. SPIRIFER cf. NITIENSIS, Diener.
Fragment of a ventral valve from Po, Spiti ; coll. Gerard.

Fig. 10. SPIRIFER sp. ind., aff. MUSAKHEYLENSIS.
Fragment of a ventral valve from the Zewán beds of Kashmir ; coll. Godwin-Austen.

Figs. 11, 12. SPIRIFERINA cf. KENTUCKENSIS, Shumard.
Two external impressions of dorsal valves, from the Zewán beds of Kashmir ; coll. Verchère.
12*b*. Reproduction of a plaster-cast taken from the specimen, fig. 12*a*.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VI.

Figs. 1, 2. MARGINIFERA HIMALAYENSIS, Dien. var.
Two ventral valves from Muth, Spiti ; coll. Stoliczka.

Fig. 3. CHONETES LISSARENSIS, Diener.
Ventral valve from Kuling, Spiti ; coll. Stoliczka.
3*a* ventral view, 3*b* lateral view, 3*c* apical view.

Fig. 4. CHONETES BARUSIENSIS, Davids.
Ventral valve from the Zewán beds of Barus ; coll. Godwin-Austen.
4*a* natural size, 4*b* twice enlarged.

Figs. 5, 6. DERBYIA cf. SENILIS, Phill.
5, plaster-cast of internal impression of a dorsal valve, from the Zewán beds of Barus ; coll. Godwin-Austen.
6, plaster-cast of external impression of a ventral valve, from the same locality ; coll. Godwin-Austen.

Figs. 7, 8. PRODUCTUS MONGOLICUS, Diener.
7, ventral valve, from the Zewán beds of Barus ; coll. Godwin-Austen.
7*a* ventral view, 7*b* lateral view.
8, cast of a ventral valve, with parts of the dorsal valve adhering to it, from the same locality ; coll. Godwin-Austen.

Fig. 9. MARTINIOPSIS (?) sp. ind., aff. SUBRADIATA, Sow.
Fragment of a ventral valve from the Zewán beds of Kashmir ; coll. Verchère.

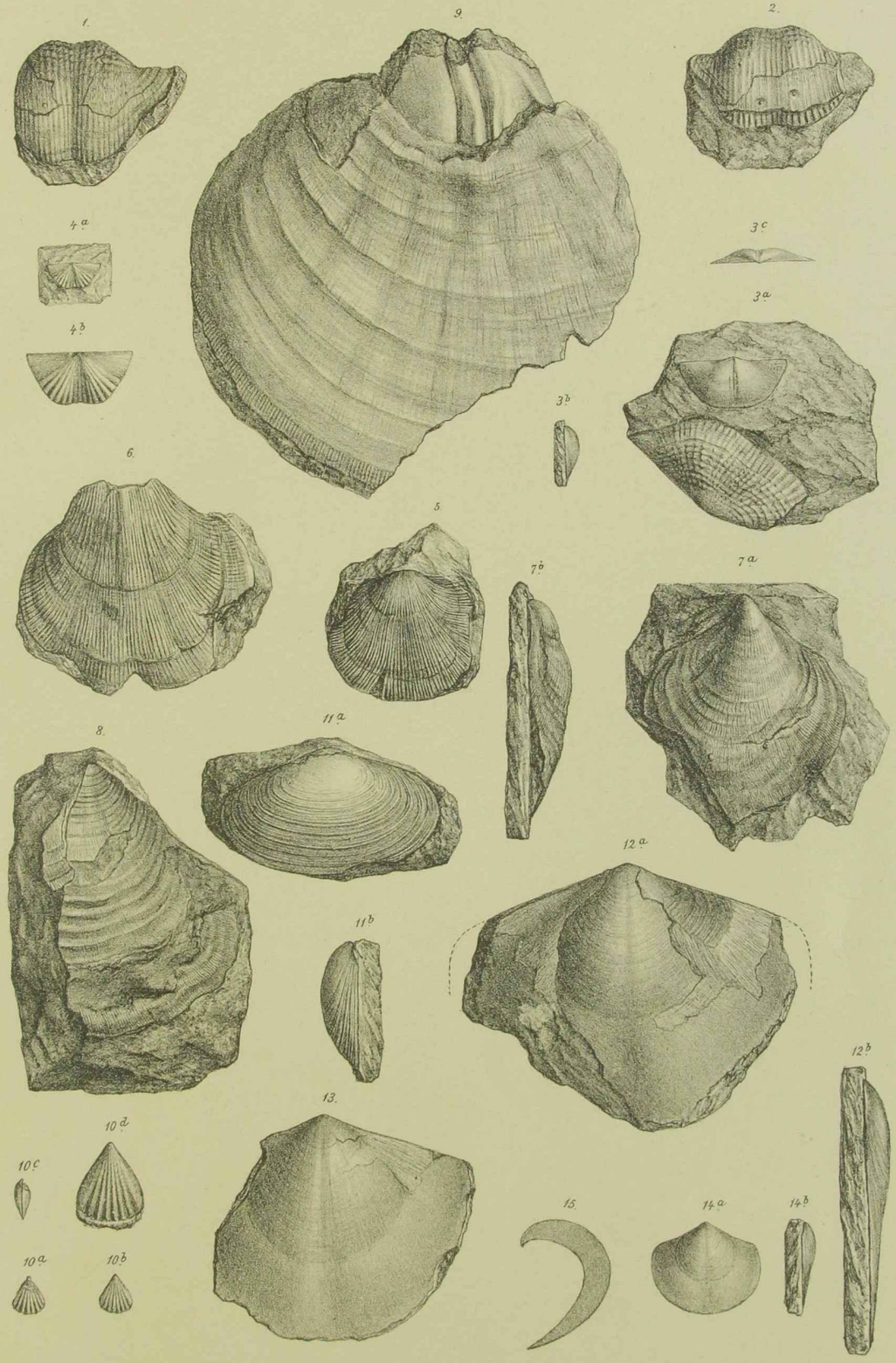
Fig. 10. EUMETRIA (RETZIA) cf. (?) GRANDICOSTA, Dav. (an COMPRESSA ? Meek).
Fragmentary specimen from the Zewán beds of Eishmakam, Kashmir ; coll. Lydekker.
10*a* dorsal view, 10*b* ventral view, 10*c* lateral view; all three of natural size.
10*d* ventral view, enlarged.

Fig. 11. ATHYRIS cf. EXPANSA, Phill.
Ventral (?) valve from the Zewán beds, N. of Khoonmoo, near Pampur ; coll. Lydekker.
11*a* ventral view, 11*b* lateral view.

Figs. 12, 14. ATHYRIS GERARDI, Diener.
Three ventral valves, from sandstone partings in the Kuling shales of Po, Spiti ; coll. Gerard.
12*a*, 13, 14*a* ventral view.
12*b*, 14*b* lateral view.

Fig. 15. MARGINIFERA HIMALAYENSIS, Dien.
Transverse section of the specimen, figured on Pl. II, Fig. 1.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VII.

Figs. 1—3. ATHYRIS SUBTILITA, Hall.

Three specimens from the Zewán beds of the Kashmir Valley; coll. Godwin-Austen.

1*a*, 2*a*, 3*a* dorsal view, 1*b* ventral view, 1*c*, 2*b*, 3*b* lateral view, 1*d* frontal view.

Fig. 4. CAMAROPHORIA cf. PURDONI, Davids.

From Kashmir (horizon unknown); coll. Lydekker.

4*a* dorsal view, 4*b* ventral view, 4*c* lateral view.

Fig. 5. DIELASMA HASTATUM, Sowerby.

Complete specimen from the Zewán beds of Eishmakam; coll. Lydekker.

5*a* dorsal view, 5*b* ventral view, 5*c* lateral view, 5*d* frontal view.

Fig. 6. CONULARIA TENUISTRIATA, M'Coy.

Fragment from a quartz-sandstone of the Ladakh Valley, Kashmir; coll. Lydekker.

6*a* frontal view, 6*b* transverse section, 6*c* lateral view; all of natural size; 6*d* and 6, parts of the surface, enlarged.

Fig. 7. ACANTHOCLADIA sp. ind.

Zewán beds, Loodoo, Vihi Valley, Kashmir; coll. Godwin-Austen.

Fig. 8. FENESTELLA sp. aff. FOSSULA, Lonsd.

Colony from the Zewán beds of Kashmir, coll. Collet, showing the non-poriferous face.

8*b* twice enlarged.

Fig. 9. FENESTELLA sp. aff. INTERNATA, Lonsd.

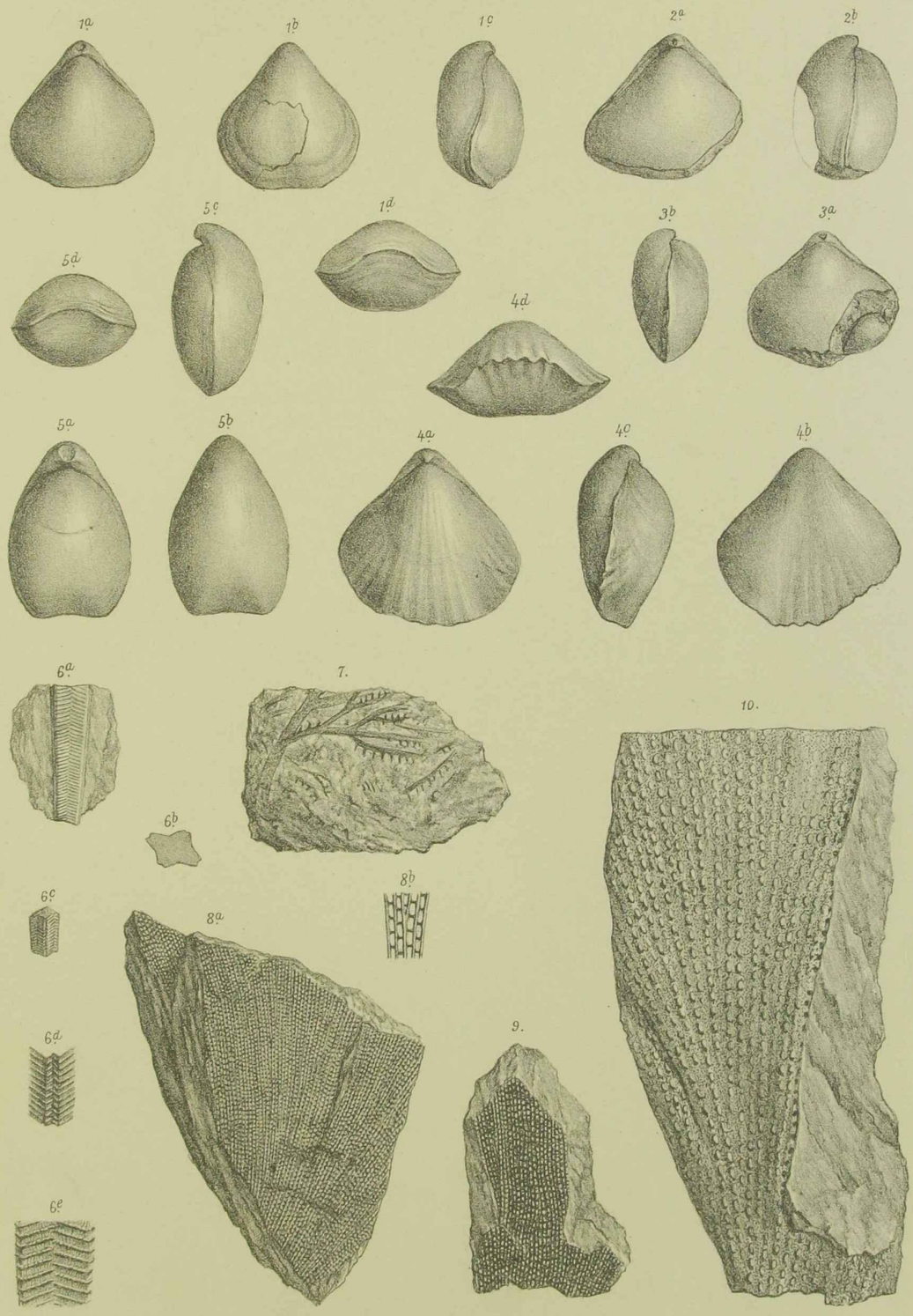
Colony from Mandakpal, N. W. of Wastarwan; coll. Lydekker.

Impression of the poriferous face.

Fig. 10. PROTORETEPORA AMPLA, Lonsdale.

Impression of the poriferous face of a colony from the Zewán beds of Mandakpale, N. W. of Wastarwan; coll. Lydekker.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VIII.

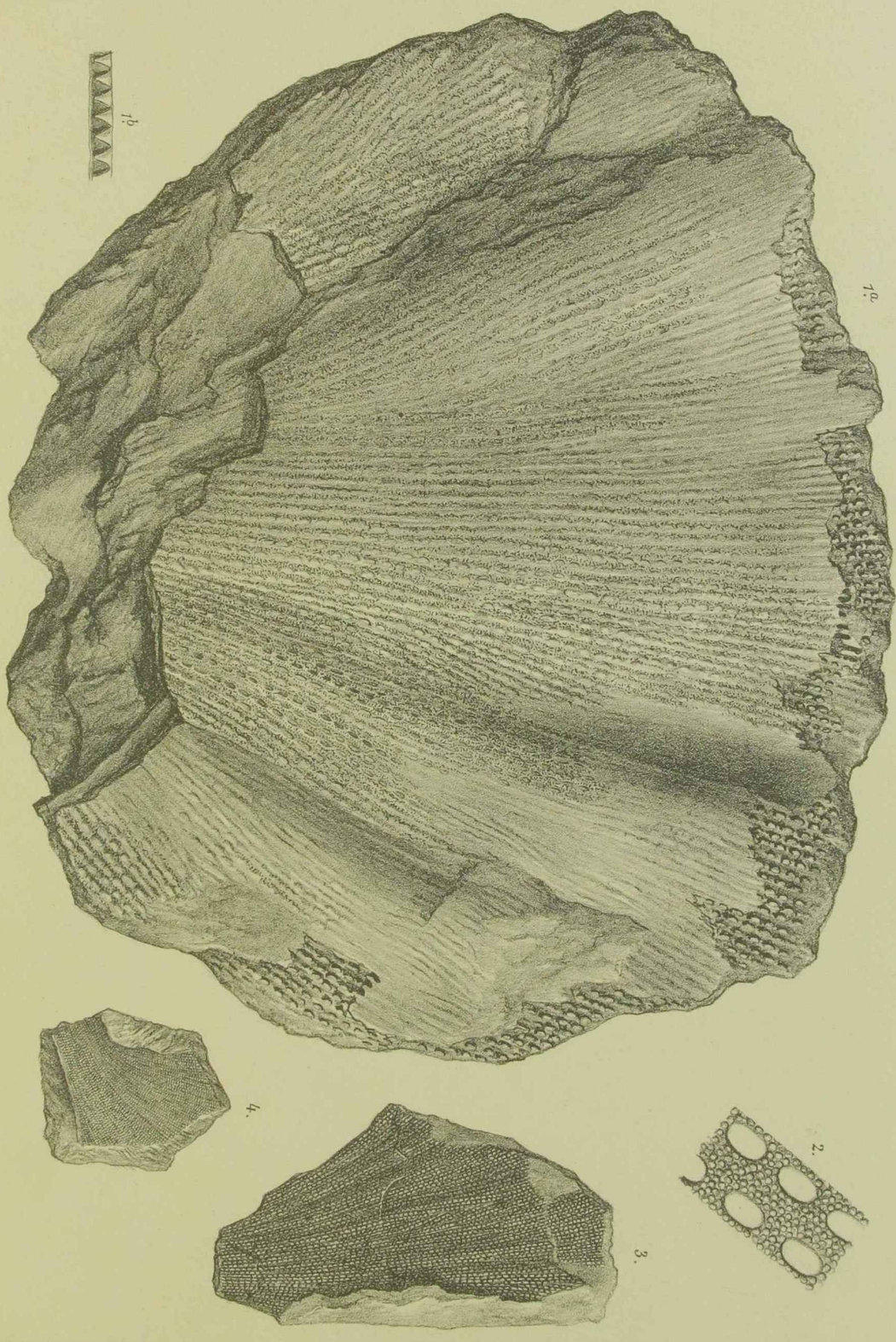
Fig. 1. PROTORETEPORA AMPLA, Lonsdale.
A very large colony from the Zewán beds of Mandakpal, N. W. of Wastanwań, Kashmir ; coll. Lydekker.
1*b* transverse section of the polyzoarium.

Fig. 2. PROTORETEPORA AMPLA, Lonsd.
Part of the surface of the specimen, figured on Pl. VII, Fig. 10, enlarged.

Fig. 3. FENESTELLA sp. aff. INTERNATA, Lonsd.
Impression of the poriferous face of a colony from the Zewán beds of the Kashmir Valley ; coll. Collet.

Fig. 4. FENESTELLA sp. ind., aff. FOSSULA, Lonsd.
External impression of the poriferous face of a colony from the Zewán beds of the Kashmir Valley ; coll. Collet.

ANTHRACOLITHIC-FOSSILS OF KASHMIR AND SPITI.



A. Swoboda del. et lith.

Th. Bannwarth print.