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Uralian stratigraphy, Trilobites and Brachiopods of the western Carnic Alps (Austria)

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with 17 Plates and 26 Text-Figures

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Abstract

The area between the Straniger-Alm and Zoellner-Ochsen-Alm contains Upper Carboniferous and Permian formations. These rocks form the western extention of the younger Palaeozoics of the Carnic Alps. The formations range in age from Uralian to Sakmarian. The sequence however does not appear to be represented completely as some of the upper parts of the Uralian are probably absent. The rocks occur as large isolated outcrops, bounded to the north and south and in places overthrust by strata of Silurian to Lower Carboniferous age.

The sediments are varied in character ranging from brecciose conglomerates through coarse sandstones, siltstones, and slaty shales to dark limestones. While the argillaceous sediments contain a dominantly brachiopod fauna, fusulinids thrived in the carbonates. It is from the fine grain clastic rock type that a large collection of the brachiopod fauna has been obtained. This collection forms the major part of the present study. The study has allowed the recognition of 49 brachiopod and 4 trilobite species of which all of the latter are new.

The brachiopods have been assigned to 9 superfamilies, 15 families (one new), 10 subfamilies (two new), 26 genera (one new), and 18 new species.

Zusammenfassung

Als letzte westliche Ausläufer des Jungpaläozoikums in den Karnischen Alpen treten zwischen der Straniger-Alm und der Zoellner-Ochsen-Alm einzelne isolierte Schollen oberkarbonischer und permischer Sedimente auf. Sie werden in S und N von Schichten silurischen bis unterkarbonischen Alters eingerahmt, stellenweise auch überlagert, so daß ein tektonisches Fenster vorliegen dürfte. Die Schichtfolge ist anscheinend nicht ganz vollständig entwickelt; jedenfalls konnten Teile des oberen Uraliums bislang nicht nachgewiesen werden.

Die Lithofazies ist mannigfaltig ausgebildet; Tonschiefer wechsellagern mit brekziösen Konglomeraten, groben Sandsteinen, Siltstein und dunklen Kalken. Während die karbonatischen Sedimente vor allem eine reiche Fusuliniden-Fauna enthalten, wurde der tonig-klastische Faziesbereich von Brachiopoden bevorzugt, die überwiegend als Skulptur-Steinkerne erhalten sind. Zuweilen findet man auch noch die teilweise verkieselten Kalkschalen. Die Bearbeitung der reichen Brachiopodenfauna ist Hauptgegenstand vorliegender Untersuchung.

Insgesamt konnten — neben 4 Triboliten-Arten, die sich durchweg als neu erwiesen — 49 Brachiopoden-Arten unterschieden werden. Sie wurden 9 Superfamilien, 15 Familien (1 neu), 10 Subfamilien (2 neu), 26 Gattungen (1 neu) und 18 neu aufgestellten Arten zugeordnet.

Acknowledgements

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My thanks go also to Prof. E. FLÜGEL, University Graz and Prof. F. KAHLER, Landes-Museum Klagenfurt who assisted me in every possible way during my stay in the Carnic Alps.

The following persons have kindly made available to me material for comparative studies: Dr. G. A. COOPER, Washington, D. C. (Enteletacea and Lyttoniacea); Prof. R. C. MOORE, Kansas (Enteletacea); Dr. H. MUIR-WOOD, London (Spiriferacea from Salt Range, Pakistan and Productoidea from the Moscow Basin); Prof. C. W. KOCKEL, Marburg (Enteletacea, Spiriferacea and Productoidea from the Moscow Basin); Prof. O. H. SCHINDEWOLF, Tübingen (Orthotetacea from the Salt Range and some of the originals of Schellwien from the Trogkofel limestones); Prof. H. W. MATHES, Halle (Schellwien's originals from the Fusulinenkalk); Prof. R. E. SIEBER, Wien (Schellwien's originals on Lyttoniacea from the Trogkofel limestones), and Prof. K. METZ, Graz (the material investigated by him in 1936).

I am especially indebted to Dr. HELEN MUIR-WOOD for her guidance and supervision during my work on the Productoidea and Chonetoidea carried out at the British Museum (Nat. Hist.), London and Dr. A. RAMOVS, Ljubljana, Jugoslavia, who showed me some sections in the Upper Carboniferous and Permian of the Karawanken.

Prof. A. WILLIAMS, Belfast, and Dr. R. GOLDRING, Reading, have offered many interesting and useful suggestions with regard to the Orthotetacea and Trilobites and Dr. W. GRÄF, Graz, and Doz. Dr. H. J. SCHWEITZER, Bonn, have assisted respectively with the identification of the corals and plant fragments. To all of them I offer my sincere thanks.

I owe a debt of gratitude to Prof. R. BRINKMANN for his permission to work in the University Geological Institute Bonn and to the German Academic Exchange Service (Deutscher Akademischer Austauschdienst) without whose financial help the study would not have been possible.

Location, stratigraphy and geological structure

The Upper Carboniferous between the Straniger- and Zoellner-Ochsen-Alm represents the western most occurrence of rocks of this age in the Carnic Alps. This sequence occurs at an average height of 1700 m above sea level and extends in an approximately E—W direction. Most of the rocks of this age occur in Austria although some occur in Italy in the southern part of the area.

The topography is youthful and the area lies for the most part above the tree line. These factors make for good exposures and assist in accurate

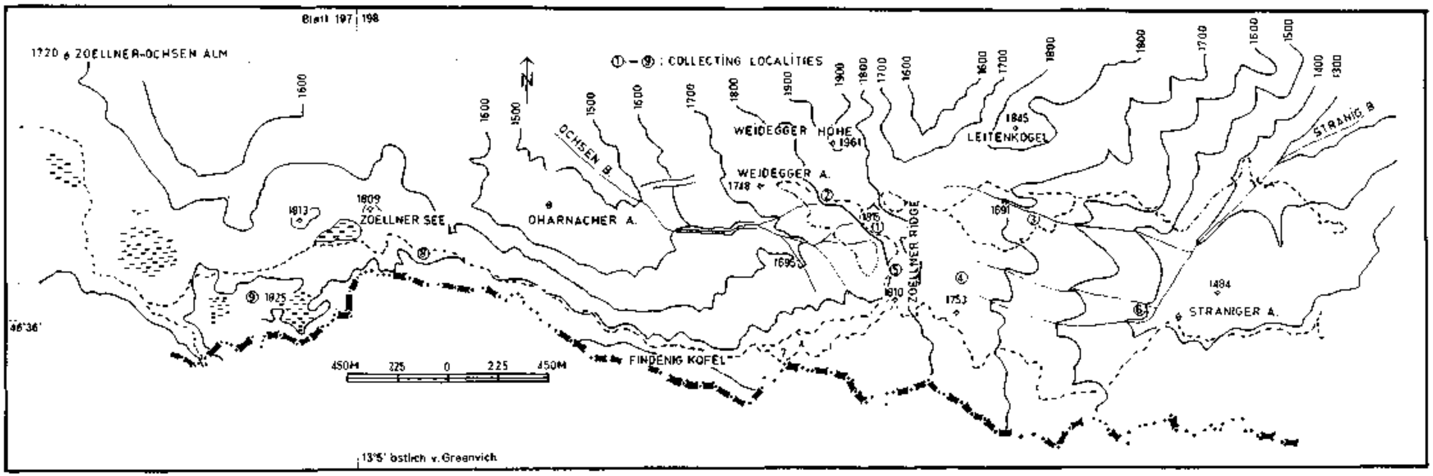


Fig. 1. Topographical map of the area investigated, showing collecting localities.

mapping. The access to the region is by way of tracks which lead from the Gailtal to numerous ranches situated on the mountain slopes.

Much work on the stratigraphy of the Carnic Upper Carboniferous has been carried out by F. HERITSCH, F. KAHLER and K. METZ in the years 1930—1940. The first author used brachiopods and corals for stratigraphic correlation, KAHLER worked on the Fusulinids and METZ on the brachiopods. All three authors concluded that the Upper Carboniferous transgression was of Mjatschkovian (late Middle Carboniferous) age. This age was attributed to a fauna termed Weidegger fauna which METZ described in 1936.

The Weidegger fauna is contained in the Weidegger shale (in the present study abbreviated as Ws.) which forms the northern part of the ridge named here as Zoellner ridge. This ridge extends N—S between the Straniger- and Weidegger-Alm and is a southerly extention of the Weideggerhöhe, reaching in the south the Italian border and consisting mainly of Upper Carboniferous sediments. The ridge is named after the customs post (Zoellner-Hütte) on the flexure containing the Ws. Composed of Ws., micaceous siltstones, sandstones, limestones and quartose and lydite conglomerates, the Zoellner ridge forms the watershed between easterly flowing tributaries of the Straniger-Bach and the westerly flowing drainage known as the Ochsen-Bach. In the N, Upper Carboniferous sequence is cut by the Hochwipfel fault, an E—W fault which extends far beyond the area under discussion; in the south the type of the contact with Lower Carboniferous and older strata is unknown but it is thought that the Lower Carboniferous and the older strata are overthrust onto the Upper Carboniferous.

Structurally, METZ considered the Ws. to form a part of an overfold to the north and concluded that they represent the oldest unit of the Carnic Upper Carboniferous. He confirmed these views further by the discovery of the so called Collendiaul transgression in the west of the area. Here he found a block of the Ws. lying beside the Lower Carboniferous and older strata. Whilst the transgression of the Ws. over the older strata needs still to be established, no overturning*) on any scale has been observed in the area under discussion, the folding at its maximum being isoclinal and vertical. Commonly the beds are gently folded but possess a good cleavage. The southern flanks of the anticlines are rarely observed and appear to be suppressed at fault lines. The consequent appearance is that of a uniformly N dipping sequence. This appearance however is illusory and the sequence is commonly repeated and true thickness of the strata is therefore much less than is at first apparent.

Recently a provisional note has been published on the Upper Carboniferous between the Straniger- and the Weidegger-Alm (H. FLÜGEL, 1962). Before a discussion of this paper which has a great bearing on the

*) For sedimentological evidence see appendix 2, p. 93.

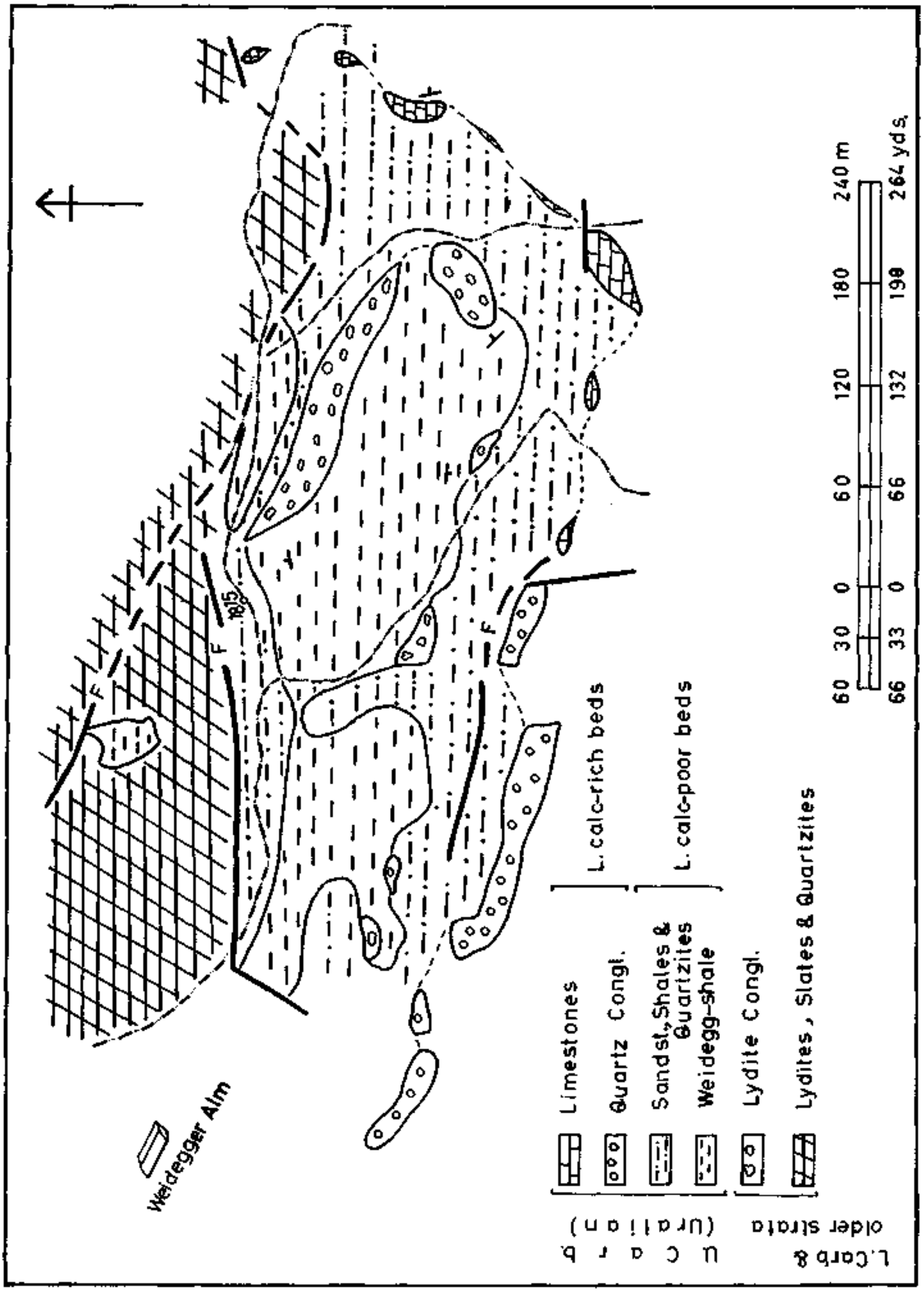


Fig. 2. Geological map of northern part of the Zoellner ridge and neighbourhood.

results of the present investigation, a short review of the stratigraphical studies of HERITSCH is essential. He divided the Carnic Upper Carboniferous (Auernig-Schichten) into five groups. The two lower, concerned here, are a) lower calc-poor beds (Untere kalkarme Schichtgruppe, same as Ws.) and b) lower calc-rich beds (Untere kalkreiche Schichtgruppe). The latter were subdivided in i) Waschbüchel-Schichten (abbreviated here as UKi) and ii) Watschiger-Schichten. To the group (a) a Mjatschkovian age was assigned and to (b) a Samarian age (Upper Carboniferous). The Zoellner ridge is composed of both these divisions, the lower being represented by the Ws.

Prof. FLÜGEL, whom I had the pleasure to accompany in the above mentioned area, notes the presence of an E—W fault cutting the Ws. in the S of the flexure. He believes that Ws. and UKi in the south are separated by this fault.

The true nature and the extent of movement on this fault is unknown but the limestone banks characterising the UKi have been found to the N of this line as well as to the S. The limestones in the N occur as isolated, well bedded lenticular masses. After the limestone is cut by the fault its strike changes from E (65/70° S) to NNE (175/45° E) and continues to the streamlet originating in the N of the flexure and is cut there by the Hochwipfel fault. Further the attitudes of the limestone banks conform to the attitude of the Ws. in the flexure. This observation leads to the conclusion that Ws. are not alien to UKi, rather that the succession appears to be normal. Moreover, although the corals discovered in the limestone bank at its northern most extention (described under locality 3) cannot be identified definitely, they appear to have an affinity with those described by HERITSCH from UKi. Further the "Samara" *Choristites* (METZ, 1935) from the limestone belonging to UKi (the identification appears to be highly doubtful and the material is not available for investigation) find a counterpart in the rich *Choristites* fauna now described from Ws. This evidence and the presence of *Eolyttonia, Pseudophillipsia* and various other Upper Carboniferous species in the Ws., and *Triticites* in the UKi indicate an Uralian age of both the Ws. and UKi. Therefore, the subdivision of this succession of beds into lower calc-poor and lower calc-rich beds is unwarranted, at least in Zoellner ridge profile (= Waschbüchel profile of HERITSCH) which was made the type section by HERITSCH.

The lydite conglomerate accompanying the Ws. was considered to be a conglomerate of transgression by METZ, 1936. As pointed out by Prof. FLÜGEL, it appears to be a pre-transgression element. The Ws. known only from two localities, namely Zoellner ridge and Zoellner lake area is the oldest member of the Upper Carboniferous sequence. At both these places it is in association with this conglomerate.

In the region between the Straniger- and the Zoellner-Ochsen-Alm the middle part of the Upper Carboniferous is absent as fauna comparable with the Gschelian of the Karawanken and the Moscow basin have not been found.

The correlation of the beds containing *Isogramma* (locality 9), in the SW of the Zoellner lake, with any other Carboniferous occurrence is impossible because this brachiopod group appears to be endemic; the corals and other brachiopod species occurring in association are too poorly preserved to allow identification. The *Pseudoschwagerina* horizon of the Samara stage however, conformably overlies these beds.

As the exposure of the formation becomes narrower in the west, its relation with older strata surrounding it becomes clearer. In the immediate vicinity of the Zoellner lake, particularly on its northern and eastern banks, it is overlain by the lydites of the Silurian and Lower Carboniferous age. It appears therefore, that the Upper Carboniferous formation, in its western extention at least, is exposed as a tectonic window.

Collecting localities

In the summer months of 1961 and 1962 a large collection of the Upper Carboniferous fauna was made. The climatic conditions prevailing in the region allow only about three months of field work, from the end of June to mid-September. It was originally proposed to collect only at the locality from which Prof. METZ's material was obtained. In order to study the tectonic and stratigraphic relations of these beds, however, some field work was carried out in the adjoining area. As a result, a large number of specimens of *Isogramma* near Zoellner lake, *Martinia* near Straniger-Alm and plant fossils near Weidegger-Alm were discovered. In the limestone east of the flexure containing Ws., corals were collected. A short trip to the Karawanken, Jugoslavia, the eastern extention of the Carnic Alps was also made. A well known and highly fossiliferous locality there, namely Slap near Jesenice yielded some more fossils.

Locality 1

On the nothernmost extention of the Zoellner ridge, south of the point 1815 and in the Ws.

The beds are folded into a small flexure. In the NE they are accompanied by a 4 m thick conglomerate bed composed dominantly of dark lydites. The true relation of this conglomerate with Ws. is unknown. In the NW, Ws. are overlain conformably by the rest of the lower calc-poor beds consisting of the following sequence of beds:

a) silvery grey micaceous siltstone — 3 m. b) bands of coarse grained reddish sandstone — 0.25 m. c) dark micaceous mudstone — 0.35 m. d) sandy bands as in b) — 0.25 m. e) very thin leafy shales with some fossils — 0.70 m. f) thick, coarse grained reddish sandstone — 1.90 m. g) coarse grained, thin laminated reddish sandstone — 0.80 m. h) silvery grey micaceous siltstone as in a) — 0.50 m. i) silvery grey micaceous siltstone, differing from preceeding in its fine laminae — 0.50 m. j) light brown to reddish sandstone — 0.30 m. k) dull grey massive mudstone —

1.30 m. l) fine laminated shale containing in upper part a highly fossiliferous band. The fossils are highly crushed and weather yellow to pink colour on the outer surface. *Linoproductus* forms the main part of this faunal assemblage. The uppermost part of this shale is a thin band consisting mainly of geodes — 3.40 m.

Locality 2

Within the Ws., in the same bed as locality 1 but situated about 50 m to its W. *Eolyttonia carnica* n. sp. has been found here. The faunal assemblage in both the localities is the same. To the west of this locality the Ws. is cut by a transverse fault.

Locality 3

In the NNE of the Zoellner ridge and in the steep wall of the streamlet which marks the Hochwipfel fault at this place. The fossils have been found in a 2 m thick bed of limestone. This limestone (lower calc-rich beds) forms the northernmost extention of the limestone cut by the fault line discussed in the chapter on the stratigraphy. Only corals have been collected. They have been identified as:

Caninia nikitini STUCKENBERG?
Gschelia sp.

Locality 4

In the above mentioned limestone (lower calc-rich beds) but about 150 m in the S of the locality 3. Corals and Fusulinids have been found.

Caninia sp.
Geyerophyllum carnicum HERITSCH
Triticites sp.

Locality 5

About 200 m S of the locality 1, farther south of the fault line cutting the Ws. in the south. Silvery grey micaceous siltstone (lower calc-rich beds) containing only plant fragments:

Pecopteris (Asterotheca) cf. *arborescensis* SCHLOTHHEIM.

This fossil is known from upper Middle Carboniferous to Lower Permian.

Locality 6

About 150 m NW of the Straniger-Alm. Micaceous siltstone overlying an algal limestone. Only brachiopods occur. The fossils are present exclusively as moulds. The outer surface of the moulds exhibiting a deep yellow colour.

Locality 7

In the southern extention of the Zoellner ridge and in the west of small caves which served as military posts during the first world war. Dark limestone (lower calc-rich beds) full of fusulinids. Corals rare:

Triticites sp.
Geyerophyllum carnicum HERITSCH

Locality 8

Near the east bank of the Zoellner lake, and in the Ws. A small number of specimens have been collected. The faunal assemblage however appears to be the same as at the locality 1.

Locality 9

In the SW of the Zoellner lake and immediately beneath *Pseudoschwagerina* limestone. The rock is a micaceous, silvery grey decalcified siltstone. Large numbers of specimens of *Isogramma* have been collected here. The shells of the *Isogramma* are highly crowded. In addition, moulds of other brachiopods and corals occur.

In the east of Zoellner ridge *Domatoceras* and *Liroceras* (nautiloids) have also been found.

Introduction to palaeontological part

Mode of occurrence

The shells occurring in the Weidegger shale and in other Carnic Upper Carboniferous shaly and silty formations are crowded. The large majority of the specimens collected is that of separate valves. This suggests that the animals did not live in the area in which they were found, but that they represent thanatocoenoses. At the same time this does not seem to be the only mode of occurrence, as quite often when, in the investigated localities, the two valves are articulated, the pedicle valve is the lowermost. The greater preponderance of the pedicle valves suggests that while they remained fixed to the substratum, the brachial valve became detached and fragmented by the waves. This is also explained by the fact that during collecting, the part of the rock freed from the main rock body and containing the brachial valve is more vulnerable. The Weidegger fauna thus represents a combination of thanatocoenoses and biocoenoses.

Preservation

The dominant mode of preservation of the fossils embedded in a shaly matrix ist that of composite moulds. The external moulds bear impressions of the shell interior. This is particularly true in the thin shelled specimens of Productoidea.

The composite moulds are impressed with the shell surface structure to a varying degree of fidelity. As a rule, the moulds with dominant external impressions have weaker impressions of the interior, and the reverse. It seems that the moulds were compressed against each other when they were still in a varying degree of plasticity.

But all the moulds showing characters of the exterior in positive, are not the composite moulds. In thin shelled specimens, the inner fibrous layer was not thick enough to even the relief of the outer lamellar layer. As a result, the characters of the exterior, especially those which are very slight, are entirely absent on the mould.

True internal moulds are rare. On these moulds, the internal characters such as muscle scars and pallial- and ovarian markings are unusually well preserved. Remarkable examples of this type are seen in *Choristites* sp., *Linoproductus cora* and in various Orthotetacids.

Commonly a space occurs between the external- and the composite- or the external- and the internal moulds. Actually, after the dissolution of the shell during diagenesis and later owing to compaction pressure, no such space can be envisaged. It is therefore thought that this space was caused later when the beds were exposed. At the junction of the moulds, substance of greater solubility might have settled, which was later easily removable.

This type of preservation is also accompanied by factors which hinder a thorough study. In the following, limitations resulting from the preservation are discussed:

External morphology:

The external moulds are indispensable for the study of the external morphology of the shells in the collection. Relative to composite and internal moulds, their number obtainable from the matrix is very low. When the internal or the composite mould has been extracted, the concave negative of the external mould becomes unsupported and breaks. The scarcity of the external moulds in Punctospiracea did not allow complete study of spine pattern and imbricating lamellae; the costellation in *Neospirifer*, *Choristites* and *Brachythyrina;* spine pattern in most of Productoidea and the mode of attachment in *Eolyttonia* and various Orthotetacea.

Internal morphology:

The internal morphology, though invariably discernable on the interior and the composite moulds, allows only approximate judgement. For instance, in the case of the genus *Choristites* the knowledge of the behaviour of the dental plates in the apical region is indispensable for specific, even generic distinction. In this case, the composite or the internal moulds are of very little help, as in this portion the dental plates are never preserved. Similarly, in some of the Enteletacea it could not be confirmed whether, anteriorly adaxially curving dental plates actually form a camera as in *Parenteletes* or whether they are the incisions caused by the muscle scars.

S h e l l s t r u c t u r e:

The mould-type preservation allows again only an approximate judgement of the shell structure.

Endopunctate (Enteletacea) and pseudopunctate (Lyttoniacea, Orthotetacea and Productoidea) shells cannot be distinguished. The surface of internal and composite moulds appears to be papillose in such a preservation.

In the punctate shells (Isogrammacea and Punctospiracea), the punctae are commonly filled with sediment, and appear now as fine rods extending from one surface of the shell to the other. The diameters of the rods however, appear to be very large. The space between the rods is hollow, and is a result of dissolution and transport of the shell substance. It seems rather enigmatical why the external and the internal moulds were not compressed against each other by compaction pressure.

T e r m i n o l o g y

T r i l o b i t a

The terminology follows that in the Treatise on Invertebrate Paleontology 1959, except the following:

Axial ridge: Triangular projection of axis over posterior border of pygidium.

Lateral band: Lower half of the lateral side of pygidial axis which continues to upper half after making a knick; axial rings and furrows are indistinct on this band.

Subocular ridge: Narrow ridge confining adaxially the subocular groove.

Terminal septum: Internal septum due to medial thickening of the exoskeleton at the steep termination of the axis.

B r a c h i o p o d a

No new terms for brachiopod morphology have been used. The terms employed in the descriptions are well established and mostly need no references to the sources. The growth stage terms, however, have been adopted after GLENISTER, 1955. They are based mainly on the varices of growth. They are reviewed in short in the following:

Nepionic growth stage: Period of the growth of the shell immediately succeeding the embryonic shell or protegulum, but before undoubted specific characters become evident.

Neanic growth stage: All the features which characterise the adult are progressively developed.

Ephebic growth stage: When the development of all adult specific features is completed.

Gerontic growth stage: The variations are complex affecting the shell growth in a particular direction, excessive shell secretions etc.

Use of growth stage terms has been made mainly in Spiriferida and Orthotetacea. In these groups the members of closely allied species exhibit striking resemblance in one or the other growth stages. Recognition of the growth of an individual is therefore necessary. These terms are not universally applicable, thus they have been used with reserve.

Catalogue numbers

All the figured specimens have been deposited in the museum of the Geological Palaeontological Institute Bonn. The catalogue numbers follow GPIBo. and are registered after the author's name.

Systematic Palaeontology

Trilobita

Superfamily PROETACEA SALTER, 1864

Family PHILLIPSIIDAE OEHLERT, 1886

Genus *Pseudophillipsia* GEMMELLARO, 1890 nov. emend.

Genotype: *Phillipsia sumatrensis* ROEMER, 1880.

Diagnosis: Glabella pyriform, weakly inflated. Anterior frontal border flat. Well defined lateral and median preoccipital lobe. Pygidium of variable outline in stratigraphically older forms, longitudinally elliptical in the younger species. Axis generally trapezoidal in cross section, rings 18—27. Anterior part of the axis arches down.

Stratigraphic range: Uralian to Middle Permian.

Discussion: This diagnosis differs from that of R. GOLDRING, 1957 in excluding the presence of the terminal septum, in giving a varied outline for the pygidium and in the decrease in the lower limit of rings.

Remarks: Four new species of Trilobites have been found during the present investigation. Whilst one can without doubt be included in the genus *Ditomopyge* NEWELL, 1931 the others show features intermediate between *Ditomopyge* and *Pseudophillipsia*. They are here included in *Pseudophillipsia* on the basis of an emended diagnosis. The low arching of the glabella is more typically pseudophillipsiid but the short anterior border may be considered to be more characteristic of *Ditomopyge*. Whilst the longitudinally elliptical outline of the pygidium is typically pseudophillipsiid, the number of rings (18—19) is greater than has been previously described in *Ditomopyge* but less than in *Pseudophillipsia.* No other *Ditomopyge* with more than 17 axial rings is so far known and no other *Pseudophillipsia* with less than 20.

P. ogivalis n. sp. is close to *Ditomopyge kumpani planiloba* (WEBER, 1933), one of the stratigraphically youngest trilobites from the Donetz-Basin, but shows features which are clearly more advanced in the probable evolutionary sequence from *Ditomopyge* to *Pseudophillipsia:* (a) the glabella is less inflated, (b) the anterior border is longer (especially in plan view), (c) the pygidium is more longitudinally elliptical and (d) the pygidial axis has more rings.

Pseudophillipsia ogivalis n. sp.

(Pl. I, figs. 1—7; text-figs. 3, 4)

1936 *Phillipsia* aff. *Kansuensis* — METZ, p. 183, pl. V, fig. 15 (non LOCZY, 1898).

Derivatio nominis: From the form of the pygidium.

Typus: Carapace, pl. I, figs. 1—3 (GPIBo. 1).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several cephala, pygidia and complete carapaces.

Diagnosis: Glabella pyriform, weakly inflated, grading into short convex border. Median preoccipital lobe large, crests flattened or pointed. Lateral preoccipital lobes suboval, diverging anteriorly. Sutural ridge high. Pygidium longitudinally elliptical. Axis trapezoidal. 18 axial rings, continuing to axial furrows through lateral bands. 10 ribs with interpleural furrows on first 3.

Measurements in mm:

	Holotype
Length of cranidium	15.00
Breadth of cranidium	10.80
Length glabella + anterior border	10.80
Distance between anterior ends of basal lobes	6.50
Distance between posterior ends of basal lobes	4.10
Length of pygidium	17.00
Breadth of pygidium	18.00
Length of axis	15.00
Breadth of axis	5.00

Description:

Cranidium. Plan: Glabella pyriform, weakly inflated with greatest breadth at one-third length from preglabellar furrow. Preglabellar furrow drawn into a broad curve, indistinct centrally, broadening laterally and succeeded by very narrow convex anterior border.

Axial furrows sharp, broadening where they join glabellar furrows 1 p, then narrowing as they curve outwards around the inner margin of the palpebral lobes, then dropping steeply to join the occipital furrow. Two fossulae (antennal muscle scars) adjacent to each other, situated slightly anterior to γ.

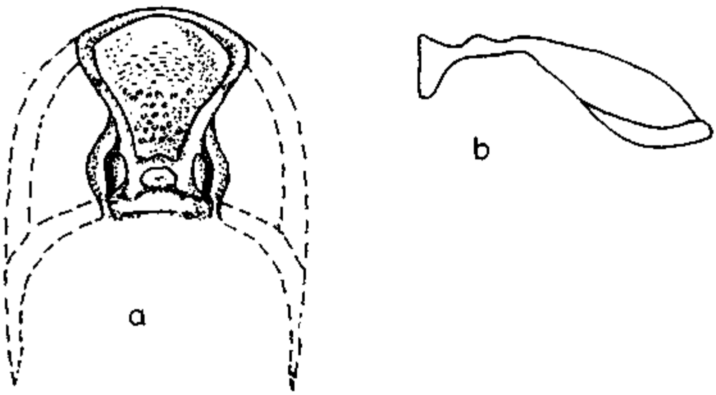


Fig. 3

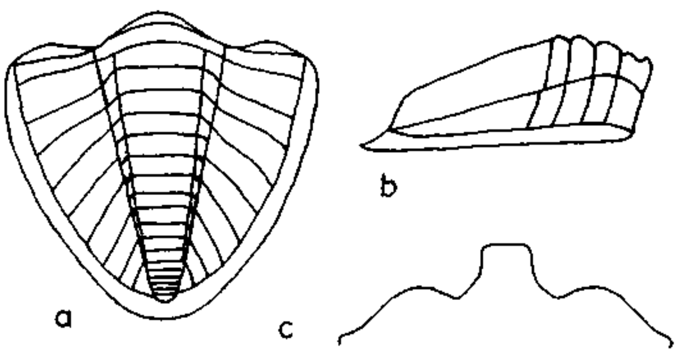


Fig. 4

Figs. 3, 4. *Pseudophillipsia ogivalis* n. sp.
Figs. 3 a, b. Cephalon: respectively plan and side view × 2.
Figs 4 a—c. Pygidium: respectively plan, side and posterior view. × 2.5.

Glabellar furrows 2 p and 3 p faint with indistinct lobes 2 p and 3 p trending sagittally and anteriorly. Furrows 1 p broad and deep apparently converging at occipital node. Preoccipital median furrow broad and shallow. Succeeding posterior margin of median lobe of glabella slightly wavy but not scalloped. Median preoccipital lobe circular with flattened crest. Preoccipital glabellar lobes (1 p) large, elongate with flattened crests.

Occipital furrow broad and deep. Occipital ring as long (tr.) as the distance between posterior ends of 1 p basal lobes, slopes gently in anterior direction, steep posteriorly.

Palpebral lobes slightly vaulted with well marked crescentic palpebral furrow. Sutural ridge high and delicate, seldom preserved.

Posterior part of median lobe of glabella coarsely granulated, granules being arranged in concentric pattern. The granulation passes anteriorly into shagreen.

Side view: Glabella forming a very gentle curve sloping anteriorly and grading into a narrow and highly convex anterior marginal band through indistinct preglabellar furrow. Occipital and preoccipital rings assymetrical arches; posteriorly disposed crests thereof rounded in former and sharp edged in latter. Preoccipital ring three-fourths height of occipital ring and stands almost at the same elevation as posterior part of median lobe of glabella. Occipital furrow rounded, broad and deep. Preoccipital furrow relatively broader and shallow.

Front view: Broad curve of occipital ring is concealed laterally by 1 p lateral lobes which continue laterally making a sharp angle with palpebral lobes. Latter not as high as basal lobes.

Facial suture: Anterior portion highly divergent from sagittal line but subparallel to dorsal furrow. γ rounded, close to axial furrow. δ rounded and not so far from sagittal line as β.

ε slightly nearer to axial furrow than γ and opposite continuation of crests of preoccipital ring. Posterior branch curving sharply outwards to terminate in ω at greater distanc from sagittal line than β.

Free cheek: Eye platform well raised. Subocular groove runs along all lateral length of eye. Subocular ridge high. Lateral border and furrow unknown, doublure ornamented with curved lines which run parallel to cheek region. Posterior border furrow very faint. Genal spines longer than breadth of cheek, sharply pointed at ends. Eye crescentic, about one-third length of glabella, holochroal.

Thorax: Less than one-third length (sag.) of carapace. Composed of 9 free segments. Axis almost as broad (tr.) as a pleural lobe. Axial rings sharp, almost subcircular in section. Interannular furrow weak, not reaching axial furrow. Preannulus low, about half as long (sag.) as postannulus. Articulating half ring invisible. Pleurae geniculating at an obtuse angle. Line joining fulcral process of different segments lies about one third adaxial length of pleural region. Axial furrows very slightly converging posteriorly. Axial rings and pleural ribs shagreened.

Pygidium. Plan: Outline longitudinally elliptical. Axial section trapezoidal with flat crest. Axis narrow, less (tr.) than breadth of a pleural lobe, tapering posteriorly between straight axial furrows which become very faint posteriorly. Border moderately broad, weakly inflated, traversed by indistinct terrace lines and separated from pleural region by faintly demarcated border furrow.

18 (+ 1) rings, first four or five broad and seemingly telescopic, remainder narrow flat bands, last indistinct. Correspondingly, ring furrows

well defined in anterior part of axis, rather slight and narrow behind. Rings and ring furrows continue to axial furrow through lateral bands. First 3—4 furrows meet axial furrows opposite pleural furrows.

10 ribs, transgressing onto border. Last 2 ribs scarcely visible. Pleural furrows broad and shallow, faint and indefinite towards border and on

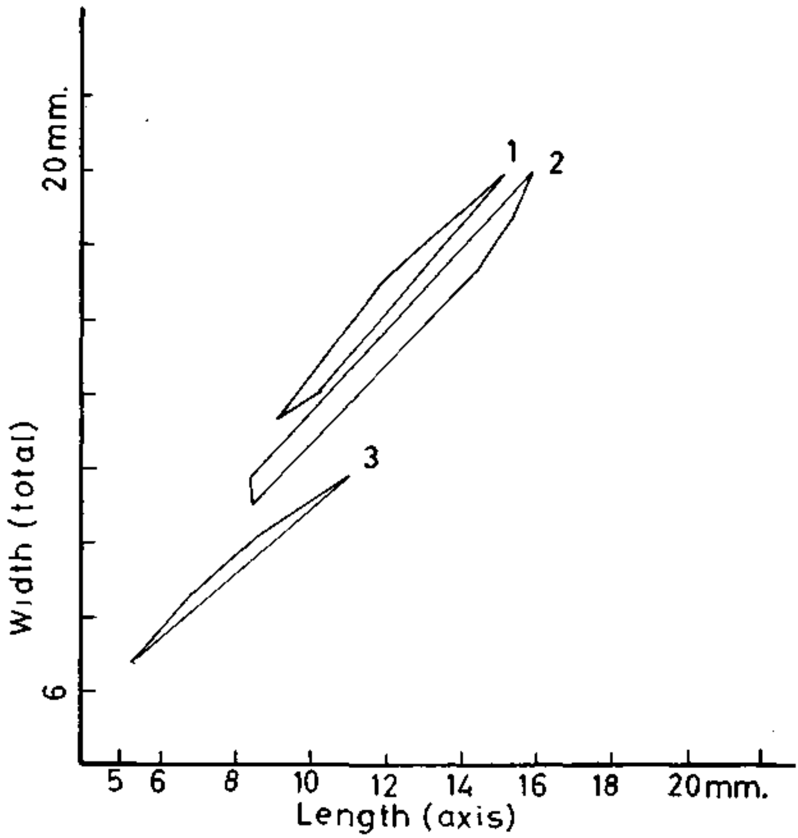


Fig. 5. Periphery diagram showing variations of length/width ratio of trilobite species.

posterior pleural region. Interpleural furrows visible only on first 3—4 ribs, slight: anterior band much larger than posterior.

Side view: Axis almost as high as a pleural lobe. Rises to ring 3 and 4 and then slopes gently to last ring, falling off more steeply and transgressing onto well defined almost flat border. Caudal end continues posteriorly in triangular axial ridge. Lateral band absent on first ring.

Posterior view: Axis highly arched and narrow. Pleural lobes asymmetrical arches, with crests at one-third length (tr.) of lobes and sloping gently towards border, steeply towards axial furrows. Shallow border furrow separates off moderately convex border.

Remarks: Statistical representation (fig. 5) shows an almost constant ratio between the length and breadth with increase in size.

Comparisons: *Ditomopyge kumpani planiloba* (WEBER, 1933) greatly resembles the described species. It differs in having fewer axial rings, (b) the pygidium is much broader than long and (c) the glabella is more strongly inflated. *D. kansuensis* (LOCZY, 1889) has a tuberculate pygidial axis. It is possible that *Phillipsia sp.* HERITSCH, 1931 belongs to this species. These specimens are insufficiently preserved for comparison to be made.

Occurrence: From the type locality and locality 2.

Pseudophillipsia semicircularis n. sp. [1])

(Pl. I, figs. 8—13; text-figs. 6, 7)

Derivatio nominis: From the outline of the pygidium.

Typus: Enrolled carapace without free cheeks. Enrollment such that besides cephalon only outline and posterior part of pygidium visible. Pl. 1, figs. 8—9 (GPIBo. 5).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: 2 carapaces and several detached pygidia.

Diagnosis: In comparison with *P. ogivalis* glabella shorter, relatively more inflated and more expanded in front. Frontal border flat, much broader on the sides. Pygidium semicircular. Pleural ribs and furrows scarcely curved.

Measurements in mm:

	Holotype
Length of cranidium	11.40
Breadth of cranidium	10.00
Length of glabella	7.90
Distance between anterior ends of basal lobes	4.00
Distance between posterior ends of basal lobes	2.20

	Paratype
Length of pygidium	10.50
Breadth of pygidium	12.00
Length of axis	9.30
Breadth of axis	4.00

[1]) While this paper was in press, Professor Küpper, Vienna kindly brought to my notice a paper on Slowakian Upper Carboniferous Trilobites. For comments see appendix 1, page 93.

Description:

Cephalon: The following differences from *P. ogivalis* may be noted: Plan. Glabella highly expanded in front, considerably shorter (sag.). Anterior border relatively broader and flat, particularly on lateral extremities. Preoccipital median lobes and 1 p lateral lobes pyramidal in small specimens. In larger specimens former coffer shaped, latter nearly flat. Basal lobes 1 p more divergent including an angle of about 90°. Posterior margin of median glabellar lobe smooth.

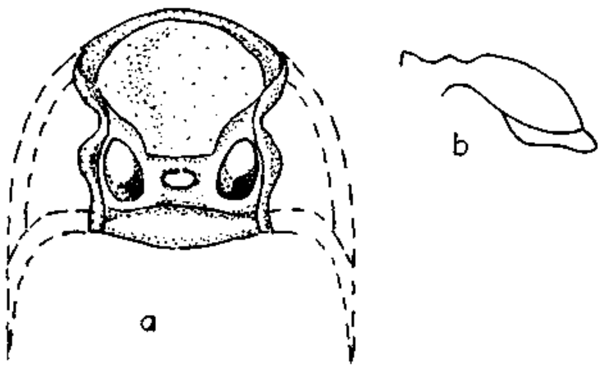


Fig. 6

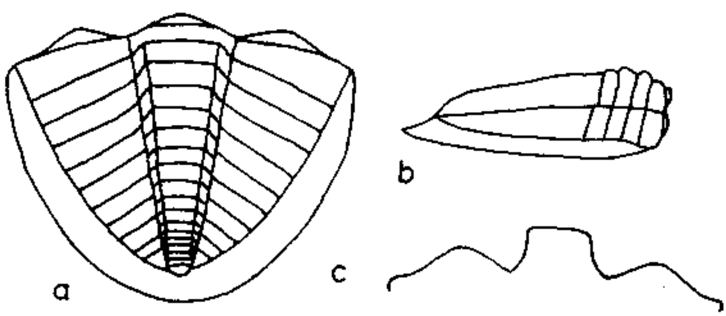


Fig. 7

Figs. 6, 7. *Pseudophillipsia semicircularis* n. sp.
Figs. 6 a, b. Cephalon: respectively plan and side view. × 3.
Figs. 7 a—c. Pygidium: respectively plan, side and posterior view. × 2.5.

Side view: Glabella more inflated, posterior curve gentle, sloping rather rapidly in anterior third. Anterior border (damaged) flat and broader. Preoccipital median lobe higher than posterior part of median lobe, preoccipital furrow relatively narrow. Occipital ring damaged, but occipital furrow broader.

Front view: Frontal profile of glabella a regular curve unlike almost geniculating lateral sides of the glabella in *P. ogivalis*. Elements situated to posterior part of median lobe not visible.

P y g i d i u m:

P l a n: Outline semicircular, broader than long. Axis narrower (tr.) than a pleural lobe. Axial furrows almost straight, converging posteriorly at 25°. Axis less transgressing onto posterior border furrow; with axial ridge.

18 rings. Postannulus comparatively longer (sag.). 10—11 ribs, rounded bands, adaxial extremities of first four curved in anterior direction to join corresponding ring furrows, others almost straight. Rib furrows deep and narrow. No interpleural furrows observed. Border broadest posteriorly.

Side view: Axis slightly to moderately convex, rather higher than pleural region; in some specimens it bends down considerably in anterior part. Pleural region almost flat posteriorly, sloping upwards gently anteriorly.

Posterior view: Axis low arch, sides vertical in upper half, slanting at lateral bands. Axial furrows broad. Pleural region sloping uniformly both in right and left direction. Border furrow shallow, border very weakly convex.

C o m p a r i s o n: *D. kumpani planiloba* (WEBER, 1933) has (a) glabella less expanded anteriorly though anterior curvature and anterior border are very similar, (b) pygidium: axis has fewer rings which are tuberculate to granulated whereas *P. semicircularis* is smooth; in posterior view pleural region falls off very steeply to border.

O c c u r r e n c e: From type locality, localities 2 and 8.

Pseudophillipsia rakoveci n. sp.

(Pl. I, figs. 14—17; text-fig. 8)

1931 *Phillipsia (Pseudophillipsia)* n. sp. RAKOVEC, p. 83, Pl. III, fig. 30.

D e r i v a t i o n o m i n i s: In honour of Prof. RAKOVEC (Ljubljana).

T y p u s: Pygidium (Pl. I, figs. 15—17; GPIBo. 9).

L o c u s t y p i c u s: Slap, Javorniski rovt, near Jescenice, Slovenia.

S t r a t u m t y p i c u m: Gschel, Uralian.

M a t e r i a l: Internal moulds of several pygidia and a cephalon have been collected from the locality where RAKOVEC's material was collected.

D i a g n o s i s: Frontal border flat, broader than P. ogivalis n. sp.; preoccipital lateral lobes high. Axial rings 19—21 (+ 1).

D e s c r i p t i o n: Most of the specimens are highly deformed. They differ from the previously described species in the following respects:

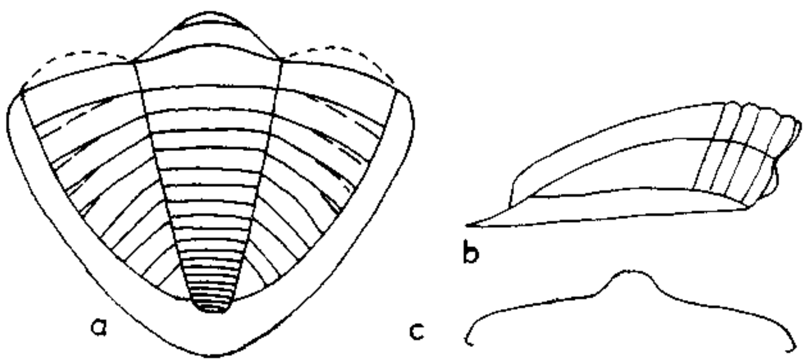
C e p h a l o n: Glabella longer, frontal border furrow well demarcated, border flat, marginal rim steep. Lateral preoccipital lobes moderately divergent anteriorly. Arching of the glabella and its various elements cannot be determined due to its bad preservation.

P y g i d i u m:

P l a n: Subtriangular in outline, broader than long. Axis trapezoidal, less broad than a pleural lobe. Axial furrows indistinct, subparallel. Lateral bands indistinct. Axial rings 19—21 (+ 1), furrows broad and shallow. Pleural ribs 9, slightly curved. Interpleural furrows distinct on first five ribs. No border furrow. Border falls off steeply.

Side view: Pleural region highly arched, axis relatively less so. Latter slightly bent downwards anteriorly. Axial ridge present.

Posterior view: Pleural region almost flat, descending rather steeply towards border; latter moderately convex.



Figs. 8 a—c. *Pseudophillipsia rakoveci* n. sp. Pygidium: respectively plan, side and posterior view. × 4.

R e m a r k s: Two tubercles on each ring disposed adaxially on the axial top and the apparent thickening of the pleural ribs near the border is due to the fact that only internal moulds were available for study. Similar phenomena have been observed in many of the specimens of the species described before.

One of the pygidia figured by RAKOVEC has been lost and the other is poorly preserved. The specimens described by him have 21 rings; present collecting shows that the number of rings varies from 19—21. The type has 19.

O c c u r r e n c e: Known from the type locality only.

Genus *Ditomopyge* NEWELL, 1931

Ditomopyge ovalis n. sp.

(Pl. I, fig. 18; Pl. II, figs. 1—3; text-fig. 9)

1931 *Phillipsia* sp. HERITSCH p. 47, Pl. I, figs. 13—14.

T y p u s: Pygidium (GPIBo. 10).

L o c u s t y p i c u s: Zoellner ridge, locality 1.

S t r a t u m t y p i c u m: Uralian.

M a t e r i a l: Several pygidia.

Diagnosis: Outline oval. Axis moderately arched, ending before posterior border furrow. Lateral bands absent or very indistinctly developed. Axial rings 15—16 (+ 1). Pleural furrows 9, strongly curved. Interpleural furrows 7.

Measurements in mm:

	L. pygidium	B. pygidium	L. axis	B. axis
Holotype	12.00	15.00	11.00	5.00

Description:

Plan: Outline oval. Axis trapezoidal with flat crest, moderately arched, width (tr.) equal to width of a pleural lobe, strongly tapering posteriorly, terminating shortly before posterior border.

Axial rings 15—16 (+ 1), broad, separated by narrow and distinct furrows. Lateral bands indistinct or absent. Ribs 9, broad bands, strongly

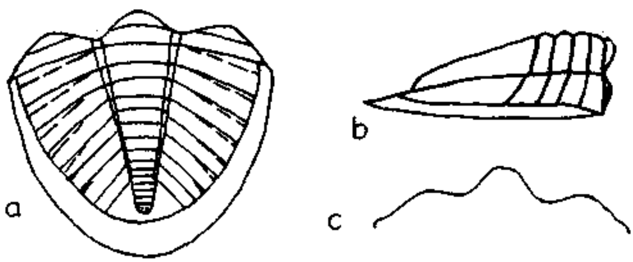


Fig. 9 a—c. *Ditomopyge ovalis* n. sp. Pygidium: respectively plan, side and posterior view. × 4.

curved in posterior part, separated by pleural furrows which become broader successively in posterior direction. First four pleural furrows join corresponding axial furrows. Interpleural furrows on first 7 ribs, inwards more strongly anteriorly directed than pleural furrows so that the anterior portion of pleural band is much larger (ex sag.) than posterior portion, first interpleural furrow terminates shortly before reaching axis, those following are successively smaller so that 8th rib does not possess this furrow.

Border furrow absent. Outer declivity of pleural region passes onto broad and flat border; broadest posteriorly.

Side view: Axial curve rises gradually anteriorly, in first few segments it is almost horizontal. Axial ridge absent but area immediately anterior to posterior border furrow slightly swollen, latter shallow and broad. Posterior border not well preserved. Longitudinal section of pleural region rises very gradually anteriorly.

Posterior view: Axis moderately convex, sloping steeply to axial furrow. Pleural region relatively strongly arched, about three-fourths height of axis, outer portion sloping rather steeply towards lateral border. Posterior part of pleural region almost flat.

Comparison: In outline and number of rings the species resembles *Griffithides transilis var.* β WEBER, 1933 which differs in having a rounded axial section and tuberculate ornamentation of rings.

Occurrence: From type locality and locality 2.

Brachiopoda

Superfamily LYTTONIACEA LICHAREW, 1960

Family LYTTONIIDAE WAAGEN, 1883

Diagnosis: Highly specialised, mostly attached and pseudopunctate brachiopoda. Interior of ventral valve characterised by septal apparatus which consists of several lateral septa and a median septum; in geologically older and less organised members, the septal apparatus is formed by a looped ridge; lateral loops absent in the most primitive genus. Brachial valve pinnate or has become secondarily entire by union of the pinnae.

Stratigraphic range: Upper Carboniferous to Triassic.

Discussion: FREDERICKS, 1916 developed the hypothesis that the family arose from *Marginifera* WAAGEN, 1884. Owing to the absence of spines in the Lyttoniacea a relationship to Productoidea is unfounded. Neither could they be assigned along with the Strophomenoidea, the only common character being the pseudopunctate shell structure, which is also possessed by Productoidea.

FREDERICKS, LICHAREW and WANNER & SIEVERTS, 1935 have shown that, basically the group developed with the specialisation of the septal apparatus. The latter, medially disposed, longitudinally elongated and posteriorly closed loop in the most primitive Genus *Cardinocrania* WAAGEN, 1895 continues then laterally and posteriorly to follow a meandering course which terminates outside of the dental area at the posterior hinge. Thus *Poikilosakos* WATSON, 1917 and *Keyserlingina* TSCHERNYSCHEW, 1902 arose. Sides of the median loop posteriorly and posterior and anterior ridges of the lateral loops near the hinge are fused completely or partly with each other giving the respective loops the form of a septum in *Eolyttonia* FREDERICKS, 1916. The process attained its culmination in *Leptodus* KEYSER, 1882 and *Oldhamina* WAAGEN, 1883 in which adjacent ridges of each loop united to form a single septum and the number of septa greatly multiplied.

Several evolutionary side branches arose which attained a specialisation of one type or the other but always within the general framework of septal formation. *Cosciniphora* COOPER & STEHLI, 1955 and *Paralyttonia* WANNER & SIEVERTS, 1935 may be mentioned as examples in which the septal apparatus became perforate or the loops were directed anteriorly in the respective cases.

WANNER & SIEVERTS while investigating rich Permian Lyttoniacid material from Timor found that the muscle scars vary even within a single genus. More recently, COOPER and STEHLI working with silicified material of the genera possessing extremely well preserved interiors do not agree with the findings of WANNER & SIEVERTS in this respect. They have proposed several new genera on the basis of symmetry or asymmetry of musculature.

During the present collecting, the genus *Eolyttonia* has been found for the first time in strata of Upper Carboniferous age. Another species obtained from the Karawanken has been described elsewhere [2]). Schellwien had discovered *Poikilosakos* sp. (= *Oldhamina ? cf. filicis* KEYS. — see SCHELL. 1900, p. 62, text-fig. 9) in the Watschig Beds = Omphalotrochus zone. *Poikilosakos* in U.S.A. and *Poikilosakos* and *Keyserlingia* in Russia make their first appearance in the Gschelian. It is interesting to note that these three genera of the family which show a varied degree of organisation came into existence within a very short span of time: certainly less than a stage.

This appears to be an excellent example of a burst pattern of evolution (= Typogenese — SCHINDEWOLF). Further, *Eolyttonia* bears in its early ontogeny such characters as the formation of a septum which is developed to completion later, in highly organised genera such as *Leptodus* and *Oldhamina*. These findings are in accord with the views held by Prof. SCHINDEWOLF that typogenesis (Typenumbildung) takes place in sudden outbursts. The typogenesis begins with proterogenesis. In the latter, the characters determining the progress of evolution are developed in early ontogeny and effect commonly taxa of higher ranks only. As a result, the lineage of this group is not traceable though the relationship with Strophomenoidea and Productoidea is evident.

Genus *Paralyttonia* WANNER & SIEVERTS, 1935
(Pl. II, fig. 4; text-fig. 10)

G e n o t y p e: *Paralyttonia transiens* WANNER & SIEVERTS, 1935.

S y n o n y m: *Rigbyella* STEHLI, 1956.

D i s c u s s i o n: *Rigbyella* has been separated from *Paralyttonia* by the following stated distinguishing characters: (a) Occasional presence of

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[2]) GAURI, K. L., and RAMOVS, A. (1964): Eolyttonia (Brach.) and Brachymetopus (Tril.) from the Upper Carboniferous (Orenburgian) of Karawanken, Jugoslavia. N. Jb. Geol. Paläont. Abh. 119, 1, 103—112.

three small myophragms in the pedicle valve, (b) symmetrical development of the brachial valve, (c) growth habit and (d) symmetrical musculature.

In order to see whether *Rigbyella* STEHLI, 1956 has any distinguishing characters which justify an independent status for it, the specimen of the holotype of *Paralyttonia transiens* (Pl. II, fig. 4; text-fig. 10) has been re-examined: (a) The holotype has three small myophragms in the pedicle valve (see WANNER & SIEVERTS, 1935, Pl. VI, fig. 7), (b) brachial valve of *Paralyttonia* is asymmetrical only to an extent that the first right lappet is incised at the anterior end. Because the brachial valve is represented by only one specimen, it is hardly possible to decide whether this is a constant feature. Moreover minor irregularities are a rule in Lyttoniacids, (c) details of life habits of *Paralyttonia* are unknown.

Fig. 10

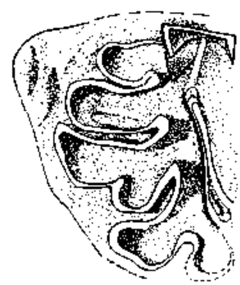

Fig. 11

Fig. 10, 11. Respectively, *Paralyttonia transiens* WANNER & SIEVERTS, 1935 showing two muscle sheaths on each side of median septum (specimen of WANNER & SIEVERTS, 1935, pl. 6, fig. 7), × 7, and *Eolyttonia carnica* n. sp. showing replica of an inner mould. × 2.

WANNER & SIEVERT erred regarding the musculature of *Paralyttonia*. The holotype bears two muscle sheaths, the one on the right side is less distinct and slightly deformed as a result of irregular growth of the valve. Consequently, the separation of *Rigbyella* from *Paralyttonia* seems to be unwarranted.

Genus *Keyserlingina* TSCHERNYSCHEW, 1902

Genotype: *Keyserlingina schellwieni* TSCHERNYSCHEW, 1902.

Pseudoleptodus STEHLI, 1956 has been separated from *Keyserlingina* on the basis of the asymmetry of the muscle scars. It is not clear whether only forms with asymmetrical musculature bear a calcareous sheath. In the internal mould of *Eolyttonia carnica* n. sp. where the musculature seems to be asymmetrical, no indication of a calcareous sheath is evident, the muscle scar being represented by a shallow depression on the inner shell surface. Moreover, in *Paralyttonia* two calcareous sheaths house symmetrical muscle scars.

The preservation of *Keyserlingina filicis* (KEYS.) (= *Oldhamina ? cf. filicis* — SCHELLWIEN, 1900, Pl. IX, figs. 19—22), the originals of which were available for study, does not allow study of the musculature. Also, there is no definite evidence whether the specimens available to TSCHERNYSCHEW possessed really symmetrical musculature. In view of these facts, erection of *Pseudoleptodus* appears to be rather abortive.

Genus *Eolyttonia* FREDERICKS, 1923

G e n o t y p e: *Oldhamina (Lyttonia) mira* FREDERICKS, 1916.

D i a g n o s i s: Saucer shaped *Lyttonidae* in which the ridges of first [3]) one or two lateral loops [4]) and the median loop partly or wholly fuse to form the septa. Lateral loops 4—8.

D i s t r i b u t i o n: Russia — Permian; Carnic Alps and Karawanken — Upper Carboniferous.

D i s c u s s i o n: It is not possible to make out form diagrams, the type of musculature characterising the genotype. Even in the specimen of *E. carnica* n. sp. in which the inner structure is excellently impressed, no indication of the muscle sheath is evident. Asymmetrical musculature, however, seems to be more probable.

Eolyttonia carnica n. sp.

(Pl. II, figs. 5—6; text-fig. 11)

T y p u s: Internal mould of a pedicle valve Pl. II, fig. 6 (GPIBo. 11).

L o c u s typicus: Locality 2.

S t r a t u m t y p i c u m: Uralian.

M a t e r i a l: Only the holotype specimen.

D i a g n o s i s: Medium size, saucer shaped *Eolyttonia*. In the first lateral loop of the septal apparatus posterior and anterior ridges almost fused. Median septum blade-like, high ridge retaining a shallow notch near anterior margin.

D e s c r i p t i o n: Pedicle valve saucer shaped, deepest near lateral margins. Shell expanded posteriorly and posterolaterally beyond hinge. Pedicle interior with hinge forming ridge one-fifth the width of the valve. Distinct triangular dental areas, longitudinally striated. A well-bounded triangular depression opposite to left dental area marks the position of the left diductor which extends anteriorly to near the median septum. On the right side such a depression seems to be lacking.

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[3]) Counting from posterior margin.

[4]) In a loop, the septal ridge includes a cavity which opens outwards. In a lobe, the cavity opens in an axial direction.

The septal apparatus consists of four lateral loops and a median septum. Ridges of the first lateral loops almost fuse, the posterior ridge being lower; following loops becoming wider successively in an anterior direction. While the first two loops stand almost normal to the median septum, the third one is curved posteriorly at adaxial termination and the fourth is subparallel with the median septum. Distal ends of ridges enclosing lobes 2 and 3 encroach upon the lateral sides. Anterior ridge of lobe 3 emarginate. Median septum blade-like, beginning almost between the first pair of lateral loops; posteriorly lamellose; step at its left mid-length marks the line of fusion of ridges; anteriorly a notch is still left. From the posterior termination of the median septum an indistinctly defined ridge extends to the middle of the hinge line. Lateral side of the median septum adjoins a deep groove.

Low but distinct callosity developed in lobes two and three. Surface of lobes papillose.

Two crescentic notches mark the slope of the postero-lateral rounded corners of the valve.

Discussion: This species is distinct from all other known *Eolyttonia* owing to the lesser number of lateral loops and the median septum not distinctly looped even anteriorly.

Distribution and range: Has been found from the type locality and the type stratum.

Superfamily ISOGRAMMACEA Paeckelmann, 1930 (*nom. transl.*, herein)

Family ISOGRAMMIDAE Paeckelmann, 1930

Diagnosis: Punctate brachiopoda marked by elevated concentric lines and triangular umbonal scar on the pedicle valve.

Discussion: The Isogrammidae, with *Isogramma* Meek & Worthen and *Megapleuronia* Cooper 1952, stand aloof though sharing characters of different brachiopod orders. Types of the cardinal process, the buttress plates, the breviseptum and the absence of teeth suggest kinship to certain Productoidea and Chonetoidea. The triangular platform, the absence of spines and punctate shell are deviations of high order from the above said groups.

Genus *Isogramma* Meek & Worthen, 1870 sens. nov.

Genotype: *Chonetes? millepunctata* Meek & Worthen, 1870.

Diagnosis: Shell surface with concentric lines. A triangular, smooth, umbonal scar extends from the beak to a varying distance anteriorly. Pedicle musculature more or less the reflection of the external triangular area, but present here as a transversely undulating platform.

In the brachial interior [5]) a long breviseptum present, occasionally bifurcated posteriorly, enclosed here betweeen buttress plates; myophore monolobed to trilobed.

Discussion: This diagnosis differs from the one hitherto understood in giving different types of the cardinal process and breviseptum. Such anatomical characters, found during the present investigation, are actually sufficient to classify a group into at least genera or even taxa of higher ranks [6]). In view of the poor preservation, however, such an attempt has not been made here.

Description: Plano- to concavo-convex shell of outline ranging from semicircular to transversely sub-elliptical. Ventral umbo well developed, projecting well beyond the interarea. Latter narrow, triangular, apsacline and furnished with transverse and parallel lineation; the last rarely preserved but invariably present; transverse lines are high and thin ridges. Brachial valve relatively smaller, so that the umbo of the pedicle valve projects well beyond its cardinal area. Therefore, when a separate pedicle valve is found, it is very often accompanied by at least the cardinal part of the brachial valve, and the myophore of the cardinal process is preserved. The brachial valve too, possesses an interarea which is likewise lineated.

Shell surface crossed by raised concentric lines. These, number on an average 2—3 in a mm, but their density differs in different species. They are separated by flat-bottomed grooves, each groove may be twice as wide as a line. In most of the specimens the punctae have been observed where the shell is occupied by the grooves.

Triangular depression on the ventral exterior is a smooth area, with its apex at the umbo, extending to nearly half of the shell length; apical angle varies from 20—50°. It is likely that the elements of the interior constituting the muscle field are reflected in this depression. Surface of this area is smooth in the sense that it is not crossed by the concentric line, but it is very finely punctate. Such a depression is lacking in the brachial valve.

Ventral interior: The denticles have not been observed. The muscle field is a triangular platform, the median part of which is grooved; this groove is bounded by two longitudinal saddles which, in turn, are separated by another pair of grooves from relatively higher and broader saddles. The medial groove and the two laterally confining saddles are cut anteriorly by a sharp transverse line the outer ends of which are joined by straight, anteriorly diverging inner flanks of the outer saddles. The adductors were housed between the first pair of saddles and the di-

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[5]) Terminology regarding brachial interior follows that in Productoidea, Muir-Wood & Cooper, 1960.

[6]) Studies in middle paleozoic brachiopoda, particularly that of Chonetacids, reveal that the bifurcation of the median septum is not very important as a character of taxionomic significance.

ductors between the first and the following lateral saddles. The position of adjustor scars is not quite clear, probably the antero-lateral ears and their assumed posterior continuation were the sites of their attachment.

Brachial interior: Breviseptum and the cardinal process well developed: former enclosed posteriorly between the buttress plates. On the bases of these feature four groups within *Isogramma* may be distinguished:

(a) Breviseptum longer than half shell length. Cardinal process: myophore rounded triangular, monolobed (tect-fig. 12); shaft highly swollen, long — *I. expansum* (De Regny & Gortani, 1906).

(b) Breviseptum as in (a) but extends farther posteriorly. Cardinal process: myophore trilobate (text-fig. 14); shaft much shorter compared to that in (a), constricted at and slightly posterior to hinge, there bounded laterally by two deep cavities. It is likely that these represent the dental sockets of Hall & Clarke and Chao — *I. zoellnerensis* n. sp.

Fig. 12 Fig. 13 Fig. 14

Figs. 12—14. Respectively, *Isogramma expansum* (De Regny et Gortani, 1905); *I. kahlerorum* n. sp. and *I. zoellnerensis* n. sp. showing myophore of the cardinal process. × 5.

(c) Breviseptum extends almost to the anterior margin of the valve and near to the hinge line. Cardinal process: myophore shorter than that in other species, trilobed, median lobe depressed (text-fig. 13); shaft short forked at the hinge — *I. kahlerorum* n. sp.

(d) Breviseptum bifurcated posteriorly. Cardinal process: myophore unknown; shaft forked at the hinge; buttress plates reach breviseptum at the point of its furcation; hollow surface between the posterior part of buttress plates corrugated — *Isogramma* n. sp.

Shell structure: Thin shells of both the valves are perforate. The pores appear to continue to the external surface as they have been observed on the external moulds as well. They are arranged in concentric bands. In the moulds the pore-fillings look like fine rods. Their length is thus the measurement of thickness of the shell: in one of the specimens of *I. expansum* it measures slightly less than 1 mm. Under high magnification, in some specimens, these rods seem to be arranged in groups separated from each other by a regular interval. They are centrally perforate, each rod containing a number of perforations. It could not be ascertained whether these perforations result from preservation, or represent some original ciliary bodies.

Four species of Isogrammidae have been distinguished on the bases of (a) character of the cardinal process and breviseptum, (b) shell outline and (c) density of the concentric lines.

Isogramma expansum (DE REGNY & GORTANI, 1905)

(Pl. II, figs. 7—9; Pl. III, figs. 4—6; text-fig. 12)

1905 *Orthotetes (?) expansus* DE REGNI & GORTANI, p. 543, Pl. XIV, fig. 4.
1928 *Aulacorhyncus paotechowensis* GRABAU & CHAO, p. 33, Pl. I, fig. 27, Pl. IV, fig. 1—5.
1931 *Isogramma paotechowensis* — HERITSCH & EIGNER, p. 307, Pl. II, fig. 32—36, Pl. III, figs. 37—44, Pl. IV, figs. 45—51, Pl. V, figs. 52, 53, 67—69.
1936 *Isogramma paotechowensis* — METZ, p. 171, Pl. IV, fig. 14.
1955 *Isogramma paotechowensis* — MINATO, p. 29, text-fig. 1.

Material: Several specimens of both valves.

Diagnosis: Outline subcircular, widest near the hinge line. In the brachial interior breviseptum longer than half valve length; myophore of the cardinal process monolobed, shaft long.

Description: Shell plano-convex of subcircular outline; maximum width nearly 1.5 times the length; former at the hinge line or slightly anterior to it. Ventral umbo projecting strongly beyond interarea; latter present in both the valves, longitudinally and transversely striated. Triangular scar on the ventral exterior seems to extend to three quarters valve length; apical angle 20°. Shell surface crossed by concentric lines which number 10 in 4 mm length at the mature part; grooves separating these lines two and a half times longer (sag.) than a line.

In the pedicle interior, muscle scars extend to near the anterior margin. Shell substance punctate only beneath the grooves of the shell. In the brachial interior myophore of the cardinal process rounded triangular, its surface concentrically marked by lines of growth. The myophore continues to the hinge line through concave slopes opposite to the ventral valve. Shaft highly thickened at and just anterior to hinge where it is forked. Buttress plates fuse with breviseptum at latter's one-third posterior length; breviseptum separated from the shaft through a small cavity, continues anteriorly to three quarters valve length.

Comparison: *I. renefrarum* COOPER, 1952 the largest American brachiopod differs from *I. expansum* in its highly transverse outline and different density of concentric lines.

Distribution and range: Upper Carboniferous of Carnic Alps and China. Lower Permian of Japan. VOLGIN 1960 discovered the species in Uralian (and Permian ?) of Fergana. His paper however has not been available. It has now been discovered at locality 1.

Isogramma zoellnerensis n. sp.

(Pl. III, figs. 1—3; text-fig. 14)

Derivatio nominis: After Zoellner lake in the vicinity of which an Uralian horizon contains myriads of *Isogramma.*

Typus: External mould of a brachial valve with myophore of the brachial interior. Pl. III, figs. 1—2 (GPIBo. 16).

Locus typicus: SW of Zoellner lake, locality 9.

Stratum typicum: Upper Uralian.

Material: Several specimens of internal and external moulds.

Diagnosis: Medium size shell of transversely sub-elliptical outline; widest considerably anterior to the hinge line. In the brachial interior myophore of the cardinal process trilobed, shaft extremely short.

Description: The following differences from *I. expansum* may be noted: Outline transversely sub-elliptical, widest slightly posterior to mid valve length, maximum width twice the length. Ventral valve relatively more convex, brachial valve resupinate. Cardinal extremities obtuse, exceedingly rounded. Ventral umbo projecting slightly beyond the interarea; latter linear, striation unknown. On the only one fragmentary external mould available, the triangular scars seems to subtend a larger apical angle. Concentric lines number 8—9 in 4 mm, groove space relatively larger. Concentric lines are strongly drawn inwards and crowd rather heavily near cardinal extremities.

In the pedicle interior, the muscle field extends to valve mid length, apical angle nearly 40°. In brachial interior myophore of the cardinal process trilobed, highly expanded posteriorly, constricted near the hinge line where two deep cavities bound it laterally; shaft extremely small, buttress plates fuse with the breviseptum at 1 cm distance from the hinge line and are separated from the shaft and the buttress plates through a deep cavity.

Comparison: Brachial interior of *I. zoellnerensis* differs from that of *I. expansum* in its trilobed myophore and a deep cavity which separates the breviseptum from the shaft of the cardinal process. In *I. expansum* this cavity is insignificant and the breviseptum terminates slightly posterior to shaft. *I. texanum* COOPER, 1952 externally seems identical to *I. zoellnerensis*, but has a different brachial interior and the brachial valve is not resupinate.

Distribution and range: Known only from the type locality and the type stratum.

Isogramma kahlerorum n. sp.

(Pl. IV, figs. 1—4; text-fig. 13)

Derivatio nominis: In honour of Drs. KAHLER, F. and KAHLER, G. (Klagenfurt). Dr. F. KAHLER found the first Isogrammidae from the Austrain part of the Carnic Alps and entrusted this material to Prof. HERITSCH for description. In co-authorship of HERITSCH Dr. G. KAHLER wrote the monograph on the family in 1931 under her maiden name AIGNER.

Typus: External mould of brachial valve with myophore of the brachial interior. Pl. IV, fig. 1 (GPIBo. 18).

Locus typicus: SW of Zoellner lake, locality 9.

S t r a t u m t y p i c u m: Upper Uralian.

M a t e r i a l: Several specimens of external and internal moulds.

D i a g n o s i s: Outline more than a semicircle. In the brachial interior, myophore of the cardinal process trilobed, median lobe depressed.

D e s c r i p t i o n: Medium size plano-convex shell of sub-circular outline, slightly wider than long, maximum width at the hinge. Cardinal extremities rectangular to feebly acute. Ventral valve convex posteriorly; here the flanks slightly undulated. Umbo projecting considerably beyond interarea; latter linear and narrow. Triangular scar extends to mid valve length, differentiated longitudinally into three parts, apical angle 22—25°. Concentric lines number 9—10 in 4 mm space at mature part, grooves separating them nearly 3 times longer; part of the valve surface occupied by the grooves, punctate. Sculpture of brachial valve as that of the ventral valve.

In the pedicle interior, the triangular platform for the muscle attachment extends to slightly more than mid valve length. In brachial interior, myophore of the cardinal process posteriorly highly expanded, trilobed; depressed and concentrically marked median lobe buttressed between thin ridge-like lateral lobes and separated from them through sharp declivities. Shaft short, forked before reaching the hinge line. Buttress plates fuse with breviseptum, much shorter as compared with the buttress plates of other species. Breviseptum lags slightly behind the valve length, highest before posterior termination.

C o m p a r i s o n: This species differs from all other known Isogrammidae owing to its outline, pronounced convexity of the ventral valve and different brachial interior.

D i s t r i b u t i o n and range: Known only from the type locality and type stratum.

Isogramma n. sp.

(Pl. IV, figs. 5—6)

M a t e r i a l: Only one fragmentory inner mould of a brachial valve.

D e f i n i t i o n: Medium size transversely sub-elliptical shell widest at posterior one-third length; maximum width more than twice the length. Hinge line continues without perceptible break into postero-lateral commissure. In the brachial interior, the breviseptum extends anteriorly to near commissure; posteriorly bifurcate; myophore unknown. Shaft forks right at the hinge line; buttress plates enclose the posterior part of the breviseptum reaching it at the point of furcation. Probably no fusion takes place; surface between buttress plates corrugated.

D i s c u s s i o n: This species is very poorly known and in outline resembles *I. zoellnerensis* n. sp. The posterior furcation of the breviseptum however singles it out from other known Isogrammidae.

Distribution and range: Known from locality 9 and from Upper Uralian.

Superfamily ENTELETACEA LICHAREW & ALICHOW, 1960

Diagnosis: Endopunctate Orthoidea in which non-flabellate ventral diductor sears donot enclose adductors commonly.

Stratigraphic range: Middle Ordovician to Permian.

Family Enteletidae WAAGEN, 1884

Diagnosis: Enteletacea in which the shell is biconvex and strongly plicate in front.

Stratigraphic range: Middle Carboniferous to Permian.

Genus *Enteletes* FISCHER, 1837

Genotype: *Choristites lamarckii* FISCHER, 1825.

Diagnosis: Enteletidae with dorsal fold and ventral sinus; these primary fold and sinus may be occupied medially by a sulcus and plication respectively.

Stratigraphic range: Middle Carboniferous to Permian.

Comparison: *Enteletella* LICHAREW, 1924 is externally like *Enteletes* but the dental plates in the former form spondylium.

Enteletes lamarckii (FISCHER, 1825)
(Pl. V, figs. 1—9)

1825 *Choristites lamarckii* FISCHER, p. 4.
1837 *Enteletes* sp. FISCHER, p. 141, Pl. XXIV, figs. 10—11.
1936 *Enteletes lamarckii* — METZ, p. 176, Pl. VI, fig. 6.
1936 *Enteletes plattsmouthensis* — METZ, p. 177, Pl. VI, fig. 8 (not NEWELL, 1931).

Material: Several moulds of separate pedicle and brachial valve.

Measurements in mm:

Ventral valve:					
Length	13	13	16	18	36
Width	15	13	19	21	30
Brachial valve:					
Length	6	26	24		
Width	12	31	28		

Description: Nepionic stage: Unplicate shell, in this stage as also in the following, demonstrates a high degree of variability in outline. Whilst most of the specimens are transversely subelliptical, others are pentagonal to sub-circular. Hinge line corresponds to the length of delthyrial base or slightly longer. Shell widest at its mid-length. Length and width do not exceed 15 mm. Umbo projecting strongly beyond hinge line, not incurved. Cardinal process in brachial interior probably monolobate.

Neanic stage: Sinus bounding and medial sinus plications appear at the anterior margin.

Ephebic stage: Two distinct lateral plications developed, confined to the anterior margin while the medial sinal plication extends farther posteriorly near to the septal apparatus. In a less deformed specimen the shell outline is nearly trapezoidal and the plications are rounded. Lateral and anterior commissure zig zag, latter considerably produced. Delthyrial base slightly more than half hinge length.

Gerontic stage: Shell becomes more inflated. Crest of the sinus bounding plications displaced outwards so that the lateral sides of the sinus slope gradually in axial direction. Pointed beak arches over the interarea. Growth lines concentrated at the anterior margin.

Besides plications, shell sculpture consists of fine radial costellae which thicken at the anterior margin and are separated here by prominent notches; growth lines may also be present at mid-valve length, generally concentrated only anteriorly.

Ventral interior: Dental plates sub-parallel at the inner shell surface. They slope outwards towards free margins, are crescentic in posterior view and reach about one-third valve length anteriorly. Median septum slightly longer than the dental plates, highest shortly before its anterior termination, bevelled at the free edge. Diductors attached to the platform between the dental plates and the median septum, rounded anteriorly. Adductors were attached probably to the median septum.

Dorsal interior: Cardinal process sessile, low, monolobate? in a nepionic and trilobate in a well grown specimen. Socket plates short and massive, support strong, anteriorly diverging and curved brachiophores. Muscle scars differentiated into posterior and anterior adductors; former overlap the latter antero-laterally; bisected by a low myophragm.

Observations: In these specimens the ventral septalia and the dorsal cardinalia are much shorter than in the specimens from Moscow basin.

In some specimens the dental plates seems to curve inward at anterior termination to form a cella as in *Parenteletes*. Since only moulds are available it is hardly possible to ascertain whether this structure results from the incurving of the dental plates or the depressions are the incisions caused by musculature.

Improbable as it may seem the cardinal process seems to undergo change from nepionic to well grown shell. Furthermore a monolobed or trilobed cardinal process is rather strange to Orthoidea where the bilobed cardinal process is a rule.

Comparison: A large number of topotype specimens is available for comparison. In some the ventral valve is almost flat, in others highly inflated. *E. plattsmouthensis* NEWELL which is considered to be a gerontic stage of *E. hemiplicatus* HALL has no plication in the ventral sinus.

Distribution and range: Moscow basin, Moscovian to Permian. Now found at localities 1, 2 and 8.

Enteletes aff. *hemiplicatus* (HALL, 1852)

(Pl. V, figs. 14—15)

1852 *Spirifer hemiplicata* HALL, p. 409, Pl. IV, fig. 3 a, b.
1931 *Enteletes plattsmouthensis* NEWELL, p. 262, Pl. XXXI, fig. 20—27.

Material: One composite mould of a ventral valve.

Distinguishing character: *Enteletes hemiplicatus* is characterised by the ventral sinus without median plication.

Discussion: DUNBAR and CONDRA, 1932 have shown that *E. plattsmouthensis* is a gerontic stage of *E. hemiplicatus.* On comparing our specimen with these forms from Oread formation, following differences are observed: The American species is wider than long, this ratio in our specimen is almost 1 : 1. The length of hinge line in American specimens is shorter; the umbo seems to be more produced and the plications originate at a considerable distance from the hinge line.

Comparing the Carnic form with *E. andii* (D'ORBIGNY, 1842), latter is much larger, though the pattern of plications is similar.

Hitherto known true ventrisinuate forms from the Carnic Carboniferous and Permian namely, *E. kayseri* WAAGEN, *E. oelharti* GEMMELLARO, *E. carniolicus* SCHELLWIEN, have very slight plications and a shallow and rounded sinus.

Occurrence: Locality 1.

Enteletes carnica (SCHELLWIEN, 1892)

(Pl. V, figs. 12—13)

1892 *Enteles carnicus* SCHELLWIEN, p. 36, Pl. VII, figs. 3, 4.
non 1900 *Enteletes carnicus* — SCHELLWIEN, p. 12, Pl. I, fig. 14.
1936 *Enteletes carnicus* — METZ, p. 176, Pl. VI, fig. 7.

Typus: SCHELLWIEN did not designate a holotype. His syntypes have been lost. A neotype, therefore, needs to be established.

Stratum typicum: Spirifer Bed, Uralian.

Locus typicus: Below Garnitzenhöhe, Carnic Alps, Austria.

Material: Two ventral and a brachial valve.

Comparison: This species presents serious resemblence to *E. lamarckii,* but may be easily differentiated owing to its pentagonal outline, obtuse cardinal extremities and later beginning of plications. Moreover, in plan view the sinus bounding plications in *E. lamarckii* slope very gently in the axial direction and steeply outwards, whereas in *E. carnicus* they are evenly rounded.

Distribution and range: Carnic Alps and Karawanken; Uralian. Now found at localities 1 und 2.

Family Schizophoridae SCHUCHERT, 1929

Diagnosis: Enteletacea having biconvex or lenticular valve and not having numerous strong undulations or plicae developed at the front end of the shell.

Stratigraphic range: Middle Ordovician to Permian.

Genus *Schizophoria* KING, 1850

Genotype: *Conchyliolithus Anomites resupinatus* MARTIN, 1809.

Diagnosis: Biconvex Schizophoridae with rectimarginate to uniplicate anterior commissure. Cardinal extremities rounded. Surface multicostellate. Dental plates and median myophragm short.

Discussion: HALL and CLARKE, 1892 separated the genus *Orthotichia* from *Schizophoria* with the forms possessing higher and longer septal plates and anteriorly crested median septum.

Schizophoria aff. *indica* (WAAGEN, 1884)

(Pl. V, figs. 10—11)

1884 *Orthis indica* WAAGEN, p. 508, Pl. LVI, figs. 7, 8, 14—16.
1934 *Schizophoria ? indica* — FREDERICKS, p. 9, Pl. IV, fig. 19.

Material: One fragmentory composite mould of a ventral valve.

Measurements in mm:

	Length	Width
Ventral valve:	14	18

Description: Transversely sub-oval shell with slight and rounded median sinus, widest at the posterior half. Hinge line continues imperceptibly into lateral commissure. Shell surface fine costellate. Interiorly, median myophragm just as long as the dental plates, extend anteriorly to about one-third valve length. Latter slightly incurved at anterior termination; enclose longitudinally sub-oval diductor scars. Adductors borne on the median septum. Surface of the mould papillose.

Discussion: The specimen of *Schizophoria aff. indica* in the present collection differs from the type in its smaller shell, more pronounced ventral sinus and shorter dental plates and the median myophragm.

Distribution and range: Asia and Europe, Upper Carboniferous to Permian. Now found at locality 1.

Superfamily SPIRIFERINACEA IVANOVA, 1960

Diagnosis: Spiriferoid brachiopoda with an endopunctate test and calcareous spires.

Stratigraphic range: Upper Silurian to Jurassic.

Family SPIRIFERINIDAE DAVIDSON, 1884

Diagnosis: Punctospiracea in which interior of pedicle valve bears strong dental plates and a high median septum, but lacks a spondylium.

Stratigraphic range: Devonian to Jurassic.

Comparison: Spiriferinidae differ from Cyrtinidae STEHLI, 1954 in the presence of spondylium in the latter.

Genus *Callispirina* COOPER & MUIR-WOOD, 1951

Genotype: *Spiriferina ornata* WAAGEN, 1884.

Diagnosis: Spiriferinidae with mostly longitudinal shell and broadly rounded cardinal extremities; neither the ventral sinus bears a plication nor the dorsal fold a groove.

Stratigraphic range: Upper Carboniferous to Permian.

Comparison: *Callispirina* differs from *Spiriferina* D'ORBIGNY in the incipient radial plications of the latter. *Punctospirifer* NORTH is highly transverse. *Spiriferellina* FREDERICKS bears a minute medial elevation in the ventral sinus. *Spiriferinaella* FREDERICKS has a small reverse plication in the fold.

Callispirina frontisquamosa n. sp.

(Pl. V, figs. 19—23; text-fig. 15)

Derivatio nominis: Owing to the presence of lamellae of growth at anterior margin only.

Typus: Ventral valve. Pl. V, figs. 19—22 (GPIBo. 34).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: External and internal moulds of two ventral valves.

Diagnosis: Concentric lamellae of growth present at anterior margin only.

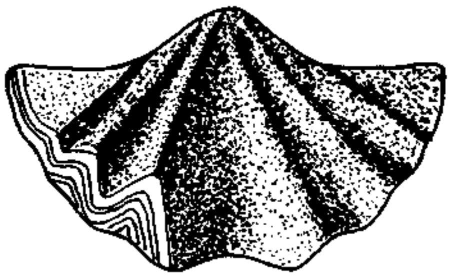


Fig. 15. *Callispirina frontisquamosa* n. sp., showing the presence of imbricating lamellae at the anterior shell margin only. The continuation of the lamellae on the right side has not been drawn. × 6.

Measurements in mm:

Ventral valve, Holotype:

Length	Width
7	8

Description: Small spiriferoid shell nearly as wide as long. Interarea high triangular, vertically lineated. Delthyrium open, narrow, base length less than half the hinge length and one-third its height. Umbo projecting considerably beyond interarea, beak highly incurved. Cardinal extremities sub-rectangular to broadly rounded: the maximum width of the shell therefore at the hinge or slightly anterior to it. Shell surface thrown into broad subangular to rounded plicae. Medial sinus narrow posteriorly, opens into a broad V-shaped trough at anterior commissure, bounded laterally by broad and high plications, at anterior commissure ½ to ⅓ as wide as maximum shell width. Lateral plications two, extend posteriorly to the umbonal region; a third at the postero-outer margin very feebly marked. Surface of the outer and inner moulds studded with rod-like structures which are observed on the inner casts as well, revealing the punctate nature of the shell substance. On the external mould between these rods but less frequent are fine pores which reflect the spines: spine pattern unknown.

Interiorly, thin and long median septum extends anteriorly to half valve length; dental plates slightly less longer than the median septum.

Comparison: *Callispirina frontisquamosa* n. sp. resembles *C. ornata* (Waagen), but differs in its greater hinge length, presence of imbricating lamellae at the anterior margin only and smaller number of plications.

Discussion: The generic designation of this species seems to be doubtful as it is not as transverse as *Punctospirifer* and not relatively as long as a true *Callispirina*. The distinction of these two genera seems to be arbitrary, transitional cases being possible.

Occurrence and range: Known from locality 1 only, Uralian.

Genus *Punctospirifer* North, 1920

Genotype: *Punctospirifer scabricostatus* North, 1920.

Diagnosis: Strongly transverse Spiriferinidae in which the fold and the sinus are about as wide at the anterior margin as three of adjacent costae and furrows separating them; surface of both valves crossed by regularly disposed imbricating lamellae.

Stratigraphic range: Lower Carboniferous to Permian.

Comparison: *Altiplecus* Stehli, 1954, another strongly transverse Spiriferinidae has strong spines which usually appear as one or two concentric rows on the frequent, irregular growth lamellae.

Punctospirifer coronae (Schellwien, 1892)

(Pl. V, figs. 16—18)

1892 *Spiriferina coronae* Schellwien, p. 49, Pl. IV, fig. 11.
1900 *Spiriferina cristata* var. *coronae* — Schellwien, p. 65.
1927 *Spiriferina coronae* — Heritsch, p. 311, Pl. II, fig. 6.
1936 *Spiriferina cristata* cf. var. *coronae* — Metz, p. 362, Pl. I, fig. 21.

Material: External and internal moulds of two brachial valves.

Diagnosis: Shell with acute cardinal extremities; 5—6 lateral plications on each side of sinus and fold.

Measurements in mm:
Brachial valve:

Length	10	9
Width	28	26

Description: Medium size, strongly transverse spiriferoid shell of triangular outline; widest at the hinge. Interarea low, rectangular, orthocline, pierced mesially by narrow tube-like notothyrium, probably both transversely and vertically striate. Cardinal extremities highly acute. Umbo projecting slightly beyond interarea but not incurved. Medial fold extremely high, narrowly rounded at the crest as all other plications, narrow posteriorly, broadens rapidly at one-fourth frontal length where it is slightly wider than one-fifth hinge length. Lateral plications 5, first adjacent to medial fold considerably less higher than the latter, those following outwards lose gradually in height; these folds are separated from each other through relatively narrower, deep and rounded furrows. The area outside of plications, excepting an inner indistinct undulation which indicates probably the 6th lateral plication, smooth. Shell surface crossed by regularly disposed imbricating lamellae of growth.

Interiorly, sockets bounded by massive hinge plates; cardinal process low and striate, bounded laterally by anteriorly diverging crural plates; shell punctate.

Comparison: *Punctospirifer coronae* differs from all other Carnic Permian and Carboniferous described subspecies of "*Spiriferina* *cristata*", which probably belong to different genera, in its highly transverse outline and the constant 5 + 1 number of lateral plications on each side.

Discussion: Shell structure in the species of *Callispirina* and *Punctospirifer* here discussed, is varyingly developed on the moulds. Whilst in the specimens of *Callispirina*, sediment rods reflecting pore spaces are present on both the external and the internal moulds, only coarse and wide spaced granulation has been observed on the internal moulds of *Punctospirifer*. The external moulds of *Punctospirifer* being completely deprived of the sedimentary rods. STEHLI's assumption that surface spines were present in all the Spiriferinidae appears to be untenable as they have not been observed in *Punctospirifer coronae*.

Occurrence: Krone ranch, Italy; Vellachtal, Karawanken (Jugoslavia); now discovered in localities 1 and 2.

Range: Upper Carboniferous.

Superfamily Rhynchoporacea MOORE, 1952

Diagnosis: Rhynchonelloid brachiopoda in which the shell is punctate.

Stratigraphic range: Carboniferous to Permian.

Comparison: In external and internal morphology, Rhynchoporacea are identical with Rhynchonellacea. The only distinction is the punctate nature of the shell. Rhynchoporacea are known by one genus alone, the *Rhynchopora*.

Genus *Rhynchopora* KING, 1865

Genotype: *Terebratula geinitziana* VERNUIL, 1845.

Definition: Small to medium size, biconvex, sub-pentagonal shell with elongate beak and short hinge line. Ventral valve with strong sulcus, produced upwards as tongue in the anterior curvature of the prominent brachial fold. Posterior half of both valves smooth. Sulcus and fold originate at mid valve length and are occupied by strong costae. Lateral flanks at anterior margin strongly costate to plicate.

Interiorly, the ventral valve possesses long, slightly diverging dental lamellae. In the dorsal valve, the hinge plate is perforated by minute hole. Crural plates form cruralium on joining the median septum. Calcareous brachidium absent.

Rhynchopora grandirostris (SCHELLWIEN, 1892)
(Pl. X, fig. 9)

1892 *Rhynchonella grandirostris* SCHELLWIEN, p. 53, Pl. VIII, fig. 13—14.

Material: An external mould of a ventral valve.

Measurements in mm:

Ventral valve:	Length	Width
	6	6

Description: Small size shell of sub-triangular to sub-pentagonal outline, as wide as long, maximum width lies slightly backwards of anterior margin; triangular umbo pointed at the beak, latter not incurved; sinus wide, bounded by strong plications; on each side of these, 2 more plications present; sinus occupied by three costae which extend posteriorly to more than half shell length; surface crossed by weak concentric lirae.

Discussion: SCHELLWIEN did not describe the shell structure. In the specimen described above, indistinct granulation passing onto shagreen has been observed, particularly at the latter flanks of the shell.

Occurrence: Krone ranch, Italy; now found at locality 1.

Range: Upper Carboniferous.

Superfamily SPIRIFERACEA IVANOVA, 1960

Family SPIRIFERIDAE KING, 1846

Subfamily Brachythyrinae FREDERICKS, 1924

Genus *Brachythyrina* FREDERICKS, 1929

Genotype: *Spirifer strangwaysi* VERNEUIL, 1845.

Diagnosis: Transverse Brachythyrinae; cardinal extremities angular; ribs coarse, only seldom dichotomising. Apical apparatus: carinae delthyriales of FREDERICKS, 1926.

Stratigraphic range: Lower Carboniferous to Permian.

Comparison: *Brachythyrina* is likely to be mistaken for (a) *Fusella* and (b) *Brachythyris*.

Externally, *Fusella* is characterised by dichotomising ribs; internally ovarian marks are present only on the posterior part of the muscle field. In *Brachythyrina* however, they extend farther anteriorly. In place of well developed dental plates in *Fusella, Brachythyrina* is characterised by delthyrial ridges. *Brachythyris* has a shorter hinge length, rounded cardinal extremities and more longitudinal outline.

Brachythyrina strangwaysi (VERNEUIL, 1845)

(Pl. VI, figs. 7—7)

1845 *Spirifer strangwaysi* VERNEUIL, p. 164, Pl. VI, fig. 1.
1925 *Anelasma strangwaysi* IVANOV, p. 109.
1929 *Brachythyrina strangwaysi* FREDERICKS, p. 103.
1936 *Spirifer (Brachythyrina) strangwaysi* — METZ, p. 165.
1936 *Spirifer kahleri* METZ, p. 171, Pl. VI, fig. 15.
1958 *Brachythyrina strangwaysi* IVANOVA, Pl. XIX, fig. 5; Pl. VIII, figs. 4—8.

Material: Large number of specimens in different stages of growth.

Diagnosis: Highly mucronate shell with hinge length more than double the shell length; a medial groove in the ventral sinus always present.

Measurements in mm:

Ventral valve:

Width	59	48	31	35	45	23
Length	26	19	18	17	19?	11

Brachial valve:

Width	64	38	52
Length	25	18	?

Description: Large transverse shell with highly mucronate cardinal extremities. Hinge length more than double shell length. In the pedicle valve beak pointed, moderately incurved. Interarea low apsacline, rectangular, marked with parallel and vertical lineation. The impressions of interarea lineation differ in different specimens; in some, the part facing the dorsal valve is strongly transversely lineated and demarcated from the lower part which bears mainly parallel growth lines; in others transverse lines are always dominant. Delthyrium open, apical angle 50—60°.

With the advancement of growth, the shell does not undergo significant change of outline. In early ontogeny the mucro are less pronounced. Length/breadth relationship remains throughout life almost the same.

Sinus narrow and deep posteriorly, broad wave at the anterior margin. Sinus bounding plicae rounded as all other plicae but thickest, each giving off secondary plicae adaxially at 7 mm length from beak. From the new pair of plicae begin, slightly anteriorly, another pair which bound the medial groove. This pair absent in smaller specimens. Plicae on lateral flanks simple, number 18 on a large specimen on each flank. Lamellae of growth irregularly distributed over shell surface, but those imbricating concentrated on the anterior margin only.

In the pedicle interior, delthyrial ridges concave in posterior direction, do not reach shell surface. Muscle scars longitudinally sub-oval. Diductors fibrous. Adductors unknown.

Dorsal valve: Feebly convex. Beak scarcely projects over the interarea; latter less broad, lineation as on the interarea of pedicle valve. Fold low, well demarcated. Two narrow and well defined grooves divide it in 3 broad plicae. The medial plication essentially, and the others may bear mesially grooves. Plicae on the lateral flanks and growth lamellae as in ventral valve.

Interiorly, crural plates fuse laterally with the hinge plates. Former seem to continue posteriorly with hinge plates which enclose, vertically striate sessile cardinal process.

Discussion: *Br. rectangulus* (KUTORGA, 1884) and *Br. carnica* (SCHELLWIEN, 1892) are closely related species. The former is less transverse, mucro are not pronounced and sinal plicae are different. The last two characters distinguish it also from *Br. carnica*. The pattern of sinal plication appears to be inconstant in *Br. strangwaysi* as some Russian specimens show occasionally a medial plication in the ventral sinus.

Br. kahleri (METZ, 1936) seems to be a specimen of *Br. strangwaysi*, damaged at the anterior margin. Such specimens are represented in the present collecting as well.

Regarding striation of interarea TSCHENYSCHEW, 1902 while discussing *Br. rectangulus* remarked, "On well preserved specimens the upper surface of interarea has fine horizontal striation below which vertical furrows appear; latter appear more prominent when the epiderm layer is removed". This is why in some specimens vertical striations appear, in others only transverse, in still others both.

Occurrence: Moscow basin, Carnic Alps and Karawanken. Now found at localities 1, 2 and 8.

Range: Middle to Upper Carboniferous.

Brachythyrina jakovlevi IVAN.

(Pl. VI, figs. 16—19)

1958 *Brachythyrina jakovlevi* — IVANOVA, p. 123, Pl. XVIII, fig. 4—6.

Material: Several composite moulds of both valves.

Discussion: The original description of *Brachythyrina jakovlevi* and year of publication is not known. IVANOVA, 1958 figured three specimens of this species. In addition, a specimen from the Moscow basin has also been available.

Measurements in mm:

Ventral valve:

Length	46	40	50	44	(Russian specimen)
Breadth	29	31	33	36	

Description: Large shell of triangular outline, wider than long, maximum width at the hinge. Cardinal extremities acute, occasionally drawn into short mucro. Pedicle valve highly convex. Beak weakly developed, projecting slightly beyond interarea, incurved. Interarea apsacline, rectangular, transversely and vertically lineated. Delthyrium open, broad, apical angle 56—62°. Median sinus well defined, anteriorly produced. Shell sculpture of plicae and lamellae of growth. Sinus bounding plicae not the thickest, give off inwards one pair of secondary plicae at five mm from the beak and another near half valve length. A median plication in the sinus is present in two specimens and the lateral flanks bear about 10 plicae each. Lamellae of growth concentrated at the anterior margin or medially. In the pedicle interior delthyrial ridges as in *Br.*

strangwaysi. A thick apical callosity present between the posterior end of the muscle scars. Latter longitudinally sub-oval, adductors smooth, diductors fibrous. Ovarian marks present outside of delthyrial ridges and continue anteriorly outside of muscle field and surrounding it at anterior margin. Pallial marking present in posterior three quarters of the valve length. The pallial sinuses cross each other enclosing rhombic areas the acute angles of which face the hinge.

Brachial valve less convex. Beak feebly developed. Fold bears a median plication. Interior as in *Br. strangwaysi.*

Variations: The Carnic specimens have slightly different dimensions, the ventral sinus is less produced and the lateral commissure less wavy. Absence of medial plication in the ventral sinus also appears to be a point of difference.

Comparison: *Br. strangwaysi* CHAO, 1929 has rectangular cardinal extremities and the ventral sinus is not produced.

Distribution and range: Moscow basin, Upper Moscovian to Uralian. Now discovered at locality 1.

Brachythyrina carnica (SCHELLWIEN, 1892) emend.

(Pl. VI, figs. 8—15)

1892 *Spirifer carnica* SCHELLWIEN, p. 45, Pl. VI, figs. 1—4.
1905 *Spirifer carnica* — GORTANI, p. 28, Pl. II, fig. 20.
1936 *Spirifer carnica grandis* — METZ, p. 179, Pl. VI, fig. 14.

Holotype: SCHELLWIEN did not designate a holotype. His syntypes have been lost. Neotype must be established.

Locus typicus: Garnitzenhöhe; Krone, Italy.

Stratum typicum: Spirifer bed 6, Uralian.

Material: Several specimens of separate valves.

Diagnosis: Mucronate shell with hinge less than double the shell length. Ventral sinus characterised by a medial plication; apical part of delthyrium covered with deltidial plate.

Discussion: This diagnosis differs from that given by SCHELLWIEN in the following respects:

The deltidial plates are invariably present. The maximum shell width does not exceed twice the length. SCHELLWIEN erred in reconstructing the outline of the specimens available to him. All his specimens were fragmentary. Moreover, he probably did not measure the length along the curvature.

Measurements in mm:

Ventral valve:

Width	36	35	38	46	35	43	45	45	31	31
Length	23	24	20	31	23	26	28	23	22	16

Brachial valve:

Width	47	25	35	40
Length	27	13	22	21

Description: The following differences from *Br. strangwaysi* may be noted: Murco small. In the ventral valve, umbo broader, projecting considerably beyond hinge, distinctly incurved. Delthyrium broader, apex of delthyrium covered with anteriorly diverging lamellae of deltidium. Sinus broader at anterior commissure, contains 3—5 plicae, of these the medial plication mostly is the strongest. The number of plicae on either side of the lateral flanks smaller, on larger specimens they do not exceed 10. SCHELLWIEN however noted 15. In the ventral interior, apical callosity occasionally developed. Ovarian marks similar to that in *Br. jakovlevi.*

In the brachial valve, fold more pronounced, mostly without middle furrow. Plicae on the flanks fewer than on the ventral valve, Number 10 on the largest specimen.

Comparison: The monotypic *Br. carnica grandis* (SCHELLWIEN, 1892), the holotype of which is available for study has larger size and is more densely ribbed. *Spirifer carnica grandis* — METZ has 10 ribs on the lateral flanks and its size also is not larger than that of most of the specimens of the main form.

Distribution and range: Carnic Alps: Krone ranch, Spirifer bed (Uralian). Now found at localities 1 and 2.

Genus *Choristites* FISCHER, 1825

Genotype: *Choristites mosquensis* FISCHER, 1825.

Diagnosis: Shell large. Cardinal extremities angular. Ribs strong, dichotomising. Dental plates in the ventral interior extend to a varying distance anteriorly, piercing through the muscle field.

Stratigraphic range: Lower Carboniferous to Lower Permian.

Discussion: There prevailed controversy for a long time regarding distinguishing characters between the genera *Choristites* and *Munella* FREDERICKS, 1919 (homonym of *M.* BONNIER, 1896, Crustacea). *Spirifer nikitini* TSCHERNYSCHEW, 1902 was designated as genotype of *Munella.* Originally, the presence of euseptoid was considered to be a feature characteristic of *Choristites* alone, but CHAO, 1929 and SEMICHATOV, 1932 have shown that its presence is inconsistent. It was on the external characters namely, elongate sub-elliptical outline, obtuse cardinal extremities, medial groove in the ventral sinus and a corresponding rib in the dorsal fold that REED, 1944 erected the genus *Purdonella* with *Sp. nikitini* as the genotype.

Within the genus *Choristites* two groups however, are distinguishable: one, in which the dental lamellae coalesce in the apical region, the other, in which they do not. In the present investigation these characters have been used for specific distinction.

Choristites fritschi (Schellwien, 1892)

(Pl. VII, figs. 1—2; text-fig. 16)

1892 *Spirifer fritschi* Schellwien, p. 43, Pl. V, figs. 4—8.
1932 *Munella fritschi* — Rakusz, p. 180, Pl. IX, fig. 7.
1936 *Spirifer (Munella ?) fritschi* — Metz, p. 173, Pl. VI, figs. 9—10.

N e o t y p e: Of the Schellwien's syntypes those in Halle have been lost and those in Vienna not traceable. Neotype must be established.

L o c u s t y p i c u s: Original material was derived from Krone- and Lochranch, Italy.

S t r a t u m t y p i c u m: Spirifer bed, Uralian.

M a t e r i a l: Several moulds of pedicle valve and a cast of highly crushed specimen. Latter sectioned.

D i a g n o s i s: Shell wider than long, widest at the hinge. In the ventral interior the dental lamellae separate even in the beak region.

M e a s u r e m e n t s in mm:

Ventral valve:

Width	42	54
Length	36	46

D e s c r i p t i o n: Large sub-pentagonal shell wider than long, widest at the hinge. Ventral valve moderately convex. In one of the specimens however, medial region is highly convex. Interarea high, triangular, apsacline, marked with parallel and vertical lines, deeply incised at the dorsal margin. Umbo tumid, tapering posteriorly into pointed incurved beak, projecting slightly beyond interarea. Delthyrium broad, closed at the apex by ventro-interiorly diverging lamellae of deltidium. Cardinal extremities mucronate. Sinus indistinct posteriorly, broadening into shallow transverse curve at anterior commissure, poorly defined. Ribs low and rounded, dichothomising, a medial- and three lateral pairs of ribs in the sinus and about 15 on each lateral flank. Concentric growth lines present at three quarters anterior length: they indicate that the trend of growth was mainly in the anterior direction in later growth stages.

In the ventral interior, long sub-parallel dental plates extend to less than one-third posterior valve length, posteriorly they extend into the beak region, remaining separate (fig. 17). Muscle area longitudinally sub-oval, divided into two longitudinal parts by a narrow platform to which the adductors were attached. Diductors posteriorly pierced by the dental lamellae.

D i s c u s s i o n: In its outline and sculpture *Ch. fritschi* is easily distinguishable from various Choristites species of the Russian upper palaeozoics, the scene of the prolific development of this genus. *Ch. gortani* (HERITSCH, 1938) (= *Spirifer fritschi*, SCHELLWIEN, 1900 Pl. X, figs. 9—10) has different outline and ventral interior. *Purdonella rakoveci* (HERITSCH, 1938) (= *Spirifer fritschi* SCHELLWIEN, 1900 Pl. X, fig. 7) has much shorter hinge length.

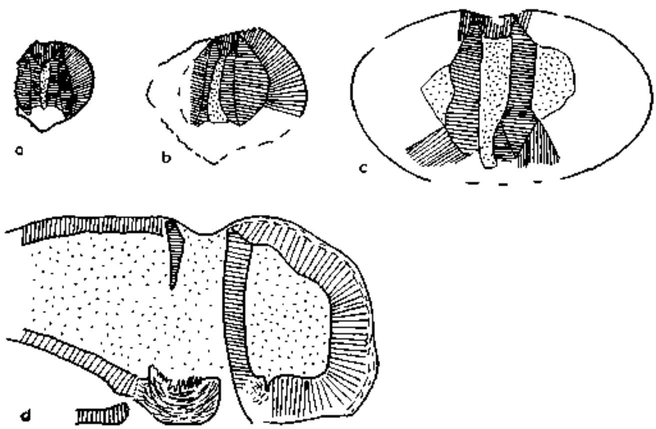


Fig. 16

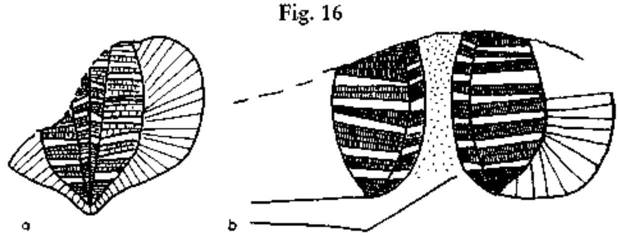


Fig. 17

Figs. 16, 17. Respectively, *Choristites fritschi* (SCHELLWIEN) and *Choristites* n. sp. A., showing serial sections (coarse punctae represent sediment filling; fig. 16 d shows cardinal process at lower middle portion). × 3.5.

D i s t r i b u t i o n and range: Recorded only from Upper Carboniferous of Carnic Alps, Karawanken and Dobsina, Hungary; now found at localities 1 and 2.

Choristites n. sp. A

(Pl. VII, figs. 3—5; text-fig. 17)

M a t e r i a l: Several composite moulds of the ventral valves, and a cast of a ventral valve.

D i a g n o s i s: Shell widest anterior to hinge; dental plates in the ventral interior form sub-umbonal spondylium.

Measurements in mm:

Hinge width	Maximum width	Length
38	44	43
31	42	44

Description: The following differences from *Choristites fritschi* may be noted:

Exteriorly, hinge length lags behind the greatest width; the cardinal extremities are slightly mucronate. Shell as wide as long; beak more incurved. Among the sinal ribs the medial one may be thinnest and appears to reach the posterior shell margin, ribs on its sides furcating, giving off thin secondary ribs towards axis.

Interiorly, the dental plates extend to more than one-third of the posterior length remaining almost parallel in their anterior extention; it has been possible to serial section the specimen of a cast: for the first 11 mm the dental plates coalesce to form a spondylium, the transverse fibres end at the longitudinal plane dividing a dental plates.

Discussion: METZ, 1935 has shown that the dental plates in *Ch. fritschi* do not coalesce in the apical region, also fig. 8, Pl. V of SCHELLWIEN, 1892 indicates the absence of a spondylium. SCHELLWIEN's reference in that paper regarding variation in hinge length displayed by various specimens might be interpretted in a way that the specimens with shorter hinge length belong to *Ch.* n. sp. A. Owing to inadequate material however, any really certain statement must be postponed. Shorter hinge length and the pattern of the sinal ribs suggests an affinity to *Purdonella*. It seems however, that the genus *Purdonella* is not certainly well defined. If a distinction is to be made, it has to be based on the internal structure; namely those forms in which the dental plates do not coalesce should belong to this genus, others to *Choristites*.

Occurrence and range: Known from the type locality and probably in the Spirifer Bed (Uralian) of Krone and Loch ranch, Italy.

Choristites heritschi n. sp.

(Pl. VIII, figs. 3—5)

Derivatio nominis: In honour of Prof. HERITSCH whose work on the Carnic stratigraphy is unparalleled.

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Holotype: Ventral valve. Pl. VIII, fig. 3 (GPIBo. 55).

Material: Two ventral valves, one with shell substance, the other an internal mould.

Diagnosis: Large shell with obtuse cardinal extremities; dental plates in the ventral interior short, anteriorly diverging, forming spondylium posteriorly.

Measurements in mm:

	Hinge width	Maximum width	Length
Holotype	48	56	64

Description: Shell large, sub-rhomboidal, highly convex posteriorly, widest at about one-fourth posterior length; cardinal extremities obtuse; umbo tumid, projected considerably beyond hinge; beak rounded, highly incurved. Sinus deep and narrow, loses depth and becomes expanded at the anterior margin; laterally not clearly defined and occupied medially by a groove. Ribs rounded, those situated in the sinus branch; grooves separating the ribs slightly less longer (tr.); concentric lamellae spread over entire shell surface.

Neanic growth stage: Shell transversely sub-oval, slightly wider than long, cardinal extremities highly obtuse.

Nepionic stage: Transversely sub-oval shell, much wider than long; cardinal extremities obtuser still.

Ephebic stage: Outline almost pear shaped, growth takes place mainly in longitudinal direction, anterior commissure produced at the sinus.

Gerontic stage: No more growth in lateral direction at the hinge, anterior projection of the commissure still more pronounced.

Interiorly, dental plates short, divergent, do not extend beyond umbonal region; coalesce in their posterior extention. Muscle scars not well impressed; prominent radial pallial sinuses crossed by thinner concentric trunks to give rectanagular pattern to posterior inner surface.

Comparison: *Ch. sowerbyi* FISCHER presents some resemblence but is distinguishable owing to flatter ribs and finer striae separating them, former branching over the whole shell surface and not only in the sinus; hinge representing the maximum shell width; shell size being smaller; interiorly dental plates extending to about half shell length and being sub-parallel in their anterior extention.

Occurrence: Known from the type locality only.

Range: Uralian.

Choristites n. sp. B

(Pl. VIII, figs. 6—7)

Material: A solitary composite mould of a ventral valve.

Diagnosis: Shell extended greatly at the hinge; mucro horn like.

Measurements in mm:

Width (double of the left side)	62
Length	48

Description: Large shell with highly tumid palintrope, latter slightly extended beyond hinge line and tapers to highly incurved and rounded beak. Interarea probably linear, extremely narrow. Hinge line represents maximum shell width which is slightly less than one and a half times the shell length. Postero-lateral commissure makes an acute angle with the hinge line, then deflected abaxially to curve again inwards giving sub-circular appearence to the anterior three-quarters of the shell. Sinus shallow and narrow, indistinctly defined, occupied medially by a rib. Sinal and lateral ribs branched.

Interiorly, dental plates extend to one-third posterior shell length, thicker near the hinge, at their half length deflected outwards at the inner shell surface to run parallel thereafter in anterior direction.

Observation: The specimen available is a pathologic one as the mucro on the right side is involutary developed.

Comparison: In greater length of the hinge line and extended mucro this species resembles *Choristites pavlowi* (STUCKENBERG, 1905), but the difference between the two in the type of mucro, length-breadth relationship and interarea are great.

Occurrence and range: Known from the type locality and type stratum.

Choristites aff. *mosquensis* FISCHER, 1825
(Pl. VIII, figs. 1—2)

Material: Composite moulds of a brachial- and a pedicle valve.

Measurements in mm:

	Width	Length
Ventral valve:	44	56
Brachial valve:	37	42

Description: Large shell longer than wide, maximum width at the hinge. Pedicle exterior: due probably to diagenetic compression, shell feebly arched; cardinal extremities acute, drawn into small mucro. Umbo tumid, projected considerably beyond hinge; umbonal slopes descending rather rapidly in postero-lateral direction and set off from mucro through weak curvature. Interarea rectangular, incised. Delthyrium broad, apical angle slightly less than 90°. Sinus broad, poorly defined. Ribs rounded, separated from each other through equally long (tr.) grooves.

Pedicle interior: Dental plates short, extend hardly anterior to hinge at the inner shell surface, here sub-parallel.

Brachial exterior: Cardinal extremities rectangular; interarea narrower, traversed vertically by deep striae; rounded beak projected slightly beyond hinge; fold prominent, as wide as anterior commissure; ribs rounded and dichotomising.

Discussion: The outline conforms broadly to *Ch. mosquensis* although differences are clearly evident: in *Ch. mosquensis* shell is much longer than wide, ribs are flatter and separated from each other through much finer striae; in the ventral interior the dental lamellae extend to more than half valve length.

Occurrence and range: *Choristites mosquensis* is known from Moscovian to Uralian of the Moscow basin. The above specimens are obtained from locality 1.

Choristites sp.

(Pl. VII, figs. 6, 7)

Material: Two internal moulds of ventral valves.

Measurements in mm:

Ventral valve:

Width	52	44
Length	43?	41

Description: Highly convex, sub-pentagonal shell sloping abruptly at the peripheries, widest at the hinge. Umbo projecting considerably beyond hinge line, beak pointed. Interarea apsacline, vertically striate. Delthyrium broad, apical angle 68°. Cardinal extremities mucronate, pointed. Ventral sinus indistinctly defined. Internally, dental plates short, divergent anteriorly. Muscle area longitudinally sub-oval; adductors attached to medially disposed broad and low platform. Diductor scars fibrous. Pallial markings consist of a) radial sinuses which thicken anteriorly and are more prominent, b) concentric sinuses crossing the first, these seem to be present only in the posterior region of the shell.

Discussion: In the absence of external characters comparison with any known species of *Choristites* is not possible.

Occurrence and range: Known from locality 1, Uralian.

Subfamily SPIRIFERINAE King, 1846

Genus *Neospirifer* Fredericks, 1924

Genotype: *Spirifer fasciger* Keyserling, 1846.

Diagnosis: Spiriferoid shell with fasciculate ribs and concentric imbricating growth lamellae.

Stratigraphic range: Middle Carboniferous to Permian.

Discussion: *Neospirifer* differs from its antecedent, *Spirifer striatus*, the type species of the genus *Spirifer* because of its bundled ribs. Internal characters of the latter species are unknown. Specimens of *Neospirifer* in the material studied show varying characters of the dental plates: in some they are reduced flanges and do not continue anteriorly along the shell inner surface, in others they do so enclosing the posterior part of the muscle scars. It is possible that the genera *Spirifer* and *Neospirifer* are polyphyletic and the stocks of each show a convergence in external characters remaining different internally in the respective groups.

In the specimen of *Neospirifer* sp. the muscle scars are excellently preserved (Pl. IX, fig. 1—2; text-fig. 18). In other specimens of the genus these scars though not well preserved, their pattern however, seems basically to be the same.

Neospirifer contracta (IVANOV & IVANOVA, 1937)
(Pl. IX, figs. 3—6; text-figs. 19, 20)

? 1900 *Spirifer fasciger* — SCHELLWIEN, p. 70—71, Pl. X, fig. 1 (non cet.).
1937 *Neospirifer tegulatus* var. *contracta* IVANOV & IVANOVA, p. 43, Pl. II, fig. 5 (non cet.).

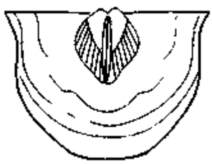


Fig. 18

Fig. 19

Figs. 18, 19. Respectively, *Neospirifer* sp., showing muscle scars of the pedicle valve, × 1, and *Neospirifer contracta* (IVANOV et IVANOVA) showing cardinal process of the brachial valve. × 3.5.

Locus typicus: Medvedka River, Russia.

Stratum typicum: Uralian.

Material: Several ventral and dorsal valves, represented by external and composite moulds.

Measurements in mm:

	Ventral valve		Brachial valve
Length	48	32	29
Width	54	38	49

Description: Large triangular shell widest at the hinge. Cardinal extremities sharply angular. Pedicle valve weakly convex. In the nepionic stage the shell is highly transverse, width exceeding twice the length. In advanced ontogeny, growth takes place mainly in the anterior direction particularly in the sinal region. The last, feebly produced in the nepionic stage, becomes later highly projected into a triangular tongue at the anterior margin. Interarea broad, apsacline, divided longitudinally by a distinct line into a ventral part which is curved triangular and a rectangular, wider (tr.) dorsal part. Both these parts crossed by parallel lines of growth and vertical striae. Beak scarcely projecting beyond interarea, highly incurved. Delthyrium varies considerably in size, apical part covered by lamellae of deltidium. The entire surface is sculptured by an extremely fine grill made up of finer, angular imbricating lamellae of growth and relatively larger (tr.) sub-rounded radial costae. Latter fasciculate to form 2—3 prominent lateral plications leaving space for more at outer margins. These costellae arise by the repeated furcation of nearly 8 primary costellae present at the beak or near to hinge, the secondary costellae furcating also in turn (fig. 20).

In the pedicle interior, the short dental lamellae rest upon the floor of the palintrope but do not continue anteriorly. In their extention from hinge to palintrope they tend to approach each other at mid valve depth but then deflect to reach the shell inner surface more distant from each other than the distance between the teeth. Muscle scars longitudinally sub-oval; adductors as narrow bands, were attached to a thin medial

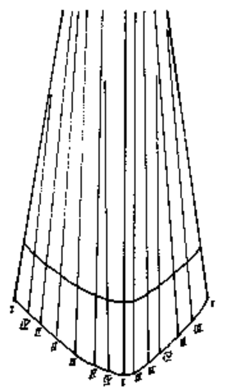


Fig. 20

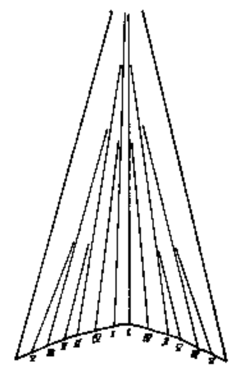


Fig. 21

Figs. 20, 21. Respectively, *Neospirifer contracta* (IVANOV et IVANOVA) showing costellation of ventral sinus, and *Neospirifer aff. tegulatus* (TRAUTSCHOLD) showing costellation of the dorsal fold. × 3.5.

myophragm. Diductors considerably expanded transversely at midlength. Ovarian markings deeply impressed on the lateral sides of the dental lamellae to about half hinge length. These are present on both the sides of the muscle scars anteriorly.

Brachial valve almost plane, excepting highly arched medial angular fold. The fold is narrow posteriorly but widens rapidly in anterior direction. Interarea rectangular, orthocline, lineated longitudinally and transversely. Beak feebly developed, neither projecting beyond hinge nor incurved.

In the brachial interior, the anteriorly diverging hinge plates bound the broad, low, vertically incised cardinal process. Some 25 incisions were counted on the figured specimen (text-fig. 19). Transversely oval dental sockets situated at the antero-outer ends of the hinge plates, to the latter of which the crural plates were attached.

D i s c u s s i o n: IVANOV & IVANOVA, 1937 separated the subspecies *contracta* from *N. tegulatus* (TRAUTSCHOLD, 1876) because of its "strongly longitudinal constriction and transversal elongation". In addition to such constricted forms they included in this subspecies also forms with the cardinal extremities highly produced beyond the lateral commissure to form lance like mucro. These latter forms are assigned to *N. lanceolatus* n. sp.

Distribution and range: Middle Carboniferous to Upper Carboniferous. Moscow basin; Upper Carboniferous and Permian? Carnic Alps. Now found at localities 1 and 2.

Neospirifer aff. *tegulatus* (TRAUTSCHOLD, 1876)

(Pl. IX, figs. 7—8; text-fig. 21)

1876 *Spirifer tegulatus* TRAUTSCHOLD, p. 354, Pl. XXXV, fig. 6.
1927 *Spirifer cameratus* — HERITSCH, p. 310, Pl. II, fig. 1—2.
1932 *Spirifer cameratus* — RAKUSZ, p. 71, Pl. III, figs. 15—17, 19.
1936 *Neospirifer fasciger* — METZ, Pl. VII, figs. 1—2.

Material: Several specimens of moulds of separate ventral and brachial valves.

Diagnosis: Shell considerably wider than long. Cardinal extremities angular. Dental plates in the ventral interior continue only a short way along shell inner surface.

Measurements in mm:

	Ventral valve	Brachial valve
Width	61	51
Length	43	26

Description: The following differences from *N. contractus* may be noted: Pedicle valve: Shell broad triangular. Hinge appreciably wider than shell length. Cardinal extremities subtend larger angle. Beak projecting not as far beyond interarea, not incurved. Sinus not as well developed. Lateral plications more pronounced, number at least 3 leaving more space on the outer margins. Here the costae do not seem to bundle. Interiorly, dental plates extend shortly along shell surface.

Brachial valve: The fold probably lesser arched.

Discussion: In *Neospirifer* the internal anatomy has seldom been accorded distinctive significance at any taxic level. Two groups are distinguishable on the basis of the development of dental plates. IVANOV & IVANOVA, 1937 figured serial sections of several species of *Neospirifer*. For *N. tegulatus contractus* only the section along the apical region has been given whereas *N. tegulatus* has been illustrated by three consecutive sections cut at increasing distances from the apex showing that the dental plates continue anteriorly. As a result the former sub-species is characterised by reduced dental plates. The group of specimens under consideration thus is related to *N. tegulatus* more than to *N. contractus*. To the first, it also shows greater morphological resemblence.

From *N. fasciger* KEYSERLING it differs in more transverse outline and more angular cardinal extremities.

Neospirifer lanceolatus n. sp.

(Pl. IX, figs. 9—10; text-figs. 22 a, b)

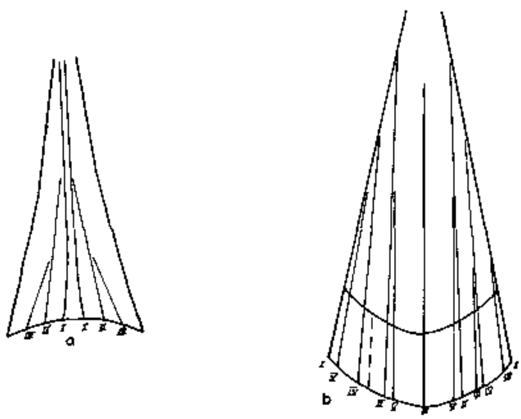
1937 *Neospirifer tegulatus* var. *contractus* IVANOV & IVANOVA, p. 188, Pl. II, fig. 6 (non cet.).

Derivatio nominis: After the shape of mucro.

Holotype: External mould of a pedicle valve. Pl. IX, fig. 9 (GPIBo. 66).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.



Figs. 22 a, b. *Neospirifer lanceolatus* n. sp. showing respectively costellation of the ventral sinus and the dorsal fold. × 3.5.

Material: Ventral and dorsal valve as external and composite moulds respectively.

Diagnosis: Cardinal extremities extending laterally into lance like mucro.

Measurements in mm:

	Holotype Pedicle valve	Brachial valve
Length	?	11
Width	64	33

Description: Pedicle valve moderately convex, highly extended at hinge without which the outline is sub-triangular. Mucro long and pointed. Umbo rapidly attenuating posteriorly. Beak projecting well beyond hinge line, highly incurved. Sulcus originates at the beak, here narrow and well defined becoming much wider and ill defined at the anterior margin. Lateral ribs 2, distinct, these at the anterior margin and those following outwards, indistinct. Surface sculpture as in figure 22. Pedicle interior unknown.

Brachial valve: Similar as in *N. contractus.*

C o m p a r i s o n: *N. fasciger* — SCHELLWIEN, 1900, Pl. X, fig. 3 has similar mucro but the outline is different.

D i s c u s s i o n: Slender cardinal extremities of this species project highly beyond lateral commissure. Thus unsupported, they are likely to give way easily. Their preservation therefore is not more than incidental. The tendency, however, to build long mucro in some stocks of *Neospirifer* does not seem to be unusual.

O c c u r r e n c e and range: Moscow basin: Mjatschkovian to Uralian. It has now been discovered at locality 2.

Genus *Plicatocyrtia* n. gen.

G e n o t y p e: *Spirifer zitteli* SCHELLWIEN, 1892, p. 48, Pl. IV, fig. 6. Geol. Palaeontol. Inst. Halle.

D i a g n o s i s: Spiriferoid shell. Ventral sinus smooth or with very fine striae. Dorsal fold plicate; plications on the flanks occasionally dichotomising.

S t r a t i g r a p h i c r a n g e: Uralian.

D i s c u s s i o n: *Licharewia* EINOR, 1939 and *Permospirifer* KULIKOV, 1950 are related genera in which the sinus and the fold are smooth or very slightly striate.

Internal structure of *Plicatocyrtia* unknown; sure assignment to a family impossible at the present.

Plicatocyrtia zitteli (SCHELLWIEN, 1892)
(Pl. II, figs. 10—12)

1892 *Spirifer zitteli* SCHELLWIEN, p. 48, Pl. IV, fig. 8.

L o c u s t y p i c u s: Below Garnitzenhöhe, Carnic Alps.

S t r a t u m t y p i c u m: Spirifer Bed, Uralian.

M a t e r i a l: A composite mould of a dorsal valve.

M e a s u r e m e n t s in mm:

Brachial valve:

Length	19
Width	36

D e s c r i p t i o n: Brachial valve: Wider than long. Interarea well developed, rectangular, orthocline to low apsacline, probably only transversely lineated; longitudinal portion near hinge notched at regular intervals. The notching does not seem to be denticulation as the notches are ventrally disposed. Umbo projecting feebly beyond hinge. Beak rounded, not incurved. Cardinal extremities pointed, drawn into small mucro. In early growth stages shell strongly transversely sub-elliptical. After the end of ephebic stage growth takes place only in longitudinal direction. Fold narrow posteriorly, about as wide at anterior commissure as half hinge length. Surface plicate. Fold traversed longitudinally by two lateral grooves and a medial groove, latter present at anterior half length. Lateral plications prominent, separated by well defined grooves which are less wider than the plications, number 9 on each side of fold.

Internally low cardinal process striate, the striae number 12, bounded laterally by slight hinge plates, to antero-outer ends of latter are attached anteriorly diverging crural plates.

Distribution and range: Carnic Alps: Garnitzenhöhe, Spirifer bed. Now found at locality 2.

Family Martiniidae WAAGEN, 1883

Genus *Martinia* M'COY, 1844

Genotype: *Spirifer decora* PHILLIPS = *Anomites glabra* MARTIN, 1809.

Diagnosis: Shell exopuncate, smooth or slightly costellate. Widest at the hinge or slightly anteriorly. Dental ridges short, just reaching the inner shell surface but not continuing anteriorly. Radial pallial markings on the inner surface of the shells of both valves.

Discussion: WAAGEN, 1883 separated from *Martinia* M'COY such forms, e. g. *Martiniopsis* which possess long dental plates and a median septum in the ventral valve. LEIDHOLD, 1928 in a paper on Rhenic Givetian fauna tried first of all to show that *Martiniopsis* is a synonym of *Martinia*. For this he assumed that M'COY had erected *Martinia* using the form of *Anomites glabra* MARTIN which was transverse in outline and possessed long dental plates and a median septum. He then erected the *Pseudomartinia* for longitudinally oval members without dental plates and a median septum. In the later pages of this paper he pointed out however, that these characters were not constant, "the behaviour of the dental plates is completely changing", "I am of the opinion that *Martinia*, *Martiniopsis* and the improvised genus *Pseudomartinia* should be dropped". For reasons unknown, later authors accepted *Pseudomartinia* to which the species, until then ascribed to *Martinia*, were transferred.

The presence or absence of the dental plates and the median septum do not obey the outline of the shell and are unknown in the genotype. *Martiniopsis* is thus a legitimate genus and *Pseudomartinia* a synonym of *Martinia*.

Martinia karawanica VOLGIN, 1959

(Pl. XII, figs. 10—13; text-fig. 23)

1892 *Martinia* cf. *glabra* — SCHELLWIEN, p. 41, Pl. VI, figs. 14—15.
1931 *Martinia* cf. *glabra* — HERITSCH, p. 31, Pl. II, figs. 46—48, 51—54.
1959 *Martinia karawanica* VOLGIN, p. 122, Pl. IV, figs. 8—10.

Material: Moulds of pedicle and brachial valves.

Measurements in mm:

Ventral valve:	
maximum width	36
hinge width	28
length along curvature	35
Brachial valve:	
length (same specimen)	29

Description: Shell transversely sub-oval, wider than long; widest at almost mid-valve length. Hinge shorter than maximum width. Ventral valve more convex than the dorsal valve. Umbo thick, projects considerably beyond hinge. Beak pointed, incurved. Delthyrium broad, apical angle 78°. Interarea unknown. Sinus feebly developed. Shell surface traversed by fine radial costellae. In the ventral interior, massive dental flanges continue to the tip of the beak. Shell inner surface marked by radial pallial trunks.

Brachial valve convex at the mid-posterior region. Anterior margin of the shell surface crossed by concentric lirae and furcating radial lirae. Interiorly cardinal process not projecting beyond interarea, striate. The cardinal process is enclosed laterally between hinge plates which recurve to form a hook with the bent dental ridges of the ventral interior. Crural plates attached along the convex under surface of the inner hinge plates. Last diverge anteriorly (text-fig. 23). Apical callosity present. Inner shell surface crossed by radial pallial markings.

Comparison: From *Martinia glabra* this species differs in its feeble ventral sinus and low convexity.

Distribution and range: Russia: Uralian; Karawanken and the Carnic Alps: probably only Uralian. Now collected at the localities 1 and 6.

Martinia aff. *parvula* TSCHERNYSCHEW, 1902

(Pl. VIII, fig. 8; Pl. IX, fig. 11; text-fig. 24)

Material: Internal mould of a ventral valve.

Measurements in mm:

Width	Length
27	37

D e s c r i p t i o n: Outline longitudinally sub-oval, widest slightly anterior to hinge. Umbo projecting highly beyond hinge, tapering gradually to rounded incurved beak. Sinus distinct. Internally, massive dental flanges subtend over 90° angle at the apex. A medial ridge extends from posterior sub-umbonal region to the posterior termination of the muscle field, here the former joins an anteriorly broadening narrow and smooth surface extending to more than half valve length. Diductor muscle scars longitudinally sub-oval, situated considerably anterior to beak, divided into posterior and anterior parts. Posterior diductors rhombic. Both fibrous. Adductors occupy the place mentioned previously as the smooth area, but unlike most brachiopods they seem to be much longer, exceeding

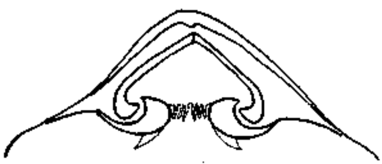


Fig. 23

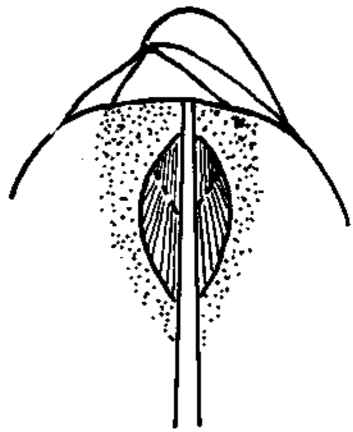


Fig. 24

Figs. 23, 24. Respectively, *Martinia karawanica Volgin* showing ventral dental flanges and brachial cardinalia, × 3, and *Martinia aff. parvula* (TSCHERNYSCHEW) showing muscle scars and the ovarian markings of the ventral valve. × 4.

diductors in length. Ovarian impressions extend anteriorly beyond the diductors. Pallial trunks faint and straight radial lines.

D i s c u s s i o n: *M. parvula* represents a remarkable variation in outline, certain specimens being highly longitudinally sub-oval, others being less so. Features of distinction from other species of *Martinia* lie in greater length than width and highly arched and keel shaped medial part of the ventral valve. *M. parvula* differs from *M. carinthica* SCHELLWIEN, 1892 in its larger size and indistinct ventral sinus.

D i s t r i b u t i o n and range: Russia, Lower Permian. Now discovered at locality 2.

Martinia aff. *uralica* TCHERNYSCHEW, 1902

(Pl. VII, figs. 8—9)

M a t e r i a l: Two composite moulds of ventral valves.

Measurements in mm:

Width	37	27
Length	43	32?

Description: Following differences from *M.* aff. *parvula* may be noted: Shell slightly longer than wide, widest near hinge. Cardinal extremities slightly obtuse. Umbo tumid, tapering posteriorly rather rapidly. Interarea triangular, high apsacline. Sinus indistinct posteriorly, assumes the form of a shallow basin with steep and low sides at the anterior margin. In the interior, muscle scars situated farther posteriorly, the smooth medial area of *M.* aff. *parvula* represented here by distinct platform for adductors attachment. Diductors do not seem to be differentiated. Pallial- and ovarian markings unknown.

Distribution and range: Russia, Lower Permian. Now found at localities 1 and 2.

Superfamily ORTHOTETACEA Williams, 1953

Diagnosis: Strophomenoids without a functional pedicle. Pedicle valve usually modified by cementation to a foreign body. Cardinal process bilobed.

Stratigraphic range: Upper Ordovician to ? Triassic.

Classification: Present classification of Orthotetacea is puzzling. The first higher taxonomic rank of subfamily level, the Orthotetinae Waagen, 1884 was born full of inherent misconceptions. Waagen's genus *Orthotetes* on which the Orthotetinae was based had to be replaced by *Schuchertella* because "the group which Waagen discriminated under the name Orthotetes became anonymous" (Girty, 1908, p. 196). On erecting *Orthotetes* Waagen had misinterpreted a ventral valve for the dorsal one. But Orthotetinae and later Orthotetidae became established. Besides, Schuchertellidae with type genus *Schuchertella* was also created in recent times.

To a proposal to base the classification on ventral septalia Prof. A. Williams (personal communication) remarked "I don't think one can use socket plates with greater impunity than the disposition of dental plates", — "nearly all the morphological features have come into being repeatedly and independently of allied stocks". In the present investigation the following classification has been adopted (table see page 62).

In the above attempt it might seem at the first instance, that the median septum has been accorded greater importance over dental plates. This is however only partly true as two families have been entirely based on the dental plates alone. In the third family however, the median septum has a greater significance. If only two families were to be recognised one with reduced dental plates and the other in which the dental plates are longer, *Derbyia* and *Orthotetes*, which are closely related forms, had to be placed in different families as was the case up to the present. The presence of the median septum is, moreover, a feature of higher organisation in as much as it provides greater strength to musculature. The above classification demanded a complete recasting of genera. Because of the inavailability of some of the literature on this group the stratigraphic ranges of families and subfamilies might undergo a change.

Phylogeny: Lines of evolution of and within the Orthotetacea are difficult to reconstruct. Reference in this connection may be made to the works of Dunbar and Condra, 1932; Stehli, 1954; Sokolskaja, 1954.

With a slow rate of evolution in early Palaeozoic times, they developed at an accelerated rate at the turn of Devonian/Lower Carboniferous and later in Upper Carboniferous Permian times. It was at the first accelerated evolution that most of the genera including almost all those studied during the present investigation evolved, with an accompanying straightening of dental plates, acquisition of median septum, formation of spondylium, increase in height of the cardinal area etc. During the second accelerated evolution the ventral beak became still higher and the shell surface became plicated. The adaptation of these stocks was little different from some other brachiopod groups, e. g. Strophalosiacea, which lived at the same time.

In the following table distinguishing characters of the genera studied during present investigation have been summed up:

	with median septum		without median septum	
	Dental lamellae:		Dental lamellae:	
	reduced:	short, form spondylium:	reduced:	long, do not form spondylium:
Nonplicate	*Derbyia*	*Orthotetes*	*Streptorhynchus*	*Pulsia*
Plicate				*Meekella*

In order to avoid repetition, some of the common characters of Orthotetacea are discussed below:

1. Shell substance: Imperforate shell substance studded with taleole. When the latter are dissolved away the calcite rods become replaced by sediment and those rods can be observed on the moulds. The inner shell surface bore probably sub-erect bristles which have the appearance of fine tubes on the inner moulds.

2. Ventral valve: Cardinal area: The ventral cardinal area is mostly high in all the species here described. It is apsacline to catacline, in certain cases rather anteriorly recurved. True height and inclination of the cardinal area however, cannot be determined because most of the specimens are pressed flat.

The ventral cardinal area is differentiated into a) Pseudodeltidium: arched and showing no evidence of foramen, bears strong concentric growth lines, b) Pre-deltidial region: Outside of pseudodeltidium, triangular, bearing transverse and vertical striations and c) Area outside of pre-deltidium, bears only transverse lineation (cf. DUNBAR & CONDRA, 1932).

Family SCHUCHERTELLIDAE WILLIAMS, 1953

Diagnosis: Orthotetacea with reduced dental lamellae becoming obsolete towards apex; median septum absent.

Stratigraphic range: Ordovician ? — Permian.

Discussion: This family with a long range from Upper Ordovician to Permian exhibits a slow rate of evolution. In stratigraphically younger forms, the pedicle valve became a deep cone and the brachial valve opercular: a departure from the ancestral biconvex condition. The cardinal process in the brachial interior also became higher with the advance of time. Since these differences are of degree, Streptorhynchynae STEHLI, 1954, to which these advanced forms were assigned, appears to be unwarranted.

Genus *Streptorhyncus* KING, 1850

Genotype: *Terebratulites pelargonatus* SCHLOTHEIM, 1816.

Stratigraphic range: Lower Carboniferous to Permian.

Diagnosis: Non-plicate Schuchertellidae, without brachial interarea.

Comparison: *Streptorhyncus* differs from *Diplanus* STEHLI, 1954 by the absence of interarea in the brachial valve; from *Kiangsiella* GRABAU & CHAO, 1927 in the absence of plications.

Streptorhyncus reliquus, n. sp.

(Pl. XI, figs. 10, 13; Pl. XII, figs. 6—9)

1892 *Orthotetes semiplanus* — SCHELLWIEN, p. 31, Pl. VI, fig. 6—9.

Derivatio nominis: reliquus (lat.) -the remnant: pertaining to the primitive character of the cardinal process in this species.

Holotype: Composite mould of a pedicle valve. Pl. XII, figs. 8 and 9 (GPIBo. 88).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several moulds of separate or partly articulated brachial and ventral valves.

Diagnosis: Shell surface concentrically even. Cardinal process low.

Measurements in mm:

Ventral valve:

Length	27	22	24	22
Width	27	22	26	18

Superfamily ORTHOTETACEA WILLIAMS, 1953				
ORTHOTETIDAE WAAGEN, 1884 Dental plates reduced to long, median septum present.		SCHELLWIENELLIDAE n. fam. Dental plates long, median septum absent.		SCHUCHERTELLIDAE WILLIAMS, 1953 Dental plates obsolete, median septum absent.
ORTHOTETINAE WAAGEN, 1884	DERBYIINAE STEHLI, 1954	SCHELL-WIENELLINAE n. subfam.	ORTHOTETININAE n. subfam.	
Reduced to long dental plates form spondylium on joining the median septum.	Reduced dental plates reach shell inner surface outside the median septum and do not continue anteriorly.	Dental plates free at their inner edges.	Dental plates coalesce to form spondylium.	
Orthotetes FISCHER, 1850 *Orthotetella* R. E. KING, 1930 *Ombonia* CANEVA, 1906	*Derbyia* WAAGEN, 1884 *Derbyiaconcha* LICHAREW, 1934 *Derbyoides* DUNBAR & CONDRA, 1932 *Licharewiella* SOKOLSKAJA, 1960 *Plicatoderbyia* THOMAS, 1937 *Grabauellina* LICHAREW, 1934	*Pulsia* IVANOV, 1926 *Meekella* WHITE & St. JOHN, 1867 *Schellwienella* THOMAS, 1910	*Orthotetina* SCHELLWIEN, 1889 *Geyerella* SCHELLWIEN, 1900	*Schuchertella* GIRTY, 1904 *Tapajotia* DRESSER, 1954 *Fardenia* LAMONT, 1935 *Streptorhyncus*, KING, 1850 *Diplanus* STEHLI, 1954 *Kiangsiella* GRABAU & CHAO, 1927

Brachial valve:		
Length	16	29
Width	18	33

Description: Sub-semicircular to transversely sub-oval shell, nearly as long as wide, widest anterior to hinge line. Pedicle valve (crushed in all the specimens) much larger than the brachial. Interarea triangular, in one specimen one-third as high as the shell length, commonly relatively lower. Beak occasionally recurved in ventro-anterior direction and twisted. Shoulders slope evenly to cardinal extremities but may be occasionally concave. Pseudodeltidium strongly convex, narrow and high, base one-fifth the hinge length, apical angle 20—25°. Predeltidium shorter than the cardinal area outside it. Cardinal extremities obtuse. Surface concentrically even. Radial costellae multiply anteriorly by intercalation, larger (tr.) than the striae separating them, number 20 at anterior commissure. Concentric lirae slight. Interiorly dental lamellae reduced to flanges, becoming weaker towards the apex.

Brachial valve low, without interarea. Sculpture as in the pedicle valve. Interiorly, poorly preserved cardinal process low, appears to be trilobed in posterior view. Crural plates recurved posteriorly at outer ends.

Discussion: Posteriorly trilobed ? cardinal process would prevent a relation with *Streptorhynchus*. Absence of median septum and reduced dental lamellae in the ventral interior and the attachment of the shell with beak are however definite criteria allowing assignation to this genus.

Distribution and range: Carnic Alps: Garnitzenhöhe, Krone ranch: Spirifer bed. Now discovered at localities 1 and 2.

Subfamily Orthotetinae WAAGEN, 1884

Diagnosis: Orthotetacea with dental lamellae and long median septum. The dental lamellae may be long or reduced to sub-umbonal flanges and may or may not join the median septum.

Stratigraphic range: Middle Carboniferous to Permian.

Subfamily *Orthotetinae* WAAGEN, 1884

Diagnosis: The dental lamellae in the ventral interior form a spondylium on joining the median septum.

Stratigraphic range: Upper Carboniferous to Permian.

Genus *Orthotetes* FISCHER, 1829

Genotype: *Orthotetes radiata* FISCHER, 1850.

Diagnosis: Short dental lamellae forming sub-umbonal spondylium.

Stratigraphic range: Middle Carboniferous to Permian.

D i s c u s s i o n: Genus *Orthotetes* is readily distinguishable from Orthotetella and Umbonia owing to a deep and long conical spondylium in the last two genera.

Regarding muscle scars a great inconsistency prevails in the two genera Orthotetes and Derbyia WAAGEN. *Orthotetes radiata* possesses bell shaped and O. *regularis* — SOKOLSKAJA, 1954 (Pl. XV, fig. 3) (= ? D. *regularis*) circular muscle scars. Similarly, *Derbyia metzi* n. sp. represents the second and *D. expansa* SCHELLWIEN the first type. Thorough revision of these two genera is necessary before a satisfactory solution is found.

Orthotetes plana (IVANOV, 1926)

(Pl. XIII, figs. 1—2)

1926 *Derbyia plana* IVANOV, p. 170.
? 1936 *Derbyia grandis* — METZ, p. 167, Pl. V, figs. 1—2.
1954 *Orthotetes plana* — SOKOLSKAJA, p. 149, Pl. XVI, figs. 1—6.

M a t e r i a l: Several moulds of pedicle valves.

M e a s u r e m e n t s in mm:

Ventral valve:

Length	56	59
Width	79	89

D e s c r i p t i o n: Large shell of sub-circular outline, almost flat, wider than long. Interarea triangular, moderately high. Deltidium slightly convex, nearly as broad as high, apical angle nearly 50°. Cardinal extremities rectangular, may occasionally be drawn into small mucro. Nepionic shell sub-circular to longitudinally sub-oval, first in the late ephebic stage it becomes more transverse. Surface sculpture consists of radial costellae and concentric lirae. Former angular, multiplying anteriorly by repeated intercalations at irregular intervals from the beak. Concentric lirae may occasionally imbricate.

Interior: short dental plates form small sub-umbonal spondylium on joining the median septum. Last thin and high, longer than one-third valve length. Muscle scars bell shaped.

D i s c u s s i o n: The differences between O. *plana* and O. *radiata* are based probably only on statistical variation: The co-efficient of width/length and absolute size of O. *radiata* being smaller. SOKOLSKAJA, 1954 has shown that there are hardly any specimens of the latter species which attain a length or width over 50 mm, whereas the specimens of O. *plana* are far larger. O. *radiata* is confined to the Middle Carboniferous.

D i s t r i b u t i o n and range: Russian platform; Upper Moscovian to Uralian. Now found at locality 1.

Subfamily Derbyiinae STEHLI, 1954

D i a g n o s i s: Dental lamellae highly reduced, reach shell inner surface outside of median septum and do not continue anteriorly.

S t r a t i g r a p h i c r a n g e: Middle Carboniferous to Permian.

Genus *Derbyia* WAAGEN, 1884 (emend. GIRTY, 1908)

G e n o t y p e: *Derbyia regularis* WAAGEN, 1884.

D i a g n o s i s: Mostly large, non plicate Derbyiinae.

S t r a t i g r a p h i c r a n g e: Upper Carboniferous to Permian.

D i s c u s s i o n: WAAGEN, 1884 distinguished two groups within his genus *Derbyia,* namely camerati and septati based on the characters of ventral interior. In the camerati group he placed such forms in which the dental plates join the median septum to form a spondylium. In septati the reduced plates reach the shell inner surface outside the median septum without continuing along it anteriorly. WAAGEN did not designate a genotype. HALL & CLARKE, 1892 chose *Derbyia regularis* WAAGEN, 1884 as the type species of the genus. This species represents the division septati of WAAGEN. The group camerati is a synonym of *Orthotetes* FISCHER, 1829.

From inner mould alone, distinction between *Derbyia* and *Orthotetes* is rendered difficult particularly when the dental plates in the latter are much smaller or when they terminate not far from the median septum in *Derbyia.*

Derbyia expansa SCHELLWIEN, 1892

(Pl. X, figs. 1—4; text-fig. 25)

1892 *Derbyia expansa* SCHELLWIEN, p. 34, Pl. VI, figs. 1—3.
1905 *Derbyia grandis* — DEREGNY & GORTANI, p. 535, Pl. XIV, fig. 2.

T y p u s: SCHELLWIEN's types have been lost. Neotype needs to be established.

L o c u s t y p i c u s: Garnitzenhöhe.

S t r a t u m t y p i c u m: Spirifer bed, Uralian.

M a t e r i a l: Several composite moulds of separate ventral- and dorsal valves.

D i a g n o s i s: Large shell with longitudinally semioval outline.

M e a s u r e m e n t s in mm:

Ventral valve:

Width	102
Length	76

D e s c r i p t i o n: Plano-convex, longitudinally semioval shell, widest at the hinge. Pedicle valve slightly swollen at the umbo. Interarea rectangular, loosing height outwards very gradually. Pseudodeltidium posteriorly convex with a medial longitudinal depression exteriorly and corresponding fold at interior surface. Cardinal extremities pointed, feebly acute. Surface sculpture consists of a) concentric varices of growth, b) fine concentric- and c) radial lirae. The concentric varices are less longitudinal in early growth stages. Later the shell growth takes place mainly in this direction. Concentric lirae impart the appearance of very finely woven net on crossing the radial lirae. Latter angular, multiply anteriorly probably only by intercalation, number 17 in 1 cm space at anterior. In the pedicle interior, dental flanges are short and massive. Median septum curved in the interior view, highest anteriorly, extends to one-fourth valve length. Muscle field large, bell shaped, crennulate at anterior margin. Diductor scars flabellate. Adductors were probably attached to median septum.

Brachial valve moderately convex. Interarea probably absent. Internally, short bilobed cardinal process spoon shaped in anterior view and with a medial ridge; posteriorly the two lobes medially incised. Crural plates anteriorly highly divergent.

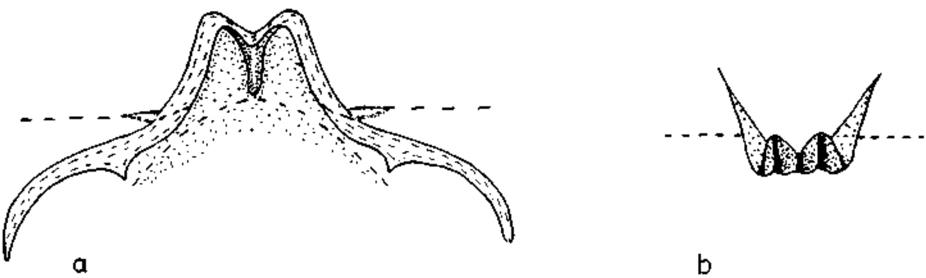


Fig. 25

Fig. 26

Figs. 25, 26. Respectively, *Derbyia expansa* (SCHELLWIEN) and *Derbyia multicostellatus* n. sp. showing cardinal process and crural plates: a) anterior view, b) posterior view. × 4.5.

D i s c u s s i o n: The fragmentary specimen of the brachial valve has been alloted to this species on the basis of the course of growth varices.

The outline is the major distinguishing character which is not possessed by any other known *Derbyia*.

D i s t r i b u t i o n and range: Garnitzenhöhe, Spirifer bed. Now discovered at locality 1.

Derbyia waageni SCHELLWIEN, 1892

(Pl. XI, figs. 1—8)

1892 *Derbyia waageni* SCHELLWIEN, p. 32, Pl. VI, figs. 4—5.
? 1927 *Derbyia altestriata* — HERITSCH, p. 300, Pl. III, fig. 7.
1936 *Derbyia acutiplicata* METZ, p. 168, Pl. V, fig. 4.
1936 *Derbyia waageni* — METZ, p. 166, Pl. V, fig. 3.

Neotype: SCHELLWIEN did not designate a holotype. His types have been lost. Neotype must be established.

Locus typicus: Krone ranch, Italy.

Stratum typicum: Spirifer bed, Uralian.

Material: Several moulds of ventral- and brachial valves separate and articulated.

Diagnosis: Small to medium size shell of rectangular to sub-quadratic outline.

Measurements in mm:

Ventral valve:								
Length	21	22	24	14	21	19	11	14
Width	25	24	24	17	23	32	10.5	14
Brachial valve:								
Length	19	31	14					
Width	28	34	18					

Description: Plano-convex small to medium size shell of rectangular to sub-quadratic outline, widest at the hinge. Pedicle valve may occasionally have indistinct resupinate longitudinal profile or may be feebly convex in postero-lateral portion. Due probably to crushing, mostly flat. Cardinal area triangular, in younger specimens one-third as high as wide and beak is mostly twisted in one direction or the other in wake of attachment. In well grown specimens the cardinal area relatively much lower and beak scarcely twisted. Cardinal extremities generally rectangular but may be slightly obtuse to insignificantly mucronate. Pseudodeltidium strongly convex posteriorly, base length equals nearly one-sixth hinge length, apical angle 30—60°; each side of perideltidial area slightly less longer than the adjacent lateral area. Interiorly, median septum hidden at posterior portion beneath apical callosity, extends anteriorly to nearly one-fifth valve length. Dental flanges strongly impressed on both sides of the deltidium. Adductor scars lanceolate. Diductors not known with certainty.

Brachial valve occasionally sinuate, most of the specimens pressed flat, only a few show moderate convexity. Interiorly, bilobate cardinal process similar, though, to that in *N. expansa,* differs in the absence of the medial ridge in anterior view and the divergent socket plates which are highly curved in *N. expansa* are now nearly straight.

Surface of both the valves sculptured with radial- and concentric lirae, former multiply anteriorly by intercalation so that between a pair of prominent lirae only one secondary lira is present. Concentric lirae number approximately 20 in 1 cm space at anterior commissure.

Discussion: Median septum in the brachial valve referred by SCHELLWIEN has not been observed in any of the present specimens. It was probably only the thickening of the shell substance at the medial part.

Comparison: *N. crassa* (MEEK & HAYDEN) presents striking resemblance. Remarkable also is the ubiquitous occurrence of these forms in the strata of almost same age. Differences however, lie in the pattern of radial lirae which fasciculate in the American forms.

Occurrence and range: Krone ranch, Italy: Uralian. Now collected at localities 1, 6 and 8.

Derbyia multicostellatus n. sp.

(Pl. III, fig. 7; Pl. IV, fig. 7; Pl. X, figs. 5—6 Pl. XI, figs. 14—16; text-fig. 26)

Derivatio nominis: After prolific costellae on the shell surface.

Holotype: External and composite moulds of a ventral valve. Pl. III, fig. 7; Pl. IV, fig. 7; Pl. XI, fig. 14 (GPIBo. 71).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several composite and external moulds and a specimen of a composite mould in which both the valves are articulated.

Diagnosis: Radial costellae characterised by pronounced multiplication in one or more growth stages.

Measurements in mm:

Ventral valve:				
		Holotype		
Length	35	52	36	60
Width	52	72	42	100
Dorsal valve:				
Length		25	22	
Width		40	32	

Description: Large convexo-concave shell of sub-rectangular outline with rounded antero-lateral commissure; widest at the hinge. Pedicle valve less arched than the dorsal, about one and a half times wider than long. Cardinal area poorly preserved. Beak high. Cardinal extremities rectangular. Characters of outline and costellation in various growth stages of the holotype are as follows:

Nepionic stage: Shell transversely sub-oval, primary costellae predominating. Interspace wider than the costellae.

Neanic stage: Shell semicircular to transversely sub-oval. Interspace between a pair of costellae occupied by 3—5 lirae the medial one of which gets thicker in an anterior direction, others die out at next growth stage. At the anterior margin about 50 costellae and lirae are present of which 12—13 belong to the former group.[7])

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[7]) This pattern is called parvicostellate (SCHUCHERT and COOPER, 1932).

Ephebic stage: Shell rectangular to sub-circular, costellation simple, i. e. between a pair of costellae only one intercalating lira present.

Gerontic stage: Shell more longitudinal than in the ephebic stage. In terms of costellation the animal reverts to its neanic habit, the intercalations being again prolific.

In other specimens variations have been observed e. g. the exuberent costellae multiplication may be attained in the nepionic stage alone or the nepionic, neanic and ephebic growth stages. Concentric lirae concentrated mostly in bands, absent from some portion of the shell or are very widely spaced.

In the pedicle interior, heavy dental flanges become obsolete before reaching the median septum; latter much thicker posteriorly, probably the thicker portion is the apical callosity and that the median septum was covered beneath it. The median septum extends 1/3—1/5 of the valve length anteriorly. Muscle scars probably transversely sub-oval in outline.

Brachial valve highly convex particularly at the posterior-medial portion. Sculpture as in the pedicle valve. Interiorly cardinal process bears medial ridge in anterior view, bilobate, posteriorly these two lobes are subdivided by weak longitudinal grooves. Crural plates shorter than in other species of Derbyia here discussed. Dorsal muscle field incompletely preserved but appears to be similar to that in *Pulsia mosquensis* described later.

Comparison: This species might be mistaken for *Orthotetes regularis* but the convexity of the shell and surface sculpture distinguish the two forms.

Occurrence and range: Known from the type locality and type stratum.

Derbyia metzi n. sp.

(Pl. XI, figs. 9, 11 and 12)

Derivatio nominis: In honour of Prof. METZ (Graz) who first described this faunal assemblage in 1936.

Holotype: Outer and inner mould of a ventral valve. Pl. XI, figs. 11—12 (GPIBo. 74).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several composite moulds of valves separate articulated.

Diagnosis: Shell of medium to large size, outline more than a semicircle. In smaller specimens length exceeds width whereas the well grown specimens are as long as three quarters the width.

M e a s u r e m e n t s in mm:

	Holotype				
Ventral valve:					
Length	48	24	10	31	belong together
Width	64	32	11	43	belong together
Brachial valve:					
Length	28			39	belong together
Width	36			43	belong together

D e s c r i p t i o n: Convexo-plane, sub-circular shell wider than long, widest at the hinge. Pedicle valve almost flat, but relatively well arched at postero-medial portion. Interarea triangular. Pseudodeltidium posteriorly arched, marked with deep transverse growth lines, apical angle nearly 70°. Beak less high than deltidial base length. Predeltidial area less long than the cardinal area outside it. Cardinal extremities rectangular to insignificantly obtuse. In a smaller specimen lateral commissure curves slightly inwards in a posterior direction so that the maximum width appears to lie at the mid-valve length. In advanced growth stages the shell grows considerably though in the axial direction, the absolute transverse growth is higher, thus shifting the coefficient of growth in favour of width. Sub-rounded radial costellae number 15 at beak; in a medium size specimens 19—20, in larger 12—14 at anterior commissure in 1 cm space. Concentric filae wavy, spread regularly over entire shell surface. Internally, circular muscle field covers more than one-third the shell area. Adductors lanceolate, extend anteriorly beyond median septum. Diductors much larger, flabellate, ropy with smooth posterior portion. Median septum is a broad massive ridge, half as long as the diductor scars, its posterior termination hidden beneath thick apical callosity. Dental flanges become obsolete before reaching umbonal surface, in one specimen they clearly do it.

Brachial valve relatively more arched, possesses narrow and distinct interarea. Internally, the cardinal process anteriorly bilobate with the medial ridge more thickened; posteriorly the two lobes are medially incised; short socket plates are less divergent.

D i s c u s s i o n: The type of muscle scars as found in *N. metzi* conjoint with shorter median septum have not been observed in other species of the genus. The bell-shaped muscle scars of *N. expansa* are clearly different to those in the species under discussion. It is however interesting to note that great variation of muscle scars and length of median septum prevails within the genus.

C o m p a r i s o n: From *N. waageni* this species differs in attaining a larger size and circular outline. *D. multicostellatus* is subquadratic and has a ventral median septum comparatively longer and the costellation different.

O c c u r r e n c e and range: Known from the type locality and type stratum only.

Family SCHELLWIENELLIDAE n. fam.

Diagnosis: Orthotetacea with strong dental plates in the ventral interior which may or may not form a spondylium. Median septum absent.

Stratigraphic range: Devonian to Permian.

Subfamily Schellwienellinae n. subfam.

Diagnosis: Schellwienellidae in which the dental plates do not form a spondylium.

Stratigraphic range: Devonian to Permian.

Genus *Pulsia* IVANOV, 1926

Genotype: *Pulsia mosquensis* IVANOV, 1926.

Diagnosis: Non-plicate Schellwienellinae with long, sub-parallel dental plates enclosing shovel-like muscle scars.

Stratigraphic range: Upper Visean to Lower Uralian.

Discussion: It appears that the genus *Pulsia* arose from *Schellwienella* THOMAS, 1910 with modifications affecting the characters of ventral valve. Interiorly, highly divergent dental plates of *Schellwienella* became sub-parallel, rather curving in the axial direction near anterior termination. In certain conservative stocks however, they may still be slightly divergent anteriorly but never to such an extent as in *Schellwienella*. Little is known regarding the function of this modified adaptation. Externally, cardinal area apparently became higher and more erect attaining further development in this direction as in the internally similar, plicate genus *Meekella*.

Pulsia mosquensis IVANOV, 1926

(Pl. XII, figs. 1—5; Pl. XIII, fig. 4)

1926 *Pulsia mosquensis* IVANOV, p. 172.
1954 *Schellwienella (Pulsia) mosquensis* — SOKOLSKAJA, p. 133, Pl. XII, figs. 6—7; Pl. XIII, fig. 9.

Material: Several composite moulds of pedicle valves and a fragmentory inner mould of a brachial valve.

Diagnosis: Shell large, sub-circular in outline.

Measurements in mm:

Ventral valve:					
Width	63	61	48	80	64
Length	54	46	36	53	54

D e s c r i p t i o n: Large convexo-plane sub-circular shell, wider than long, widest at the hinge in well grown or slightly anterior to it in smaller specimens. Pedicle valve rather flat. Interarea (crushed in most of the specimens) triangular. Pseudodeltidium posteriorly convex, marked with concentric growth lines, narrow, base length equal to height, apical angle nearly 60°. Cardinal extremities rectangular, insignificantly mucronate or even obtuse. Radial costellae narrow and angular, wide spaced, number 9—11 in 1 cm space at anterior margin. Concentric lirae very slight. In early growth stages the length equals or even exceeds width: this feature is however not constant as in some specimens the early shell appears to be transversely sub-oval. Interiorly teeth pointed, supported by long and massive dental plates. Latter one-third as long as the valve length, subparallel, mostly incurved before anterior termination: in one specimen however, they diverge rather strongly. Muscle scars large, shovel-like, enclosed between the dental plates. The adductors were probably attached to a thin myophragm running in the middle of the muscle scars.

Brachial valve strongly convex at posterior three-quarters shell length, nearly flat at anterior margin. Interiorly, cardinal process incompletely preserved, with anterior medial ridge. Socket plates short and massive, diverging slightly in an anterior direction. Adductors pentagonal, posterior adductors short, probably dendritic, anterior adductors large and fibrous. Muscle scars traversed medially for three-quarter posterior length by a low, rounded ridge which yields place anteriorly to a longitudinal depression. Latter with a thin medial ridge.

C o m p a r i s o n: Smaller specimens of the species are likely to be mistaken for *P. janischewskii* SOKOLSKAJA, 1952 which has a much shorter hinge length than the maximum width, and never attains the large size as is common with *P. mosquensis.*

D i s t r i b u t i o n and range: Russian platform: Upper Moscovian to Lower Uralian. Now collected from the locality 1.

Pulsia linguaeformis n. sp.

(Pl. XIII, fig. 3)

D e r i v a t i o n o m i n i s: Linguae formis (lat.), tongue-shaped; pertains to shell outline.

H o l o t y p e A composite mould of a ventral valve. Pl. XIII, fig. 3 (GPIBo. 86).

L o c u s t y p i c u s: Locality 2.

S t r a t u m t y p i c u m: Uralian.

M a t e r i a l: Two composite moulds of ventral valves.

D i a g n o s i s: Large shell with anterior commissure produced.

M e a s u r e m e n t s in mm:

Ventral valve:

	Holotype	
Length	51	67
Width	70	70

D i s c u s s i o n: The two specimens available display considerable variability in length/width ratio. The holotype is three-quarters longer than wide, whereas in the second specimen this relation is almost 1 : 1. Since the holotype is a pathologic one, it is likely that the growth was arrested in the longitudinal direction. At the left anterior portion, signs of injury and repair are exhibited by the deflected course of the costellae. Poor preservation hardly allows an exact study of costellation. It is however probable that the costellation is not different from that found in *Derbyia multicostellatus* n. sp. In all other details this species resembles *P. mosquensis* excepting the prominent projection of the anterior commissure. It is extremely interesting that a similar development is witnessed in *Derbyia cardiformis* IVANOV, 1926 which lived almost at the same time.

O c c u r r e n c e and range: Known from the type locality and the type stratum.

Pulsia ? undecimus (HERITSCH, 1931)

(Pl. X, fig. 7)

1931 *Streptorhyncus undecimus* HERITSCH, p. 7, Pl. I, figs. 35—37.

M a t e r i a l: A composite mould of a ventral valve.

M e a s u r e m e n t s in mm:

Ventral valve:	Length	Maximum width
	18	18

D i s c u s s i o n: HERITSCH's assignation of this species to the genus *Streptorhyncus* is unwarranted, as its ventral interior is characterised by long dental lamellae. The last seem to join each other posteriorly not unlike that in the Spiriferacea genus *Choristites*, but are sub-parallel anteriorly. It is owing to the last named character that this species has been placed conditionally with *Pulsia*. Actually it seems to represent some unknown genus whose erection is still impossible owing to inadequate material. It differs from *Orthotetina* because of the posterior and not anterior confluence of the dental lamellae.

HERITSCH's description of the species needs emendation: Triangular shell widest near anterior margin. Longitudinal curve falls off rather rapidly in the anterior half. Radial costellae appear to increase by intercalation, fewer and larger (tr.) posteriorly they are closely spaced and finer at anterior half where they number over 30 in 1 cm space.

O c c u r r e n c e and range: Vellachtal, Karawanken: Uralian. Now collected at locality 1.

Genus *Meekella* WHITE & ST. JOHN, 1867

Genotype: *Plicatula striatocostata* COX, 1857.

Diagnosis: Schellwienellinae in which the shell is plicate.

Stratigraphic range: Lower Carboniferous to Permian.

Meekella depressa SCHELLWIEN, 1900
(Pl. X, fig. 9)

1900 *Meekella depressa* SCHELLWIEN, p. 23, Pl. III, figs. 3—4.

Material: A composite mould of a ventral valve.

Measurements in mm:

Length	14
Width (maximum)	23
Width (hinge)	12

Description: Irregular sub-pentagonal shell wider than long, maximum width at the anterior margin. Hinge half as long as the maximum width. Interarea catacline, moderately high. Pseudodeltidium moderately convex, base little less than half hinge length. Predeltidial area shorter than the cardinal area outside it. Shell surface irregularly plicate at anterior one-third: two antero-lateral plications originate more posteriorly than the other, in all number 8. Radial lirae extremely fine. Interiorly, dental plates extend anteriorly along inner shell surface for less than one-third posterior valve length.

Comparison: It differs from *M. exima* (EICHWALD) in its irregular outline and the plications originating more anteriorly.

Occurrence and range: Trogkofel, Austria: Permian. Now collected at locality 2.

Superfamily PRODUCTACEA WAAGEN, 1883
Family LINOPRODUCTIDAE STEHLI, 1954
Subfamily Linoproductinae STEHLI, 1954
Genus *Linoproductus* CHAO, 1927

Genotype: *Productus cora* D'ORBIGNY, 1842.

Diagnosis: Pedicle valve convex, non-geniculate. Brachial valve highly geniculate at the front; rugae crossing visceral disc; without spines; cardinal process trilobate.

Stratigraphic range: Upper Carboniferous (Pennsylvanian) to Permian.

Linoproductus cora (D'ORBIGNY, 1842)

(Pl. XIV, figs. 1—5)

1842 *Productus cora* D'ORBIGNY, p. 55, Pl. V, figs. 8—10.
1914 *Productus cora* — KOZLOWSKI, p. 48, Pl. IV, fig. 19; Pl. V, fig. 5; Pl. VI, figs. 1—10.
1933 *Cora schellwieni* FREDERICKS, p. 32.
1935 *Linoproductus cora* var. *tschernyschewi* IVANOV, Pl. V, fig. 1, 2, 4, 5, 7—9; Pl. VII, fig. 8.

Material: Several moulds of mostly separate valves.

Diagnosis: Shell rounded sub-quadrate in outline, highly convex pedicle valve weakly sinuate medianly. 2—5 spines scattered irregularly over pedicle valve surface.

Description: Concavo-convex shell of medium to large size, wider than long, maximum width at hinge. Pedicle valve highly convex, medianly weakly sulcate. Umbo tapering posteriorly, overarching hinge, incurved. Ears bearing several arches. Flanks mostly spreading. Sculpture of sinuous costellae, new intercalating, number about 20 in 1 cm space at anterior margin. Spines along hinge probably in one row, 2—5 scattered irregularly over venter. In the pedicle interior: Diductors large, longitudinally striate. Adductors more posteriorly placed, posterior adductors larger than anterior, latter inwards migrated, both dendritic. Surface of internal mould papillose.

Brachial valve strongly geniculated, trail short, visceral disc slightly concave, medially weakly arched. Ears large, traversed by strong rugae which on crossing the visceral disc become weaker. Diaphragm unknown. Spines absent. Interiorly, cardinal process sessile, bilobate? in anterior view, posteriorly trilobate. Breviseptum as long as the length of the visceral disc. Diductor scars placed just anterior to lateral ridges, each like a rounded cone with apex directed outwards, dendritic. Lateral ridges short, sub-parallel to hinge, their half inner length transversely incised at posterior margin.

Discussion: *L. cora* has a world wide distribution. Slight differences from S. American (the type area) forms are therefore natural. The specimens in the present collecting are slightly wider and the sinus and fold more accentuated. *L. cora tschernyschewi* IVANOV cannot be accepted as it is founded only on larger dimensions.

Distribution and range: Russia: Middle Carboniferous to Permian; S. America: Lower Permian. Now found at localities 1, 2 and 8.

Linoproductus kentrometopon n. sp.

(Pl. XIV, figs. 6—8)

Derivatio nominis: Pertains to the presence of a row of spines at the anterior margin. Kentron (Gr.) = spine, metopon (Gr.) = forehead.

Holotype: Composite mould of a pedicle valve. Pl. XIV, figs. 6—8 (GPIBo. 96).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several specimens of moulds.

Distinguishing characters: This species closely resembles *L. cora*, but differs in the presence of a transverse row of 2—3 spines near anterior margin of the pedicle valve. *L. nodosus* (NEWBERRY, 1861) is distinct in its row of nodes along the medial line.

Occurrence and range: Known from the type locality and the type stratum.

Linoproductus coralineatus IVANOV, 1935

(Pl. XIII, figs. 5—7)

1935 *Linoproductus cora-lineatus* IVANOV, p. 132, Pl. VII, figs. 1—4.
1952 *Linoproductus cora-lineatus* — SARYCHEVA and SOKOLSKAJA, p. 115, Pl. XXI, fig. 148.

Material: Two complete specimens preserved as moulds.

Diagnosis: Brachial valve with long visceral disc and relatively shorter but highly spreading trail.

Description: Plan to concavo-convex shell of large size, subpentagonal in outline, wider than long, maximum width at anterior margin. Pedicle valve moderately convex, slightly geniculated anteriorly where it is strongly expanded. Umbo tapering posteriorly, projecting considerably beyond hinge, incurved. Ears large, traversed by rugae. Median sinus a broad undulation, disappearing anteriorly. Costellae rounded, number about 15 in 1 cm space at anterior margin, striae separating them larger. Spines along hinge and irregularly scattered over shell surface. Rugae not continuing on the venter. Interior unknown.

Brachial valve highly geniculate, visceral disc weakly concave. Rugae cross entire surface of the visceral disc. Trail highly spreading. Costellae as in the pedicle valve. Spines absent. Interiorly, cardinal process sessile, anteriorly with two lobes, posteriorly trilobed. Median septum as long as the visceral disc.

Comparison: *L. coralineatus* differs from *L. lineatus* in its spreading trail, presence of sinus and in the absence of spines on the brachial valve.

Distribution and range: Moscow basin: Uralian to Permian. Now collected at localities 1 and 2.

Linoproductus neffedievi (VERNEUIL, 1845)

(Pl. XIV, figs. 10—12)

1845 *Productus neffedievi* VERNEUIL, p. 259, Pl. XVIII, fig. 11.
1935 *Linoproductus neffedievi* — IVANOV, p. 42, Pl. VIII, figs. 4—7.
1952 *Linoproductus neffedievi* SARYCHEVA & SOKOLSKAJA, p. 113, Pl. XXI, fig. 146.

M a t e r i a l : Several moulds of ventral valves.

D i a g n o s i s : Shell longitudinally elongate, with indistinct ventral sinus.

D e s c r i p t i o n : Large shell of longitudinal subrectangular outline, longer than wide, widest at hinge. Pedicle valve geniculated with highly convex visceral disc and slightly curved, weakly sulcate trail. Umbo massive, projecting highly beyond hinge, extremely incurved. Ears prominent, triangular. Flanks steep. Sculptured with rounded, irregular costellae which bend around the spines, number 13 in 1 cm space at anterior margin. Suberect spines scattered over valve, number about 6, a row of about 4 prostrate to suberect spines along hinge on each side and along ridges on ears. Interior unknown.

Brachial valve unknown. Posterior portion of cardinal process preserved with a pedicle valve, former trilobate in posterior view.

C o m p a r i s o n : From *L. coralineatus* this species differs in its highly overarching umbo, long curved trail and shorter ears. From *L. lineatus* in its feebler sinus and somewhat expanding trail.

D i s t r i b u t i o n and range: Moscow basin: Upper Mjatschkovian to Uralian. Now collected at locality 1.

Linoproductus ovalis Ivanov, 1935
(Pl. XIII, fig. 8; Pl. XIV, fig. 9)

1905 *Productus cora* var nov. Stuckenberg, p. 72, Pl. VIII, fig. 5.
1935 *Linoproductus ovalis* Ivanov, p. 106, Pl. VI, figs. 5—6.
1952 *Linoproductus ovalis* — Sarycheva & Sokolskaja, p. 115, Pl. XXI, fig. 148.

M a t e r i a l : Several moulds of pedicle and brachial valves.

D i a g n o s i s : Outline longitudinally sub-oval, ventral sinus and dorsal fold absent.

D e s c r i p t i o n: This species differs from *L. neffedievi* in the following points: Pedicle valve not geniculated, not sulcate, slightly convex. Umbo weakly developed, incurved slightly beyond hinge. Two rows of spines along hinge, the posterior row appears to terminate before reaching the cardinal extremities. Spines on surface fewer, number not more than three. Brachial valve geniculated anteriorly. Spines absent. Interiorly, cardinal process sessile, in anterior view bilobate, posterior portion not preserved. Median septum short, about one-third as long as the valve.

C o m p a r i s o n: Ivanov 1935 summarised the points differentiating this species from other *Linoproductus* as follows: from *L. cora* and *L. coralineatus* by its outline; from *L. lineatus* Waagen and *L. neffedievi* by the absence of sinus and tapering lateral sides.

D i s t r i b u t i o n and range: Moscow basin: Upper Carboniferous. Now collected at localities 1 and 2.

Family ECHINOCONCHIDAE Stehli, 1954

Subfamily Echinoconchinae Stehli, 1954

Discussion: The subfamily was proposed by Muir-Wood & Cooper but had to bear the name of Stehli as he was the first to propose the family name. They included 7 genera in this subfamily of which the five were new. Almost all these genera have been separated from the genus *Echinoconchus*, Weller, 1914. During investigation of present material on the group, certain difficulties appeared which forced to use the original diagnosis of certain genera in a restricted sense. For example, anteriorly imbricating concentric lamellae which should characterise *Calliprotonia* Muir-Wood & Cooper, 1960 alone, have been witnessed now in the specimens of Echinaria Muir-Wood & Cooper, 1960. In *Echinaria* as well as in *Calliprotonia* anteriorly closely placed lamellae bearing one spine row are also present. Furthermore the *Echinaria* are not always longitudinally elongate. Thus the differences between *Echinaria* and *Calliprotonia* are housed only in the internal morphology especially in the lateral ridges which extend only along the lateral margin of the shell in *Echinaria*.

Genus *Echinaria* Muir-Wood & Cooper, 1960

Genotype: *Productus semipunctatus* Shepard, 1838.

Diagnosis: Shell elongate oval to transversely oval. Concentric bands non-lamellose to lamellose. Spines mostly of 3 series. Anteriorly closely placed lamellae bearing only one spine row may be present. Lateral ridges in the brachial interior extend along hinge only.

Stratigraphic range: Upper Carboniferous (Pennsylvanian) to Permian.

Echinaria longa n. sp.

(Pl. XV, figs. 9—10; Pl. XVI, figs. 1—2)

Holotype: Composite mould of a complete specimen. Pl. 16, figs. 1—2 (GPIBo. 104).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several specimens of composite and outer moulds of both valves articulated and separate.

Diagnosis: Shell highly elongate. Anterior part of pedicle exterior with lamellae bearing one row of spines. Brachial valve without a fold and with extremely elevated adductors.

Description: Shell large, longitudinally sub-oval in outline, widest at the anterior margin. Pedicle valve moderately convex, medianly sulcate, tapering posteriorly into highly incurved umbo which projects considerably beyond hinge. The latter much shorter than maximum width which lies slightly behind the anterior commissure. Flanks of venter steep. Ears poorly developed (or probably not preserved). Surface sculpture with lamellose concentric bands crossing the entire shell surface, decrease in width anteriorly. Spines prostrate, located on the concentric bands: on posterior bands of two series and widerspread; on anterior bands of three series, smaller and narrowly spaced; of one series on few narrower bands near anterior margin.

Brachial valve moderately convex, medial fold absent, postero-lateral slopes steep. Concentric bands much narrower than those of the pedicle valve but of uniform size throughout. Spine pattern probably same as in the pedicle valve. Interiorly, the median septum extends for half shell length. Posteriorly thin and low, it is a high massive ridge anterior to muscle scars, supports the shaft of the cardinal process. The shaft is dorsally recurved: myophore massive, lobation unknown. Shaft extending shortly before hinge, tapering anteriorly. Adductors very prominent, anteriorly highly raised: posterior scars dendritic, anterior scars probably smooth. Lateral ridges short, sub-parallel to hinge.

D i s c u s s i o n: The poorly preserved myophore of the cardinal process reveals no lobation either in the anterior or posterior view. This is not an original character as the myophore characteristic of the genus has been observed in the specimens of this species from Karawanken.

From *E. semipunctatus* SHEPARD, 1938. *E. longa* n. sp. differs in its greater length and shorter hinge line and the anterior thickening of the median septum. From the above named and *E. moori* DUNBAR & CONDRA, 1932 in the absence of brachial medial fold.

O c c u r r e n c e a n d r a n g e: Known from the type locality and the type stratum.

Echinaria sp.
(Pl. XV, fig. 8)

M a t e r i a l: Two inner moulds of a brachial and a pedicle valve.

D i a g n o s i s: Shell sub-circular in outline; concentric bands on the pedicle surface very narrow. The spines form a dense brush at the anterior margin.

D e s c r i p t i o n: Following points of difference from *E. longa* n. sp. may be noted:

Shell sub-circular in outline, wider than long, widest slightly anterior to hinge. Pedicle valve weakly convex, median sulcus wider and shallower. Flanks of venter descend gradually to ears, latter not well demarcated; concentric bands lamellose, widest medially, relatively narrower at posterior and anterior margins. Spines very closely spaced anteriorly where they form a dense brush.

Brachial valve plan to insignificantly concave with a weak medial fold. Lamellose concentric bands as in the pedicle valve, but wider. Median septum longer than half shell length. Brachial ridges probably also longer. Myophragm of the cardinal process smooth in ventral view.

Comparison: This species differs from all other known *Echinaria* in its sub-rounded outline, greater width, width and distribution of concentric bands and density of spines.

Distribution and range: Zoellner ridge, locality 1. Uralian.

Family BUXTONIIDAE MUIR-WOOD & COOPER, 1960
Subfamily Buxtoniinae MUIR-WOOD & COOPER, 1960
Genus *Buxtonia* THOMAS, 1914, emend. MUIR-WOOD, 1928

Genotype: *Productus scabriculus* J. SOWERBY, 1814.

Diagnosis: Shell costate with fine bands on trail. The bands with minute prostrate spines. Cardinal process anteriorly bilobate and trilobate posteriorly. Median septum with antron.

Stratigraphic range: Upper Devonian to Upper Carboniferous.

Buxtonia ? transversalis n. sp.
(Pl. XVI, figs. 3—9)

Holotype: Composite mould of a complete shell with external mould of the brachial valve. Pl. XVI, figs. 3—6, 9 (GPIBo. 112).

Locus typicus: Zoellner ridge, locality 1.

Stratum typicum: Uralian.

Material: Several inner and outer moulds of ventral and brachial valves separate and articulated.

Diagnosis: Highly transverse shell. Pedicle valve with long visceral disc and short trail.

Measurements in mm:

Brachial valve:

Length (in the horizontal plan)	38	34
Width (hinge)	69	57

Description: Large concavo-convex shell, transversely sub-rectangular in outline, widest at the hinge. Pedicle valve weakly convex, tapering posteriorly into a massive umbo which projects slightly beyond the hinge but not incurved. This valve geniculated anteriorly, visceral disc long, almost plan, traversed medianly by a wide and shallow sulcus. Trail very short. Sculpture consists of radial costae and concentric rugae. The last crossing entire venter surface medially. Spines of larger diameter present on the hinge and of smaller diameter on the concentric bands which are placed mostly anteriorly: one such band, 2 mm wide, runs along the anterior margin of the venter. The radial costae on crossing these bands become obsolete. Interiorly, adductor scars dendritic, enclosed laterally by large, obliquely striate, more anteriorly placed diductors.

Brachial valve weakly convex, geniculated. Trail short, recurved. Ears highly convex. Sculpture consisting of radial costae which are crossed at the posterior half of the venter by concentric costae giving to this part of the shell reticulate pattern. Spines present on the outer margins of ears. Wide band at the anterior margin of venter, as on the ventral valve, also present. Interiorly, cardinal process unsupported by median septum, there being no signs of buttress plates or antron. Myophore dorsally weakly recurved, bilobate anteriorly, posteriorly trilobate. Median septum slightly less longer than the valve length, highest anteriorly. Diductor scars longitudinally suboval, elevated anteriorly, dendritic. Endospines prostrate, radially arranged, present on the anterior margin only. Lateral ridges short, sub-parallel to the hinge.

Comparison: *B. scabricula* (cf. SARYCHEVA & SOKOLSKAJA, 1952, Pl. XVI, fig. 114) also possesses the broad band bearing minute spines near anterior margin, but differs from *B. transversalis* n. sp. in its longitudinal profile.

Discussion: Antron and buttress plates so characteristic of Buxtonidae, have not been observed. In another specimen which probably belongs to this species, antron is weakly developed. The endospines extend along the lateral margin as well, and the lateral ridges appear to be transversely lineate posteriorly.

Distribution and range: Known from the type locality and type stratum.

Subfamily Juresaniinae MUIR-WOOD & COOPER, 1960

Genus *Juresania* FREDERICKS, 1928

Genotype: *Productus juresanensis* TSCHERNYSCHEW, 1902.

Stratigraphic range: Uralian to Lower Permian.

Discussion: Internal characters of the type species are unknown. MUIR-WOOD & COOPER 1960 redefined the genus, the internal characters however were derived from *P. nebrascensis* OWEN, 1852 to which *J. juresanensis* is externally related. A specimen of a well preserved inner mould belonging to the genus is present in the present collecting. This shows somewhat different internal characters than possessed by *P. nebrascensis*. Since there is hardly any Carnic Upper Palaeozoic brachiopod genus which is not known from Russia, it is thought that the Carnic and the Russian members of this genus are more related to each other than the Russian and the American. Should the characters mentioned in the following be adequate to distinguish *J. jurasanensis* from *P. nebrascensis* the species grouped around the latter must be assigned to a new genus.

Definition: Spine ridges concentrically arranged, spines of one diameter posteriorly and of two diameters at the anterior margin. Cardinal process dorsally highly recurved, bilobate, without a third posterior lobe and the lateral lobes not incised at posterior face. The shaft is forked in front of lateral ridges The prongs of the shaft do not seem to enclose the posterior end of median septum, rather probably fuse with it (in the internal mould median septum is represented by a deep fissure which is posteriorly covered by sediment layer and seems to continue beneath it. Posteriorly this fissure is joined with the cavity caused by the dissolution of the ridge formed by the fusion of buttress plates at their anterior termination. Adductor scars rounded triangular, undifferentiated. Lateral ridges curved. Endospines prostrate, arranged on concentric bands.

Juresania juresanensis (TSCHERNYSCHEW, 1902)

(Pl. XV, figs. 1—4)

1902 *Productus juresanensis* TSCHERNYSCHEW, p. 620, Pl. XXIX, figs. 1—2; Pl. XLVII, figs. 1—2; Pl. LIII, fig. 4.

1952 *Buxtonia juresanensis* — SARYCHEVA & SOKOLSKAJA, p. 98, Pl. XVII, fig. 117.

Material: Two specimens preserved as moulds.

Description: Medium size shell of elongate sub-quadrate outline, widest anteriorly. Pedicle valve with highly convex visceral disc and slightly curved, medianly sulcate trail. Umbo massive, incurved, projecting slightly beyond hinge, probably truncated by cicatrix. Flanks steep, slightly diverging. Ears not preserved. Surface crossed by broad concentric bands which appear to be lamellose. Spine ridges arranged on these bands, of one diameter posteriorly, of two diameters near anterior margin. Interior unknown.

Brachial valve moderately concave, medianly slightly raised, posteriorly weakly geniculate. Interior as described while discussing the genus.

Remarks: Most of the specimens figured by TSCHERNYSCHEW lack concentric bands, but the specimen from Omphalotrochus-Horizont (Pl. XXIX, fig. 1) does possess them.

Comparison: Besides the different cardinal process, median septum, lateral ridges, *P. nebrascensis* has also different shape of muscle scars: they are differentiated into posterior dendritic adductors and smooth longitudinally oval, elevated anterior adductors.

Distribution and range: Moscow basin: Upper Moscovian to Uralian; Juresan River, Timan: Lower Permian (Schwagerina limestone). Now collected at locality 1.

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*) FAGERSTROM and BOELSTORFF, 1964 have shown that the cardinal process in *Juresania nebracensis* is highly variable.

FAGERSTROM, J. A. und BOELLSTORFF, J. D., 1964. Taxonomic criteria in the classification of the Pennsylvanian productid *Juresania nebrascensis*. Paleontology, 7, 1; 23—28; pl. 2.

Juresania subpunctata (NIKITIN, 1890)
(Pl. XV, figs. 5—7)

1890 *Productus subpunctata* NIKITIN, p. 58, Pl. I, figs. 5—6.
1952 *Buxtonia subpunctata* — SARYCHEVA & SOKOLSKAJA, p. 98, Pl. XVI, fig. 119.

Material: Several moulds of ventral valves.

Diagnosis: Shell transversely sub-quadrate. Rugae prominent on ears and posteriorly.

Description: Shell medium to large, transverse sub-quadrate in outline, widest at the hinge. Pedicle valve with highly convex visceral disc and curved, medianly sinuate trail. Umbo strongly incurved, projecting considerably beyond hinge. Flanks steep, parallel. Ears large; rugae prominent, narrow and closely spaced at ears, faint on the venter. Spine ridges extend from one concentric wrinkle to the following, occasionally overlapping the spine ridges of the next wrinkle, dense up the rugae on ears and hinge; near anterior margin spines of finer diameter interspersed between those of larger diameter; on smaller specimens finer spine ridges absent.

Remarks: Russian specimens seem to have rather regular longitudinal curve and are shorter for same breadth than the Carnic specimens.

Comparison: *J. juresanensis* is longitudinally elongate.

Occurrence and range: Moscow basin: Uralian to Lower Permian. Now collected at locality 1.

Family MARGINIFERIDAE STEHLI, 1954
Subfamily Marginiferinae STEHLI, 1954
Genus *Kozlowskia* FREDERICKS, 1933

Genotype: *Productus capicii* D'ORBIGNY, 1842.

Diagnosis: Small shell. Pedicle valve with row of spines along hinge and 6 halteroid spines on the surface. Interiorly, crenulated marginal ridge present, often extending around the valve.

Stratigraphic range: Upper Carboniferous (Pennsylvanian) to Permian.

Kozlowskia ? sp.

Material: Several specimens of external and internal moulds of the brachial valves with which the trails and occasionally cardinal region of the pedicle valve is preserved, and a composite mould of the pedicle valve.

Measurements in mm:

Brachial valve:

Hinge length	10	9	11
Length visceral disc	5	7	6
Length trail	2	3	3

Description: Shell small, rounded sub-quadrate in outline, widest at the hinge. Cardinal extremities drawn into pointed mucro in some specimens. Pedicle valve with convex visceral disc tapering posteriorly into incurved umbo overarching the hinge. Ears small. Trail short, medianly weakly sulcate. Sculpture of the visceral disc unknown, trail plicate. Spines on the hinge and on the shell surface. Interiorly, marginal ridge extending around front of the visceral disc; adductor scars longitudinally sub-oval, smooth; diductors unknown; surface of the visceral disc outside of the adductor scars capillate.

Brachial valve with weakly convex visceral disc and short trail. Disc sculptured with rugae which are indistinct medially. Trail plicate, the plicae continuing over the anterior margin of visceral disc where they reticulate with rugae. Interiorly, cardinal process sessile, myophore trilobate. Median septum extends anteriorly to half the length of the visceral disc. Adductor scars longitudinally sub-elliptical, anteriorly elevated. Endospines in rows in front of the median septum.

Discussion: The spine pattern of the investigated specimens is imperfectly known. Sure assignation to *Kozlowskia* is therefore impossible. Inavailability of the Russian literature on the genus has hindered the specific identification.

Occurrence: Found at the localities 1 and 2.

Summary of the Fauna

The faunal assemblage consists of Brachiopods, Trilobites, Lamellibranchs, Gastropods, Bryozoa, Crinoids and rarely Corals. The first two groups however, owing to their greater profusion and phylogenetic importance have been selected for special study.

TRILOBITA

Four new species of Trilobites, three from the main locality and one from Karawanken, are described. Whilst one of them belongs undoubtedly to the genus *Ditomopyge*, NEWELL, 1931, the others show features intermediate between *Ditomopyge* and *Pseudophillipsia*. They are however assigned to *Pseudophillipsia* GEMMELLARO, emend. In addition two species of the genus *Brachymetopus* from the Karawanken have been described elsewhere.

BRACHIOPODA

The brachiopods played the main role in the animal life inhabiting the Upper Carboniferous seas. In this collection alone, they are represented by 9 superfamilies.

It is difficult to establish which brachiopod superfamilies formed the largest group in the entire assemblage as the unsatisfactory preservation especially in the Productacea made collecting rather biased. This group however seems to be as large as Spiriferacea which is represented by as many as 17 species. The Rhynchoporacea and Lyttoniacea are the smallest superfamilies with one species each, followed by Punctospiracea with two species, Enteletacea and Isogrammacea with four species each. The Orthotetacea represented though by 10 species, seem however to have the largest number of specimens.

Lyttoniacea LICHAREW, 1960

The genus *Eolyttonia* FREDERICKS, 1923 has now been found in the Upper Carboniferous. One of the two species originates from the Karawanken and was made available by the courtesy of the Geological Institute Ljubljana. This species has been described elsewhere. The presence of highly organised Lyttoniacea in the Upper Carboniferous suggests that this group underwent a burst pattern of evolution.

Isogrammacea PAECKELMANN (*nom. transl.* herein)

The peculiar feature characterising the group is the presence of a smooth, transversely undulating, triangular area on the ventral exterior, extending from the umbo anteriorly.

The present discovery of different types of cardinalia, a feature which is rather conservative in the most related group Orthotetacea, and the plicated shell in one of the genera, *Megapleurina* COOPER, 1952, indicate that this group attained a sufficient specialisation within a short life time. For a phylogenetic investigation a comprehensive study of a greater amount of material would be essential.

Enteletacea LICHAREW and ALICHOW, 1960

The specimens of *Enteletes* FISCHER like the specimens of *Choristites* FISCHER possess shorter dental plates than the specimens of the genus from the Moscow basin.

The genus *Schizophoria* SCHUCHERT is represented by a single specimen of a ventral valve.

Spiriferinacea IVANOVA, 1960

The genera *Punctospirifer* NORTH and *Callispirina* FREDERICKS are represented by one species each. These genera however, do not seem to be well established, the differences being only of varying hinge length. Transitional cases are possible.

R h y n c h o p o r a c e a MOORE, 1952

The Rhynchoporacids are extremely rare in the collecting. *Rhynchopora grandirostris* (SCHELLWIEN) is the only species found.

S p i r i f e r a c e a IVANOVA, 1960

The genera *Brachythyrina* FREDERICKS, 1929 and *Choristites* FISCHER, 1825 which are profusely and widely distributed in the Russian Middle and Upper Carboniferous have been found to have a very large distribution in the Upper Carboniferous of the Carnic Alps. The Carnic specimens of *Brachythyrina* seem to be relatively larger and the dental plates in *Choristites* much shorter. These two features might have accrued from varied biotopes.

A new genus *Plicatocyrtia* has been proposed on the type specimen of *Spirifer zitteli* SCHELLWIEN, 1892. In contrast to *Licharewia* EINOR, 1939 and *Permospirifer* KULIKOV, 1950, related Permian Spiriferacea in which the fold and the sinus are smooth, *Plicatocyrtia* has smooth sinus and plicate fold.

O r t h o t e t a c e a WILLIAMS, 1953

The lines of evolution of this group cannot be reconstructed. A practical classification has thus been adopted in the present study. The present classification based mainly on the development of the dental plates, gives due importance to the median septum which appears to be a later acquisition. A complete recasting of the genera has been made assigning them to three families, one of which is new. Two subfamilies have also been proposed.

Pulsia ? undecimus (HERITSCH, 1931) appears to represent a new genus, whose erection is still impossible owing to indaquate material.

P r o d u c t a c e a WAAGEN, 1883

After the appearance of the comprehensive work on Productoidea by MUIR-WOOD & COOPER, the taxonomy of this group has become highly specialised. The work of these authors is based primarily on the silicified material in which the morphology is perfectly preserved. Owing to the poor preservation of the Productoid material in the present collecting and the inability to obtain most of the modern Russian literature, this group could not be thoroughly treated.

In the following some of the Productacids are mentioned which either, subject to preservation, could not be described, or for which a place in the known groups could not be found.

The genus *Alexania* IVANOVA, 1935 is probably present but true generic identification is impossible as in none of the specimens is the internal structure preserved. Should these specimens belong to *Alexania*, they might be assigned to *A. reticulata* IVANOV, 1935.

A specimen with dorsally recurved cardinal process and the spine bands at the anterior margin seems to belong to Buxtoniidae. But it possesses a gutter at the anterior margin. Such a gutter is unknown in the Buxtoniidae.

Another specimen which also appears to be a Buxtoniid has a diaphragm running around the front of the visceral disc.

The genus *Antiquatonia* MILORADOVICH, 1945 is also probably present.

C h o n e t o i d e a MUIR-WOOD, 1955

Neochonetes MUIR-WOOD, 1962 and *Chonetinella* RAMSBOTTOM, 1952 make their appearance. Because of almost entire absence of brachial valves in the present collecting their description must remain in abeyance for the present.

Relationship

The fauna studied exhibits a close relationship with the one from the Moscow basin. There is hardly any genus which is not common to both the regions. The carbonate facies was predominating in the Moscow region and the clastic in the Carnic Alps. This difference of biotopes lead to varying development of the species in certain cases.

The Upper Carboniferous fauna of the Karawanken though less well known, is probably in all essentials similar to contemporaneous Carnic fauna.

The following table shows the range of species common between the Russian Carboniferous and the Carnic fauna now investigated

	Middle Carboniferous, Moscovian					Upper Carboniferous, Uralian	
	Wereiskian C_2^v	Kaschirskian C_2^k	Podolskian C_2^p	Mjatschkovian $C_2^m n$	Mjatschkovian $C_2^m p$	Kasimovskian C_3^{ks}	Gschelian C_3^{gj}
Enteletes lamarckii FISCHER	.....	*	*	*		*	*
Pulsia mosquensis IVANOV	.....	.....	*	*		*	.....
Ortholetes plana IVANOV	.....	*	*	*		*	*
Juresania juresanensis (TSCHERNYSCHEW)	.....	.....	.....	.....	*	*	*
Juresania subpunctata (NIKITIN)	.....	.....	.....	.....	.....	*	*
Linoproductus neffedievi (VERNEUIL)	.....	*	*	*	*	*	.....
Linoproductus cora (ORBIGNY)	.....	.....	.....	.....	*	*	*
Linoproductus coralineatus IVANOV	.....	.....	.....	.....	*	*	*
Linoproductus ovalis IVANOV	.....	.....	.....	.....	.....	*	*
Neospirifer tegulatus (TRAUTSCHOLD)	.....	.....	*	*	*	*	*
Brachythyrina strangwaysi (VERNEUIL)	.....	.....	*	*	*	*	*
Brachythyrina jakovlevi IVAN.	.....	.....	*	*	*	.....	.....
Choristites mosquensis FISCHER	.....	*	*	*	*	*	.....
Martinia parvula TSCHERNYSCHEW	.....	.....	.....	.....	.....	.....	* ?
Martinia uralica TSCHERNYSCHEW	.....	.....	.....	.....	.....	.....	* ?
Martinia karawanica VOLGIN	.....	.....	.....	.....	.....	* ?	*

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Appendix 1

(cf. p. 17)

Specimens of *Paladin eichwaldi* — BOUCEK and PRIBYL, 1960, p. 35, pl. 7, fig. 1A; pl. 8, fig. 1A; pl. 9, figs. 1—4; pl. 10, figs. 1—2 (non FISCHER, 1825) appear to belong to several species of genera other than *Paladin*. Of present interest are the figures of the pygidium of „*Paladin eichwaldi*" (pl. 10, fig. 2) and of the cranidium on the right lower half of plate 7.

The pygidium shows resemblance to *Pseudophillipsia semicircularis* n. sp. in its outline, the trapezoidal transverse section of the axis, the relationship of post- and pre-annulus, the character of the pleural- and inter-pleural furrows, the border, and in the granulation especially of the axial rings. The only difference which would bar designation of this specimen to *Pseudophillipsia semicircularis n. sp.*, even to the genus *Pseudophillipsia*, is the smaller number of rings, viz. 15 (+ 1). On this reason alone, it shall have to be assigned to *Ditomopyge* (if *Cyphinium* WEBER, 1933 were to be considered a synonym of *Ditomopyge*). But a really sure designation would demand discovery of a cephalon and a pygidium in articulated position.

BOUCEK and PRIBYL have stated that the pygidium in discussion belongs to the same form as the cranidium previously mentioned (pl. 7). As far as one can derive from their diagrams, such a possibility is not established. However, the pear shaped glabella, complete isolation of 1p basal lobes from main part of glabella and the transgression of glabella over anterior border suggest an association with the line *Griffithides-Ditomopyge-Pseudophillipsia*. Of these three genera *Ditomopyge* would again be the best choice for various reasons. But this specimen is said to be deprived of a median preoccipital lobe.

Reference:

BOUCEK, B. and PRIBYL, A. (1960): Revision der Trilobiten aus dem Slowakischen Oberkarbon. Geologické Prací, Zpravy 20, 17—49, pls. 1—10. Bratislava.

Appendix 2

(cf. p. 4 and plate 17)

METZ (1936) considered the Weidegg-Beds to be overturned. The present author, for reasons given on pages 4—6 and those now constituting this appendix, does not subscribe to this opinion. The present reasoning is based on sedimentological investigation, namely the study of load-casts, their internal structure and the flame-structures.

The load-casts occur on the base of certain sandstone beds which form part of the sandstone-shale-quartzite sequence of the Lower Calc-poor beds (fig. 2). Undoubtedly, these beds have a normal contact with the Weidegg-Shale lying beneath. The load-casts are high, elongate, transversely sub-symmetrical bulges showing an indistinct N—S to NW—SE alignment. A section transverse and perpendicular to the load-cast bulges reveals that the stratum is not clearly graded because the lower part is not coarser than the middle. The lower surface is undulatory and sends off the finer material in form of projections at the top or flanks of the „anticlines". These projections, disposed almost perpendicular to the lower surface, cross the entire bed to the next upper finer surface and are twisted in an easterly direction in their upper reaches. In these projections probably the flame structures of WALTON, 1956 (cf. POTTER and PETTIJOHN, 1963), the mica plates are oriented parallel to the bounding walls of the projections. The mica plates immediately outside these structures show an orientation sub-parallel to the projection. This orientation vanishes gradually with increasing distance from the flame structure.

The troughs between the flame structures show an indistinct cross-lamination. The laminae disturbed at the margin, though, appear to have a general easterly dip.

As the load-casts result from an unequal loading of the sediment, they always occur at the base of a bed. Now they have been discovered on the lower surface of the sandstone investigated. Thus there hardly remains any doubt that the sequence is normal.

The original relief for the load-casts may have been formed by some sort of current action as the load-casts show an almost N—S alignment. This is substantiated by the fact that the flame structures have a direction perpendicular to the orientation direction of the load-casts.

The flame structures, as they are generally believed to be a result of current drag, give the direction of the current, namely from an approximately westerly to an easterly direction.

The cross-lamination is very indistinctly developed and the laminae are deformed during the process of load-casting. Any conclusion regarding the sedimentation direction on the ground of cross-lamination here must be highly speculative.

The above observations are made on very limited material and pertains to locality 1 (fig. 1) only. For inferences of paleogeographic import investigation of more material from wider area will be essential.

Reference:

POTTER, P. E., and PETTIJOHN, F. J. (1963): Paleocurrents and Basin Analysis. 1—296, Springer-Verlag, Berlin.

Plates 1—17

PLATE 1

Pseudophillipsia ogivalis n. sp.
Figures 1—7
(1—3) respectively plan, side and anterior view, × 1.5, holotype GPIBo. 1 (rubber replica of the external mould); (4) free cheek, × 1.5, paratype GPIBo. 2 (internal mould); (5) cephalon, × 1.5, paratype GPIBo. 3 (internal mould); (6—7) pygidium, respectively plan and posterior view, paratype GPIBo. 4 (internal mould).

Pseudophillipsia semicircularis n. sp.
Figures 8—13
(8, 9) cephalon rolled over the pygidium, respectively plan and side view, × 2.5, holotype GPIBo. 5 (internal mould); (10—12) pygidium, respectively plan, side and posterior view, × 2.5, paratype GPIBo. 6 (rubber replica of the external mould); (13) pygidium, plan, × 2, GPIBo. 7 (rubber replica of external mould).

Pseudophillipsia rakoveci n. sp.
Figures 14—17
(14) cephalon, plan, × 2, paratype GPIBo. 8 (internal mould); (15—17) Pygidium, respectively plan, side and posterior view, × 2, holotype GPIBo. 9 (internal mould).

Ditomopyge ovalis n. sp.
Figure 18
Pygidium, plan, × 1, holotype GPIBo. 10 (internal mould).

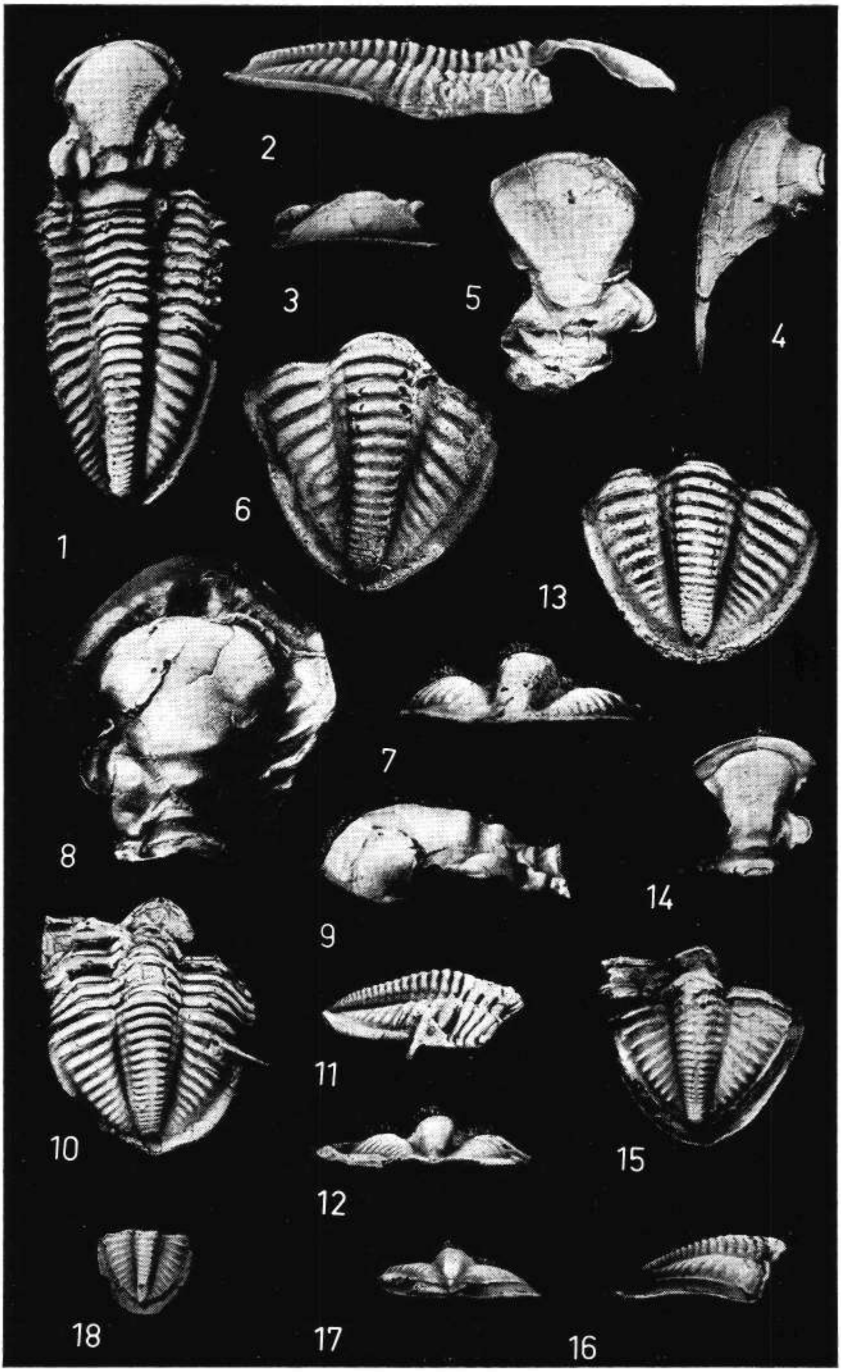
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PLATE 2

Ditomopyge ovalis n. sp.
Figures 1—3
Respectively plan, side and posterior view, × 2.5 (posterior view × 2), holotype GPIBo. 10 (rubber replica of external mould).

Paralyttonia transiens WANNER & SIEVERTS, 1935
Figure 4
interior view of ventral valve showing two muscle sheaths, × 7, original of WANNER & SIEVERTS, 1935, p. 210, Pl. VI, figs. 7 a, b, GPIBo. 2254, Permian (Basleo).

Eolyttonia carnica n. sp.
Figures 5—6
interior view of the ventral valve, (5) rubber replica of internal mould, (6) internal mould, × 3, holotype GPIBo. 11.

Isogramma expansum (DE REGNY & GORTANI, 1905)
Figures 7—9
external mould of a brachial valve with which the mould of the cardinal process of brachial interior and the cardinal area and umbo of the ventral valve are preserved, (7—8) plan and posterior view respectively, × 1, (9) rubber replica of the mould of cardinal process, × 2.5, GPIBo. 12.

Plicatocyrtia zitteli (SCHELLWIEN, 1892)
Figures 10—12
(10) plan view of a brachial valve, × 1, GPIBo. 57, (11, 12) plan view of dorsal and ventral valve, × 1, genotype: original of SCHELLWIEN, 1892, Geol. Pal. Inst. Halle.

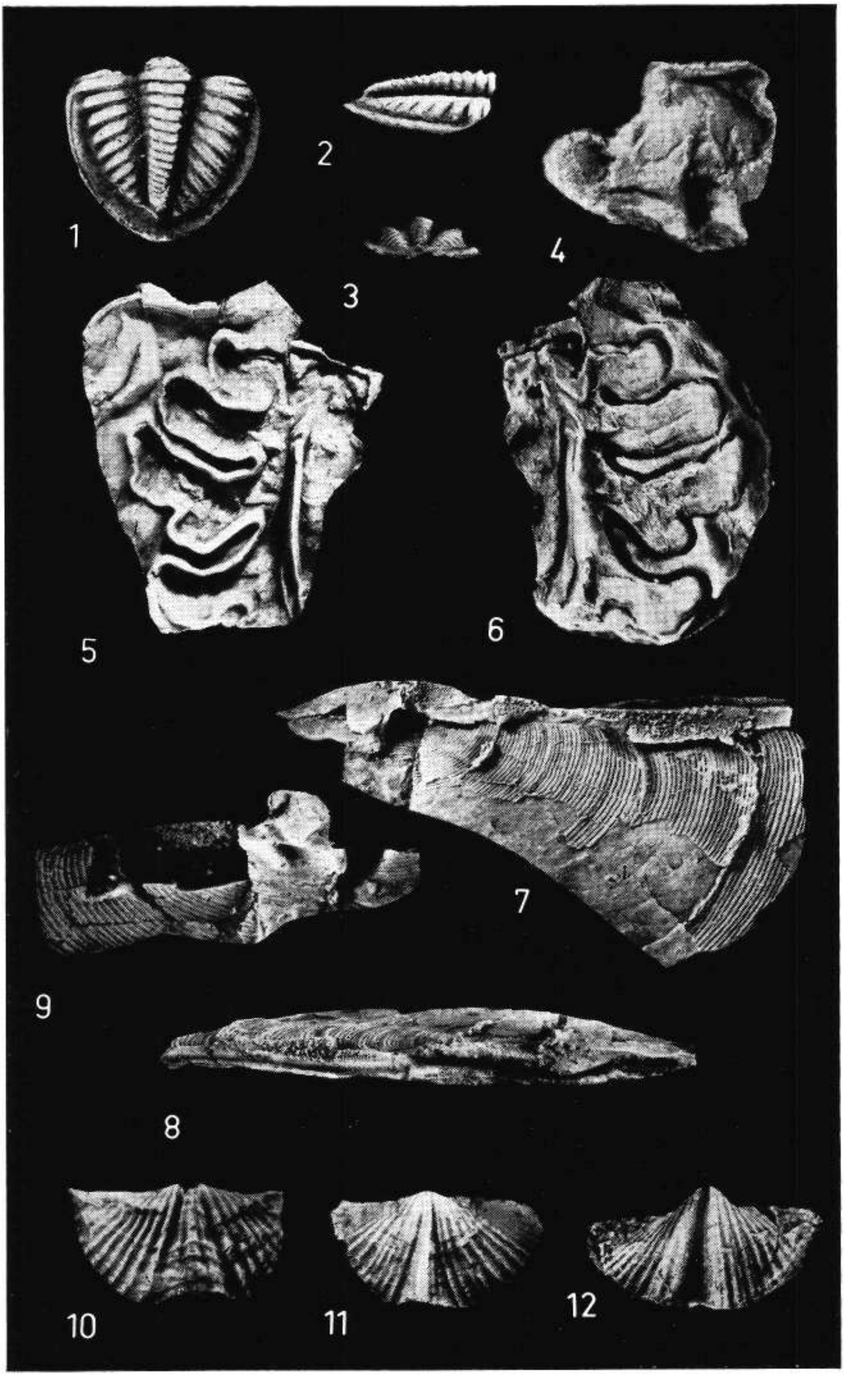
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PLATE 3

Isogramma zoellnerensis n. sp.
Figures 1—3
(1) rubber replica of the external mould of brachial valve with which the cardinal process of brachial interior is preserved, × 1, holotype GPIBo. 16; (2) same, lateral view, × 1; (3) rubber replica of the internal mould of pedicle valve showing muscle scars, × 1, paratype GPIBo. 17.

Isogramma expansum (DE REGNY & GORTANI, 1905)
Figures 4—6
(4, 5) respectively rubber replicas of the internal moulds of brachial and pedicle valves, GPIBo. 13, 14 respectively, × 1; (6) *I. expansum ?*, showing mould of brachial interior lying over the external mould of pedicle valve, GPIBo. 15, × 1.5.

Derbyia multicostellatus n. sp.
Figure 7
posterior portion of the replica of external mould of pedicle valve, showing parvicostellation, × 2, Holotype GPIBo. 71.


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PLATE 4

Isogramma kahlerorum n. sp.
Figures 1—4
rubber replicas of (1) external mould of brachial valve with which the mould of cardinal process is preserved, × 1, holotype GPIBo. 18 (2) of the internal mould of brachial valve, × 1, paratype GPIBo. 19 (3) of the internal mould of pedicle valve, × 2, GPIBo. 20 and (4) the external mould of pedicle valve, × 1, paratype GPIBo. 21.

Isogramma n. sp.
Figures 5—6
respectively internal mould of the brachial valve, and its rubber replica, showing posteriorly bifurcate breviseptum, × 1, GPIBo. 22.

Derbyia multicostellatus n. sp.
Figure 7
rubber replica of the external mould of pedicle valve, × 1, holotype GPIBo. 71.

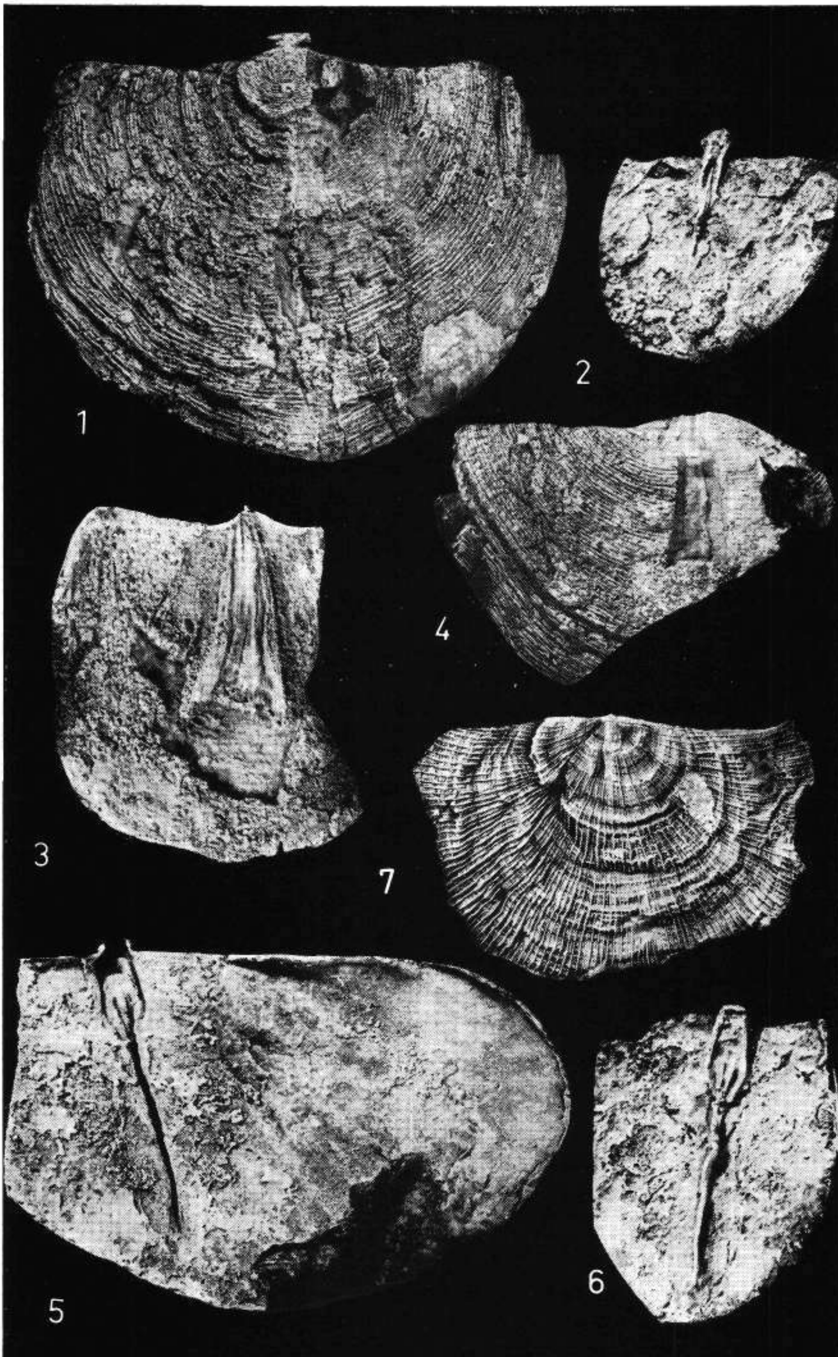
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PLATE 5

Enteletes lamarckii FISCHER, 1825
Figures 1—8
(1—4) composite moulds of shells in respectively nepionic, neanic, ephebic and gerontic stages, ventral valve (fig. 4, showing incurving dental plates?), × 1; GPIBo. 23, 24, 25, 26 respectively (5) same specimen as (4), anterior view; (6—7) brachial valve, respectively plan and anterior view of rubber replica of an external mould, × 1, GPIBo. 27; (8) rubber replica of an internal mould of the posterior portion of a brachial valve, showing trilobate cardinal process, strong crural plates and median myophragm, × 4, GPIBo. 28, (9) very small, internal mould of a brachial valve showing monolobed cardinal process and the posterior adductors overlapping the anterior adductors, × 6, GPIBo. 29.

Enteletes carnica (SCHELLWIEN, 1892)
Figures 12—13
respectively plan and anterior view of composite mould of a ventral valve, × 1, GPIBo. 30.

Enteletes aff. *hemiplicatus* (HALL, 1852)
Figures 14—15
respectively plan and anterior view of composite mould of a ventral valve, × 1, GPIBo. 31.

Schizophoria aff. *indica* (WAAGEN, 1884)
Figures 10—11
respectively plan and anterior view of composite mould of a ventral valve, × 1, GPIBo. 32.

Punctospirifer coronae (SCHELLWIEN, 1892)
Figures 16—18
respectively plan, side and anterior view of rubber replica of an external mould of a brachial valve, × 2, GPIBo. 33.

Callispirina frontisquamosa n. sp.
Figures 19—23
(19—21) respectively plan, anterior and side view of an internal mould of the pedicle valve, × 3, holotype GPIBo. 34; (22) same, external mould, inversely illuminated, showing lamellae of growth at anterior margin; (23) another ventral valve, internal mould, GPIBo. 35.

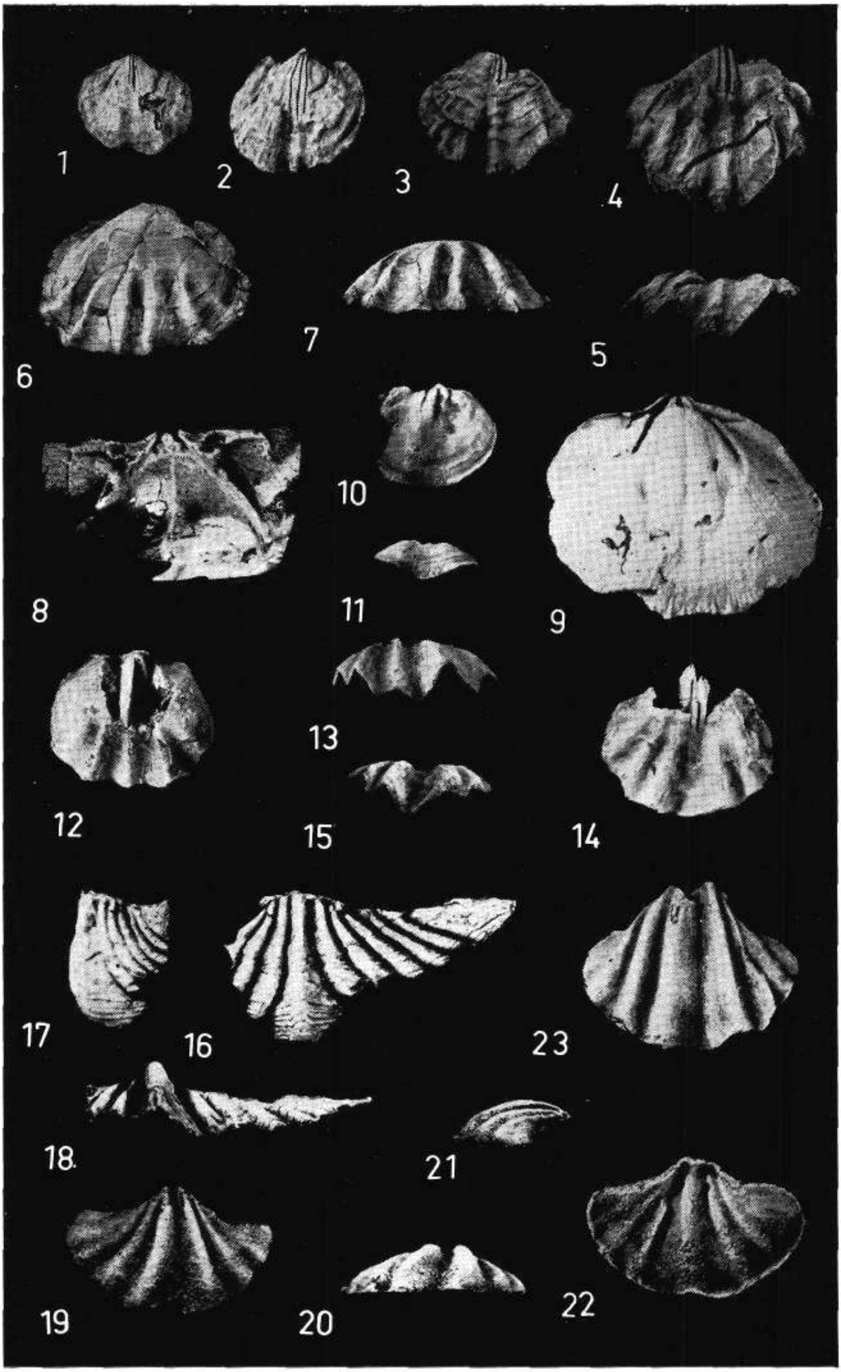
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PLATE 6

Brachythyrina strangwaysi (VERNEUIL, 1845)
Figures 1—7
(1—3) plan view of composite moulds of ventral valves in different growth stages, × 1, GPIBo. 36, 37, 38; (4—5) plan view of composite moulds of brachial valves in different growth stages, × 1, GPIBo. 39, 40; (6) rubber replica of the specimen of fig. 2, × 1; (7) dorso-posterior view of rubber replica of a fragmentory external mould, × 1, GPIBo. 41.

Brachythyrina carnica (SCHELLWIEN, 1892 emend.)
Figures 8—15
(8—9) respectively plan and posterior view of composite mould of a pedicle valve, × 1, GPIBo. 42; (10—12) respectively plan, anterior and side view of the specimen of Spirifer carnica Grandis — METZ, 1936, Pl. VI, fig. 14, × 1 (Geol. Pal. Inst. Graz, Austria); (13) plan view of rubber replica of a fragmentary external mould of a ventral valve, × 1, GPIBo. 43; (14) dorsal view of internal mould of a complete specimen, × 1, GPIBo. 44; (15) rubber replica of pedicle internal mould showing muscle scars and genital markings, × 1, GPIBo. 45.

Brachythyrina jakovlevi IVANOV
Figures 16—19
(16—17) plan and anterior view of composite mould of a ventral valve, × 1, GPIBo. 46; (18) rubber replica of composite mould of a ventral valve showing pallial markings, muscle scars, delthyrial ridges and thick apical callosity, × 1, GPIBo. 47; (19) plan view of composite mould of another ventral valve, × 1, GPIBo. 48.

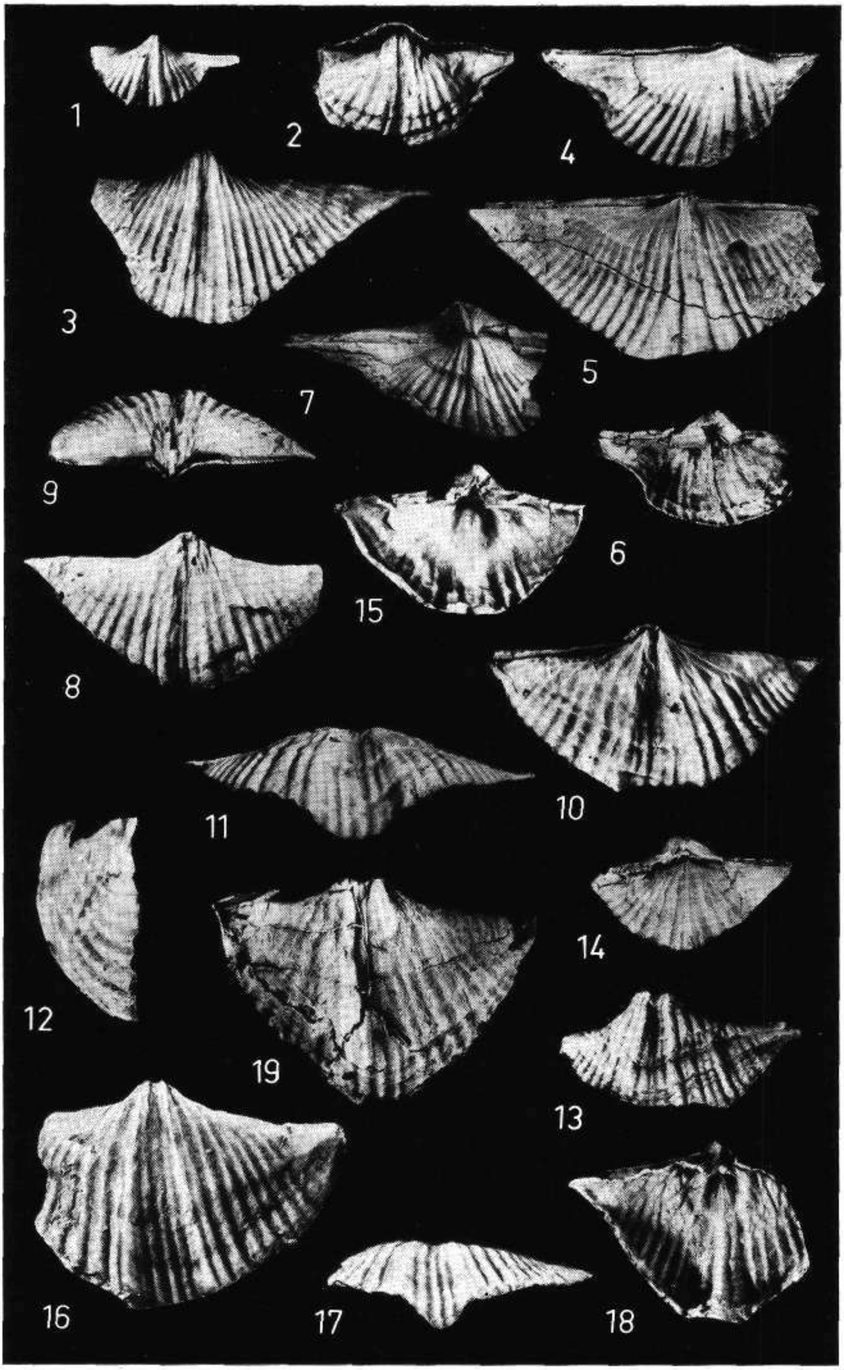
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PLATE 7

Choristites fritschi (SCHELLWIEN, 1892)
Figures 1—2
(1) plan view of composite mould of a pedicle valve, × 1, GPIBo. 49; (2) rubber replica of the same showing ventral interior, × 1.

Choristites n. sp. A.
Figures 3—5
(3—4) respectively plan and anterior view of composite mould of a pedicle valve, × 1, GPIBo. 50; (5) plan view of rubber replica of an external mould of a pedicle valve, × 1, GPIBo. 51.

Choristites sp.
Figures 6—7
(6—7) respectively internal mould and its rubber replica showing pallial markings and the diductor scars pierced posteriorly by the dental plates, × 1, GPIBo. 52.

Martinia aff. *uralica* TSCHERNYSCHEW, 1902
Figures 8—9
(8, 9) respectively plan and anterior view of composite mould of a pedicle valve, × 1, GPIBo. 58.

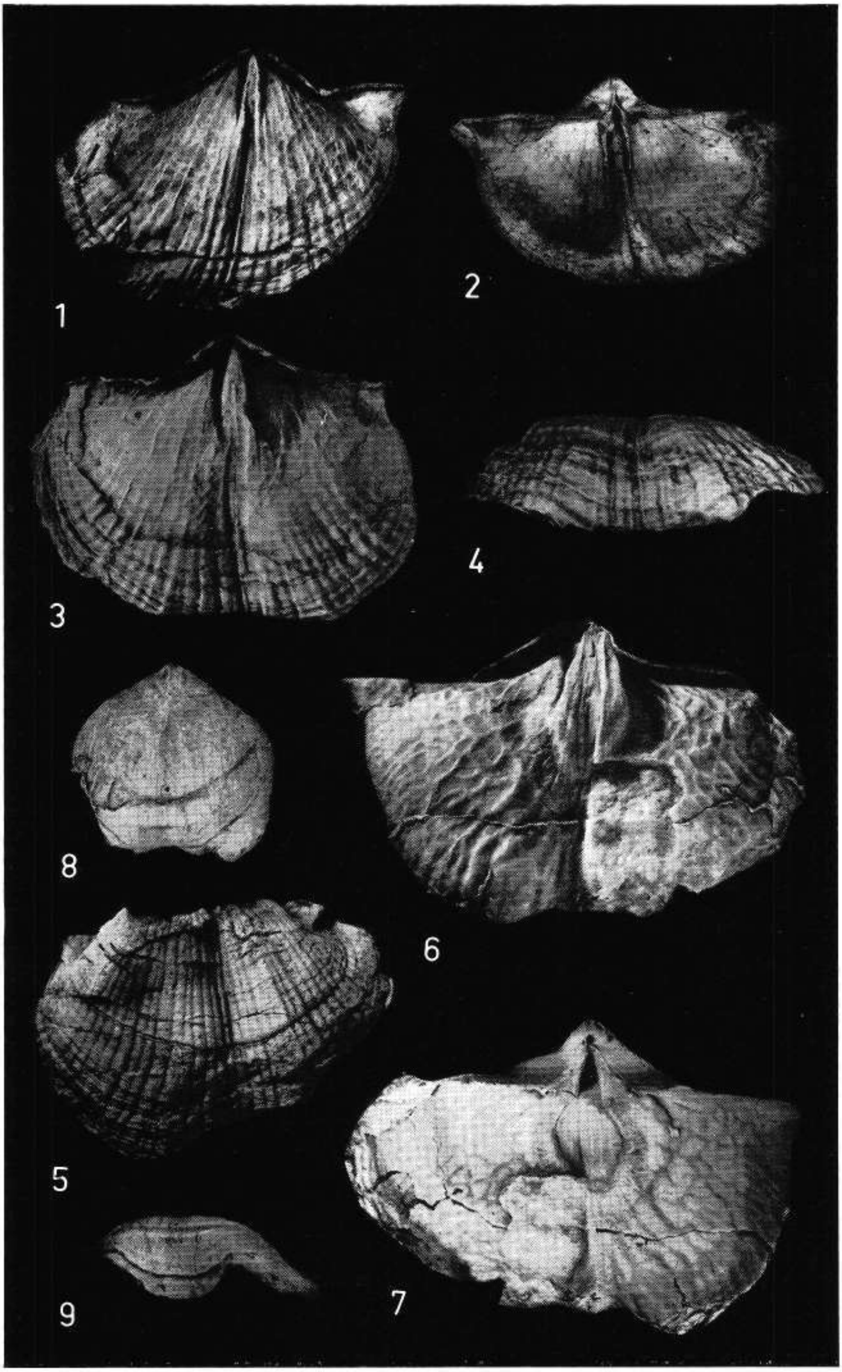
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PLATE 8

Choristites aff. *mosquensis* FISCHER, 1825
Figures 1—2
(1) composite mould of a pedicle valve, showing also spiralia? of the brachial interior, × 1, GPIBo. 53; (2) composite mould of a brachial valve, × 1, GPIBo. 54.

Choristites heritschi n. sp.
Figures 3—5
(3, 5) respectively plan, and anterior view of a pedicle valve in which the shell substance is preserved, × 1, holotype GPIBo. 55; (4) same, side view showing the length of the dental plate, × 1.

Choristites n. sp. B.
Figures 6—7
(6—7) respectively plan and anterior view of composite mould of a pedicle valve, × 1, GPIBo. 56.

Martinia aff. *parvula* TSCHERNYSCHEW, 1902
Figure 8
internal mould of a pedicle valve showing muscle scars and genital markings, × 1, GPIBo. 59.

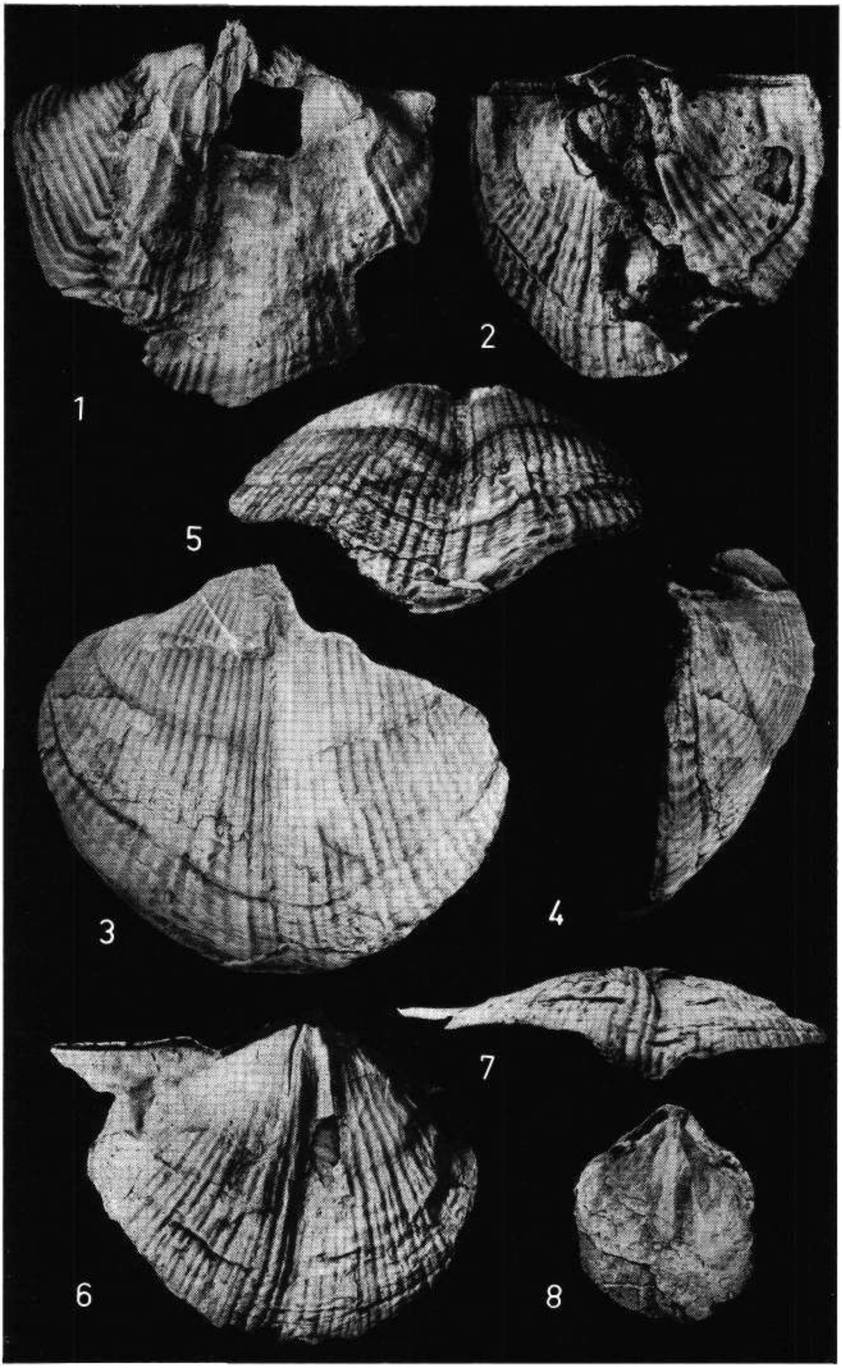
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PLATE 9

Neospirifer sp.
Figures 1—2
(1, 2) respectively composite mould of a ventral valve and its rubber replica showing the muscle scars, × 1.3, GPIBo. 61.

Neospirifer contracta (IVANOV & IVANOVA, 1937)
Figures 3—6
(3, 4) respectively composite mould of a ventral valve and its rubber replica, latter in antero-interior view, showing genital markings, × 1, GPIBo. 62 (the specimen was damaged after the replica had been made); (5) rubber replica of external mould of a fragmentory pedicle valve, × 1, GPIBo. 63; (6) composite mould of a brachial valve, × 1, GPIBo. 64.

Neospirifer aff. *tegulatus* (TRAUTSCHOLD, 1876)
Figures 7—8
(7, 8) respectively plan and anterior view of composite mould of a pedicle valve, the former showing long dental plates extending anterior to the hinge, × 1, GPIBo. 65.

Neospirifer lanceolatus n. sp.
Figures 9—10
(9) plan view of rubber replica of external mould of a pedicle valve, × 1, holotype GPIBo. 66 (10) plan view of composite mould of a brachial valve, × 2, paratype GPIBo. 67.

Martinia aff. *parvula* TSCHERNYSCHEW, 1902
Figure 11
rubber replica of internal mould of pedicle valve (same as Pl. VIII, fig. 8), × 1, GPIBo. 59.

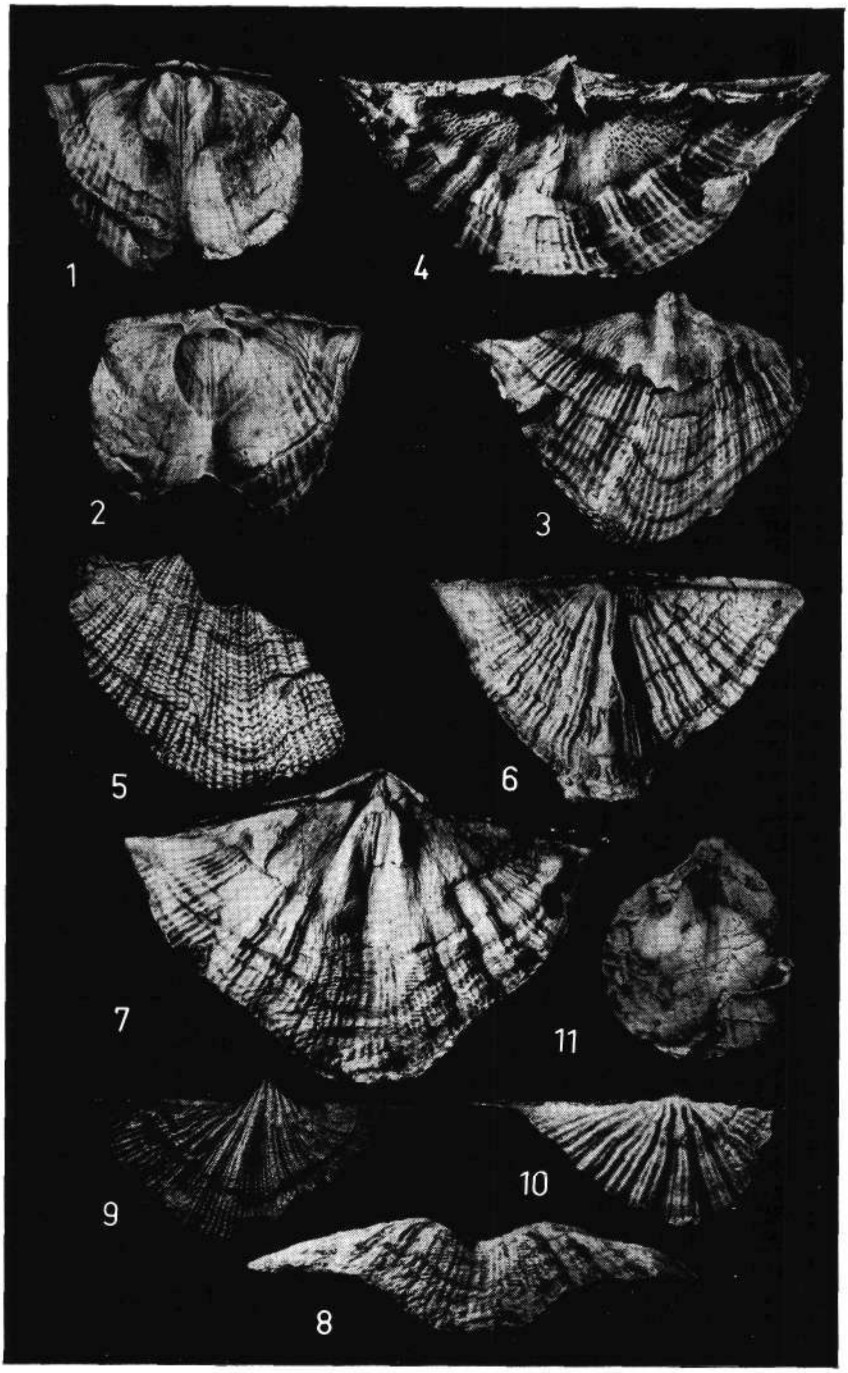
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PLATE 10

Derbyia expansa SCHELLWIEN, 1892
Figures 1—4
(1) composite mould of a pedicle valve showing bell-shaped muscle scars, × 1, GPIBo. 69; (2) rubber replica of the postero-medial portion of the same showing the dental flanges, independent posterior termination of the median septum and the muscle scars (3) composite mould of a brachial valve showing the cardinal process, its anterior medial ridge and the socket plates, × 1, GPIBo. 70; (4) rubber replica of the postero-medial portion of the same showing anteriorly bilobed cardinal process.

Derbyia multicostellatus n. sp.
Figures 5—6
(5, 6) respectively dorsal and anterior view of mould of a fragmentory shell, × 1, GPIBo. 73.

Pulsia ? undecimus (HERITSCH, 1931)
Figure 7
plan view of composite mould of a pedicle valve showing posteriorly confluencing dental plates, forming spondylium, × 1, GPIBo. 87.

Meekella depressa SCHELLWIEN, 1892
Figure 8
plan view of composite mould of a pedicle valve, × 1, GPIBo. 91.

Rhynchopora grandirostris (SCHELLWIEN, 1892)
Figure 9
plan view of rubber replica of external mould of a pedicle valve, × 3, GPIBo. 68.

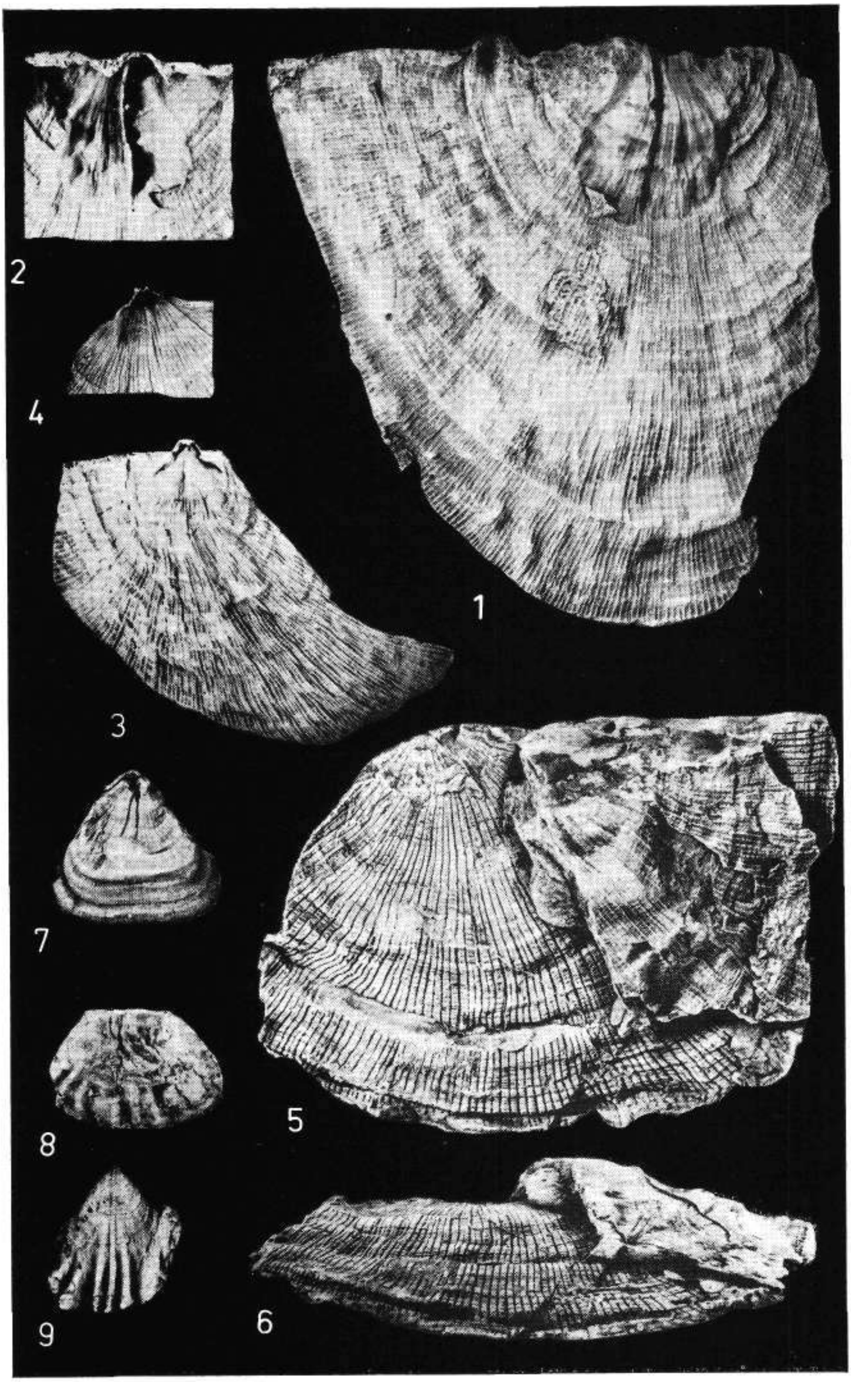
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PLATE 11

Derbyia waageni SCHELLWIEN, 1892
Figures 1—8
(1, 3, 4) composite moulds of pedicle valves showing variation of outline, × 1, GPIBo. 76, 77, 78 respectively; (5) lateral view of 4, × 1; (2) rubber replica of external mould of a pedicle valve, × 1, GPIBo. 79; (6) composite mould of a brachial valve, × 1, GPIBo. 80; (7, 8) same, posteriorly tilted (× 1) and enlarged respectively to show the cardinal process in posterior view.

Derbyia metzi n. sp.
Figures 9—12, except 10
(9) composite mould of a pedicle valve, × 1, GPIBo. 75; (11, 12) respectively rubber replicas of composite and fragmentary external mould of a pedicle valve, former showing circular muscle scars and short median septum, × 1, holotype GPIBo. 74.

Streptorhyncus reliquus n. sp.
Figures 10 and 13
respectively rubber replicas of external and composite mould of a brachial valve; the latter showing posteriorly recurving crural plates and anteriorly bilobed cardinal process with medial ridge, × 1, paratype GPIBo. 90.

Derbyia multicostellatus n. sp.
Figures 14—16
(14) rubber replica of the composite mould, showing pedicle interior, × 1, holotype GPIBo. 71; (15, 16) respectively inner (× 1) and posterior (× 5) view of replica of composite mould of a brachial valve, GPIBo. 72.

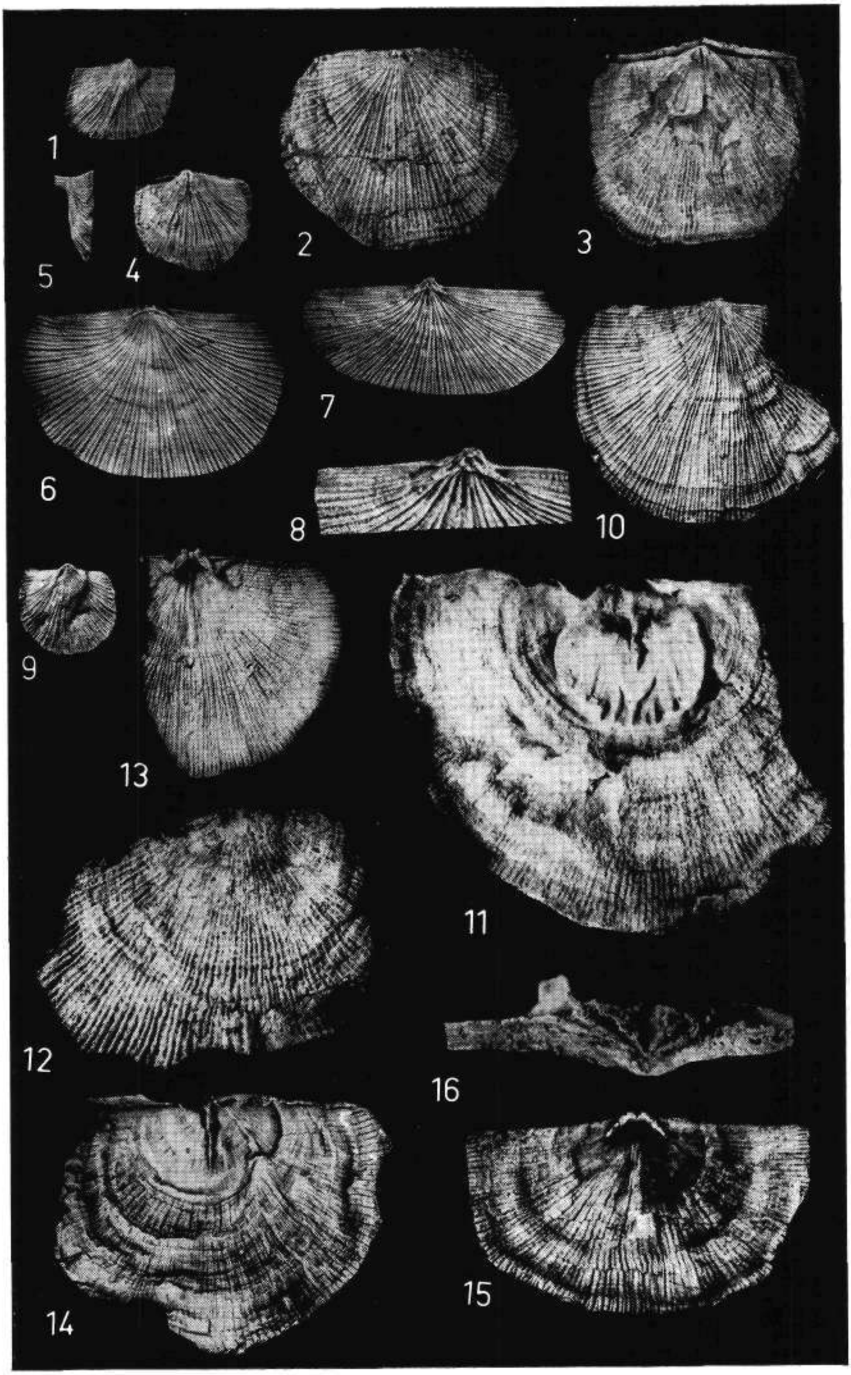
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PLATE 12

Pulsia mosquensis IVANOV, 1926
Figures 1—5
(1, 2) composite moulds of pedicle valves, × 1, GPIBo. 82, 83 respectively; (3, 4) respectively internal mould of a brachial valve and the rubber replica of its postero-medial portion, × 1, GPIBo. 84; (5) lateral view of the same.

Streptorhyncus reliquus n. sp.
Figures 6—9
(6, 7) respectively internal mould of a brachial valve with which the cardinal area of the pedicle valve is preserved (× 1) and enlarged rubber replica of postero-medial portion, GPIBo. 89; (8, 9) respectively plan and posterior view of composite mould of a pedicle valve, latter showing twisted beak, × 1, holotype GPIBo. 88.

Martinia karawanica VOLGIN, 1959
Figures 10—13
(10—13) respectively rubber replica of pedicle external mould, brachial internal mould with pedicle cardinalia, posterior view of internal mould and 11 enlarged at postero-medial portion to show the hook formed by the dental plates and inner socket plates; except 13 all natural size, GPIBo. 60.

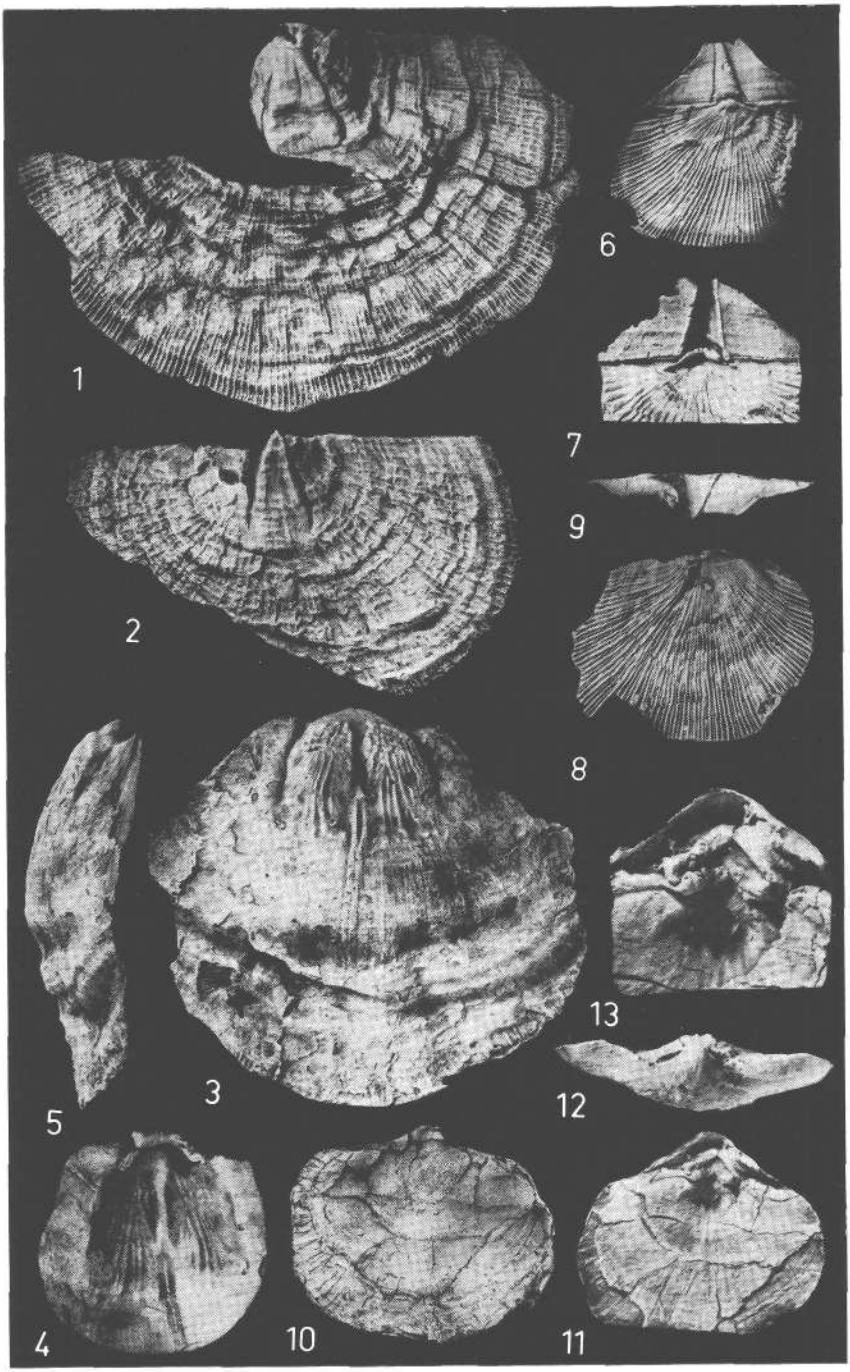
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PLATE 13

Orthotetes plana (IVANOV, 1926)
Figures 1—2
(1, 2) respectively rubber replica of external mould and composite mould of a pedicle valve, latter showing bell-shaped muscle scars and the dental plates joining the median septum in sub-umbonal region, × 1, GPIBo. 81.

Pulsia linguaeformis n. sp.
Figure 3
plan view of composite mould of a pedicle valve showing dental plates and produced anterior commissure, × 1, holotype GPIBo. 86.

Pulsia mosquensis IVANOV, 1926
Figure 4
rubber replica of fragmentary external mould of a pedicle valve, × 1, GPIBo. 85.

Linoproductus coralineatus IVANOV, 1935
Figures 5—7
(5) external brachial mould; (6) replica of internal brachial mould showing breviseptum and anteriorly bilobed cardinal process, same specimen; (7) composite ventral mould, same specimen; all natural size, GPIBo. 100.

Linoproductus ovalis IVANOV, 1935
Figure 8
rubber replica of composite mould of a brachial valve with which portion of external mould of pedicle cardinal area is preserved, showing breviseptum, cardinal process of the brachial interior and 2 rows of spines along hinge on the ventral exterior, × 1, GPIBo. 98.

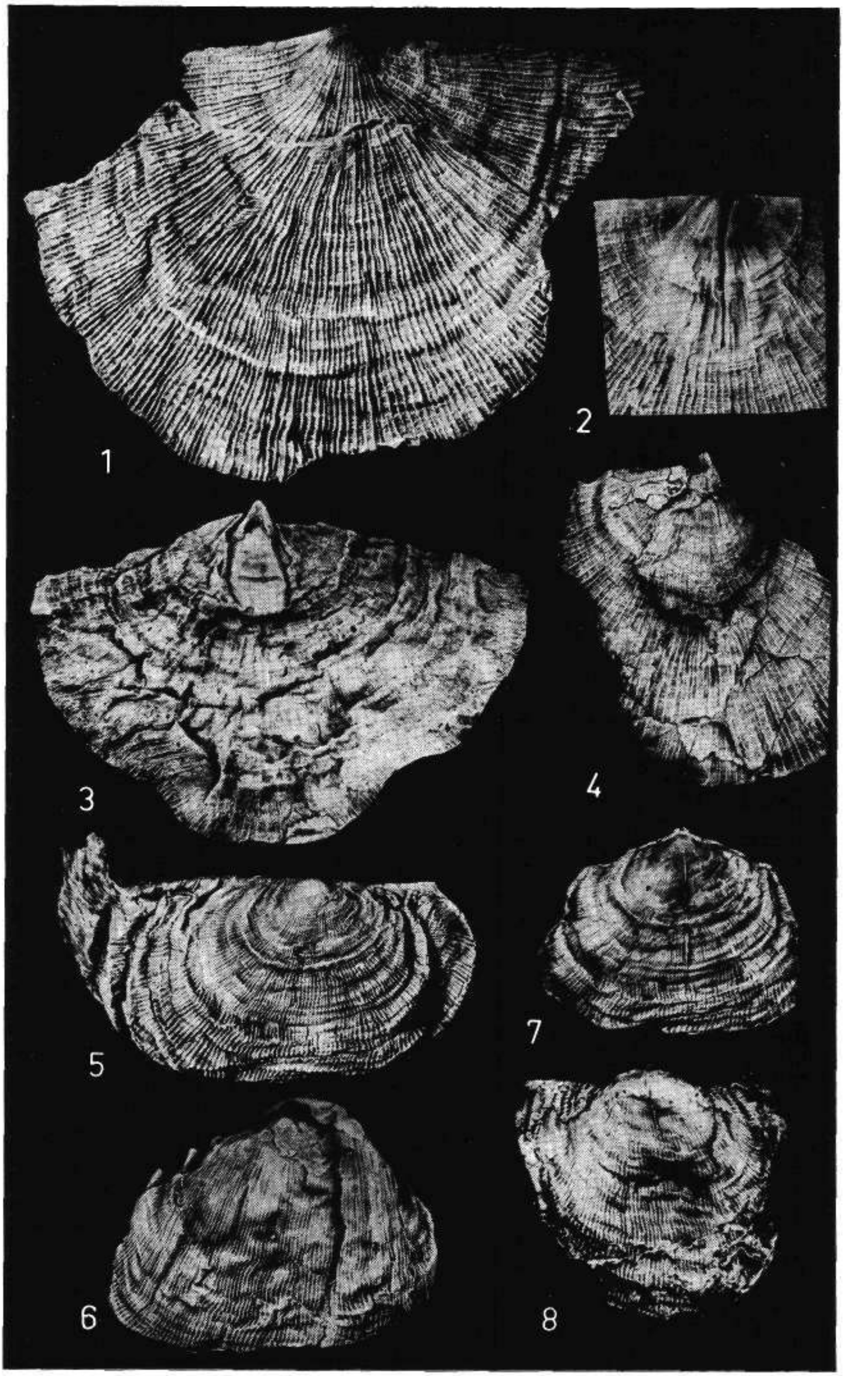
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PLATE 14

Linoproductus cora (D'ORBIGNY, 1842)
Figures 1—5
(1, 4) respectively composite mould of ventral valve and rubber replica of composite mould of brachial valve of the same specimen, × 1, GPIBo. 92; (2) composite mould of brachial valve, × 1, GPIBo. 95; (3) rubber replica of internal mould of a pedicle valve showing striate diductors and dendritic posterior and anterior adductors, × 1, GPIBo. 93; (5) composite mould of brachial valve showing dendritic diductor scars, breviseptum and anteriorly bilobate cardinal process, × 1, GPIBo. 94.

Linoproductus kentrometopon n. sp.
Figures 6—8
(6, 7, 8) respectively plan, side and anterior view of composite mould of a pedicle valve, × 1, holotype GPIBo. 96.

Linoproductus ovalis IVANOV, 1935
Figure 9
composite mould of a pedicle valve, × 1, GPIBo. 97.

Linoproductus neffedievi (VERNEUIL, 1845)
Figures 10—12
(10, 11, 12) respectively plan, side and posterior view of composite mould of ventral valve to which the mould of the posteriorly trilobed cardinal process of the brachial interior is attached: latter shown in fig. 12, × 1, GPIBo. 99.

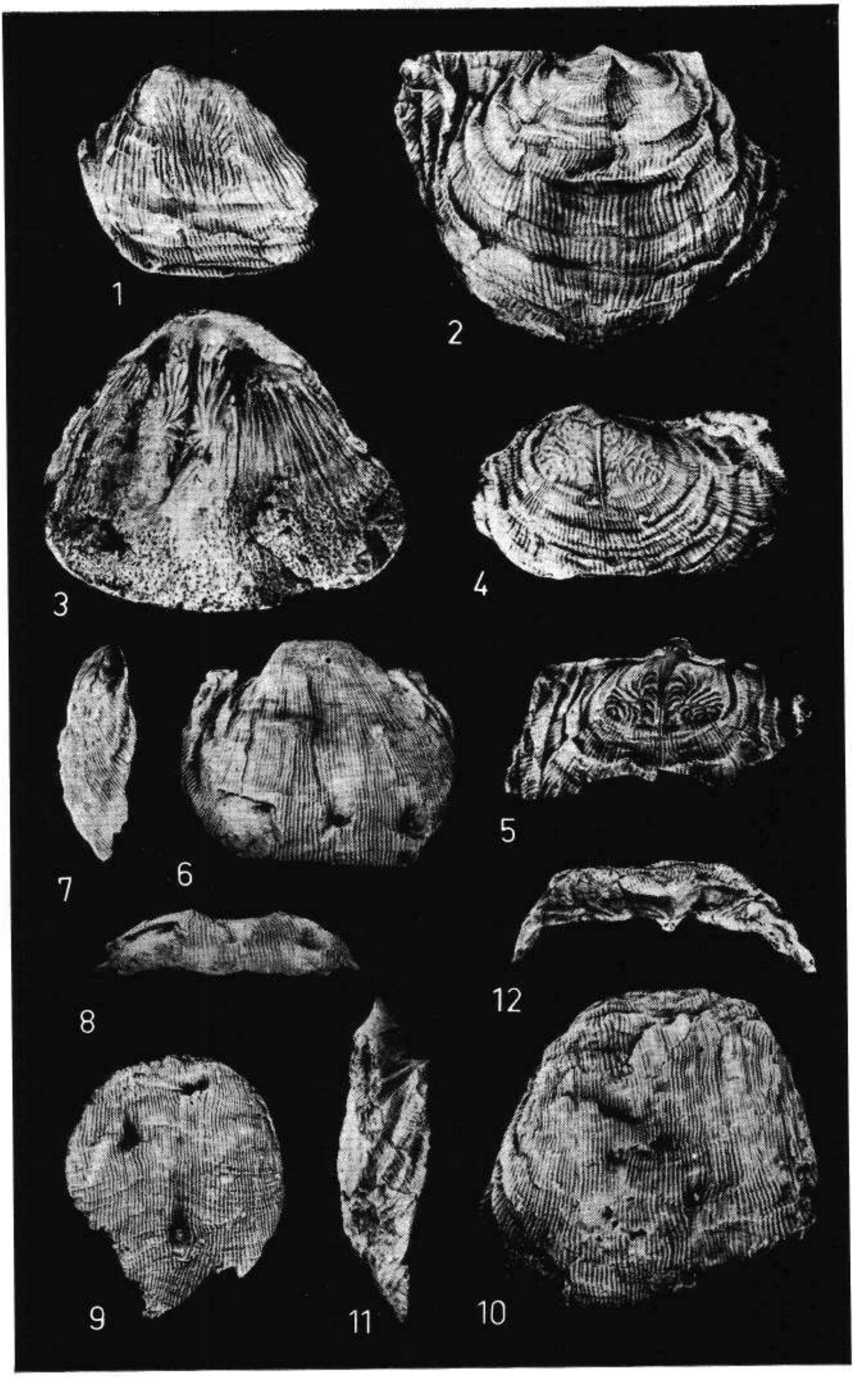
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PLATE 15

Juresania juresanensis (TSCHERNYSCHEW, 1902)
Figures 1—4
mould of a complete specimen: (1) ventral view, showing spine ridges of different diameters at the anterior margin; (2) brachial view; (3) lateral view; (4) posteriorly tilted rubber replica of the brachial internal mould showing antron and bilobed cardinal process, × 1, GPIBo. 101.

Juresania subpunctata (NIKITIN, 1890)
Figures 5—7
(5, 6) ventral and side view of composite pedicle mould, × 1, GPIBo. 102; (7) smaller specimen, × 1, GPIBo. 103.

Echinaria sp.
Figure 8
rubber replica of composite mould of brachial valve showing breviseptum, posteriorly dendritic diductor scars and non-lobate cardinal process, × 1, GPIBo. 107.

Echinaria longa n. sp.
Figures 9—10
(9) rubber replica of external mould of a pedicle valve, × 1, holotype GPIBo. 105; (10) rubber replica of composite mould of brachial valve showing interior, × 1, GPIBo. 106.

Kozlowskia ? sp.
Figures 11—13
(11) external mould of pedicle valve with cardinal process and the pedicle trail beyond marginal ridge, × 2, GPIBo. 109; (12) internal mould of a brachial valve, × 2, GPIBo. 110; (13) brachial external mould, cardinal process and pedicle trail, × 2, GPIBo. 111.

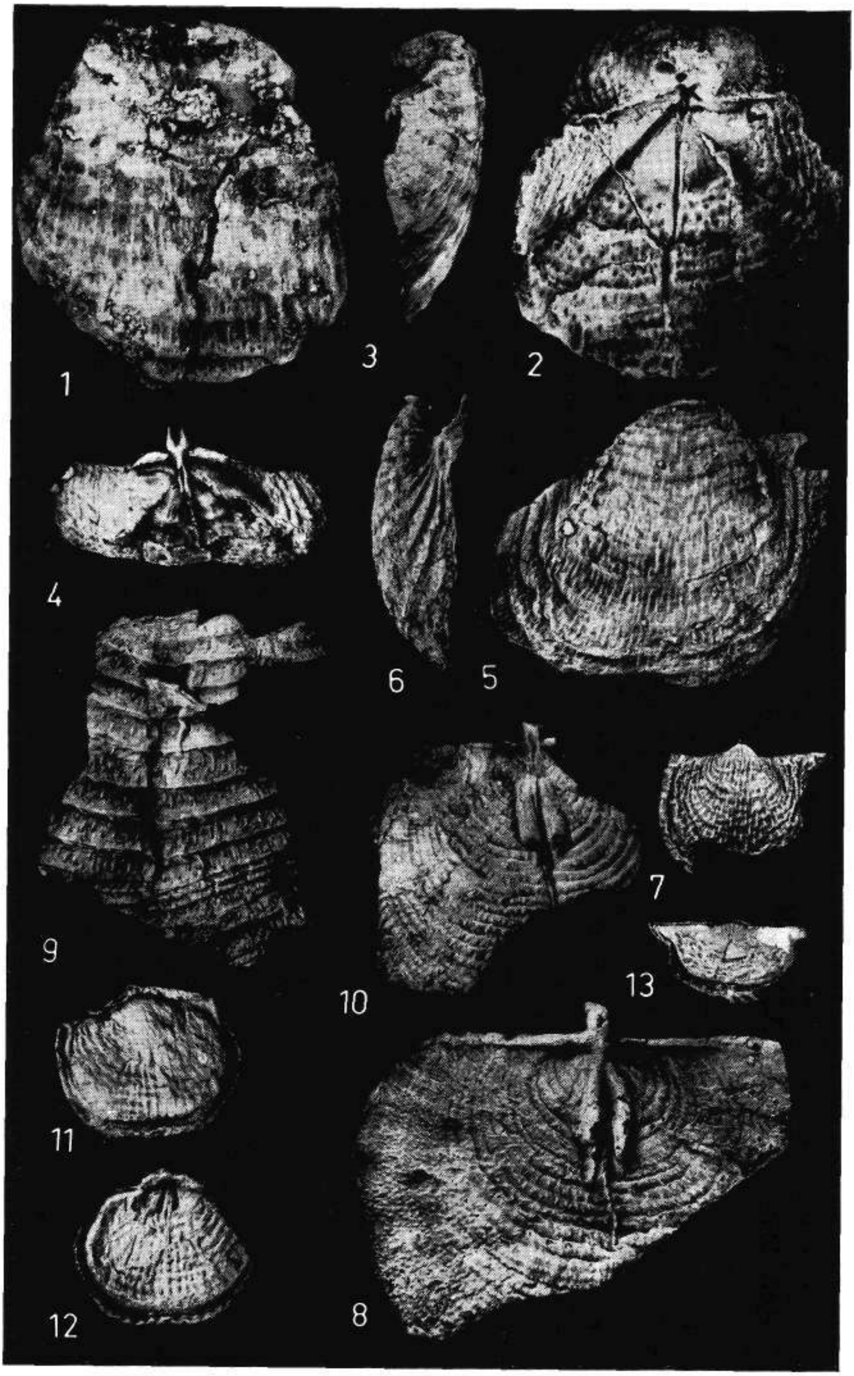
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PLATE 16

Echinaria longa n. sp.
Figures 1—2
(1, 2) composite mould of a complete specimen; respectively ventral and dorsal view, × 1, holotype GPIBo. 104.

Buxtonia ? transversalis n. sp.
Figures 3—8
(3) composite mould of the pedicle valve, × 1; (4, 5, 6) respectively plan, anterior and side view of the external mould of brachial valve with which the mould of cardinal process is preserved, × 1, holotype GPIBo. 112; (7, 8) internal and posterior view of rubber replica of internal mould of the brachial valve, × 1, paratype GPIBo. 113.

Echinaria sp.
Figure 9
composite mould of pedicle valve, × 1, GPIBo. 108.

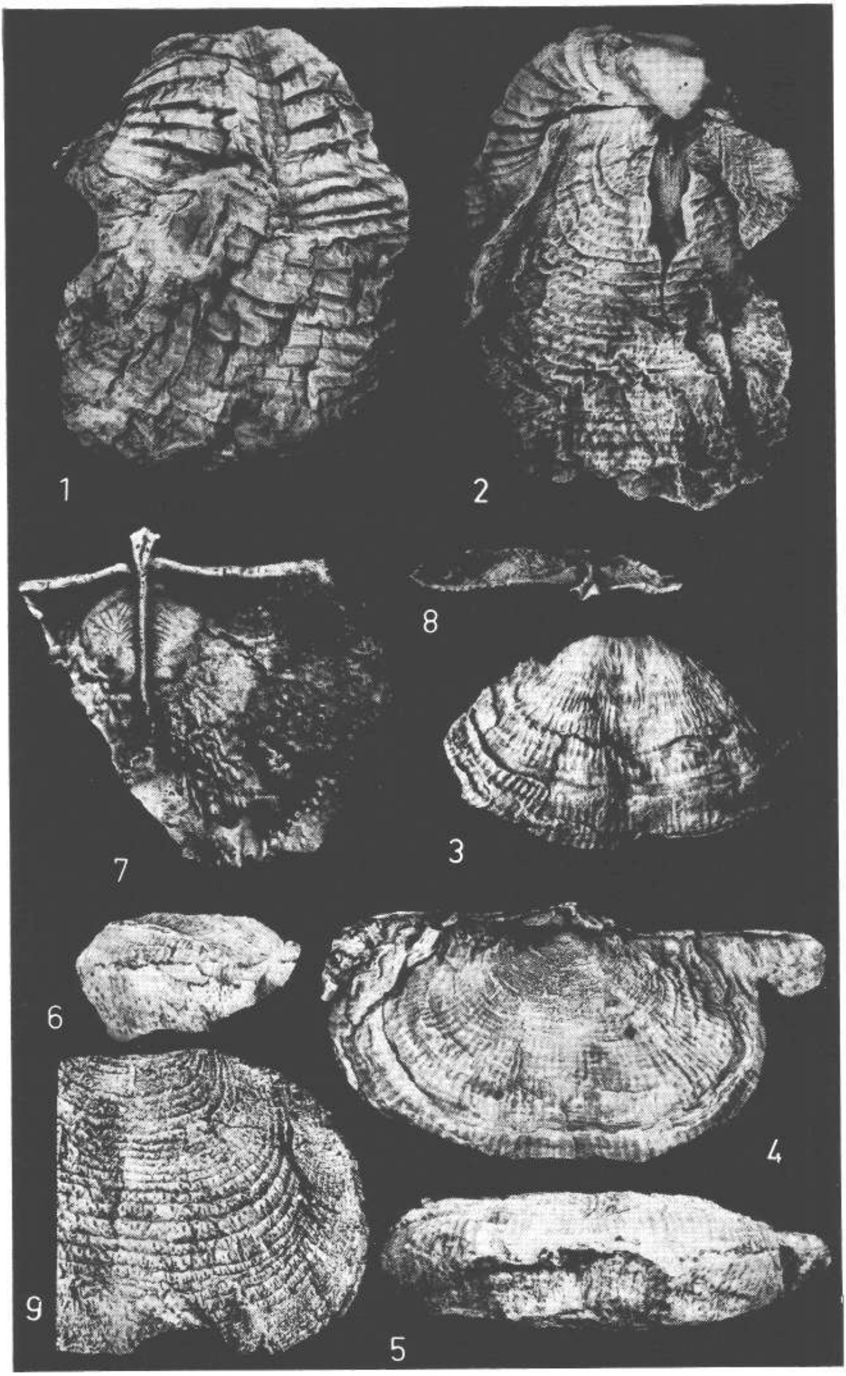
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PLATE 17

Figure 1. Load-casts on the lower surface of a sandstone bed showing a N—S to NW—SE alignment. × 1.

Figure 2. Section transverse and perpendicular to the load-casts showing flame structure. The dark, finer material at the base and in the flame structure consists of mainly muscovite plates. These plates have their long axes parallel to the stratification at the base and the bounding walls of the flame structure. × 12.

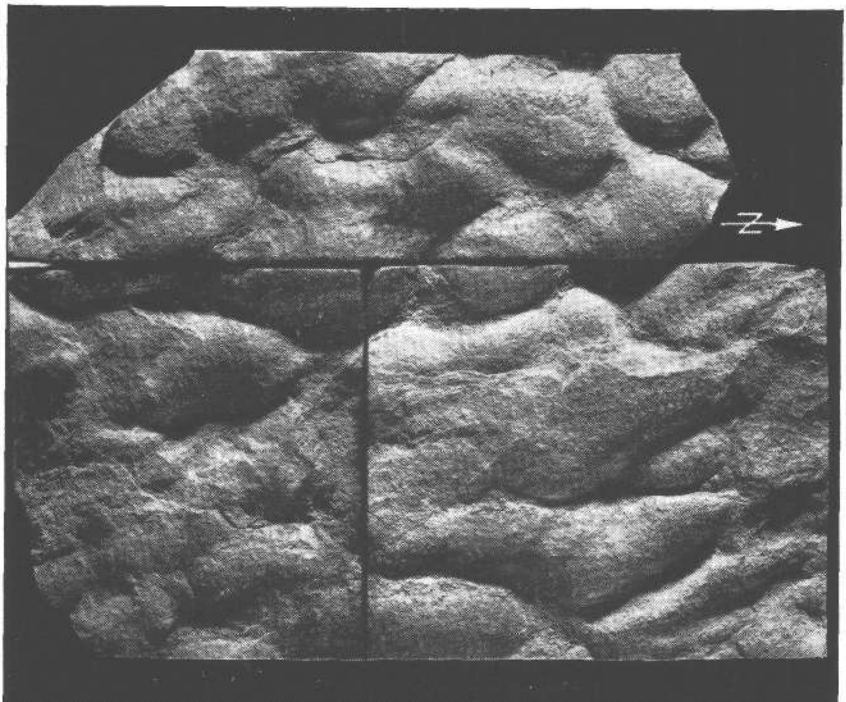

Fig. 1

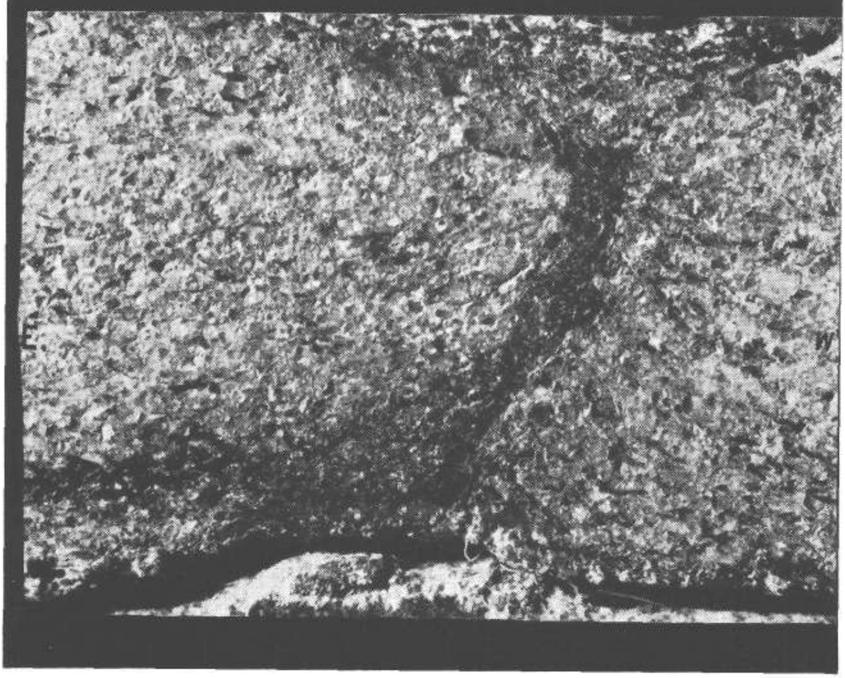

Fig. 2