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UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

(TRYLOBITY GÓRNO-ORDOWICKIE POLSKI I PEWNE FORMY ZBLIŻONE Z CZECH I SKANDYNAWII)

BY

ZOFIA KIELAN

(WITH 50 TEXT-FIGURES AND 36 PLATES)

WARSZAWA 1959

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Tome I, 1929 — ROMAN KOZŁOWSKI. Les Brachiopodes gothlandiens de la Podolie Polonaise. I-XIII, 254 pp., 1 carte, 95 fig. dans le texte, 12 planches.

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CONTENTS

GENERAL PART

INTRODUCTION

The present paper is a study of the Upper Ordovician (Ashgillian) trilobites from the Holy Cross Mountains (Góry Świętokrzyskie) in Poland, including a comparison with related forms from Scandinavia and Bohemia. The beds investigated are above the zone of *Pleurograptus linearis* and are developed as shelly facies in the Holy Cross Mountains, where they include the following zones: 1) zone of *Eodindymene pulchra*, 2) zone of *Staurocephalus clavifrons*, 3) zone of *Dalmanitina olini*, 4) zone of *Dalmanitina mucronata*. The latter two zones are called the *Dalmanitina* beds (cf. Jaanusson, 1944).

The majority of the species described is from Poland, but conspecific specimens from Scandinavia, Bohemia and sometimes also Great Britain are taken into account. Some Scandinavian and Bohemian trilobites not occurring in Poland are also described, as they are relevant to a discussion of the phylogeny of the Polish forms.

A description of the localities and the more detailed stratigraphy of the Holy Cross Mountains is given, whilst the investigations of the Czech and Scandinavian authors on the Bohemian and Scandinavian beds are accepted for comparison and correlation purposes.

The Upper Ordovician series in the Holy Cross Mountains were discovered by the late J. Czarnocki (1928*a*, 1928*b*, 1929, 1939). A part of the material collected by him in the Holy Cross Mountains from Wólka and Brzezinki, as well as all the collections from Zalesie and Stawy in the Bardo syncline, were destroyed during the war. In 1951, Czarnocki handed over to me the remaining part of his collections of the trilobites from Wólka and Brzezinki, which had escaped destruction. In 1952 and 1953, I repeated the field work at all the fossil bearing sites mentioned above, at Wólka and Brzezinki yielding light mudstones of the *Eodindymene pulchra* zone and *Staurocephalus clavifrons* zone, and at Zalesie and Stawy yielding greenish, sandy mudstones of the *Dalmanitina* beds.

The collection of trilobites from the Holy Cross Mountains investigated here thus includes Czarnocki's, as well as my own collection, and it consists of:

I. The collection of Czarnocki — about 800 specimens from Brzezinki and Wólka. The specimens from Wólka are from the zone of *Staurocephalus clavifrons*. With regard to the specimens from Brzezinki, as the labels were lost, it has not been possible to ascertain from which part of the section the specimens had been obtained. The lithological character of the rock occasionally gives some indication, but as the differences in lithology are slight, this is by no means always a good criterion. These specimens are thus designated e. g. «Upper Ordovician, probably zone of *Staurocephalus clavifrons*».

II. My own collection consisting of: 1) about 150 specimens from the *Eodindymene pulchra* zone in Brzezinki, 2) about 3500 specimens from the *Staurocephalus clavifrons* zone in Brzezinki, 3) about 400 specimens from the *Staurocephalus clavifrons* zone in Wólka, 4) about 400 specimens from the *Dalmanitina olini* zone in Stawy, 5) about 700 specimens

from the *Dalmanitina mucronata* zone in Stawy, 6) about 1200 specimens from the *Dalmanitina mucronata* zone in Zalesie.

66 species are described from the zone of *Eodindymene pulchra* and the zone of *Staurocephalus clavifrons* from Wólka and Brzezinki, but some of them are not identified to specific level, being designated only by letters of the alphabet — for example *Actinopeltis* sp. *a*. In addition to the species described, there are good many fragmentary pygidia and cephalons, as well as some hypostomes, of which the identification is impossible. It would be beyond the scope of the present paper to describe them. In the mudstones of the zone of *Eodindymene pulchra* and *Staurocephalus clavifrons*, in addition to a very rich trilobite fauna, there occur other fossils belonging to such groups as abundant brachiopods and ostracods, and also rare graptolites, echinodermes, cephalopods and gastropods. Except the graptolites of which the identification was necessary for stratigraphical purposes, the investigation of the other fossils was beyond the scope of the present paper.

In the sandy mudstones of the *Dalmanitina* beds of Zalesie and Stawy, there occur abundant brachiopods, ostracods and trilobites. It is of great interest that in addition to the trilobite species, described here from these beds, there occur a very rich trilobite fauna, of at least twenty new, but unfortunately unidentifiable species. These trilobites are very poorly preserved, they are isolated, depressed cranidia, cheeks and pygidia, no entire specimen or even cephalon being found. As they belong not only to new genera, but frequently to new families, their description requires more and better preserved material. It is of great interest that no trilobites of this kind are known from the corresponding beds of Bohemia, Scandinavia and Great Britain, where the highest Ashgillian is characterized by the species common in the Holy Cross Mountains, as for instance *Dalmanitina mucronata*, *Leonaspis olini* and *Brongniartella platynotus*.

Since 1954, the laboratory investigations have been carried out in the Palaeozoological Institute of the Polish Academy of Sciences in Warsaw. During that time, three papers (Kielan, 1955, 1956, 1957) have been published from the collections studied. Three species (*Ceraurinella intermedia* (Kjelan), *Staurocephalus clavifrons* Angelin and *Oedicybele kingi* Whittington) from the zone of *Staurocephalus clavifrons* of Brzezinki and Wólka were described, and some questions concerning the ontogenetic development, anatomy and taxonomy of these species were discussed. The paper of 1956 is a preliminary note on the stratigraphy of the highest Ordovician in the Holy Cross Mountains.

All the specimens from the Holy Cross Mountains here described are housed in the Museum of the Geological Institute (Geol. Survey) in Warsaw (Instytut Geologiczny, Warszawa, Rakowiecka 4).

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During the years of my work I have enjoyed the privilege of discussion with Prof. R. Kozłowski, under whose supervision the work was carried out, many problems connected with my studies. Prof. Kozłowski has offered me much constructive criticism and assistance.

Dr. M. Żelichowska, Director of the Museum of the Geological Institute in Warsaw, has provided me with facilities for studying the specimens in her charge. Dr. B. Areń (Geological Institute in Warsaw) has given me much assistance and valuable information with regard to the fossiliferous localities in the Holy Cross Mountains. Dr. H. Tomczyk (Geological Institute in Kielce) identified the graptolites mentioned in the present paper. Financial support for the field work was received from the Geological Institute in Warsaw.

I received a scholarship from the Polish Academy of Sciences in order to visit Sweden. Through the courtesy of Prof. E. A. Stensiö and Prof. P. Thorslund, I was able to study in the State Museum of Natural History, Stockholm, and in the Palaeontological Institute, Uppsala University. Dr. V. Jaanusson (Uppsala University) has ever been willing to give me any possible assistance, kindly read a part of a manuscript of the present paper and offered much constructive criticism. His continued advise and encouragement during the years of correspondance have been of a great value for my investigations. Dr. B. Bohlin discussed several questions with me.

Dr. E. I. White provided facilities for me to study at the British Museum (Natural History), London. Dr. A. G. Cooper (U. S. National Museum) sent latex casts of Ordovician trilobites.

Through the courtesy of Doc. F. Prantl, I was able to study in the National Museum in Prague. Dr. I. Chlupač (Geological Institute (Geol. Survey) in Prague) kindly placed at my disposal the manuscript of his unpublished paper.

The following persons and institutions provided me with facilities for studying the specimens in their charge:

In Scandinavia: Prof. E. Stensiö and Dr. H. Mutvei (State Museum of Natural History in Stockholm), Dr. F. Brotzen (Museum of the Swedish Geological Survey in Stockholm), Prof. P. Thorslund (Palaeontological Institute of Uppsala University), Prof. G. Régnell (Palaeontological Institute of Lund University), Prof. L. Størmer and Dr. G. Henningsmoen (Palaeontological Museum of Oslo University), Prof. Ch. Poulsen (Palaeontological Museum of Copenhagen University).

In Great Britain: Dr. E. I. White and Dr. W. Dean (British Museum (Natural History)), Dr. J. C. Stubblefield (Museum of the Geological Survey in London), Mr. A. G. Brighton (Sedgwick Museum in Cambridge).

In Czechoslovakia: Doc. F. Prantl (National Museum in Prague), and Doc. Z. Špinar (Palaeontological Institute of Charles University in Prague). Mr. V. Plas in Prague allowed me to use his private collection of trilobites.

Dr. L. B. Tarlo (British Museum) has kindly corrected the English of the present paper.

The accompanying photographs of Polish specimens have been taken by Miss M. Czarnocka in Warsaw, those of Scandinavian specimens — by Mr. N. Hjort at the Palaeontological Institute in Uppsala. The drawings have been made by Mrs. E. Gadomska and Mrs. K. Budzyńska, from my pencil sketches.

It is a pleasure to acknowledge my great indebtedness and thanks to all these persons and institutions.

I use the following abbreviations:

Museum of the Geological Institute (Geol. Survey) (Instytut Geologiczny) in Warsaw — IG.
Museum of the Palaeontological Institute of Lund University — LM.
Museum of the Palaeontological Institute of Uppsala University — UM.
State Museum of Natural History (Naturhistoriska Riksmuseet) in Stockholm — RM.
Museum of the Geological Survey (Sveriges Geologiska Undersökning) — SGU.
Museum of the Palaeontological Institute, University of Copenhagen — CM.
Palaeontological Museum of Oslo University — PMO.
National Museum (Narodní Museum) in Prague — NM.
Museum of Palaeontological Institute of Charles University in Prague — KUM.
Mr. V. Plas private collection in Prague — Mr. Plas coll.
British Museum (Natural History) in London — BM.
Sedgwick Museum in Cambridge — SM.

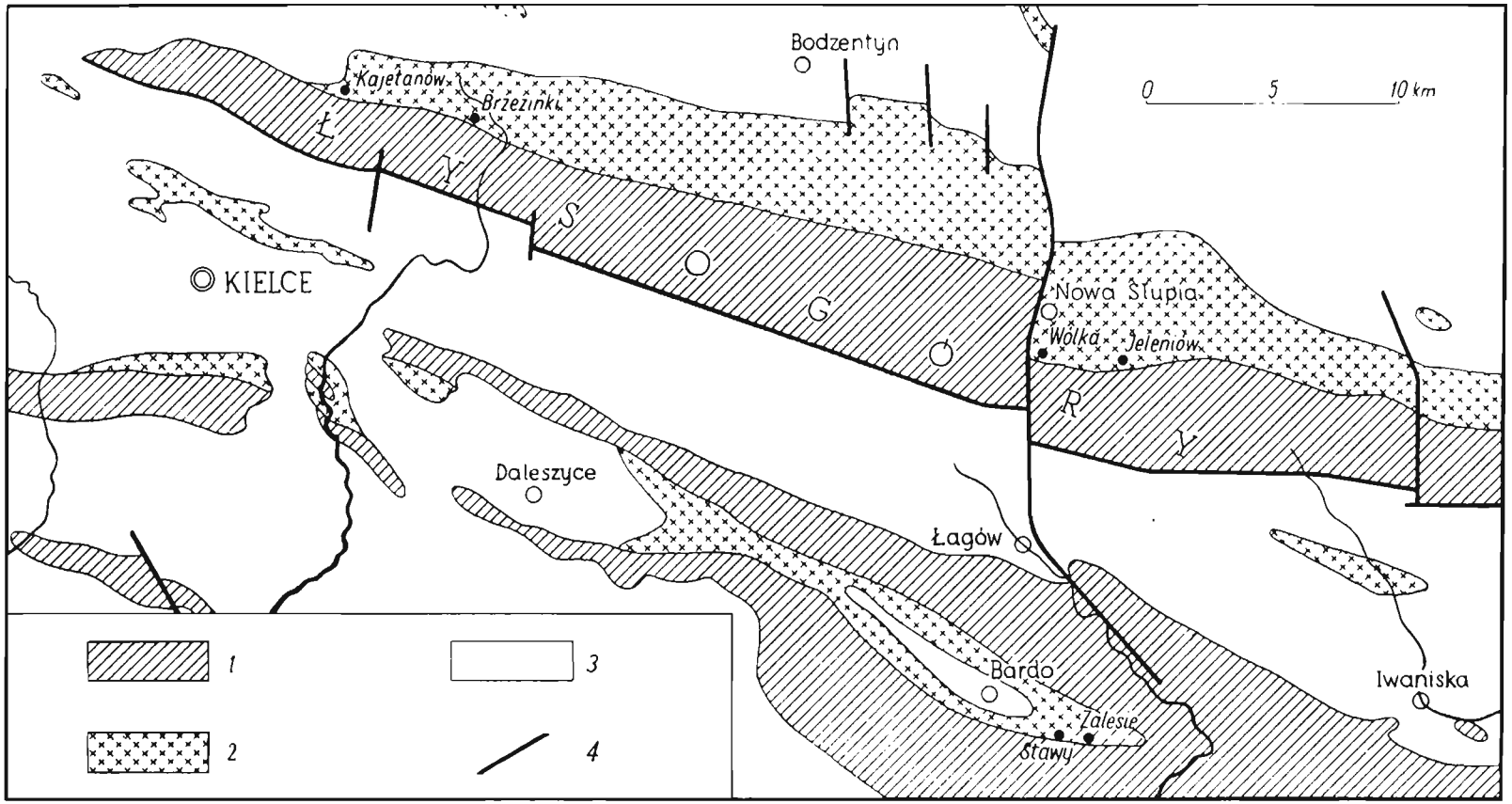
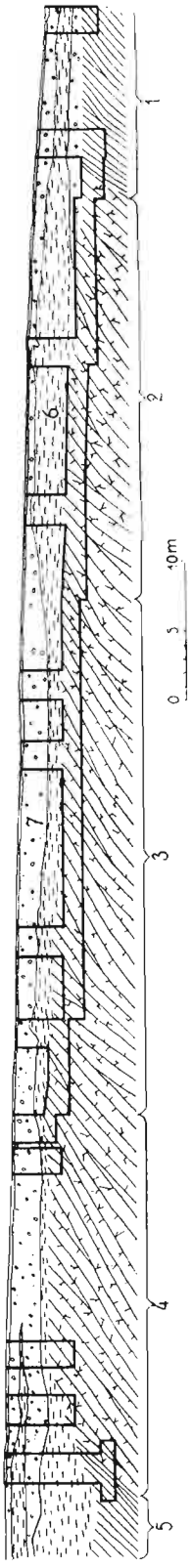


Fig. 1

Diagrammatic geologic map of the middle part of the Holy Cross Mountains (after J. SAMSONOWICZ: *in* M. KSIĄŻKIEWICZ & J. SAMSONOWICZ: Zarys Geologii Polski, Warszawa 1953)

1 Cambrian, *2* Ordovician and Silurian, *3* younger formations, *4* faults.



METHODS

Field work. — The palaeozoic rocks in the Holy Cross Mountains are usually covered by thick pleistocene deposits and loess, so that they are exposed only in river and stream valleys. On account of this any palaeontological exploration in this area calls for extensive excavation, including the digging of trenches or shafts.

The Upper Ordovician trilobites from the Holy Cross Mountains here described are chiefly from four localities: Wólka, Brzezinki, Zalesie and Stawy (see fig. 1). In three of them the Ordovician mudstones are exposed in part at the surface in the valleys of streams (Zalesie and Stawy), or in a ravine (at Wólka). In these localities the excavation was not very difficult and consisted only in the removal of the weathered rock and the digging of small trenches. At Brzezinki, where the mudstones were especially rich in fossils, the Ordovician deposits are not exposed, but are situated 3 to 6 m below the surface. In order to examine the complete section of the beds in question, the excavation was as follows: along a line perpendicular to the strike 12 shafts were dug, from 5 to 15 m from each other. The shafts were rectangular in section 1.20 × 1.20 m. Their depth depended on the occurrence of the unweathered mudstones and amounted to four or five metres on the average. The deepest shaft was eight metres deep. The shafts were connected below the surface by tunnels (see fig. 2), about 1.40 m heigh and 1 m wide. The direction of the tunnels approximately followed the direction of the dip of the beds. As the mudstones are poorly bedded and fractured irregularly, it was impossible to collect the fossils layer by layer. Therefore, every cubic metre dug in the tunnel was drawn out separately and the fossils collected from it marked by the successive number, proper to this metre. In such a way 110 cubic metres of the tunnel were dug and several thousands fossils (more than 3500 trilobites among them) collected.

Laboratory work. — Out of the fossils collected from the four localities, the trilobites have been separated and suitably marked. All the specimens have been examined under the binocular Zeiss microscope «Citoplast». The specimens have been prepared with needles of different sizes and also with a dental drill. As the mudstones, in which the trilobites are preserved, are soft and sometimes flake in water, the preparation of the fossils was comparatively easy. In the mudstones of Brzezinki and Wólka the trilobites sometimes were depressed, at other times, however, they were not distorted, being preserved as internal and external moulds. The external moulds as a rule show details of the ornamentation, so that

Fig. 2

Diagrammatic sketch of the Upper Ordovician section in Brzezinki. Straight lines indicate the trenches and tunnels

1 black graptolitic shales of *Pleurograptus linearis* zone, *2* yellow mudstones of *Eodindymene pulchra* zone, *3* yellow mudstones of *Staurocephalus clavifrons* zone, *4* unfossiliferous yellow mudstones, *5* black graptolitic shales of *Orthograptus vesiculosus* zone, *6* weathered mudstones, *7* alluvium.

latex casts have to be made from them in order to show the details of the external surface of the test. The latex used for this was coloured with Indian ink.

In the sandy mudstones of Zalesie and Stawy (*Dalmanitina* beds) the fossils were poorly preserved, usually depressed and latex casts could rarely be made from them.

The specimens were measured using fine calipers and an eye piece scale with a binocular microscope.

Most species were represented by numerous more or less depressed fragments. In order to obtain an idea of the appearance of the indistorted specimen the reconstructions were made. For each species many specimens were drawn on tracing paper, using the camera lucida. These drawing were reduced to the same size by a photographic enlarger, so that a composite drawing was produced. As however, as stated above, almost all the specimens are more or less depressed, the reconstructions obtained must be treated as somewhat tentative.

All the specimens and latex casts were coated with ammonium chloride before being photographed, with the exception of the specimen figured on pl. XXVII, fig. 1, which was photographed under alcohol.

TERMINOLOGY

The terminology used in this paper is with few exceptions chiefly that of WARBURG (1925, p. 1-7).

The median portion of the trilobite exoskeleton, delimited by the dorsal furrows, has been called in trilobite literature the rhachis or axis, but more recently the latter term has been more commonly used. As however «axis» has a generally accepted meaning of an ideal line dividing the body into two symmetrical portions, it seems unreasonable to use this term for a part of a body as well. Therefore the term «rhachis» is used in the present paper, and consequently there are rhachial rings instead of axial rings, and dorsal furrows instead of axial furrows.

The pleurae of the pygidium are considered to be marked off by pleural furrows, each pygidial pleura being divided by an interpleural furrow.

The terminology of the different types of ventral cephalic sutures, used in the present paper, corresponds to that of RASETTI (1952) and JAANUSSON (1956*a*).

In the terminology of the lateral glabellar lobes and furrows I follow JAANUSSON (1956*a*): the furrows and lobes being numbered from back to front, the lobes being lettered «L» *(lobus)*, the furrows «S» *(sulcus)*.

R. and E. RICHTER (1940, p. 16) suggested the use of the following directions of measurements: transverse (tr.) — perpendicular to the plane of symmetry; saggital (sag.) — longitudinal, following the axis; exsaggital (exsag.) — longitudinal, parallel to the axis. This terminology has been already accepted by several trilobite students. Comparable abbreviations have been used for a long time in the vertebrate literature, with the difference that there medial — means following the axis, and saggital — longitudinal, parallel to the axis. The use of RICHTER's terminology may thus cause confusion, concerning the term «saggital». Therefore in the present paper the term longitudinal (long.) is used to show the longitudinal direction, and if necessary it is explained, whether it follows the axis or is parallel to it.

One nomenclatural question, concerning the definition of the glabella in staurocephalids, has been recently discussed (KIELAN, 1957). It has been stated (*l. c.*, p. 163): «As usually defined, glabella forms a part of the cranidium; as the latter is limited by the facial and rostral

sutures, the rostral plate can neither belong to the cranidium, nor consequently to the glabella. On the other hand, the glabella may be defined as the convex, central portion of the cephalon, delimited in front by the preglabellar furrow, which seems to be more reasonable. But in *Staurocephalus* the preglabellar furrow runs across the rostral plate, topographically in front of the denticulated margin, dividing the rostral plate into two parts. If one accepts the latter definition, the anterior part of the rostral plate would belong to the glabella, but not the posterior part». In order to avoid misunderstanding, the first definition of the glabella (as a part of the cranidium) was accepted. The same problem arises with other trilobite groups, where the suture runs across the bulbous part of the cephalon on its dorsal side, as for example in *Encrinurus* EMMRICH, *Cromus* BARRANDE, or in *Eodindymene pulchra* (OLIN). For the bulbous part of the cephalon, lying in front of the cranidium, within the dorsal furrows (and formerly being a part of the glabella), the new term — precranidial lobe — is proposed.

STRATIGRAPHY

INDEX FOSSILS IN THE UPPER ORDOVICIAN

The shelly facies of the Ashgillian Series in Great Britain were recently divided by KING and WILLIAMS (1948; cf. also: BANCROFT, 1928, 1945; PUGH, 1929; LAMONT, 1935; WHITTINGTON, 1938) into three horizons: lower — *Diacalymene marginata* zone, middle — *Phillipsinella parabola* zone, and upper — *Dalmanitina mucronata* zone. In the *Phillipsinella parabola* zone there occurs *Staurocephalus clavifrons* and these beds are called in Sweden and Denmark (Bornholm) the *Staurocephalus clavifrons* zone. Equivalents of these three zones of Great Britain may be recognized also in Scandinavia, Poland and Bohemia.

The careful examination of the occurrence of the different trilobites, used as index fossils for separate zones, shows that hardly any of them are restricted to the zone, for which they were recorded as index fossils. It is a well known fact to all palaeontologists and zoogeographers that a fauna rarely disappears at the same time over a very large area. It is more common for some species to disappear in several regions, whilst remaining a long time in other regions, as relict forms.

Phillipsinella parabola and *Staurocephalus clavifrons* seemed to be good index fossils, with a wide geographical distribution, restricted to the Middle Ashgillian. *Ph. parabola* recorded in Scania (OLIN, 1906) from the *Chasmops* beds (= Upper *Ludibundus* beds) seems to belong to another species — cf. p. 38. In the Holy Cross Mountains both of them commonly occur in the *Staurocephalus clavifrons* zone, accompanied by *Lonchodomas portlocki* (BARRANDE), *Liocnemis recurvus* (LINNARSSON), *Amphitryon radians* (BARRANDE), *Oedicybele kingi* WHITTINGTON, *Raphiophorus tenellus* (BARRANDE), *R. gratus* (BARRANDE), *Tretaspis granulata* (WAHLENBERG), and many others. At the close of the *S. clavifrons* zone, in a large area of Europe, there appeared a sudden impoverishment of the fauna. The following zone, recognized in Scandinavia as the *Dalmanitina olini* zone, is characterized by an extremely poor fauna. The same conditions occurred in Poland and in some parts of Great Britain. Neither *Staurocephalus clavifrons*, nor *Phillipsinella parabola* are known from *D. olini* zone anywhere in Europe. But in the next zone, known as the *Dalmanitina mucronata* zone, which is characterized by an improvement of the faunal assemblage, *S. clavifrons* and *Ph. parabola* appear in Poland for the second time. They occur now in quite a different faunal assemblage from that in the zone of *S. clavifrons*. Both species and some other relicts of the *S. clavifrons* zone fauna survived

somewhere during the unfavorable time of the *D. olini* zone and then migrated back to Poland again. One can also assume that these species survived in Poland during the *D. olini* zone, being here very rare and therefore they have not been yet found in this zone. The finding of *Staurocephalus clavifrons* or *Phillipsinella parabola* alone cannot mean that we are always dealing with the *S. clavifrons* zone. Only the entire faunal assemblage characteristic of this zone may prove it. Therefore, I consider (comp. p. 15) the Red *Tretaspis* mudstones of Västergötland as equivalent to the *S. clavifrons* zone in Poland and Scania, though it is not quite certain whether *S. clavifrons* itself occurs there. Similarly, the beds above the Red *Tretaspis* mudstones in Västergötland, known as the «*Staurocephalus* beds», though yielding *S. clavifrons*, must be considered as equivalent to the passage beds between the zone of *S. clavifrons* and the *Dalmanitina* beds.

I do not consider there to be any reason for changing the name of the zone of *Staurocephalus clavifrons* on account of the argument given above. It is probably more practical to keep this well established name whilst recognizing that not a single index fossil, but the whole faunal assemblage must be taken into consideration in order to establish the presence of a given zone.

A similar question arises with regard to the zones of *Dalmanitina olini* and *D. mucronata*. *D. mucronata* occurs in Bohemia throughout the entire Ashgillian, similarly it occurs together with *Staurocephalus clavifrons* in Britain, Västergötland, Siljan district, and Scania, but it has been accepted as an index fossil for the uppermost part of the Ashgillian only. In the uppermost Ashgillian, *D. mucronata* is known in very many places in Europe, and it occurs accompanied by *Leonaspis olini* and *Brongniartella platynotus*.

The geographical distribution of *Dalmanitina olini* is not, however, so wide. It occurs in Great Britain, Scania and Poland in beds above the *S. clavifrons* zone and below the zone of *D. mucronata*. In some places in the beds intermediate between *D. olini* and *D. mucronata* zone both species occur together, and moreover *D. olini*, though very rare occurs also in the *D. mucronata* zone.

Nevertheless, I consider it useful to retain the names of both zones, being aware, however, that *D. olini* zone is a zone of a local character, above the *S. clavifrons* zone and below *D. mucronata* zone, characterized by the impoverishment of the fauna. *D. mucronata*, on the other hand, being the zone including the uppermost Ashgillian beds, with *D. mucronata* commonly occurring accompanied by the species cited above. In Poland, in the zone of *D. mucronata*, there occur species surviving from the *S. clavifrons* zone, as well as a new fauna which migrated to Poland from an unknown evolutionary centre.

STRATIGRAPHY OF THE UPPER ORDOVICIAN BEDS IN THE HOLY CROSS MOUNTAINS

The occurrence of the Upper Ordovician series in the Holy Cross Mountains has been recognized in two regions:

1. Along the northern flank of the Łysogóry range (sheet Kielce and Bodzentyn 1 : 100000),
2. In the Bardo syncline about 10 km south of the village of Łagów (sheet Staszów 1 : 100000).

The development of the Ordovician beds in both these regions is different. Along the northern part of the Łysogóry range there occur the lower and middle horizons of the Upper Ordovician comprising the following zones: 1) zone of *Pleurograptus linearis*, 2) zone of *Eodin-*

dymene pulchra, 3) zone of *Staurocephalus clavifrons*. The highest zones of the Upper Ordovician do not occur in this region. In the Bardo syncline, on the other hand, there occur the uppermost part of the Upper Ordovician, represented here by the zone of *Dalmanitina olini* and the zone of *D. mucronata*. The lower zones of the Upper Ordovician are not developed here. On account of the different stratigraphical, lithological and faunal development of the Ordovician sequence in both regions, they will be described separately.

UPPER ORDOVICIAN ALONG THE NORTHERN FLANK OF THE ŁYSOGÓRY RANGE

The strike of the Upper Ordovician beds here is along the valley situated to the north of the Łysogóry range. In the southern side of this valley there occur the Ordovician sediments, whereas in the middle and northern part of this valley the Silurian beds outcrop. The occurrences of the Ordovician have been already noted at Kajetanów, Brzezinki, Wólka, Dębniak and Jeleniów. It seems probable that in some places along this strip the Ordovician is absent, the Silurian beds resting directly on the Cambrian.

The presence of the Ordovician in this region was recorded for the first time by Czarnocki (1928*a*), who noted the occurrence in the locality of Wólka of light (yellow) shales yielding a trilobite fauna recognized by him as Ordovician. In 1929, Czarnocki reported the occurrence of similar beds in Kajetanów, correlated by him with beds from Wólka, but attributed this time to the Silurian. Later the same author (1939) gave a provisional list of the fauna collected in Wólka and also more detailed information on the stratigraphy of these beds. (The list of the fauna, identified by Czarnocki, has been reprinted by him in the paper of 1957, p. 15). One should mention that Wólka is the only locality of the Ordovician in this area, where the Ordovician beds occur exposed at the surface and are the most easily accessible. Unfortunately, the Ordovician at Wólka lies unconformably within the zone of faulting. In Wólka the Ordovician is in direct contact with the Cambrian beds, which have been thrust over the Ordovician beds. The contact of the Ordovician with Silurian is unknown in Wólka, as it is concealed under several metres of loess. The lowest Silurian zone exposed in Wólka, about 20 m away from the Ordovician mudstones, is that of *Cyrtograptus lundgreni*. Between the Ordovician and Silurian in Wólka there is a great hiatus probably of tectonic origin. In the Ordovician of Wólka, Czarnocki (1939) recognized two zones: a lower one in contact with the Cambrian and termed by him black shales with *Dicellograptus* sp., and an upper with a trilobite fauna, characterized by him (1939, p. 17) as: «grey marls with bluish shade in unweathered condition and yellow shales entirely decalcified when weathered». Contact between these two series has a tectonic character (comp. *l. c.*, pl. 2, fig. 2). In the light (yellowish) shales (mudstones) of Wólka there occurs a rich trilobite fauna, from which Czarnocki identified 32 species, calling the shales the «*Trinucleus* beds» and correlating them with the lower part of British Ashgillian and with the horizon Dd_5 of the Bohemian Ordovician.

In order to collect more trilobites from the light mudstones of Wólka, in 1952 I repeated the excavation there. During this work I dug the available series of the light mudstones, about 40 m of thickness. The beds are hard, yellow-green mudstones with a poor fauna, containing strongly depressed fragments of *Tretaspis granulata* (Wahlenberg) and *Trinodus tardus* (Barrande). There occur in the section two lenses characterized by a richer fauna. The first, called here lens No. 1, is the layer situated about 20 m above the contact with black shales. This lens has a lithological character a little different from the remaining mudstones. It is a soft,

light yellowish mudstone with bluish spots, with a rich trilobite fauna. The lens was 7 cm thick extending 8 m along the strike. The trilobites in this lens were depressed and poorly preserved.

2 m above the first lens was the second one. It represents the brownish-yellow mudstone, prolific in numerous and well preserved, undistorted trilobites. The trilobites collected by Czarnocki from Wólka came from this lens. This lens was almost entirely exploited by Czarnocki, but in my field work I found traces of it, so that I could define its approximate extent. It was about 10 cm thick, 6 m along the strike, and 2 m down the dip. If one accepts the conclusion of Czarnocki that the mudstones in Brzezinki are secondarily decalcified marls in the area of weathering, a conclusion which seems to be confirmed by my own observations, — it appears that the second lens in Wólka was previously more calcified than the surrounding mudstones, and therefore the trilobites preserved in it are not distorted, being preserved in a similar way as fossils in limestones. The assemblage of trilobites in both lenses in Wólka is closely comparable. The occurrence of *Staurocephalus clavifrons*, *Phillipsinella parabola*, *Carmon mutilus*, *Panderia megalophthalma* and others, shows that both lenses represent the *S. clavifrons* zone. The occurrence of the *Eodindymene pulchra* zone has not been established in Wólka with any certainty, but the graptolites, collected from the yellow-greenish mudstones of Wólka, show that we are also dealing with horizons lower than *S. clavifrons* zone (*Orthograptus truncatus* Lapworth, *Plegmatograptus nebula* Elles & Wood, *Climacograptus* cf. *scalaris miserabilis* Elles & Wood, and *Dicellograptus* sp.).

In 1938, J. Czarnocki together with B. Areń found a new occurrence of the Upper Ordovician beds on the northern side of the Łysogóry range — at Brzezinki. In 1939, they carried out field work to collect the fauna at this place. On account of the beginning of war in 1939, no data concerning the locality of Brzezinki were ever published. In 1953, I repeated the field work at Brzezinki. The Brzezinki section has given the most detailed information on the stratigraphy of the Ordovician on the northern side of the Łysogóry range. 110 consecutive metres of Upper Ordovician mudstones, diping 30 to 50°, and occasionally also 60° northwards, were excavated (comp. fig. 2). The thickness of this sequence is about 80 m. The section beginning in the southern part with black graptolitic shales yielding rare and badly preserved graptolites. 7 m of black graptolitic shales were dug. The contact with Cambrian rocks (or some lower part of the Ordovician) could not be demonstrated on account of the difficult water conditions. From the lower part of the graptolitic shales the following graptolites have been identified: *Orthograptus* cf. *truncatus* Lapworth, *O. calcaratus* Lapworth, *Orthograptus* sp. and *Dicellograptus* sp.; from the uppermost part of the graptolitic shales *Climacograptus styloideus* Lapworth, *C. minimus* Carruth and *Climacograptus* sp. have been identified. These data show that we are dealing here with the lowest horizon of the Upper Ordovician, i. e. with *Pleurograptus linearis* zone. Gradually the graptolitic shales pass into mudstones, at first bluish-green in colour, later yellowish-green and yellow. Between the graptolitic and mudstone series there is in Brzezinki a continuous deposition of sediment. The mudstone series in Brzezinki is, similarly to Wólka, uncalcareous, and the fossils are preserved in a similar way.

The identification of the trilobite fauna collected in Brzezinki has allowed me to recognize three horizons within the yellowish mudstones. In the lowermost part of the mudstones 25 m thick, resting on the graptolitic shales, there occasionally occur graptolites so badly preserved that only *Climacograptus* cf. *scalaris miserabilis* could be identified. The trilobites in these beds are rare, occurring in some layers only. *Eodindymene pulchra* Olin, being here rather common and not known from the beds above, was recognized as an index fossil for this horizon called *Eodindymene pulchra* zone. Here occurs also *Pseudosphaerexochus laticeps* Linnarsson, unknown from the higher beds, but it is represented in my collection by only a single specimen.

All the remaining trilobites found here, for example *Tretaspis granulata* (WAHLENBERG), *Trinodus tardus* (BARRANDE), *Lonchodomas portlocki* (BARRANDE) and *Cyclopyge quadrangularis* n. sp., occur also in the succeeding zone.

The beds (32 m thick) above the *Eodindymene pulchra* zone are identified as the *Staurocephalus clavifrons* zone. A large number of trilobite species and specimens occur here. Numerous species known already from the zone of *E. pulchra* were found; in addition to them there appear for the first time *Staurocephalus clavifrons* ANGELIN, *Phillipsinella parabola* (BARRANDE), *Ceraurinella intermedia* (KIELAN), *Panderia megalophthalma* (LINNARSSON), *Diacanthaspis decacantha* (ANGELIN), *Oedicybele kingi* WHITTINGTON, *Hammatocnemis tetrasulcatus* n. sp., *Opsimasaphus jaanussoni* n. sp., and others.

On the beds of *Staurocephalus clavifrons* zone rest series of about 23 m in thickness of unfossiliferous mudstones. In top of this series there rest black graptolitic shales again. The black shales yield *Orthograptus vesiculosus*. Between the Ordovician and Silurian in Brzezinki there is a break of tectonic origin, which spread over the uppermost Ordovician (*Dalmanitina* beds) and the lowermost Silurian *Glyptograptus persculptus* zone and *Akidograptus acuminatus* zone.

The Ordovician in Kajetanów, discovered by CZARNOCKI (1929) is not easily accessible and has not been investigated by me. In the collection handed over to me by CZARNOCKI, there are some specimens from Kajetanów, showing that the *Staurocephalus clavifrons* zone occurs there.

The Ordovician in Dębniak was recorded in a boring (CZARNOCKI, 1939), but the material was destroyed during the war.

With regard to the occurrence of the Upper Ordovician in Jeleniów, TOMCZYK stated (1957) that there occur black Caradocian graptolitic shales, including the *Climacograptus wilsoni* zone, *Dicranograptus clingani* zone and *Pleurograptus linearis* zone, on which rest yellow mudstones containing poor trilobite fauna. Within the trilobites collected by TOMCZYK in Jeleniów, I identified *Tretaspis granulata* (WAHLENBERG), *Phillipsinella parabola* (BARRANDE), *Staurocephalus clavifrons* ANGELIN and *Lonchodomas portlocki* (BARRANDE).

UPPER ORDOVICIAN IN THE BARDO SYNCLINE

The occurrence of the Upper Ordovician in the Bardo syncline was previously recorded in two localities — at Zalesie and Stawy — the latter locality situated about 1 km west of Zalesie. The Ordovician series in Zalesie were described for the first time by CZARNOCKI (1928*b*), who characterized the Ordovician there as including (p. 555): «the entire series of the Lower, Middle and Upper Ordovician». The thickness of the entire Ordovician there does not exceed 30 m. Within the Ordovician at Zalesie, CZARNOCKI recognized 18 layers. The lower part of the section (layers No. 1-6) was developed as sandstones, the middle part (layers 7-14) was defined by him as dolomites and dolomitic marls, the uppermost part (layers 15-18) as shales. From the lower part of the section several fossils, which proved the Lower Ordovician age of these beds (Tremadocian and in part Arenigian), were identified by him. The middle part of the section did not yield any fossils which could be properly identified, except some forms from layer 10, identified (*l. c.*, p. 558) as *Lingulella* sp., *Acrothele* sp. and *Climacograptus* sp. Lastly, from the upper part of the section, CZARNOCKI recorded a rich fauna from layers 16 and 18: *Dalmanites kiaeri* TROEDSSON (layer 16) and *D. mucronatus* BRONGNIART (layer 18). In correlating the Zalesie section with the Ordovician of the Baltic Region and Sweden, he

compared the layers 7-14 with the stages *D* and *E* of the Baltic Region and with the *Chasmops* and *Trinucleus* beds of Sweden, and the layers 15-18 with the stage *F* of the Baltic Region and the *Harpes* beds of Sweden.

This correlation was criticized by Troedsson (1935), since according to him the layers 16-18 are equivalents of the *Dalmanitina* beds of Sweden; with regards to the beds below them he states (*l. c.*, p. 501): «Because there is no palaeontological evidence for the classification of the dolomite beds (couches 7-15) their age remains an open question. I am inclined to assume a large hiatus at the top of the Ordovician within the dolomites, or between the dolomites and the *Dalmanites* beds».

The field work carried out by me in 1952-1953 at Zalesie and Stawy confirmed the doubts of Troedsson. In the preliminary note on the Upper Ordovician stratigraphy in the Holy Cross Mountains, I stated (Kielan, 1956, p. 59 of the summary): «...the identification of the trilobite fauna collected there (at Zalesie and Stawy) has led to the conclusion that the Zalesie profile does not represent all the Ordovician horizons, but the Lower Ordovician Series only (Tremadocian and also partly Arenigian) consisting of sandstones, on which rest the *Dalmanitina* beds». This conclusion is proved by the following facts: in the layers 11-14, defined by Czarnocki as Middle and in part Upper Ashgillian dolomites, the fauna is very poorly preserved and usually unidentifiable. These beds in Zalesie are, in my opinion, strongly weathered sandy mudstones. I have collected from them some poorly preserved traces of trilobites, which I identified as *Dalmanitina* sp. The equivalents of the beds in question are fortunately much better preserved at the locality of Stawy. Their identification with the Zalesie beds is easy to recognize, because layer 11 occurring in both sections is represented by very distinct, dark-red shale with hematite concretions. On this layer at Stawy there rests sandy mudstones 4.5 m thick, yielding in their lower part fairly well preserved and common specimens of *Dalmanitina olini*, with the different ontogenetic stages also preserved. No other species were found in these beds; 2 m above layer 11 there occur the beds yielding both *Dalmanitina mucronata* and *D. olini*, and in the beds resting on them, representing more pelitic yellowish mudstones, *D. mucronata* is predominant with *Raphiophorus acus* also occurring. On these beds rest unconformably graptolitic shales yielding *Climacograptus scalaris normalis* and *C. scalaris miserabilis*, above which *Akidograptus acuminatus* was found. Thus in Stawy we are dealing with the *Dalmanitina* beds, resting on the hematite shale (layer 11). Within the *Dalmanitina* beds in Stawy there is developed the zone of *D. olini* and the only lower part of the *D. mucronata* zone. The highest parts of the *D. mucronata* zone, developed in Zalesie (see below), which yield a rich fauna, are missing at Stawy, having been faulted out.

In the section of Zalesie, the uppermost part of the Ordovician series is more fully developed. The beds corresponding to the *D. olini* zone of Stawy are, as stated above, completely weathered, the fossils being almost unidentifiable. On them there rest, however, the mudstones of the *D. mucronata* zone, yielding at first only *D. mucronata*, and very rarely other species (top of the layer No. 15). This is equivalent to the beds with *D. mucronata* in Stawy. Above this layer there rest in Zalesie greenish and later yellowish mudstones yielding a very rich fauna of *Dalmanitina mucronata* (Brongniart), *Leonaspis olini* Troedsson, *Raphiophorus acus* (Troedsson), *Brongniartella platynotus* (Dalman), *Staurocephalus clavifrons* Angelin, *Phillipsinella parabola* (Barrande), *Trinodus tardus* (Barrande), *Whittingtonia* sp., and moreover an assemblage of quite new and for the moment undescribed trilobites. On these beds, representing the upper part of the *Dalmanitina mucronata* zone, rest conformably graptolitic shales, at first with *Climacograptus scalaris normalis*, and then some metres higher up with *Akidograptus acuminatus*.

Thus, the occurrence of the Lower and Middle Ashgillian beds in the Bardo syncline has not been established. With regard to the Upper Ordovician we are dealing here with only the *Dalmanitina* beds, including two zones (*D. olini* and *D. mucronata*), developed in a similar way as those in Scania and in some parts of Great Britain. The similarity of the sections described here to those of Scania applies also to the graptolitic shales at the top of the *Dalmanitina* beds.

The Zalesie section thus covers the Lower Ordovician sandstones, on which rest the beds identified by CZARNOCKI as dolomites, of which the age is still an open question. On them rest the *Dalmanitina* beds, delimited by the characteristic layer of hematite shale of unknown age.

CORRELATION OF THE UPPER ORDOVICIAN BEDS OF POLAND, SOUTHERN SWEDEN AND BOHEMIA

The term «Upper Ordovician» is applied in the present paper as generally defined in Scandinavia and Baltic Region (cf. THORSLUND, 1948; STØRMER, 1953; JAANUSSON & STRACHAN, 1954; KALJO, RÕÕMUSOKS & MÄNNIL, 1958). According to this definition, the lower boundary of the Upper Ordovician is drawn currently at the level corresponding to the boundary between the zone of *Dicranograptus clingani* and the zone of *Pleurograptus linearis*, the upper boundary between the Ordovician and Silurian Systems as defined in Great Britain. In Poland, the Upper Ordovician beds comprise the following zones: *Pleurograptus linearis* zone, *Eodindymene pulchra* zone, *Staurocephalus clavifrons* zone, *Dalmanitina olini* zone and *D. mucronata* zone.

The question of the reference of the «*Dalmanitina* beds» (JAANUSSON, 1944) and of the Ordovician-Silurian boundary was discussed by several authors. TROEDSSON (1918, 1920), following TULLBERG (1882, 1883), draw the Ordovician-Silurian boundary above the *Dalmanitina* beds. However later, the same author (TROEDSSON & ROSWALL, 1926; TROEDSSON, 1935, 1936) referred the *Dalmanitina* beds to the Silurian and was followed in this respect by THORSLUND (1935), WARBURG (1939), WAERN (1948), ALICHOVA (1957) and others. KIELAN (1956) treated the age of the *Dalmanitina* beds as an open question. More recently the problem has been investigated by JONES (1949), KAUTSKY (1949, 1953), HENNINGSMOEN (1954) and JAANUSSON (1956*c*), who proved the Ordovician age of the *Dalmanitina* beds.

A discovery of *Staurocephalus clavifrons* ANGELIN, *Phillipsinella parabola* (BARRANDE) and other Ashgillian species in the *Dalmanitina* beds of Poland (described in the present paper), is considered here as a new evidence towards the latter view. Thus, the *Dalmanitina* beds are referred here to the Upper Ordovician as an uppermost part of the Ashgillian.

It must be, however, stressed that the existing chronostratigraphical classification of the Upper Ordovician, as defined above, is somewhat confused. This applies especially to the term «Ashgillian», introduced by MARR (1905, cf. also 1907, 1913, 1916). According to KING and WILLIAMS (1948), (cf. also LAMONT, 1935, and WHITTINGTON, 1938), the Ashgillian in shelly facies is tripartite and not bipartite, as it has been formerly divided by MARR, being represented by three zones: lower — *Diacalymene marginata* zone, middle — *Phillipsinella parabola* zone, and upper — *Dalmanitina mucronata* zone.

The question is that we fall into great difficulties when trying to correlate the shelly facies of the Ashgillian with the graptolitic zones of Great Britain, and it is doubtful whether in the present state of our knowledge such a correlation is possible.

With regard to the correlation with the graptolitic succession, MARR (1913, p. 12) states: «it is evident that the Ashgillian Series is the zone of *Dicellograptus anceps*». ELLES & WOOD (1914, p. 526) state that the Ashgillian includes the zones of *Dicellograptus complanatus* and of *D. anceps*. The latter view was accepted by several authors. WHITTINGTON (1954) treats the Ashgillian as an equivalent of both graptolitic zones. JONES (1949) treats «Upper Bala» as a synonym of the Ashgillian, stating (*l. c.*, p. 10): «In the Lake district and at Cautley the lower beds of the Upper Bala contain *Dicellograptus anceps* only, whereas the Upper Hartefell shales of Scotland include two zones, *Dicellograptus anceps* above and *Dicellograptus complanatus* below». ELLES (1937) states that two horizons of the division of MARR are an equivalent of the zone of *Dicellograptus anceps*, whereas *D. complanatus* zone has a local character only, but in the stratigraphic table in the same paper this is not taken into account at all. It should be stressed, however, that in Scotland (Girvan) *Dicellograptus complanatus* occurs in the beds of the Upper Whitehouse group (cf. PRINGLE, 1948), the lower Whitehouse group yielding *Pleurograptus linearis*. If to accept the definition of the Ashgillian of KING and WILLIAMS (1948), the Upper Whitehouse group underlies the lowermost Ashgillian and consequently should be recorded as the Caradocian. Thus, it is not certain where the boundary between the Caradocian and the Ashgillian beds in graptolitic facies should be drawn and therefore it should be perhaps better to treat tentatively the Upper Whitehouse group as the «passage beds» between the Caradocian and the Ashgillian, realizing however that it may even belong to the Lower Ashgillian.

Dicellograptus complanatus is known also from Scania (Röstanga) (OLIN, 1906, p. 25), where it has been found in the uppermost part of the zone defined by OLIN as *Ampyx portlocki* zone, and in the lower part of the *Staurocephalus clavifrons* zone. Also in Västergötland, *Dicellograptus complanatus* was found (TÖRNQUIST, 1913, p. 426) in shales underlying the Green *Tretaspis* mudstones in Bestorp. In Bornholm *D. complanatus* is not known, but POULSEN (1936) found there numerous specimens of *D. anceps* var. *bornholmiensis*, in beds corresponding to the zone of *Staurocephalus clavifrons* (cf. JAANUSSON, 1956*c*, p. 388).

It should be also stressed that in Bohemia, where the Ashgillian is represented by the Králův Dvůr beds (beds equivalent to the zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons*), *Dicellograptus anceps* occurs according to recent evidence (CHLUPAČ, 1952, in manuscript), in the middle and in the lower part of the Králův Dvůr beds as well.

The discussion given above shows that both graptolitic zones (that of *Dicellograptus complanatus* and of *D. anceps*) cover each other to some extent and their exact vertical range is not certain. Therefore the correlation of Ashgillian in shelly facies with graptolitic succession is only tentative, and in the table of correlation (see p. 16) both graptolitic zones in question are cited in brackets.

The Lower Ashgillian is represented in the section of Brzezinki by the zone of *Eodindymene pulchra* on which rest the beds yielding *Staurocephalus clavifrons*. In Poland, *Eodindymene pulchra* occurs only in the Lower Ashgillian; in Scania it has been found only in one locality (Tommarp, loc. No. 6; cf. OLIN, 1906, p. 37), in the lowermost beds of the *Tretaspis* mudstones, 60-85 cm above the graptolite shales of the zone of *Pleurograptus linearis*. Therefore it is accepted as an index fossil for the Lower Ashgillian.

Within the «*Tretaspis* beds» of Scania, TULLBERG (1883) recognized two horizons: a lower — with «*Niobe*» *lata* and *Dicellograptus complanatus*, and an upper, defined as the *Staurocephalus* beds. According to OLIN (1906), the *Tretaspis* beds of Scania are divided into two zones: the lower zone of *Asaphus ingens* and *Ampyx portlocki*, the upper zone of *Staurocephalus clavifrons* and *Phacops eucentra*. Unfortunately, in the paper of OLIN (*l. c.*) there are

but few indications from which of the two horizons the trilobites described by him were derived. No list of trilobites collected from the lower and upper horizon was given. For this reason, it is difficult to get an idea of the stratigraphical value of the zones he recognized, especially as it now appears that neither «*Niobe*» *lata* (recte *Opsimasaphus latus*), nor *Asaphus ingens* occur in Scania. Therefore, in the present state of our knowledge on these beds, there is not yet a basis for dividing them into two horizons. The *Tretaspis* beds of Scania are equivalent to both the zone of *Eodindymene pulchra* and the zone of *Staurocephalus clavifrons* in Poland. It appears from the sections described by Troedsson (1918, p. 14, 16, 21) that in the upper part of the *Tretaspis* beds in Scania there occur beds yielding *S. clavifrons* and *Dalmanitina mucronata* as well. These beds are regarded here as an equivalent of the «passage beds» between the Middle Ashgillian and *Dalmanitina* beds, however tentatively only, as it is not certain whether *S. clavifrons* occurs lower than these beds.

The *Tretaspis* beds of Bornholm are not divided into smaller zones; they are equivalent to the *Tretaspis* beds of Scania — and therefore in the correlation table they are not taken into account.

The Upper Ordovician strata of Västergötland (Linnarsson, 1869*b*; Wiman, 1910; Henningsmoen, 1948) are developed as Black and Green *Tretaspis* shales and mudstones in the lower part, Red *Tretaspis* mudstones in the middle part, and *Staurocephalus* beds in the upper part. The *Staurocephalus* beds are superimposed by siltstones of the *Dalmanitina* beds, locally with limestones rich in corals. Except the *Dalmanitina* beds, the classification of the Upper Ordovician is in Västergötland lithostratigraphic, based mainly on the colour of the rock. The boundaries between the Black, Green and Red *Tretaspis* shales and mudstones do not correspond to those between the faunal units (cf. Henningsmoen, 1948), but the latter are still poorly known.

Between the *Staurocephalus* beds and the *Dalmanitina* beds there is a hiatus in Västergötland, which corresponds, according to Troedsson (1921), to the zone of *Dalmanitina olini*.

In a tentative correlation table of the Upper Ordovician beds in Southern Sweden, Poland and Bohemia (Kielan, 1956) I regarded the *Staurocephalus* beds of Västergötland as equivalent to the *Staurocephalus* beds of Scania. A further examination of the trilobite assemblage of the Red *Tretaspis* beds and the *Staurocephalus* beds of Västergötland, and a comparison with the fauna of Poland, has resulted in some slight modifications of my earlier correlation table.

The trilobite fauna yielded by the Red *Tretaspis* mudstones is very rich, being represented by 33 trilobite species. *Staurocephalus clavifrons* has not been found in these beds, and therefore they have been considered the equivalent of the Lower Ashgillian, whereas only the *Staurocephalus* beds resting on them — the equivalent of the *S. clavifrons* zone. During an excursion to Skogastorp and Skultorp in Västergötland, I found in the Red *Tretaspis* mudstones two specimens (cranidium and pygidium) of *Staurocephalus*, described as *Staurocephalus* sp. *c* (Kielan, 1957, p. 170, pl. 4, fig. 4-5). Both specimens are poorly preserved and could not been identified with any certainty, but it is very probable that they are conspecific with *Staurocephalus clavifrons*. Moreover, there occur in the Red *Tretaspis* mudstones several trilobite species, known from Poland from the *S. clavifrons* zone, and not occurring in Poland in the zone of *Eodindymene pulchra*, for instance: *Hammatocnemis tetrasulcatus* n. sp., *Dindymene longicaudata* n. sp., *Liocnemis recurvus* (Linnarsson) and others. It is the most probable that the Red *Tretaspis* mudstones are equivalent to the zone of *Staurocephalus clavifrons*, whereas the lower part of the Red *Tretaspis* mudstones and perhaps also a part of Green *Tretaspis* mudstones should correspond to the zone of *Eodindymene pulchra*.

Table 1

Correlations of the Upper Ordovician beds in Southern Sweden, Poland and Bohemia

			Graptolitic succession in Great Britain	Sweden		Poland		Bohemia
				Scania	Västergötland	Northern side of Łysogóry range (Brzezinki)	Bardo syncline	
Silurian	Llandovery		*Orthograptus vesiculosus* zone	*Orthograptus vesiculosus*	*Orthograptus vesiculosus*	*Orthograptus vesiculosus*	*Orthograptus vesiculosus*	*Orthograptus vesiculosus*
			Akidograptus acuminatus zone	*Akidograptus acuminatus*	*Akidograptus acuminatus*	Unknown	*Akidograptus acuminatus*	*Akidograptus acuminatus*
			Glyptograptus persculptus zone	*Climacograptus scalaris normalis*	*Climacograptus scalaris normalis*		*Climacograptus scalaris normalis*	*Akidograptus ascensus*
					Hiatus			Hiatus
Ordovician	Ashgillian	Upper Ashgillian	Shelly facies	*Dalmanitina* beds	*Dalmanitina* beds		*Dalmanitina* beds	Kosov beds
					Hiatus			
		?Passage beds	(*Dicellograptus anceps* zone)	Beds yielding *S. clavifrons* and *D. mucronata*	*Staurocephalus* beds	Unfossiliferous beds	Hiatus until the Lower Ordovician	Upper Králův Dvůr beds
		Lower and Middle Ashgillian	(*Dicellograptus complanatus* zone)	*Tretaspis* mudstones	Red *Tretaspis* mudstones	*Staurocephalus clavifrons* zone (mudstones)		Middle and Lower Králův Dvůr beds
					Green *Tretaspis* mudstones	*Eodindymene pulchra* zone (mudstones)		
	Caradocian		*Pleurograptus linearis* zone	Black graptolitic shales with *Pleurograptus linearis* and *Climacograptus styloideus*	Black *Tretaspis* shales	Black graptolitic shales with *Climacograptus styloideus*		Bohdalec beds

On the beds yielding *Staurocephalus clavifrons* in Brzezinki there rest the mudstones — 25 m thick, which are completely unfossiliferous.

In the *Staurocephalus* beds in Västergötland resting on the Red *Tretaspis* mudstones, the fauna is rather poor in comparison with rich fauna of the Red *Tretaspis* mudstones. There occur here *Staurocephalus clavifrons*, *Phillipsinella parabola* and *Pseudosphaerexochus laticeps*, and in addition to these species passing from the Red *Tretaspis* mudstones, a new species *Dalmanitina mucronata* occurs for the first time. The «*Staurocephalus* beds» in Västergötland are intermediate in character between the middle and uppermost Ashgillian, i. e. between the Red *Tretaspis* mudstones and the *Dalmanitina* beds.

In the Holy Cross Mountains, on the other hand, there are no beds with such an intermediate fauna between the zone of *Staurocephalus clavifrons* and the *Dalmanitina* beds. In the lower part of the zone of *Dalmanitina mucronata* in Zalesie, in addition to *D. mucronata* and *Leonaspis olini*, there occur some rare fragments of *Trinodus tardus*, *Staurocephalus clavifrons* and *Phillipsinella parabola*. In spite of the rare occurrence of these species, the general faunal assemblage is quite different from that characterizing the zone of *S. clavifrons* and many new species occur (the majority of which is too poorly known to be described). It is also of great interest that in the Holy Cross Mountains, in contrast to the conditions in Sweden and Bohemia, *Dalmanitina mucronata* does not occur, even in the uppermost part of the *S. clavifrons* zone. It seems that the beds with the intermediate fauna are not preserved in the Holy Cross Mountains, or that to such beds correspond the unfossiliferous mudstones resting on the mudstones with *S. clavifrons* in Brzezinki.

In the original division of the Palaeozoic beds of Central Bohemia established by Barrande (1846*a*, 1852), the uppermost part of the Ordovician beds was designated Dd_5. In the course of more than a hundred years of extensive geological and palaeontological exploration of Palaeozoic beds by Czech scientists, Barrande's classical division has been greatly altered and the «Barrandian» divided in more detail.

Krejči (1860) divided the Dd_5 beds into two units: the lower — beds designated the Králův Dvůr beds, and the upper — the Kosov beds (after the name of localities: Králův Dvůr village near Beroun, and Kosov hill near Králův Dvůr). Kettner and Kodym (1919) called the Dd_5 beds — the Zdice beds (after the village of Zdice) designating them according to a new, more detailed stratigraphical division as $d\zeta$, the Králův Dvůr beds being designated $d\zeta_1$, and the Kosov beds — $d\zeta_2$. This division and designations have been adopted up to the present (Bouček, 1937; Kettner & Prantl, 1948; Prantl & Přibyl, 1949, and others).

The recognition of the smaller stratigraphic units in the Králův Dvůr beds has been made by Kodym (1919) and more recently by Chlupač (1951*a*, 1951*b*, 1952, 1953) and Marek (1952). Chlupač (1951*a*) gave the detailed stratigraphy of the Králův Dvůr beds at the locality of Velká Chuchle and later (1951*b*) at the localities of Karlík and Zadní Třebaň. In this latter paper he correlated the sections of these three localities.

Chlupač (1951*b*, 1952) has recognized within the Králův Dvůr beds three horizons, the lowest yielding *Dicellograptus anceps* Nicholson, *Amphitryon radians* (Barrande), *Colpocoryphe declinata* (Hawle & Corda), *Tretaspis granulata* (Wahlenberg), *Phillipsinella parabola* (Barrande) and many other trilobites (31 species altogether). The middle layer with a similar faunal assemblage with *Dicellograptus anceps*, but also with *Climacograptus angustus* (Perner), *Tretaspis granulata*, *Phillipsinella parabola*, *Trinodus tardus* (Barrande), and *Dindymene fridericiaugusti* Hawle & Corda. The assemblage of trilobites in both horizons is similar, but in the middle one, more species occur. The exact correlation between the zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons*, and two above discussed horizons

of Bohemia is difficult, but the occurrence of 17 common species in these horizons of Bohemia and in Holy Cross Mountains, shows that the lower and middle horizons of the Králův Dvůr beds of Bohemia may be together considered equivalent to the zone of *Eodindymene pulchra* and zone of *Staurocephalus clavifrons* in Poland. It is worth mentioning that, in both the Bohemian horizons mentioned above, there occurs *Dalmanitina mucronata*, which has not been found in the equivalent zones in Poland. With regard to the third horizon of Chlupač division, in the beds overlying the horizon with *Climacograptus angustus* (Perner), at Karlík and Zadní Třebaň there are intercalations of marly limestone yielding a rich fauna of *Stenopareia oblita* (Barrande), *Octillaenus hisingeri* (Barrande), *Dalmanitina socialis grandis* (Barrande), (recorded here as a junior subjective synonym of *D. mucronata* (Brongniart)), *Dalmanitina morrisiana* (Barrande) and *Cryptolithus ultimus* (Barrande). Chlupač (1951*b*, p. 211) stated: «This association differs from the normal one of the Králův Dvůr Shales and is very resembling to the fauna known from the Barrande's locality «Kosov»... From the petrographical point of view, the material from the locality «Kosov» resembles very much our material from the localities at Karlík and Zadní Třebaň. Therefore, I consider that one from the locality «Kosov» belongs to the upper part of the Králův Dvůr Shales».

This conclusion of Chlupač has been proved by Marek who (1952) has discovered in the uppermost part of the Králův Dvůr beds at Kosov a layer of calcareous shale with *Dalmanitina mucronata* (Brongniart), *D. morrisiana* (Barrande), *Stenopareia oblita* (Barrande), *Octillaenus hisingeri* (Barrande), *Actinopeltis insocialis* (Barrande), *Dindymene fridericiaugusti* Hawle & Corda, *Cryptolithus cosoviensis* Marek, *Calymene asperula* Novák Ms., *Acanthaloma mirka* Marek (recorded here as a junior subjective synonym of *Leonaspis olini* Troedsson), *Nileidarum* gen. indet., and other, non-trilobite species. This uppermost layer of the Králův Dvůr beds lies directly below the Kosov quartzites, and shows the intermediate character between the fauna of the middle part of the Králův Dvůr beds (Lower and Middle Ashgillian) and the fauna of the *Dalmanitina* beds. The occurrence of *Leonaspis olini* would suggest that this zone belongs to the uppermost Ashgillian; on the other hand, there occur also the characteristic species of the Middle Ashgillian. In this layer we are dealing with the decline of the Middle Ashgillian fauna and the appearance of fossils characteristic of the uppermost Ashgillian such as *Leonaspis olini*. The upper part of Králův Dvůr beds (locality of Kosov of Barrande, 1852, 1872, and Marek, 1952, as well as a «pelocarbonatic layer at Zadní Třebaň» of Chlupač, 1951*b*) — should be treated in part as equivalent to the unfossiliferous «passage beds» of Brzezinki — in the Holy Cross Mountains, and the *Staurocephalus* beds of Västergötland, and in part as equivalent of the lower part of the *Dalmanitina* beds of these countries.

The age of the Kosov quartzites overlying the Králův Dvůr beds has been for a long time an open question, on account of the lack of any faunal evidence from these beds. Troedsson (1936) and Bouček (1937) have recorded the Kosov beds as a basal sediment of the Silurian. More recently, however, Bouček (1953) has recorded the discovery of a further graptolitic zone, viz. that of *Akidograptus ascensus* in the Lower Silurian below the zones of *Orthograptus vesiculosus* and *Akidograptus acuminatus*. The beds yielding *A. ascensus* overlay the Kosov beds, the latter being therefore presumably of Ordovician age. Similarly, Röhlich and Chlupač (1952) are of the opinion that the Kosov beds are of Ordovician age. The question has fortunately been resolved in recent years by the discovery of a real Ordovician fauna in the Kosov beds in several places in Bohemia. Prantl and Přibyl (1944) have described *Eohomalonotus (Eohomalonotus) foveolatus* Prantl & Přibyl from the upper part of the Kosov beds in the boring at Tachlovice, fragmentary specimens of *Glyptograptus* sp. and *Climaco-*

graptus sp. being found together. Similarly, *E. (Eohomalonotus) foveolatus* has been found by HAVLÍČEK in the upper part of Kosov beds at Běchovice (cf. MAREK, 1951). However, the most interesting is the discovery by MAREK (1951) in the uppermost layers of Kosov beds, at Nová Ves near Prague, of *Dalmanitina mucronata* (BRONGN). and *Brongniartella inexpectata* (BARRANDE). Both trilobite species here mentioned prove the Ordovician age of the Kosov beds.

A correlation of the uppermost part of the Ashgillian of Scandinavia, Poland and Bohemia is now comparatively easy. In the uppermost Ashgillian of Scania and Västergötland there occur the beds known commonly as the «*Dalmanitina* beds», in which *Leonaspis olini* and *Brongniartella platynotus* accompanied by *Dalmanitina mucronata* have been identified. The same trilobite assemblage has been identified in the Holy Cross Mountains, in the Upper Ordovician of the Bardo syncline.

In the uppermost part of the Králův Dvůr beds discussed above in Bohemia there occur also *Leonaspis olini* and *Dalmanitina mucronata*. It is probable, but not however sure, that *Brongniartella inexpectata* (BARRANDE), recorded by MAREK from the Kosov beds, is conspecific with *Brongniartella platynotus* (DALMAN). Thus, on the whole area from Västergötland, through Scania, Holy Cross Mountains and Bohemia, there occur in the uppermost Ashgillian three common species: *Dalmanitina mucronata*, *Leonaspis olini* and *Brongniartella platynotus*, which render possible a precise correlation of these beds.

One should, however, mention that in addition to the three species mentioned here, there occur in the Holy Cross Mountains in the zone of *Dalmanitina mucronata* a rich fauna of other trilobites, some of which are described in the present paper, the remaining being entirely new forms which are imperfectly known and must remain unfortunately for the time being undescribed. A similar fauna has not been reported from other regions. Moreover, the uppermost Ordovician is represented in Bohemia by the very thick Kosov quartzites with an extremely poor fauna. Beds of the same age represented in the Holy Cross Mountains by the mudstones only several metres thick. These mudstones in the Holy Cross Mountains are in some layers coarse grained. In Sweden there occur in the beds of the same age mudstones and sandy shales.

In the Lower and Middle Ashgillian the conditions all over Southern Sweden, Poland and Bohemia were fairly similar — causing the deposition of similar mudstones yielding rich trilobite fauna. At the close of the Ordovician, in the uppermost Ashgillian the sea became shallower in Sweden, Poland and Bohemia, but there were evidently differences in the depth of that sea. In Sweden, TROEDSSON (1935, 1936) suggested that the sea there became shallower towards the end of the *Tretaspis* shales and ultimately an emergence occurred in this region. According to KAUTSKY (1953, p. 121) in the other occurrences of the *Dalmanitina* beds in Sweden (in Västergötland and Västerbotten) there are two stratigraphical breaks above and below the *Dalmanitina* beds. At any rate, the uppermost Ashgillian is represented in Sweden by sandy beds, deposited in a very shallow water and yielding a scanty fauna.

Similarly the Kosov quartzites in Bohemia are the sediments deposited in very shallow water and are characterized by an extremely scanty fauna.

The *Dalmanitina* beds in Poland are represented still by mudstones. These mudstones are more sandy than those of the zones of *Eodindymene pulchra* and *Staurocephalus clavifrons* in the section of Brzezinki, and are deposited in the evidently shallower water than the mudstones of the Lower and Middle Ashgillian. But in the zone of *Dalmanitina mucronata* in the Holy Cross Mountains there occurs a rich fauna of trilobites and no evidence is available that any emergence occurred there. In spite of the differences in the thickness, in the lithological character

and in quantity of the fossils, the occurrence of the three common index fossils seems to prove that they are of the same age.

It is also worth mentioning that in a boring in Dębniak (near Wólka), Czarnocki (1950, p. 247-250) stated the occurrence of some metres of sandstones, below the Silurian graptolitic shales and above the mudstones, yielding the trilobite fauna. The occurrence of similar sandstones was stated by Tomczyk (1957) in a new boring in Dębniak. There is no faunal evidence from these sandstones but their stratigraphical position prove that they are of the uppermost Ashgillian age. Czarnocki (1950) identified from the mudstones, underlying the sandstones, *Dalmanitina* sp. If this means that we are dealing here with *D. mucronata*, it would be possible to assume that the *Dalmanitina* beds occur along the northern side of Łysogóry range, their top being here developed as sandstones. This would render possible a more precise comparison of the conditions during the deposition of *Dalmanitina* beds between Scandinavia, Poland and Bohemia. As however, as stated above, there is no faunal evidence from these sandstones, the above considerations must remain for the time being entirely tentative.

The more detailed correlation of the Upper Ordovician beds of Bohemia, Poland, Scandinavia and Great Britain, with more distant regions characterized by the different faunal assemblage, would be beyond the scope of the present paper. With regard to the Baltic provinces, a detailed correlation of the Swedish and Norvegian Upper Ordovician beds with those of Estonia was done by Jaanusson (1956*c*).

With regard to North American regions, a tentative correlation with the Upper Ordovician beds of Percé, Quebec, Canada (cf. Clarke, 1905; Schuchert, 1930; Kindle, 1936) may be done. In the Upper Ordovician Whitehead formation of Percé, there occur a rich fauna of brachiopods, corals, trilobites, cephalopods and rare graptolites (Cooper, 1930; Cooper & Kindle, 1936; Foerste, 1936; Ruedemann, 1936). The fossils are preserved in limestones, and the general assemblage of the fauna (the occurrence of corals and cephalopods) is different from that characteristic of the Ashgillian Central European mudstones, discussed in the present paper. The Whitehead formation assemblage seems to be more like that characteristic of the Siljan reef limestone and Keisley limestone, as it has been already stressed by Schuchert (1930, p. 170) and Cooper & Kindle (1936, p. 349). In fact, among the trilobites of Percé there are several forms showing «Dalarna» and «Keisley» affinities, however, on the other hand, there occur a number of species (the representatives of the genera *Sphaeragnostus*, *Novaspis*, *Ogmocnemis*, *Cyclopyge*, *Raphiophorus*, *Lonchodomas*, *Tretaspis* and *Leonaspis*), showing closer affinities with the fauna of the Ashgillian European mudstones of Great Britain, Poland, Bohemia and Scandinavia. Thus, in the Whitehead formation the fauna of both Ashgillian European facies (reef limestones and mudstones) is mixed, and this may be taken as a new evidence for correlating all these beds.

GEOGRAPHICAL DISTRIBUTION OF TRILOBITES IN THE UPPER ORDOVICIAN SEAS OF EUROPE

The general knowledge of the Upper Ordovician European trilobites is still very scanty. The field work carried out in the Holy Cross Mountains has enabled me to recognize 19 new trilobite species and subspecies from this region, belonging often to new genera and even families, and moreover has shown that there occur at least twice as many further new species which are as yet unsufficiently known to be properly described. I fully realize that if more fossils are collected from other places in Europe, even just those mentioned in the present

paper, let alone new areas and localities, the general pattern of the distribution and migration of trilobites in the Upper Ordovician European seas would be changed to a very great extent. The conclusions drawn here, however, only reflect the present state of our knowledge of this subject.

In discussing the distribution of trilobite species (comp. the list on p. 28), it was necessary to count the number of species occurring in separate zones of the Upper Ordovician in the different regions. This was done by accepting the following points:

1. The incompletely known species, such as for example *Geragnostus* sp. and *Actinopeltis* sp. *a*, are without doubt separate species. They could not be recognized on account of the scanty material available, but when more specimens are collected, it should be possible to give them specific names. In the following discussion therefore all such forms are treated as species.

2. It is accepted that a species occurs in a given region, even though there may be some slight doubt about it, as for example in the occurrence of *Proceratocephala terribilis bituberculata* n. subsp. and *Whittingtonia whittingtoni* n. sp. in Scania.

3. Similarly species identified, as for example *Actinopeltis globosa* (BARRANDE) from Bohemia and *Actinopeltis* cf. *globosa* (BARRANDE) from the Holy Cross Mountains, are treated here as conspecific. An exception is *Octillaenus hisingeri* (BARRANDE) from Bohemia and *O.* cf. *hisingeri* (BARRANDE) from Scania (comp. TROEDSSON, 1924). As this species has not been recorded from Poland, one cannot accept that Scanian and Bohemian forms are conspecific, and they are treated here tentatively as separate species, endemic for each region in question.

ZONES OF **EODINDYMENE PULCHRA** AND OF **STAUROCEPHALUS CLAVIFRONS**

(text-fig. 3)

The lower and middle horizons of the Ashgillian in the Holy Cross Mountains were recognized respectively as the zone of *Eodindymene pulchra* and the zone of *Staurocephalus clavifrons*. From the reasons given in the chapter «Stratigraphy», the exact equivalents of these horizons in the neighbouring regions (Bohemia, Bornholm, Scania and Västergötland) could not be defined with certainty. Therefore, when discussing the geographical distribution of the trilobites, the zones of *E. pulchra* and *S. clavifrons* are treated together. In the neighbouring regions they correspond to: in Bohemia — the lower and middle horizons of the Králův Dvůr beds (CHLUPAČ, 1951*a*, 1951*b*, 1952); in Bornholm — the *Tretaspis* beds (Trinucleusskifer of RAVN, 1899); in Scania — the *Tretaspis* beds (Trinucleuslager of OLIN, 1906); in Västergötland — the Green and the Red *Tretaspis* mudstones (HENNINGSMOEN, 1948) = (Trinucleidskiffer of LINNARSSON, 1869*b*, Trinucleusschiefers of WIMAN, 1910).

In Scania as well as in Bornholm the beds discussed are represented by grey mudstones, sometimes well bedded, yielding similar assemblages of trilobites. There are, however, some species known from Scania, which have not been found in Bornholm, but this seems to be due to the larger collections from Scania. Therefore, in the present discussion Bornholm and Scania are treated as one region.

The discussion of the present paper is concerned mainly with four regions: Bohemia, Holy Cross Mountains, Bornholm — Scania and Västergötland, for which detailed information concerning the occurrence of trilobite species has been recorded. The regions situated further west (Oslo region, Great Britain, and Quebec, Canada), which in spite of some species in

common are characterized by different faunal assemblages, are considered only for comparison.

From the four regions in question, 113 trilobite species have been described from the beds corresponding to the zones of *Eodindymene pulchra* and *Staurocephalus clavifrons* (comp. fig. 3). The total number of species living in this area was certainly much greater; in all the collections there are fragments of a good many new species, too fragmentary to be described.

There are 64 species known from the Holy Cross Mountains, 43 from Bornholm-Scania, 33 from Västergötland, and 40 from Bohemia. It appears that the fauna in the Holy Cross Mountains was richer than in the neighbouring regions, but this may be due to the fact that more fossils were collected from this region.

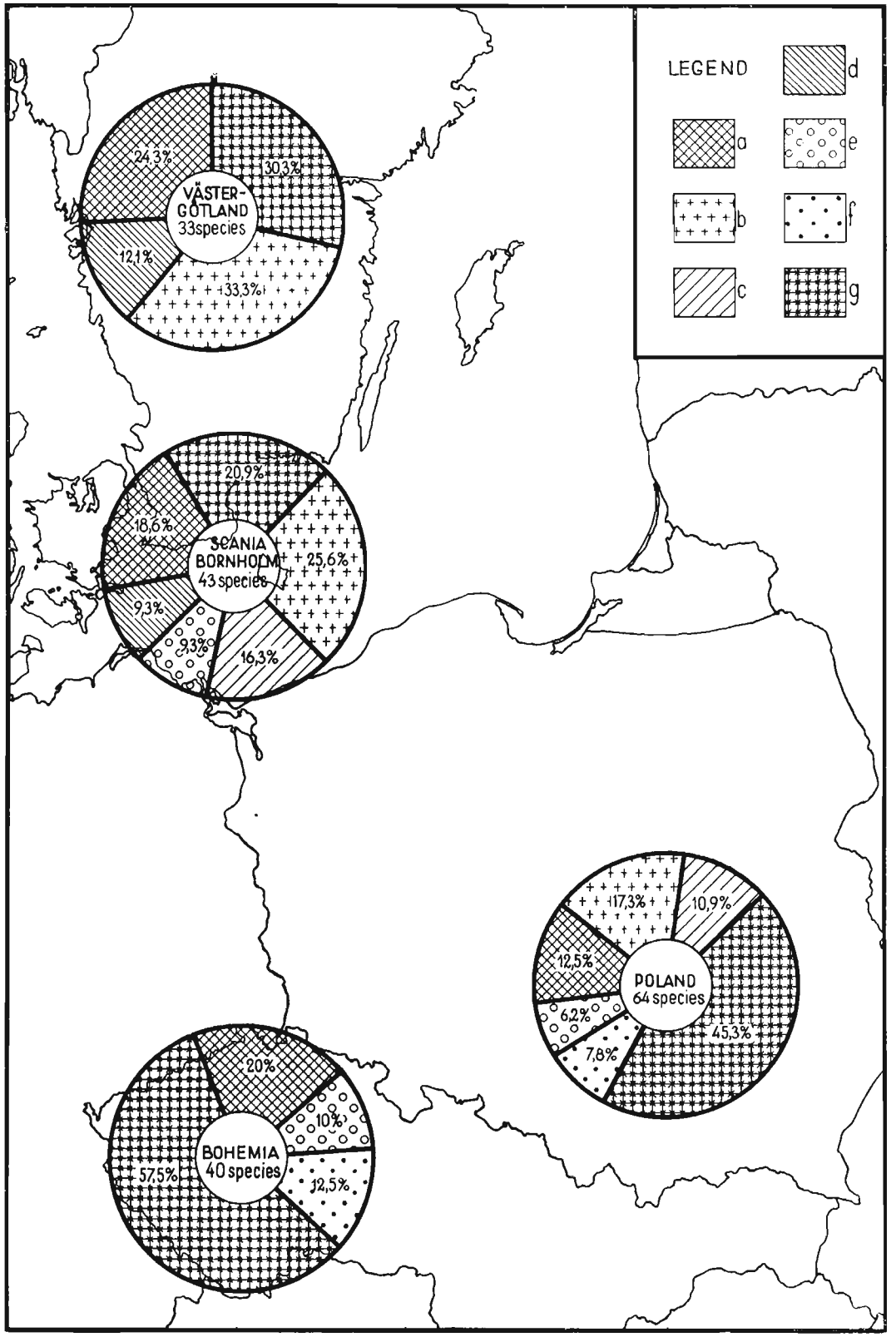
Among 113 species recorded from the four regions, there are 8 species which occur throughout the entire area. They are: *Trinodus tardus* (Barrande), *Amphitryon radians* (Barrande), *Cyclopyge speciosa* (Barrande), *Phillipsinella parabola* (Barrande), *Dindymene heidingeri* Barrande or *D. ornata* Linnarsson (regarded here as conspecific, see p. 147), *Lonchodomas portlocki* (Barrande), *Tretaspis granulata* (Wahlenberg) and *Tretaspis seticornis* (Hisinger). All these species, except *T. seticornis* which is rare, belong to the most common fossils in all the regions. Some of them have a greater geographical distribution, occurring also in the Oslo region and in Great Britain. *Phillipsinella parabola* has the widest geographical distribution, being known not only from the Oslo region and Great Britain (North Wales, South Wales, Lake District, West Yorkshire and Girvan), but also from Portugal (Delgado, 1908). *Cyclopyge speciosa* is a common species in all four regions. In Britain there occurs *Cyclopyge bumasti* Reed (in Girvan), similar to *C. speciosa*, but it is too poorly known to be discussed. *Tretaspis granulata* is the most common species in both the zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons* in the Holy Cross Mountains. Its remains are common even in beds in which almost no other species have been found, as for instance in greenish hard mudstones resting on graptolitic shales in Wólka. It is also the most common fossil in all the other regions. Besides these areas it has been recorded also from the Oslo region, though it is very rare there. In Britain, *Tretaspis granulata* does not occur, but is replaced by the closely related species recorded by Reed (1935, p. 3) as *Trinucleus ceriodes* var. *scotica*. The second tretaspid species — *Tretaspis seticornis* — on the contrary is very common in Norway and seems to be more rare in Västergötland and Scania, but very rare in Poland and Bohemia. Its main distribution falls, however, into beds corresponding to the zone of *Pleurograptus linearis*. *Lonchodomas portlocki* occurring in large numbers in all the regions, does not spread into Great Britain, where in the corresponding beds there occur, however, the closely related species *L. drummuckensis* (Reed). *Dindymene heidingeri* or *D. ornata* is known only from the four regions; similarly *Amphitryon radians* occurs only in the four regions discussed. It is of great interest that this species seems to be especially common in Västergötland, a little less common in Scania and Bornholm, rather rare in Poland, and again abundant in Bohemia. But it is not quite certain whether the Västergötland specimens identified as *Remopleurides radians* Barrande (Linnarsson, 1869*b*) are in fact conspecific with the Bohemian representatives of this genus. Remopleuridid material

Fig. 3

Diagram showing the percentage distribution of trilobite species in the Lower and Middle Ashgillian in Bohemia, Poland, Scania-Bornholm and Västergötland

a 8 species common for Bohemia, Poland, Scania-Bornholm and Västergötland, *b* 11 species common for Poland, Scania-Bornholm and Västergötland, *c* 7 species common for Poland and Scania-Bornholm, *d* 4 species common for Scania-Bornholm and Västergötland, *e* 4 species common for Bohemia, Poland and Scania-Bornholm, *f* 5 species common for Bohemia and Poland, *g* species endemic for every region (23 in Bohemia, 29 in Poland, 9 in Scania-Bornholm, 10 in Västergötland).

On the list enclosed (cf. p. 28) there are 44 species recorded from the *Tretaspis* beds of Scania, but *Dalmanitina mucronata* occurring in the uppermost part of these beds, which are probably an equivalent of the «passage beds», has not been taken into account in this diagram.


LEGEND
a
b
c
d
e
f
g
VÄSTER-
GÖTLAND
33species
24,3%
30,3%
12,1%
33,3%
SCANIA
BORNHOLM
43 species
20,9%
18,6%
25,6%
9,3%
9,3%
16,3%
POLAND
64 species
17,3%
10,9%
12,5%
6,2%
7,8%
45,3%
BOHEMIA
40 species
20%
10%
57,5%
12,5%

from Great Britain belongs to quite different species, and no one species which could be compared to *Amphitryon radians* is known from this area. Lastly *Trinodus tardus* is a very common species in the four regions, especially in Poland. It is not certain whether it occurs also in Great Britain. If *Trinodus agnostiformis* McCoy, occurring in the same beds in Great Britain, is not conspecific with *T. tardus*, it is certainly very closely related to it.

There are 11 species not known from Bohemia, but occurring in Västergötland, Scania-Bornholm and Poland. They are: *Staurocephalus clavifrons* Angelin, *Oedicybele kingi* Whittington, *Dindymene longicaudata* n. sp., *Pseudosphaerexochus laticeps* (Linnarsson), *Liocnemis recurvus* (Linnarsson), *Diacanthaspis decacantha* (Angelin), *Panderia megalophthalma* Linnarsson, *Ectillaenus leptopleura* (Holm), «*Illaenus*» *angelini* Holm, *Stygina* sp. and *Stubblefieldia* sp.

Staurocephalus clavifrons and *Oedicybele kingi* occur not only in the three regions, but also in Great Britain. *O. kingi* is one of the less common fossils in all these regions. *S. clavifrons*, on the contrary, seems to be very common in Poland (in the zone of *S. clavifrons*) and fairly common in Scandinavia (Bornholm, Scania, Västergötland and Siljan district). In Västergötland and in the Siljan district it is common in the so-called *Staurocephalus* beds, which are treated here as equivalent to the passage beds between the *Staurocephalus clavifrons* zone and *Dalmanitina* beds. It probably occurs also in the Red *Tretaspis* mudstones (comp. *Staurocephalus* sp. *c*; Kielan, 1957), being however rare in these beds. *Liocnemis recurvus* and *Panderia megalophthalma* are fairly common species in all the three regions, being unknown from any other area. *Pseudosphaerexochus laticeps* is very common in Västergötland, common in Scania and Bornholm, but in Poland it is represented by a single specimen only, found in the zone of *Eodindymene pulchra*, being unknown from the zone of *Staurocephalus clavifrons*. *Dindymene longicaudata* n. sp., on the contrary, is a very common species in the zone of *S. clavifrons* in Poland, but is comparatively rare in Scania-Bornholm and Västergötland. *Stygina* sp. and *Stubblefieldia* sp. — forming evidently a new species too poorly known to be described at present — are rather rare forms, occurring in Poland and Västergötland, and probably also in Scania-Bornholm. Lastly *Ectillaenus leptopleura* and «*Illaenus*» *angelini* are only known with certainty from Västergötland. «*Illaenus*» *angelini* has been cited by Olin (1906) from Scania too, but is represented there by a single, poorly preserved cephalon. In Poland, it is represented by a related form «*Illaenus*» cf. *angelini*. *Ectillaenus leptopleura* is known from Västergötland and (*E.* cf. *leptopleura*) from Poland. If it occurs in these two regions, its occurrence in Scania and Bornholm must be accepted too on account of the geographical position of these regions.

There are 7 species of which the occurrence is restricted to two regions only: Poland and Scania-Bornholm. They are: *Zdicella bornholmiensis* n. sp., *Zbirovia longifrons* (Olin), *Proceratocephala terribilis bituberculata* n. subsp., *Whittingtonia whittingtoni* n. sp., *Ceraurinella intermedia* (Kielan), *Eodindymene pulchra* (Olin) and *Dionide subrotundata* n. sp.

Proceratocephala terribilis bituberculata is a very rare species in both regions. It is of great interest, that this species has its equivalent in Great Britain (Scotland) in the beds of the same age (Upper Drummuck Group), being represented there by a different subspecies *P. terribilis terribilis* (Reed). *Whittingtonia whittingtoni* n. sp. is a second rare species in Poland and Scania-Bornholm, not known elsewhere. *Whittingtonia bispinosa* (McCoy) occurs in the Upper Ordovician limestone of Chair of Kildare in Eire and in the Upper Ordovician Siljan reef limestone (Upper *Leptaena* limestone) in Siljan district, Sweden. Thus it occurs in the beds of the same age as *W. whittingtoni*, but deposited in different conditions, forming reef limestones. On the whole, the fauna of the Siljan reef limestone and of the Kildare limestone is quite different

from that characteristic of *Tretaspis* mudstones in Europe. Two representatives of *Whittingtonia*, though being different species, are rare examples connecting these two different faunas. *Eodindymene pulchra* seems to be fairly rare in Poland and Scania. The four remaining species, which are characteristic of Poland and Scania-Bornholm, represent fairly common forms in both regions and are not known from any other areas.

To conclude with the Swedish regions, the forms found only in Västergötland and Scania-Bornholm should be discussed. Only four such species may be cited, and they are: *Dionide euglypta* (Angelin), *Flexicalymene trinucleina* Tullberg, «*Cheirurus*» *subulatus* Linnarsson and *Tretaspis latilimbus* (Linnarsson). *T. latilimbus* is known from the Oslo region and Jämtland (Størmer, 1930; Asklund, 1936; Thorslund, 1940), *D. euglypta* has been recorded from Jämtland (Asklund, 1936) and *F. trinucleina* — from the Black *Tretaspis* shales of Östergötland and the Siljan district (Törnquist, 1884/85).

In discussing the our four regions, two other groups of species (besides endemic forms) may be distinguished. They are species occurring in Bohemia, Poland and Scania-Bornholm, which are not known from Västergötland. Such forms include only four species: *Cyclopyge quadrangularis* n. sp., *Opsimasaphus jaanussoni* n. sp., *Raphiophorus gratus* (Barrande) and *R. tenellus* (Barrande). *C. quadrangularis* (recorded previously by several authors as *C. rediviva*) occurs frequently in Great Britain as well. The remaining three species are not known from any other areas and are fairly rare in the regions discussed here.

Lastly there are species occurring in Bohemia and Poland, and not known from Scandinavia at all. There are five such species: *Cyclopyge gigantea* (Barrande), *Carmon mutilus* (Barrande), *Actinopeltis gryphus* (Barrande), *A. globosa* (Barrande) and *Dindymene fridericiaugusti* Hawle & Corda. None of these species is known outside the two regions, moreover Poland and Bohemia are the only regions from which the genera *Carmon* and *Actinopeltis* are known. The different representatives of *Actinopeltis* are more common in Bohemia than in Poland. *Carmon mutilus* is very common species in Poland, and seems to be less abundant in Bohemia. *Cyclopyge gigantea*, on the other hand, is rare in both regions. *Dindymene fridericiaugusti* is also fairly rare in Bohemia and in Poland, especially when compared with the other very abundant dindymenid species in the latter region.

The remaining species from the total number of 113, occurring in all the four regions, are endemic forms in every region. The assemblage of endemic forms in every region may be easily recognized from the list enclosed. There are 29 endemic species known from the Holy Cross Mountains, 23 from Bohemia, 10 from Västergötland, and 9 from Scania-Bornholm. Some of the «endemic» forms are known from other regions too, but occur there in the different zones. Thus, for instance, *Dalmanitina mucronata* is endemic for Bohemia in the Lower Ashgillian, but it occurs in the «passage beds» in Scania and Västergötland, as well as in the uppermost Ashgillian in Scania (Angelin, 1851; Troedsson, 1918, 1920, 1921; Temple, 1952*a*), in Västergötland (Linnarsson, 1866, 1869*b*; Holm, 1901), in Dalarna (Thorslund, 1935), in the Oslo region (Kjerulf, 1865; Kiaer, 1897; Troedsson, 1918), in Poland (Czarnocki 1928*b*; Kielan, 1956) and in Great Britain (Salter, 1853, 1864; Elles & Wood, 1896; Reed, 1907; Temple, 1952*a*).

Similarly *Platylichas laxatus* is cited here as endemic for the Red *Tretaspis* mudstones of Västergötland, but this only means that it does not occur in the corresponding beds of Scania-Bornholm, Poland and Bohemia; it does, however, occur in the *Chasmops* Limestone of the Oslo region (Størmer, 1945), in the Boda limestone — Siljan district of Sweden (Warburg, 1939); it has been cited by Olin (1906) from the *Chasmops* beds of Scania, occurs in the Lyckholm formation of Estonia (F. Schmidt, 1885), and is a common species in the

Upper Ordovician of Great Britain (SALTER, 1848, 1851; MURCHISON, 1867; NICHOLSON & ETHERIDGE, 1878-1880; REED, 1896).

Also *Illaenus roemeri* VOLBORTH, «endemic» for Västergötland, occurs in the Lyckholm formation in Estonia (HOLM, 1886; JAANUSSON, 1956*c*), in the Upper Ordovician of the Oslo region (BRÖGGER, 1882), and it is known from the erratic boulders of Germany (ROEMER, 1861).

The analysis given above shows that among the four regions discussed, the connections between Poland and Scania-Bornholm were the greatest. There are 30 common species for Poland and Scania-Bornholm, which in comparison with 43 species known from this period in Scania-Bornholm is a very great number. 64 species are known from these beds in Poland. If more thorough collecting of fossils is done in Scania, it will be certainly shown that there are still more forms in common and that the Holy Cross Mountains and Scania-Bornholm may be considered as one geographical region, in which conditions were closely similar in two of its provinces (Poland and Scania-Bornholm). The fauna of Scania-Bornholm shows, on the other hand, some similarities with that of Västergötland, though these connections seem to be less close than with Poland. There are 23 common species, and the lithological development of the beds in question in Scania seems to differ more from that of the Red *Tretaspis* mudstones than from the equivalent mudstones in Poland. There are 17 common species for Poland and Bohemia; thus the region of the Holy Cross Mountains seems to be in certain respects intermediate between Bohemia and Scandinavia.

DALMANITINA BEDS

Between the zone of *Staurocephalus clavifrons* and the *Dalmanitina* beds there usually occur «passage beds» yielding the fauna of both zones. The exact correlation of the passage beds is difficult. In Västergötland, the *Staurocephalus* beds have been claimed as passage beds, but in Scania and Bornholm the passage beds cannot be recognized with any certainty. It is, however, probable that in Scania they may correspond to the beds underlying the *Dalmanitina* beds, in which *S. clavifrons* and *D. mucronata* occur together (cf. TROEDSSON, 1918). In Poland they are represented by the unfossiliferous beds of Brzezinki, or it is also possible that they are tectonically faulted out. Lastly, in Bohemia the third horizon of the Králův Dvůr beds of CHLUPAČ division (CHLUPAČ, 1951*a*, 1951*b*) has a faunal assemblage different from that of the Králův Dvůr beds and is claimed as the passage beds between the Králův Dvůr and the Kosov beds. As the passage beds were recognized with certainty only in two regions out of the four discussed, a comparison of the geographical distribution of trilobites in these beds cannot be made.

In Scania, Poland and also Great Britain, the *Dalmanitina* beds cover two zones; the lower zone of *D. olini*, and the upper zone of *D. mucronata*. The *D. olini* zone has not been recognized, however, in other districts of Sweden and in Bohemia. Therefore, in the discussion of the geographical distribution of trilobites in the uppermost Ashgillian, both zones are treated together.

There are three species which are common to all the four regions, they are: *Dalmanitina mucronata* (BRONGNIART), *Leonaspis olini* TROEDSSON and *Brongniartella platynotus* (DALMAN). In addition to them, there occur some endemic forms. Thus, *Leonaspis centrina* (DALMAN) is known from Västergötland only. *Stenopareia oblita* (BARRANDE), «*Dalmanites*» *morrisiana* BARRANDE, *Actinopeltis insocialis* (BARRANDE) and *Cryptolithus cosoviensis* MAREK have

been recognized in the uppermost part of the Králův Dvůr beds and are unknown from the other areas. No endemic forms, however, from the Kosov beds, where the fauna is extremely rare, were recognized. Similarly in Scania, the faunal assemblage in the *Dalmanitina* beds is very poor, no endemic forms being hitherto described.

In Poland, in the *D. mucronata* zone, *D. mucronata* is the most abundant fossil, representing more than 60 per cent of all the fossils collected from this zone. In addition to it and to *Leonaspis olini* and *Brongniartella platynotus*, there occur several species passing from the zone of *Staurocephalus clavifrons*. They are: *S. clavifrons* Angelin. *Phillipsinella parabola* (Barrande), *Oedicybele kingi* Whittington and *Trinodus tardus* (Barrande). The second group of trilobites is poorly known and has not been identified to specific level, e. g. *Whittingtonia* sp. Lastly, there occur in Poland in the zone of *Dalmanitina mucronata* a group of new forms, known neither from the preceding zone nor from any neighbouring region. To such species belong, for example, «*Proetus*» sp. *a*, «*Proetus*» sp. *b*, «*Proetus* sp. *c*, «*Otarion*» sp. *a*, *Trilobites* sp. and many other undescribed species. Among them only *Trilobites* sp. seems to be known also from Great Britain (comp. p. 179).

MIGRATION

(text-fig. 4)

From the data given in the preceding chapters certain conclusions can be made about the migration of trilobites in the Upper Ordovician seas of Europe.

LOWER AND MIDDLE ASHGILLIAN

In the Caradocian (zone of *Pleurograptus linearis* and lower beds) the area of the Holy Cross Mountains formed a part of a sea in which black graptolitic shales were deposited (Tomczyk, 1957). Similarly to Poland, in Bornholm (Hadding, 1915), Scania (Funkquist, 1919; Olin, 1906) and Västergötland (Thorslund, 1948; Henningsmoen, 1948), the zones, of *Pleurograptus linearis* and of *Dicranograptus clingani* are developed as black graptolitic shales, which are underlaid by the Upper *Ludibundus* limestone, yielding shelly fauna (cf. Olin, 1906; Lindström, 1953). Black, in part graptolitiferous shales of the *Pleurograptus linearis* zone extends farther northwards and westwards in Central and Northern Sweden, being known also from the Oslo region. In Östergötland, Siljan district and Jämtland they are known as Black *Tretaspis* shales and in the Oslo region as Lower *Tretaspis* shales. Trilobite fauna of the *P. linearis* zone is known from Östergötland, Siljan district and Jämtland, but — except the Siljan district — is poor and imperfectly known. Törnquist (1884/85) described from the Black *Tretaspis* shales of the Siljan district 9 trilobite species.

Caradocian graptolitic shales are known from North Wales (Conway) (Smith & George, 1948), but not from the Middle and South Wales, where the limestones and shales were deposited (Jones, 1938; Pringle & George, 1948).

In the area to the south-west of the Holy Cross Mountains, i. e. in Bohemia, the Caradocian strata, underlying the Králův Dvůr beds, are represented by shelly facies, the so-called Bohdalec beds, with grey shales in the lower part and sandy shales in the upper part (Röhlich, 1957).

The assemblages of the Caradocian trilobites of northern Sweden and Bohemia are markedly different, no common species being known. One should stress, however, that the

Table 2

List of distribution of trilobites in the Lower, Middle and Upper Ashgillian of Bohemia, Poland and Scandinavia

Species	Bohemia: Lower & Middle Králův Dvůr beds	Bohemia: Upper Králův Dvůr beds	Bohemia: Kosov beds	Poland: Brzezinki: *Eodindymene pulchra* zone	Poland: Brzezinki: *Staurocephalus clavifrons* zone	Poland: Wólka: *Staurocephalus clavifrons* zone	Poland: Bardo syncl.: *Dalmanitina* beds	Bornholm: *Tretaspis* beds	Scania: *Tretaspis* beds	Scania: *Dalmanitina* beds	Västergötland: Red *Tretaspis* mudstones	Västergötland: *Staurocephalus* beds	Västergötland: *Dalmanitina* beds	Remarks
Sphaeragnostus gaspensis europeensis n. subsp.														*S. gaspensis gaspensis* COOPER & KINDLE occurs in Canada.
G. cingulatus (OLIN)														
Seragnostus sp.														
Trinodus tardus (BARRANDE)														Cited by OLIN (1906) from the Upper *Ludibundus* beds in Scania.
Trinodus sp.														
«*Otarion*» *tenuis* n. sp.														
«*O.*» *sola* (BARRANDE)														
«*Otarion*» sp. *a*														
«*Otarion*» sp. *b*														
«*Otarion*» sp. *c*														
Amphitryon radians (BARRANDE)														
Amphitryon sp.														
Remopleurides dorsospinifer (PORTLOCK)														
Remopleurides? sp. *a*														
Remopleurides? sp. *b*														
Ogmocnemis irregularis n. sp.														
O. brevifrons (ANGELIN)														It is probable that the specimens from the Red *Tretaspis* mudstones are not conspecific with those from the *Dalmanitina* beds.
«*Proetus*» *scanicus* OLIN														
«*Proetus*» sp. *a*														
«*Proetus*» sp. *b*														
«*Proetus*» sp. *c*														
Phillipsinella parabola (BARRANDE)														Occurs in the Ashgillian of the Oslo region, Great Britain and Portugal.

*) Sign + means the species occurs in a given region; sign — means the occurrence of the species probable, but not certain.

(continued)

Species	Bohemia: Lover & Middle Králův Dvůr beds	Bohemia: Upper Králův Dvůr beds	Bohemia: Kosov beds	Poland: Brzezinki: *Eodindymene pulchra* zone	Poland: Brzezinki: *Staurocephalus clavifrons* zone	Poland: Wólka: *Staurocephalus clavifrons* zone	Poland: Bardo syncl.: *Dalmanitina* beds	Bornholm: *Tretaspis* beds	Scania: *Tretaspis* beds	Scania: *Dalmanitina* beds	Västergötland: Red *Tretaspis* mudstones	Västergötland: *Staurocephalus* beds	Västergötland: *Dalmanitina* beds	Remarks
Platylichas laxatus (McCOY)	.	.	.	.	.	.	.	.	.	.	+			Occurs in the Upper *Ludibundus* beds of Scania, in the Siljan reef limestone of Siljan district, Sweden, in the Lyckholm formation of Estonia and in the Ashgillian of the Oslo region and Great Britain.
Lichas laciniatus WAHLENBERG	.	.	.	.	.	.	.	.	.	.	.	.	+	
L. affinis (ANGELIN)	.	.	.	.	.	.	.	.	.	.	.	.	+	
Dicranopeltis polytoma (ANGELIN)	.	.	.	.	.	.	.	.	.	.	.	.	+	
«*Isotelus*» *laevigatus* (ANGELIN)	.	.	.	.	.	.	.	.	.	.	+			
Opsimasaphus latus (ANGELIN)	.	.	.	.	.	.	.	.	.	.	+			
O. jaanussoni n. sp.	+	.	.	+	+	+	.	+	+					
Opsimasaphus sp.	.	.	.	.	.	.	.	+	+					
Stygina sp.	.	.	.	.	+	+	.	—	—	.	+			
Cyclopyge quadrangularis n. sp.	+	.	.	+	+	+	.	—	—	.	+			Occurs in Great Britain.
C. gigantea (BARRANDE)	+	.	.	.	+									
C. speciosa HAWLE & CORDA	+	.	.	.	+	+	.	+	+	.	+			
C. sulcata (BARRANDE)	—													Occurs in the Caradocian of Bohemia, its occurrence in the Ashgillian not certain.
Cyclopyge sp. *a*	.	.	.	.	+									
Cyclopyge sp. *b*	.	.	.	.	+									
Cyclopyge sp. *c*	.	.	.	.	+									
Symphysops armata (BARRANDE)	+													
S. subarmata elongata n. subsp.	.	.	.	.	+									*S. subarmata subarmata* (REED) occurs in Great Britain.
Symphysops sp. *a*	.	.	.	.	+									
Symphysops sp. *b*	.	.	.	.	+									
«*Illaenus*» *angelini* HOLM	.	.	.	.	.	.	.	.	+	.	+			Considered here conspecific.
«*Illaenus*» cf. *angelini* HOLM	.	.	.	.	+									

(continued)

Species	Bohemia			Poland				Bornholm	Scania		Västergötland			Remarks
				Brzezinki		Wólka	Bardo syncl.							
	Lower & Middle Králův Dvůr beds	Upper Králův Dvůr beds	Kosov beds	*Eodindymene pulchra* zone	*Staurocephalus clavifrons* zone	*Staurocephalus clavifrons* zone	*Dalmanitina* beds	*Tretaspis* beds	*Tretaspis* beds	*Dalmanitina* beds	Red *Tretaspis* mudstones	*Staurocephalus* beds	*Dalmanitina* beds	
«*Illaenus*» sp.	. .	. .	. .	. .	+									
«*Illaenus*» *roemeri* VOLBORTH	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	+			Occurs in Estonia, Oslo region and in the erratic boulders of Germany.
«*Illaenus*» *hospes* BARRANDE	+													
Panderia megalophthalma LINNARSSON	. .	. .	. .	. .	+	+	. .	+	+	. .	+	+		
Stenopareia oblita (BARRANDE)	. .	+												
Octillaenus hisingeri (BARRANDE)	+	+												
O. cf. *hisingeri* (BARRANDE)	. .	. .	. .	. .	. .	. .	. .	. .	+					
Ectillaenus leptopleura (HOLM)	. .	. .	. .	. .	. .	. .	. .	. .	—	. .	+			Considered here conspecific.
E. cf. *leptopleura* (HOLM)	. .	. .	. .	. .	. .	+								
Zetillaenus wahlenbergianus (BARRANDE)	+													
Zdicella zeidleri (BARRANDE)	+													
Z. bornholmiensis n. sp.	. .	. .	. .	. .	+	. .	. .	+						
Zbirovia longifrons (OLIN)	. .	. .	. .	. .	+	+	. .	+	+					
Leonaspis olini TROEDSSON	. .	+	. .	. .	. .	. .	+	. .	. .	+	. .	. .	+	
L. centrina (DALMAN)	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	+	
Selenopeltis buchi buchi (BARRANDE)	+													Occurs also in the Llanvirnian of Bohemia.
Diacanthaspis decacantha (ANGELIN)	. .	. .	. .	. .	+	+	. .	+	+	. .	+			
Whittingtonia whittingtoni n. sp.	. .	. .	. .	. .	+	+	. .	. .	—					
Whittingtonia sp.	. .	. .	. .	. .	. .	. .	+							
Proceratocephala terribilis bituberculata n. subsp.	. .	. .	. .	. .	+	. .	. .	. .	—					*P. terribilis terribilis* (REED) occurs in Great Britain.
Telephina fracta (BARRANDE)	+													
Colpocoryphe declinata (HAWLE & CORDA)	+													
«*Calymene*» *incerta* BEYRICH	. .	. .	. .	. .	. .	. .	. .	. .	+					Identification not certain. *C. incerta* occurs in the Caradocian of Bohemia.
«*Calymene*» *pulchra* BEYRICH	. .	. .	. .	. .	. .	. .	. .	. .	+					
Calymene asperula NOVÁK Ms.	+	+												
«*Calymene*» sp.	. .	. .	. .	. .	+									

(continued)

Species	Bohemia			Poland				Bornholm	Scania		Västergötland			Remarks
				Brzezinki		Wólka	Bardo syncl.							
	Lower & Middle Králův Dvůr beds	Upper Králův Dvůr beds	Kosov beds	*Eodindymene pulchra* zone	*Staurocephalus clavifrons* zone	*Staurocephalus clavifrons* zone	*Dalmanitina* beds	*Tretaspis* beds	*Tretaspis* beds	*Dalmanitina* beds	Red *Tretaspis* mudstones	*Staurocephalus* beds	*Dalmanitina* beds	
Flexicalymene trinucleina (TULLBERG)	. .	. .	. .	. .	. .	. .	. .	. .	+	. .	+			Occurs in the Black *Tretaspis* shales of Västergötland and the Siljan district.
Brongniartella platynotus (DALMAN)	. .	. .	. .	. .	. .	. .	+	. .	. .	+	. .	. .	+	It is highly probable that three species quoted here are conspecific.
B. inexpectata (BARRANDE)	+	+	+											
Eohomalonotus (Eohomalonotus) foveolatus NOVÁK Ms.	. .	+	+											
Carmon mutilus (BARRANDE)	+	. .	. .	. .	+	+								
Dalmanitina olini TEMPLE	. .	. .	. .	. .	. .	. .	+	. .	. .	+				Occurs in Great Britain.
D. mucronata (BRONGNIART)	+	+	+	. .	. .	. .	+	. .	. .	+	. .	. .	+	Occurs in Great Britain and in the Oslo region.
«*Dalmanites*» *morrisiana* BARRANDE	. .	+												
Liocnemis recurvus (LINNARSSON)	. .	. .	. .	+	+	+	. .	+	+	. .	+			
L. concinnus n. sp.	. .	. .	. .	. .	+									
Calliops ecclesiastica (OLIN)	. .	. .	. .	. .	. .	. .	. .	. .	+					
Kloučekia phillipsi (BARRANDE)	+													
Placoparia (H.) prantli n. sp.	. .	. .	. .	. .	+									
Ceraurinella intermedia (KIELAN)	. .	. .	. .	. .	+	+	. .	+	+					
Ceraurus? sp.	. .	. .	. .	. .	+									
Eccoptochile tumescens (BARRANDE)	+													
Actinopeltis gryphus (BARRANDE)	+													Considered here conspecific.
A. cf. *gryphus* (BARRANDE)	. .	. .	. .	. .	+									
A. globosa (BARRANDE)	+													Occurs in the Caradocian of Bohemia. Considered here conspecific.
A. cf. *globosa* (BARRANDE)	. .	. .	. .	. .	+									
A. barrandei n. sp.	+													
A. insocialis (BARRANDE)	. .	+												
Actinopeltis sp. *a*	. .	. .	. .	. .	+									
Actinopeltis sp. *b*	. .	. .	. .	. .	+									
Pseudosphaerexochus pectinifer (BARRANDE)	+													
P. laticeps LINNARSSON	. .	. .	. .	+	. .	. .	. .	+	+	. .	+	+		
P. ravni (OLIN)	. .	. .	. .	. .	. .	. .	. .	+	+					
P. wolkae n. sp.	. .	. .	. .	. .	+	+								

(continued)

Species	Bohemia: Lower & Middle Králův Dvůr beds	Bohemia: Upper Králův Dvůr beds	Bohemia: Kosov beds	Poland: Brzezinki: *Eodindymene pulchra* zone	Poland: Brzezinki: *Staurocephalus clavifrons* zone	Poland: Wólka: *Staurocephalus clavifrons* zone	Poland: Bardo syncl.: *Dalmanitina* beds	Bornholm: *Tretaspis* beds	Scania: *Tretaspis* beds	Scania: *Dalmanitina* beds	Västergötland: Red *Tretaspis* mudstones	Västergötland: *Staurocephalus* beds	Västergötland: *Dalmanitina* beds	Remarks
Pseudosphaerexochus sp. *a*					+									
Pseudosphaerexochus sp. *b*					+									
Pseudosphaerexochus sp. *c*					+									
Stubblefieldia neglecta (BARRANDE)	+													
Stubblefieldia sp.					+				—		+			
Hammatocnemis tetrasulcatus n. sp.					+	+								
Cheirurus subulatus LINNARSSON									—		+			
«*Ch.*» *fortis* BARRANDE	+													
Cyrtometopus neuter (BARRANDE)	+													
Areia suecica OLIN									+					
A. bohemica BARRANDE	+													
Atractopyge verrucosa (DALMAN)											+			
Paracybeloides loveni (LINNARSSON)											+			
Dindymene heidingeri BARRANDE	+													Considered here conspecific.
D. ornata LINNARSSON				+	+	+		+	+		+			
D. fridericiaugusti HAWLE & CORDA	+	+			+									
D. longicaudata n. sp.				+	+	+		+	+		+			
Eodindymene pulchra (OLIN)				+					+					
Staurocephalus clavifrons ANGELIN					+	+	+	+	+			+		Occurs in Great Britain and in the Siljan district of Sweden. Considered here conspecific.
Staurocephalus sp. *c* (in KIELAN, 1957)											+			
Sphaerocoryphe dentata ANGELIN											+			
Oedicybele kingi WHITTINGTON					+	+	+	+	+		+			Occurs in Great Britain.
Hibbertia sanctacrucensis n. sp.					+									
Hibbertia sp.											+			
Arraphus corniculatus ANGELIN													+	
Shumardia polonica n. sp.					+									
Dionide subrotundata n. sp.					+	+		+						
D. decorata n. sp.				+	+	+								
D. speciosa HAWLE & CORDA	+	+												

(continued)

Species	Bohemia			Poland				Bornholm	Scania		Västergötland			Remarks
				Brzezinki		Wólka	Bardo syncl.							
	Lower & Middle Králův Dvur beds	Upper Králův Dvůr beds	Kosov beds	*Eodindymene pulchra* zone	*Staurocephalus clavifrons* zone	*Staurocephalus clavifrons* zone	*Dalmanitina* beds	*Tretaspis* beds	*Tretaspis* beds	*Dalmanitina* beds	Red *Tretaspis* mudstones	*Staurocephalus* beds	*Dalmanitina* beds	
D. euglypta (ANGELIN)	. .	. .	. .	. .	. .	. .	. .	+	+	. .	+			Occurs in Jämtland.
Raphiophorus tenellus (BARRANDE)	+	. .	. .	. .	+	. .	. .	. .	+					
R. gratus (BARRANDE)	+	. .	. .	+	+	. .	. .	+	+					
R. acus (TROEDSSON)	. .	. .	. .	. .	+	. .	+	. .	+					
Lonchodomas portlocki (BARRANDE)	+	+	. .	+	+	+	. .	+	+	. .	+			
Cryptolithus ultimus (BARRANDE)	+													
C. cosoviensis MAREK	. .	+												
Tretaspis granulata (WAHLENBERG)	+	+	. .	+	+	+	. .	+	+	. .	+	+		Probably occurs in the Oslo region.
T. seticornis seticornis (HISINGER)	+	. .	. .	. .	. .	+	. .	. .	+	. .	+			Occurs in the Oslo region, in Estonia and Jämtland.
T. latilimbus (LINNARSSON)	. .	. .	. .	. .	. .	. .	. .	. .	—	. .	+			Occurs in the Oslo region and in Jämtland.
Novaspis albida (REED)	. .	. .	. .	. .	+	+								Occurs in Great Britain.
Trilobites sp.	. .	. .	. .	. .	. .	. .	+							Occurs in the *Dalmanitina* beds in Great Britain.

trilobite fauna of the *Pleurograptus linearis* zone of the Siljan district, as described by TÖRNQUIST (1884), shows already «Ashgillian» affinities. There occur three species: *Tretaspis seticornis* (HISINGER), *Lonchodomas portlocki* (BARRANDE) and *Amphitryon radians* (BARRANDE) — a different subspecies, characteristic of the Ashgillian *Tretaspis* beds, and in addition to them, *Raphiophorus setirostris* ANGELIN, which may be perhaps considered as a forerunner of *R. acus* (TROEDSSON).

The beginning of the Ashgillian times in Poland, Bornholm and Sweden is characterized by the shallowing of the sea, and gradual change of facies from black graptolitic shales, to mudstones yielding a shelly fauna. The latter type of sedimentation is characteristic of this area for the Lower and Middle Ashgillian, recorded in Poland as the zone of *Eodindymene pulchra* and the zone of *Staurocephalus clavifrons*. The shallowing of the sea during the Ashgillian times seems to have had a great influence on the distribution of the shelly fauna in Middle and Northern Europe. If the trilobite assemblages from the Ashgillian of Bohemia, Poland, Bornholm, Scania and Västergötland are compared, it certainly appears that the trilobites of Bohemian and Scandinavian origins could freely migrate in both directions. STUBBLEFIELD (1939, p. 61), characterizing the beginning of the Ashgillian, stated that in Scotland: «...in *Dicellograptus complanatus* beds is a trilobite fauna which indicates that some previously existing

barrier had disappeared and a Central European fauna entered Scotland for the first time, according to our record».

At the beginning of the Ashgillian, the conditions became unified throughout Central and Northern Europe, and new areas able to support shelly faunas came into existence.

The chief migration to the Holy Cross Mountains at the beginning of the Ashgillian took place from three centres: Bohemia, Great Britain and Scandinavia (comp. fig. 4).

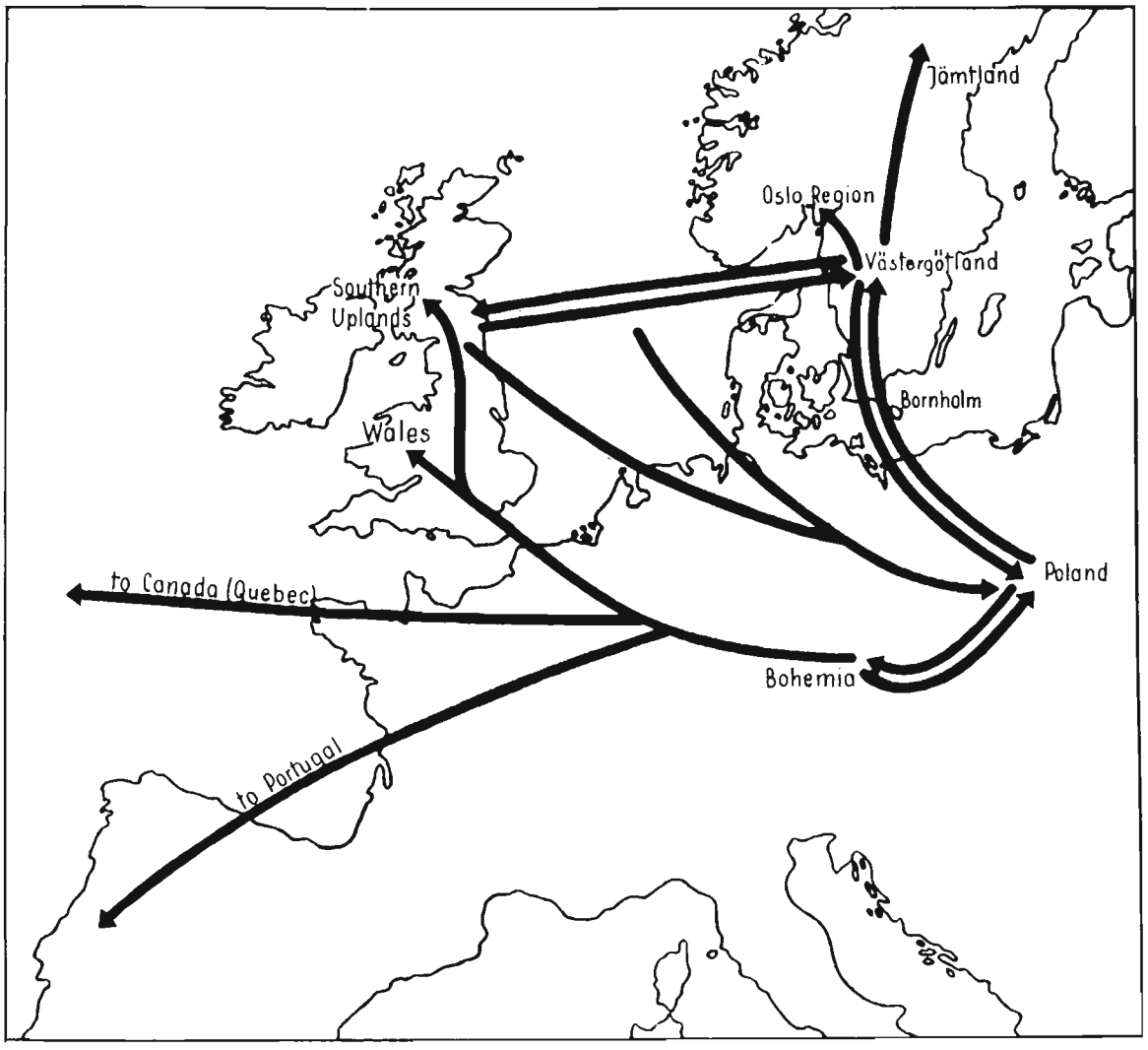


Fig. 4

Sketch map of North and Central Europe, showing the main directions of the migration of trilobites at the beginning of the Ashgillian

The Upper Ordovician reef limestone facies (of Eire, the Siljan district in Sweden, and of Estonia) are not taken into consideration.

Bohemian migration

In the Lower Ordovician the Cyclopygidae are known in Bohemia, as well as in Bornholm and Sweden (cf. TJERNVIK, 1956). During the Middle Ordovician this family seems, according to our record, to be restricted to Bohemia only. In the Ashgillian this family reached a wide

geographical distribution again, migrating to Poland, Scandinavia, Great Britain and Canada. *Cyclopyge quadrangularis* n. sp., which presumably evolved from the Middle Ordovician Bohemian species *C. rediviva* (BARRANDE), spread at the beginning of the Ashgillian to Poland, Bornholm, Scania and Great Britain. Similarly *C. speciosa* HAWLE & CORDA had at that time a wide geographical distribution (Bohemia, Poland and Scandinavia), but had not reached Great Britain. The pattern of distribution of such cyclopygids as the representatives of the genus *Symphysops* is somewhat different. *Symphysops* spread from Bohemia westward, reaching Great Britain and Canada, and on the other hand it entered Poland. One can recognize there closely related species in these regions: *Symphysops armata* (BARRANDE) known from Bohemia, *S. subarmata* (REED) — from Great Britain and Poland, and *S. spinifera* COOPER & KINDLE — from Canada. This genus did not, however, reach Scandinavia. I consider that *S. subarmata* from Poland differs in some respects from that of Great Britain and forms a separate subspecies. As *S. subarmata subarmata* (REED) is known from the Whitehouse beds in Scotland, and *S. subarmata elongata* n. subsp. occurs in Poland in the *Staurocephalus clavifrons* zone (Middle Ashgillian only), it is possible to assume that this form came to Poland from Great Britain rather than from Bohemia. The three species here mentioned are very closely similar to each other and it seems reasonable to assume that geographical isolation was the cause of their differentiation. At the same time, other cyclopygid species entered Poland from Bohemia: *Cyclopyge gigantea* (BARRANDE) and some imperfectly known cyclopygids such as *Cyclopyge* sp. *a* and *Cyclopyge* sp. *b*. The latter shows similarities to the Bohemian *C. sulcata* (BARRANDE), and it is possible that it represents a descendant of this Lower Ordovician species.

The actinopeltid stock is another group of trilobites which had a long history in the Ordovician of Bohemia (not being known from any other region), and entered Poland during the Ashgillian. Text-fig. 8 on p. 51 represents the main trends in the evolution of Bohemian actinopeltids during the Ordovician. In Poland, in addition to the Bohemian representatives of *Actinopeltis*, there occur some incompletely known species, described here as *Actinopeltis* sp. *a* and *Actinopeltis* sp. *b*, separate from the main evolutionary line of the genus which holds good in Bohemia. The new environment provided by Poland enabled several of these forms to evolve in a different and independent direction.

Similarly to the actinopeltids, it seems that *Stubblefieldia*, hitherto a monotypic genus known only from Bohemia, also entered Poland and Scandinavia during the Ashgillian. In the latter regions it is imperfectly known, being represented by a form described here as *Stubblefieldia* sp.

The early history of *Dindymene* also took place in Bohemia. The oldest known representative of *Dindymene* is *D. plasi* n. sp., described in the present paper from the Llanvirnian (Svata Dobrotivá beds) of Bohemia. In the Middle Ordovician, *Dindymene* is not known outside of Bohemia. It is doubtful whether *D. plasi* may be accepted as an ancestral form for all the Ashgillian dindymenids. In certain features, especially in the course of the facial suture, *Eodindymene pulchra* (OLIN) from the Lower Ashgillian of Poland and Scania seems to represent a form more primitive than the Llanvirnian *D. plasi*. The history of the genus is only partly known and it is clearly much more complicated than appears from the fossil record. Nevertheless the fact is, that the Ashgillian was a period of sudden and great differentiation of the genus, which attained its widest geographical distribution, being known from Bohemia (BARRANDE, 1852, 1872), Poland, Bornholm (RAVN, 1899), Scania (OLIN, 1906), Västergötland (LINNARSSON, 1869*b*) and Great Britain — Girvan and Yorkshire (REED, 1906; REYNOLDS, 1894). *Dindymene heidingeri* BARRANDE, or *D. ornata* LINNARSSON (treated here as conspecific, comp. p. 147), has the widest geographical distribution of any single

species of the genus, being known in Bohemia, Poland and the two Scandinavian districts. It is possible to consider *D. heidingeri (= ornata?)* as descended from *D. plasi*. The similarities of two species are great, including even the type of ornamentation. The differences are chiefly in the number of rhachial rings of the pygidium and in the length of the thoracic and pygidial spines. In Great Britain, *Dindymene* is represented by two species: *D. cordai* NICHOLSON & ETHERIDGE and *D. hughesie* REYNOLDS, which are unknown from the other regions. But the differences among all the Ashgillian representatives of *Dindymene* are not very great and show that their differentiation from a common stock occurred only a comparatively short while before Ashgillian times.

The representatives of *Dionide* have both a long geological range and a wide distribution, occurring from the Lower to Upper Ordovician in Bohemia (KLOUČEK, 1919), from the Middle to Upper Ordovician in Great Britain (NICHOLSON & ETHERIDGE, 1880; REED, 1903, 1912; WHITTINGTON, 1952), in the Middle Ordovician (Champlainian) of Virginia, USA (RAYMOND, 1920), in the Ordovician of China (MANSUY, 1912) and in the Upper Ordovician of Poland and Sweden (ANGELIN, 1854; LINNARSSON, 1869*b*; OLIN, 1906; RAVN, 1899). It seems, however, that the migration of the dionidids to Poland and Scandinavia in the Upper Ordovician was chiefly from Bohemia. In the *Staurocephalus clavifrons* zone of Poland, Bornholm and Scania there occur *Dionide subrotundata* n. sp., which shows similarities to the Upper Ordovician Bohemian form *D. speciosa* HAWLE & CORDA. Simultaneously with *D. speciosa* there occurs in Poland the endemic form *D. decorata* n. sp., resembling the contemporaneous Scandinavian *D. euglypta* (ANGELIN). The latter species occurs in Scandinavia not only in Bornholm, Scania and Västergötland, but spread also to Jämtland (ASKLUND, 1936).

The occurrence of the *Tretaspis* beds in Jämtland has been during a long time an open question (cf. WIMAN, 1898, 1900; HÖGBOM, 1920; KIAER, 1921), but after the investigations of THORSLUND & ASKLUND (1935) and of ASKLUND (1936), their occurrence may be accepted as certain. The trilobite fauna yielded by the *Tretaspis* beds in Jämtland is scanty and poorly known (*Tretaspis latilimbus* (LINNARSSON), *T. seticornis* (HISINGER), *Dionide euglypta* (ANGELIN) and *Remopleurides?* sp.), but their presence prove that during the Lower Ashgillian time took place also a northwards migration from Västergötland to Jämtland (comp. fig. 4).

The asaphids are comparatively rare in the Upper Ordovician fauna of the regions discussed. *Opsimasaphus jaanussoni* n. sp. occurs at that time in Bohemia, Poland and Bornholm (probably in Scania too), and it is possible that this species originated in Bohemia, where during the Lower and Middle Ordovician the closely related asaphids were richly represented. At the beginning of the Ashgillian, *O. jaanussoni* spread eastwards to Poland and then northwards to Bornholm. In Västergötland there also appeared the endemic species *O. latus* (ANGELIN), the origin of which remains obscure.

Placoparia (Hawleia) prantli n. sp., occurring in the *Staurocephalus clavifrons* zone of Poland is without doubt of Bohemian origin. Placoparids were not previously known from the Upper Ordovician. Our species shows close similarities with the Middle Ordovician Bohemian species *P. (H.) grandis* BARRANDE, and probably derives from this form. It is of great interest that *P. prantli* is not known from the Upper Ordovician beds of Bohemia. One can envisage that it died out earlier in Bohemia and survived only in a new region open for the trilobites in the Ashgillian — in the Holy Cross Mountains.

The majority of the Polish Ashgillian illaenids belongs to the subfamily Ectillaeninae. The earliest members of this subfamily occur in the Llanvirnian of Bohemia and Shropshire, but in the Middle Ordovician this group seems to have been restricted to Bohemia. In the Ashgillian, the representatives of the Ectillaeninae occur in Bohemia, Poland, Scania and

Västergötland, and it is possible to assume that Bohemia was a centre of migration of this group. It must be, however, stressed that Polish and Scandinavian illaenids belong to different species, than those from Bohemia. *Octillaenus hisingeri* (BARRANDE) is an exception, being known from Bohemia, and probably occurring (*O.* cf. *hisingeri*) in Scania (cf. TROEDSSON, 1924). As it has not been hitherto found in Poland, the Bohemian and Scanian forms are tentatively treated as different species.

British migration

Among the species common to both, Poland and Great Britain, *Symphysops subarmata* (REED) has been already discussed. A similar pattern of distribution is given by the genus *Novaspis*. As pointed out by WHITTINGTON (1941 *a*) the origin of this genus and its relations with other trinucleids are not clear. It is represented by two species: *Novaspis elevata* (COOPER & KINDLE), known from the Upper Ashgillian of Quebec, and *N. albida* (REED), occurring in Scotland and Poland. It is of great interest that *N. albida* is known from Scotland only from the Whitehouse beds, whereas in Poland it occurs in the *Staurocephala clavifrons* zone (Middle Ashgillian). An examination of better preserved material of the British and Polish forms would show perhaps that they represent separate subspecies, or even different species. But in the present state of our knowledge, it appears that *N. albida* entered Poland from Great Britain, between the Lower and Middle Ashgillian, and survived in the new area, presumably giving rise to a further form, described here as *Novaspis* sp., whilst it died out in Scotland.

Shumardia polonica n. sp. may be counted within the group of species which entered Poland in the Ashgillian from Great Britain. This group of species (STUBBLEFIELD, 1939) had its history in the Lower and Middle Ordovician of Great Britain and Sweden (MOBERG & SEGERBERG, 1906). The only known Upper Ordovician species is *Shumardia scotica* REED, described from the Whitehouse beds, from Scotland. As stated by STUBBLEFIELD, this species is of a rather Lower Ordovician pattern and does not differ very much from its earlier ancestors. From the Middle Ashgillian beds no shumardiids are known in Great Britain. *Shumardia polonica* is the only descendant of this stock which came to Poland and survived here until the Middle Ashgillian; it seems to differ in its cephalic structure from *S. scotica* and the earlier shumardiids.

The Polish and Scandinavian Ashgillian odontopleurids seem to have British rather than Bohemian affinities. The Bohemian *Selenopeltis buchi* (BARRANDE), occurring in the Králův Dvůr beds and in the Middle Ordovician of Bohemia as well, is an endemic form. *Proceratocephala terribilis* (MCCOY) is known from Great Britain, Poland and probably also from Scania. It is accepted in the present paper that this species is represented in Poland by a different subspecies (*P. terribilis bituberculata* n. subsp.) from that in Great Britain (*P. terribilis terribilis* (REED)). As our knowledge on these subspecies is still unsatisfactory, it is possible that the apparent differences are due to the state of preservation and that they form in fact one single subspecies.

Scandinavian migration

A further group of species of which the early history took place in Scandinavia rather than in Bohemia, also entered Poland in the Ashgillian.

Staurocephalus clavifrons ANGELIN and *Phillipsinella parabola* (BARRANDE) are very common Ashgillian species, characterized by a wide geographical distribution. The absence of *S. clavifrons* in the Ashgillian of Bohemia and any other staurocephalids in the Bohemian Ordovician, shows that the centre of the evolution of this group was in the more northern regions of Europe.

This is confirmed by the discovery of the earliest known staurocephalids in the uppermost Middle Ordovician of Norway and in the lower part of the Upper Ordovician in Dalarna, described elsewhere (see KIELAN, 1957, *Staurocephalus* sp. *b* and *Staurocephalus* sp. *c*). The Staurocephalidae which are rare in the Middle Ordovician being known only in Scandinavia, become more abundant in the Middle Ashgillian, when they are found in Scandinavia, Poland and Great Britain, being represented by *S. clavifrons*. In Poland this species has survived until the end of the Ashgillian, occurring in the *Dalmanitina* beds. The geographical distribution of the staurocephalids reached a maximum in the Silurian, when *S. murchisoni* BARRANDE and related forms spread over the entire world, being known from Bohemia (BARRANDE, 1852), Great Britain (SALTER, 1864, 1865), Kazakhstan (WEBER, 1948), Australia (RATTE, 1888; ETHERIDGE & MITCHELL, 1917) and the United States — Chicago area (WELLER, 1907).

Similarly, the history of *Phillipsinella parabola* seems to be connected with Scandinavia. A *Phillipsinella* belonging to a new, thus far undescribed species, identified by OLIN (1906, p. 78) as *Phillipsia parabola*, has been recorded for the first time from the Upper *Ludibundus* beds, zone of *Diplograptus multidens* of Scania. In the Middle Ashgillian true *Phillipsinella parabola* appeared in Sweden and spread to Poland, Bohemia, Britain and Portugal.

Oedicybele kingi WHITTINGTON has a wide geographical distribution, being known in the *Staurocephalus clavifrons* zone in Västergötland, Scania, Poland and Great Britain (cf. KIELAN, 1957). It is possible to assume Scandinavian origin of this species, which has its predecessor — *O. clava* (THORSLUND) (cf. THORSLUND, 1940) in the Middle Ordovician of Jämtland.

The Raphiophoridae evolved in the Ordovician of both Bohemia and Baltoscandia. *Lonchodomas portlocki* (BARRANDE) is a species characterized by a wide geographical distribution in the Lower and Middle Ashgillian, being known at that time from Sweden, Poland and Bohemia; it occurs — according to TÖRNQUIST (1884) — in the *Pleurograptus linearis* zone of the Siljan district. In the Upper *Ludibundus* beds of Scania there occurs *Lonchodomas rostratus* (SARS), which is known also from Great Britain. *L. portlocki* is not known from Great Britain, but there occurs at that time the closely related species *L. drummuckensis* (REED). The place of origin of both species may be assumed to be somewhere in Northern Europe, and in the Ashgillian *L. portlocki* must have migrated southwards. Also *Raphiophorus acus* (TROEDSSON) seems to be a species of Scandinavian origin, having a closely related form — *R. setirostris* ANGELIN — in the Black *Tretaspis* shales (*Pleurograptus linearis* zone) of the Siljan district. In the Ashgillian *R. acus* spread to Poland only. But in Bohemia there occur in the Llandovery a related form *R. rouaulti* (BARRANDE), which shows that the evolution of this line took place in this region in the Silurian. *Raphiophorus gratus* (BARRANDE) and *R. tenellus* (BARRANDE) are known from the Ashgillian beds of Bohemia, Poland, Bornholm and Scania, but it is difficult to say whether or not they were derived from the same Scandinavian stock.

Similarly the Polish Ashgillian proetids, such as the new genus *Ogmocnemis*, are connected with Scandinavia rather than with Bohemia.

Different pterygometopids have been recognized in the *Chasmops* (Upper *Ludibundus*) beds of Scandinavia. OLIN (1906) described only from Scania four pterygometopid species, two of them occurring in the Upper *Ludibundus* beds. *Liocnemis recurvus* (LINNARSSON) occurs in the Ashgillian of Poland and Scandinavia, and seems to have entered Poland from northern regions, not reaching Bohemia. In the *Staurocephalus clavifrons* zone there occurs *Liocnemis concinnus* n. sp., an endemic form for Poland, which probably originated from *L. recurvus*.

The early history of styginids also took place in Scandinavia. *Stygina minor* SKJESETH is a very common species in the Upper *Chasmops* Limestone of the Oslo region. According to SKJESETH (1955, p. 26): «This species is a forerunner of *Stygina latifrons* (PORTLOCK)

occurring in the Upper Ordovician of England, Ireland, Norway and Sweden». In my opinion, Scandinavian Upper Ordovician styginids are not conspecific with *Stygina latifrons*, though they may derive from the same stock. In the Middle Ashgillian a styginid species, described here as *Stygina* sp., reached Poland.

Species of unknown origin

The origin of some cheirurids occurring in the Ashgillian of the Holy Cross Mountains is not clear. Several representatives of *Pseudosphaerexochus* occur there and they seem to be more closely related to the Middle Ordovician Scandinavian forms than to the Bohemian. The genus *Ceraurinella* seems to be of North American origin being common there already in the Middle Ordovician (Champlainian). *C. intermedia* (Kielan) is the only representative of this genus, which is known with certainty from Europe, though it is probable that some congeneric forms occur in Estonia and in the Siljan district of Sweden (cf. Männil, 1958*b*).

Carmon mutilus Barrande may be considered a form of quite unknown origin and affinities. It occurs in Poland from the beginning of the Ashgillian (in *Eodindymene pulchra* zone and *Staurocephalus clavifrons* zone) and has been recorded from the contemporaneous beds of Bohemia, but as its affinities with any other trilobites are uncertain, we cannot say anything about its evolution and migration.

Hammatocnemis tetrasulcatus n. sp. occurs in the zone of *Staurocephalus clavifrons* in Poland, being here fairly abundant, but has been hitherto recorded neither from neighbouring regions, nor from the *Eodindymene pulchra* zone. It can be thus cited as an example of the sudden appearance of a new species, belonging to a new systematic unit, such as a family, but not connected with any of the known forms. Of course, its sudden appearance in the Holy Cross Mountains may be due to migration from some centre in which its evolution took place. But, as has been stressed, no closely related forms are known in the neighbouring regions.

DALMANITINA BEDS

The beginning of the Upper Ashgillian (*Dalmanitina* beds) represents the second cycle of the shallowing of the sea in the Middle and North Europe, resulting in the deposition of sandy mudstones and sandstones, and a great impoverishment of the fauna. The majority of the Middle Ashgillian trilobite species died out, and only a few of them flourished, attaining a wide geographical distribution at that time. Many of the Middle Ashgillian trilobite species, which became extinct in most of the regions here discussed, still survived in the others. Thus, for example, in the Holy Cross Mountains there still occur in the *Dalmanitina* beds some Middle Ashgillian species. Also *Whittingtonia* sp., known from the *Dalmanitina* beds of the Holy Cross Mountains, seems to be the direct descendant of the Middle Ashgillian *Whittingtonia whittingtoni* n. sp.

Leonaspis olini Troedsson and *Brongniartella platynotus* (Dalman) are, in addition to *Dalmanitina mucronata*, the most common species in the zone of *D. mucronata*, which reached wide geographical distribution, being known all over Scandinavia, Poland and Bohemia.

The distribution of the dalmanitid stock at that time is extremely difficult to interprete. The relations between *Dalmanitina mucronata* (Brongniart) and *D. olini* Temple, and their migration was discussed by several authors (Troedsson, 1918, 1935; Richter, 1925; H. Schmidt, 1935; Temple, 1952*a*; Struve, 1958). The data obtained from the recent investigations in Poland and some new identifications of the Bohemian species, allow one to

alter to some extent the pattern of the distribution of the species in question. The facts are as follows: *Dalmanitina mucronata* occurs in Bohemia throughout the entire Ashgillian, being known in the Lower, Middle and Upper Králův Dvůr beds and in the Kosov beds as well. *D. olini*, on the contrary, is not known from Bohemia. It seems that in Bohemia we are dealing with the earliest appearance of *D. mucronata* (in the lowermost Ashgillian). In the Middle Ordovician of Bohemia there occurs the closely related species *D. socialis* (BARRANDE), which may be accepted as an ancestral form of *D. mucronata*. It seems reasonable to conclude therefore that Bohemia was a place of origin of *D. mucronata* (comp. conclusion of TEMPLE, 1952*a*). In the Middle Ashgillian (*Staurocephalus clavifrons* zone), *D. mucronata* appears also in other places in Europe, being known from different localities in Great Britain (comp. TEMPLE, 1952*a*, p. 14) and Sweden. It is not known, however, from the Middle Ashgillian of Poland, nor from the Red *Tretaspis* beds of Västergötland. In Västergötland and Scania *D. mucronata* appears in the so-called *Staurocephalus* beds, which in spite of the occurrence of *S. clavifrons* are accepted here as equivalent to the passage beds between the Middle and Upper Ashgillian, e. g. between the *S. clavifrons* zone, characterized by the faunal assemblage typical of the Red *Tretaspis* mudstones, and the *Dalmanitina* beds. In Scania and in several places in Great Britain in the beds above *S. clavifrons* zone and below *D. mucronata* zone there occurs *D. olini*, almost entirely replacing *D. mucronata*. TEMPLE characterizes this period as follows (1952*a*, p. 27): «During the period corresponding to the Lower Brachiopod Beds, the *D. olini* zone, the other end of the range of variation was predominant, and almost all the Dalmanitinae from this zone in Northern England, North Wales and Scania are *D. olini* itself. Later the amount of variation increased and reached local maxima as at Nyham, and at Deganwy in North Wales, at a time probably corresponding to the transition between the zones of *D. olini* and *D. mucronata*: at both these places the two species are found with a wide range of intermediate forms. Later still at the time of *D. mucronata* zone and the lowest Silurian, the *D. mucronata* type became predominant everywhere, although still with much variation and with occasional individuals approaching *D. olini*». It seems evident from TEMPLE's conclusion that *D. olini* is a species which arose from *D. mucronata* at the end of the *Staurocephalus clavifrons* zone in Great Britain, Scania or somewhere else in North-Western Europe, and during a short time (*D. olini* zone) it became predominant in these places over *D. mucronata*. It has not spread, however, to Bohemia, where *D. mucronata* occurs during the whole Ashgillian. *D. olini* is also unknown from Västergötland, where, beginning from the *Staurocephalus* beds, there occur only *D. mucronata*, but according to TROEDSSON (1921) the hiatus between the *Staurocephalus* beds and *Dalmanitina* beds in Västergötland comprises the zone of *D. olini*. In the Holy Cross Mountains we are dealing, however, with conditions similar to those of Scania and Britain. In the lower part of the *Dalmanitina* beds (*D. olini* zone), at the locality of Stawy, there occurs only *D. olini*. Similar to the characteristic condition of Scania, other trilobites in these beds are almost entirely absent. In some higher beds there occurs *D. mucronata* together with *D. olini*, and later *D. mucronata* becomes predominant, occurring with a prolific assemblage of different trilobite species. In these beds one single specimen of *D. olini* has also been found.

The only reasonable conclusion concerning the migration of these trilobites, drawn from the pattern of distribution given above, is as follows: *Dalmanitina mucronata* appeared at the beginning of the Ashgillian in Bohemia. During the Middle Ashgillian it migrated from Bohemia northwest to Britain, and then to Scania and Västergötland, not however through the Holy Cross Mountains. At the close of the *Staurocephalus clavifrons* zone *D. olini* arose from *D. mucronata* somewhere in North-Western Europe, and became predominant over *D. mucronata* for a short time in Britain and Scania, spreading also to the Holy Cross Mountains.

At the close of the Ashgillian in the *D. mucronata* zone, *D. olini* became less common in the Holy Cross Mountains, Scania and Great Britain, where there appeared in these regions *D. mucronata* again (in the Holy Cross Mountains for the first time), becoming predominant and occurring commonly in equivalent zones of the highest Ashgillian all over Europe, in Scandinavia (including the Oslo region), Great Britain, Poland and Bohemia. Troedsson (1918) concluded that the sudden impoverishment of the fauna at the close of *Staurocephalus clavifrons* zone was due to a change of environment at the base of the *Dalmanitina* beds. Only *D. mucronata* becoming modified to *D. olini* adopted itself to these unfavourable conditions. Later, when conditions improved again, *D. mucronata* was once more developed from *D. olini*. Such an interpretation is quite contrary to the principle of irreversibility of evolution (Dollo, 1893). More reasonable seems to be the interpretation of Richter (1925) that the reappearance of *D. mucronata* above *D. olini* was due to its migration back to Scania, whence it had been driven during the age of the zone of *D. olini*.

In the Holy Cross Mountains in the *Dalmanitina* beds there occur, in addition to the species discussed above, a great many new forms, only a part of which is described in the present paper. They are for the greatest part otarionids and proetids, but some of them, e. g. *Trilobites* sp., seem belong to new genus or even family, not related to any other known trilobite stock. This fauna came to Poland in the Upper Ashgillian times from some unknown centre of evolution. *Trilobites* sp. seems to occur at that time not only in Poland, but also in the Lake District of Britain (comp. p. 179). Thus a part of this fauna must have spread at that time also to Great Britain.

At the close of the *Dalmanitina* beds (Ordovician-Silurian boundary) the conditions throughout the areas discussed change again. The shelly fauna disappears for a certain time from the fossil record in the Central and in part of the Northern Europe (Bohemia, Poland, Scania, Västergötland, Östergötland, Siljan district and some parts of Great Britain) and graptolitic shales are deposited during the beginning of the Silurian.

VARIATION

The individual variation of the species described in the present paper can be discussed in only a few cases. The majority of the specimens is more or less depressed, and then it is difficult to judge whether the differences among them are due to the state of preservation or to individual variation.

Barrande (1852) recognized within very many trilobite species of Bohemia the occurrence of two types of forms, called by him «forme large» and «forme longue». The differences between two forms of one species are in the proportions only, and Barrande suggested (1852, p. 103): «La constance avec laquelle ces deux formes se présentent dans nos trilobites, nous a conduit à penser que leur contraste n'exprimait pas seulement des différences individuelles, mais qu'il pouvait avoir quelque connexion avec le sexe». Barrande gave a long list of species of different age, in which he recognized the occurrence of two types of forms. The existence of such forms has been noted by some later authors, as for instance by Reed (1895).

A criticism of Barrande's theory was put forward by Prantl (1942), but as it was printed only in Czech, and in rather obscure journal, I consider it worth while to discuss this question once more in the present paper.

Two types of forms occur very often among the trilobites preserved in the mudstones of Brzezinki. As stated above, almost all of them are more or less depressed (comp. for ex.

Trinodus tardus — pl. I, fig. 7, 8, 12, 13). The measurements of all the cephalons of *T. tardus* in our collection have, however, shown that between the «wide» and «long» form are all the intermediate stages. (Comp. also broad, intermediate and narrow forms of *Ceraurinus craigensis* Tripp (Tripp, 1954, p. 675-677)). This shows that the differences discussed cannot be in any way connected with sex. There exists an example showing that the differences in shape are not due to individual variation, but depend quite simply on the state of preservation. At the locality of Wólka in the mudstones of *Staurocephalus clavifrons* zone, there is a lens of harder mudstone, in which the trilobites are preserved as in limestones — undistorted. Within the specimens from this lens no examples of variation, no wide or long forms have been found. As stated on p. 10, the lens discussed is secondarily decalcified as all the mudstones on the northern side of Łysogóry range in the Holy Cross Mountains, but it is assumed that formerly it formed a mudstone much richer in calcium, than the surrounding beds, and this caused the differences in the preservation of fossils between this lens and the other beds.

With regard to the examples given by Barrande, all the trilobites represented by wide and long form, have been found (as stated by Prantl, 1942) in shales, grauwackes, sandy shales and mudstones, but never in limestones where the fossils are not distorted. As such a differentiation has never yet been found in well preserved and undistorted fossil material, it seems reasonable to conclude that a sexual dimorphism in trilobites has not been established, indeed such differences, as have been observed, can always be attributed to the conditions of preservation.

The examination of large collections of trilobites of the same age from different geographical regions, could enable one to observe whether there exists «group variation» between the fossil assemblages from different regions. As defined by Mayr (1949, p. 23) a group variation is the: «variation between different populations within the species. Geographical variation that is, variation between geographically localized populations, is the most common form of group variation encountered by the taxonomist».

Dealing with fossil material one cannot speak, however, about the population. The collection of for example *Trinodus tardus*, from the zone of *Staurocephalus clavifrons* at the locality of Brzezinki, comes from very many populations, which lived in this area during the years in which the mudstones of the zone in question were deposited. Even the specimens of one single layer must have come from several populations, and represent several generations. Davitashvili (1945) proposed the new term «orictocoenose» defined by him (p. 533, translated from Russian) as follows: «Orictocoenose is the type of association of organic remains, with which a palaeontologist actually deals in studying the fauna and flora of a given layer». According to Davitashvili, the organic remains, which were preserved, and for which the term of Quenstedt (1927) «Grabengemeinschaft» (tafocoenose) is used, are not always the material accessible to a palaeontologist. On account of different geological and mineralogical processes, a part of a tafocoenose is usually destroyed during subsequent geological processes and for the part actually preserved and available for study the new term is proposed.

Nevertheless, if one studies the orictocoenoses of apparently the same age, from different geographical regions, one can observe whether there occurred group variation between the representatives of a given species from these regions.

Mayr (1949) discussed what characters are subject to geographical variation and listed among the morphological characters: size, proportions, epidermal and chitinous structures, patterns of colouration, genital armatures, internal and cytological structures. In addition to morphological characters there are physiological characters and habits which are also subject to geographical variation. A very small part of these characters may be studied on fossil material,

and therefore the variation, which possibly occurred for example in the trilobites studied here, cannot be completely established by a palaeontologist.

The geographical variation has been hitherto studied chiefly on land animals. There are, however, works concerning the geographical variation in marine animals. RENSCH (1929, 1933) gave a review of such works and listed the papers chiefly on fish, crustacea, molluscs, bryozoa and coelenterates. HELMCKE (1940) showed the occurrence of geographical variation in brachiopods. The most extensive racial studies of marine animals have been made on fish. The conclusion from the papers reviewed is, that racial differences have been observed in all marine animals, on which suitable investigations have been made.

The comparison of trilobite assemblages of Ashgillian age from Bohemia, Poland and Västergötland has shown that there occur faunal differences between these regions, and several species, known for example from Bohemia, do not occur in Scandinavia, though there are very many common species for these regions. On the other hand, the comparison of the specimens of a single trilobite species, occurring in four or three of the geographical regions discussed, does not demonstrate in a single case the existence of geographical races. Some of the species studied were represented by many well preserved specimens not only in the collection from the Holy Cross Mountains, but also in collections from the other regions. Thus for example *Diacanthaspis decacantha* (ANGELIN) is a very common species in Poland and Scandinavia, the details of its external surface and the ornamentation being well known, and no differences concerning the size, proportions or type of ornamentation could be observed.

The conclusion is that if geographical variation occurred in the specimens from the different regions, it affected features which are not preserved in the palaeontological record. The alternative and more likely conclusion is that the four regions discussed (Bohemia, Holy Cross Mountains, Scania and Västergötland), which are situated not very far from each other (the longest distance Bohemia-Västergötland being 1000 km), formed an uniform marine basin, and the trilobites inhabiting it were not differentiated into geographical races. The latter conclusion seems to be reasonable, especially when one compares it with HELMCKE's (1940) investigations on the geographical races of brachiopods. Three races (previously described as separate species) of the brachiopod genus *Cryptophora* inhabited such distant regions as the North Atlantic, South African and Southern Australian seas.

The occurrence of geographical races (subspecies) has been noted in the present paper within some species inhabiting Great Britain and Poland. Thus, for example, *Proceratocephala terribilis* and *Sphaeragnostus subarmatus* are claimed here as represented in these regions by different subspecies. There are, however, several cosmopolitan species, known from Poland and Great Britain *(Phillipsinella parabola, Oedicybele kingi, Staurocephalus clavifrons)*, not differentiated into the races. The occurrence of different subspecies in Poland and Great Britain is not, however, definitely established, the subspecies discussed are comparatively poorly known, and in all the cases mentioned it seems to be possible that the differences observed might be due to the state of preservation.

With regard to the above discussion, it must be stated that the identification of a species or a subspecies is in palaeontology quite subjective. During the identifications of the species described in the present paper, I had not any doubt concerning the distinction of sympatric species. Difficulties have been encountered, however, by me when I attempted to delimit allopatric species. MAYR (1949, p. 149) stated: «The gaps between allopatric species are often gradual and relative, as they should be on the basis of the principle of geographic speciation». Let us turn once more again to the genus *Symphysops*. As stated above, it is represented in Bohemia, Poland, Great Britain and Canada by three species closely comparable with each

other. The differences between *Symphysops armata*, *S. subarmata* and *S. spinifera* are smaller than within the species of the other trilobite genera studied here; they concern only small changes in shape and proportions, the ornamentation being almost identical in all three species. It is possible that the three species represent only three geographical races of one species, or represent new species *in statu nascendi*. The same argument may be used with regard to the genus *Sphaeragnostus* which similarly to *Symphysops* has a wide geographical distribution in the Ashgillian, occurring in Poland, Scania and Canada, and the differences between the Polish and Canadian forms are so small that they are considered as forming only geographical races (subspecies) of one species.

On the basis of the above given discussion, tentative conclusions may be drawn. Among the Ashgillian trilobites of Central and Northern European and Canadian seas, geographical variation occurred within species, inhabiting very distant geographical regions (Canada and Poland, or perhaps also Poland and Great Britain). Among the species living at that time in the single basin covering Bohemia, Poland, Scania and Västergötland no evidence of the existence of geographical races can be observed.

ON THE MORPHOLOGY, SYSTEMATICS AND PHYLOGENY OF SOME TRILOBITE GROUPS STUDIED IN THE PRESENT PAPER

Rich and often well preserved trilobite material described in the present paper, especially from the *Staurocephalus clavifrons* zone in the Holy Cross Mountains in Poland, has enabled me to recognize some new structures in the morphology of the trilobites studied. This has led me in some cases to conclusions concerning the systematics and the phylogeny of the trilobite lines in question. As these considerations are based not only on the material investigated, but in part also on data from the literature, I have considered it desirable to deal with them in a separate chapter. This chapter is, however, unequal, revising only some of the trilobite lines treated in the descriptive part. Some of the families here studied have been recently revised, for example the Illaenidae — by Jaanusson (1954, 1957) and Šnajdr (1957), the Odontopleuridae — by Prantl and Přibyl (1949) and Whittington (1956*a*, 1956*b*), the Asaphidae — by Jaanusson (1953*a*, 1953*b*, 1956*b*). Several species, including some new ones (e. g. *Zdicella bornholmiensis* n. sp., *Whittingtonia whittingtoni* n. sp.) and even new genera (*Opsimasaphus* n. gen.), belonging to the families mentioned above, are described in the present paper. They are discussed, however, in the descriptive part only, as the new morphological data obtained do not give any important information of a more general character. Other families such as the Remopleurididae require a modern revision, but the material of this family at my disposal is scanty and poorly preserved, so that such a revision has been beyond the scope of the present work.

For these reasons, only a few trilobite groups from the good many treated in the descriptive part, are considered in the present chapter.

Carmon Barrande, 1872 (see p. 112), is a genus of which the affinities and the systematic position were hitherto the most obscure. It is known so far from the Upper Ordovician of Bohemia and the Holy Cross Mountains (Poland), represented in both countries by a single species *Carmon mutilus* (Barrande, 1852). From the Middle Ordovician of Bohemia the second species, designated as *Carmon*, has been described by Barrande, viz. *Carmon primus* Barrande, 1872. It is, however, represented by a single cranidium, preserved as an internal mould, which has very little in common with *Carmon mutilus* — the type species. It seems thus

to be more reasonable to exclude *Carmon primus* from *Carmon*, which remains a monotypic genus.

BARRANDE (1852), in a group of «Trilobites de genre indéterminé», described *Trilobites mutilus*, and later (1872) he has established for it the new genus *Carmon*. In the systematic description (1872) he put it between *Phillipsia* PORTLOCK *(Phillipsinella parabola)* and *Cyphaspis* BURMEISTER (*Otarion* ZENKER), but from the short discussion given it is evident that the systematic position of the genus in question was not clear to him. The only comparison with other genera concerns the structure of the hypostome (1872, p. 20): «L'hypostôme, que nous voyons imparfaitement, mais en place, a beaucoup d'analogie avec celui de la plupart des *Proetus*». The hypostome was not, however, figured by BARRANDE or described in more detail, and in the collection of the National Museum in Prague, I have not seen any specimens with the hypostome preserved.

Similarly PŘIBYL (1953), in the register of Bohemian trilobite genera, placed *Carmon* in a group of «Incertae Generae». In the «Classification des Trilobites» of HUPÉ (1953*b*, 1955), *Carmon* BARRANDE is entirely overlooked. The fairly large amount of material (about 150 specimens) of the type species of this genus, from the Holy Cross Mountains, has allowed me to study the morphology of *Carmon* in more detail, especially the structure of the ventral side of the cephalon, which has added much that is new to the question of the affinities of this genus. The ventral cephalic sutures (comp. text-fig. 31 on p. 115) of *Carmon* are of stenoptychopariid type, the rostral plate being small and subtriangular. The subtriangular rostral plate occurs in other unrelated trilobite genera (comp. fig. 5), as for instance in *Holotrachelus* LINNARSSON, *Raymondites* SINCLAIR, and *Placoparia* HAWLE & CORDA (comp. WARBURG, 1925; WHITTINGTON, 1953; PRANTL & ŠNAJDR, 1957). In some other pliomerids, for example *Pseudocybele* ROSS, the rostral plate is (ROSS, 1951, p. 137): «shaped somewhat like a stem of a boat». In *Hystricurus genalatus* ROSS (comp. fig. 5*E*) the rostral plate, as described by HINTZE (1953), is trapezoidal, but the ends of cheeks almost touch. In *Hystricurus paragenalatus* ROSS, however, (to judge from ROSS' description, 1951, p. 43): a «proportion of other cheeks suggest that they may actually have extended all the way to midline, so that right and left cheeks met at a point», — thus the rostral plate was evidently subtriangular.

The occurrence of similar rostral plates in different trilobite groups, such as the carmonids, holotrachelids, hystricurids, bathyurids and pliomerids, shows that the evolution of the rostral plate could take place independently in different trilobite lines, as was suggested by KIAER (1916) and WARBURG (1925) hypothesis. Thus the structure of the rostral plate, though a good taxonomic feature, cannot be used as an absolute criterion for establishing the relations between trilobite groups.

The structure of the hypostome of *Carmon* gives more evidence for establishing its systematic position. The hypostome of *Carmon* (comp. pl. XVII, fig. 3 and text-fig. 31) is very similar to those occurring in the Calymenidae and the Pharostomatidae [1]. The general shape of the hypostome of *Carmon*, the presence of the middle body divided by the shallow, transverse furrow into two lobes, the forked posterior margin and the lateral margin with incisions — are such as occur in different representatives of the Calymenacea (comp. our fig. 6, and: WHITTINGTON, 1941*b*; EVITT & WHITTINGTON, 1953; BARRANDE, 1852; G. LINDSTRÖM, 1901). The differences in the structure of hypostome between *Carmon* and *Pharostoma*, are of the same rank as between *Pharostoma*, *Diacalymene* and *Flexicalymene* (comp. fig. 6). The rostral

[1] Similar hypostomes have been also figured by BARRANDE (1872, pl. 8, fig. 40, 49) as belonging to *Placoparia zippei* and *P. grandis* respectively, the latter being redrawn subsequently by HUPÉ (1955, text-fig. 231/4) under the same designation, but as it has been shown by NOVÁK (1884*a*) and PRANTL&ŠNAJDR (1957), it belongs to *Pharostoma pulchrum*.

plate of *Carmon* is different from those in the Calymenidae, where (comp. SHIRLEY, 1936. fig. 4) it is wide (tr.) and euptychopariid. But in the structure of the dorsal exoskeleton, *Carmon mutilus* is reminiscent in some respects of the representatives of both the families discussed

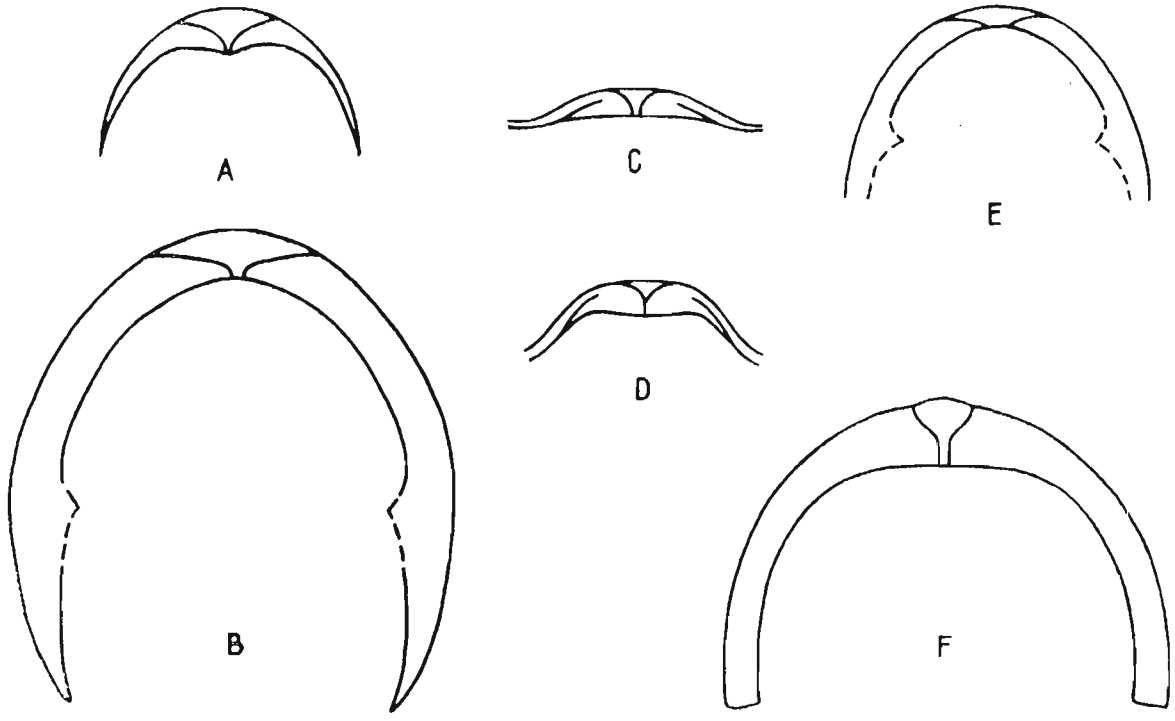


Fig. 5

Examples of subtriangular rostral plates in different trilobites

A *Holotrachelus punctillosus* Törnquist — after Warburg, 1925, fig. 16; B *Raymondites longispinus* (Walcott) — after Whittington, 1953, pl. 65, fig. 16; C *Placoparia (Placoparia) zippei* (Boeck) — after Prantl & Šnajdr, 1957, pl. 2, fig. 9; D *Placoparia (Hawlela) grandis* Hawle & Corda — after Barrande, 1872, pl. 8, fig. 44; E *Hystricurus genalatus* Ross — after Hintze 1952, pl. 6, fig. 1c; F *Carmon mutilus* (Barrande) (orig.).

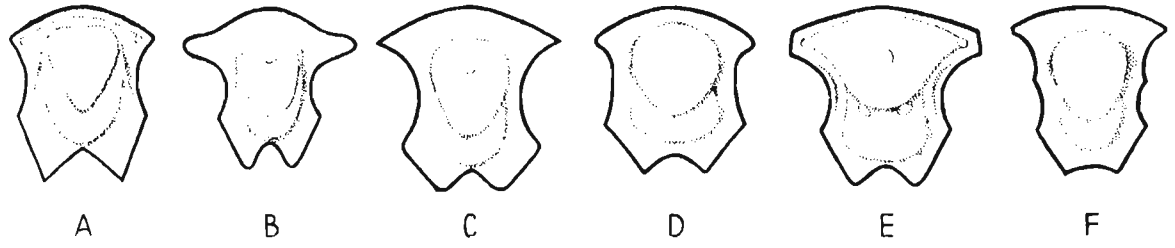


Fig. 6

Hypostomes in Calymenacea

A *Flexicalymene senaria* (Conrad) — after Whittington, 1941*b*, pl. 72, fig. 34; B *Colpocoryphe declinata* (Barrande) — after Barrande, 1852, pl. 43, fig. 57; C *Diacalymene diademata* (Barrande) — after Barrande, 1852, pl. 19, fig. 15; D *Pharostoma pulchrum* (Barrande) — after Barrande, 1852, pl. 19, fig. 7; E *Calymene intermedia* (Lindström) — after G. Lindström, 1901, pl. 3, fig. 6; F *Carmon mutilus* (Barrande), (orig.).

here. The glabella in *Carmon* narrows anteriorly, as in the Pharostomatidae and Calymenidae. There are two pairs of lateral glabellar furrows in *Carmon*, whereas usually three pairs in the families in question, but in *Pharostoma pulchrum* there are only two pairs of lateral glabellar furrows (though differently shaped from those in *Carmon*). The convex anterior border, the

lack of the preglabellar field and the deep anterior furrow are the same as in the Calymenidae. The course of the facial suture, the posterior branch of which cuts the posterior border close to the genal corners, reminds one also of the condition in the Calymenacea. *Carmon* differs from the representatives of the Calymenacea in the absence of eyes, and in having very narrow free cheeks, restricted almost entirely to the lateral border of the cephalon. This is presumably caused by the migration of the facial suture towards the cephalic margin, connected with the disappearance of the eyes. The number of thoracic segments is usually 13 in the Pharostomatidae and Calymenidae, but in the latter family may be exceptionally 12 segments (in *Flexicalymene* SHIRLEY and *Calymene* sensu stricto BRONGNIART). *Carmon* has 11 thoracic segments only, but the pattern of thoracic pleurae is generally similar to that of the Calymenacea.

The results of the analysis given above show that *Carmon* cannot be placed in either the Pharostomatidae or the Calymenidae, as it differs in essential features from both of them. On the basis of the foregoing argument, it is taken here to be a member of a separate monotypic family Carmonidae nov., and it is suggested that this family should be placed within the superfamily Calymenacea MILNE-EDWARDS.

The presumable ancestors of Calymenacea are to be found among forms related to the Upper Cambrian Conocoryphidae and Ptychopariidae. Already in certain Upper Cambrian representatives of this family, one can observe «carmonid trends». For example, *Bailiaspis* RESSER, 1936, is a blind conocoryphid, characterized by the absence of a preglabellar field, deep anterior furrow and convex anterior border (comp. *Bailiaspis prominens* RESSER, or *B. tuberculata* LAKE *in* RESSER, 1937, and LAKE, 1940). In *Bailiaspis* the free cheeks are very small being restricted to part of the lateral border only, the cephalic surface being strongly granulated. In *Conocoryphe sulzeri* SCHLOTHEIM, the rostral plate is narrower (tr.) than in the other conocoryphids (comp. BARRANDE, 1852, pl. 2B, fig. 24; ŠNAJDR, 1958, text-fig. 32), and the connective sutures convex medially — one can easily envisage the evolution of such a rostral plate towards the type represented by *Carmon mutilus*. Also the hypostome of *Conocoryphe sulzeri* seems to show «calymenid trends». Its middle body is divided into two lobes, the general shape is similar to that in calymenids, the only difference lying in the fact that in *Conocoryphe* its margin is continuous, whereas it is forked and incised in both calymenids and carmonids.

Phillipsinellidae WHITTINGTON, 1950 (see p. 72) is second monotypic Upper Ordovician family, the lineages of which are not clear. *Phillipsinella* NOVÁK was recorded (NOVÁK, 1885; REED, 1931) as belonging to the Asaphidae or Styginidae. WHITTINGTON (1950*a*) placed *Phillipsinella* in a separate family Phillipsinellidae, pointing out that the large rostrum and long, narrow hypostome are quite different from those of styginids, and that the asaphids have a median suture. No attempt was, however, made to suggest the relations of the Phillipsinellidae to the other families or to refer it to any superfamily. HUPÉ (1953*a*, cf. also 1955) erected the superfamily Scutelloidae, including 5 families (Styginidae VODGES, Theamataspidae HUPÉ, Phillipsinellidae WHITTINGTON, Scutelluidae R. & E. RICHTER and Illaenidae HAWLE & CORDA). The reference of the Phillipsinellidae to Scutelluidae by HUPÉ was based on some similarities of the dorsal exoskeleton and the large rostrum, but a large rostrum occurs too in other trilobites, for instance in some proetids. The structure of a hypostome of *Phillipsinella* argues strongly against these lineages. The hypostome of *Phillipsinella* (comp. pl. IV, fig. 4; pl. V, fig. 2; text-fig. 19 on p. 74) is very long, narrow and forked on its posterior border, whereas in the Scutelluidae it is subcircular, pointed at the posterior margin, with distinct maculae, and in the Illaenidae it is in general wide and short, with long anterior wings, a rounded posterior border and maculae present. A hypostome, similar in some ways to that in *Phillipsinella*, occurs

among the Proetacea, where it is long and slender, forked at its posterior margin; the anterior part of its middle body being very convex. This does not indicate that the Phillipsinellidae should be placed among the Proetacea, may however show that the relation of *Phillipsinella* with this line are presumably closer than with the Illaenidae or Scutelluidae.

Hammatocnemis n. gen. (see p. 141) is the third Upper Ordovician genus, forming a monotypic family, of which the affinities are obscure. Two genera discussed above, *Carmon* and *Phillipsinella*, were already well known. *Carmon* occurs in Bohemia and Poland, and *Phillipsinella* has a wide geographical distribution occurring in the Middle Ashgillian of Bohemia, Poland, Scandinavia, Great Britain and Portugal. *Hammatocnemis* n. gen., on the contrary, is known from the zone of *Staurocephalus clavifrons* of Poland, being here fairly abundant, but has not been hitherto recorded from neighbouring regions. It is of great interest that it is not known from the zone of *Eodindymene pulchra*, where neither occurs the related or similar genus from which it could be derived, nor are such forms found with it in the zone of *Staurocephalus clavifrons*.

In the course of the facial suture and the general shape of the glabella (well defined preoccipital ring (L_1) and strongly widening anterior portion of glabella) — the cephalon of *Hammatocnemis* n. gen. resembles that of a phacopid. But the shape of the three anterior lateral glabellar furrows (S_2, S_3, S_4) and the lateral glabellar lobes (L_2, L_3, L_4), as well as the presence of four lateral glabellar furrows, are not phacopid characters.

Ordovician Phacopacea belong to the dalmanitid and pterygometopid stocks, characterized by moderately convex cephalon, well developed glabellar lobes and relatively large, commonly subtriangular pygidium. The new genus here discussed cannot in any way be referred to them. There is the question whether it could be accepted as a relative of the Ordovician ancestors of the phacopid line. It has been pointed out by Delo (1940, p. 13) that presumably ancestors of Phacopidae can be found among some Ordovician dalmanitids, as for instance *Kloučekia phillipsi* (Barrande). The latter species represents an Ordovician dalmanitid with a compact and transversely convex body, a short pygidium and a tendency to lose the anterior glabellar furrows. Taking into consideration the earliest known representatives of Phacopidae (e. g. the American Ordovico-Silurian genus *Eophacops* Delo (comp. Delo, 1935), which is stated by Delo (1940) to be «probably an offshoot of the pre-*Phacops*») — its resemblance to the dalmanitid stock can be seen. It is quite possible to visualize the evolution of the phacopid line from the dalmanitid stock, with which *Hammatocnemis* cannot be compared in any way. On the other hand, the new genus shows some similarities with the cheirurid line. These similarities concern chiefly the thoracic and pygidial structures. The differentiation of the cephalic pleurae of the new genus into inner and outer portions, with two strongly convex triangular areas on the inner one, is similar to cheirurid characters. There is no diagonal furrow, dividing the inner part of the pleurae as in the cheirurids, but the presence (in the new genus) of two strongly convex nodules in one line seems to be the same type of structure. The type of pygidium, characteristic of the new genus, does not occur in any cheirurid subfamily, but the free ends of the pygidial pleurae are a feature characteristic of cheirurids. In the cephalic structure it is possible to see some similarities with certain cheirurids, especially the cyrtometopids. In some species of *Sphaerocoryphe* Angelin, e. g. *Sphaerocoryphe atlantoides* Öpik (Öpik, 1937) and *S. thomsoni* Reed (Begg, 1940), the preoccipital ring is well defined, and the anterior portion of the glabella in front of the preoccipital furrow is strongly convex and widening anteriorly. The chief difference in glabellar structure lies in the lack of lateral glabellar furrows in *S. atlantoides* and *S. thomsoni*. The lateral glabellar furrows of *Hammatocnemis* are a very characteristic feature which does not occur in any known cyrtometopids. The question of the

closer affinities of the new genus can only be decided after examining its ventral cephalic sutures. The dorsal structure indicates, however, that it can be placed among the Cheiruridae, as a member of a new monotypic subfamily.

The genus *Actinopeltis* HAWLE & CORDA (comp. p. 130) has been known thus far only from the Middle and Upper Ordovician beds of Bohemia, four species having been recognized there (PRANTL & PŘIBYL, 1947): *Actinopeltis globosa* (BARRANDE, 1846), *A. insocialis* (BARRANDE, 1852), *A. completa* (BARRANDE, 1872), *A. gryphus* (BARRANDE, 1872). In the Upper Ordovician beds, zone of *Staurocephalus clavifrons*, in the Holy Cross Mountains, there are several representatives of this genus, unfortunately rather rare, represented in my collection by one cranidium and some pygidia. A correct identification of this material requires a good recognition of Bohemian species. PRANTL and PŘIBYL (1947, p. 27) have given a new diagnosis, description and discussion of the genus in question. To the definition of the genus, as given by PRANTL and PŘIBYL (1947), I would add that the ventral cephalic sutures, as recognized in *Actinopeltis gryphus* (BARRANDE) are of euptychopariid type (comp. fig. 7). The rostral suture runs along the preglabellar furrow, the hypostomal suture along the anterior margin of the glabella. The rostral plate is very narrow (long.), restricted to the anterior border of the cephalon, situated below the convex glabella. The connective sutures run obliquely across the anterior cephalic margin, antero-medially, the rostral plate being of trapezoid shape. After an examination of BARRANDE's type specimens housed in the National Museum in Prague, I came to the conclusion that there are more than four actinopeltid species in the Ordovician of Bohemia (comp. fig. 8).

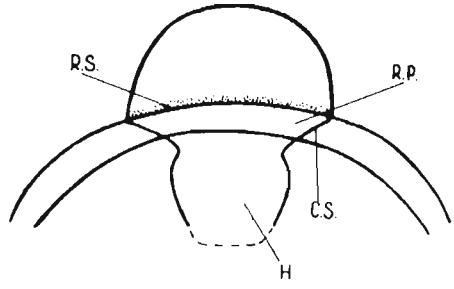


Fig. 7

Actinopeltis gryphus (BARRANDE) — slightly diagrammatic sketch of ventral cephalic sutures; approx. × 3.5

R.P. rostral plate, *R.S.* rostral suture, *C.S.* connective suture, *H* hypostome (NM CD1724).

Actinopeltis insocialis (BARRANDE, 1852) has been erected on the material from the locality of Kosov, belonging to the uppermost part of the Králův Dvůr beds (comp. CHLUPAČ, 1951*b*), and corresponding to the passage beds between the zone of *Staurocephalus clavifrons* and *Dalmanitina* beds in Poland and Sweden. There are in the collection of the National Museum some cranidia and pygidia from this locality, but no entire specimen. It is probable that, as it has been recorded by BARRANDE, the pygidium figured by him (1852, pl. 40, fig. 31) is conspecific with the cephalon (BARRANDE, 1852, pl. 40, fig. 28-29) — as they are the only representatives of the genus in question in this horizon, and occur together, but this cannot be stated with certainty. Later, BARRANDE (1872, p. 89, pl. 7, fig. 15-18) described some specimens from the Králův Dvůr beds, locality of Leiškov, recorded by him also as *Actinopeltis insocialis*. The comparison of BARRANDE's figures, let alone the specimens, already show the differences between the forms from both localities. In my opinion, «*Actinopeltis insocialis*» (BARRANDE, 1872) from Leiškov is not conspecific with *A. insocialis* (BARRANDE, 1852) from Kosov, and is recognized in the present paper as *A. barrandei* n. sp. The table on the p. 130 gives the comparison of the two species.

The oldest representative of this genus, known so far, is *Actinopeltis completa* (BARRANDE, 1872), occurring in the Middle Ordovician (Drábov Quartzites) of Bohemia. This species differs from the other representatives of *Actinopeltis* in having much less bulbous glabella, long genal spines and longer and slender pygidial spines.

From the Caradocian of Bohemia (Zahořany beds) *Actinopeltis globosa* has been described. This species has a glabella which is more convex than that of *A. completa*, long genal spines and a pygidium with comparatively wider spines. *A. globosa* has been recorded also from Králův Dvůr beds (BARRANDE, 1852, pl. 43, fig. 27). When comparing these specimens, it seems to me that the one from the Králův Dvůr beds has slightly more slender pygidial spines than that from the Zahořany beds. There are, however, in BARRANDE'S collection two pygidia from the Zahořany beds, recorded as *A. globosa* under one catalogue number (NM CD 1181), one with comparatively wider and shorter spines than the other. It is probable that there are two species in Bohemia, described as *A. globosa*, but the material is too fragmentary for differentiating these two species, no differences in their glabellae can be noted at present. It is also possible that the differences are an infraspecific variation within *A. globosa*. This seems, however, less probable, as a great infraspecific variation very seldom occurs within trilobite species. A classification of this point requires the discovery of more material from the Zahořany and Králův Dvůr beds as well.

In the Králův Dvůr beds there occur *Actinopeltis gryphus* (BARRANDE, 1872) which differs from *A. globosa* chiefly in having very short and wide genal spines and a more bulbous glabella. The pygidia of both species seem to be very similar, except that the pygidial spines of *A. gryphus* are slightly pointed, whereas they seem to be more lobate in *A. globosa*. The latter difference is, however, very small and may depend on the state of preservation.

There occur in the Králův Dvůr beds *Actinopeltis barrandei* n. sp., differing from both species here discussed in having the genal angles only slightly pointed and not produced into spines, smaller eyes situated more forward, and pygidium with very wide and short pygidial spines. The youngest representative of the *Actinopeltis* line, known so far, is *A. insocialis* from the Uppermost part of the Králův Dvůr beds, characterized by rounded genal angles and a pygidium with very wide, lobate spines, closely adhering to each other.

When one compares the Bohemian actinopeltid species here discussed, one can place them in order in a morphological range with gradual changes from one species to another, in the following way: *Actinopeltis completa — A. globosa — A. gryphus — A. barrandei — A. insocialis* (comp. fig. 8). As the morphological differences between the species concerned are in accordance with their geological occurrence, one can presume that this morphological line, here described, is — at least in some parts — an evolutionary line.

So the evolution of the actinopeltid line, which took place during the Middle and Upper Ordovician of Bohemia, was in general a change towards a genus with a more compact body, with a reduction of all the thin projections of the body. This covered the increase of the convexity of glabella, the shortening of the genal spines up to their entire reduction, and the widening of the pygidial spines, which in *A. insocialis* closely adhere to each other, forming almost a compact pygidium. It seems to be evident that there have been some other as yet unknown formes in this line of evolution. *A. barrandei* seems to stay a little apart from the general line, differing from the other species in having much smaller eyes and situated more forward, whereas in *A. insocialis* the eyes are comparable with those of *A. globosa* and *A. gryphus*. Similarly in the zone of *Staurocephalus clavifrons* of Poland, there are some representatives of *Actinopeltis*, which seem to stay apart from the main evolutionary line of the genus. Unfortunately, they are represented by single pygidia only. But the pygidia described here as *Actinopeltis* sp. *a* and *Actinopeltis* sp. *b* seem to be close to the most primitive representative of the genus, such as *A. completa*, and show a new trend in the evolution of the genus.

When discussing the systematic position of the genera *Staurocephalus* BARRANDE and *Oedicybele* WHITTINGTON, I pointed out (KIELAN, 1957, p. 157) that: «The members of the Encrinuridae can be recognized among the other Cheiruracea chiefly by their pygidial

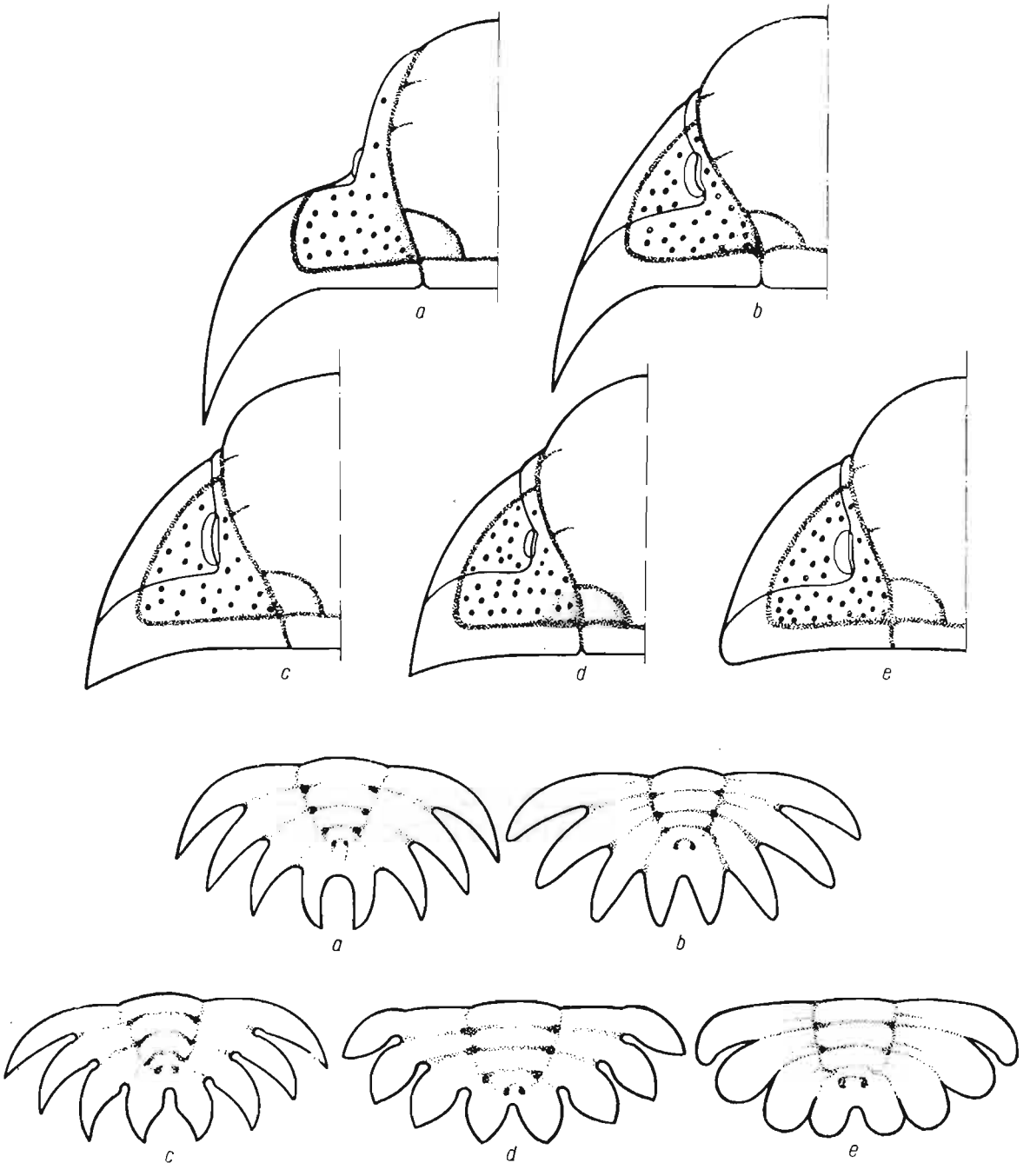


Fig. 8

Diagrammatic sketches of cephalons and pygidia of 5 representatives of the genus *Actinopeltis*, showing an evolutionary trend towards a more compact body form; approx. × 3

a *A. completa* (Barrande), b *A. globosa* (Barrande), c *A. gryphus* (Barrande), d *A. barrandei* n. sp., e *A. insoclalis* (Barrande).

structure, characterized by a great number of rhachial segments and comparatively fewer pleural segments. All the characters of the cephalon and thorax of the Encrinuridae as defined by F. SCHMIDT (1881), REED (1928), and HUPÉ (1953*a*, 1955) and others, can be recognized also in some representatives of the Cheiruridae and Pliomeridae and therefore cannot be claimed as *par excellence* encrinurid».

More recently, TEMPLE (1956) discussed the position of the anterior pits and of the preglabellar furrow as features differentiating the Encrinuridae from the Cheiruridae and the Phacopidae. As however there is a difference in the development of these features within the encrinurid subfamilies: the Encrinurinae and the Cybelinae, and moreover as the anterior pits are missing in some representatives of the families in question, especially in most phacopids, — their position cannot be accepted as a good taxonomic feature, differentiating the Encrinuridae. On the other hand, it ought to be remembered that the course of the ventral cephalic sutures is a feature of great stability within the different trilobite families, and seems to be a good taxonomic character for this systematic level. But the Encrinuridae in this respect are an exception among the trilobite groups. In the structure of the ventral side of the cephalon the Encrinuridae show much diversity.

About 15 valid encrinurid genera have so far been described. The ventral side of the cephalon, however, is known only in some of them. Even in our present state of knowledge of the encrinurid family, it is possible to distinguish three different patterns of the ventral side of the cephalon. *Encrinurus* EMMRICH, *Encrinuroides* REED, *Cybele* LOVÉN, and *Cromus* BARRANDE — are characterized by an extremely narrow rostral plate of stenoptychopariid type (comp. F. SCHMIDT, 1881; NOVÁK, 1886; ROSENSTEIN, 1941; WHITTINGTON, 1950*a*; TRIPP, 1957).

In *Atractopyge* HAWLE & CORDA, for example in *A. affinis* SCHMIDT, the rostral plate is narrow, similar to that of *Cybele bellatula*. But in *Atractopyge wörthi* (EICHWALD) it is broader, and in *A. xipheres* ÖPIK comparatively very broad, of euptychopariid type (comp. F. SCHMIDT, 1881; ÖPIK, 1937). The difference between the steno- and euptychopariid type of the ventral cephalic sutures in the Encrinuridae is, however, not so striking. It concerns the size of the rostral plate only, which may be broader (tr.) or narrower, but there are intermediate stages, characterized by a more or less broad plate. In general, it is subtrapezoid in shape, the connective sutures running antero-medially, and the distal margin of the plate being narrower than the proximal one. It is situated on the anterior border, or on the dorsal side of the cephalon. In the latter case, the former glabella is divided by the facial and the rostral suture into the glabella and rostral plate (comp. p. 6, 7).

All these considerations do not concern the subfamily Dindymeninae nov. (*Dindymene* HAWLE & CORDA and *Eodindymene* n. gen.), (see p. 143), which in the pattern of ventral cephalic sutures differs from all the other representatives of the Encrinuridae. BARRANDE (1872, p. 117) stated that in *Dindymene fridericiaugusti* there exists: «... la grande suture, que nous observons sur une tête, dont le bord antérieur se trouve visible dans toute son étendue. Cette ligne, au droit du front est concentrique au bord, et se trouve placée dans la rainure qui le détermine; puis, elle se prolonge dans le sillon le long du bord génal, jusque vers le milieu de la joue, où nous la voyons franchir obliquement le limbe extérieur. En décrivant *Dind. Bohemica*, espèce récemment découverte, à l'origine de notre Faune seconde, nous signalons l'existence d'une suture semblable à celle que nous venons d'indiquer». To judge from BARRANDE's figure of *D. fridericiaugusti* (1872, pl. 2, fig. 11-12), the free cheeks restricted to the lateral border of the cephalon seem to be fused anteriorly. On the contrary, OLIN (1906, pl. 1, fig. 21 a, c) has drawn the facial sutures of *Eodindymene pulchra* (OLIN), as cutting the anterior cephalic margin, the

free cheeks not being fused. An examination of several representatives of *Dindymene* and *Eodindymene*, chiefly from the Ashgillian of Poland, has shown that the ventral cephalic sutures of these genera are of levisellid type, the free cheeks having coalesced anteriorly and no rostral plate being developed (comp. pl. XXVII, fig. 1; pl. XXVIII, fig. 3, 4; text-fig. 9). In all the representatives of *Dindymene*, the free cheeks are narrow being restricted to the lateral border of the cephalon. In *Eodindymene* n. gen. the facial suture runs antero-medially through the

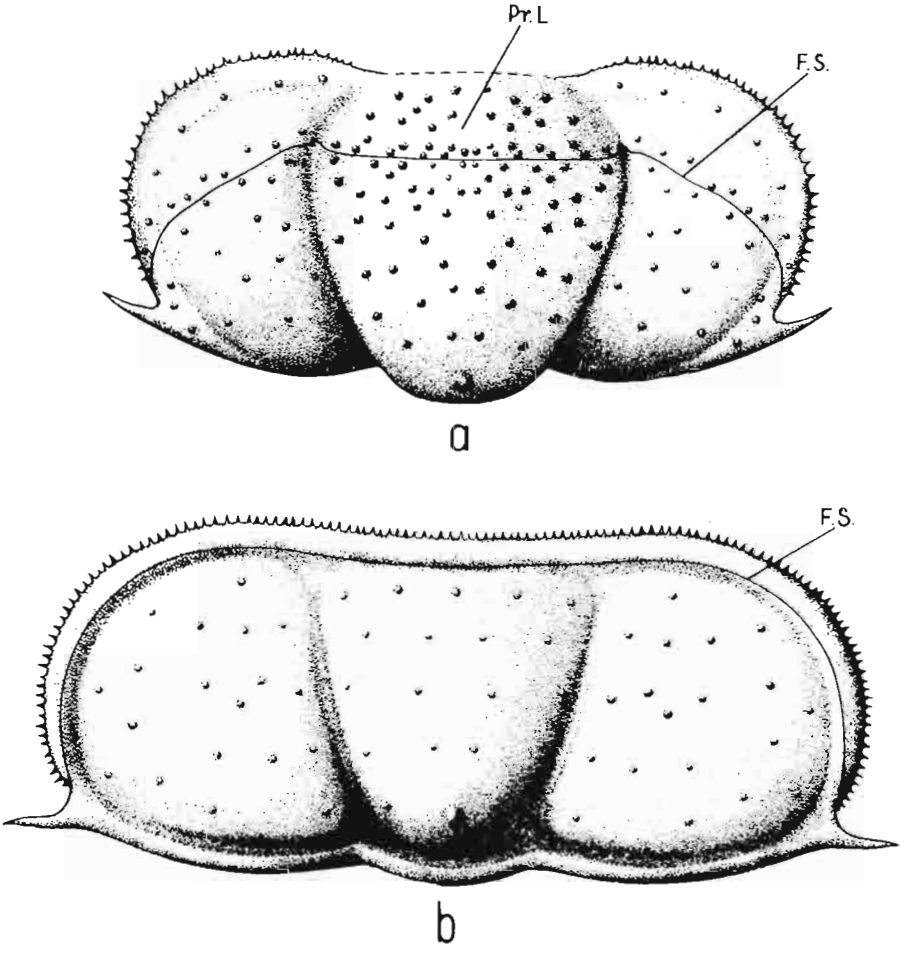


Fig. 9

Diagrammatic sketches of the cephalons: a *Eodindymene pulchra* (OLIN), approx. × 6; b *Dindymene fridericiaugusti* HAWLE & CORDA, showing the difference in the course of the facial suture; approx. × 7

F.S. facial suture, *Pr. L* precranidial lobe

gena, cuts the dorsal furrow and continues on the rhachial portion of the cephalon, dividing it into the glabella and the convex precranidial lobe (see fig. 9*a*). I have examined quite a number of specimens of different species of *Dindymene* and *Eodindymene pulchra*, and in none of them have I observed any traces of connective sutures or rostral plate. This seems to be rather strange, when comparing *Dindymene* with other representatives of Encrinuridae, in which the rostral plate is always developed. With regard to «*Dindymene bohemica*», PRANTL and PŘIBYL (1948) have erected for this species a separate genus—*Plasiaspis*, and stated that the course of the facial suture is

of dindymenid type. This however is not the case. The rostral plate in this species (see fig. 10) is subtrapezoid in shape, situated on the anterior border, similar in general pattern to that of *Atractopyge xipheres* Öpik. Thus, in the structure of ventral cephalic sutures *Plasiaspis* resembles the other encrinurids and differs in this respect from *Dindymene* and *Eodindymene*.

On the other hand, the genera *Plasiaspis*, *Eodindymene* and *Dindymene* are very similar to each other; they are blind, with narrow free cheeks and with free thoracic and pygidial ends extended into spines. The differences between *Dindymene* and *Plasiaspis* have been pointed out by Prantl and Přibyl (1948, p. 20) and they concern the structure of the glabella (no lateral glabellar furrows in *Dindymene*) and the different number of thoracic segments (12 in *Plasiaspis*, and 10 in *Dindymene*). According to these authors, there exists also a difference in the number of pygidial pleurae (3 in *Plasiaspis*, and 2 in *Dindymene*), but in fact this is not the case, because in 2 species of *Dindymene* and in *Eodindymene pulchra* (comp. table 6, between pp. 148/149) there are 3 pygidial pleurae.

The question is what are the phylogenetic relations of the three genera here discussed (*Dindymene*, *Eodindymene* and *Plasiaspis*) with the other encrinurids. With regard to *Dindymene* and *Eodindymene*, the most difficult thing is to explain the unexpected pattern of the ventral cephalic sutures, which are so different from all the other encrinurids. *Plasiaspis* is one of the earliest known encrinurids described so far. Several features of this genus, for instance the comparatively broad rostral plate situated on the anterior border (not dorsally), the free thoracic and pygidial ends, and the presence of lateral glabellar furrow — are primitive characters. On the other hand, the lack of eyes and the facial suture running subparallel to the cephalic outline, presumably secondary opisthoparian, are highly specialized features. For these reasons, it cannot be treated as an ancestor of the encrinurids. The remaining question is whether *Plasiaspis* may be considered an ancestral form of *Eodindymene* and *Dindymene*. According to the hypothesis of Kiaer (1916) and Warburg (1925), all trilobite lines originally had a large, separate rostrum like that in *Holmia* and *Kjerulfia*. During evolution, the rostrum became more and more reduced and narrower. In the Asaphidae it has entirely disappeared, but the free cheeks are still separated by a median suture, which finally in the Phacopidae and some other groups become obliterated. According to this hypothesis, the evolution from the euptychopariid toward the levisellid type of ventral cephalic sutures is very long indeed. But one can assume that the obliteration of connective sutures could take place also at their original place. If the connective sutures have been obliterated sometimes at their original place, the intimate genetic association between forms characterized by euptychopariid and levisellid pattern may be claimed as probable.

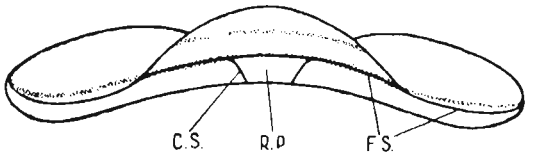


Fig. 10

Plasiaspis bohemica (Barrande) — diagrammatic sketch of the cephalon in anterior view; approx. × 3.5
F.S. facial suture, *C.S.* connective suture, *R.P.* rostral plate

There is no tangible evidence which may be termed either phylogenetic or ontogenetic in confirmation of this hypothesis. Attention ought, however, to be drawn to the different tendencies of obliteration of facial sutures among the different trilobite groups. R. and E. Richter observed (1926) the migration of the fused facial suture towards the cephalic margin in Upper Devonian Phacopidae. The Upper Devonian proetid *Typhloproetus* indicates the tendency toward the obliteration of the fused facial suture, without any migration. If the same theory is applied to the connective sutures, one can envisage the development of the levisellid type of ventral cephalic sutures of *Dindymene* from the euptychopariid type of *Plasias-*

pis, by the obliteration of the connective sutures. The course of the facial suture subparallel to the cephalic outline, is a highly specialized feature connected with the absence of eyes and the migration of the facial suture. In this respect, then *Eodindymene pulchra* is less specialized than *Plasiaspis bohemica*, as in *E. pulchra* the facial suture cuts the gena, and its migration towards the cephalic margin is not so advanced as in *P. bohemica*. *Plasiaspis* can by no means be treated as an ancestor of *Eodindymene* and *Dindymene*, but one can accept it as a form closely related to the ancestors of dindymenids, which is in accordance with the geological range of these genera.

With regard to the evolution of the genera *Eodindymene* and *Dindymene*, the first seems to be more primitive, especially in the course of the facial suture and comparatively large free cheeks. *Eodindymene pulchra*, which occurs in the lower part of the Ashgillian, cannot however be considered as an ancestor of the Middle Ashgillian representatives of *Dindymene*. More specialized *Dindymene* species *(D. plasi)* are already known from the Middle Ordovician of Bohemia. The most reasonable view is to treat *Eodindymene pulchra* as a conservative form of a primitive dindymenid line, closely related to the actual ancestors of the representatives of the genus *Dindymene*.

SYSTEMATIC PART

Family **SPHAERAGNOSTIDAE** KOBAYASHI, 1939

Genus **SPHAERAGNOSTUS** HOWELL & RESSER, 1938

Sphaeragnostus gaspensis europeensis n. subsp.

(pl. I, fig. 1-3; text-fig. 11)

Holotype: Pygidium — pl. I, fig. 3.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: europeensis — occurring in Europe.

Diagnosis. — Cephalon oval in outline. Pygidium subovate in outline, elongated. Rhachis oval, occupying three-fifths of pygidial length, one tubercle on the anterior portion of rhachis, on its most elevated point. The second, small tubercle on the posterior portion of the rhachis, near dorsal furrow.

Material. — One nearly entire but depressed specimen, several pygidia. All the specimens from the type horizon and locality.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	
IG Mus. cat. no.	2. II. 308	2. II. 307
Length of pygidium	5.6	ca. 2.8
Length of rhachis	3.5	1.7
Width of pygidium	4.4	2.2
Width of rhachis	3.1	1.6

Description. — *Cephalon.* Only one specimen preserved, it has been strongly depressed. It is oval in outline, no morphological features can be observed.

Thorax unknown.

Pygidium suboval in outline, elongated longitudinally, length to width ratio being 1.27. The rhachis occupies three-fifths of the pygidial length. The dorsal furrow is very deep. The rhachis is strongly elevated with its highest point in the anterior portion, where there is located a small tubercle. At the most posterior point of the rhachis at the dorsal furrow, in the midline there is a second though very small tubercle, which is only preserved in some specimens. The anterior border of the pygidium is almost straight and directed transversely. The part of the pygidium surrounding the rhachis is gently convex and widest (long.) in the posterior part. It becomes narrower (tr.) at the sides. The border is very narrow, limited by a very deep, distinct border furrow. It is well marked on the posterior portion of the pygidium, becoming narrower

and disappearing anteriorly. All specimens are preserved as internal moulds, there are no traces of an ornamentation preserved.

Discussion. — The new subspecies here described seems to be almost identical to *S. gaspensis gaspensis* Cooper & Kindle, 1936, and it differs from it only in small details. There is a small tubercle in the midline in our subspecies, although it is preserved only in some specimens. This tubercle seems to be absent in *S. gaspensis gaspensis*. The pygidium in *S. gaspensis gaspensis* is minutely punctate; in our species on account of the state of preservation no traces of ornamentation are visible. All these differences, in my opinion, cannot be treated as of specific rank. It seems more likely that such closely related Polish and Canadian forms, occurring in beds apparently of the same geological range, are geographical races (subspecies) of one species.

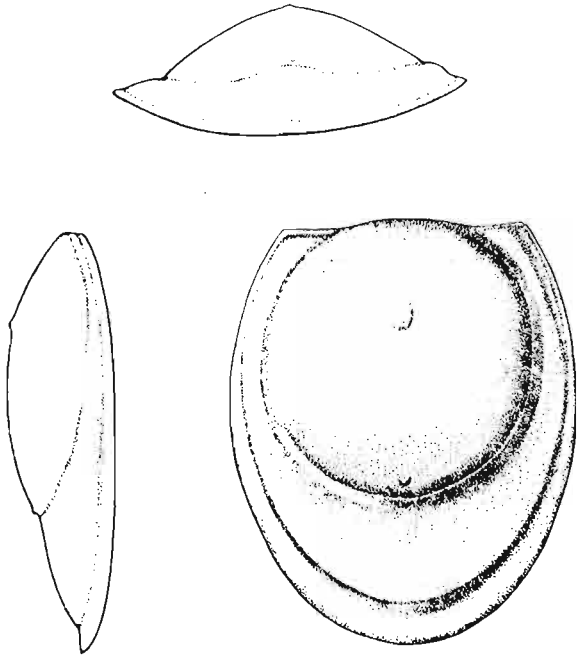


Fig. 11

Sphaeragnostus gaspensis europeensis n. subsp. — reconstruction of the pygidium, in dorsal, lateral and posterior views; approx. × 10.

Olin (1906, p. 72, pl. 5, fig. 17) described *Agnostus cingulatus* from the *Tretaspis* beds of Scania. This species is represented in Olin's collection (Lund Museum) by a single, poorly preserved specimen. There is also one, very poorly preserved specimen (cephalon and pygidium) from the *Tretaspis* beds of Bornholm in the collections of Copenhagen University (CM no. 1930. 104). It is probable that the specimen from Bornholm is conspecific with *Sphaeragnostus cingulatus*; both specimens are, however, so poorly preserved that their identification is a little difficult. *S. cingulatus* differs from *S. gaspensis* from Poland as well as from Canada in the less elongated shape of the pygidium. The rhachis, which is oval in *S. gaspensis*, is quite round (as long as wide) in *S. cingulatus*. No traces of tubercles or ornamentation are preserved in *S. cingulatus*. It is uncertain whether the differences between *S. cingulatus* and *S. gaspensis* are due to the bad state of preservation of *S. cingulatus*. This can be cleared up when more and better preserved material from the type locality (Scania, Koängen) is described.

Family **GERAGNOSTIDAE** Howell, 1935

Genus **GERAGNOSTUS** Howell, 1935

Geragnostus sp.

(pl. I, fig. 4; text-fig. 12)

Material. — One depressed, but well preserved cephalon from *Staurocephalus clavifrons* zone of Brzezinki, Poland.

Dimensions (in mm):

Locality	Brzezinki
IG Mus. cat. no.	2. II. 68
Length of cephalon	2.9
Width of cephalon	2.3
Length of glabella	1.8
Width of glabella	0.8

Description. — *Cephalon* is semielliptical in outline, longer than wide. Length of the glabella is a little less than two-thirds cephalic length, the width — one-third that of the cephalon. The dorsal furrows are deep, parallel, slightly approaching each other in the middle of the length of the glabella and meeting in a semicircle in front of it. Posterior end of the dorsal furrows bifurcates. One branch of it runs postero-medially and meets the end of the second similar branch in the middle posterior point of glabella. The second branch runs outwards and, forming an arch, meets the lateral border furrow of the cephalon. There are small, triangular basal lobes between the base of the glabella and the cheeks. On the two-thirds of glabellar length, there is one chevron-shaped furrow. There is a flat border running from the basal triangles around the whole cephalon. It is narrow posteriorly, becoming gently broader anteriorly. The border furrow is deep in the posterior part, becoming shallower and wider anteriorly.

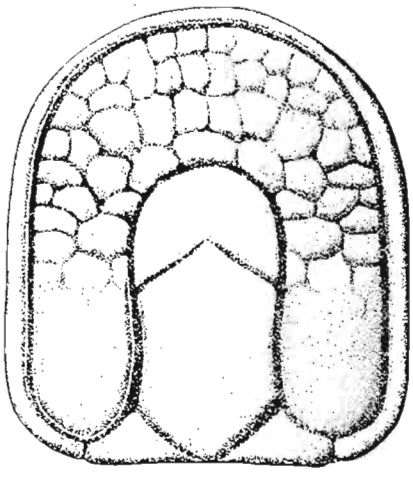


Fig. 12

Geragnostus sp., cephalon — reconstruction; approx. × 20.

Ornamentation. On the cheek surface there is an ornamentation of grooves, surrounding irregular, rounded fields. There are two, three or four such rounded fields in a row between the dorsal and border furrow. The very posterior part of the cheeks is smooth.

Discussion. — Whittard (1955, p. 6) stated: «*Corrugatagnostus* differs in so many respects from *Geragnostus* that it is here given the status of a genus». The specimen here described exhibits the characters intermediate in some way between the genera *Corrugatagnostus* Kobayashi (Kobayashi, 1939) and *Geragnostus* Howell (Howell, 1935) — so its generic attribution is doubtful. The presence of only one chevron-shaped furrow on the glabella reminds one of the condition in *Geragnostus* and my form is provisionally referred to this genus.

In the ornamentation of the cephalon it resembles the representatives of *Corrugatagnostus*, for instance *C. morea* (SALTER) (comp. WHITTARD, 1940, 1955) and *C. perrugatus* (BARRANDE), differing however from them in having an ornamentation of irregular grooves, surrounding oval or circular fields, whereas in *Corrugatagnostus* those are more or less regular, and there are radial grooves on the cheeks.

Family **TRINODIDAE** HOWELL, 1935

Genus **TRINODUS** MCCOY, 1816

Trinodus tardus (BARRANDE, 1846)

(pl. I, fig. 6-13; text - fig. 13)

1846*a*. *Battus tardus* n. sp.; J. BARRANDE, Notice préliminaire..., p. 35.
1847. *Arthorhachis tarda* n. sp.; J. HAWLE & A. CORDA, Prodrom einer Monographie..., p. 115, pl. 6, fig. 60.
1851. *Agnostus glabratus* n. sp.; N. P. ANGELIN, Palaeontologia Scandinavica, p. 6, pl. 6, fig. 5.
1852. *Agnostus tardus* BARRANDE; J. BARRANDE, Système Silurien..., vol. I, p. 913, pl. 49, fig. 1-4.
1869*b*. *Agnostus trinodus* SALTER; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 83, pl. 2, fig. 62.
1899. *Agnostus trinodus* SALTER; J. P. J. RAVN, Trilobitfaunaen..., p. 53.
1906. *Agnostus trinodus* SALTER; E. OLIN, Om de Chasmopskalken..., p. 72, pl. 4, fig. 15-16.
1950*a*. *Trinodus tarda* (HAWLE & CORDA); H. B. WHITTINGTON, Sixteen Ordovician..., pl. 68, fig. 4-6.
1956. *Trinodus tardus* (HAWLE & CORDA); Z. KIELAN, On the stratigraphy..., pl. 1, fig. 4-5.

Material. — 8 entire specimens, about 200 cephalons and 250 pygidia from the *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland; several cephalons and pygidia from the *Tretaspis* beds of Bornholm, Scania and Västergötland; several cephalons and pygidia from the Králův Dvůr beds of Bohemia.

Dimensions of 8 specimens (in mm):

Locality	Wólka	Brzezinki					Wólka	
IG Mus. cat. no.	2. II. 46	2. II. 64	2. II. 62	2. II. 67	2. II. 50	2. II. 57	2. II. 54	2. II. 60
Length of cephalon	4.1	4.0	3.9	4.7	3.9	2.2	—	
Width of cephalon	4 9	3.6	4.6	4.5	4.7	2.4	—	
Length of glabella	2.9	2.6	2.4	3.1	2.3	1.0	—	
Width of glabella	1.4	1.3	1.6	1.5	1.4	0.9	—	
Length of pygidium	3.3	3.5	3.3	—	—	—	3.4	4.1
Width of pygidium	4.4	3.3	4.3	—	—	—	4.1	4.4
Length of rhachis	1.6	1.4	1.3	—	—	—	1.6	1.8
Width of rhachis	1.8	1.1	1.8	—	—	—	1.6	1.8
Length of entire individual	8.7	10.9	8.9	—	—	—	—	—

Description. — *Cephalon.* The outline is half an ellipse, the length being only slightly longer than the width. The posterior end of the cephalon forms a transverse line. The width of the cephalon is slightly increased in front, so that the greatest width is across the uppermost part of the glabella. At the base of the glabella there are wide (tr.), triangular basal lobes. Their ends meet each other in the midline of the cephalon. The dorsal furrows are very deep, running parallel forward from the tops of the basal lobes, and meeting in a semicircle in front

of the glabella. In half of the glabellar length the dorsal furrows become slightly broader, at the cost of the glabellar width, which is slightly narrower at this point. The glabella is moderately convex, a little higher than the cheeks. The cheeks surrounding the glabella are moderately convex, their width is constant and about equal to the width of the glabella. Posterior, lateral and anterior borders are continuous. At the genal angle the postero-lateral border is very narrow, but it does not disappear entirely. Anteriorly the lateral border becomes wider and more convex attaining its greatest width in the antero-lateral and anterior part of the cephalon. Lateral border furrow is very broad and deep, especially in the anterior part of the cephalon.

There is a single tubercle, slightly elongated longitudinally, situated in the middle part of the glabella.

Thorax is composed of two segments. Rhachis comprises two-thirds of the total segmental widht. There are two furrows on the thoracic rhachis, directed longitudinally (slightly laterally) and dividing the rhachis into a middle trapezoid-shaped part and two slightly smaller, subspherical knobs. Pleurae are wide (tr.), slightly convex, divided by pleural furrows (tr.) into narrow (long.) anterior part and wider posterior. Pleural ends are rounded, directed slightly anteriorly.

Pygidium. The outline of the pygidium is subquadrate. Rhachis comprises about a half or less of the pygidial length (without border), and about a half of the pygidial width (also without border). Dorsal furrows are very deep, slightly converging posteriorly, and forming a gentle arch at the rhachial end. There is a middle cylindrical part on the rhachis, which occupies one-third of its width and two-thirds of its length. There are three rhachial segments. The first two are separated from each other by transverse furrows running from the dorsal furrow to the medium furrows. The third segment forms a semicircle situated posterior to the first two segments. The pleural part of the pygidium surrounding the rhachis is strongly convex, its length (long.) in the posterior part being greater than its width (tr.) in the anterior part. Lateral border is slightly convex, broad in the posterior part, narrowing anteriorly, with a deep and broad border furrow. On the postero-lateral point of the border there is a narrow ridge crossing the border, which is produced into a very short and thin, gently arched spine, directed postero-laterally. Along the anterior margin of the pygidium, on the pleurae, there is a furrow running parallel to the margin and delimiting a narrow anterior border.

Ornamentation. The whole body surface is covered by minute anastomosing threads (raised lines), surrounding small circular or irregular fields. On the pygidial and cephalic border the raised lines are less distinct and the fields surrounded by them smaller. The ornamentation is visible, however, only on very well preserved specimens, chiefly on the latex casts, made from the external moulds.

Discussion. — *Trinodus tardus* (Barrande) is one of the species in which Barrande (1852) recognized a wide and a long form. The same two forms occur in the Polish material of this species, but in my opinion (comp. p. 41), these differences are due to the state of preservation only. In my collection there are several intermediate specimens between the wide and long form. The proportions, which have been given in this description, are based on some specimens, which have suffered no distortion, from the *Staurocephalus clavifrons* zone of Wólka, Holy Cross Mountains.

Barrande (1852, p. 914) in describing this species stated: «La surface du corps observée sur le moule interne, paraît complètement lisse». This difference with Barrande's specimens is due to the state of preservation, as the most of the Polish specimens, as well as those from Scandinavia, preserved as internal moulds, seem also to be entirely smooth. Similarly, two short spines on the pygidial margin have not been observed by Barrande — as they are only

very seldom preserved. They have been, however, figured by WHITTINGTON (1950*a*) on specimens from Bohemia, and I have observed their presence in some specimens of *Trinodus tardus* from Bohemia, housed in the National Museum in Prague. Thus it appears that no differences between *Trinodus tardus* (BARRANDE) from Bohemia and Poland can be observed.

The examination of the Scandinavian specimens previously described as *Agnostus trinodus* SALTER from the Upper Ordovician of Bornholm, Scania and Västergötland by LINNARSSON (1869*b*), RAVN (1899) and OLIN (1906), as well as the other trinodid collections from the same

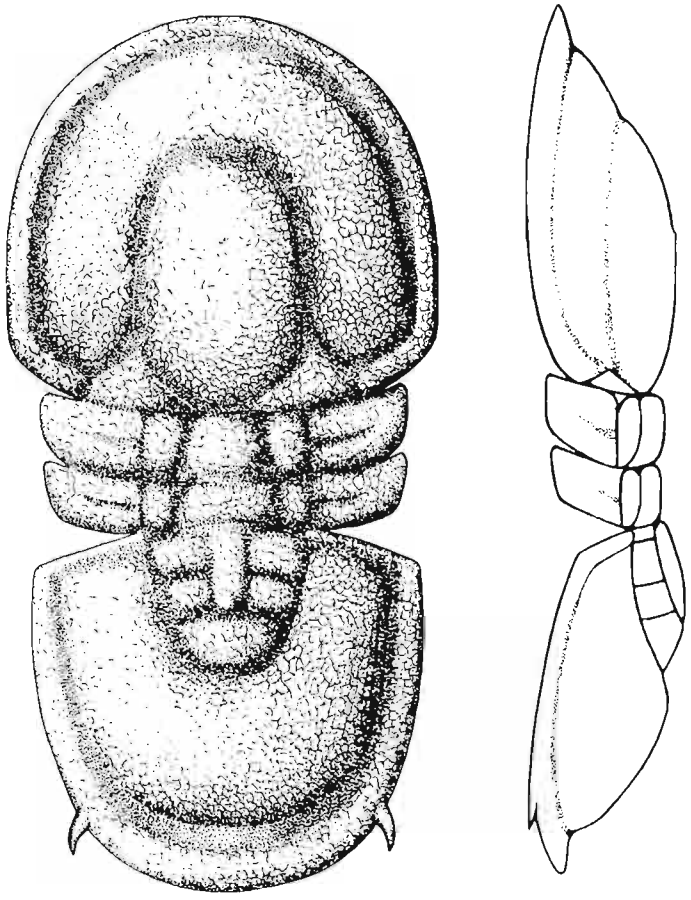


Fig. 13

Trinodus tardus (BARRANDE) — reconstruction, in dorsal and lateral views; approx. × 10.

localities at Museum of Nat. Hist. in Stockholm (RM) and Uppsala Museum has led me to the conclusion that these species are conspecific with *Trinodus tardus* from Poland and Bohemia. LINNARSSON (1869*b*, p. 83) has also taken *Agnostus glabratus* ANGELIN to be a synonym of *A. trinodus*. The identification of ANGELIN's original specimen of *A. glabratus* in the RM collection was impossible, but there are in this collection several specimens of *T. tardus* (BARRANDE) from ANGELIN's type locality (viz. Västergötland, Bestorp, Mösseberg), and this seems to give support to LINNARSSON's conclusion, given above.

According to LINNARSSON (1869*b*, p. 89), the Scandinavian *Agnostus trinodus* is conspecific with the Bohemian specimens of *A. tardus*, as well as with those from Great Britain. In my opinion, this statement seems to be true, but with regard to the British specimens it

cannot be proved with any certainty. In fact, *Trinodus tardus* (BARRANDE) seems to be very similar to *T. agnostiformis* McCOY (comp. McCOY, 1846, 1851, and WHITTINGTON, 1950*a*) from Great Britain (*A. trinodus* SALTER being a junior synonym of the latter). WHITTINGTON (1950*a*) described the holotype of *T. agnostiformis* and drew the conclusion that it was congeneric with *T. tardus*. The differences between these two species are difficult to ascertain. The holotype of *T. agnostiformis* figured by WHITTINGTON (1950*a*, pl. 68, fig. 1-3) is very poorly preserved. The chief difference in the cephalic structure seems to be that in *Agnostus agnostiformis* (comp. WHITTINGTON, 1950*a*, text-fig. 1) the basal lobes are well separated, whereas they meet in *Trinodus tardus*. There is a possibility that these differences are due to the state of preservation, in which case both species would be conspecific. This, however, requires better preserved material of *Trinodus agnostiformis* from the type locality.

Trinodus sp.

(pl. I, fig. 5; text-fig. 14)

In the collection from Wólka, Poland, zone of *Staurocephalus clavifrons*, there is one pygidium of *Trinodus*, differing in some respects from *Trinodus tardus* (BARRANDE). The rhachis in *Trinodus* sp. is much longer than in *T. tardus*. This depends on the length of the third rhachial

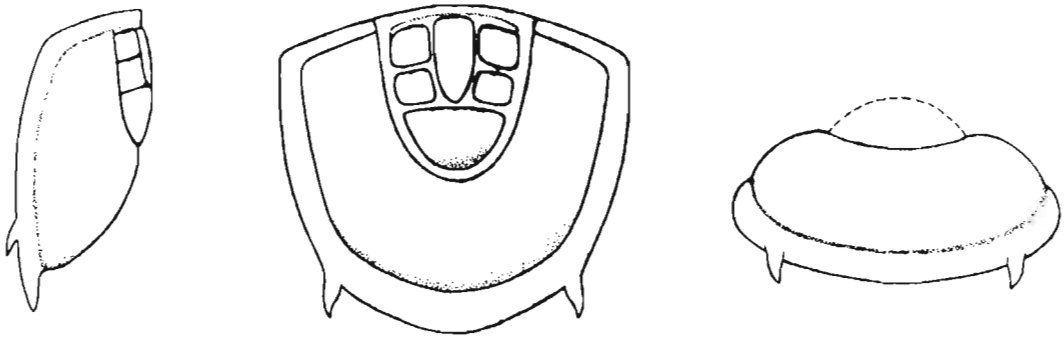


Fig. 14

Trinodus sp. — diagrammatic sketches of pygidium, in lateral, dorsal and posterior views; approx. × 13.

segment, which is twice as long as the second segment in *Trinodus* sp., whereas in *T. tardus* its length is equal to that of the second segment. This means that the pleural part of the pygidium, surrounding the rhachis, is in *Trinodus* sp. of a constant width all around the rhachis, whereas in *T. tardus* the pleural length (long.) in the posterior part is greater than its width (tr.) on the sides of the pygidium.

Dimensions (in mm):

Locality	Wólka
IG Mus. cat. no.	2. II. 61
Length of pygidium	3.3
Width of pygidium	3.7
Length of rhachis	2.0
Width of rhachis	1.5

Family **OTARIONIDAE** R. & E. RICHTER, 1936

Subfamily OTARIONINAE R. & E. RICHTER, 1926

Genus **OTARION** s. l. ZENKER, 1833

«**Otarion**» **tenuis** n. sp.

(pl. II, fig. 1-2; text-fig. 15)

Holotype: Cephalon and fragmentary thorax, figured on pl. II, fig. 1.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: tenuis — narrow, is an allusion to the slender shape of the glabella.

Diagnosis. — Cephalon moderately convex, eyes large situated close to glabella, border furrow deep, in frontal part of cephalon wider than the border. Thoracic pleurae have deep pleural furrows and taper conspicuously, producing very short spines. Pygidium with 4 rhachial rings and 4-5 pleurae with deep pleural and interpleural furrows. The whole body strongly granulated, two rows (tr.) of tubercles on both sides of pleural furrow on thoracic pleurae, several tubercles on rhachial rings with one stronger in middle part.

Material. — Several specimens, mostly cranidia, from the *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	Wólka
IG Mus. cat. no.	2. II. 255	2. II. 254
Length of cephalon	1.7	3.8
Length of glabella	0.99	2.5
Width of glabella (across the basal lobes)	0.83	2.4

Description. — *Cephalon.* The outline is half an ellipse. The border furrow is wide and deep, wider than a comparatively narrow border. The dorsal furrows are wide and very deep. From the occipital furrow they converge slightly at first, then run parallel, forming a gentle curve in front of the glabella. The lateral glabellar furrow S_1 — is as deep as the dorsal furrow; it runs in the continuation of the anterior part of the dorsal furrows, towards the occipital ring, slightly inwards. The middle lobe of the glabella is subcylindrical, slightly narrower at the base. The basal lobes cut off by the S_1 are suboval, slightly sharpened anteriorly, their length being one-third that of the glabella. The occipital ring is narrow, strongly convex. The occipital furrow is as wide as the occipital ring, very deep. In front of the glabella there is a large (long.) preglabellar field, its length (with the border) being equal to half the glabellar length.

In longitudinal profile the occipital ring is strongly convex, the occipital furrow very deep, the base of the glabella is situated higher than the occipital ring, and the glabella itself is moderately convex. The preglabellar field which is situated much lower than the occipital ring, forms a high arch between the preglabellar and border furrows. In profile the border seems to be almost flat, its distal end being bent slightly upwards.

The width of the glabella at the base is about one-third that of the cephalon.

The facial suture cuts obliquely the posterior border and the posterior border furrow, and runs towards the glabella. Close to the glabella, at the level of the top of the basal lobe, it curves around the palpebral lobe, the latter being slightly longer than the basal lobe. Then, it runs antero-laterally to the anterior border furrow, bends and cuts the border obliquely inwards. The anterior part of the fixed cheeks is longer than the posterior one. The free cheeks are large, the visual lobes badly preserved. The posterior border furrow is deep, the posterior border convex. The genal angles are produced into spines, which have wide bases; these spines are broken off. The posterior furrow and the border furrow meet each other and continue on the genal spine.

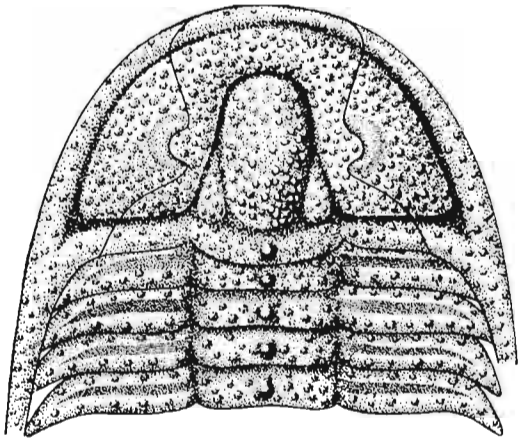


Fig. 15

«*Otarion*» *tenuis* n. sp. — reconstruction of cephalon and some thoracic segments; approx. × 9.

Thorax. Only a few of the first thoracic segments are preserved. The rhachis is narrower (tr.) than the pleura. The dorsal furrows are deep, the rhachial rings convex. The pleurae are directed transversely at the dorsal furrows, then, after two-thirds of their length (tr.) they bend slightly posteriorly. Their ends are sharply pointed, forming very short spines. A deep and wide pleural furrow divides (tr.) each pleura into two unequally broad parts, of which the posterior is slightly broader (long.) than the anterior.

Pygidium. No pygidium together with the cephalon has been preserved. In the collection from Brzezinki there is one fragment of an otarionid pygidium. It is wide and short, the rhachial width being less than one-fourth that of the pygidium, with 4 rhachial rings and 4 pleural segments. It is not, however, sure whether it is conspecific with the cephalon and thorax described here.

Ornamentation. The whole cephalic surface, except the furrows, is strongly granulated. The granulation seems to be coarser on larger specimens. There are about 7 regularly arranged tubercles along each part of the pleura and several irregularly arranged tubercles on the rhachial rings, with one stronger on the middle of every ring. The whole surface of the pygidium mentioned is also granulated.

Discussion. — Prantl and Přibyl (1950) gave the diagnosis of the genus *Otarion* Zenker, 1833, stating that (p. 90): «The thoracic pleurae are longitudinally striated, at the outer ends bluntly rounded». This is the case with the Silurian and Devonian representatives of this genus, but the Ordovician species, however, have the thoracic pleurae pointed, or even produced into very short spines. Such a structure of thoracic pleurae may be observed in the new species described here, as well as for instance in *Otarion planifrons* (Eichwald) — comp. Öpik, 1937, pl. 2, fig. 1-2. The other characters of the Ordovician species mentioned here seem to be the same as those characteristic of the Silurian and Ordovician representatives of *Otarion*. A more careful analysis of the Ordovician representatives of *Otarion* would lead probably to the recognition of a separate genus or at least subgenus within *Otarion*. As the Polish material of this genus is very scanty and poor, such an analysis must remain beyond the scope of the present paper. Therefore, the new species here described is attributed provisionally to *Otarion* Zenker, the generic name being cited in brackets.

Family **REMOPLEURIDIDAE** HAWLE & CORDA, 1847

The remopleuridid material from Poland, as well as from the *Tretaspis* and *Staurocephalus* mudstones from Scandinavia, is very incomplete and consists in the greater part of isolated and often fragmentary cranidia. As the distinction of the genera *Remopleurides* PORTLOCK and *Amphitryon* HAWLE & CORDA is based chiefly on the course of the ventral cephalic sutures and on the pygidial structure, the correct identification of the material available to me is so far impossible. Therefore, in doubtful cases, when only the isolated cranidium or pygidium is known, it is described here as *Remopleurides?* realizing, however, that it may belong to *Amphitryon* or to some other so far unrecognized remopleuridid genus. The necessary revision of the remopleuridids requires much better preserved material and is beyond the scope of the present work.

Genus **AMPHITRYON** HAWLE & CORDA, 1847

Amphitryon radians (BARRANDE, 1846)

(pl. II, fig. 3-7; pl. III, fig. 11)

1846*a*. *Cyphyra radians* n. sp.; J. BARRANDE, Notice préliminaire..., p. 32.
1847. *Amphitryon murchisoni* n. sp.; J. HAWLE & A. CORDA, Prodrom einer Monographie..., p. 113.
1851. *Remopleurides quadrilineatus* n. sp.; N. P. ANGELIN, Palaeontologia Scandinavica, p. 13, pl. 9, fig. 8.
1852. *Remopleurides radians* BARRANDE; J. BARRANDE, Système Silurien..., p. 359, pl. 43, fig. 33-39.
1869*b*. *Remopleurides radians* BARRANDE; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 67, pl. 1, fig. 21-22.
1906. *Remopleurides radians* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 54, pl. 2, fig. 1-2.

Material. — About 10 cranidia, 2 free cheeks, 1 pygidium from the *Staurocephalus clavifrons* zone, Brzezinki and Wólka, Poland. Several Bohemian and Scandinavian specimens have been examined for comparison.

Dimensions of 7 specimens (in mm):

Locality	Bohemia, Lejškov			Poland, Brzezinki		Sweden	
						Scania Tosterup	Västergötland
Mus. cat. no.	PMO A. 15410	PMO A. 15374	PMO A. 15400	2. II. 167	2. II. 166	LM LO. 1925	SGU LINNARSSON'S original
Length of cranidium without tongue	6.1	6.8	4.0	7.5	7.9	10.9	13.0
Length of tongue without roof	1.7	2.0	1.7	2.0	2.5	2.4	5.1
Width of glabella	7.2	8.0	4.7	?8.0	—	12.2	17.1
Width of tongue	1.4	2.0	1.0	1.7	2.0	1.9	3.6
Length of cranidium to length of tongue ratio	3.58	3.4	3.0	3.7	3.1	4.4	2.5

Description. — *Cephalon.* The outline of the glabella without the tongue is transversely oval. The glabella is nearly flat, and slightly convex in its middle part. There are three lateral glabellar furrows; L_1 strongly convex anteriorly, L_2 and L_3 less convex, L_3 half as long (tr.) as L_2. The occipital lobe is broad (long.) and flat, with a very small occipital node behind the occipital furrow. The lateral sides of the tongue are subparallel, on the top there is a triangular roof, separated from the rest of the tongue by a transverse furrow. The width of the roof (tr.) is a little greater than that of the tongue. Palpebral lobes are wide in the posterior part, narrowing anteriorly into thread-like strips. The free cheeks of the Polish specimens are incompletely preserved. The genal angles are produced into long spines.

Thorax. Only fragments of thoracic pleurae are known, forming narrow, leaf-like, posteriorly directed spines.

Pygidium is much elongated. The rhachis is short, occupying one quarter of the pygidial length, strongly convex and triangular. Two rhachial segments are visible. Pleurae are flat and divided (into four portions) by three faint longitudinal furrows. The middle furrow is situated in the prolongation of the axis of pygidium, the two lateral furrows — in the continuation of dorsal furrows. These furrows divide the posterior border of the pygidium into four parts, which are produced posteriorly into spines. The two middle spines are much shorter than the lateral ones.

Ornamentation. On some well preserved specimens a very fine ornamentation of striae is visible. The striae are almost concentric on the glabella, and transverse on the pygidial and thoracic pleurae.

Discussion. — An examination of BARRANDE's type specimens of *Amphitryon radians* (BARRANDE) in the National Museum in Prague, as well as a number of conspecific specimens from the Králův Dvůr beds in the Geological Institute of Charles University in Prague, has led me to the conclusion that the Polish specimens are conspecific with the Czech ones. I have found that there is some inaccuracy in BARRANDE's drawings of *Amphitryon radians*, which may cause some confusion. In all the Polish as well as the Czech specimens of this species there occurs a small occipital node just behind the occipital furrow, not figured on BARRANDE's drawings (comp. BARRANDE, 1852, pl. 43, fig. 33 - 34). Moreover, all the hypostomes I have seen (comp. pl. II, fig. 4) are more elongated than in BARRANDE's drawings (1852, pl. 43, fig. 37-38) and ornamented with transverse striae. It is however worth mentioning that *Amphitryon radians* is one of the species in which BARRANDE recognized a wide and a long form. The hypostome figured by him belongs to the wide form, but in my opinion (comp. p. 41, 42) it is only more depressed transversely.

It is not certain whether the Scandinavian specimens, identified by LINNARSSON (1869) and OLIN (1906) as *Remopleurides radians*, are conspecific in fact with the Bohemian species. The chief difference seems to be in the shape of tongue (comp. table of dimensions). In *Amphitryon radians* from the Holy Cross Mountains and Bohemia the ratio of the length of the cephalon to length of the tongue amounts to between 3 and 3.7, whereas in the specimen figured by LINNARSSON (1869*b*, pl. 1, fig. 22), from the Red *Tretaspis* beds of Västergötland, the tongue is very long and this ratio amounts to 2.5, whilst on the contrary in the specimen, figured by OLIN (1906, pl. 2, fig. 2) from the *Tretaspis* beds of Tosterup, it amounts to 4.4 (the tongue being very short). These differences may be due in part to the state of preservation. As no other differences have been observed, I provisionally treat these Scandinavian specimens as belonging to *A. radians*.

Amphitryon sp.

(pl. III, fig. 12)

Material. — One cranidium from the Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.

Dimensions (in mm):

Locality	Brzezinki
IG Mus. cat. no.	2. II. 168
Length of cranidium without tongue	ca. 6.0
Width of glabella	ca. 10.0
Length of tongue with roof	2.0
Width of tongue	1.1

Description. — The outline of the glabella without the tongue is transversely oval. Three lateral glabellar furrows: L_1 convex anteriorly, L_2 and L_3 less convex, L_3 half as long (tr.) as L_2. Occipital furrow is deep, running transversely. Occipital ring is flat, broad (long.) and long (tr.) with a very small occipital node just behind the occipital furrow. Tongue is very narrow (tr.), with a triangular roof on its summit, separated from the rest of the tongue by the distinct, broad transverse furrow. Palpebral lobes wide in the posterior part, narrowing strongly anteriorly. No traces of any ornamentation are preserved.

Discussion. — This specimen resembles to some extent the specimens described here as *A. radians*, but differs from them in the broader (tr.) glabella, and especially in the shape of the tongue, which is here more slender (tr.). Length to width ratio of the tongue of the specimen in question is 1.8:1, whereas in *A. radians* it is 1.1:1.

As the specimen here described has the glabella broader (tr.) than *A. radians*, and the tongue more slender, the differences observed cannot be considered as due to the state of preservation.

Genus **REMOPLEURIDES** PORTLOCK, 1843

Remopleurides? sp. **a**

(pl. III, fig. 10)

Material. — One badly preserved cranidium with some fragmentary thoracic segments, from the Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.

Dimensions (in mm):

Locality	Brzezinki
IG Mus. cat. no.	2. II. 169
Length of cranidium (without tongue)	9.9
Width of glabella	9.2
Length of tongue	4.6
Width of tongue at the base	4.1

Description. — The outline of the glabella (without the tongue) is nearly circular. Glabella is almost flat. The tongue is very large, wide and long, its base equivalent to half the width of the glabella. The width of the tongue gently diminishes anteriorly. No traces of lateral glabellar furrows are preserved. Occipital ring is broad (long.) and flat. Occipital furrow wide and deep. Palpebral lobes are broad in the posterior part, strongly narrowing anteriorly. Rhachial segments of thorax are broad (long.) and flat. Pleurae seem to be short (tr.). Each pleura is divided (tr.) by a furrow into an anterior and posterior portions. On the proximal end of the anterior portion there is a boss, corresponding to the socket of the posterior portion of the previous segment.

Discussion. — The cranidium here described differs from all remopleuridid species in having an extremely large tongue. The bad state of preservation, especially the lack of any ornamentation, does not allow any further comparisons to be made.

Remopleurides? sp. **b**

(text-fig. 16)

Material. — One pygidium from the Upper Ordovician, *Staurocephalus clavifrons* zone of Brzezinki, Poland.

Dimensions (in mm):

Locality	Brzezinki
IG Mus. cat. no.	2. II. 170
Length of pygidium	ca. 3.0
Width of pygidium	3.9
Length of rhachis	1.6
Width of rhachis	2.4

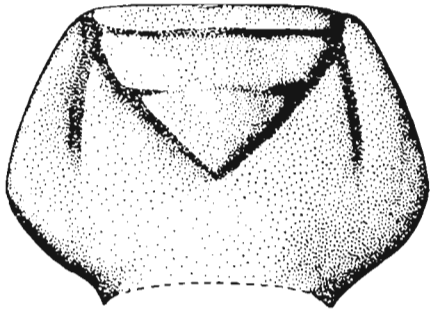


Fig. 16

Remopleurides? sp. *b* — pygidium; approx. × 11.

Description. — The pygidium is slightly wider than long, its outline being subquadrate but with the postero-lateral corners rounded. The rhachis is triangular, strongly convex. On the rhachis there is one articulating half ring and two rhachial segments. The first segment forms a transverse ring, the second being developed as a triangle, its summit being sharp-pointed. Pleurae are wide, slightly concave at the dorsal furrows and elevated in the postero-lateral part of the pygidium. There are no furrows on the pleurae. On the posterior pygidial margin there are two short spines, directed posteriorly, situated on the prolongation of the edges of the rhachial base. The very posterior part of the margin between the spines is not preserved.

Discussion. — The pygidium here described differs from other remopleuridid pygidia in being shorter and having a more regular (less notched) outline.

Family **PROETIDAE** Hawle & Corda, 1847

Subfamily PROETINAE Hawle & Corda, 1847

Genus **OGMOCNEMIS** nov.

Type species: Ogmocnemis irregularis n. sp.
Derivation of name: Ogmocnemis — provided with straight pleurae (*ογμωσ* = straight, *κνημισ* = cuish [2]).

Diagnosis. — Anterior branches of facial sutures divergent. Glabella narrowing only slightly anteriorly, where it is bluntly rounded off. One pair of faint lateral glabellar furrows or lateral furrows entirely missing. Eyes long, situated close to glabella. Preglabellar field long (sag.). 10 thoracic segments. Thoracic pleurae pointed or produced into short spines. Pygidial rhachis strongly convex, with 5-7 rings. Pleurae with pleural and interpleural furrows developed, both reaching pygidial margin, no border. The whole body usually ornamented by striae.

Occurrence. — Upper Ordovician, Europe and Canada.

Species:

Ogmocnemis irregularis n. sp. — type species
Trilobites asellus Esmark, 1833
Forbesia brevifrons Angelin, 1854
Proetus modestus Törnquist, 1884
Proetus remotus Warburg, 1925
Proetus subornatus Cooper & Kindle, 1936.

Discussion. — *Ogmocnemis* n. gen. is erected to include several Upper Ordovician proetid species, attributed hitherto to the genus *Proetus*. Přibyl (1946, p. 5) stated that: «the species *Proetus modestus* Törnquist probably belongs to a new subgenus of the genus *Proetus*, which I am temporarily calling by the new name *Warburgaspis* nov. subgen.» *Warburgaspis*, of which there is no description in Přibyl's paper, is claimed here to be *nomen nudum*.

There are several Upper Ordovician European and American species showing some similarities to *Ogmocnemis*, not included however in it. Thus, for instance, *Proetus chambliensis* Foerste (cf. Foerste, 1924), shows certain similarities to *Ogmocnemis* in cephalic pattern, but differs from all the representatives of the genus in the presence of a distinct pygidial border. The British Upper Ordovician proetids, such as *Proetus girvanensis* Nicholson & Etheridge and *Proetus procerus* Nicholson & Etheridge (claimed by Begg, 1939, as conspecific), as well as the Swedish species: *Proetus convexus* Warburg, *Proetus ainae* Warburg and *Proetus parvigena* Warburg from the Upper *Leptaena* limestone, differ from the representatives of *Ogmocnemis* in the course of the anterior branches of facial sutures, which are nearly parallel, and in the presence of a shorter preglabellar field.

Hupé (1953*a*) has erected a new subfamily Proetidellinae, including in it *Proetidella* and *Warburgaspis*. *Warburgaspis*, as has been stated above, is a *nomen nudum*. The difference between Proetinae and Proetidellinae is, according to Hupé, in the course of the anterior branches of facial sutures, which in Proetinae are «peu divergent», whereas in Proetidellinae «très divergent». In my opinion, there is insufficient basis to retain the subfamily Proetidellinae (comp. also Přibyl, 1957), and I include the new genus *Ogmocnemis* into the Proetinae.

[2] *Cuish* — defensive plate armor for the thighs, considered here as comparable with thoracic pleurae protecting the limbs.

Ogmocnemis irregularis n. sp.

(pl. III, fig. 6-9; pl. IV, fig. 8-9; text-fig. 17)

Holotype: Cephalon figured on pl. III, fig. 8.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: irregularis — allusion to the ornamentation of irregular striae.

Diagnosis. — Preglabellar field comparatively long, anterior border convex. One pair of lateral glabellar furrows almost invisible. Pygidial rhachis with seven rings, five to six broad (long.) pygidial pleurae. Entire body surface ornamented with striae.

Material. — 3 almost entire specimens, about 50 fragmentary specimens (cranidia, cheeks and pygidia).

Dimensions of 3 specimens (in mm):

Locality	Brzezinki		
IG Mus. cat. no.	2. II. 266	2. II. 267	2. II. 262
Length of entire individual	15.0	—	—
Length of cephalon	5.8	6.8	—
Length of glabella	—	3.9	—
Width of glabella	—	3.8	—
Length of pygidium	2.9	—	3.4
Width of pygidium	5.8	—	6.6
Width of pygidial rhachis	1.9	—	2.0

Description. — The outline of the entire animal is oval.

Cephalon is sub-semicircular in outline. The glabellar length is about seven-twelfths that of the cephalon. The dorsal furrows running from the occipital ring are subparallel, only slightly converging anteriorly, forming a slightly vaulted arch in front of the glabella. The occipital ring is flat, with a small occipital node. The occipital furrow is distinct but narrow. On the glabella there are traces of one pair of lateral glabellar furrows, visible only in an especially good state of preservation. S_1 in half the length of the palpebral lobe is directed postero-laterally, delimiting a scarcely visible triangular basal lobe. In front of the glabella there is a long and convex preglabellar field, delimited by a deep anterior furrow from the convex anterior border. The facial suture cuts the posterior border antero-medially, runs to the dorsal furrow, swings around the semilunar palpebral lobe which adhers closely to the glabella, runs at first along the dorsal furrows, then it deviates slightly laterally, and runs to the anterior border, cutting it antero-medially. The fixed cheeks are very small, the free cheeks large. The eyes are large, elongated longitudinally, convex, with hexagonal facets, the exact number of which is difficult to establish. The border is wide and convex, delimited by a deep and wide border furrow. The posterior border is narrower than the border, the posterior border furrow is deep, but narrower than the border furrow. The genal angle is produced into a posteriorly (slightly laterally) directed genal spine, reaching back to the 5th thoracic segment.

Thorax is composed of ten segments. On some of the first thoracic segments the rhachial width (tr.) is equal to that of the pleura. Posteriorly the rhachis narrows. The thoracic rings are wide and flat. The pleurae are wide (long.), with a pleural furrows, running from the antero-medial corner of the pleura, postero-laterally, obliquely through the pleura, dividing it into triangular areas, narrower (long.) anteriorly and wider posteriorly. The pleural ends are bent posteriorly and are pointed, but not produced into spines.

Pygidium. The outline is slightly wider than a semicircle. The rhachial width is less than one-third that of the pygidium. The rhachis is composed of seven rings, the first of which is situated a little higher than the following. The dorsal furrows are distinct, converging posteriorly. The rhachis occupies three-fourths of the pygidial length, so that behind it there is a long, flat area. There are five pleural segments, the pleural furrows delimiting them are distinct and deep. The interpleural furrows are shallower than the pleural furrows and are marked off on the distal part of the pleurae only, they run parallel to the pleural furrows, dividing the peripheral part of every segment into two equal (long.) parts. Both pleural and interpleural furrows reach the pygidial margin, so that there is no pygidial border. The pygidial doublure with concentric lines occupies about one-fourth of the pygidial length.

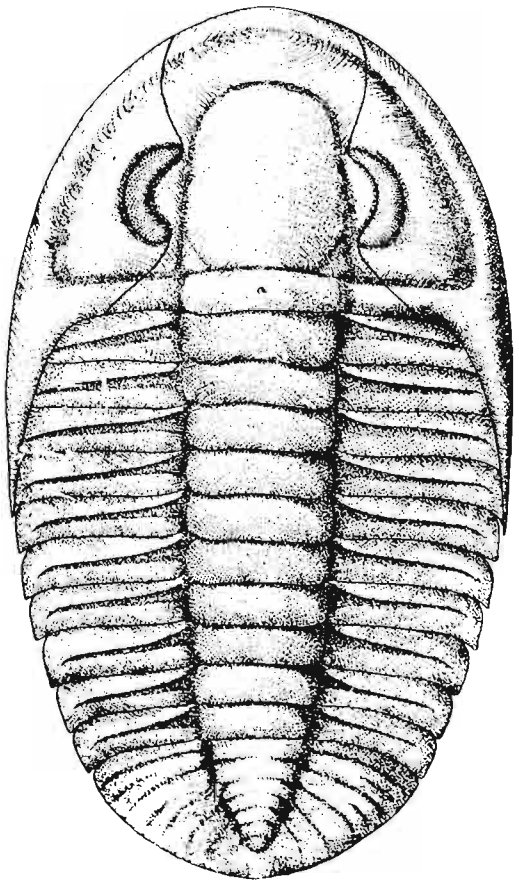


Fig. 17

Ogmocnemis irregularis n. sp. — reconstruction; approx. × 8.

Ornamentation. The entire body is closely covered by fine anastomosing, thread-like striae. On the glabella these lines are arranged in a similar way to the papillar lines in a finger print. On the cheeks they are directed transversely, slightly bending anteriorly on the lateral border.

On the thoracic and pygidial rhachis the striae are convex anteriorly, on the pleurae they are directed transversely, being slightly bent anteriorly in the peripheral part.

Discussion. — The new species described here has a similar cephalic pattern to that of *Ogmocnemis subornatus* (Cooper & Kindle) from the Upper Ordovician beds of Canada. In the cephalic structure the only difference being in the course of the facial suture, which in *O. subornatus* are less divergent. The pygidia of the species in question differ more markedly, the rhachis of *O. subornatus* being greater, occupying one-third of the pygidial width, whereas in *O. irregularis* it is narrower. *O. irregularis* reminds one also of *O. asellus* (Esmark) (comp. Esmark, 1833, and Størmer, 1940) from the *Tretaspis* beds of Norway, differing however from it in having longer eyes, smaller glabella and the ends of thoracic pleurae bent more posteriorly.

Family **PHILLIPSINELLIDAE** WHITTINGTON, 1950

Genus **PHILLIPSINELLA** NOVÁK, 1885

Phillipsinella parabola (BARRANDE, 1846)

(pl. IV, fig. 1-7; pl. V, fig. 1-3; text-fig. 18,19)

1846*a*. *Phacops parabola* n. sp.; J. BARRANDE, Notice préliminaire..., p. 6.
1852. *Phillipsia parabola* BARRANDE; J. BARRANDE, Système Silurien..., p. 477, pl. 18, fig. 24-29.
1869*b*. *Phillipsia parabola* BARRANDE; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 72, pl. 2, fig. 30-32.
1872. *Phillipsia parabola* BARRANDE; J. BARRANDE, Système Silurien..., Suppl., p. 18, pl. 1, fig. 16.
1884*b*. *Phillipsia parabola* BARRANDE; O. NOVÁK, Zur Kenntnis..., p. 27.
1885. *Phillipsinella parabola* (BARRANDE); O. NOVÁK, Studien an Hypostomen..., p. 581, pl. 3, fig. 1-3.
1899. *Phillipsia parabola* BARRANDE; J. P. J. RAVN, Trilobitfaunaen..., p. 58.
1904. *Phillipsinella parabola* (BARRANDE); F. R. C. REED, The Lower Palaeozoic..., p. 85, pl. 12, fig. 1-2.
1906. *Phillipsia parabola* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 60, pl. 2, fig. 18.
1931. *Phillipsinella parabola* (BARRANDE); F. R. C. REED, The Lower Palaeozoic..., Suppl. 2, p. 11.
1943. *Phillipsinella parabola* (BARRANDE); J. L. BEGG, Hypostomes..., p. 60, pl. 2, fig. 8.
1950*a*. *Phillipsinella parabola* (BARRANDE); H. B. WHITTINGTON, Sixteen Ordovician..., p. 559, pl. 75, fig. 3-7, text-fig. 8.
1956. *Phillipsinella parabola* (BARRANDE); Z. KIELAN, On the stratigraphy..., pl. 4, fig. 1-2.

Material. — About 220 more or less fragmentary specimens from the zone of *Staurocephalus clavifrons* of Brzezinki and Wólka, Poland. BARRANDE's original specimens from the Králův Dvůr beds of Bohemia, some specimens from the Red *Tretaspis* mudstones of Västergötland and the *Tretaspis* mudstones of Scania.

Dimensions of 6 specimens (in mm):

Locality	Brzezinki			Wólka	Brzezinki	
IG Mus. cat. no.	2. II. 151	2. II. 348b	2. II. 344	2. II. 154	2. II. 157	2. II. 150
Length of entire individual	—	—	—	—	11.2	16.6
Length of cephalon	1.64	1.04	1.6	3.04	5.1	8.0
Width of cephalon	—	1.2	—	—	7.2	11.2
Width of glabella at the base	0.48	0.3	0.52	0.92	1.9	3.0
Greatest width of glabella	1.04	0.64	0.92	1.8	3.7	6.0
Length of pygidium	—	—	—	—	3.3	4.8
Width of pygidium	—	—	—	—	6.0	9.0

Description. — The outline of the entire body is suboval.

Cephalon. The outline is half-parabolic, the length of the cephalon being only slightly less than a half of the entire body length. In longitudinal and transverse profiles the cephalon is moderately convex. The occipital ring is moderately convex, situated higher than the glabella. The occipital furrow is distinct and transversely directed. The dorsal furrows are deep, from the occipital furrow they run subparallel, slightly converging anteriorly; cutting a little more than one-fourth of the glabellar length, they swing laterally around the convex,

anterior part of the glabella. The anterior part of the glabella is about twice as wide as the posterior. There are no lateral glabellar furrows, but on the dorsal furrows there are two deep, round pits; one (p_1) situated on the level of the most anterior portion of the eye, the second (p_2) a little in front of it (comp. text-fig. 18, 19). On smaller specimens these pits are more distinct (comp. pl. IV, fig. 3, 7).

The fixed cheeks are small. The facial suture cuts the posterior margin and runs in an exteriorly convex arch towards the eye, then around the palpebral lobe and, parallel to the

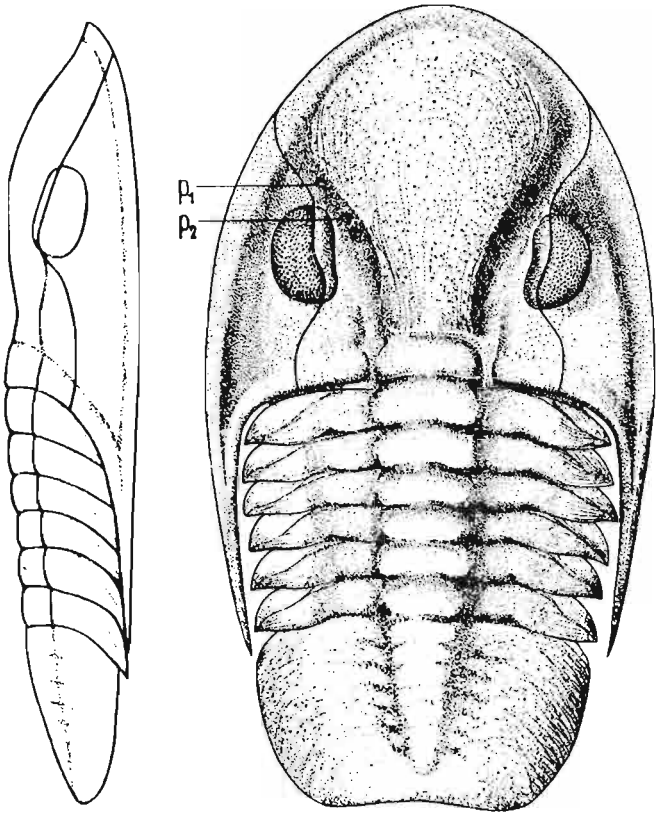


Fig. 18

Phillipsinella parabola (BARRANDE) — reconstruction, in lateral and dorsal views; approx. × 6.5

p_1, p_2 anterior and posterior pits.

dorsal furrow — to the anterior cephalic margin. The eye is large, very convex, with about four or five hundred round lenses, the exact number of which is difficult to determine. The posterior border is gently convex, narrow (long.) and indistinct, the lateral border almost flat, with a wide and shallow lateral border furrow. The lateral border continues in front of the glabella, forming a strongly flattened, wide (long.) anterior border. The posterior and lateral borders are produced into narrow genal spines, reaching back to the end of thorax. Sometimes, the genal spine is shorter, reaching back only to the fourth thoracic segment.

The doublure is comparatively narrow (tr.) at the sides, becoming almost three times broader in its anterior part. The rostral plate is large, convex, subtrapezoidal, its anterior outline forming an arch, the connective sutures being directed postero-medially.

Hypostome. The hypostome of *Phillipsinella parabola* was previously imperfectly known (comp. BEGG, 1943, pl. 2, fig. 8; WHITTINGTON, 1950*a*, pl. 75, fig. 5-6, text-fig. 8). Three fairly well preserved specimens of the ventral side of the cephalon, from which the latex casts were made (comp. pl. V, fig. 2), allowed me to make a reconstruction of a hypostome (see text-fig. 19). The hypostome is large, long, extending slightly beyond the posterior margin of the cephalon. The anterior margin is wide (tr.), with triangular lateral wings, extending laterally beyond the rostral plate. The anterior furrow is very wide and deep. The middle body is suboval in outline, broader (tr.) in its anterior portion than in its posterior. The anterior part of the middle body is situated higher than the posterior convex part, which is divided by a very faint median furrow into two lobes, passing gradually into the less convex posterior part. The lateral furrow is comparatively narrow and shallow in the anterior part, becomes very wide and deep posteriorly, where the hypostome is wider. The posterior furrow is wider and shallower than the lateral. The lateral and posterior borders are narrow and convex. The posterior margin is concave and its lateral angles sharp. Beneath the lateral and posterior borders there is a doublure, the outline of which is difficult to establish.

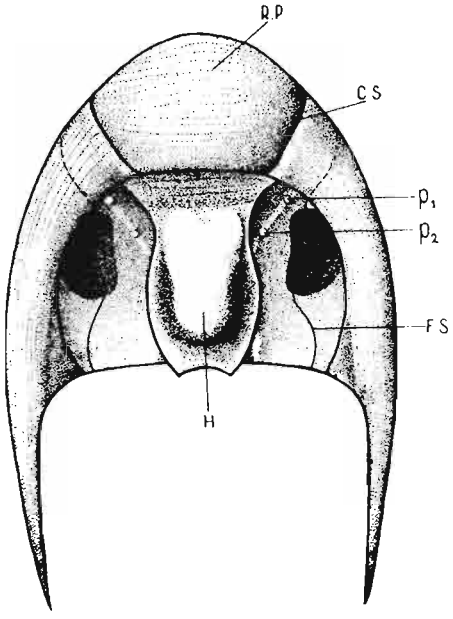


Fig. 19

Phillipsinella parabola (BARRANDE) — reconstruction of the ventral side of the cephalon: approx. × 6. 5

R.P. rostral plate, *C.S.* connective suture, *F.S.* facial suture, *H* hypostome, p_1, p_2 anterior and posterior pits.

Thorax is composed of 6 segments. The rhachis is as wide as the pleura, hardly converging posteriorly. The rhachial rings are very slightly convex anteriorly in the middle part, and bent slightly anteriorly again at the dorsal furrows. The pleural segments are directed transversely and are obliquely cut off at their ends, without however being produced into spines. There is a very indistinct pleural furrow directed transversely in the anterior part of the segment and visible only in its proximal part. Across the pleura there runs a postero-laterally directed raised line, cutting off the antero-lateral, triangular part.

Pygidium is subquadrate in outline, moderately convex transversely and longitudinally. The rhachis is long, triangular, converging posteriorly. There are about 8, very indistinct rhachial segments, visible only as shadows, the posterior ones being entirely fused together. On the pleurae there are traces of about 3 pleural segments, no pygidial border or border furrow being developed. The posterior pygidial margin is slightly concave.

Ornamentation. The whole body is covered with an ornamentation of thread-like raised lines. On the glabella they run anteriorly from the occipital furrow, diverge dichotomously on the sides of the glabella, and run around the anterior convex part of the glabella. On the glabella, in addition to this ornamentation, there are small pits along the grooves between the raised lines. On the cheeks the raised lines are less distinct, they run along the posterior margin and along the lateral margin, the most distinct being on the genal angle. On the thorax they are directed transversely across the rhachial rings and postero-laterally across the pleurae. One of them, as mentioned above, divides the pleura into two parts. On the small antero-lateral part of the pleura the raised lines are more distinct. On the pygidium they

run transversely across the rhachis and postero-laterally on the pleurae, being however more distinct on the pleurae.

The doublure is ornamented with more distinct terraced lines, parallel to the margin. On the rostrum the terraced lines are parallel to the outer and interior margins, in the anterior and posterior parts of the doublure respectively. Some of them in the middle part of the rostrum are divided dichotomously. On the hypostome indistinct terrace lines run along the lateral and the posterior borders, the most distinct being on the doublure.

Discussion. — The representatives of *Phillipsinella parabola* from the zone of *Staurocephalus clavifrons* of the Holy Cross Mountains seem to be identical with those from Scandinavia, Bohemia and Great Britain (cf. also discussions on p. 7, 38 and 47).

Family **ASAPHIDAE** Burmeister, 1843

Subfamily ASAPHINAE Burmeister, 1843

Genus **OPSIMASAPHUS** nov.

Type species: Opsimasaphus jaanussoni n. sp.
Derivation of name: Opsimasaphus — οψιμοσ = late *Asaphus*.

Diagnosis. — Cephalon and pygidium with broad flattened border. Anterior branches of facial suture quite close to the external cephalic margin. Preglabellar field long, one-third to one-fourth of the total cephalic length. Eyes large, situated behind the transverse midline of the cranidium. Genal angles produced into spines, librigenal panderian organ developed as a small separate opening. Hypostome with oval, inflated middle body, broadly rounded lateral margin and deeply notched posterior margin. Eight thoracic segments. Thoracic rhachis narrow, its width only half the width of the pleura or less. Lateral ends of the thoracic segments straight. Development of the panderian organ on the thoracic pleurae unknown. Pygidium wide, rhachis narrow, prominent, post-rhachial field long, pleurae with strong, unfurrowed ribs. Pygidial doublure moderately broad.

Occurrence. — Upper Ordovician, zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons*, Bohemia, Central Poland, Bornholm, Scania and Västergötland.

Discussion. — This genus is created to include two species:

Niobe lata Angelin, 1854
Opsimasaphus jaanussoni n. sp.

Opsimasaphus n. gen. differs from *Pseudobasilicus* by: 1) its longer preglabellar field, 2) the position of the anterior branches of the facial suture very close to the external cephalic margin, 3) the narrower rhachis of the whole exoskeleton, 4) the thoracic pleural terminations not being produced into spines, and 5) the narrower pygidial doublure. All the species of *Pseudobasilicus* have a characteristic shape of the inner margin of the thoracic pleural doublure (comp. Siegfried, 1936, p. 22, fig. 6), but as this character is still unknown in *Opsimasaphus* it cannot be compared at present. *Pseudoasaphus* and *Ogmasaphus* have a similar shape of pygidial doublure, but differ in having a shorter preglabellar field, wider rhachis and longer post-rhachial field. The position of the foremost part of the facial suture of *Opsimasaphus* suggests the condition in *Basilicus* and *Basiliella*, but in these genera the facial suture is marginal, the preglabellar field much shorter and the rhachis broader.

BARRANDE (1846*a*, 1852, 1872) described *Asaphus nobilis* BARRANDE as occurring in the Chrustenice beds, Zahořany beds and Králův Dvůr beds of Bohemia. The specimens figured by him are, however, only from the Zahořany beds (Caradocian) and Králův Dvůr beds (Ashgillian).

In the collection of the National Museum in Prague there are some specimens from the Middle Ordovician (Svata Dobrotivá beds), identified as *Asaphus nobilis*. One of them is an almost complete specimen, about 8 cm long, with the cephalon and thorax imperfectly preserved. The pygidium shows, however, some differences with the specimens from the Zahořany beds, being less truncate posteriorly (having a transverse posterior margin) and a wider doublure. It is doubtful whether this specimen is conspecific with those of *Asaphus nobilis* from the Zahořany beds. As ŠNAJDR (1956) does not mention either this species in the list of trilobites from the Llandeilo of Bohemia, its occurrence in the Middle Ordovician appears suspect. *Asaphus nobilis* from the Zahořany beds figured by BARRANDE (1852, pl. 31, fig. 1, 4, 5; pl. 32, fig. 1-6; pl. 35, fig. 8) differs to a very great extent from that from the Králův Dvůr beds (BARRANDE, 1852, pl. 31, fig. 2, 3, 6-8; 1872, pl. 8, fig. 19-20). For the comparison of «*Asaphus*» *nobilis* BARRANDE from the Zahořany and Králův Dvůr beds — see table 3.

Table 3

Comparison of «*Asaphus*» *nobilis* BARRANDE
from the Zahořany and the Králův Dvůr beds

	«*Asaphus*» *nobilis* BARRANDE from Zahořany beds	«*Asaphus*» *nobilis* BARRANDE from Králův Dvůr beds = *Opsimasaphus jaanussoni* n. sp.
Anterior branches of the facial suture	Running far away from the anterior margin and meeting each other under the angle.	Running almost along the anterior margin of the cephalon and together forming a semicircle.
Anterior border	Developed, convex (comp. BARRANDE, 1852, pl. 32, fig. 4).	No anterior border.
Length of the preglabellar field	Equal to one-fourth of the cephalon.	Equal to one-third or more of the cephalon.
Ends of the thoracic pleurae	Directed postero-laterally, produced into short spines.	Directed transversely, bluntly cut off.
Length to width ratio of the pygidium	0.6 - 0.7	0.47
Number of rhachial rings	14 - 15	8 - 9
Shape of the furrows between rhachial rings	In the middle part strongly curved posteriorly, similar furrow on rhachial rings.	Furrows between the rhachial rings directed transversely, no furrow on rhachial rings.
Posterior part of the rhachis	Narrow.	Slightly inflated.

This comparison proves that BARRANDE, under the name of *Asaphus nobilis*, described specimens which are not conspecific and probably not even congeneric either. I suggest that the specimen figured by BARRANDE (1852, pl. 31, fig. 1) to be chosen as the lectotype of

«*Asaphus*» *nobilis* BARRANDE, thus maintaining this name for the species from the Zahořany beds, the Králův Dvůr's specimens forming a new species. This new species occurs also in the Upper Ordovician in Poland, Bornholm and probably also in Scania. It is described as *Opsimasaphus jaanussoni* n. gen. n. sp. and is taken as the type species for this new genus.

Opsimasaphus jaanussoni is represented in Bohemia, Poland and Bornholm by comparatively small specimens, the average length being about 3 cm. The largest specimen of this species known to me is one from the Králův Dvůr beds of Bohemia, housed in the National Museum in Prague, being probably about 8 cm long. The length of the pygidium and fragmentary thorax preserved is 5 cm. In the collection from Bornholm, in Copenhagen Museum, there are, besides these small specimens, some very large, but very poorly preserved asaphid pygidia and cheeks. Similar large asaphid pygidial and cheek fragments have been described by OLIN (1906, p. 62, pl. 3, fig. 1-5) from the corresponding beds of Scania and identified by him as *Asaphus ingens* BARRANDE (cf. below).

JAANUSSON (1953*a*, p. 445) has considered OLIN's specimens conspecific with «*Niobe*» *lata*, stating however that: «Nach den beobachten Merkmalen is «*Niobe*» *lata* ANG. von «*Asaphus*» *ingens* BARR. deutlich verschieden».

«*Niobe*» *lata*, described by ANGELIN from the Red *Tretaspis* mudstones of Västergötland, is treated here as belonging to the new genus *Opsimasaphus*. The large asaphid pygidia and free cheeks from Bornholm and Scania differ, however, from those of *Opsimasaphus latus* from Västergötland. In the Riksmuseum collections there are two free cheeks from the Red *Tretaspis* mudstones of Västergötland, corresponding very well in shape to the cranidium of *O. latus* from the same beds. They are identical with those figured by ANGELIN (1854, pl. 10) in his reconstruction of «*Niobe*» *lata*, and evidently belong to this species. The genal spines of these cheeks are long, narrow, with a narrow base (comp. our pl. VIII, fig. 4). The large free cheeks from Scania and Bornholm (comp. pl. VIII, fig. 3) are produced into a comparatively short, wide genal spine, with a wide base. Similarly, the large fragmentary pygidia from Scania and Bornholm seem not to be conspecific with *O. latus*, as they are more elongated, and evidently more segmented. The large pygidia and cheeks in question seem to be more similar to *O. jaanussoni*, than to *O. latus*. As the correct identification of these species requires more and better preserved material, I have considered it more reasonable to identify them for the moment as *Opsimasaphus* sp. Thus, the occurrence of *O. jaanussoni* and *O. latus* in Scania remains in doubt.

The generic attribution of «*Asaphus*» *nobilis* BARRANDE is not clear. It cannot be considered as belonging to *Opsimasaphus* on account of the different course of the facial suture and the shape of the thoracic pleurae, which are produced into spines. REED (1930) has placed it in the genus *Pseudobasilicus* REED and has been followed in this respect by Czech authors. JAANUSSON (1953*a*, p. 445) has considered this species «mit gewissem Zweifel», as belonging to *Pseudobasilicus*. In discussing this question Dr. V. JAANUSSON has drawn my attention to the fact, that the presence of an anterior border in «*Asaphus*» *nobilis* (as figured by BARRANDE, 1952, p. 32, fig. 4) and the shape of the pygidial doublure — narrower than in the *Pseudobasilicus* — suggest the pattern characteristic of the genus *Basilicus*. On the other hand, the shape of the internal margin of the thoracic pleurae, if it is correctly drawn on BARRANDE's figure (1852, pl. 31, fig. 1 — the second thoracic pleura on the right side), is such as is characteristic *par excellence* of *Pseudobasilicus*. So, the question of the generic attribution of this species, as well as of the «*Asaphus*» *ingens* BARRANDE, still remains in doubt.

Opsimasaphus latus (ANGELIN, 1851)

(pl. VI, fig. 1-2; pl. VII, fig. 3; pl. VIII, fig. 4; text-fig. 20)

1851. *Niobe lata* n. sp.; N. P. ANGELIN, Palaeontologia Scandinavica, p. 14, pl. 10.

Lectotype: Cranidium figured by ANGELIN (1851, pl. 10, RM no. Ar. 14299b), refigured in the present paper — pl. VII, fig. 3.

Type horizon and locality: Upper Ordovician, Red *Tretaspis* mudstones of Kinnekulle, Västergötland, Sweden.

Diagnosis. — Preglabellar field long, equal to one-fourth of cephalic length. Length of the eye equal to one-sixth that of cephalon. Glabellar tubercle present. Hypostome unknown,

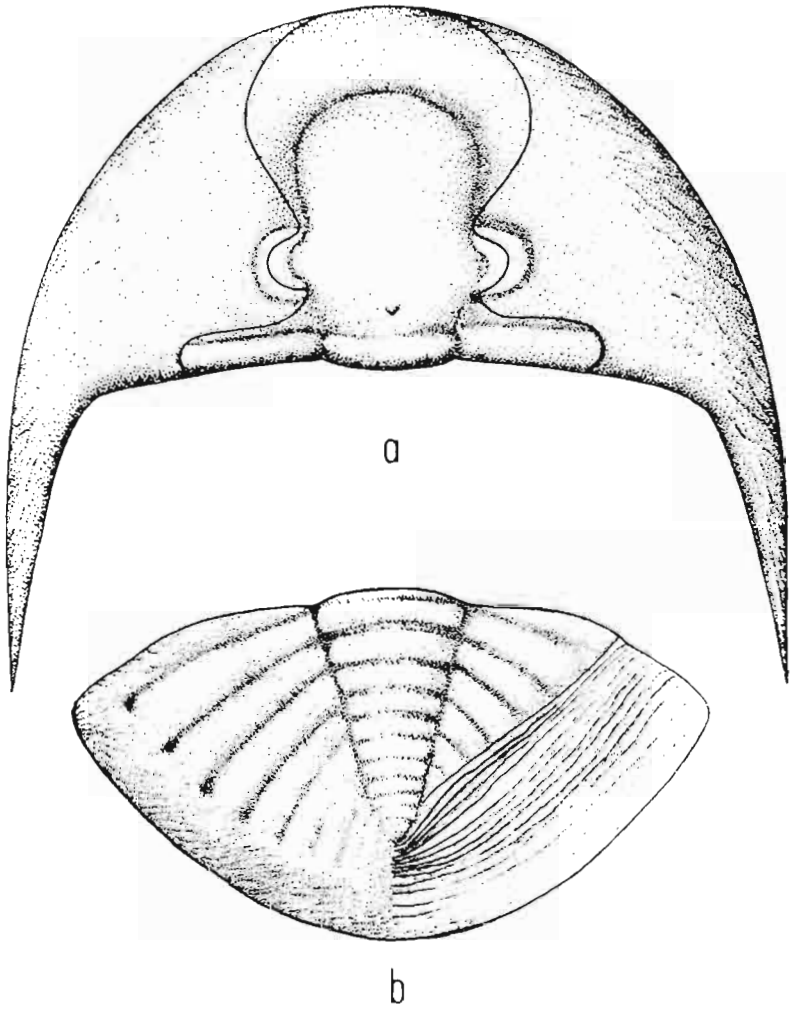


Fig. 20

Opsimasaphus latus (ANGELIN) — reconstruction; approx. nat. size

a cephalon, *b* pygidium; right side of pygidium showing doublure.

thorax imperfectly known, thoracic pleurae straight (transverse), not produced into spines. Pygidium sub-semicircular. Rhachis equal to almost six-eighths of pygidial length. 10-12 rhachial rings, 7-8 pleurae. Almost the whole body ornamented with anastomosing lines.

Material. — Two cranidia, two free cheeks, 12 pygidia — up to 50 mm long (RM and UM collections) from the Red *Tretaspis* mudstones of Västergötland, Sweden.

Description. — *Cephalon.* The outline is semicircular, the cephalon being very slightly convex only, longitudinally and transversely. The glabella occupies four-fifths of the cephalic length. The occipital ring is flat and narrow (long.), the occipital furrow very faint. In the posterior portion of the glabella the dorsal furrows are very faint, indistinct, they disappear entirely at the level of the eyes and become more distinct again in front of the eye level, running at first anteriorly and forming a gentle arch in front of the glabella. The preglabellar field is flat. The eyes are long, situated quite close to the glabella, both palpebral and visual lobes being semilunal, strongly convex exteriorly. The posterior border is as long (long.) as the occipital ring being marked along the fixed cheek only, and entirely disappearing on the free cheek. The fixed cheeks are large, produced into long and narrow, pointed genal spines, with a narrow base.

The facial suture cuts the posterior cephalic margin and runs as a convex arch peripherally around the posterior border, then medially, subparallel to the posterior border furrow. It reaches the posterior eye corner and runs around the palpebral lobe. In front of the eye it runs antero-laterally and then forms an arch and runs antero-medially quite close to the anterior cephalic margin and in the most anterior portion almost along it.

Thorax is imperfectly known.

Pygidium is semicircular in outline. The rhachis occupies one-fifth of the pygidial width and about three-fourths of its length. The rhachial furrows are distinct, converging posteriorly. There are about 11-12 rhachial rings. On the pleurae there are 8 pleural segments, widening peripherally. The earlier ones are directed almost transversely, the later postero-laterally and posteriorly. There is a flat border marked off by the disappearance of pleural furrows, no border furrow being developed. The doublure is wide (tr.) occupying a half the pleural width along the anterior pygidial margin. The interior margin of the doublure is directed parallel to the outline of the pygidium, and swings around the posterior end of the pygidial rhachis, so that the doublure becomes narrower (long.) on the very posterior part of the pygidium. There are several terrace lines on the doublure, more dense behind the rhachis on account of the curved shape of the doublure in this part.

Ornamentation. All around the cephalon and the pygidium there is an ornamentation of anastomosing lines, subparallel to the cephalic and pygidial outline, disappearing in the middle part of the cephalon and pygidium.

Opsimasaphus jaanussoni n. sp.

(pl. VII, fig. 1-2; text-fig. 21)

1846*a*. *Asaphus nobilis* n. sp.; J. BARRANDE, Notice préliminaire..., p. 30 (partim).
1852. *Asaphus nobilis* BARRANDE; J. BARRANDE, Système Silurien..., p. 657 (partim), pl. 31, fig. 2, 3, 6-8; non pl. 31, fig. 1, 4, 5; pl. 32, fig. 1-6; pl. 35, fig. 8.
1872. *Asaphus nobilis* BARRANDE; J. BARRANDE, *Ibid.*, Suppl., p. 53, pl. 8, fig. 19-20.
1899. *Asaphus (Ptychopyge) nobilis* BARRANDE; J. P. J. RAVN, Trilobitfaunaen..., p. 55 (partim).
1906. *Asaphus ingens* BARRANDE; E. OLIN, Om de Chasmopskalken..., pl. 2. fig. 25.
1956. *Pseudobasilicus nobilis* (BARRANDE); Z. KIELAN, On the stratigraphy..., pl. 2, fig. 6.

Holotype: The entire specimen — pl. VII, fig. 2.

Type horizon and locality: Upper Ordovician, Tretaspis beds, Bornholm, Vasagaard.

Derivation of name: jaanussoni — in honour of the distinguished Estonian palaeontologist Dr. VALDAR JAANUSSON (now Uppsala University).

Diagnosis. — Preglabellar field long (sag.) occupying one-third of cephalic length. Eyes long, equal to one-fourth of cephalic length. Genal angles produced into spines, reaching back to 6th thoracic segment. Pygidium sub-semicircular, wider than a semicircle. Rhachis narrow, occupying less than one-seventh of pygidial width and three-fifths of pygidial length, 11-12 rhachial rings. Posterior part of rhachis inflated. 8 pleural ribs.

Material. — Two entire specimens from *Tretaspis* shales of Bornholm (Vasagaard), 3 nearly entire specimens and one hypostome from *Staurocephalus clavifrons* zone, Brzezinki and Wólka, Poland. Several specimens from the Králův Dvůr beds of Bohemia.

Dimensions of 3 Bohemian specimens (in mm):

NM Mus. cat. no.	CD 1629	CD 1632	CD 1627
Length of entire specimen	16.5	21.0	28.5
Length of cephalon	7.2	8.5	12.3
Width of cephalon	13.4	18.0	21.2
Length of pygidium	6.0	6.5	11.0
Width of pygidium	10.6	13.8	16.3

Description. — The outline of the entire body is suboval.

Cephalon. The outline is semicircular. The dorsal furrows are very faint and shallow, running subparallel to the bluntly terminated anterior end of the glabella. The length of the glabella occupies two-thirds of the cephalic length. The occipital ring is narrow (long.) and flat, the occipital furrow being narrow and thread-like. The posterior border is flat and narrow, disappearing peripherally. The facial suture cuts the posterior cephalic margin, forms a convex arch peripherally, then runs subparallel to the posterior margin and inwards to the dorsal furrow. Close to the dorsal furrow it curves around the long palpebral lobe and then runs antero-laterally towards the cephalic margin. Near the cephalic margin it forms an arch and runs antero-medially, almost along the cephalic margin, forming an arch with the branch of the facial suture from the other side. The eyes are situated behind the transverse midline of the cranidium, their length being one-fourth of the cephalic length. The wide and indistinct border furrow runs in an arch from the posterior cephalic margin (cutting it outwards to the facial suture), towards the top of the glabella, delimiting wide and flattened lateral and anterior borders. The free cheeks are large, being produced into long and wide spines, which reach back to the 6th thoracic segment.

Hypostome. The cephalic doublure is slightly wider than the border. The hypostome has an oval inflated body with a deep furrow around it. There are two deep pits at this furrow in the posterior part of the hypostome. The posterior margin of the hypostome is deeply notched, forming two long prongs.

Thorax. There are 8 thoracic segments. The rhachis is narrow (tr.), occupying one-fifth of the thoracic width. The dorsal furrows are fairly shallow, the rhachial rings very slightly convex. The thoracic pleurae are directed transversely, with only their ends slightly bent posteriorly. The ends of the thoracic pleurae are bluntly truncated and are not produced into spines. There is a pleural furrow directed postero-laterally through each pleura and cutting two-thirds of the pleural length (tr.).

Pygidium is sub-semicircular, being wider than a semicircle, the rhachis is very narrow, occupying less than one-seventh of the pygidial width. The rhachial rings, of which there are 11-12, are moderately convex, the posterior ends being indistinct and the posterior portion of the rhachis inflated. There are 8 fairly flat pleural segments, directed transversely, ending

before they reach the margin and forming in this way the pygidial border. The pygidial doublure, broad (tr.) in the anterior part of the pygidium, becomes slightly narrower (long.) in its posterior part, where it curves slightly around the end of the pygidial rhachis.

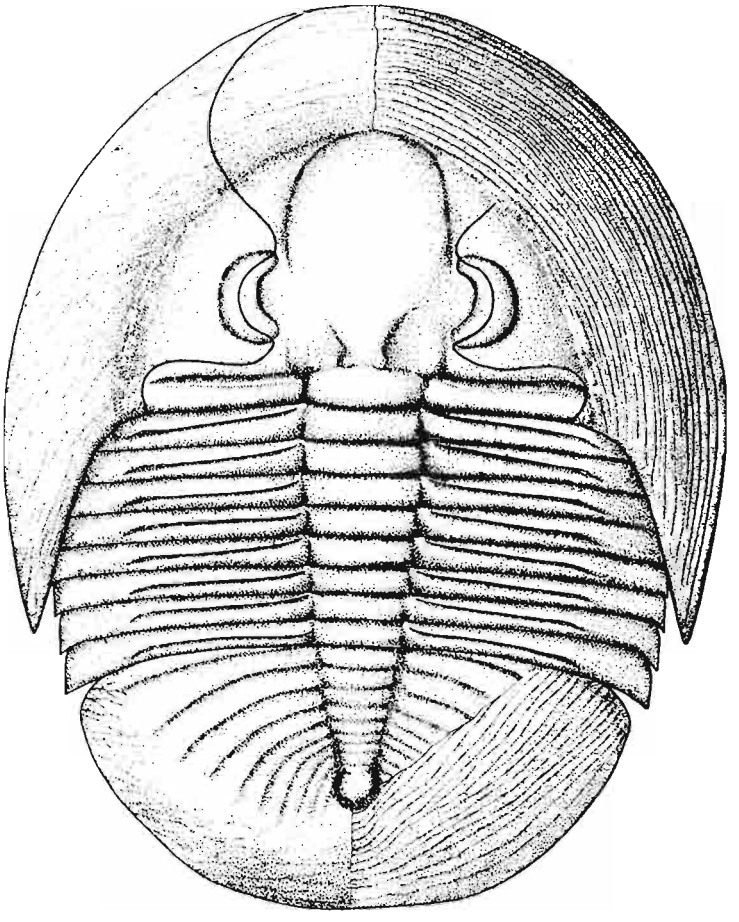


Fig. 21

Opsimasaphus jaanussoni n. sp. — reconstruction, right sides of the cephalon and pygidium showing the doublures; approx. × 4.

Ornamentation consists of thread-like, anastomosing lines on the cephalic and pygidial border. These lines are irregular, but in general are subparallel to the cephalic and pygidial margins. It is not certain whether there is any ornamentation on the rest of the exoskeleton. On the cephalic and pygidial doublure there are the regular striae, running parallel to the cephalic and pygidial margins.

Opsimasaphus sp.

(pl. VIII, fig. 3)

1899. *Asaphus (Ptychopyge) nobilis* BARRANDE; J. P. J. RAVN, Trilobitfaunaen..., p. 55 (partim).
1906. *Asaphus ingens* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 62 (partim), pl. 3, fig. 1-5.

Material. — Several poorly preserved pygidia and free cheeks from the *Tretaspis* beds, Bornholm and Scania.

Description. — The free cheek has a large doublure and is produced into a wide, stout, comparatively short spines. The opening of the panderian organ is situated at the base of the spine, close to the posterior cheek margin. Pygidium is comparatively long, length to width ratio being about 0. 6. The number of rhachial and pleural segments is unknown. The doublure is large, of *Opsimasaphus* type. The whole pygidial surface has an ornamentation of anastomosing striae.

Family **STYGINIDAE** Vodges, 1893

Genus **STYGINA** Salter, 1853

Stygina sp.

(pl. VIII, fig. 1-2)

Material. — One cranidium (7.5 mm long) and one almost entire specimen (about 10 mm long), both poorly preserved, from the zone of *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland.

Description. — The cephalon is semicircular in outline, moderately convex transversely and also longitudinally. The width of the glabella at the base is about one-fifth that of the cephalon. The dorsal furrows from the occipital ring run subparallel, then converge anteriorly, so that the greatest width of the glabella is twice that of its base. There are no lateral glabellar furrows. The occipital furrow is directed transversely, the transverse occipital ring is moderately convex. The free cheeks are comparatively small. The eyes are situated posteriorly, close to the dorsal furrows. The facial suture cuts the posterior margin and runs antero-medially towards the eye, around the palpebral lobe, which is strongly convex exteriorly, then antero-laterally and in an arch antero-medially towards the anterior cephalic margin. The free cheeks are large, sloping from the eyes downwards. The posterior and lateral borders are not defined. The genal angles form pointed apices of triangles, but are not produced into spines. There is no anterior border developed in front of the glabella which reaches the anterior cephalic margin.

Hypostome. In one specimen (comp. pl. VIII, fig. 2) an imprint of a hypostome and a part of a rostrum is preserved. The doublure is broad (long.), the rostrum wide (tr.) being defined by the connective sutures which run inwards and backwards across the doublure. The hypostome is slightly tapered posteriorly, but is subquadrate rather than subtriangular in outline. There are large anterior wings, the middle body is very slightly defined by almost invisible furrows. There are two small symmetrical pustules on both sides of the anterior part of the middle body.

Thorax. The rhachis occupies about one-fourth or more of the total thoracic width. The pleurae are directed transversely and are not produced into spines; there is a transverse pleural furrow along the anterior part of each pleura.

Pygidium is semicircular in outline. The rhachis is defined laterally, narrowing posteriorly, not defined at the posterior end. The rhachial width is about one-fifth of the total width. The rhachis is poorly preserved, the number of rhachial rings being unknown. The pleurae slope downwards. There is a broad concave border around the pygidium, with a wide doublure, reaching inwards to the end of the rhachis posteriorly.

Ornamentation is poorly preserved. There are terrace lines on the glabella, and on the cephalic and pygidial doublures, the latter being parallel to the cephalic and pygidial margins.

Discussions. — *Stygina latifrons* (PORTLOCK, 1843) has been redescribed more recently by WHITTINGTON (1950*a*). Representatives of *Stygina* occur also in the Upper Ordovician of Scandinavia, in Scania, Västergötland and the Oslo region, and have been described or cited by LINNARSSON (1869*b*), OLIN (1906), WIMAN (1907/08) and others, and more recently by SKJESETH (1955) — as *Stygina latifrons* (PORTLOCK). SKJESETH (1955) has figured several specimens of *Stygina latifrons* from Scandinavia and stated (*l. c.*, p. 13): «As it appears from the plates the forms here referred to as *Stygina latifrons* show great variations which in the future may justify the erection of new species and subspecies». The Scandinavian material of *Stygina* has not been available to me for comparison. But judging from SKJESETH's figures, the Scandinavian forms do not seem to be conspecific with *Stygina latifrons* and moreover the specimens from Västergötland seem not to be conspecific with those from the Oslo region.

In the collection from the Holy Cross Mountains there are two specimens (pl. VIII, fig. 1-2) which are evidently conspecific with the specimen figured by SKJESETH (pl. 2, fig. 3) from the Red *Tretaspis* mudstones of Västergötland. With regard to the specimen figured on pl. 2, fig. 3, SKJESETH states (*l. c.*, p. 13) that this specimen: «... has only a narrow preglabellar field and apparently shorter genal spines than the type». On this specimen the preglabellar field does not seem to be developed at all, and the same is the case with Polish specimens. It is, however, remarkable that some other specimens from the Red *Tretaspis* mudstones figured by SKJESETH (as for instance pl. I, fig. 1 and pl. 2, fig. 4) have longer genal spines and in this differ from the specimen on pl. 2, fig. 3. The anterior part of the cephalon unfortunately is not preserved in these Västergötland specimens.

In one of the Polish specimens identified here as *Stygina* sp., an imprint of a hypostome is preserved. It differs from the hypostome of *Stygina latifrons* (PORTLOCK) — as figured by SALTER (1864-1883, pl. 18, fig. 9) and WHITTINGTON (1950*a*, p. 548, pl. 72, fig. 10) in being comparatively larger and having a less triangular outline. Otherwise, both hypostomes of *Stygina latifrons* and *Stygina* sp. are poorly known so that any further comparison is impossible.

The Polish specimens identified here as *Stygina* sp. are conspecific with the specimens from the Red *Tretaspis* mudstones (SKJESETH, 1955, pl. 2, fig. 3) and belong evidently to a new species, which is however too poorly known to me to be erected at present.

Family **CYCLOPYGIDAE** RAYMOND, 1925

Genus **CYCLOPYGE** HAWLE & CORDA, 1847

Cyclopyge quadrangularis n. sp.

(pl. IX, fig. 1-9; text-fig. 22-23)

1878-80. *Cyclopyge rediviva* BARRANDE; H. C. NICHOLSON & R. ETHERIDGE jun., A monograph..., p. 284, pl. 19, fig. 4.

1904. *Cyclopyge rediviva* (BARRANDE); F. R. C. REED, The Lower Paleozoic..., p. 52, pl. 8, fig. 2-3.

1906? *Aeglina rediviva* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 73, pl. 4, fig. 18-19.

Holotype: Nearly entire individual, figured on pl. IX, fig. 6.

Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.

Derivation of name: quadrangularis — with subquadrangular outline of glabella.

Diagnosis. — Glabella a little wider than long, its outline subquadrangular. Two broad (long.) lateral glabellar furrows, directed almost transversely, slightly posteriorly. A gentle

circular swelling, posterior to each glabellar furrow. The eyes surrounding glabella on sides and in front, meet in front and are separated from each other by a narrow groove. Pygidium in adult forms sub-semicircular in outline, with only one rhachial ring and one rib on pleurae. Border very narrow. The pygidial surface finely ornamented with anastomosing raised lines.

Material. — About 20 more or less fragmentary cephalons, several doublures, more than 300 pygidia.

Dimensions of 8 specimens (in mm):

Locality	Brzezinki							
IG Mus. cat. no.	2. II. 227	2. II. 225	2. II. 208	2. II. 215	2. II. 222	2. II. 235	2. II. 234	2. II. 209
Length of glabella	7.6	3.0	3.8	—	—	—	—	—
Width of glabella	7.4	3.3	4.6	—	—	—	—	—
Length of pygidium	4.0	—	—	1.8	1.7	2.4	2.1	3.4
Width of pygidium	8.4	—	—	2.1	2.1	3.8	2.7	6.3
Length of pygidial rhachis	1.8	—	—	1.0	0.9	1.1	1.1	1.5
Width of pygidial rhachis	2.4	—	—	0.8	0.9	1.2	1.2	1.4

Description. — *Cephalon.* The length of the glabella is about four-fifths of its greatest width. The outline of the glabella is subquadrangular. The posterior border forms a straight, transverse line in the middle part. At the dorsal furrows, it bends anteriorly and cuts off the glabella from the small triangular surfaces, adhering to the glabella and eye at the posterior end of the dorsal furrow. The dorsal furrows run subparallel, slightly converging anteriorly. Anterior border of glabella forms a transverse line, slightly convex anteriorly. There is a pair of lateral glabellar furrows, situated one-third to one-fourth of the glabellar length from the posterior margin, near the midline. The furrows are broad (long.), shallow, running almost transversely, slightly postero-laterally. Posterior to each furrow there is a gentle, circular swelling, the diameter of which approximates to the length of the glabellar furrow. The fixed cheeks are very narrow, separated from glabella by a narrow furrow, running around its sides and front.

Eyes are large, extending around the sides and front of the glabella and meeting in front, separated from each other by a narrow groove. Doublure is triangular in shape, wide (long.) in the middle part, narrowing at the sides. There is a wide shallow groove in the midline, lying in the anterior continuation of the groove separating the eyes. Before reaching the external end of the doublure the groove widens suddenly into a wide, triangular surface. There are several transverse terrace-lines on the doublure.

Thorax is very imperfectly preserved on one specimen only. It consists of 5 segments. The rhachis is very wide (tr.), in the first segments it narrows strongly posteriorly.

Pigidium of the adult form is sub-semicircular in outline. The width of the rhachis is about a quarter of that of the pygidium, a little greater than its length. There is one rhachial ring visible on the rhachis. Dorsal furrows are very deep, running subparallel and meeting behind the rhachis in a semicirle. Pleurae are moderately convex. There is only one furrow, separating the first triangular half-pleura from the rest of the pleurae. Pygidial border is very narrow, indicated by the presence of a very shallow, poorly visible furrow. There is doublure with fine concentric striae. Its width in the midline is equal to a quarter of the pygidial length.

There are several young stages of transitional pygidia in the collection (see text-fig. 23). In ontogenetic development the width of the pygidium increased in size in comparison with

the length. In the youngest stages (about 1.7 mm long.) the rhachis is narrow and composed of 3 rings, there are as well three ribs on the pleurae. The next stage represents specimens with two rhachial rings and two ribs. Finally there is no ring indicated and only the first half rib is visible on the pleurae.

On well preserved adult pygidia there are fine ribs running radially from the rhachis onto the pleurae. On some well preserved specimens also an ornamentation of anastomosing fine raised lines is preserved.

Discussion. — *Cyclopyge rediviva* (BARRANDE) was commonly cited from the Upper Ordovician beds of Europe (Bohemia, Scandinavia and Great Britain (BARRANDE, 1852, 1872; NICHOLSON & ETHERIDGE, 1878-80; REED, 1904; OLIN, 1906). *C. rediviva* (BARRANDE, 1846) was recorded by BARRANDE as occurring in the Lower, Middle and Upper Ordovician of Bohemia. All the specimens figured by him (1852, pl. 34, fig. 3-13; 1872, pl. 14, fig. 9-11) are from the Lower and Middle Ordovician only — no Ashgillian (Králův Dvůr beds) specimen of this species has been hitherto figured. The latter specimens, examined by me in the National Museum in Prague do not seem to be conspecific with those from the lower beds, differing in the shape of the glabella and in the shape of lateral glabellar furrows, which are directed almost longitudinally in *C. rediviva*, and nearly transversely in the specimens from the Králův Dvůr beds. In this respect the specimens from the Králův Dvůr beds are identical with *C. quadrangularis* n. sp. from the Holy Cross Mountains, and are considered here as conspecific, *C. rediviva* being restricted to the Lower and Middle Ordovician only.

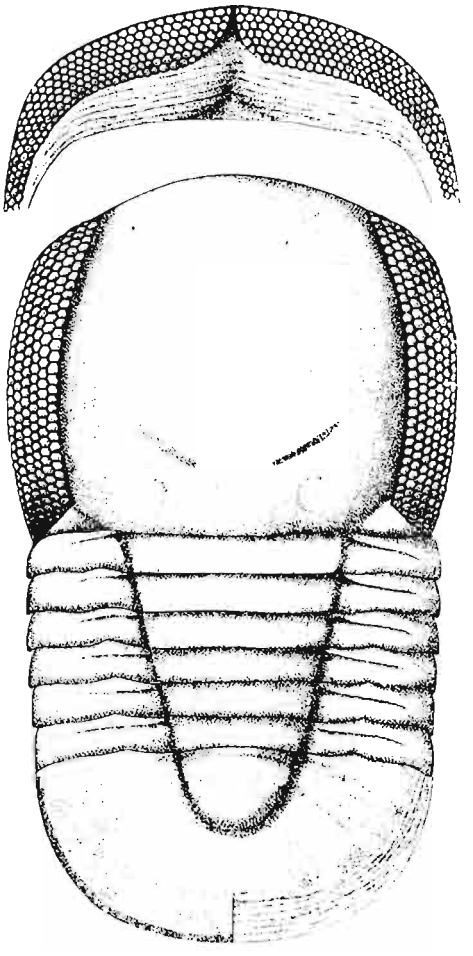


Fig. 22

Cyclopyge quadrangularis n. sp. — reconstruction of the cephalic doublure and of the entire individual, right side of the pygidium showing the doublure; approx. × 8.

In *Cyclopyge quadrangularis* the eyes are fused anteriorly, whereas in *C. rediviva* they are separated by the distance of one-third of the maximum cephalic width (comp. R. & E. RICHTER, 1954, p. 12). Pygidia of *C. rediviva* and *C. quadrangularis* seem to be, however, very similar.

The pygidium described by OLIN as *Aeglina rediviva* (1906, p. 73, pl. 4, fig. 19) may perhaps belong to *Cyclopyge quadrangularis* n. sp., but as the differences between these species concern the cephalic structure, it cannot be identified with any certainty.

NICHOLSON & ETHERIDGE (1878-80) and later REED (1904, p. 52, pl. 8, fig. 2-3) described *Cyclopyge rediviva* from the Upper Ordovician (Whitehouse Group) of Great Britain (Girvan, Whitehouse Bay). To judge from REED's figures, the specimens figured by him have lateral glabellar furrows running almost longitudinally and in this respect could be very similar to *C. rediviva* from Bohemia. But an examination of quite a number of Scottish specimens recorded as *C. rediviva* in the British Museum, from the Whitehouse Group, Girvan, has shown that

in fact the glabellar furrows in the Scottish species are directed obliquely, almost transversely, as in the Polish species. Moreover, the chief difference between *C. rediviva* and *C. quadrangularis* is in the eye structure. In the collection from the Whitehouse beds in British Museum, together with cephala and pygidia recorded by REED as *Cyclopyge rediviva*, there are several doublures, evidently conspecific with the cephala, which show the fused eyes of an identical pattern to that in *C. quadrangularis*. Therefore the Scottish specimens from the Whitehouse beds are here considered conspecific with the Polish and Scandinavian species.

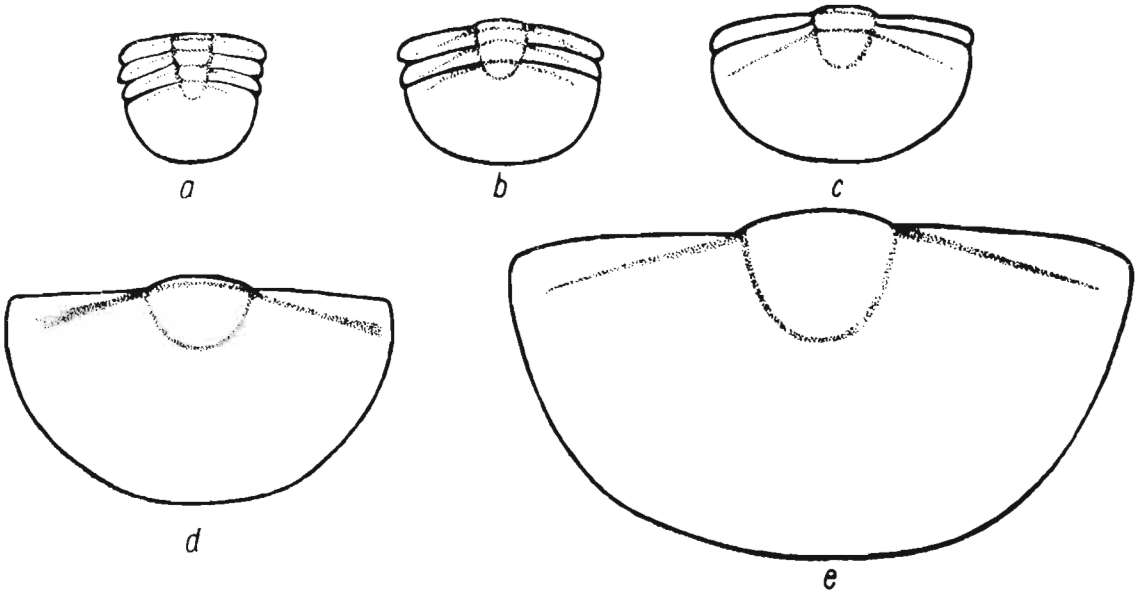


Fig. 23

Diagrammatic sketches of 5 pygidia of *Cyclopyge quadrangularis* n. sp., showing the changes of shape in the ontogenetic development. All specimens approx. × 12.

The most similar species to *C. quadrangularis* is *C. vigilans* (COOPER & KINDLE) from the Upper Ordovician of Percé, Quebec. The new species differs from *C. vigilans* in the shape of the glabella which is here subquadrangular, whereas in *C. vigilans* it is round. In the shape of the lateral glabellar furrows, the presence of circular swellings behind them and in the eye structure, both species are however almost identical. Further differences are in the pygidium, which in *C. vigilans* has a much broader border, and more strongly indicated ornamentation of radial strips (the last difference may be due, however, to the state of preservation).

From *Cyclopyge mirabilis* FORBES, in SALTER (comp. SALTER, 1853; WHITTARD, 1952) *C. quadrangularis* differs in having a shorter glabella, which is fairly elongated in *C. mirabilis*, smaller eyes and the groove dividing the eyes wider.

Cyclopyge gigantea (BARRANDE, 1872)

(pl. X, fig. 2)

1872. *Cyclopyge gigantea* n. sp.; J. BARRANDE, Système Silurien..., Suppl., p. 60, pl. 1, fig. 1-5.

Material. — One specimen composed of 6 thoracic segments and pygidium, from the zone of *Staurocephalus clavifrons* of Brzezinki.

Dimensions (in mm):

Locality	Brzezinki
IG Mus. cat. no.	2. II. 240
Length of pygidium	13.5
Width of pygidium	34.0
Length of rhachis	10.2
Width of rhachis	11.5

Description. — *Thorax* is composed of 6 segments. The width (tr.) of the rhachis of the first thoracic segment occupies two-thirds of the thoracic width. The rhachis strongly converges posteriorly, so that on the posterior segment the rhachial width occupies two-fifths of the segmental width. The dorsal furrows are very distinct and deep. The pleurae are directed transversely, and are only slightly bent posteriorly. There is a deep pleural furrow on each pleura, but this only runs on the distal part of the pleura. The proximal part of the pleura, at the dorsal furrow, is smooth. The pleural furrow strongly increases in width (long.) peripherally, so that the very distal part of the pleurae is sharply divided (tr.) into anterior and posterior parts. The pleural ends are bluntly truncated, perpendicularly to the segmental length (tr.).

Pygidium. The outline is wider than a semicircle. The rhachial width at the basis occupies one-third of the pygidial width. The dorsal furrows are faint, strongly converging posteriorly. The rhachis is triangular. There are faint traces of 2 or 3 indistinct rhachial rings. On the pleurae one furrow delimiting the first half-segment is very strongly marked. There are otherwise two indistinct, shallow furrows on the pleurae, dividing 3 flat and indistinct segments. There is a moderately wide pygidial border, but it is poorly preserved on this specimen.

Discussion. — The specimen described above shows very close similarities with the one figured by BARRANDE (1872, pl. 1, fig. 5) as a young form of *Cyclopyge gigantea* (BARRANDE). *C. gigantea* is fairly poorly known, no entire specimen has so far been found. In my collection it is represented by a single specimen. The doublure of a cyclopygid species figured in this paper as *Cyclopyge* sp. *a* (comp. pl. XI, fig. 7) shows in the general shape some similarities with that of *Cyclopyge gigantea* (BARRANDE), but differs strongly from it in having much larger and longer eyes, so that it cannot as yet be recorded as conspecific with *C. gigantea*.

Cyclopyge sp. **a**

(pl. XI, fig. 7)

In the collection from the *Staurocephalus clavifrons* zone of Brzezinki, Poland, there is one doublure of a cyclopygid species, showing some similarities with *Cyclopyge gigantea* (BARRANDE), but differing from the latter in having much greater (twice as long) eyes.

Cyclopyge sp. **b**

(pl. X, fig. 3)

In the collection from the *Staurocephalus clavifrons* zone of Brzezinki there are two doublures resembling in some way that of *Cyclopyge sulcata* (BARRANDE) (comp. BARRANDE, 1872, pl. 8, fig. 3) from the Lower Ordovician of Bohemia. They differ from the BARRANDE'S

specimen in having the inner margin of the doublure bent twice, whereas it forms a regular semicircle in *C. sulcata*, and in having wider (long.) lateral parts of the doublure. *Cyclopyge sulcata* (BARRANDE) although recorded by BARRANDE from the Lower Ordovician and from the Králův Dvůr beds, does however appear to be absent from the Králův Dvůr beds, and therefore the attribution of our specimens to *Cyclopyge sulcata* seems a little doubtful.

Cyclopyge sp. c

(pl. X, fig. 1)

In the collection from the *Staurocephalus clavifrons* zone of Wólka there is one doublure, which may perhaps belong to *Cyclopyge speciosa* BARRANDE, but differs from the latter (as figured by BARRANDE, 1852, pl. 3, fig. 6) in having a wider (tr.) and much less arched outline. This may be due, however, to the compression of our specimen.

Genus **MICROPARIA** HAWLE & CORDA, 1847

Microparia speciosa HAWLE & CORDA, 1847

(pl. X, fig. 4-9)

1847. *Microparia speciosa* n. sp.; J. HAWLE & A. CORDA, Prodrom einer Monographie..., p. 52, pl. 3, fig. 26.
1852. *Aeglina speciosa* CORDA; J. BARRANDE, Système Silurien..., p. 667, pl. 43, fig. 40-43.
1854. *Aeglina? oblongula* n. sp.; N. P. ANGELIN; Palaeontologia Scandinavica, p. 42, pl. 24, fig. 5.
1869*b*. *Aeglina oblongula* ANGELIN; J. G. O. LINNARSSON, Om Västergötlands, Cambriska..., p. 83.
1872. *Aeglina speciosa* CORDA; J. BARRANDE, Système Silurien..., Suppl., p. 67, pl. 8, fig. 7-9.
1906. *Symphysurus superstes* n. sp.; E. OLIN, Om de Chasmopskalken..., p. 64 (partim), pl. 3, fig. 7-9 (non fig. 6 = Panderia megalophthalma).

Type horizon and locality: Upper Ordovician, Králův Dvůr beds, Bohemia, Králův Dvůr.

Material. — Several specimens (one entire) from Brzezinki and Wólka, Poland; two entire specimens and some pygidia from the Red *Tretaspis* mudstones of Västergötland, several pygidia from Scania and several specimens from the Králův Dvůr beds of Bohemia.

Dimensions of 4 specimens (in mm):

Locality	Sweden		Poland	
	Väster-götland	Scania Röstanga	Brzezinki	
Mus. cat. no.	RM Ar. 14822	LM L. O. 1957 t	IG 2. II. 241	IG 2. II. 244
Length of entire individual	11.4	—	16.5	—
Length of cephalon	5.7	—	6.6	—
Width of cephalon	6.1	—	7.5	—
Length of pygidium	3.2	7.0	5.6	6.8
Width of pygidium	5.3	10.1	8.7	10.4
Width of pygidial rhachis	2.5	4.5	4.2	4.4
Length of pygidial rhachis	—	3.2	3.0	4.0

Description. — *Cephalon.* The outline is subcircular. The width a little greater than its length. The cephalon is moderately convex, — there are no traces of the lateral glabellar furrows, or ornamentation. Eyes are not preserved.

Thorax is composed of five segments. The dorsal furrows are very distinct, converging posteriorly. Rhachis is very wide (tr.) especially on the first segment, where it is four times as wide as the pleural part. Rhachial rings are convex (tr. and long.). On the dorsal furrows, at the posterior part of every segment there is a small, deep pit. Pleurae are directed transversely. There is a pleural furrow on each pleura, running from the anterior end of the pleura at the dorsal furrow, postero-laterally through half the length of the pleura. It divides the pleura into a very short (long.) anterior part, and a much larger posterior. The pleural ends are bluntly truncated.

Pygidium. The outline is a little narrower than a semicircle. Pygidium is moderately convex. The width of the rhachis (at its base) is equal to half the pygidial width. Dorsal furrows are distinct only at the base of the rhachis, posteriorly they can be recognized only as strongly converging shadows. There is one rhachial ring visible on the rhachis. Pleurae are smooth. There is only a single furrow near the anterior border which runs from the dorsal furrow postero-laterally to cut off a single triangular half-segment. There is a pygidial border, marked off by the presence of the very shallow border furrow. The width (long.) of the border on the posterior part of pygidium is equal to a quarter of the pygidial length. There is a doublure under the border with concentric lines.

On well preserved specimens one can see a very fine ornamentation of thread-like lines on the pygidial surface.

Discussion. — *Aeglina? oblongula* Angelin, 1854, is taken here as a junior subjective synonym of *Microparia speciosa* Hawle & Corda. The type-specimen (RM no. Ar. 14822) of Angelin's species is figured on pl. X, fig. 7.

Microparia speciosa is a common species in the Upper Ordovician (Králův Dvůr beds) of Bohemia. It occurs also in layers corresponding to the Králův Dvůr beds, in Poland and Sweden.

R. & E. Richter (1954, p. 13, fig. 3) described a specimen identified by them as *Cyclopyge (Microparia) speciosa*, from «Wupperhof, Bl. Solingen, Tiefstes Llandeilo, Zone 7 (nach Beyer)». To judge from the figure in Richter's paper (pl. 1, fig. 3), this specimen does not seem to be conspecific with the Bohemian, Polish and Scandinavian specimens. The chief difference between them lies in the thorax. In *Microparia speciosa* the rhachis is very wide (tr.) and the dorsal furrows are strongly converging posteriorly. In the specimen figured by Richter, the rhachis is much narrower and the dorsal furrows run parallel. Otherwise the cephalon and pygidium of Richter's specimen is rather poorly preserved, so it is difficult to point out further differences.

Reed (1914, p. 19, pl. 3, fig. 8) described a new species *Cyclopyge bumasti* from the Whitehouse Group of Scotland. In discussing the new species, Reed pointed out (*l. c.*, p. 20) the similarities of the pygidium to *Microparia speciosa* Hawle & Corda. Reed's species is based on one specimen, so poorly preserved that neither its specific characters nor a comparison with *C. speciosa* can be given.

Olin (1906, p. 64, pl. 3, fig. 6-9) described and figured a new species, identified by him as *Symphysurus superstes* Olin (comp. our pl. X, fig. 8-9). The occurrence of the species has been cited later in Scandinavian literature by Wiman (1907, p. 36) from «ältere Chasmopskalk» — from «Nordbaltische Silurgebiet», and by Funkquist (1919, p. 39) from

the limestones with *Trinucleus coscinorrhinus* and from the limestones with *Ampyx rostratus*, from different localities (Tommarp, Tosterup, Bollerup) of Scania.

An examination of OLIN's material has led me to the conclusion that comparatively well preserved pygidia of this species are conspecific with *Microparia speciosa* HAWLE & CORDA. The part of the cephalon figured by OLIN (1906, pl. 3, fig. 6 a-b) is, however, very poorly preserved. I am choosing the pygidium figured by OLIN (1906, pl. 3, fig. 9) as a lectotype of *Symphysurus superstes* OLIN. *S. superstes* OLIN is then stated here to be a junior subjective synonym of *Microparia speciosa* HAWLE & CORDA.

The original specimen of the cephalon of *S. superstes* OLIN seems to be conspecific with *Panderia megalophthalma* LINNARSSON.

In the collection of Uppsala Museum, I have seen the pygidium identified by WIMAN as *S. superstes*. It is a comparatively large pygidium (20 mm long.) of some illaenid, strongly convex, with a narrow rhachis, without any doubt not conspecific with pygidia described by OLIN as *S. superstes*. I have not, however, had an opportunity of examining FUNKQUIST's specimens.

Genus **SYMPHYSOPS** RAYMOND, 1925

Symphysops subarmata elongata n. subsp.

(pl. XI, fig. 1-4)

Holotype: Pygidium figured on pl. XI, fig. 3.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: elongata — provided with an elongated pygidial rhachis.

Material. — 15 pygidia from the *Staurocephalus clavifrons* zone of Brzezinki. One glabella, which may be conspecific with the pygidia here described, in the present paper is described as *Symphysops* sp. *a*.

Diagnosis. — The outline of the pygidium more like a parabola than a semicircle. The rhachis is narrow, long and triangular, composed of one strongly differentiated ring and three scarcely visible rings on the remaining part of the rhachis. The well defined border is narrow in the anterior part, wider posteriorly. The whole pygidial surface is covered with ornamentation of thread-like striae.

Dimensions of 4 specimens (in mm):

Locality	Brzezinki			
IG Mus. cat. no.	2. II. 250	2. II. 249 b	2. II. 248	2. II. 247 a
Length of pygidium	7.9	7.6	7.5	6.4
Width of pygidium	13.0	16.2	13.0	13.2
Width of rhachis	4.4	5.6	4.0	4.0
Length of rhachis	5.0	5.2	5.1	3.9

Description. — The outline of the pygidium is more like a parabola than a semicircle, its length being more than a half of its width. There are some pygidia which are semicircular or wider than a semicircle, but this may be due to depression. The width of the rhachis

at the base is greater than one-third of the pygidial width. The dorsal furrows are very deep. the rhachis is long and triangular. On the rhachis there is one strongly differentiated ring and three other rings with shallow furrows between them, only slightly differing from each other. On the pygidium there is one transverse furrow delimiting the first half-segment. On the pleurae there are three very shallow furrows, delimiting only slightly visible segments. There is a wide and deep border furrow around the pygidium. The pygidial border is narrow in the anterior part of the pygidium, twice as wide posteriorly. It is strongly convex.

The whole pygidial surface which is covered by fine thread-like lines, directed transversely on the rings, slightly convex in the midline anteriorly. On the pleurae they are directed transversely, but passing on to the border they bend anteriorly and are arranged on the border concentrically.

Discussion. — The Polish specimens described here are very similar to those from Girvan, described by Reed (1914) as *Symphysops subarmata*. The pygidium figured by Reed (1914, pl. 3, fig. 10) does not in fact possess two tubercles on the third rhachial segment, as it is figured. The only difference in the pygidial structure I could observe is that Polish specimens have a longer pygidial rhachis than the British ones. The glabella and thoracic segment figured here as *Symphysops* sp. *a* and *Symphysops* sp. *b*, are perhaps conspecific with the pygidia here described. There is one medial tubercle in the anterior part of the glabella of Polish specimen, which does not occur in *Symphysops subarmata*. The pits on the thoracic segment described here as *Symphysops* sp. *b*, are larger than the pits on the third thoracic segment of *Symphysops subarmata*.

The Polish species is incompletely known. No entire specimen has been preserved, we do not know the structure of the first thoracic segment (so characteristic in *S. subarmata*) and the cephalon. Therefore further comparison and a definitive conclusion, as to whether the Polish specimens are conspecific with Scottish, cannot be given at present. The similarities between Polish and Scottish specimens are so striking that it is thought reasonable not to create a new species for the Polish material, but to identify it provisionally as a subspeces of *S. subarmata*. It should be mentioned that *S. subarmata* occurs in Scotland, in the Whitehouse Beds, and thus is an older form than the Polish subspecies. From the Drummuck Group of Scotland, which corresponds to the *Staurocephalus clavifrons* zone, it seems to be unknown.

In the Králův Dvůr beds of Bohemia there occur *Symphysops armata* (Barrande, 1872; cf. also Novák, 1884*b*). Reed (1914, p. 22) in discussing the differences between *S. armata* and *S. subarmata* stated: «The shape of the glabella and the long spinose first pair of pleurae necessitate the separation of this species *(Symphysops subarmata)* from *C. armata* Barr., to which it was previously referred». It should be, however, stated that the first pair of thoracic pleurae is not preserved on any of the specimens of *S. armata* housed in the National Museum in Prague, so this difference cannot be treated as a real one. The differences in the shape of the glabella may be due to the state of preservation. So *S. armata* and *S. subarmata* may be more similar forms than it has been previously thought.

When comparing the Polish specimens described here with *Symphysops armata*, I stated that there are some differences in the pygidial structure between the Polish and Bohemian forms. The pygidium of *S. armata* is in all the specimens wider than in Polish forms (though this may be due to the state of preservation), moreover the rhachis is wider and more convex, being composed of two strongly differentiated rings, the rest of the rhachis forming an undivided triangular plate, whereas in the Polish forms, the rhachis is narrow, only the first ring being strongly differentiated, and on the remaining part of the rhachis there are

traces of three rings. For this reason, I treate the Polish form as more closely related with the Scottish than with the Bohemian representative of the genus *Symphysops*.

Symphysops spinifera Cooper & Kindle, 1936, from the Upper Ordovician of Quebec, also shows close similarities to the Polish species. Our form has, however, a longer and more slender rhachis. The differences in the shape of the glabella cannot be discussed, as we do not know whether the glabella of *Symphysops* sp. *a* is in fact conspecific with the pygidia described here.

Symphysops sp. **a**

(pl. XI, fig. 6)

Material. — One glabella from the *Staurocephalus clavifrons* zone of Brzezinki, Poland.

Description. — The glabella is considerably elongated, its length (without the spine) being one and a half times the maximum width. The dorsal furrows converge anteriorly. The length of the spine is equal to one-seventh of the glabellar length. There are two pairs of lateral glabellar furrows, the first pair (S_1) situated in the first one-sixth of the length of the glabella from the posterior border, cutting more than one-third of the glabellar width. It is wide (long.) and slightly arched anteriorly. The second pair S_2 is parallel to the anterior. In the midline of the glabella at a point about two-thirds of its length there is a small tubercle.

Discussion. — As has been already pointed out (p. 91), it is possible that the glabella described above is conspecific with the pygidia recorded here as *Symphysops subarmata elongata* n. subsp.

Symphysops sp. **b**

(pl. XI, fig. 5)

There are in my collection two single thoracic segments from the *Staurocephalus clavifrons* zone of Brzezinki, which may be conspecific with the pygidia here described as *Symphysops subarmata elongata* n. subsp. The rhachis is twice as wide (tr.) as the pleurae, there are two deep round pits on the rhachis. The pleurae are directed postero-laterally, and are stoutly terminated. There is a wide oblique furrow cutting the pleurae.

Family **ILLAENIDAE** Hawle & Corda, 1847

In the assemblage of trilobites from the zone of *Staurocephalus clavifrons* of Poland, there are several representatives of the family Illaenidae. Unfortunately, the greatest part of this material is very poorly preserved. All specimens are compressed, the ventral side of the cephalon is not preserved and traces of ornamentation can only very seldom be seen. For this reason, the greatest part of the material in question is specifically indeterminable. The state of preservation of illaenids in the corresponding beds of Bornholm, Scania and Västergötland is similarly poor. In spite of the fact, that some of the Polish species can be recognized in the collections from the Scandinavian Upper Ordovician, the erection of new species, even though based on comparatively abundant material from both Poland and Scandinavia, can only very seldom be done at present.

Among the Scandinavian Upper Ordovician illaenids so far described, *Panderia megalophthalma* Linnarsson, 1869, and *Zbirovia longifrons* (Olin, 1906) occur in Poland. The latter has been provisionally placed by Jaanusson (1954) in the genus *Ectillaenus*. Later

ŠNAJDR (1956) created the genus *Zbirovia*, to which this species seems to correspond better. As however the number of thoracic segments and the ventral side of the cephalon of this species are not known as yet, its generic attribution to genus *Zbirovia* cannot be regarded as certain.

From the Red *Tretaspis* mudstones of Västergötland, apart from *Panderia megalophthalma*, three other illaenid species have been described. They are: *Illaenus roemeri* VOLBORTH, 1864, *I. leptopleura* HOLM, 1882, *I. angelini* HOLM, 1882.

Illaenus roemeri, considered by JAANUSSON (1954) as belonging to *Parillaenus* group, does not occur in the Upper Ordovician beds of other parts of Scandinavia, nor in Poland. The other two species mentioned are very poorly known.

The facial suture of *Illaenus leptopleura* has been described by HOLM (1882, p. 118) as follow: «Sutura facialis abnormis, prope marginem angulumque capitis currens». JAANUSSON (1954) has regarded this species as belonging to the genus *Ectillaenus*. On HOLM's original specimens of this species, which were available to me for examination, no facial suture can be recognized. They are preserved as internal moulds without traces of ornamentation, thus an identification of conspecific specimens from other localities seems to be impossible. Therefore the note of RAVN (1899) on the occurrence of *Illaenus leptopleura* in the *Tretaspis* beds of Bornholm (Vasagaard), must also remain in doubt. Several specimens among the Polish Upper Ordovician illaenids show some similarities to *Ectillaenus leptopleura*, but for the reasons mentioned above the Polish specimens are described here as «*Illaenus*» sp.

Illaenus angelini HOLM is in a similar way incompletely known. It differs from *Ectillaenus leptopleura* in having 9 thoracic segments and a longer glabella with dorsal furrows running almost parallel. Its facial suture runs quite close to the external margin and around the genal corner. The free cheeks are thus extremely narrow and small. It has been pointed out by JAANUSSON (1954, p. 572) that: «Die verwandschaftlichen Beziehungen von «*Illaenus*» *angelini* sind noch unklar», and he placed it within the group of «9-gliedrige Illaeniden inc. gen.». The general pattern of the thorax and pygidium of «*Illaenus*» *angelini* is similar to that of *Zdicella* ŠNAJDR, 1957. There are, however, 9 thoracic segments in «*Illaenus*» *angelini*, whereas 10 are characteristic of *Zdicella*, and this does not allow us to assign the above species to this genus. Therefore, the specimens similar to «*Illaenus*» *angelini* from Poland, are described here as «*Illaenus*» cf. *angelini*. One new species from Bornholm and Poland, recorded as *Zdicella bornholmiensis*, is described in the present paper.

In the Polish material there are several representatives of different and evidently new illaenid species, but on account of their poor preservation, the majority of them are indeterminable and therefore are not described here.

Subfamily ILLAENINAE RAYMOND, 1916

Genus **PANDERIA** VOLBORTH, 1863

Panderia megalophthalma LINNARSSON, 1869

(pl. XII, fig. 6)

1869*a*. *Panderia megalophthalma* n. sp., J. G. O. LINNARSSON, Diagnoses specierum novarum..., p. 195.

1869*b*. *Panderia megalophthalma* LINNARSSON; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 78, pl. 2, fig. 45.

1882. *Illaenus megalophthalmus* (LINNARSSON); G. HOLM, De Svenska arterna..., p. 110, pl. 6, fig. 12-14.

1899. *Illaenus (Panderia) megalophthalmus* LINNARSSON; J. P. J. RAVN, Trilobitfaunaen..., p. 56.
1906. *Illaenus megalophthalmus* LINNARSSON; E. OLIN, Om de Chasmopskalken..., p. 65, pl. 3, fig. 12-13.
1906. *Symphysurus superstes* n. sp.; E. OLIN, *Ibid.* p. 64 (partim), (cephalon only), pl. 3, fig. 6 a-b, non fig. 7-9.
1954. *Panderia megalophthalma* LINNARSSON; V. JAANUSSON, Zur Morphologie..., p. 565.

Material. — The original specimens of OLIN (1906), 1 entire specimen, about 10 more or less fragmentary cephalons and about 50 pygidia from the *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland. As all the specimens are poorly preserved, the detailed measurements are not given.

Description. — The outline of the entire body is suboval.

Cephalon. The outline is narrower than a semicircle. In transverse profile the cephalon is convex, and somewhat less convex in the longitudinal profile. The width of the glabella at its base is half that of the cephalic width, but in the smaller specimens the glabella is narrower when compared with the cephalic width. The dorsal furrows run subparallel from the base of the cephalon, being shallower anteriorly, they end after cutting about two-thirds of the cephalic length. There are two pits on the dorsal furrows, situated quite close to the base of the cephalon. The fixed cheeks are very narrow. The facial suture cuts the posterior cephalic margin close to the glabellar furrows, runs antero-medially, and then anteriorly parallel to the dorsal furrow, finally around the long palpebral lobe. The anterior branch of the cephalic suture runs anteriorly, and slightly laterally. The free cheeks are narrow with rounded genal angles. There is a wide and only slightly convex lateral and posterior border around the cheek. The posterior cephalic margin at the cheeks is directed antero-laterally, forming an arch with the antero-medially directed lateral border. The posterior and lateral border furrow is very wide and shallow. The posterior and lateral borders and the border furrow occupy the greatest part of the free cheek. The remaining part of the cheek is occupied by the eye. The length of the eye is equal to half the cephalic length.

Thorax. There are 6 thoracic segments. The width of the rhachis of the anterior segments is greater (tr.) than that of the pleurae, on the posterior segments it is equal to the pleural width. The dorsal furrows are deep, the rhachis and pleurae convex (tr.). The thoracic pleurae are flat and are not produced into spines.

Pygidium. The outline forms half an ellipse. Pygidium is moderately convex. The width of the rhachis at its base is up to the third of the pygidial width. The dorsal furrows are shallow but distinct, converging slightly posteriorly and forming an arch at the rhachial end. The length of the rhachis is equal to three-fifths that of the pygidium. There are some traces of the transverse furrows on the rhachis, cutting 5 slightly visible rings. The pleurae are smooth. Only the first narrow (long.) half segment is recognizable on the pleurae. There are small round pits on the dorsal furrows at the basis. There is a pygidial border, which is very wide posteriorly; in fact it forms almost a third of the total pygidial length, laterally however it narrows considerably. There are concentric lines on the pygidial doublure.

Discussion. — The Polish specimens described above are conspecific with those described by LINNARSSON (1869*b*, pl. 2, fig. 45) from the Red *Tretaspis* beds of Västergötland. The only difference is the absence of a tubercle on the middle part of glabella in our specimens.

OLIN (1906, p. 64, pl. 3, fig. 6-9) described a new species *Symphysurus superstes* OLIN. After an examination of his original specimens, I came to the conclusion, that the cephalon of *Symphysurus superstes* is conspecific with that of *Panderia megalophthalma,* while the pygidium is conspecific with *Microparia speciosa* HAWLE & CORDA (comp. p. 89, 90).

Genus **ILLAENUS** s. l. DALMAN, 1826

«**Illaenus**» cf. **angelini** HOLM, 1882

(pl. XIV, fig. 7-9; cf. also fig. 6)

Material. — 4 fragments of cephalons and 4 pygidia from the zone of *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland.

Description. — *Cephalon* is fragmentarily preserved. The width of the glabella at the base is a little less than one-third of the cephalon. The dorsal furrows run subparallel, cutting about a half of the cephalic length. The whole cephalic surface is ornamented with small pits.

Thorax unknown.

Pygidium. The outline is sub-semicircular, a little narrower than a semicircle. Pygidium is strongly convex longitudinally. The presence of the border is indicated by the lowering of the pygidial surface. The rhachial width is about one-fifth or less than that of pygidium. The rhachis is indicated only in the anterior part of the pygidium, by a slight swelling of that part of the pygidium, and the curving of the anterior pygidial border in the middle (rhachial) part. The wide doublure (comp. pl. XIV, fig. 8) has concentric lines. The whole pygidial surface is covered by pits, identical with those of the cephalon.

Discussion. — The fragmentary cephalons and pygidia here described are similar in general shape to those of «*Illaenus*» *angelini* HOLM (comp. pl. XIV, fig. 6). The characteristic feature of the Polish specimens in question is their ornamentation of small pits. Similar ornamentation occurs on the specimen figured by OLIN (1906, pl. 3, fig. 11). The original specimen of HOLM, housed at SGU Museum in Stockholm is poorly preserved, showing no traces of ornamentation, thus the correct identification of Polish specimens is impossible.

«**Illaenus**» sp.

(pl. XIV, fig. 5)

Material. — 4 cephalons from the zone of *Staurocephalus clavifrons*, Brzezinki, Poland.

Description. — The cephalon is strongly convex (long. and tr.), its outline being narrower than a semicirle. The posterior cephalic margin between the dorsal furrows is convex posteriorly, slightly concave on the cheeks at dorsal furrows and forming a rounded semicircle with the marginal border. The dorsal furrows are deep, slightly converging anteriorly and cutting one-third of the cephalic length. The width of the glabella is less than one-third that of the cephalon.

Discussion. — The cephalons here described are incompletely known and are reminiscent of *Ectillaenus leptopleura* (LINNARSSON), but differ from it in having a longer glabella.

Subfamily ECTILLAENINAE [3] JAANUSSON, 1959

Genus **ZDICELLA** ŠNAJDR, 1957

Zdicella bornholmiensis n. sp.

(pl. XII, fig. 7-8; pl. XIII, fig. 1-4; text-fig. 24)

Holotype: An almost entire specimen from the *Tretaspis* beds of Bornholm, figured on pl. XIII, fig. 4.
Type horizon and locality: Upper Ordovician, *Tretaspis* shales, Vasagaard, Bornholm.
Derivation of name: bornholmiensis — occurring in Bornholm.

Diagnosis. — Blind, the glabella very narrow, its width being one-seventh that of cephalon. Length of glabella is about three-fifths that of cephalon. Facial suture cuts the posterior margin far away from glabella and runs almost straight forward. Free cheek is very small and is produced into a very small, but wide genal spine. Thorax is imperfectly known and has flat segments. Pygidium is sub-semicircular, with a narrow rhachis and traces of three faint rhachial rings.

Material. — 3 nearly complete specimens (with the thorax incompletely preserved) from the *Tretaspis* beds of Bornholm, 1 nearly complete specimen, 7 cephalons and 3 pygidia from the zone of *Staurocephalus clavifrons*, Brzezinki, Poland. All the specimens are strongly deformed and it is why the dimensions are not given.

Description. — The outline of the entire animal is suboval.

Cephalon. The outline is sub-semicircular, the cephalon being convex (tr. and long.). The posterior border of the cephalon is a straight line, except at the base of the glabella, which is slightly convex posteriorly. The glabella is very narrow, its width being one-sixth that of the cephalon. The dorsal furrows are deep, from the posterior cephalic margin they converge slightly anteriorly, and then run parallel, ending abruptly. The length of the glabella is three-fifths that of the cephalon. The facial suture cuts the posterior cephalic margin (comp. pl. XIII, fig. 4) — the facial suture is visible on the right side of the cephalon — and then runs forwards to the cephalic margin slightly curving twice in its course. The free cheek is very small and triangular, the genal angle being produced into a short, wide spine. There are no eyes.

Thorax is imperfectly known. The thoracic segments are very narrow (long.) and flat, their number being unknown. The rhachial width (tr.) is less than a half that of the pleura. There are deep pits on the dorsal furrows, in the posterior part of each segment. The ends of the pleurae are produced into narrow, postero-laterally directed thoracic spines.

Pygidium is smaller than the cephalon, its length being about two-thirds that of the cephalon. It is much less convex than the cephalon. The dorsal furrows are very faint, slightly converging posteriorly. The rhachial width at the base is one-fifth that of the pygidium, its length being about one-fifth that of the pygidial length. On the rhachis there are traces of three very faint rings. There is a flat, wide border, occupying less than one-third of the pygidial length. The anterior pygidial margin forms a straight transverse line, which on the parts corresponding to the pygidial border is directed postero-laterally.

The ornamentation of the pygidium is not preserved.

Discussion. — As the number of the thoracic segments of a new species is not known, its generic assignment cannot be made with certainty; it is, however, most probable that it

[3] Dr. V. JAANUSSON has kindly informed me that he had erected a new subfamily Ectillaeninae, in the «Treatise on Invertebrate Paleontology», part O (*in print*).

does belong to *Zdicella* ŠNAJDR, 1957. *Zdicella bornholmiensis* n. sp. in its general pattern is similar to «*Illaenus*» *angelini* HOLM (comp. pl. XIV, fig. 4) and it is probably congeneric with it. It differs from «*Illaenus*» *angelini* in having a much narrower glabella and a more

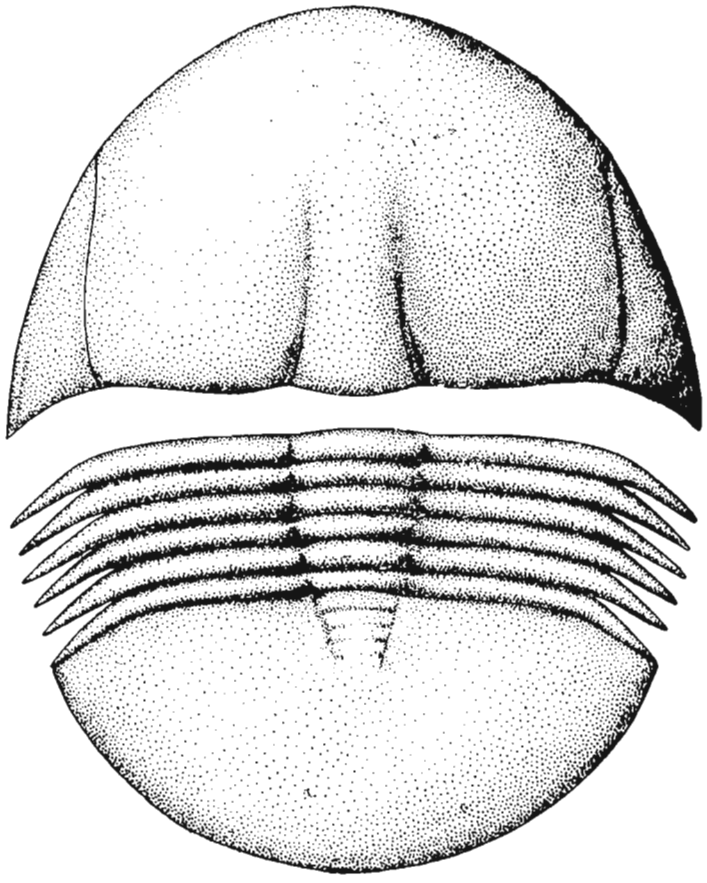


Fig. 24

Zdicella bornholmiensis n. sp. — reconstruction (number of thoracic segments unknown); approx. × 5.

differentiated pygidial rhachis. It is also reminiscent of some Bohemian illaenids, especially *Zdicella zeidleri* (BARRANDE), but it clearly differs from the latter species in having much shorter and smaller genal spines (comp. ŠNAJDR, 1957, p. 101).

Genus **ZBIROVIA** ŠNAJDR, 1956

Zbirovia longifrons (OLIN, 1906)

(pl. XII, fig. 1-5)

1906. *Illaenus longifrons* n. sp.; E. OLIN, Om de Chasmopskalken..., p. 65, pl. 3, fig. 14-15; probably not fig. 16.
1954. *Ectillaenus longifrons* (OLIN); V. JAANUSSON, Zur Morphologie..., p. 577.

Material. — The original Swedish specimens of OLIN (1906) and about 20 cephalons from the *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland.

Dimensions of 4 specimens (in mm):

Locality	Poland, Brzezinki		Sweden, Västergötland, Mösseberg	
Mus. cat. no.	IG 2. II. 365	IG 2. II. 364 a	UM Vg. 712	LM L. O. 1962 T
Length of cephalon	2.1	2.35	3.15	2.3
Width of cephalon	3.3	ca. 4.4	5.1	3.7
Width of glabella at the base	0.5	6.8	1.1	0.8

Description. — *Cephalon.* The outline is narrower than a semicircle. The posterior cephalic margin forms a straight line, the genal angles are rounded. The width of the base of the glabella is about one-fifth that of the cephalon. The dorsal furrows are very deep, the glabella is convex (tr.), and is as long as the cephalon. The dorsal furrows from the base of the cephalon at first slightly converge, and then they run parallel, diverging at the anterior part, so that the anterior width of the glabella is twice as large as the width at the base. The base of the glabella is situated slightly higher, and this higher part forms a narrow (long.) occipital ring, not much differentiated, however, from the glabella. The cheeks are convex. The facial suture is unknown. There are no eyes.

Discussion. — Olin (1906) has described the pygidium of this species (pl. 3, fig. 16). Similar pygidia do occur in Poland, but as an entire specimen of *Zbirovia longifrons* has never yet been found, it is doubtful whether the pygidium figured by Olin is conspecific with the cranidium. This doubt is increased by the fact that the pygidium figured by Olin (1906, pl. 3, fig. 16) shows some similarities to the representatives of the genus *Čekovia* Šnajdr, 1957, and is quite different from the pygidia of the representatives of *Zbirovia*, to which the cephalon belongs. Therefore, I do not accept this pygidium as conspecific with the cephalon.

Family **ODONTOPLEURIDAE** Burmeister, 1843

Subfamily ODONTOPLEURINAE (Burmeister, 1843)

Genus **LEONASPIS** R. & E. Richter, 1917

Leonaspis olini Troedsson, 1918

(pl. VII, fig. 5, 6; pl. XIV, fig. 1-4; pl. XV, fig. 4; pl. XVIII, fig. 6; text-fig. 25)

1818. *Entomostracites granulatus* n. sp.; G. Wahlenberg, Petrificata Telluris..., p. 30-31 (partim), pl. 2, fig. 4[x] (non fig. 4 = Tretaspis granulatus (Wahlenberg, 1818)).

1918. *Acidaspis (Leonaspis) olini* n. sp.; G. T. Troedsson, Om Skånes..., p. 98, pl. 1, fig. 29.

1952. *Acanthaloma mirka* n. sp.; L. Marek, Contribution to the stratigraphy..., p. 452, pl. 2, fig. 3.

Type horizon and locality: Upper Ordovician, *Dalmanitina mucronata* zone, Bestorp, Mösseberg, Västergötland, Sweden.

Material. — Several cranidia, cheeks, pygidia and fragmentary thorax from Zalesie, Poland; some specimens from Mösseberg, Västergötland, Sweden; Troedsson's and Marek's original specimens.

Dimensions of 2 specimens (in mm):

Locality	Zalesie	
IG Mus. cat. no.	401. II. 19	401. II. 21
Length of cephalon	4.4	—
Length of glabella	3.4	—
Width of glabella at the base	3.2	—
Width of central glabellar lobe	1.7	—
Greatest glabellar width	2.1	—
Length of pygidium without spines	—	1.6
Width of pygidium	—	4.3
Width of rhachis	—	1.4

Description. — *Cephalon.* The dorsal furrows are deep and wide. Running from the occipital furrow they converge slightly anteriorly, bend around the anterior glabellar lobe and reach each other, forming a very wide angle in front of it. The false glabellar furrows are almost as wide as the dorsal furrows, and run subparallel to the second lateral glabellar furrow. The medial glabellar lobe occupies the greatest part of the glabella and is composed of a cylindrical posterior portion and a transverse and large (long.) anterior portion. In transverse profile the median lobe is moderately convex, in longitudinal profile more convex, the highest point being at the level of L_2. The lateral glabellar furrows (S_1 and S_2) are deep, directed postero-medially, connecting the dorsal furrow with the false glabellar furrow. The two lateral glabellar lobes L_1 and L_2 are distinct and convex, suboval, L_1 greater than L_2. The occipital furrow is directed transversely in the middle part, becomes deeper and narrower and curves anteriorly at the dorsal furrows. The occipital furrow is wide (long.) and flat in the middle part, it curves anteriorly at the sides and becomes narrower. In front of the glabella there is an indistinct and flat, narrow (long.) anterior border, directed slightly upwards.

The facial suture cuts the posterior border close to the genal spine, in an arch convex exteriorly and runs medially, close to the posterior border furrow, where it bends around the eye and runs anteriorly, parallel to the cephalic axis. At the level of S_2 it bends and runs obliquely antero-medially to the cephalic margin. The eye is situated fairly posteriorly, opposite to L_1. There is a narrow and convex eye-ridge running from the eye towards the anterior glabellar lobe. It is delimited by a deep furrow running along it to the posterior border furrow. The surface of the fixed cheek, closed between this furrow and the dorsal furrow, forms a narrow triangle, slightly bent medially. Exteriorly the eye ridge is delimited by a deep furrow, running as a continuation of the anterior furrow. Exterior to this furrow there is on the fixed cheek a small triangular surface, connected with the anterior border and slightly bent upwards. The posterior border is convex and is increased in width peripherally. The eye is not preserved. The free cheek is moderately convex. The lateral border is almost flat, delimited by the distinct lateral border furrow. There are 12 lateral spines along the lateral border, situated perpendicularly to the margin. The length of these spines increases posteriorly. At the point of meeting of the lateral and posterior borders there is a long, genal spine, directed postero-laterally.

Thorax is composed of nine segments. The dorsal furrows are very deep, only slightly converging posteriorly, the rhachis is strongly convex (tr.). There is a transverse furrow across the rhachial rings, dividing the ring into a narrow (long.) anterior part, and more convex and wider the posterior. The pleurae are directed transversely at the dorsal furrows. There are the pleural furrows on the pleural segments, dividing each segment into a narrow (long.) and flat anterior part, and wider and more convex posterior. The posterior part of the pleural segment is produced into a long spine, directed postero-laterally, the anterior part of the segment is produced into a short spine.

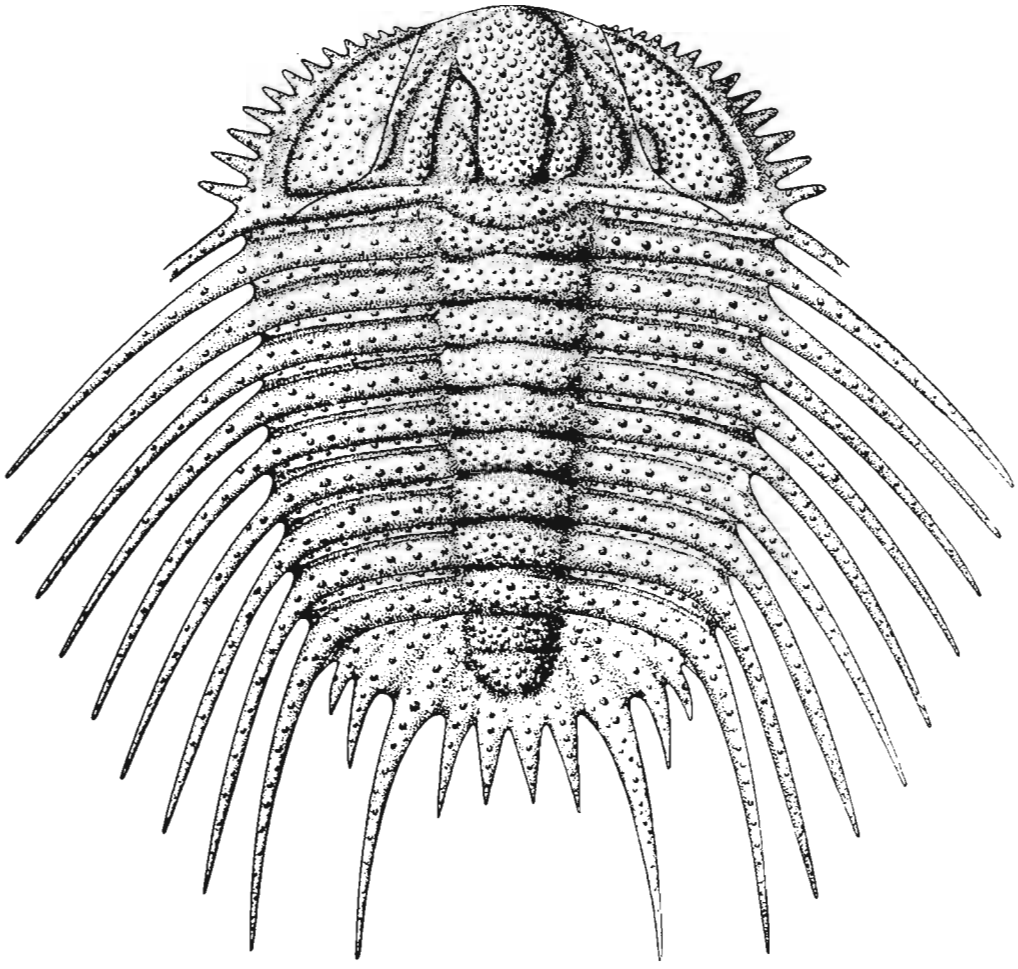


Fig. 25

Leonaspis olini TROEDSSON — reconstruction; approx. × 7.

Pygidium is short and transversely elongated. The dorsal furrows are very deep and delimit the strongly convex rhachis, composed of two segments. The first segment forms a convex band, the second is larger (long.) and has the shape of a semicircle. In front of these two segments there is a short (long.) half-ring. There are three pleural segments, the first situated in the prolongation of the first half-ring, strongly widening peripherally and connected with two spines on the pygidial margin. The second segment is connected with the first rhachial ring and forms a convex ridge across the pleura, produced into a long and wide

spine, much longer and wider than the other pygidal spines. The third pleural segment is connected with the second rhachial ring. On the posterior pygidial margin between the two main spines there are four short spines, their length being equal to that of the rhachis. The anterior pygidial spines seem to be shorter than the posterior ones.

Ornamentation. The whole cephalon, thorax and pygidium, excepting the furrows, are densely covered with different sized tubercles.

Discussion. — WAHLENBERG (1818, p. 30) described *Entomostracites granulatus*. The cephalon figured by him (pl. 2, fig. 4) is the type specimen of *Tretaspis granulata* (WAHLENBERG) and is from the *Staurocephalus* beds, Ålleberg, Västergötland, Sweden. The pygidium figured by him (pl. 2, fig. 4x) belongs to the genus *Leonaspis* R. & E. RICHTER, and is from the Upper Ordovician, zone of *Dalmanitina mucronata*; it is refigured in the present paper on pl. VII, fig. 6. TROEDSSON (1918, p. 98, pl. 1, fig. 29) described *Acidaspis (Leonaspis) olini* from the *Dalmanitina* beds of Scania. A good many specimens of *Leonaspis olini* occurring in the same beds in Poland (Holy Cross Mountains, Zalesie), led me to conclude that the pygidium, as well as a fragmentary thorax mentioned above and described by WAHLENBERG as *Entomostracites granulatus*, are conspecific with *Leonaspis olini* TROEDSSON.

MAREK (1952, pl. 2, fig. 3) described from the uppermost part of the Králův Dvůr beds of Bohemia *Acanthaloma mirka* n. sp. This species is known from one cranidium only. After a comparison of this specimen with those from Holy Cross Mountains and Scania, Dr. MAREK agreed with my opinion that *Acanthaloma mirka* is conspecific with *Leonaspis olini* TROEDSSON.

From the Upper Ordovician beds of Bohemia one more specimen of *Leonaspis* pattern has been described, viz. *Acidaspis peregrina* BARRANDE, 1872. This species was based on a single cranidium, preserved as an internal mould. The general pattern of the cranidium is similar to that of *Leonaspis olini*; as however no ornamentation is preserved, any certain identification cannot and could not in the future be done. Therefore, in my opinion, it is better to treat *Acidaspis peregrina* as a *nomen dubium*.

Leonaspis centrina (DALMAN, 1828)

(pl. XV, fig. 5; text-fig. 26)

1828*a*. *Calymene? centrina* n. sp.; J. W. DALMAN, Nya Svenska Palaeader..., p. 135.

Lectotype (here selected): External mould of almost entire individual, the latex cast of which is figured on pl. XV, fig. 5.

Type horizon and locality: Upper Ordovician, *Dalmanitina* beds, Mösseberg, Västergötland, Sweden.

Material. — DALMAN's original specimen, being an impression of the entire animal.

Dimensions (in mm):

Locality	Mösseberg
RM Mus. cat. no.	Ar. 15474
Length of entire individual without spines	12.6
Length of cephalon (preserved part)	3.3
Width of cephalon	10.0
Length of pygidium without spines	1.9
Width of pygidium	5.4

Description. — *Cephalon* is strongly elongated transversely. The dorsal furrows seem to be shallow; running from the occipital furrow they converge slightly anteriorly, and form an arch in front of the anterior glabellar lobe. The false furrows seem to be shallower than the dorsal ones, and they run subparallel to the second lateral glabellar furrow. The median glabellar lobe occupies the greatest part of the glabella. The lateral glabellar furrows (S_1 and S_2) are deep, directed postero-medially. The lateral glabellar lobes (L_1 and L_2) are distinct and convex, elongated longitudinally, L_1 twice as long as L_2. The occipital furrow is shallow in the

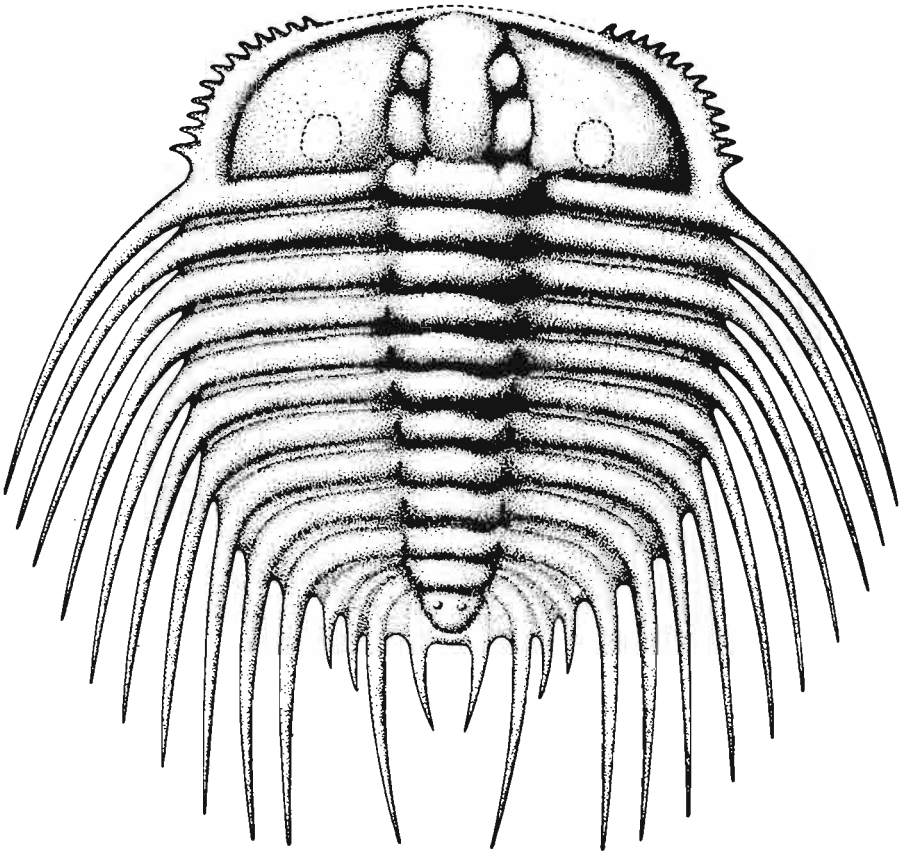


Fig. 26

Leonaspis centrina (DALMAN) — reconstruction; approx. × 6.6.

middle part, much deeper at the dorsal furrows. The occipital ring is wide (long.) and convex, narrower at the dorsal furrows. The cheeks are large, flat and elongated transversely. The facial suture and the eyes are not preserved. The posterior border is comparatively narrow at the dorsal furrow, becoming wider peripherally. The border is moderately convex, narrowing anteriorly. It is directed from the genal corner at first almost anteriorly (slightly antero-medially), then it bends almost in a right angle and is directed transversely. About 12 marginal spines are preserved along the border. The anterior part of the cephalon (the anterior border) is not preserved. The genal corner is produced into a very long, postero-laterally (rather more posteriorly) directed spine, reaching back to the 7th thoracic segment.

Thorax. There are 9 thoracic segments. The rhachial rings are strongly convex. The thoracic pleurae are divided by a transverse furrow into a narrow and flat anterior portion,

and much wider (long.) and convex posterior. The posterior portion of each pleura is produced into a very long spine. The spines of some of the first segments are directed postero-laterally, those of the later segments — posteriorly. The spines of the anterior part of the thoracic pleurae are not preserved.

Pygidium is wide (tr.). There are two rhachial rings. The pleural lobes are comparatively flat, with 3 pleurae, produced into spines. The two anterior spines are short, the third (main) spine is very long; it lies in the prolongation of the pleura connected with the first rhachial ring. On the posterior border, between the main spines there are two short spines, directed posteriorly, slightly bent outwards, connected with the second rhachial ring. On this ring there are two tubercles. Otherwise no traces of ornamentation are preserved.

Discussion. — DALMAN (1828*a*, p. 35) described *Calymene? centrina* from Mösseberg, Västergötland, Sweden, apparently from the *Dalmanitina* beds. DALMAN's original specimen, although not figured by him, is from his description an impression of an entire individual. In the collection of the Natural History State Museum in Stockholm, there is one specimen (RM no. Ar. 15474), the latex cast of which is figured in the present paper (pl. XV, fig. 5), from the *Dalmanitina* beds of Västergötland. There is ANGELIN's label on this specimen identifying it as *Acidaspis granulata*, and WARBURG's label identifying it as *Acidaspis centrina* (DALMAN). After discussing this question with Dr. V. JAANUSSON I came to the conclusion that it is DALMAN's original of *Calymene? centrina*, and it is figured here as the lectotype. ANGELIN has wrongly identified it as *Acidaspis granulata* (WAHLENBERG) (recte *Leonaspis olini* TROEDSSON), as it differs from the latter species to a very great extent. The table 4 gives the comparison of specific characters of two here discussed species.

Table 4

Comparison of specific characters of *Leonaspis centrina* and *L. olini*

Leonaspis centrina (DALMAN, 1828)	*Leonaspis olini* TROEDSSON, 1918
Cephalon strongly elongated transversely, subrectangular.	Outline of the cephalon subsemicircular.
Marginal spines comparatively short.	Marginal cephalic spines long in the posterior part, shorter anteriorly.
Main pygidial spines directed posteriorly, slightly convex outwards, situated close to each other. Two short spines on the posterior cephalic margin between the main spines.	Main pygidial spines directed posteriorly, slightly laterally, situated far from each other. Four short spines on the posterior cephalic margin between the main spines.

Genus **DIACANTHASPIS** WHITTINGTON, 1941

Diacanthaspis decacantha (ANGELIN, 1854)

(pl. XV, fig. 1-3; pl. XVI, fig. 2-3; pl. XVII, fig. 7, 8; text-fig. 27)

1854. *Cyrtometopus? decacanthus* n. sp.; N. P. ANGELIN, Palaeontologia Scandinavica, p. 35, pl. 12, fig. 5 (only the thorax and pygidium, non cephalon).

1899. *Acidaspis («Cyrtometopus»?) decacantha* ANGELIN; J. P. J. RAVN, Trilobitfaunaen..., p. 57.

Holotype: Thorax and pygidium from the Red *Tretaspis* bed from Mösseberg, Västergötland, Sweden, figured by ANGELIN (1854, pl. 22, fig. 5), refigured in the present paper — pl. XV, fig. 1.

Type horizon and locality: Upper Ordovician, Red *Tretaspis* beds, Mösseberg, Västergötland. Sweden.

Material. — Very many fragmentary specimens from the Red *Tretaspis* beds of Västergötland, about 60 more or less fragmentary specimens (2 entire individuals), from the *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland.

Dimensions of 4 specimens (in mm):

Locality	Brzezinki			Wólka
IG Mus. cat. no.	2. II. 11	2. II. 13	2. II. 8	2. II. 10
Length of entire individual with pygidial, without thoracic spines	11.0	5.5	—	—
Length of cephalon	4.5	1.8	—	7.2
Length of glabella	3.6	—	—	5.9
Width of glabella	3.6	—	—	6.0
Length of occipital spines	2.0	—	—	3.0
Length of pygidium with spines	2.7	1.1	4.5	—
Width of pygidium	4.1	1.6	8.0	—

Description. — *Cephalon.* The outline is subelliptical, being transversely elongated. The cephalon is moderately convex transversely and longitudinally. The dorsal furrows are weak, shallower than the false furrows. Running from the occipital furrow they are parallel, converging slightly in the anterior part of the glabellar length and forming an arch in front of the glabella. There are two lateral glabellar furrows, directed postero-laterally. S_1 is shallow, S_2 very deep. They join the dorsal furrows with the false furrows. There are two oval (long.) lateral glabellar lobes, the first L_1 twice as long as the L_2. The false furrows are deep, they run parallel from the occipital furrow to S_2 and end abruptly at it. The central glabellar lobe is composed of a long, cylindrical posterior part and a transversely elongated, but relatively long (long.) anterior part.

The occipital furrow is wide (long.), with an occipital node, situated slightly anteriorly. On the posterior margin, on the points lying in the prolongation of false furrows, there are two long spines, gently convex exteriorly, directed slightly upwards. They are produced as far as the fourth thoracic segment. The posterior margin of the occipital ring between the two spines is directed transversely. Away from the occipital spine, the posterior cephalic margin is directed at first anteriorly, and then antero-laterally, so that the occipital ring becomes narrower and disappears entirely at the dorsal furrows. The occipital furrow is wide and shallow, slightly convex posteriorly, deeper at the dorsal furrows, opposite to L_1. The posterior border is convex, wider peripherally, narrowing proximally until its disappearance at the dorsal furrows. The posterior border furrow is very deep at the dorsal furrows, shallowing peripherally. The lateral furrow is very shallow and wide, the lateral border is very wide and only slightly convex, forming an arch with the posterior border. The cheeks are very large (tr.). The facial suture cuts the posterior margin in half its length (tr.), between the dorsal furrow and the lateral margin. It runs anteriorly, then antero-medially to the eye situated opposite to the S_1, then runs anteriorly, slightly outwards, cuts the lateral furrow and bends sharply anteriorly, reaching the anterior cephalic margin. On the large fixed cheek one can recognize a triangular surface, delimited by the dorsal furrow and two oblique furrows, the posterior running from the periphery of the occipital ring toward the eye, and the anterior, running from the eye antero-laterally towards the S_2. This triangular part of the cheek is slightly convex. Peripherally to it there is a flat part of the cheek, connected with the inferior part of the free cheek in the semilunar

surface surrounding the eye. The eye is small and imperfectly known. On the lateral cephalic margin, forming an arch, there are 10 spines directed transversely, the anterior very short, the posterior gradually longer. Just behind the lateral spines, on the genal angle there is the genal spine which is directed postero-laterally and is slightly convex outwards.

Hypostome. One well preserved specimen of a hypostome (comp. pl. XVI, fig. 3) was found in an enrolled specimen. It is large, its length being three-fourths that of pygidium with

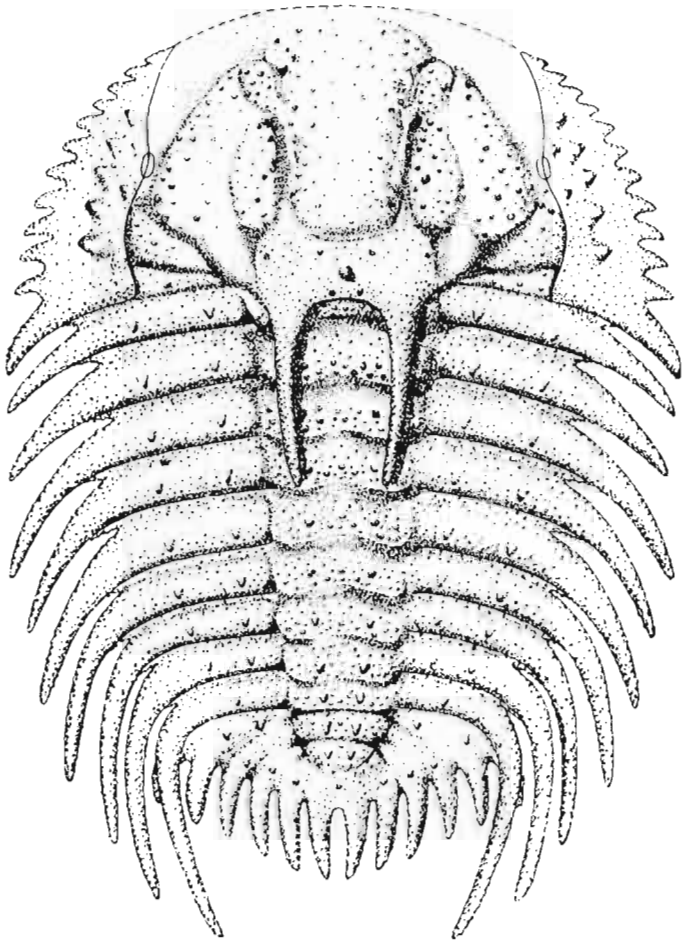


Fig. 27

Diacanthaspis decacantha (ANGELIN) — reconstruction; approx. × 6.

spines, slightly wider than long. The middle body is gently convex, wider in the anterior part, narrowing posteriorly with a shallow middle furrow, running backward and inward. There is no anterior furrow, the middle body reaching the anterior margin. The anterior wing is very small and rounded, behind it there is a notch on the lateral border and a distinct shoulder projecting outward. Postero-lateral border is wide, the posterior margin distinctly notched.

Thorax. There are 9 thoracic segments. The rhachial width is greater than that of the pleurae without the spines. The rhachial rings are convex, slightly bent anteriorly in the middle part, swinging anteriorly at the dorsal furrows. The pleura is divided (tr.) by a pleural furrow into a narrow (long.) and flat anterior part, and much wider and convex posterior part. Both parts are produced into spines: the anterior part into a short, narrow, transversely directed

spine, which is usually not visible under the spine of the posterior part of the anterior adhering segment. The spine of the posterior part is much stronger, wider, directed postero-laterally in a convex arch. The spines of the posterior segments become gradually longer, so that the spines of the posterior segments end far beyond the pygidium.

Pygidium is elongated transversely. The anterior pygidial edge forms a straight transverse line. The rhachial width is equal to that of the pygidium. The rhachis is strongly convex, the dorsal furrows subparallel, forming an arch in the posterior part of the rhachis. There are two rhachial rings, the first is convex and directed transversely, the second forms a semicircle. The pygidial pleurae are almost flat. The first half-segment is triangular and very wide (long.), strongly widening peripherally, delimited by a shallow furrow. There is one slightly visible pleural segment, connected with the first rhachial ring, directed postero-laterally, slightly convex peripherally. On the pygidial margin there are 12 spines of the equal length, slightly convex anteriorly.

Ornamentation. The whole glabellar and fixed cheek surface is covered by small different sized tubercles. On the exterior part of the cheeks the tubercles are greater and more regularly arranged. On the flat semilunar part of the cheek there are 6 large tubercles, surrounding the eye. On the lateral border there are 5 large, conspicuous spine-like tubercles. There are some similar large tubercles on the posterior border. The whole cheek surface is otherwise covered by a minute granulation, visible only under a lens. In the thoracic rhachis there are very many different sized tubercles, irregularly arranged, with two greater tubercles symmetrically arranged on both sides of the rhachis. On the posterior part of every pleura there are two symmetrically arranged spines. In addition to this, the whole surface of the pleurae with spines is minutely granulated. On every segment of the pygidial rhachis there are two spine-like tubercles, and very many different sized smaller tubercles among them. On the pleura there are 5 greater spine-like tubercles. The whole pygidial surface among these tubercles is minutely granulated. The pygidial spines are also minutely granulated with small spine-like tubercles on the margin of the spines.

Discussion. — ANGELIN (1854) described *Cyrtometopus? decacanthus* from the Red *Tretaspis* beds of Mösseberg, Västergötland, Sweden. The cephalon figured by him is not, however, conspecific with the thorax and pygidium. ANGELIN's original specimen of a thorax and pygidium is erected here as the lectotype and refigured in the present paper (pl. XV, fig. 1). Later this species was recorded by RAVN (1899) from Bornholm as *Acidaspis* («*Cyrtometopus*») *decacantha* ANGELIN. It has not been recorded so far from Scania, but as it occurs in the Holy Cross Mountains, Bornholm and Västergötland, its occurrence in Scania may be assumed.

Cyrtometopus decacanthus ANGELIN, 1854, is regarded here as belonging to *Diacanthaspis* WHITTINGTON. It also shows some similarities to *Primaspis* R. & E. RICHTER, and is in fact in certain respects intermediate between these two genera (cf. WHITTINGTON, 1941*b*; R. & E. RICHTER, 1917). The structure of the fixed and free cheek, the shape of the spines on the lateral cephalic margin — are of *Primaspis* type. The thoracic structure seems to be intermediate between these genera, but the lack of the third glabellar lobe, the structure of the occipital ring and also the lack of the major spines on the border of pygidium seems to ally it more to *Diacanthaspis*, than *Primaspis*, though it is notable that there are some species regarded by WHITTINGTON (1956*b*) as belonging to *Diacanthaspis*, with the *Primaspis* type of pygidium.

Comparing all these differences, it seems more reasonable to regard it as a representative of *Diacanthaspis*, pointing out at the same time that the distinction of these genera is not very clear.

Subfamily MIRASPINAE R. & E. RICHTER, 1917

Genus **PROCERATOCEPHALA** PRANTL & PŘIBYL, 1949

Proceratocephala terribilis bituberculata n. subsp.

(pl. III, fig. 3; pl. XVI, fig. 1)

Holotype: Cranidium, figured on pl. XVI, fig. 1.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: bituberculata — provided with 3 pairs of large tubercles on central glabellar lobe.

Diagnosis. — Cephalon covered by a minute ornamentation, in addition to which there are three pairs of distinct tubercles on the central area of the glabella and several tubercles on the lateral glabellar lobes and cheeks.

Material. — One almost entire cephalon with two thoracic segments and two cranidia, from *Staurocephalus clavifrons* zone, Brzezinki, Poland.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	
IG Mus. cat. no.	2. II. 29	2. II. 75
Length of cranidium	5.0	2.8
Width of cranidium	10.6	6.0
Width of glabella	5.4	2.8

Description. — *Cephalon* is moderately convex longitudinally and transversely, its outline being subelliptical and elongated transversely. The dorsal furrows are wide and distinct; from the occipital furrow they diverge slightly, so that the maximal glabellar width is across the lower part of L_1; then they converge slightly, forming an arch in front of the glabella. The false furrows are only slightly shallower than dorsal furrows, and run parallel to the second lateral glabellar furrow. The central glabellar lobe is composed of the cylindrical posterior portion, which widens anteriorly into the short (long.), anterior portion, transversely elongated. There are two transverse lateral glabellar furrows. The first lateral glabellar lobe (L_1) is elongated longitudinally, suboval, and twice as long as the rounded L_2. The occipital ring is very wide (long.) in the middle part, and three times as narrow (long.) at the dorsal furrows. These lateral parts of the occipital ring coalesce with the cheeks, as the dorsal furrows are not distinguishable on the occipital segment. The occipital furrow is distinct and strongly curved on its course, forming three convex arches; the middle one opposite the central glabellar lobe; the lateral, situated more posteriorly, opposite the lateral glabellar lobes.

On the cheek one can recognize the interior, triangular surface, slightly convex, closed among the dorsal, posterior and the additional cheek furrow, the latter running postero-laterally from the anterior glabellar corner to the posterior furrow. The posterior furrow begins its course on the posterior cephalic margin, opposite the dorsal furrow, then runs antero-medially to the additional cheek furrow, forming an angle with the latter. The posterior border strongly widens peripherally. Outwardly to the additional cheek furrow, there is a semicircular external part of the cheeks, with a lateral border furrow, delimiting a wide lateral border. On the lateral border there are several fairly long and slender marginal spines, the number of

which is difficult to establish. The postero-lateral angle of the cheek seems to be rounded, but there is a genal spine, situated on the posterior border, close to the genal angle. The genal spine is directed postero-laterally. The exterior part of the cheek is poorly preserved, so that the details of its structure cannot be observed. No traces of the facial sutures and eyes are preserved.

Thorax. The rhachial width (tr.) is slightly greater than that of the pleurae (without spines). The rhachial rings are directed transversely in the middle part, bent anteriorly and slightly rounded at the dorsal furrows. There is a pleural furrow dividing each pleura into a narrower (tr.) anterior part and a slightly convex, wider (tr.) posterior one. The pleural furrow is directed postero-laterally, so that the anterior part of pleura widens peripherally, whereas the posterior part narrows at the same time. In the prolongation of both pleural parts there are two thoracic spines, that of the anterior part being shorter and directed transversely, whereas that of the posterior is longer and directed postero-laterally.

Pygidium unknown.

Ornamentation. The whole cephalic surface, except the furrows, is densely covered by minute tubercles, among which one can recognize regularly arranged larger tubercles. There are three pairs of larger tubercles on the central glabellar lobe, one larger tubercle on L_1, one on L_2, and three on interior, triangular part of cheek. On the occipital ring there is a pair of spines, directed upwards and posteriorly. As they are broken off, their length cannot be ascertained. The thoracic segments are covered with small tubercles; on the thoracic rings there is a pair of spines, similar to those on the occipital ring.

Discussion. — Reed (1914) described from the Upper Ordovician, Starfish Bed, Upper Drummuck Group, Thraive Glen, Girvan, Scotland, the species *Acidaspis terribilis* Reed, and later (1935) from the same locality and horizon — a new species *Acidaspis (Ceratocephala) discreta*. Both species have been made the types of two new genera by Prantl & Přibyl (1949), viz. *Proceratocephala* (for *Acidaspis terribilis*) and *Drummuckaspis* (for *Acidaspis (Ceratocephala) discreta*). An examination of casts of Reed's original material has, however, led Whittington (1956*a*, p. 515) to the conclusion, that: «... there is no reason for thinking that these specimens represent different species, let alone distinct genera.» *Drummuckaspis* Prantl & Přibyl is stated by Whittington to be a subjective synonym of *Proceratocephala*.

Olin (1906, p. 49, pl. 1, fig. 18-19) described from the *Tretaspis* beds of Scania *Acidaspis törnquisti* Olin, based on one cranidium and one free cheek. The cranidium described by him belongs apparently to the genus *Proceratocephala*, whereas the cheek — to *Whittingtonia*. Both specimens are, however, very poorly preserved, no traces of any ornamentation can be observed, so that no specific identification of these specimens can be made. Therefore, it seems to be more reasonable to treat *Acidaspis törnquisti* as *nomen dubium*, whilst noting that some representatives of *Proceratocephala* do occur in Scania.

The representatives of *Proceratocephala* from Poland, described above, show very close similarities with *P. terribilis* Reed, differing from the latter only in the ornamentation. This difference seems to be too small to accept it as worthy of specific distinction, and therefore I consider the Polish form to be a subspecies (geographical race) of the British species. *P. terribilis bituberculata* differs from *P. terribilis terribilis* in having larger tubercles on the cephalon among the smaller, whereas in the British form the ornamentation seems to be more uniform, consisting of small tubercles only. It is probable too, that these differences are due to the state of preservation of British specimens, in which the larger tubercles are not preserved. In such a case our form would be conspecific with the British. There is a long genal spine in *P. terribilis bituberculata*, however as yet we do not know anything about the genal spine in *P. terribilis terribilis*.

Genus **WHITTINGTONIA** PRANTL & PŘIBYL, 1949

Diagnosis. — *Cephalon* subtrapezoidal in outline strikingly convex (tr. and long.). False and dorsal furrows broad and deep, three small, narrow lateral glabellar lobes, the third one may by lacking. Fronto-medial glabellar lobe very convex, overhanging the anterior border. Eyes relatively large, with strong eye-ridge, a pair of occipal spines, stout and short genal spines. Number of thoracic segments unknown, thoracic pleurae produced into long, posteriorly directed spines. Pygidium small with two rhachial segments and one pleural, with a pair of long spines in its prolongation and two short spines between them.

Occurrence. — Upper Ordovician of Eire, Sweden (Siljan district and probably Scania) and Poland.

Whittingtonia whittingtoni n. sp.

(pl. XVI, fig. 5; pl. XVIII, fig. 1-4; text-fig. 28)

Holotype: Cephalon figured on pl. XVIII, fig. 1 *a-c*.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Wólka, Poland.
Derivation of name: whittingtoni — in honour of distinguished American palaeontologist Prof. H. B. WHITTINGTON.

Diagnosis. — Eyes large, situated fairly anteriorly, their length being slightly more than one-fourth of the cephalic length. Occipital spines very short, occipital node transversely elongated. Genal spines short (a little more than one-third of the cephalic length), and directed postero-laterally, 12 short spines around the cheek margin.

Material. — One entire cephalon, about 14 fragments of cephalons, one thorax with pygidium and one isolated pygidium from the *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland.

Dimensions of the holotype (in mm):

Length of cephalon	2.9
Width of cephalon	5.0
Length of glabella	2.4
Width of middle glabellar lobe	1.5
Length of eye	0.7
Length of genal spines	1.0
Length of occipital spines	0.3

Description. — *Cephalon* is transverse, its greatest width being in front of the transverse midline. The cephalon is very strongly convex transversely and longitudinally. In longitudinal profile the cheek and eye are situated lower than the glabella. In transverse profile the medial glabellar lobe forms a semicircle situated higher than the cheeks and eyes.

The greatest part of the glabellar surface is occupied by an oval, swollen and strongly differentiated central glabellar lobe. The dorsal furrows are faintly marked, they run subparallel, slightly converging anteriorly, forming an arch in front of the glabella. The false furrows run parallel, and are strongly marked by the presence of a convex central glabellar lobe. The dorsal and false furrows are situated on the same level, the space between them is narrow, so that they form a common wide furrow on each side of the glabella, in the bottom of which there are two small, oval, slightly inflated bodies — the lateral glabellar lobes, L_1 and L_2 (the third lateral

glabellar lobe is visible only as a trace). L_1 is greater than L_2, it is situated just in front of the occipital furrow; L_2 is smaller, situated in half the length of the central glabellar lobe. The occipital furrow opposite to the central glabellar lobe is directed transversely, then it bends strongly forwards, opposite to the lateral glabellar lobes, so that the lateral glabellar lobes are situated more anteriorly than the base of the central lobe. Opposite to the lateral glabellar lobes the occipital furrow is deeper than in the middle part. The occipital ring is

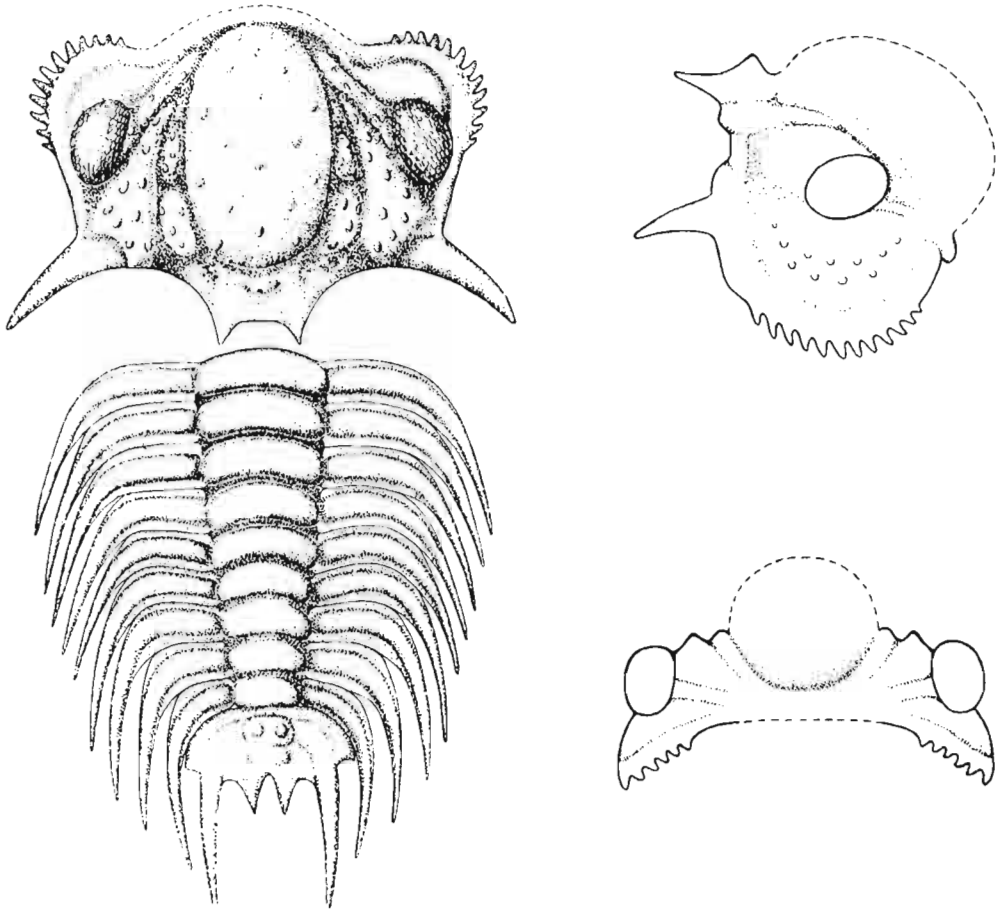


Fig. 28

Whittingtonia whittingtoni n. sp.: left — reconstruction (number of thoracic segments unknown), right — reconstruction of the cephalon; in lateral and anterior views; approx. × 8.

wide and flat in the middle part, opposite to the central glabellar lobe; here its posterior margin is parallel to the occipital furrow. In the prolongation of the false furrows there are on the posterior margin of the occipital ring two short occipital spines, directed postero-laterally. Peripheral to these spines the margin of the occipital ring bends strongly anteriorly and runs obliquely towards the occipital furrow, so that the lateral part of the occipital ring becomes gradually narrower and disappears at the dorsal furrows. There is a large, transverse occipital node.

The cheeks are large, strongly sloping down. In half of the cheek's length there is a large, strongly convex eye, situated obliquely, its axis being directed antero-medially. In the antero-

medial prolongation of the eye there is a convex eye-ridge, running towards the anterior glabellar lobe. There are about 100 hexagonal lenses on the eye, arranged in oblique rows. The part of the cheek situated between the eye and the dorsal furrow is a strongly convex, triangular surface. The eye is delimited from this surface by a deep furrow, directed antero-medially, this furrow prolongates along the eye-ridge anteriorly. Exteriorly the eye is surrounded by a shallow furrow, which prolongates along the exterior part of the eye-ridge and reaches the anterior border.

The lateral border is wide and runs in a curve forming three quarters of the circular outline, around the cheek. The lateral border furrow is shallow but distinct. The anterior border is similarly convex and forms an arch in front of the glabella. Thus the anterior outline of the cephalon is composed of three adhering arches: the anterior border in the middle and the lateral borders on both sides of it. The anterior border as well as the lateral borders are denticulated. The number of denticles along the anterior border is unknown. Along the lateral border there are about 12 spines, the spines in the middle part of the border being longer than those on the sides. The posterior border is very short (tr.), convex, wide in the peripheral part, narrowing strongly medially — it disappears completely before reaching the dorsal furrow. The lateral and the posterior borders at their junction are produced into a short, conspicuous and postero-laterally directed genal spine.

Thorax is imperfectly known, only one natural impression has been preserved, from which a latex cast has been made. The number of thoracic segments is nine or ten. The rhachial rings are convex (tr.), rhachis narrowing posteriorly. The pleural segments are convex (long.), divided by a pleural furrow into a very narrow (long.) and flat anterior part, and a much longer (long.), convex posterior part. The pleural segments are directed transversely at the dorsal furrows, then they form a strong arch and bend posteriorly producing long spines. The spines of some first thoracic segments are directed postero-laterally, and are not very long; posteriorly their length gradually increases, and they are directed more backwards. The length of the last thoracic spine is more than twice as long as the transversely directed part of this segment.

Pygidium is small. The rhachis is very short (long.), composed of one convex segment. On the pleurae there is one convex pleural segment visible, directed in an arch postero-laterally, situated in the prolongation of the rhachial segment, and produced into long, posteriorly directed spine. On the posterior part of the pygidium, beyond the rhachis there are traces of indistinct posteriorly directed segments, situated in the prolongation of the rhachis and produced into short, posteriorly directed spines. The outline of the pygidium without the spines is wider than a semicircle. The anterior pygidial margin is directed transversely, forming short wings.

Ornamentation. The entire cephalon, excluding the furrows, is sparsely covered by small, but conspicuous spines. In addition to this ornamentation, the whole cephalic surface is densely covered by minute granulation. The whole surface of the thorax is densely covered by small granules. The whole pygidial surface, similarly to that of the thorax, is covered by small, densely arranged granulations.

Discussion. — The new species here described differs from *Whittingtonia bispinosa* (McCoy), (comp. Whittington, 1956*a*, pl. 59, fig. 4, 5, 7, 8) in having larger eyes, shorter genal and occipital spines and more coarse granulation. In *Whittingtonia bispinosa* the third lateral glabellar lobe is fairly large and distinct, whereas it has disappeared almost entirely in our species. As the thorax and pygidium of this genus were hitherto unknown, no farther comparison can be done.

Whittingtonia sp.

(pl. XVIII, fig. 5; text-fig. 29)

In the collection from Zalesie, Poland, the zone of *Dalmanitina mucronata*, there is one poorly preserved cephalon, belonging to the genus *Whittingtonia*.

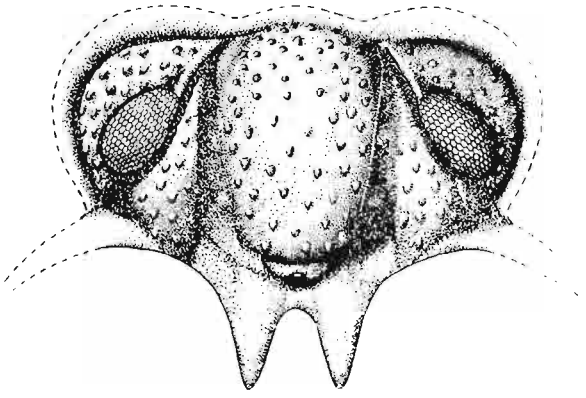


Fig. 29

Whittingtonia sp. — reconstruction of the cephalon; approx. × 5.5.

Dimensions of the cephalon (in mm):

Length of cephalon	7.3
Width of cephalon	12.9
Length of glabella	5.7
Width of glabella	3.7
Length of eye	2.3
Length of occipital spines	1.9

The specimen from Zalesie differs from *Whittingtonia whittingtoni* n. sp. in having wider and longer occipital spines. The dorsal and the false furrows are here entirely fused together, forming a very wide furrow, and very indistinct traces of lateral glabellar lobes only are preserved in this furrow. This fused furrow is narrower than the space occupied by the dorsal and false furrows in *Whittingtonia whittingtoni*. The eyes seem to be as large as in *W. whittingtoni*, and the ornamentation similar as well. No other differences between the two species can be observed.

Family **CARMONIDAE** nov.

Diagnosis. — Blind, opisthoparian, free cheeks narrow, restricted to the lateral border of the cephalon. Dorsal furrows on the cephalon narrowing anteriorly, two lateral glabellar furrows in shape of oval depressions. Ventral cephalic sutures steno-ptychopariid, rostral plate subtriangular. Hypostome small, with the middle body divided into two lobes, the posterior border forked, the lateral border incised. 11 thoracic segments, with pleurae bluntly cut off. Pygidium very small, convex, with two rhachial and one pleural segments. The entire body surface strongly granulated.

Occurrence. — Upper Ordovician, Bohemia and Poland.

Discussion. — The new family is monotypic, erected to include *Carmon mutilus* (BARRANDE). See discussion on p. 44-47.

Genus **CARMON** BARRANDE, 1872

Carmon mutilus (BARRANDE, 1852)

(pl. XVI, fig. 4; pl. XVII, fig. 1-6; text-fig. 30, 31)

1852. *Trilobites mutilus* n. sp.; J. BARRANDE, Système Silurien..., p. 915, pl. 34, fig. 43.
1872. *Carmon mutilus* (BARRANDE); J. BARRANDE, *Ibid.*, Suppl., p. 20, pl. 2, fig. 4-6.
1956. *Carmon mutilus* (BARRANDE); Z. KIELAN, On the stratigraphy..., pl. 3, fig. 5-6.

Material. — About 150 specimens from the *Eodindymene pulchra* zone and *Staurocephalus clavifrons* zone of Brzezinki and Wólka, Poland; several specimens from the Králův Dvůr beds, Bohemia.

Dimensions of 6 specimens (in mm):

Locality	Brzezinki		Wólka			Brzezinki
IG Mus. cat. no.	2. II. 39	2. II. 38	2. II. 40	2. II. 42	2. II. 32	2. II. 30
Length of entire individual	13.7	14.6	10.0	—	—	—
Length of cephalon	5.7	5.2	3.3	2.0	—	4.2
Length of glabella	3.6	3.3	2.4	1.3	—	3.0
Width of cephalon	9.8	8.0	5.3	—	—	8.0
Length of pygidium	1.2	1.5	0.9	—	1.2	—
Width of pygidium	3.0	3.4	2.2	—	2.0	—

Description. — The outline of the entire individual is suboval and strongly elongate.

Cephalon. The outline is narrower than a semicircle. In transverse and longitudinal profile the cephalon is moderately convex. The dorsal furrows are deep, they converge slightly anteriorly and form an arch in front of the glabella. There are two lateral glabellar furrows. The first (S_1) forms an oval depression at the dorsal furrows in the posterior part of the glabella, is directed transversely and cuts less than one-fourth of the glabellar width. The second (S_2) is situated in half the glabellar length, is narrow (long.) and very shallow, but is not recognizable on poorly preserved specimens. The occipital ring in the middle part is wide (long.) and directed transversely, at the dorsal furrows it becomes narrower and is directed slightly anteriorly. The occipital furrow is wide, directed transversely, wider at the dorsal furrows than in the middle part. The cheeks are large, slightly narrower (tr.) than the glabella. The posterior border is wide (long.) and convex, its width (long.) increasing slightly peripherally. The lateral border furrow is wide in its posterior part and narrower in the anterior. The lateral border is narrower than the posterior and it is convex. There is a wide (long.) and convex anterior border, delimited from the glabella by a deep anterior furrow, no preglabellar field being developed.

The free cheeks are very narrow, restricted almost entirely to the lateral border of the cephalon. The facial suture cuts the posterior border not far away from the genal angle and runs subparallel to the outer cephalic margin, quite close to it, along the peripheral edge of the lateral border furrow. Half way along the cephalic length it cuts the lateral border furrow and runs anteriorly along the interior edge of this furrow, on the convex part of the cheek. Then it cuts the anterior border furrow, runs on the anterior border obliquely antero-medially and cuts the anterior cephalic margin not far away from the midline of the body. There are no eyes.

Doublure. In the posterior part of the cephalon the doublure is narrow (tr.), about as wide as the free cheeks. In the anterior part it is a little wider (long.). The ventral cephalic sutures have been observed on three slightly damaged cephala. The rostral plate is small, subtriangular, composed of two parts: a distal, triangular part, and a very narrow (tr.), oblong proximal part, which is the prolongation of the apex of the triangular part (comp. pl. XVII, fig. 6, and text-fig. 31). On the internal moulds of the cranidium, on some specimens there is a narrow (tr.) ridge, running from the top of the glabella towards the anterior margin (comp. pl. XVII, fig. 4). An interpretation of this structure is difficult, but it ought to be

stressed that its site corresponds to the position and the shape of the proximal part of the rostral plate, on the doublure, which is strongly turned up and lies close to the cephalon.

Hypostome is comparatively small, its length being three-fourths that of the glabella. It is subrectangular in outline, the middle body being moderately convex, divided by a very shallow furrow into anterior and posterior lobes. The anterior (topographically) lobe is sub-

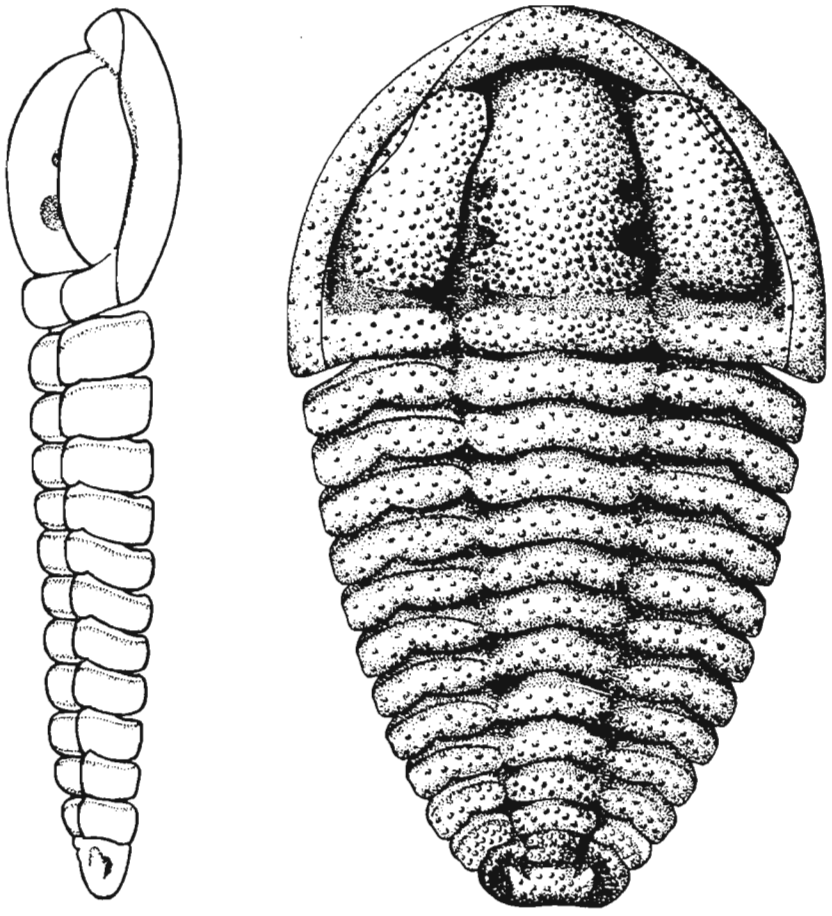


Fig. 30

Carmon mutilus (BARRANDE) — reconstruction, in lateral and dorsal views; approx. × 12.

oval, the posterior — semilunar. The anterior wings are extended laterally, forming small triangles. The posterior and lateral furrows are continuous, the lateral deeper than the posterior, with distinct elongated deepenings at the anterior ends of the lateral furrow. The anterior furrow is shallow. The lateral border is narrow and slightly flexed ventrally. Along the lateral margin there are two semilunar incisions, concave exteriorly. The posterior border is flat and slightly forked with a shallow and wide notch. Along the lateral and posterior border there is a doublure, of which the shape and size is difficult to ascertain. On the hypostome the ornamentation is not preserved, except for faint striae along the posterior and lateral borders.

Thorax is composed of 11 segments. The dorsal furrows are deep, the width of the rhachis being about one-third of the thoracic width in the anterior segments, it is less in the posterior segments. The thoracic rings are convex and at the dorsal furrows are slightly directed anteriorly. The pleurae are situated lower than the rhachis, they run at first transversely, then after cutting about one-third of their length (tr.) they bend, being directed postero-laterally and downwards. There is a longitudinal (tr.) pleural furrow, dividing each pleura into a narrow (long.) anterior part, forming a wide, very long triangle, and a much wider (long.) and more convex posterior part. The pleural ends are slightly widened, directed slightly anteriorly, but not produced into spines.

Pygidium is very small, its length being less than one-fourth that of the cephalon. The dorsal furrows on the pygidium are recognizable only as a faint furrows in its anterior part, delimiting a fairly wide rhachis. They cut less than a half the pygidial length, and end abruptly, so that there is no differentiated rhachis in the posterior part of the pygidium. There are two rhachial rings, of which the second is very indistinct. The posterior part of the pygidium is directed downwards. There is one pleural segment on the pygidium, situated in the prolongation of the first rhachial ring, directed transversely, slightly convex anteriorly. The pleurae at the dorsal furrows are directed transversely, and then they are strongly bent downwards, similarly to the posterior part of the pygidium.

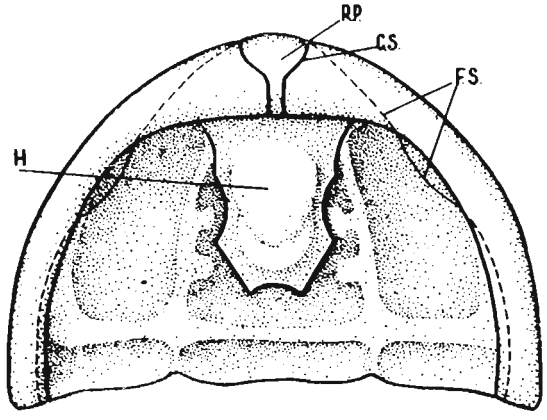


Fig. 31

Carmon mutilus (BARRANDE) — reconstruction of the ventral side of the cephalon; approx. × 12

R.P. rostral plate, *C.S.* connective suture, *F.S.* facial suture, *H* hypostome.

Ornamentation. The entire body surface is strongly ornamented by different sized small tubercles. On the cephalon the furrows only are not granulated. On the anterior and lateral border the granules are slightly smaller than on the cheeks and glabella. There are irregularly situated tubercles on the rhachial rings, on both parts of the pleurae and on the pygidium.

Discussion. — The specimens of *Carmon mutilus* from Poland are identical with those from the Králův Dvůr beds of Bohemia. The Bohemian specimens are preserved as internal moulds, and therefore the ornamentation was not observed by BARRANDE. However, on some Bohemian specimens I could see traces of ornamentation.

Family **CALYMENIDAE** MILNE-EDWARDS, 1840

Genus **CALYMENE** s. l. BRONGNIART, 1822

«**Calymene**» sp.

(pl. VII, fig. 7)

In the collection of the *Staurocephalus clavifrons* zone of Brzezinki, Poland, there is one calymenid pygidium. It is poorly preserved and the correct generic identification cannot be done. I considered, however, it worth while to describe it shortly in the present paper, in order to show that the calymenids, common in the Upper Ordovician of Scania and Bohemia, occur in Poland as well.

The pygidium is comparatively short and wide, length to width ratio being about 1:2. The rhachis is narrower than the pleurae, occupying less than one-third of the pygidial width. It is composed of about 7 or 8 rings. On the pleurae there are 5 pleural segments visible, with deep pleural furrows between them. They are directed postero-laterally, the fifth segment being short and indistinct, directed posteriorly.

Family **HOMALONOTIDAE** CHAPMAN, 1890

Subfamily HOMALONOTINAE CHAPMAN, 1890

Genus **BRONGNIARTELLA** REED, 1918

Brongniartella platynotus (DALMAN, 1828)

(pl. XIX, fig. 1-3)

1828*a*. *Asaphus platynotus* n. sp.; J. W. DALMAN, Nya Svenska Palaeader, p. 135.
1854. *Homalonotus platynotus* DALMAN; N. P. ANGELIN, Palaeontologia Scandinavica, p. 29, pl. 19, fig. 6.
1869*b*. *Homalonotus platynotus* DALMAN; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 72.
1872. *Homalonotus inexpectatus* n. sp.; J. BARRANDE, Système Silurien..., Suppl., pl. 37, pl. 1, fig. 8; pl. 7, fig. 31; pl. 14, fig. 27-28; pl. 15, fig. 38-39.
1918. *Homalonotus platynotus* DALMAN; G. T. TROEDSSON, Om Skånes..., p. 76, pl. 2, fig. 25.
1951. *Brongniartella inexpectata* (BARRANDE); L. MAREK, New observations..., pl. 1, fig. 4-6.

Diagnosis. — Outline of cephalon narrower than a semicircle, glabella with 3 pairs of lateral glabellar furrows, indistinct but recognizable as internal moulds; S_1 and S_2 long, S_3 shorter, all furrows directed postero-medially. Dorsal part of the rostrum comparatively long. Eyes small, situated far forward, close to glabella, opposite S_2. Pygidium with 11 rhachial rings and 7 pleurae. The whole cephalic and pygidial surface covered by small pits. In addition to this ornamentation, small grooves on sides of the rhachial rings, also posterior pygidial margin and pygidial doublure minutely granulated.

Material. — 2 poorly preserved cranidia from the *Dalmanitina mucronata* zone of Zalesie, Poland; 2 cranidia from *D. mucronata* zone of Tommarp, Scania; 6 cranidia, 4 pygidia from the same zone, Mösseberg, Västergötland, Sweden; BARRANDE's and MAREK's original specimens from the Králův Dvůr and Kosov beds of Bohemia.

Description. — *Cephalon.* The outline is sub-semicircular, a little narrower than a semicircle. Cephalon is moderately convex (tr. and long.). The occipital ring is flat transversely and of equal width (long.) along its whole length (tr.). Occipital furrow is shallow on the specimens with the exoskeleton preserved, deep on internal moulds.

The dorsal furrows are broad and shallow, running subparallel, converging slightly anteriorly between the occipital furrows and half the glabellar length, then strongly swinging inward and running again subparallel to reach the transverse furrow, forming the anterior border of the glabella. The width of the anterior portion of the glabella is equal to two-thirds of the posterior part. On the internal moulds three indistinct lateral glabellar furrows are preserved. They form very faint grooves directed postero-medially; S_1 and S_2 are larger, S_3 very short and indistinct. On the exoskeleton traces of these furrows are almost invisible. Cheeks are triangular. There is no lateral border or lateral border furrow. The posterior border is slightly convex (long.); the posterior border furrow is deeper than the occipital furrow, and it ends before reaching the lateral margin. The genal corners are rounded. Eyes are small,

situated close to the glabella, opposite the S_2. The palpebral lobe is small, its distal end being elevated. The visual lobes are small and convex, the lenses are not preserved.

The posterior branch of the facial suture cuts the lateral border almost in the corner and then runs antero-medially, subparallel to the outer margin of the cheek, then it bends rather suddenly and runs transversely to the eye. The anterior branch of the facial suture runs anteriorly to the cephalic margin. The rostral suture forms a straight, transverse line, running between the ends of the facial suture, on the dorsal part of the cephalon. The preglabellar field, between the end of the glabella and the rostral suture is longer (sag.) than the occipital ring. A part of the rostral plate is on the dorsal side of the cephalon and this is in the shape of a crescent; the connective sutures run from the point of the crossing of the facial suture with the rostral one. They run transversely across the doublure, then bend and run perpendicular to the external margin of the doublure. Thus the central part of the rostral plate is composed of two parts: a wide (tr.) crescentic interior part, and a narrow (tr.) parallel-sided, exterior one. The doublure is wide (long.) in the middle part of the cephalon, becoming narrower and disappearing at the sides. The hypostome is not known.

Thorax is not preserved. Troedsson (1918, pl. 2, fig. 25b) described a fragment of a thoracic segment as belonging to this species.

Pygidium has a rounded outline, narrower than a semicircle. It is moderately convex transversely and longitudinally. The dorsal furrows are shallow but distinct, narrowing posteriorly; they end at the transverse furrow forming the termination of the rhachis. Rhachis is composed of 10-11 rings. The rhachial rings are very flat, the furrows between them are shallow and narrow.

There are about 7 pleurae on the pleural lobes. Pleural furrows are running as direct continuations of the ring furrows. They run postero-laterally, almost to the pygidial margin. There is a trace of an interpleural furrow on every pleura, but it is very shallow and indistinct. The first half-segment of the pleura is triangular in outline.

Ornamentation. The whole surface of the cephalon and pygidium is covered by very small, regularly arranged pits. In addition to this ornamentation there is on the pygidium an ornamentation of small, short grooves, localized on both sides of the rhachial rings, and directed postero-medially. There is quite a number of them on the posterior rhachial rings, where they are directed posteriorly. The posterior pygidial margin and pygidial doublure are minutely granulated.

Discussion. — *Brongniartella platynotus* (Dalman) was described originally from the *Dalmanitina* beds of Västergötland, where it is one of the most common fossils. The specimens of *B. platynotus* from Västergötland are very large, the average length of the cephalons being from 3-5 cm, that of pygidia about 4 cm.

In Scania this species is rare, only two cranidia from the uppermost part of the *Dalmanitina* beds were found by Troedsson (1918). This led Troedsson to treat *B. platynotus* as an index form for the uppermost part of the *Dalmanitina* beds. In the Holy Cross Mountains *B. platynotus* has also only been found in the uppermost part of *Dalmanitina* beds, but as is the case in Scania — it is rare and is represented so far in my collection by only two poorly preserved cranidia.

The specimens of *B. platynotus* from the Holy Cross Mountains differ from those from Västergötland. They are smaller: the length of cranidium being between 7 and 14 mm. In smaller specimen (comp. pl. XIX, fig. 1) the dorsal furrows converge anteriorly, but run without the swinging inwards in the middle part, which is characteristic for all the other specimens. The small number of specimens does not allow one to decide whether this change is ontogenetic, or means we have here a different species or subspecies.

From the *Brongniartella* species from Great Britain, for example *B. bisulcatus* (SALTER) and *B. sedgwicki* (SALTER), *B. platynotus* differs chiefly in having 3 pairs of lateral glabellar furrows (which in the British species are absent), a longer rostral plate on the dorsal part, and eyes situated much closer to the glabella.

The presence of 3 pairs of lateral glabellar furrows in our species approaches the condition in representatives of *Eohomalonotus (Eohomalonotus)* REED, 1918. The lateral glabellar furrows in *Eohomalonotus* are, however, quite distinct, whereas in our species they are nearly absent, being visible only in internal moulds. The lack of a lateral border of the cephalon and the shape of pygidium prove that the relationship of our species is closer to *Brongniartella* than to *Eohomalonotus*.

From the Upper Ordovician of Bohemia two homalonotid species have been described. *Brongniartella inexpectata* (BARRANDE, 1872) was recorded by BARRANDE from the Králův Dvůr beds of Lejškov and Libomyšl, and more recently by MAREK (1951) from the Kosov beds at Nová Ves near Prague. The specimens figured by MAREK seem to be conspecific with *Brongniartella platynotus* (DALMAN), and *B. inexpectata* is tentatively claimed here to be a junior subjective synonym of *B. platynotus*.

The other homalonotid species quoted from the Upper Ordovician of Bohemia is *Eohomalonotus (Eohomalonotus) foveolatus* NOVÁK Ms (in PRANTL and PŘIBYL, 1944). The cephalon of this species was figured, according to PRANTL and PŘIBYL, by NOVÁK and PERNER (1918, pl. 4, fig. 20) under the name *Calymene (Synhomalonotus) argo*. *E. (E.) foveolatus* has been recorded by PRANTL and PŘIBYL (1944) from the Kosov beds of Tachlovice boring. The NOVÁK-PERNER specimen is from the locality of Kosov, which according to CHLUPAČ (1951*b*, p. 211) belongs to the uppermost part of the Králův Dvůr beds, yielding *Dalmanitina mucronata* (BRONGNIART). This specimen is an internal mould of a cephalon, with traces of lateral glabellar furrows preserved. I have not had an opportunity to examine the specimens from Tachlovice boring, and so I cannot venture an opinion as to whether or not *E. (Eohomalonotus) foveolatus* is conspecific with *Brongniartella platynotus*, though the probability that they are not only congeneric, but conspecific as well, seems likely.

The homalonotid species show great variability in their ontogenetic development. In *B. platynotus* for instance the lateral glabellar furrows are more distinct in younger specimens, and in older ones they are recognizable only in internal moulds. Similarly the cephalic dorsal furrows are straight, running antero-medially in younger specimens, whereas they swing inwards for half their length in older specimens. This may lead to some confusions and incorrect identification of different growth stages of one species.

Family **DALMANITIDAE** DELO, 1935

Subfamily DALMANITINAE REED, 1905

Genus **DALMANITINA** REED, 1905

Dalmanitina mucronata (BRONGNIART, 1822)

(pl. XIX, fig. 4; pl. XX, fig. 5-11; comp. also pl. XIX, fig. 7-9, and pl. XX, fig. 1-4)

Dalmanitina mucronata (BRONGNIART) has been recently described and discussed by TEMPLE (1952*a*). As no differences between the representatives of this species from Poland and Bohemia, and those figured and described by TEMPLE from Sweden and Great

Britain, are observed, it is not thought desirable to describe it once more in the present paper.

Discussion. — TEMPLE (1952*a*), whilst revising *Dalmanitina mucronata* and related species, did not discussed *Dalmanitina kiaeri* TROEDSSON, 1918. *D. kiaeri* was erected on a single specimen only, from the Upper Ordovician of Norway. A comparison of this specimen with those of *D. mucronata* proves that they are conspecific, *D. kiaeri* being claimed to be a junior subjective synonym of *D. mucronata*.

As quoted by TEMPLE (1952*a*, p. 14), *Dalmanitina mucronata* occurring in Scandinavia and Great Britain has also been recorded from Poland. It is of great interest to find the occurrence of this species in Bohemia as well.

BARRANDE (1846*a*) described *Phacops* sp. and *Phacops socialis*, identified later by him (1852) as *Dalmanites socialis*. In 1852 BARRANDE recognized in *Dalmanites socialis* 3 subspecies (varietas), including *Phacops proevus* EMMRICH, 1839, in the synonymics. The correct systematic identification of BARRANDE's subspecies is as follows: *Dalmanitina socialis socialis* (BARRANDE, 1846) = *D. proeva socialis* (BARRANDE, 1846); *D. socialis proeva* (BARRANDE, 1852) = *Dalmanitina proeva proeva* (EMMRICH, 1839); *D. socialis grandis* (BARRANDE, 1852) = *Dalmanitina proeva grandis* (BARRANDE, 1852).

The latter subspecies occurs in the uppermost part of the Ordovician of Bohemia (schistes gris-jaunâtres) of BARRANDE's division (Králův Dvůr beds). MAREK (1951) found *Dalmanitina proeva grandis* in the Kosov beds, this being the uppermost member of the Upper Ordovician of Central Bohemia. An examination of quite a number of specimens of *D. proeva grandis* in the National Museum, as well as in the Geological Institute of the Charles University in Prague, has proved to me that *D. proeva grandis* (BARRANDE, 1852) is conspecific with *D. mucronata* (BRONGNIART, 1822). The differences between BARRANDE's three subspecies concerning the shape of the lateral glabellar furrows, the length of the eyes, type of ornamentation and the number of pygidial segments seem to be of specific and not subspecific rank.

Thus three dalmanitid species in the Ordovician of Bohemia can be recognized: *Dalmanitina socialis* (BARRANDE, 1846), *Dalmanitina proeva* (EMMRICH, 1839), *Dalmanitina mucronata* (BRONGNIART, 1822).

Dalmanitina olini TEMPLE, 1952

(pl. XIX, fig. 5-6; pl. XX, fig. 12, 13; comp. also pl. XIX, fig. 7-9, and pl. XX, fig. 1-4)

Discussion. — *Dalmanitina olini* from Sweden and Great Britain was described by TEMPLE (1952*a*). In the present paper I should like to mention its occurrence in Poland (locality of Stawy) already elsewhere cited (KIELAN, 1956, pl. 4, fig. 6-8) as *Dalmanitina* cf. *olini* TEMPLE. A more detailed examination of the Polish specimens and a comparison with those from Scandinavia, has shown that no morphological differences can be observed, and the Polish specimens may be identified as *Dalmanitina olini*. For this reason it is not considered necessary to describe it once more in the present paper.

It is worth mentioning, however, that *D. olini*, having a wide geographical distribution in the uppermost Ordovician (Great Britain, Scania, Poland), is not known from Bohemia.

In some layers of the *Dalmanitina olini* zone of Stawy (Poland), several early growth stages of a *Dalmanitina* were discovered. In the upper part of these beds *Dalmanitina mucronata* occurs together with *D. olini*. As it is not possible to say to which of these closely

related species the early growth stages belong, they are recorded here as *D. olini* or *D. mucronata*. In the lower part of these beds, however, there only *D. olini* occurs and in these beds larval stages were also found, belonging almost certainly to *D. olini*.

The ontogeny of *Dalmanitina olini* was first described by TROEDSSON (1918) and more recently by TEMPLE (1952*b*) in detail. As the Polish material is comparatively poorly preserved, and does not seem to add anything new to the ontogeny of this species, I do not consider it worth while to describe it once more in the present paper, referring the reader to TEMPLE's (1952*b*) description. I consider it, however, useful to figure some of the larval stages in question in the present paper (comp. pl. XX, fig. 1-4 and pl. XIX, fig. 7-9).

Subfamily PTERYGOMETOPINAE REED, 1905

Genus **LIOCNEMIS** nov.

Derivation of name: Liocnemis — λειοσ = smooth, χνημισ = cuish (cf. p. 69), with smooth thoracic pleurae.

Diagnosis. — Frontal lobe very large, longer than the remaining portion of glabella together with occipital ring. L_1 knob-shaped, similar to that in *Calliops*. L_3 three to four times shorter (long.) than frontal lobe. S_1 and S_2 deep, short (tr.); S_3 shallow, composed of two parts: outer — very shallow, thread-like, scarcely visible, subparallel to the dorsal furrow, and inner — directed nearly transversely (postero-medially) or transversely, forming an angle with outer part. Eyes very large, reaching backward to posterior border furrow. Short genal spines. Hypostome subquadrate with the anterior margin strongly curved. Narrow lateral borders and flat posterior border, wider (long.) in the middle part. Middle furrow short (tr.), deep, directed postero-laterally. Thoracic pleurae produced into short, thin, posteriorly directed spines. Pygidium of moderate size, rhachis narrow with 7-8 rings, 4-6 pleural segments. Posterior end of pygidium slightly pointed, directed upwards.

Occurrence. — Upper Ordovician (zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons*), Poland, Bornholm, Sweden (Scania and Västergötland).

Species:

Phacops recurvus LINNARSSON, 1869 — type species

Liocnemis concinnus n. sp.

Discussion. — The new genus is erected to include two Upper Ordovician species: *Liocnemis recurvus* (LINNARSSON), occurring in Scandinavia and Poland, and *L. concinnus* n. sp., known so far only from Poland. The genus most closely related to *Liocnemis* is *Calliops* DELO, 1935. *Liocnemis* differs from *Calliops* in having a larger and longer frontal lobe, and consequently a smaller third lateral glabellar lobe. The latter in *Calliops* is distinctly triangular, whereas in our genus its anterior and posterior boundaries are subparallel. S_3, which in *Calliops* is very distinct, deep and directed strongly obliquely (postero-laterally), in our genus is composed of two parts which form an angle. The outer part is scarcely visible in dorsal view and runs subparallel to the dorsal furrow, the clearly visible inner part is directed almost transversely. Moreover, the pygidium of the new genus is composed of a smaller number of segments than in *Calliops*.

DELO (1940) stated that *Calliops* occurs only in North America. It seems, however, highly probable to refer also some Upper Ordovician European species to this genus. For instance *Phacops ecclesiastica* OLIN, 1906, described by OLIN (*l. c.*, p. 43, pl. 1, fig. 6) from the *Tretaspis* beds of Scania, seems to belong to *Calliops*. On the other hand, it shows some similarities to *Liocnemis*, especially in the pygidial structure. This species is represented,

however, in the collections of OLIN by a single specimen and has never been found in other Upper Ordovician localities of Sweden, Bornholm or Poland, so that a more detailed comparison of it is difficult.

Liocnemis differs from the Middle Ordovician Estonian genus *Estoniops* MÄNNIL, 1958 (cf. MÄNNIL, 1958*a*) chiefly in having pointed genal angles (which in *Estoniops* are rounded) and a longer frontal glabellar lobe. The pygidium of *Liocnemis* is comparatively large and slightly pointed, whereas as stated by MÄNNIL (1958*a*, p. 388) in *Estoniops* it is: «short, with rounded posterior margin».

The hypostome of the genus is of pterygometopid type, differing from that in *Pterygometopus* SCHMIDT in having a less convex anterior margin, in being wider and having a deeper and shorter middle furrow.

Liocnemis recurvus (LINNARSSON, 1869)

(pl. IX, fig. 11-12; pl. XXI, fig. 8-11; pl. XXII, fig. 1-2; text-fig. 32)

1866. *Ogygia? apiculata* n. sp.; J. G. O. LINNARSSON, Om de Siluriska..., p. 20, pl. 2, fig. 5.
1869*a*. *Phacops recurvus* n. sp.; J. G. O. LINNARSSON, Diagnoses specierum novarum..., p. 191.
1869*b*. *Phacops recurvus* LINNARSSON; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 59, pl. 1, fig. 1-2.
1899. *Phacops recurvus* LINNARSSON; J. P. J. RAVN, Trilobitfaunaen..., p. 56.
1906. *Phacops recurva* LINNARSSON; E. OLIN, Om de Chasmopskalken..., p. 42, pl. 1, fig. 4 (non fig. 5).
1956. *Pterygometopus recurvus* (LINNARSSON); Z. KIELAN, On the stratigraphy..., pl. 2, fig. 4 (non fig. 2 and 3).

Material. — 3 entire individuals, 70 cephalons and pygidia from the zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland; several cranidia and pygidia from the Red *Tretaspis* beds of Västergötland and *Tretaspis* beds of Bornholm and Scania.

Dimensions of 6 specimens (in mm):

Locality	Brzezinki					Wólka
IG Mus. cat. no.	2. II. 84	2. II. 88	2. II. 83	2. II. 77	2. II. 86	2. II. 80
Length of entire individual	26.5	23.0	—	—	—	—
Length of cephalon	8.8	ca. 7.0	4.3	3.0	—	2.9
Width of cephalon	13.2	11.0	—	8.0	—	4.8
Length of anterior glabellar lobe	4.3	—	2.1	1.6	—	1.5
Width of anterior glabellar lobe	5.8	—	4.0	3.5	—	2.2
Length of pygidium	5.9	5.8	—	—	6.0	—
Width of pygidium	10.6	9.0	—	—	10.6	—

Description. — *Cephalon.* The outline is semicircular. The cephalon is moderately convex transversely as well as longitudinally. The dorsal furrows are very deep. From the occipital furrow to S_2 they run subparallel, converging slightly at L_2, so that the glabella is narrowest across this lobe, and then run anteriorly while diverging sharply. The anterior lobe is considerably more than half as long as the glabella. The occipital ring is wide in the middle part, narrowing at the dorsal furrows. The occipital furrow is transverse and moderately shallow in the middle, directed slightly anteriorly, and is very deep at the dorsal furrows. S_1 is directed transversely and is very deep, cutting about one-fourth of the glabellar width, then dividing into two branches; the first is very short, directed transversely (slightly

anteriorly), and another, which is very shallow, directed posteriorly, towards the occipital furrow, but not quite reaching this latter however. In such a way the distinct and convex basal lobes (L_1) are marked off from the rest of the glabella. S_2 is shallower than S_1, directed transversely and slightly anteriorly, cutting less than one-fourth of the glabellar width, S_3 is directed transversely, cutting more than one-fourth of the glabellar width. It is situated well behind the anterior base of the palpebral lobe. L_3 is one and half times as long as L_2.

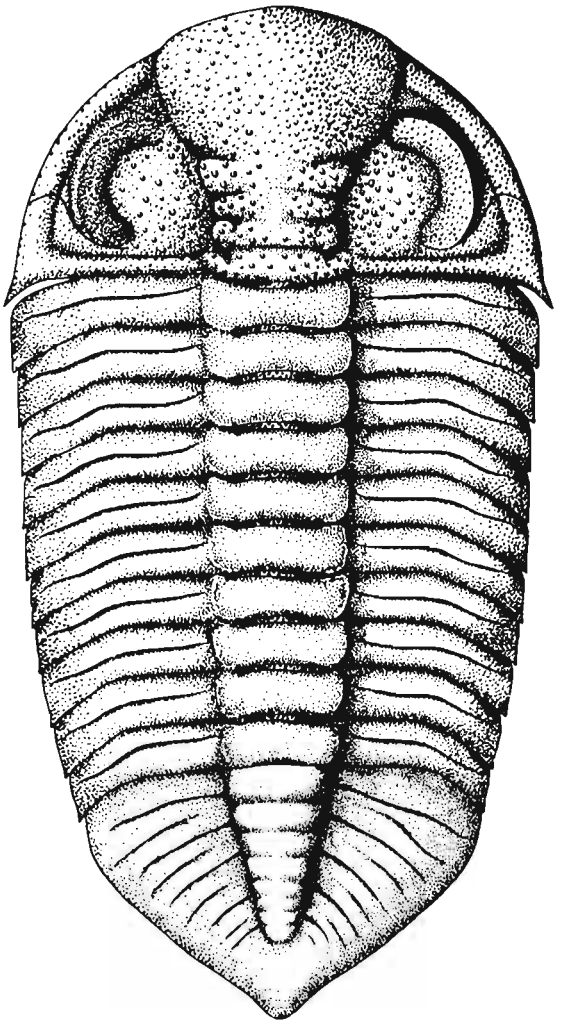


Fig. 32

Liocnemis recurvus (LINNARSSON) — reconstruction; approx. × 5.

The cheeks are large. The greatest part of the cheek is occupied by the large eye, which begins one-third of the way down of the frontal lobe and reaches far back to the posterior furrow. The palpebral lobe is semilunar, delimited from the rest of the cheeks by a deep furrow, the visual lobe is not preserved in any of the specimens. The posterior border is very narrow (long.) at the dorsal furrows, increasing greatly in length peripherally. The posterior border furrow becomes shallower peripherally. The lateral border is wide and moderately convex, delimited by a shallow lateral border furrow. The posterior and lateral borders on meeting are produced into a very short and thin postero-laterally directed spine. The spine is only rarely preserved — in the majority of specimens it is broken off and the cheek gives the false impression that it is rounded. The facial suture cuts the lateral border fairly far in front of the genal spine, at first it runs antero-medially, and then in a very strongly sigmoid arch postero-medially, to the posterior base of the eye, around the palpebral lobe, along the dorsal furrow and around the glabella. The free cheek is very small, being composed of the eye and the lateral border.

Thorax is composed of ten segments. In transverse profile the rhachial segments are strongly convex, forming a semicircle, the dorsal furrows are deep, and the pleurae run at first transversely and then strongly slope down. The rhachis converges slightly posteriorly. The rhachial rings are differentiated to form small rounded lobes. The pleurae are directed transversely and horizontally two-thirds of the way down the transverse length, then they bend backwards and downwards. They are produced into short thin spines, reaching back to half the length of the following segment. Each pleura is divided into two triangular parts by a pleural furrow directed postero-laterally, running obliquely through every pleura.

Pygidium. The length of the pygidium is about three-fourths that of the cephalon. The outline of the pygidium is sub-semicircular. The rhachis is long, slightly converging posteriorly,

composed of 8 segments. Some of the first rhachial segments are well defined, but the furrows between the posterior segments are preserved only at the dorsal furrows. On the pleurae there are 5-6 segments. The pleural furrows are deep cutting two-thirds of the pleural width, the interpleural furrows are shallow and indistinct at the dorsal furrows, deeper peripherally, and cut the pleurae rather more peripherally than the pleural furrows. The border is marked only through the absence of the pleural and interpleural furrows. There is, however, no border furrow. The very posterior part of the pygidium behind the rhachis is pointed, directed slightly upwards.

Ornamentation. The whole cephalic surface is densely covered by various sized tubercles. The tubercles are larger on the posterior part of the glabella and on the part of the fixed cheek, situated between the dorsal furrow and the eye. These larger tubercles are situated in such a way, that there are 6 of them at the basal lobe. On the posterior part of the glabella and on the fixed cheeks there are, however, smaller granules among them. Anteriorly on the glabella the tubercles become gradually smaller and more densely spaced. They are very small on the peripheral part of the fixed cheek and on the free cheek. The whole thoracic and pygidial surface is covered by minute tubercles.

Discussion. — I could not find the original specimen (the cephalon) of *Phacops recurvus* LINNARSSON, 1869 (1869*b*, pl. 1, fig. 1) in the Museum of SGU, neither in any other museum in Sweden. There are, however, in the collections of the Swedish museums several specimens of this species from the Red *Tretaspis* beds of Västergötland, which without doubt may be considered as conspecific with LINNARSSON's type specimen. In all of them the S_3 is shaped as described above (the latter feature being the chief difference between *Liocnemis recurvus* and *L. concinnus*). Thus, all the Scandinavian specimens of *Liocnemis* are recorded here as belonging to *Liocnemis recurvus* LINNARSSON.

The pygidium figured by OLIN (1906, pl. 1, fig. 5) as *Phacops recurvus* differs from the other representatives of this species from Scandinavia and Poland in having a shorter, parallel-sided and truncated transversely rhachis. It is probable that this pygidium is not conspecific with *L. recurvus*, although it may belong to the genus *Liocnemis*. For comparison with *Liocnemis concinnus* see p. 125.

Liocnemis concinnus n. sp.

(pl. IX, fig. 10; pl. XXII, fig. 3-7; text-fig. 33)

1956. *Pterygometopus recurvus* (LINNARSSON); Z. KIELAN, On the stratigraphy..., pl. 2, fig. 2, 3 (non fig. 4).

Holotype: Cephalon and fragmentary thorax, figured on pl. IX, fig. 10.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: concinnus — fine, is an allusion to the fine ornamentation of the cephalon.

Diagnosis. — Comparatively large individuals, up to 30 mm long. L_3 relatively large, triangular, inner branch of S_3 beginning at dorsal furrow, opposite anterior edge of palpebral lobe. Very small tubercles covering the whole cephalon, 14-16 tubercles on the basal lobe of glabella. On anterior part of glabella tubercles very closely spaced.

Material. — One almost complete specimen, 8 more or less fragmentary cephalons, from the zone of *Staurocephalus clavifrons* of Brzezinki, Poland.

Dimensions of 3 specimens (in mm):

Locality	Brzezinki		
IG Mus. cat. no.	2. II. 173	2. II. 172	2. II. 178
Length of cephalon	8.7	7.2	7.8
Width of cephalon	—	13.5	—
Length of frontal lobe	4.9	3.3	4.1
Width of frontal lobe	7.2	6.1	6.6

Description. — *Cephalon* is semicircular in outline, transversely and longitudinally moderately convex. The dorsal furrows are deep; running from the occipital furrow they converge slightly anteriorly, and then diverge strongly. At the level of L_2 the width of the dorsal furrows increases greatly, so that the minimum width of the glabella is across this lobe. The occipital ring is comparatively narrow at the dorsal furrows and it widens (long.) to almost double its length in the middle part. The occipital furrow is deep at the dorsal furrows (behind the basal lobes), shallows and swings forward in the middle part. S_1 is deep, directed transversely, cutting one-sixth of the glabellar width it divergences into two branches; the first being its continuation, directed inwards, slightly anteriorly, the second directed posteriorly, towards the occipital furrow, but not however reaching the latter. The basal lobes cut off in such a way are rounded and strongly convex. S_2 shallower than S_1, is directed laterally, slightly anteriorly, cutting one-fourth of the glabellar length. S_3 the shallowest, composed of two parts. The first runs as a shallow, almost invisibile furrow along the inner border of the dorsal furrow. At the level of the anterior base of the palpebral lobe it bends inwards and runs as a shallow furrow, directed transversely, slightly posteriorly, cutting about one-third of the glabellar length.

The posterior border at the dorsal furrow is much narrower than the occipital ring, it widens greatly peripherally. The cheeks are large, the greatest part of the cheek being occupied by the eye, which begins at S_3 and extends far back to the posterior furrow. The palpebral lobe is lunar-shaped, delimited by a distinct furrow; the visual lobe is not preserved. The lateral border is wide being delimited by a shallow furrow. The genal spine is not preserved, it is however probable that the genal angle is produced into a spine, similar to that in *Liocnemis recurvus*. The course of the facial suture is identical with that of *L. recurvus*.

Hypostome is subquadrate in outline, with the anterior margin strongly curved. There is no anterior furrow. The anterior wings are large and triangular. The lateral borders are narrow and convex, parallel to each other, with deep lateral furrows. The posterior border is flat, wider (long.) in the middle part, narrowing at sides. The posterior furrow is shallow in the middle part, deepening peripherally. The middle furrow is deep at the lateral furrow, shallowing interiorly, commencing at a point about half the hypostomal length and running diagonally inwards and backwards, cutting about one-sixth of the hypostomal width on each side.

Thorax. On the rhachial rings there is a transverse furrow dividing it into a narrow (long.) articulating half-ring and a more convex, wider posterior part. The thoracic pattern seems to be identical with that described in *L. recurvus*.

Pygidium is incompletely known, only in one specimen it is preserved together with the thorax. It seems to be identical with that of *L. recurvus*, so that the correct identification of isolated pygidia can hardly be done.

Ornamentation is composed of small tubercles apparently densely covering the whole body. On the glabella the tubercles are especially closely set on the frontal lobe, they are more

scattered on the posterior part of the glabella and on the cheeks. On the basal lobe there are 14-16 tubercles. The tubercles of the anterior part of the glabella are smaller than those of the posterior part, this difference not being very marked. On the thorax, especially well preserved minute granulations have been observed on the articulating half-rings of two specimens. Otherwise, the whole thoracic and pygidial surface seems to be minutely granulated. On the internal moulds the ornamentation is usually not preserved — it has been observed from the latex casts of natural impressions.

Discussion. — *Liocnemis concinnus* n. sp. is known so far only from the zone of *Staurocephalus clavifrons* of Poland, where it occurs together with *L. recurvus*. It is interesting that the latter species has been yielded also by the lower beds (zone of *Eodindymene pulchra*, Brzezinki section). The chief difference between the two species lies in the shape of L_3 and S_3. *L. concinnus* n. sp. has a larger (long.) and more triangular third lateral glabellar lobe than *L. recurvus*. In the course of S_3 in *L. recurvus* there is a very distinct angle between the outer and inner parts of the furrow, and the inner part runs transversely. In *L. concinnus* the inner part of the furrow is directed almost transversely, with a slight declination backwards, and the angle between the two parts of the furrow is more obtuse. In *L. concinnus* S_3 begins at the dorsal furrow, opposite the anterior edge of the palpebral lobe, whereas in *L. recurvus* it lies more posteriorly, almost opposite the middle of the palpebral lobe. Further differences are in the type of ornamentation, which in *L. concinnus* is more delicate being composed of smaller and more uniform sized tubercles. In *L. recurvus*, on the contrary, the tubercles, especially those of the posterior part of the glabella, are greater and there are smaller granulations among them. There are about 6 tubercles on the basal lobe in *L. recurvus*, compared to 14-16 in *L. concinnus*. Moreover the average size of specimens of *L. concinnus* is greater than in *L. recurvus*, although quite large specimens of *L. recurvus* do occur.

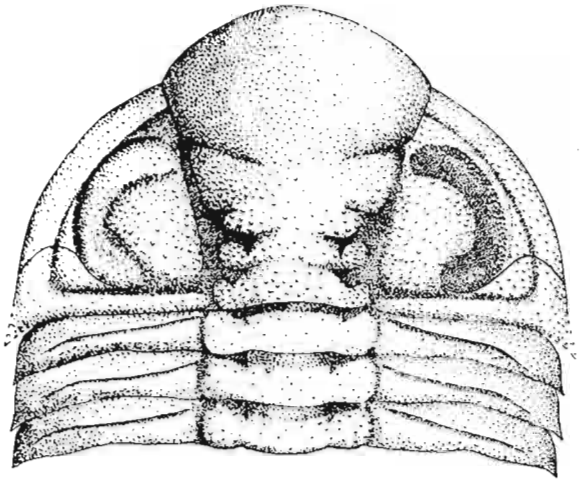


Fig. 33

Liocnemis concinnus n. sp. — reconstruction of the cephalon and three thoracic segments; approx. × 4.5.

Family **PLIOMERIDAE** (RAYMOND, 1913)

Subfamily PLACOPARINAE HUPÉ, 1953

Genus **PLACOPARIA** HAWLE & CORDA, 1847

Subgenus PLACOPARIA (HAWLEIA) PRANTL & ŠNAJDR, 1957

Placoparia (Hawleia) prantli n. sp.

(pl. XXIII, fig. 4-6; text-fig. 34)

Holotype: Cranidium figured on pl. XXIII, fig. 6.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: prantli — in honour of distinguished Chech palaeontologist Doc. Dr. F. PRANTL.

Diagnosis. — Length of the frontal glabellar lobe slightly exceeding half that of the glabella. The lateral glabellar furrows (S_1 and S_2) cutting only one-fourth of the glabellar width, directed transversely, S_3 directed postero-laterally. The third lateral glabellar lobe (L_3) large and long, its length being more than one-fourth that of the glabella. Free cheeks and hypostome unknown. Fixed cheeks, thorax and pygidium as in *Placoparia (Hawleia) grandis*. The whole body surface covered with minute pits.

Material. — Two cranidia, a fragmentary thorax with pygidium, one strongly depressed pygidium. All the specimens are from the *Staurocephalus clavifrons* zone, of Brzezinki, Poland.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	
IG Mus. cat. no.	2. II. 238	2 .II. 236
Length of cranidium	18.0	13.0
Width of glabella at the base	11.0	8.5
Length of L_3	4.0	2.9

Description. — *Cephalon.* The dorsal furrows are very wide and moderately deep, diverging anteriorly. At the level of the second lateral lobe, the width of the dorsal furrows increased to one and a half width at L_1 and L_3. Two first lateral glabellar furrows S_1 and S_2 are directed almost entirely transversely, but slightly posteriorly, and they cut one-fourth of the glabellar width. The third lateral furrow (S_3) is directed postero-medially. The first lateral lobe L_1 is short (long.), L_2 — longer, the length of the L_3 being twice that of L_1. The frontal lobe is large and long, its length being more than a half that of the glabella. The occipital furrow is wide (long.), but much narrower than the dorsal furrows. The occipital ring is wide (long.) and flat.

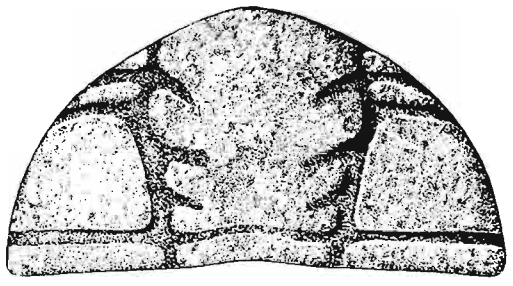


Fig. 34

Placoparia (Hawleia) prantli n. sp. — reconstruction of the cranidium; approx. × 2.

The cheeks are incompletely preserved. The posterior furrow, running as a continuation of the occipital furrow, is slightly wider (long.) than the latter. The posterior border is almost flat, its width (long.) increasing towards the periphery. There is a cheek ridge running from the dorsal furrow at the level of third lateral glabellar lobe, transversely across the anterior part of the cheek. It is slightly convex anteriorly and delimited by two wide and distinct cheek furrows. Both cheek, ridge and the furrows delimiting it, disappear at the border furrow. In the dorsal furrow, at the anterior cheek furrow, there is round and distinct anterior pit.

Thorax is incompletely preserved. The dorsal furrows are very wide. The rhachial rings are convex (long.) with deep furrows between them, in the middle part they are slightly convex anteriorly. The pleurae are convex, transversely directed, with their ends being rounded.

Pygidium. The rhachis form a triangle strongly tapering posteriorly. It is composed of 5 convex rings with deep furrows among them. There are 4 convex pleural segments, strongly widening towards the periphery. The fourth pleura is a triangle fitting tight to the end of the rhachis.

Ornamentation. The whole body is densely covered by minute pits.

Discussion. — The different representatives of the genus *Placoparia* HAWLE & CORDA have in the Lower and Middle Ordovician a wide geographical distribution, being known from the Llanvirnian and Llandeilo of Bohemia (STERNBERG, 1825; HAWLE & CORDA, 1847; BARRANDE, 1852, 1872; KLOUČEK, 1919; BOUČEK, 1926; NOVÁK, 1884*b*; PRANTL & ŠNAJDR, 1957), from France (ROUAULT, 1847), Spain (DELGADO, 1892) and Great Britain (HICKS, 1875; REED, 1898*a*, 1898*b*; SHIRLEY, 1931; WHITTARD, 1940, 1958). PRANTL and ŠNAJDR (1957) recognized within the genus *Placoparia* two subgenera: *Placoparia (Placoparia)* HAWLE & CORDA and *P. (Hawleia)* PRANTL & ŠNAJDR, *P. grandis* HAWLE & CORDA being the subgenotype of the latter subgenus. The new species described above shows very great similarities to *P. (Hawleia) grandis*, known from the Llandeilo of Bohemia, and is the second species recorded to this subgenus.

P. (Hawleia) prantli n. sp. is the only species of *Placoparia*, known so far from the Upper Ordovician. The similarities between two species in question are very great. The differences seem to concern only the type of ornamentation. All the specimens of *P. (Hawleia) grandis*, I have examined in the National Museum in Prague, are preserved as internal moulds. Nevertheless, an indistinct ornamentation of comparatively large pits is preserved on the cheeks of one of them (comp. BARRANDE, 1872, pl. 8, fig. 43). On the latex casts of the specimens from the Holy Cross Mountains, I could observe an ornamentation of very small pits, densely covering the whole cephalon (comp. pl. XXIII, fig. 3). The further differences are in the proportions of the cephalon. The lateral glabellar furrows are longer (tr.) in *P. grandis* than in the new species, cutting one-third of the glabellar width (one-fourth in our spec es). The third lateral glabellar furrow (S_3) seems to be more bent in its course in *P. grandis*, and the third lateral glabellar lobe and the frontal lobe shorter (long.) than in our species. The width of the pygidial rhachis seems to be wider in our species than in *P. grandis*, but this may be caused by the state of preservation. Otherwise the two species show a very great similarities and one can probably envisage the evolution of *Placoparia (Hawleia) prantli* from its presumable Middle Ordovician ancestor — *Placoparia (Hawleia) grandis*.

Family **CHEIRURIDAE** HAWLE & CORDA, 1847

Subfamily CHEIRURINAE RAYMOND, 1913

Genus **CERAURINELLA** COOPER, 1953

Ceraurinella intermedia (KIELAN, 1955)

(pl. XXIII, fig. 2, 3)

1906. *Cheirurus insignis* BEYRICH; E. OLIN, Om de Chasmopskalken..., p. 45, pl. 1, fig. 8.
1955. *Ceraurus intermedius* n. sp.; Z. KIELAN, A new trilobite..., p. 65, text-fig. 1; pl. 1, fig. 1-8; pl. 2, fig. 1-6.

Description. — *Ceraurinella intermedia* (KIELAN) from Poland has been described (KIELAN, 1955) in detail. An examination of the entire collection of trilobites from the zones of *Eodindymene pulchra* and of *Staurocephalus clavifrons* of Brzezinki and Wólka has resulted in the discovery of the hypostome of *Ceraurinella intermedia*, which has not been described before.

Hypostome is suboval in outline, the middle body being strongly convex and undivided by a middle furrow, wider in the anterior part, narrowing posteriorly. There are very small

and indistinct maculae in the posterior part, visible only under large magnification. The anterior margin is very convex, there is no anterior border in the middle part. On the sides there is an anterior border widening laterally, and produced into triangular anterior wings, directed postero-laterally. There is a very deep incision on the lateral margin between the lateral border and anterior wing. The lateral and posterior borders are comparatively wide and slightly convex, delimited by fairly deep and wide posterior and lateral furrows. The postero-lateral corners of the hypostome form angles, without being however produced into spines. The entire hypostomal surface is granulated. The doublure is not preserved.

Discussion. — Prof. H. B. WHITTINGTON has drawn my attention (personal communication) to the fact, that *Ceraurus intermedius* shows some similarities to *Ceraurinella* COOPER (comp. COOPER, 1953) and ought probably to be placed within this genus. The hypostome of this species, not known before, described above seems to be also more like that of *Ceraurinella* than *Ceraurus* (comp. hypostomes of *Ceraurinella typa* COOPER, and *Ceraurinella chondra* WHITTINGTON & EVITT, in WHITTINGTON & EVITT, 1954, and a hypostome of *Ceraurus pleurexanthemus* GREEN, in RAYMOND & BARTON, 1913, and EVITT, 1953) and this species is therefore placed now in the genus *Ceraurinella*.

It is also worth mentioning that some representatives of *Ceraurinella* were recently (MÄNNIL, 1958*b*) recorded from the Middle Ordovician of Estonia.

Genus **CERAURUS** GREEN, 1832

Ceraurus? sp.

(pl. XXI, fig. 4-7; text-fig. 35)

Material. — 8 cranidia from the *Staurocephalus clavifrons* zone of Brzezinki, Poland.

Dimensions of 5 specimens (in mm):

Locality	Brzezinki				
IG Mus. cat. no	2. II. 356	2. II. 355	2. II. 352	2. II. 354	2. II. 353
Length of cephalon	1.5	1.7	1.9	2.2	6.2
Width of cephalon	2.1	3.5	4.0	—	—
Length of glabella	1.2	1.5	1.6	1.8	4.3
Greatest width of glabella	0.6	1.0	1.3	1.6	4.4
Length of genal spine	0.6	—	0.7	—	—

Description. — *Cranidium.* The dorsal furrows are deep. From the occipital furrow they run parallel and form an arch in front of the glabella. In the longitudinal section the glabella is highly convex, the highest point being between the second and the third lateral glabellar furrow. In the transverse section the glabella forms a semicircle. There are three lateral glabellar furrows. The first (S_1) is the deepest, directed postero-laterally, becoming shallower in front of the occipital furrow, but not reaching the latter. The first lateral glabellar lobe (L_1) forms a triangle. The second and the third lateral glabellar furrows are shallower, cutting less than one-fourth of the glabellar width; S_2, being directed transversely and slightly posteriorly, while S_1 is directed entirely transversely. The occipital ring is slightly convex. The occipital furrow is moderately deep, deepening at the dorsal furrows.

The cheeks are as wide as the glabella. The posterior border is more strongly convex than the occipital ring. It is narrow (long.) at the dorsal furrow, becoming shallower peripherally. The posterior furrow is deep at the dorsal furrow and shallower peripherally. The lateral border (as preserved on the fixed cheek) is flat. The genal angle is produced into a long, postero-laterally directed genal spine. On the margin of the fixed cheek, in front of the genal spine, in young forms, there is a second spine much shorter than the genal spine, directed transversely. The facial suture cuts the lateral margin obliquely in front of the second lateral spine, then runs in a subparallel manner to the posterior cephalic margin, slightly anteriorly, to reach the small palpebral lobe, situated on the level of the second lateral glabellar furrow. Then it runs, parallely to the dorsal furrow, to the anterior cephalic margin. The anterior branch of the facial suture, between the eye and the anterior cephalic margin, curves twice, forming two small arches, concave exteriorly. There is a wide (long.), flat anterior border in front of the glabella, the anterior margin of which forms a transverse line.

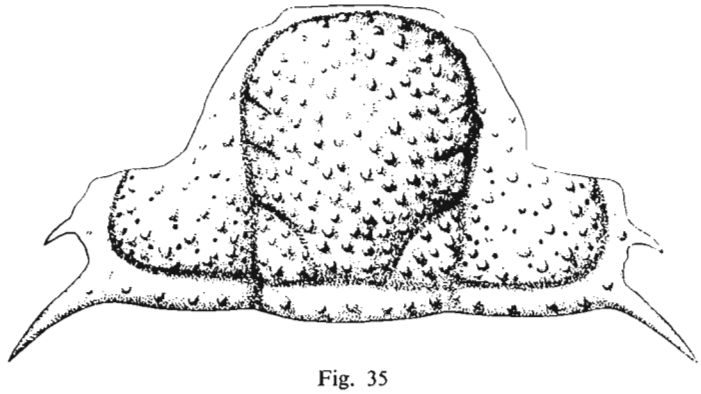


Fig. 35

Ceraurus? sp. — reconstruction of the young cranidium; approx. × 20.

The smallest specimen of *Ceraurus?* sp. has a cephalon 1.5 mm long, the greatest 6.2 mm long. There are few specimens intermediate between these two forms. The changes in ontogenetic development, which may be observed on them, concern chiefly the shape of the cephalon, which becomes comparatively wider, and that of the glabella. The lenght to width ratio of the glabella of the smallest specimen (1.5 mm cephalic length) is 2.0, at the cephalic length of 1.9 mm it amounts to 1.2, and at the cephalic length of 6.2 mm it amounts to 0.9 — the glabella becoming slightly wider. The genal spine, comparatively long in small forms (0.6 mm at 1.5 mm of the cephalic length) remains almost the same length (0.7 mm) at 1.9 mm of the cephalic length. It is not preserved in larger specimen. The short additional spine, occurring in front of the genal spine, becomes smaller in the ontogenetic development, unfortunately the cheek border is not preserved in the larger forms, where it is probably entirely reduced.

Ornamentation. The whole cephalic and the posterior part of the cheek's surface is covered by different sized, conspicuous tubercles. On the L_1 there are about 10 tubercles. The very anterior part of the fixed cheek, in front of the level of the third lateral glabellar furrow, is smooth. Among the tubercles on the fixed cheeks are small pits. There are similar pits on the occipital ring and on the posterior border.

Discussion. — The generic attribution of the species here described creates some difficulties, and it has been recorded as belonging to *Ceraurus* with some hesitation. It has a more convex glabella than the other representatives of *Ceraurus*, and in this it shows some similarity to *Pseudosphaerexochus*. The basal glabellar lobes are here triangular, as is characteristic of *Cheirurus*, while they are subquadrate in *Ceraurus*. The width of the glabella is equal to that of the cheek and in this character the species is intermediate between *Ceraurus* and *Cheirurus*. The coarse granulation is characteristic of *Ceraurus*, but the type of ornamentation of the cheeks (pits among the tubercles) is like that of the many representatives of *Pseudosphaerexochus*

(for instance *Pseudosphaerexochus wolkae* n. sp. described in this paper). It is similar to *Pseudosphaerexochus* in the shape of the anterior border and the course of the anterior branch of the facial suture. On account of the shape of the glabella it cannot be identified as *Pseudosphaerexochus*, and therefore I recorded it as *Ceraurus?* sp. The question may be cleared up only when the remaining parts of the exoskeleton of this species are found.

Subfamily CYRTOMETOPINAE Öpik, 1937

Genus **ACTINOPELTIS** Hawle & Corda, 1847

See discussion on p. 49-51.

Actinopeltis barrandei n. sp.

(text-fig. 8*d*)

1872. *Cheirurus insocialis* n. sp.; J. Barrande, Système Silurien..., Suppl., p. 89, pl. 7, fig. 15-18.

Holotype: Entire specimen figured by Barrande (1872, pl. 7, fig. 15-18).
Type horizon and locality: Upper Ordovician, Králův Dvůr beds, Lejškov, Bohemia.
Derivation of name: barrandei — in memory of great Bohemian palaeontologist Joachim Barrande.

Diagnosis. — Glabella is very strongly convex (long.) and comparatively narrow. The fixed cheeks are relatively large (long.). Eyes are very small, situated opposite to S_2. The glabellar surface is minutely granulated, the cheeks pitted. Hypostome is unknown. Pygidium is of an actinopeltid type with 4 pairs of short, wide, lanceolate-shaped and slightly pointed spines.

Discussion. — The new species is erected to include Bohemian specimens from the Králův Dvůr beds (but not the locality of Kosov), recorded by Barrande (1872) as *Actinopeltis insocialis*. The table 5 gives a comparison of *Actinopeltis insocialis* (Barrande, 1852) and a new species.

Table 5

Comparison of *Actinopeltis barrandei* n. sp. and *A. insocialis* (Barrande, 1852)

	Actinopeltis barrandei n. sp.	*Actinopeltis insocialis* (Barrande, 1852)
Eyes	Very small (long.), situated far forward, opposite to S_2.	Longer, situated further backward, opposite to L_2.
Fixed cheeks	Large (long.)	Narrow (long.).
Genal angles	Pointed, forming very short spine.	Rounded.
Pygidial spines	Situated distinctly from each other, narrower at the base, lanceolate-shaped, with pointed ends.	Adhering to each other, lobate like, broadly rounded at the ends.

Actinopeltis cf. **gryphus** (BARRANDE, 1872)

(pl. XXIV, fig. 3)

Material. — One pygidium from the *Staurocephalus clavifrons* zone, Wólka, Poland.

Dimensions (in mm):

Locality	Wólka
IG Mus. cat. no.	2. II. 357 a
Length of pygidium without spines	3.0
Width of pygidium without spines	8.2
Width of rhachis	3.1

Description. — The rhachis is composed of 4 rings, the first of which is convex and directed transversely, wider (long.) at the dorsal furrows, than in the middle part. The other rhachial rings are curved forward, the posterior one forming a strong arch. The furrows between the rings are deeper at the dorsal furrows, than in the middle part. Posterior to the fourth ring there are two symmetrical pits, forming the posterior boundary for this ring. There are 3 pleural segments with distinct furrows between them. On the first and second segments there is a faint interpleural furrow. The pleural segments are produced into wide, arched spines, directed postero-laterally and curved forward. The fourth pair of spines lies in the continuation of the fourth rhachial segment. The posterior pair of spines is shorter than the others. In the proximal part, every spine is slightly thinner, than in the distal part. On the pleurae and spines there are traces of ornamentation of small tubercles.

Actinopeltis cf. **globosa** (BARRANDE, 1852)

(pl. XXIV, fig. 1-2)

Material. — One cranidium and one pygidium from the *Staurocephalus clavifrons* zone, Brzezinki, Poland.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	
IG Mus. cat. no.	2. II. 331 a	2. II. 330
Length of cephalon	2.7	—
Length of genal spine	1.1	—
Length of pygidium with spines	—	8.0
Length of pygidium without spines	—	4.6
Width of pygidium without spines	—	11.7
Width of rhachis	—	4.1

Description. — *Cranidium.* The dorsal furrows are deep and wide. They run from the occipital furrow to the first lateral glabellar furrow subparallel, and then swing outwards

around the strongly convex glabella. The first lateral glabellar furrow is deep at the dorsal furrows and shallower before reaching the occipital furrow. It is directed postero-laterally, cutting off the triangular and convex first lateral lobe. The second and third furrows are preserved as faint imprints, directed transversely. The occipital ring is narrow (long.) and convex. The occipital furrow is narrow in the middle part, deeper at the dorsal furrows. In the longitudinal profile the occipital ring is narrow, the occipital furrow deep and narrow, and the glabella highly convex, overhanging the anterior margin of the cephalon. The palpebral lobes are large, being as long as the second glabellar lobe. The facial suture cuts the lateral border, runs transversely subparallel to the posterior cephalic margin to the eye, then around the palpebral lobe and then parallel and quite close anteriorly to the dorsal furrow. The posterior border is narrow, the posterior border furrow being wider than it. The lateral border is wider than the posterior. The genal angle is produced into a comparatively long, postero-laterally directed spine. On the surface of the cheek there are large shallow pits. No ornamentation is preserved on the glabella.

Pygidium. The outline is semicircular. The rhachis is slightly wider than one-third of the pygidial width. The dorsal furrows are deep. There are 4 distinct rhachial rings, which are wide at the dorsal furrows and narrower (long.) in the midline. The fourth ring is strongly arched anteriorly. There are 3 flat pleural segments, widening peripherally. There are 4 pairs of pygidial spines. The spines are short, wide, lobate-shaped, slightly convex anteriorly. The first is situated transversely, in the continuation of the first pleura, the other postero-laterally; the last pair being the shortest, directed posteriorly.

Discussion. — The cranidium and pygidium here described show some similarities with *Actinopeltis globosa* from Bohemia, and therefore are described here together. The cranidium differs from that of *A. globosa* from Bohemia in having slightly shorter and less conspicuous genal spines. The pygidium differs from the pygidia of Bohemia in having wider spines.

Actinopeltis sp. **a**

(pl. XXIV, fig. 4; text-fig. 36)

Material. — Two pygidia from the *Staurocephalus clavifrons* zone, Brzezinki, Poland.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	
IG Mus. cat. no.	2. II. 320	2. II. 332 b
Length of pygidium with spines	1.3	3.4
Length of pygidium without spines	0.76	2.0
Width of pygidium with spines	3.6	6.8
Width of pygidium without spines	1.8	4.4
Width of rhachis	0.8	1.8
Length of second spine	1.1	—

Description. — The outline of the pygidium is wider than a semicircle. The rhachial furrows are deep, the rhachis strongly convex. The rhachial rings are narrow (long.) in the

middle part, wider at the dorsal furrows. The first ring is directed transversely, the other convex forward in the middle part, the fourth being very strongly convex. The outer margin of the pleurae is situated higher than the inner part. There are 3 distinct pleural segments on the pleurae, with deep furrows between them. The pleural segments are produced into long, arched spines. The first spines are directed postero-laterally, the posterior ones — posteriorly. The fourth pair of spines lies in the continuation of the rhachis and is shorter than the other spines. The whole pygidial surface is densely covered by minute granulation.

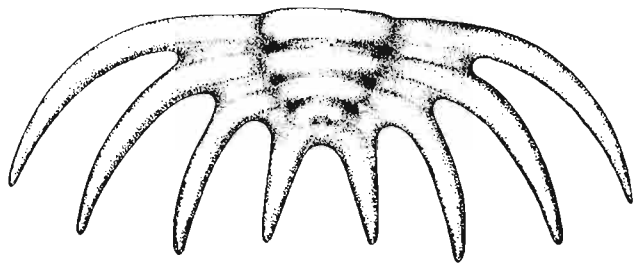


Fig. 36

Actinopeltis sp. *a*, pygidium — drawing based on specimen from Brzezinki (IG no. 2. II. 320); approx. × 24.

Discussion. — The general pattern of the pygidium described above is of an *Actinopeltis* type. It differs from the representatives of this genus, as for instance *A. gryphus*, *A. globosa*, *A. completa*, in having much longer and thinner spines, the length of which exceeds that of the pygidium. It belongs evidently to a new species of *Actinopeltis*, the errection of which, however, requires more material.

Actinopeltis sp. **b**

(pl. XXIII, fig. 7)

Material. — 3 pygidia from the *Staurocephalus clavifrons* zone, Brzezinki and Wólka, Poland.

Dimensions (in mm):

Locality	Wólka
IG Mus. cat. no.	2. II. 333
Length of pygidium with spines	6.7
Width of pygidium without spines	8.7
Width of rhachis	3.3

Description. — The outline of the pygidium is semicircular. The rhachial width is more than one-third that of the pygidium. There are 4 rhachial rings: the first three directed transversely, the fourth strongly arched anteriorly. There are 3 pleural segments on the pleurae, with distinct furrows between them. There are 4 pairs of arched, relatively slender, long spines, the first pair being directed transversely, the other — postero-laterally. The whole pygidial surface is covered with small granules.

Discussion. — The pygidium here described resembles that of *Actinopeltis completa* Barrande, but differs from the latter in having slightly longer spines. On the other hand, the pygidial spines are here wider and shorter than those of *Actinopeltis* sp. *a*, here described, and thus the pygidium shows the intermediate characters between *Actinopeltis* sp. *a* and *Actinopeltis completa*. It is important to note that *A. completa* is the oldest known representative of this

genus, appearing in the Middle Ordovician. Both pygidia here described, *Actinopeltis* sp. *a* and *Actinopeltis* sp. *b*, resemble *A. completa* in some ways, differing from the Upper Ordovician Bohemian representatives of this genus in having slender and longer pygidial spines, and showing in this respect primitive characters.

Genus **PSEUDOSPHAEREXOCHUS** SCHMIDT, 1881

Pseudosphaerexochus octacanthus (ANGELIN, 1854)

(pl. XXV, fig. 7)

1854. *Cyrtometopus octacanthus* n. sp. partim; N. P. ANGELIN, Palaeontologia Scandinavica, p. 36 (pygidium only), pl. 22, fig. 6a (non fig. 6).

Lectotype: Pygidium figured by ANGELIN (1854, pl. 22, fig. 6a), refigured in the present paper — pl. XXV, fig. 7.
Type horizon and locality: Middle Ordovician, *Chasmops* limestone, Kinnekulle, Västergötland, Sweden.

Material. — One pygidium - lectotype.

Description. — The width of the rhachis is greater than one-third of the pygidium. The rhachis tapers slightly posteriorly. There are three wide (long.) rhachial rings, the third one delimited posteriorly by two transversely directed pits. Three flat pleurae are scarcely distinguishable, the first one being directed transversely, the two others — postero-laterally. There are 4 pygidial spines, the first three are prolongations of the pleurae, the fourth — a prolongation of the rhachis. The spines are flat, broad, lanceolate-shaped, narrower at their base than in the middle part. Each spine is divided by a longitudinal furrow into two parts. The first three pairs of spines are directed postero-laterally, the last one — posteriorly. The fourth pair is shorter than the third. No traces of ornamentation are preserved.

Discussion. — ANGELIN (1854, p. 36, pl. 22, fig. 6) figured a cranidium and pygidium from the *Chasmops* limestone of Kinnekulle, Västergötland, described by him as *Cyrtometopus octacanthus* n. sp. The original specimen of the cranidium figured by ANGELIN is so poorly and incompletely preserved, that it cannot be identified at all. The well preserved pygidium is refigured in the present paper. *Pseudosphaerexochus octacanthus* does not occur in Poland, but there occurs in Poland in higher layers (*Staurocephalus clavifrons* zone) a related species *Pseudosphaerexochus wolkae* n. sp. Therefore, I have considered it desirable to redescribe *P. octacanthus* in the present paper.

Pseudosphaerexochus wolkae n. sp.

(pl. XXIV, fig. 5; pl. XXV, fig. 1-2; text-fig. 37)

Holotype: Cranidium figured on pl. XXV, fig. 2.
Type horizon and locality: Upper Ordovician, *Staurocephalus clavifrons* zone, Wólka, Poland.
Derivation of name: wolkae — from the type locality Wólka.

Diagnosis. — Dorsal furrows slightly diverging anteriorly. Basal lobes (L_1) very distinctly marked off. Fixed cheek large, long, genal spine situated a little internally to the genal angles, on the posterior border. Free cheeks, eyes and hypostome unknown. Pygidium with two distinct rhachial rings and the third marked by the presence of two transverse pits on its posterior border. Four pairs of broad, convex spines. The fourth pair shorter than the third. The whole

exoskeleton surface covered by large and small, sharply pointed tubercles, with small pits among them on cheeks.

Material. — One cranidium from the *Staurocephalus clavifrons* zone of Wólka, one almost entire specimen very poorly preserved, five pygidia from the same zone of Brzezinki, Poland.

Dimensions of 3 specimens (in mm):

Locality	Wólka	Brzezinki	
IG Mus. cat. no.	2. II. 160	2. II. 161	2. II. 318
Length of entire individual	—	ca. 10.3	—
Length of cephalon	5.7	—	—
Width of glabella	5.6	—	—
Length of pygidium with spines	—	1.6	2.5
Width of pygidium with spines	—	3.2	—
Width of rhachis	—	1.2	2.0

Description. — *Cephalon.* The dorsal furrows are very deep, slightly diverging anteriorly. Maximum width of the glabella is across L_3. The glabella is strongly convex (long). and overhanging in front. There are three lateral glabellar furrows. S_1 is very deep and broad, roughly transverse (directed slightly backwards) at the dorsal furrow, then it curves sharply backwards, reaching the occipital furrow, as a broad but shallower groove. The basal lobe (L_1) is very distinctly separated, convex, rounded and large, its width being a little less than one-third that of the glabella. S_2 and S_3 are much shallower, shorter (tr.) and transversely directed. The occipital furrow is very deep and wide at the dorsal furrows; in the middle part it curves slightly forward and becomes shallower. The occipital ring is strongly convex (long.), comparatively narrow at the dorsal furrows and a little broader in the middle. The fixed cheeks are very large, the posterior border is convex (long.) and narrow (long.), the posterior border furrow being very deep at the dorsal furrows and shallowing slightly peripherally. The genal spine is situated not in the genal corner itself, but very slightly inwards from it, on the posterior margin. In front of the genal angle, on the marginal border of the cheek, there is a pustule, evidently the base of a broken off marginal spine. The facial suture cuts the marginal border just in front of this pustule and runs antero-medially to the palpebral lobe, situated far forward, opposite to S_2. The anterior branch of the facial suture runs parallely to the dorsal furrow, but distant from it, then curves and runs antero-medially, along the curve forming two notches (concave outwards) and cuts the anterior border obliquely. The anterior border is flat, narrow (long.) and concealed under the glabella. The free cheeks and eyes are unknown.

Thorax is imperfectly known. The width (tr.) of the rhachial rings is equal to that of the pleurae with the spines. Rhachial rings are convex (long.), gently curving anteriorly at the dorsal furrows. Pleurae are convex (long.), produced into postero-laterally directed spines. Each pleura is divided by a very faint, shallow, thread-like interpleural furrow, into a narrow (long.) anterior part and much broader (long.) convex, posterior.

Pygidium. The width of the rhachis is greater than one-third that of the pygidium. The rhachis is composed of two distinct, broad (long.) rings, and a third one, distinguished only by the presence of two small, transversely directed pits on its posterior border. There are three flat pleurae, corresponding to the three rhachial rings. The furrows between them are very

shallow, marked off distinctly only at the dorsal furrows. The first pleura is directed transversely, the two others — postero-laterally. Three pairs of pleurae are produced into three pairs of pygidial spines. The fourth pair of spines is situated in the prolongation of the rhachis. Spines are broad and convex, directed postero-laterally in the form of slightly curved arches. The first pair of spines forms an angle with the corresponding pleurae and is directed postero-laterally. The two last spines are posteriorly directed. The fourth pair is much shorter than the third.

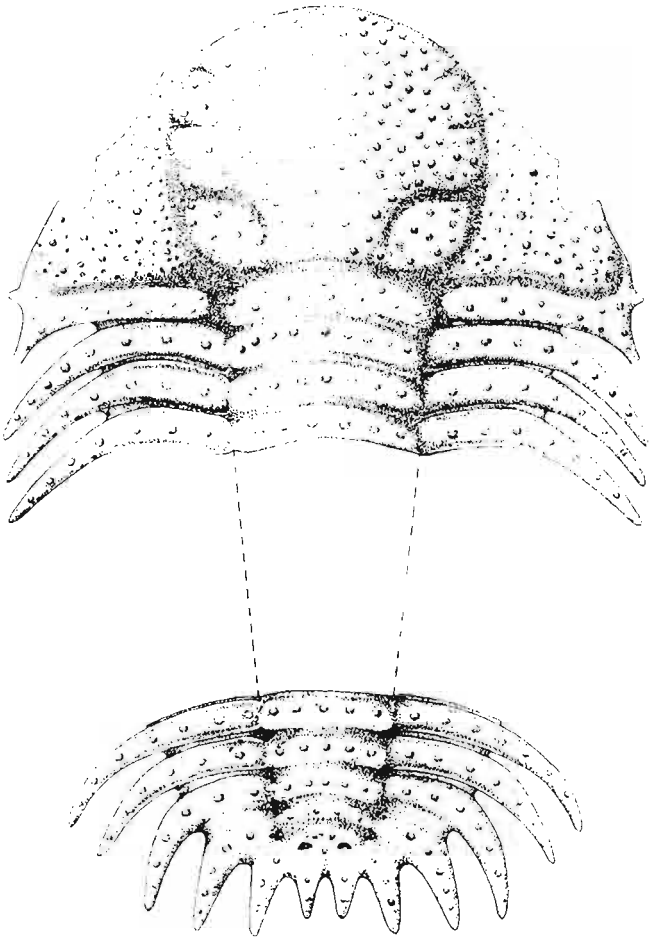


Fig. 37

Pseudosphaerexochus wolkae n. sp. — reconstruction (number of thoracic segments and free cheeks unknown); approx. × 7.

Ornamentation. The whole cephalic surface is covered by large, sharply pointed tubercles. There are about 14 tubercles on each basal lobe, and about 10 along the posterior border. In addition to this ornamentation, there are smaller tubercles among them on the whole cephalic surface and very small pits on the cheeks. There is a row (tr.) of tubercles on the thoracic rings and a similar row on the posterior part of each pleura. There are four large tubercles on the first ring of the pygidium, two on the second and two on the third, as well as a single row of several tubercles along each pleura and spine. In addition to this ornamentation, a very fine granulation covers the whole pygidial surface and probably that of the thorax.

Discussion. — The pygidium of *Pseudosphaerexochus wolkae* n. sp. reminds that of *P. octacanthus* Angelin, but differs from the latter in having more arched and more convex spines. The first pleural spine is in *P. wolkae* directed more transversely than in *P. octacanthus*. The general pattern of the rhachial rings and that of the pleurae is, however, strongly comparable in both species. The cranidium and thorax of *P. octacanthus* is not known so far, so the further comparison cannot be done. On the other hand, the new species shows some similarities with *P. granulatus* (Angelin). *P. wolkae* differs from *P. granulatus* in having a glabella increasing in width anteriorly, more sharply differentiated basal glabellar lobes (L_1), coarser granulation and larger (long.) fixed cheeks. In *P. wolkae* the fourth pair of pygidial spines is much shorter than the third one (as in *P. octacanthus*), whereas in *P. granulatus* both pairs here mentioned are of the same length. *Pseudosphaerexochus wolkae* shows also some similarities to the Middle Ordovician Estonian species *P. orvikui* Männil (cf. Männil, 1958*b*), from which it differs in having coarser granulation and the glabella more strongly increasing in width anteriorly.

Pseudosphaerexochus laticeps (LINNARSSON, 1869)

In the collection of *Eodindymene pulchra* zone of Brzezinki, there is one badly preserved pygidium, recorded here as belonging to *P. laticeps*. It is too poorly preserved to be figured. This is only to let know that *P. laticeps*, a well known and very common species in the Upper Ordovician of Scandinavia (Västergötland and Scania), occurs in Poland as well, in the zone of *Eodindymene pulchra* only, being here however very rare.

Pseudosphaerexochus sp. a

(pl. XXIV, fig. 6-7)

Material. — 8 pygidia from the zone of *Staurocephalus clavifrons*, Brzezinki, Poland.

Dimensions of 2 specimens (in mm):

Locality	Brzezinki	
IG Mus. cat. no.	2. II. 314	2. II. 337
Length of pygidium with spines	3.9	2.5
Length of pygidium without spines	2.2	1.5
Width of pygidium with spines	7.6	6.4
Width of rhachis	2.2	1.5

Description. — The outline of the pygidium without spines is slightly narrower than a semicircle. The width of the rhachis is more than one-third that of the pygidium. The dorsal furrows are deep, converging posteriorly, so that the rhachis is triangular. There are on the rhachis four rings, but the fourth one is only slightly marked. The rings are wide (long.) at the dorsal furrows, narrowing in the midline. The fourth ring forms an arch strongly convex anteriorly. The furrows between the rhachial rings are deeper at the dorsal furrows, where they form deep, round pits. The surface of the pleurae towards the periphery is directed upwards, so that the proximal part is situated much lower than the distal part of the pleurae. There are three distinct pleural segments on the pleurae and a fourth which is faintly apparent, with shallow furrows between them. There are four pairs of straight, conspicuous spines around the pygidium, the first pair being directed postero-laterally, the next — posteriorly. The ends of all the spines are along one transverse line (with the first pair ending slightly in front of the others). This gives to the pygidium (with spines) a subtrapezoidal shape. The first spine forms a distinct angle with the anterior margin of the pygidium. There is a longitudinal furrow along every spine. There are traces of an ornamentation, 4 small tubercles on the first rhachial ring and 2 tubercles on the next. Minute granules can be seen on the doublure of spines.

Discussion. — The pygidium here described differs from the other representatives of *Pseudosphaerexochus* SCHMIDT, 1882, in having 4 rhachial rings, whereas 3 rhachial rings are characteristic of this genus. But the presence of 4 straight spines and the subtrapezoid shape of the pygidium are more reminiscent of the conditions of *Pseudosphaerexochus*,

than those of *Actinopeltis* Hawle & Corda, 1847. *Actinopeltis* has in fact the pygidium composed of 4 rings and with 4 pairs of pygidial spines. The spines, however, are arched and thus the pygidium with spines has a sub-semicircular and not subtrapezoid outline, as is characteristic of our species. Only the discovery of the cephalon will help to decide, to which of these two genera the pygidium in question belongs.

Pseudosphaerexochus sp. **b**

(pl. XXV, fig. 6)

Material. — Two cephalons from the *Staurocephalus clavifrons* zone, Wólka, Poland.

Description. — The dorsal furrows are very deep, diverging anteriorly as they run from the occipital furrow, so that the greatest width of the cephalon is between the first (S_1) and the second (S_2) lateral glabellar furrows. They then converge again and form an arch in front of the glabella. The occipital ring is incompletely preserved, and the occipital furrow in the middle part slightly bent forward. In the longitudinal profile the glabella is very strongly convex, forming an arch, that is three-fourths of the perimeter of a circle. The first lateral glabellar furrow (S_1) is very deep and wide, it runs at first transversely from the dorsal furrow, then turns posteriorly, disappearing however before reaching the occipital furrow. The first lateral glabellar lobe (L_1), cut off in this way, forms a very distinct oval, directed slightly antero-laterally. The second (S_2) and third (S_3) lateral furrows are also very deep, directed postero-laterally, S_2 cutting a little less than one-third of the glabellar width, and S_3 about one-fourth of the glabellar width. The posterior border is only fragmentarily preserved. The posterior border furrow is very deep. The lateral border is flat and wide; the lateral border furrow is very wide and shallow. The genal angles are produced into spines, imperfectly preserved. In front of the genal spine of the lateral margin there is a small tubercle, being evidently a trace of an additional spine. There is a wide and flat anterior border. The facial suture cuts the lateral margin just in front of the presumably additional spine, runs through the lateral border antero-medially, then subparallel to the posterior cephalic margin through the cheek; being well away from the dorsal furrow, it turns abruptly around the long and narrow (tr.) palpebral lobe, runs parallel to the dorsal furrow and cuts the anterior border obliquely inwards. The eyes are not preserved, they are as long as the third (L_3) lateral glabellar lobe, situated opposite to it. The free cheeks are small and triangular. The anterior outline of the cephalon has an irregular shape, the cranidium being produced further forward than the free cheeks.

Ornamentation. The whole glabellar surface, except the furrows, is covered by small granules. On the cheeks surface the granules are more scattered and there are small pits among them.

Discussion. — The cephalon here described resembles somewhat that of the *Pseudosphaerexochus hemicranium* (Kutorga, 1854), as figured by F. Schmidt (1881, pl. 16, fig. 22, 23, 25). The points of resemblance are: the convexity of the glabella, the position of eyes and the type of ornamentation. The other specimens of this species, figured by F. Schmidt (*l. c.*, pl. 10, fig. 1-3) and by Männil (1958*b*, pl. 3, fig. 2-5) have the glabella much less convex, with a coarser ornamentation. The species here described differs from the other representatives of this genus, occurring in the Upper Ordovician of the Holy Cross Mountains and Sweden, in having a more convex glabella and more minute granulation.

Pseudosphaerexochus sp. c

(pl. XXIII, fig. 1)

Material. — Two cranidia from the *Staurocephalus clavifrons* zone, Wólka, Poland.

Description. — The dorsal furrows are very deep. In the longitudinal as well as transverse profile the glabella is strongly convex. The occipital ring is convex, the occipital furrow wide, deeper at the dorsal furrows than in the midline. There are three distinct lateral glabellar furrows. The first (S_1), the deepest, running in an arch to the occipital furrow, but not reaching the latter. The basal lobes defined in such a way are convex and rounded. S_2 and S_3 are shallower, directed transversely, slightly posteriorly, cutting about one-third of the glabellar width. The posterior border is narrow and strongly convex at the dorsal furrow, widening (long.) peripherally. The lateral border, as preserved on the fixed cheek, is flat. There is a narrow postero-laterally directed genal spine and a small tubercle on the lateral margin in front of it, this being a trace of a secondary spine. The eyes are fairly large, situated opposite to the S_2. The facial suture cuts the lateral border obliquely in front of the additional spine, and runs antero-medially towards the palpebral lobe. The anterior branch of the facial suture and free cheeks are not preserved.

Ornamentation. The glabella and the occipital ring are covered by minute tubercles. There are about 80 of them on the basal lobe. On the cheeks the tubercles are more scattered, and there are pits among them.

Discussion. — The specimen here described differs from the Scandinavian representatives of *Pseudosphaerexochus*, as for instance *Pseudosphaerexochus granulatus* (Angelin, 1854), *P. tvaerensis* Thorslund (comp. Thorslund, 1940, pl. 10, fig. 3-5) and others, in having larger posterior part of the free cheeks, the eyes being situated more anteriorly. These features of our specimen are similar to those of *P. pectinifer* (Barrande, 1872), differing however from the latter species in having more minute ornamentation, smaller pits on the cheeks and narrower (tr.) cheeks. The ornamentation of the glabella of *P. pectinifer* is not preserved, the eyes in the latter species seem to be situated still more forward than in our specimen.

Genus **STUBBLEFIELDIA** Prantl & Přibyl, 1947

Stubblefieldia sp.

(pl. XIII, fig. 5; pl. XXIV, fig. 8)

Material. — Two cranidia from the *Staurocephalus clavifrons* zone, Brzezinki, Poland; two cranidia from the Red *Tretaspis* beds, Västergötland, Sweden.

Description. — The glabella is strongly convex (long. and tr.), the dorsal furrows are subparallel, forming a semicircle around the front of the glabella. There are three lateral glabellar furrows. S_1 is wide and deep, directed postero-medially and then posteriorly, not however reaching the occipital ring. The first lateral glabellar lobe (L_1) is very well defined and strongly convex. S_2 and S_3 are directed postero-medially and nearly transversely, S_2 is much longer (tr.) than S_3. The latter is situated very far forward in the anterior portion of the glabella, so that the frontal glabellar lobe is very short (long.). The occipital ring is moderately convex, the occipital furrow is deep, especially at dorsal furrows. The anterior border is wide (long.), flat, and in the dorsal view of the cephalon hardly visible. The fixed cheeks

are large (tr.), but the genal spines are not preserved. The posterior border furrow is very deep at the dorsal furrow, becoming shallower towards the periphery. The border furrow is very shallow. The facial suture cuts the lateral border roughly transversely, then it bends sharply and runs parallel to the dorsal furrow to reach the anterior border.

Ornamentation. The whole glabellar surface is covered by minute granules, there are also small granules and pits on the cheek. The occipital ring and the posterior border are covered by small pits. This ornamentation is preserved only on the specimen from Poland. In the specimens from Scandinavia only the pits on the cheeks are preserved.

Discussion. — *Stubblefieldia* PRANTL & PŘIBYL, 1947, is a monotypic genus, erected to include *Cheirurus neglectus* BARRANDE, 1852, occurring in the Upper Ordovician, Králův Dvůr beds of Bohemia. No representative of this genus has been previously recorded outside of Bohemia. An examination of BARRANDE's type specimens of *Stubblefieldia neglecta* (BARRANDE) has led me to the conclusion that the specimen figured by him (1872, pl. 3, fig. 18) is not conspecific with the other (1852, pl. 40, fig. 20-21; 1872, pl. 3, fig. 19). The specimen here mentioned has a very small (long.) first lateral glabellar lobe, whereas it is fairly long and wide in the other specimens, moreover the anterior branch of the facial suture curves twice on its course, whereas it forms a straight line, subparallel to the dorsal furrow in *Stubblefieldia neglecta*. It seems to me more probable that this specimen belongs to *Actinopeltis insocialis*, occurring in the same beds.

The cranidia from Poland and Västergötland described above show close similarities with *Stubblefieldia neglecta* from Bohemia. As however no pygidium of *Stubblefieldia* type has been found so far in Poland or Sweden, even the generic identification of the cranidia in question cannot be made with certainty. It has been pointed out by PRANTL and PŘIBYL (1947, p. 33) that: «...in the shape of the cephalon this genus *(Stubblefieldia)* is rather reminiscent of the genera *Cyrtometopus* and *Eccoptochile*». The similarities of the cephalons of *Cyrtometopus* and *Stubblefieldia* are very great indeed, and it may be probable that the cranidia here described by me belong to *Cyrtometopus*.

ANGELIN (1854, p. 35, pl. 22, fig. 5) described *Cyrtometopus decacanthus* n. sp. The thorax and pygidium figured by him belong to the genus *Diacanthaspis*, and the original specimen of this thorax and pygidium is refigured in the present paper (pl. XV, fig. 1), and made the lectotype of *Diacanthaspis decacantha* ANGELIN. The identification of the specimen of the cranidium figured by ANGELIN was very difficult. There are in the Riksmuseum collections two cranidia from the Red *Tretaspis* beds of Västergötland, identified by ANGELIN as *Cyrtometopus decacanthus*. They are described in the present paper as *Stubblefieldia* sp.

Subfamily HAMMATOCNEMINAE nov.

Diagnosis. — Facial suture proparian. Glabella divided into preoccipital ring and portion in front of preoccipital furrow (strongly widening anteriorly). Four lateral glabellar furrows, S_1 (preoccipital) crossing the entire width of glabella; S_2, S_3, S_4 — in form of short, wide (long.) grooves, perpendicular to dorsal furrows. Eyes present, situated anteriorly. Ventral cephalic sutures and hypostome unknown. Number of thoracic segments unknown. Thoracic pleurae divided (long.) into inner portion with two strongly convex nodules, in one line (tr.) and outer lanceolate portion, produced into spine. Pygidium short, wide, 3-4 rhachial rings, 3 strongly convex pleurae, with short free ends.

Occurrence. — Upper Ordovician, zone of *Staurocephalus clavifrons*, Poland.

Discussion. — This subfamily in monotypic, erected to include *Hammatocnemis* n. gen., represented in the *Staurocephalus* beds of Holy Cross Mountains by a single species. See also discussion on p. 48.

Genus **HAMMATOCNEMIS** nov.

Derivation of name: Hammatocnemis — $\alpha\mu\mu\alpha$ = knot, $\kappa\nu\eta\mu\iota\sigma$ = cuish (cf. p. 69), provided with two knots (nodes) on thoracic pleurae.

Diagnosis and occurrence. — As for subfamily.

Hammatocnemis tetrasulcatus n. sp.

(pl. XXV, fig. 3; pl. XXVI, fig. 2-4; pl. XXVII, fig. 6-8; text-fig. 38, 39)

Holotype: Cephalon figured on pl. XXVI, fig. 2.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: tetrasulcatus — provided with four lateral glabellar furrows.

Material. — About 260 specimens — chiefly isolated cranidia, thoraxes and pygidia, one entire cephalon and one cephalon with few thoracic segments.

Dimensions of 5 specimens (in mm):

Locality	Brzezinki				
IG Mus. cat. no.	2. II. 359	2. II. 186	2. II. 189	2. II. 180	2. II. 195b
Length of cephalon	1.4	1.2	4.5	6.9	-
Width of cephalon	2.3	2.0	6.0	12.5	
Length of glabella	0.9	0.8	3.0	4.9	
Width of glabella	1.2	1.0	3.1	6.1	-
Length of spine	0.6	0.8	0.2	0.1	—
Length of pygidium	—	—	—	—	2.1
Width of pygidium	—	—	—	—	6.0
Length of rhachis	—	—	—	—	1.5
Width of rhachis	—	—	—	—	1.9

Description. — *Cephalon* is semicircular in outline and moderately convex (transversely and longitudinally). Glabella is moderately convex, and does not overhang the anterior border. Dorsal furrows are narrow and very deep; they run from the posterior margin to the preoccipital ring and slightly converge anteriorly. Anteriorly to the preoccipital furrow, the dorsal furrow becomes broader and strongly divergent. Occipital ring is narrow (long.) at the dorsal furrows, increasing in width towards the middle, becoming there twice as broad as at the sides. The occipital furrow is in the form of deep, round pits at the dorsal furrows, but it shallows so much that in the midline one cannot distinguish the occipital ring from it. Preoccipital ring bears round, strongly convex nodes at the dorsal furrows; its middle

part is much lower than the occipital ring and runs into the preoccipital furrow, so that it is impossible to distinguish the ring from the furrow. Glabella in front of the preoccipital furrow is distinctly set off. Its base is very narrow (tr.), narrower than the width (tr.) of the preoccipital ring. The maximum width of the glabella across the frontal lobe is three times as wide as the base. There are three anterior pairs of glabellar furrows (S_2, S_3, S_4) in the shape of very short, broad grooves. L_2, L_3, L_4 — are small, rounded lobes. Cheeks are

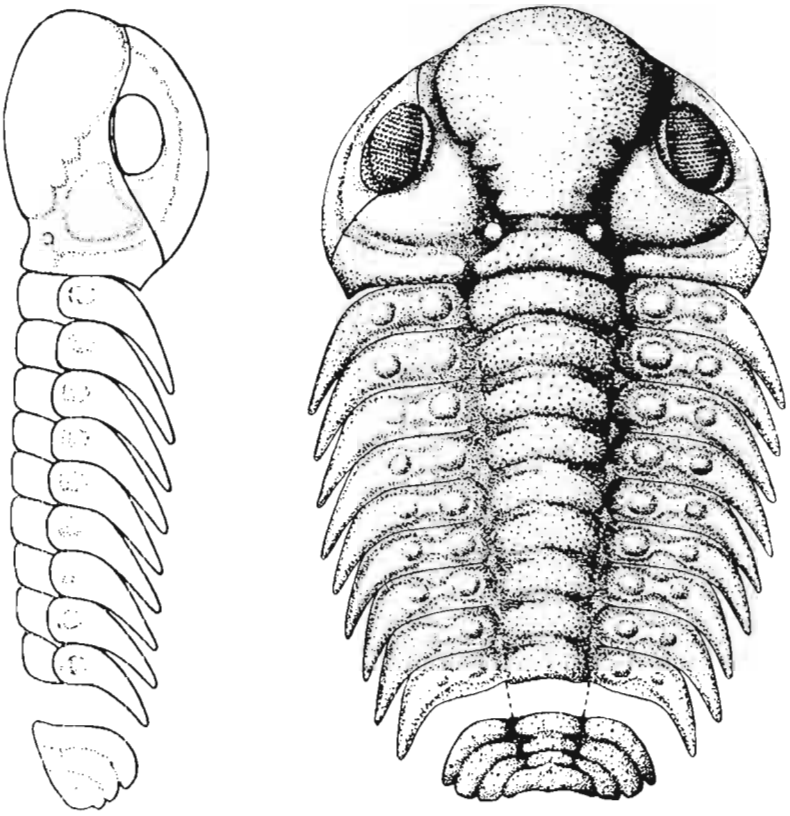


Fig. 38

Hammatocnemis tetrasulcatus n. sp. — reconstruction, in lateral and dorsal views (number of thoracic segments unknown); approx. × 5.

large and moderately convex. Posterior border is convex, broad at the dorsal furrow, slightly narrowing distally and (on its posterior margin close to the genal angle) there is a small pustule, being a remnant of the genal spine in ontogenetic development (see fig. 39). Posterior border furrow is very broad and deep at the dorsal furrow, becoming shallower peripherally, where it meets the border furrow. Lateral border is moderately convex and broad. Lateral border furrow is broad and shallower than the posterior border furrow. Eyes are large, situated anteriorly, close to the glabella and opposite S_4. Palpebral lobe is relatively small, narrow and steep; its outer border is higher than the inner one. Visual lobe is large, convex and covers nearly the whole surface of the free cheek. There are about 150 small subhexagonal lenses. Fixed cheek is large and moderately convex. Facial suture runs around the anterior border of glabella, then postero-medially, close to the dorsal furrow to the eye. It curves around the eye and runs postero-laterally to the outer margin of the cephalon, which cuts it in front of the rounded genal angle.

Thorax. The number of thoracic segments is unknown. Rhachial width (tr.) is only a little less than that of the pleurae (tr.). Rhachis is convex transversely; dorsal furrows are very deep and pleurae are strongly convex. Rhachial rings are narrow in the midline, widening at the dorsal furrows, where they bear convex nodes. Pleurae in half their length are directed transversely, then curve down and are directed postero-laterally. On the inner (directed transversely) part of the pleurae there are two large nodes in a transverse line and connected with each other by a saddle-shaped constriction. Outer portion of pleurae extended into broad (long.) spine. This part of the pleurae is smooth.

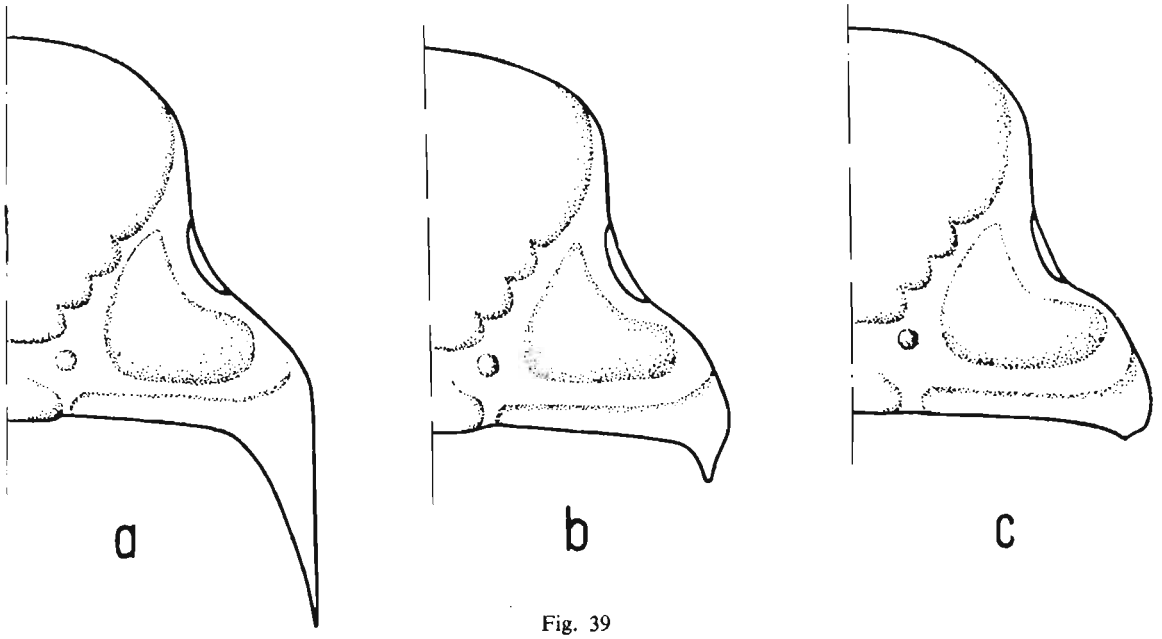


Fig. 39

Hammatocnemis tetrasulcatus n. sp. — diagrammatic drawings of three cephalons, showing reduction of the genal spine in the ontogenetic development. Cephalic length of the specimens: *a* 1.2 mm, *b* 3 mm, *c* 6.1 mm.

Pygidium is short and wide. Posterior border is wide (tr.), gently concave, the rhachis ends before reaching it. There are three or four rhachial rings and four pleurae, three first distinct, directed transversely, slightly backwards, the fourth very indistinct. On the lateral margin of the pygidium there are four pairs of broad, very short, lobe-like free ends, which are longer in small specimens, forming there wide spines. On the proximal part of the pleurae one can recognize the traces of two nodes, similar to those on the thoracic pleurae.

Ornamentation. The whole body is finely granulated.

Family **ENCRINURIDAE** Angelin, 1854

Subfamily DINDYMENINAE nov.

Diagnosis. — Blind, free cheeks narrow, ventral cephalic sutures incompletely known, probably of levisellid type. Hypostome unknown. Glabella bulbous, widening anteriorly,

no lateral glabellar furrows. 10 thoracic segments, with pleural ends produced into spines. Pygidium elongated with 6-12 rhachial rings and 2-3 pleurae with free ends.

Occurrence. — Llanvirnian (Svata Dobrotivá beds of Bohemia) to Upper Ordovician (Bohemia, Poland, Bornholm, Sweden, Great Britain).

Discussion (cf. also discussion on p. 52-55). — This subfamily is erected to include two genera: *Eodindymene* nov. and *Dindymene* HAWLE & CORDA, 1847. The genus *Plasiaspis* PRANTL & PŘIBYL, 1948, though showing great similarities to *Eodindymene* and *Dindymene* in the structure of the dorsal exoskeleton, cannot be included into the Dindymeninae on account of the different type of the ventral cephalic sutures and the presence of the lateral glabellar furrows.

Genus **EODINDYMENE** nov.

Derivation of name: εοσ = dawn, early *Dindymene*.
Type species: Dindymene pulchra OLIN, 1906.

Diagnosis. — Facial suture cuts the cephalic margin in front of the genal spine, runs antero-medially through the gena and continues on the rhachial portion of the cephalon, dividing it into glabella and the convex precranidial lobe.

Occurrence. — Upper Ordovician, zone of *Eodindymene pulchra*, Poland and Sweden (Scania).

Discussion. — The new genus is monotypic, erected to include *Dindymene pulchra* OLIN. The latter species differs so strikingly from the other representatives of the genus *Dindymene* in the course of the facial suture (comp. fig. 9 on p. 53), that it is thought desirable to separate in into a new genus.

Eodindymene pulchra (OLIN, 1906)

(pl. XXVII, fig. 1-2; pl. XXVIII, fig. 3-4; pl. XXIX, fig. 6; text-fig. 9*a*, and 40)

1906. *Dindymene pulchra* n. sp.; E. OLIN, Om de Chasmopskalken..., p. 50, pl. 1, fig. 21.
1906. *Dindymene* sp.; E. OLIN, *Ibid.*, p. 52 (pygidium only), pl. 1, fig. 26.
1956. *Dindymene pulchra* OLIN; Z. KIELAN, On the stratigraphy..., pl. 2, fig. 1.

Type horizon and locality: Upper Ordovician, *Tretaspis* shales of Tommarp, Scania and Sweden.
Lectotype: Cephalon figured by OLIN (1906, pl. 1, fig. 21), refigured in the present paper — pl. XXVII, fig. 1*a*, 1*b*.

Diagnosis. — On the anterior part of the glabella and on the precranidial lobe there are closely spaced, small tubercles; on the posterior part of the glabella — larger scattered tubercles. The cheeks are pitted and granulated with tubercles, the latter are especially closely spaced along the facial suture, also there is a row of larger tubercles on the lateral border. Thoracic pleurae with comparatively short spines. Pygidium with 8-9 rhachial rings and 3 pleurae.

Material. — One nearly complete specimen, 13.5 mm long, one pygidium, some fragments of cephalons from the lower part of Brzezinki section, recorded here as a zone of *Eodindymene pulchra*. Cephalon and pygidium described by OLIN (1906, pl. 1, fig. 21, 26).

Description. — *Cephalon* is sub-semicircular in outline, longitudinally and transversely strongly convex. Dorsal furrows are very deep, strongly diverging anteriorly. The width of the glabella at the base is about half of the anterior width. The occipital ring is narrow (long.), convex (long.) and produced laterally a little beyond the base of the glabella. The occipital furrow is narrow, swinging forward and deeply notched at the dorsal furrows, forming there round deep pits. In front of them one can recognize a second pair of pits on the dorsal furrows. In lateral view the glabella is highly convex, being most elevated at about one-third of its length from the base and steeply sloping down to the anterior margin, passing without any interruption into the anterior, convex part of the fused cheeks, called here the precranidial lobe. In anterior view the glabella is higher than the cheeks, which are sharply turned down. The cheeks are large and convex, the lateral border is flat and broad, lateral furrow broad and shallow. Posterior border is narrow (long.) at the dorsal furrow, widening peripherally; it is produced into a genal spine directed outwards, slightly forwards and upwards. The facial suture begins on the margin of the lateral border, in front of the genal spine, runs antero-medially through the gena, curves inwards a little, then cuts the dorsal furrow and continues on the rhachial portion of the cephalon, parallel to its outer margin. In such a way the facial suture divides the rhachial portion of the cephalon into glabella and convex precranidial lobe. The latter is an uninterrupted continuation of the glabella and is separated from it by the suture only. The border furrow does not continue on the rhachial portion of the cephalon, so that the anterior border is not distinguishable here.

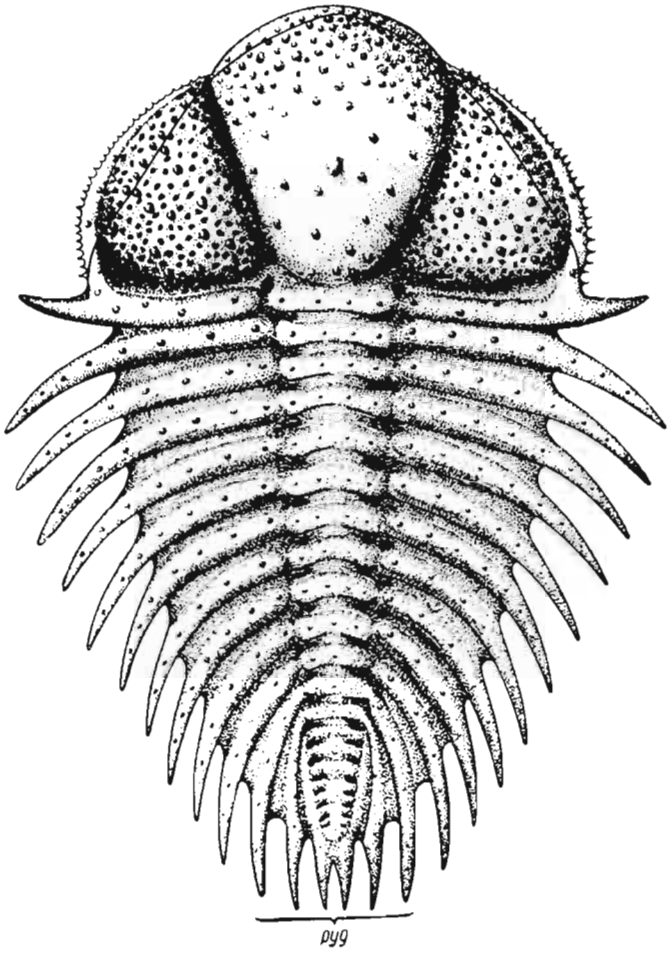


Fig. 40

Eodindymene pulchra (OLIN) — reconstruction; approx. × 9.

Thorax is imperfectly known. The rhachial rings are convex (tr. and long.), the rhachis tapering gradually posteriorly. Each ring is divided into a convex posterior part and a much lower articulating half-ring, on the lateral sides of which, at the dorsal furrows, there occur deep round pits. Pleurae of the first thoracic segments are directed transversely, their length, without the spine (tr.) being equal to that of the corresponding rhachial ring. Pleurae of the posterior thoracic segments are comparatively short and directed postero-laterally. The pleurae are extended into comparatively short, pointed spines.

Pygidium. The rhachis is long, conical and consists of 8-9 convex rings, separated by deep furrows, on which at the dorsal furrows there are small, transverse, deep pits. There are three pleurae, of which the first two are convex and distinct, separated by deep furrows and corresponding to the two first rings of the rhachis. Third pleural segment is short (long.), closely pressed against the side of the rhachis and meeting the pleural segment of the other side behind it. The pleurae have free ends, extended into short spines. The length of the third pair of spines is less than one-fourth that of the pygidium.

Ornamentation. There are closely spaced, small tubercles on the anterior part of the glabella and on the precranidial lobe, and larger, scattered tubercles on the posterior part of the glabella. A single, large median tubercle (or spine?) is situated at about one-third of the length of the glabella. The cheeks are pitted and granulated. The small tubercles are closely but irregularly spaced on both sides of the facial suture; there are two rows of somewhat larger tubercles on the lateral border, and scattered tubercles on the posterior border. The margin of the lateral border is minutely denticulated. The rhachis, the pleurae of thorax and pygidium bear small tubercles, spaced as a single row along every rhachial ring and pleura. On the lower side of thoracic and pygidial spines there is a very fine granulation, preserved only as impressions.

Discussion. — The pygidium figured by Olin (1906, pl. 1, fig. 26) as *Dindymene* sp. does not show any essential differences with the pygidia of *Eodindymene pulchra* from the Holy Cross Mountains and is considered here as conspecific. Olin (1906, pl. 1, fig. 21c) has drawn a facial suture of *E. pulchra* as cutting the anterior cephalic margin, the free cheeks not being fused anteriorly. I have examined Olin's original specimen at the Palaeontological Institute in Lund, and this has proved to me that the branch of the «facial suture», cutting the margin of the cephalon, is an adventitious crack of the exoskeleton (comp. our pl. XXVII, fig. 1). The course of the facial suture of *E. pulchra* is shown on the text-fig. 9*a* (see p. 53), drawn from Olin's specimen. A similar course of the facial suture has been observed on the specimens from the Holy Cross Mountains (comp. pl. XXVIII, fig. 3-4).

In Poland (Brzezinki section), *Eodindymene pulchra* occurs only in the lower part of the section, in the beds overlying the graptolitic shales of the *Pleurograptus linearis* zone and underlying the mudstones of the *Staurocephalus clavifrons* zone. In Scania, *E. pulchra* has been found in one locality only (Tommarp), 60-85 cm above the graptolitic shales of the zone of *Pleurograptus linearis*. Therefore it is accepted here as an index fossil for the Lower Ashgillian.

Genus **DINDYMENE** Hawle & Corda, 1847

Diagnosis. — Facial suture cuts the cephalic margin in front of the genal spine and runs subparallel to the outline of the cephalon along the border furrow. Free cheeks are very narrow, restricted to the lateral border of the cephalon, fused anteriorly.

Occurrence. — As for the subfamily.

Species:

Dindymene fridericiaugusti Hawle & Corda, 1847 — type species
Dindymene heidingeri Barrande, 1852

?Dindymene ornata Linnarsson, 1869
Dindymene cordai Nicholson & Etheridge, 1878
Dindymene hughesie Reynolds, 1894
Dindymene plasi n. sp.
Dindymene longicaudata n. sp.

Discussion. — Apart from the seven species here mentioned, three species of *Dindymene* have been described by Olin (1906) and one by Reed (1931). *Dindymene spinulosa* Olin (1906, pl. 1, fig. 22; comp. our pl. XXVII, fig. 3) is, in my opinion, conspecific with *D. ornata* Linnarsson. *Dindymene venusta* Olin is conspecific with *Raphiophorus gratus* (Barrande), the apparent granulation on the cheeks and glabella of the specimen figured by Olin (1906, pl. 1, fig. 23; comp. also our pl. XXXII, fig. 6) being nothing else but adventitious pyrite grains. *Dindymene cornuta* Olin is represented by one, fragmentary specimen, which although showing some resemblances to *D. longicaudata* n. sp., is so badly preserved, that it cannot be identified with any certainty and must be considered as *nomen dubium*.

Reed (1931, p. 54, pl. 3, fig. 24) described a new species — *Dindymene minuta* from the Balclatchie Group, Balclatchie, Girvan, Ayrshire, based on a single specimen. This specimen housed in the British Museum, Nat. History (no. In 37529) is a poorly preserved internal mould, situated on a piece of rock, about 3 mm from a cephalon identified as *Agnostus girvanensis*. In my opinion, the «head shield» of *D. minuta* is a fragment of the central portion of one thoracic segment of a *Trinodus*, belonging probably to the cephalon preserved on the same rock specimen. Together with the «head-shield», the small fragment of the second thoracic segment is preserved on this specimen, not figured however in Reed's drawing. The three small tubercles on the «glabella and cheeks» of *D. minuta*, figured in Reed's drawing, are not visible in fact on the specimen. Thus *D. minuta* Reed must be also considered as *nomen dubium*.

In the list of species of *Dindymene* given above, there is a question mark in front of the name of *Dindymene ornata* Linnarsson. *D. ornata* resembles very much *D. heidingeri* Barrande. The latter species was described by Barrande (1852, p. 819, pl. 43, fig. 25-26) from the Upper Ordovician, Králův Dvůr beds, locality of Karlova Hut' of Bohemia, being based on a single specimen. No other specimens of this species have been found since from the Králův Dvůr beds. Unfortunately, the original specimen of *D. heidingeri* is very poorly preserved. There are almost no traces of ornamentation on the cephalon, the pygidial rhachis being damaged too. The shape of the thorax, the very long thoracic and pygidial spines, are like those, characteristic of *Dindymene ornata* Linnarsson. Similarly, the genal spines are directed postero-laterally as in *D. ornata*. The pygidial rhachis although not preserved is very short (long.), the number of segments being probably small, so that it is possible to presume that it was composed of only six segments, as it is characteristic of *Dindymene ornata*. In my opinion, it is almost certain, that *D. heidingeri* is conspecific with *D. ornata*, the latter would be in such a case the junior synonym of *D. heidingeri*. As however the cephalic ornamentation and the structure of the pygidial rhachis of *D. heidingeri* is imperfectly known, the question must remain open, until more and better preserved material of *D. heidingeri* from the type locality becomes available.

The table 6 gives a comparison of the specific characters of the representatives of *Dindymene* and *Eodindymene* (cf. also Barrande, 1852, 1872; Linnarsson, 1869; Reynolds, 1894; Nicholson & Etheridge, 1878; Reed, 1906; Olin, 1906).

Dindymene fridericiaugusti Hawle & Corda, 1847

(pl. XXVIII, fig. 1, 2; text-fig. 9*b*)

1847. *Dindymene Friderici Augusti* n. sp.; J. Hawle & A. Corda, Prodrom einer Monographie..., p. 120, pl. 1, fig. 3.
1847. *Dindymene speciosa* n. sp.; J. Hawle & A. Corda, *Ibid.*, p. 121.
1852. *Dindymene Friderici Augusti* Corda; J. Barrande, Système Silurien..., p. 818, pl. 43, fig. 20-24.
1872. *Dindymene Friderici Augusti* Corda; J. Barrande, *Ibid.*, Suppl., p. 117, pl. 2, fig. 11-12.

Material. — In the collection from the Holy Cross Mountains this species is rare, represented only by 3 cephalons.

Discussion. — *Dindymene fridericiaugusti* from the Králův Dvůr beds of Bohemia was described by Barrande (1852, 1872) in detail. As it is incompletely preserved in our collection, no thorax or pygidium being found, I do not consider a redescription necessary; thus I shall indicate only the differences and similarities with the other dindymenid species occurring in the same beds.

The most similar species to *D. fridericiaugusti* is *D. longicaudata*, being characterized by a similar type of ornamentation of the cephalon (pits and small tubercles on the cheeks and smaller and greater irregularly arranged tubercles on the glabella) and the genal spine directed anteriorly. The differences concern the shape of the glabella, which widens more strongly anteriorly in *D. longicaudata* than in *D. fridericiaugusti*, the ornamentation of the thorax and the structure of the pygidium. The thoracic pleurae in *D. fridericiaugusti* are ornamented by a transverse row of large tubercles, whereas there are very many small tubercles in *D. longicaudata*. The pygidium of *D. longicaudata* has three pleurae, and the rhachis is composed of 11 segments, whereas there are two pygidial pleurae and 8-9 rhachial segments in *D. fridericiaugusti*. Also the median spine on the glabella in *D. longicaudata* is stronger than in *D. fridericiaugusti*. The differences with the other dindymenid species are even greater and concern the ornamentation of the cephalon and the thoracic and pygidial structures.

Dindymene ornata Linnarsson, 1869

(pl. XXVI, fig. 6; pl. XXVII, fig. 3-5; pl. XXIX, fig. 5; pl. XXX, fig. 4; text-fig. 41)

1869*a*. *Dindymene ornata* n. sp.; J. G. O. Linnarsson, Diagnoses specierum novarum..., p. 192.
1869*b*. *Dindymene ornata* Linnarsson; J. G. O. Linnarsson, Om Västergötlands Cambriska..., p. 64, pl. 1, fig. 15-17.
1899. *Dindymene ornata* Linnarsson; J. P. J. Ravn, Trilobitfaunaen..., p. 52, 57.
1906. *Dindymene spinulosa* n. sp.; E. Olin, Om de Chasmopskalken..., p. 51, pl. 1, fig. 22.
1956. *Dindymene ornata* Linnarsson; Z. Kielan, On the stratigraphy..., pl. 3, fig. 1, 2.

Lectotype: The complete specimen figured by Linnarsson (1869*a*, pl. 1, fig. 15), refigured in the present paper — pl. XXVII, fig. 5*a*, 5*b*.

Type horizon and locality: Upper Ordovician, Red *Tretaspis* mudstones of Mösseberg, Bestorp, Västergötland, Sweden.

Diagnosis. — Genal spine directed postero-laterally. Ornamentation of the glabella consisting of small tubercles, in addition to which there is a row of 5 larger tubercles parallel to cephalic margin, two rows of two tubercles behind it, and one large tubercle in one-third of the glabellar length. Seven regularly arranged very large tubercles on cheeks. Thoracic and pygidial pleurae produced into very long spines. Pygidium with 6 rhachial rings and two pleurae.

Table 6

Comparison of specific characters of the representatives of *Eodindymene* n. gen. and *Dindymene* HAWLE & CORDA *

Genera	*Eodindymene* n. gen.	*Dindymene* HAWLE & CORDA, 1847						
Species	*E. pulchra* (OLIN, 1906)	*D. plasi* n. sp.	*D. ornata* LINNARSSON, 1869	*D. heidingeri* BARRANDE, 1852	*D. fridericiaugusti* HAWLE & CORDA, 1847	*D. longicaudata* n. sp.	*D. cordai* NICHOLSON & ETHERIDGE, 1878	*D. hughesie* REYNOLDS, 1894
Facial suture	Running antero-medially through gena, and transversely across the rhachial portion of the cephalon, dividing it into glabella and precranidial lobe.	Running along the inner edge of the border.	Running along the inner edge of the border.	Presumably running along the inner edge of the border, free cheeks unknown.	Running along the inner edge of the border.	Running along the inner edge of the border.	Presumably running along the inner edge of the border, free cheeks unknown.	Presumably running along the inner edge of the border, free cheeks unknown.
Ornamentation of the cephalon	Glabella irregularly ornamented, with tubercles especially closely spaced on the precranidial lobe. Cheeks irregularly ornamented, tubercles closely spaced along the facial suture, two rows of larger tubercles on the lateral border.	Imperfectly known. More dense tubercles on the anterior part of the glabella. Two rows of two tubercles in front of the median spine. Cheeks granulated with about seven larger tubercles.	Small tubercles on the glabella, in addition to which a row of five larger tubercles parallel to cephalic margin, and two rows of two tubercles behind it. Seven regularly arranged large tubercles on cheeks.	Unknown.	Glabella ornamented with smaller and greater tubercles, a great many large tubercles on cheeks and small ones on the border.	Glabella irregularly ornamented by different sized tubercles, great many different sized tubercles on cheeks.	Glabella and cheeks uniformly granulated.	Glabella and cheeks minutely granulated, two large tubercles along the midline of glabella, one large tubercle on each cheek.
Genal spine	Short, directed antero-laterally.	Very stout, long, directed postero-laterally.	Long — one-third of the glabellar length, directed postero-laterally.	As in *D. ornata*.	Directed antero-laterally.	Directed antero-laterally.	Unknown.	Unknown.
Pygidium	8 rhachial rings, 3 pleurae.	9 rhachial rings, 2 pleurae.	Rhachis very short (long.), 6 rings, 2 pleurae.	Rhachis very short (long.), number of rhachial rings unknown, 2 pleurae.	8-9 rhachial rings, 2 pleurae.	11-12 rhachial rings, 3 pleurae.	10-12 rings, of which only the first 7-8 are distinct, 2 pleurae.	9? rhachial rings, 3 pleurae.
Thoracic and pygidial spines	Comparatively short, wide.	Comparatively short, thin.	Very long, thin.	Identical to *D. ornata*.	Comparatively long, thin.	Very short, stout.	Comparatively short.	Long.
Geological range	Upper Ordovician, zone of *Eodindymene pulchra*.	Middle Ordovician, Svata Dobrotivá beds of Bohemia.	Upper Ordovician, zones of *E. pulchra* and *Staurocephalus clavifrons*.	Upper Ordovician, Králův Dvůr beds of Bohemia.	Upper Ordovician, zone of *Staurocephalus clavifrons* and *Dalmanitina mucronata*.	Upper Ordovician, zone of *Staurocephalus clavifrons*.	Upper Ordovician (Whitehouse group to Drummuck group).	Upper Ordovician (Bala beds).
Horizontal distribution	Poland, Sweden (Scania).	Bohemia.	Poland, Bornholm, Sweden (Scania and Västergötland).	Bohemia.	Bohemia, Poland.	Poland, Bornholm, Sweden (Scania and Västergötland).	Great Britain (Girvan).	Great Britain (Yorkshire).

* The characters common to all the species, as for instance median spine on the glabella, pitted cheeks and so on, are not taken into consideration in the present comparison.

Material. — 212 specimens (15 entire among them) from the zones of *Eodindymene pulchra* and *Staurocephalus clavifrons* of Brzezinki and Wólka in Poland; the original specimens of LINNARSSON (1869*b*) and OLIN (1906).

Dimensions of 4 specimens (in mm):

Locality	Brzezinki			Wólka
IG Mus. cat. no.	2. II. 99	2. II. 96	2. II. 101	2. II. 102
Length of entire individual	9.1	6.0	—	—
Length of cephalon	3.0	2.1	4.0	2.5
Width of cephalon	5.3	4.0	6.6	5.2
Width of glabella at the base	1.1	0.8	1.2	1.2
Maximal glabellar width	2.6	1.9	3.0	2.2
Length of pygidium without spines	1.1	—	—	—

Description. — *Cephalon.* The outline is sub-semicircular. The cephalon is strongly convex longitudinally and transversely. In longitudinal profile the occipital ring is almost flat, the occipital furrow deep and wide, and the glabella strongly arched. In transverse profile the glabella is strongly arched and situated higher than the cheeks, which slope down steeply. The width of the base of the glabella is equal to one-fourth that of the cephalon. The occipital ring is narrow (long.), the occipital furrow in the middle part is as wide as the ring. On the sides of the occipital furrow, at the basal furrows, there are round pits; on the dorsal furrows there is a similar pair of pits in front of them. The dorsal furrows are very deep, running from the occipital ring they converge slightly, and then run anteriorly, strongly diverging. The greatest glabellar width, near the anterior cephalic margin is three times as wide as the basal width. The posterior cephalic margin behind the glabella is slightly arched (convex posteriorly) forming a straight line along the cheeks.

The posterior border is narrow (long.) and slightly convex, the posterior border furrow is narrow and deep at the dorsal furrow, becoming shallower at the periphery. The border is comparatively narrow posteriorly, becoming wider anteriorly, where its width is equal to that of the posterior border. The border furrow is narrow and shallow. There is a postero-laterally directed genal spine, the length of which is about one-third that of the glabella. In front of the genal spine the outline of the cheeks makes a small incision inwards and then it projects outwards forming a strong arch. The facial suture cuts the cephalic margin in front of the genal spine, runs antero-medially through the border, and then around the cephalon, parallel to the border, on the outer side of the border furrow.

Thorax. The width (tr.) of the first thoracic rings is equal to three-fourths that of the pleura without the spine. The rhachial width diminishes strongly posteriorly. The rhachial rings are convex anteriorly, wider (long.) at the dorsal furrows than in the middle part. On the fourth rhachial ring there is a strong spine, not completely preserved however on any of the specimens. The pleurae of the first thoracic segments are directed transversely, those of the following segments slightly postero-laterally. There is a pleural furrow dividing each pleura into a narrow (long.) and comparatively flat anterior part, and a wider (long.) and more convex posterior one. Thoracic pleurae are produced into long spines. The spines of the two first segments are comparatively short, their length being equal to that of the pleura, and directed almost transversely, being only slightly curved posteriorly. Those of the following segments

are directed postero-laterally and of the posterior segments entirely backwards. Posteriorly the spines become longer, so that the length of the spine of the last segment is more than twice as long as the pleura of that segment.

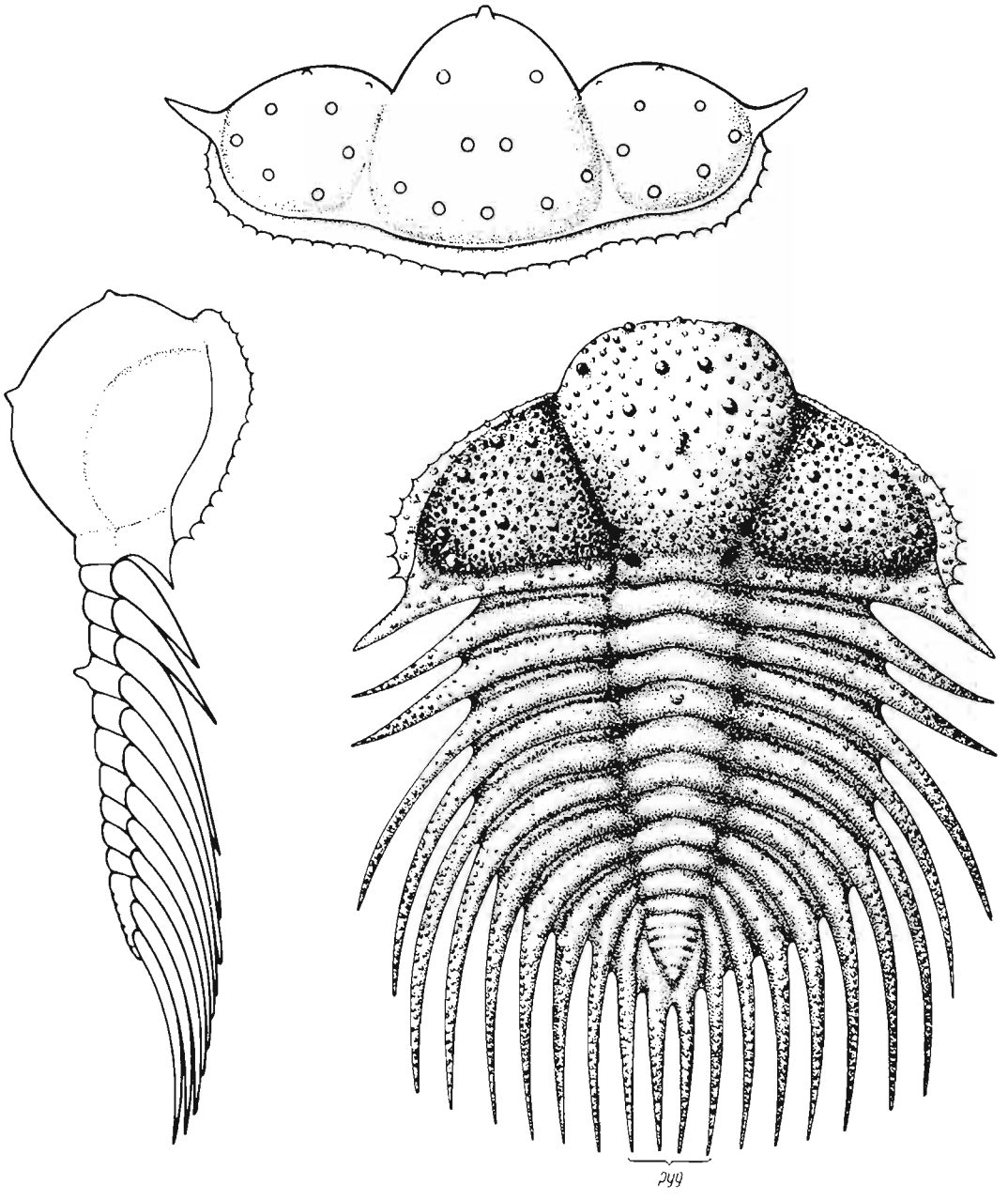


Fig. 41

Dindymene ornata LINNARSSON — reconstruction, in anterior, lateral and dorsal views; approx. × 10.

Pygidium. The pygidial rhachis forms an inverted triangle. It is composed of six rings, with deep furrows between them. The first three rings are directed almost entirely transversely, the following are slightly arched anteriorly. On the pleurae there are two very convex segments,

with deep pleural furrow between them. The first segment is connected with the first rhachial ring and is directed posteriorly, being slightly convex outwards, and becomes wider posteriorly. The second pleural segment is connected with the second rhachial ring and is directed posteriorly fitting tightly to the rhachis. It also widens posteriorly. In the posterior part of the pygidium, behind the rhachis, the parts of the second pleural segment from both sides meet each other, being divided by only a longitudinal furrow. Both pleural segments are produced into thin pointed spines, more than twice as long as the rhachis.

Ornamentation. The entire glabellar surface is covered by small tubercles, which are more dense in its anterior part. In addition to this ornamentation, there is a large tubercle (probably a spine, incompletely preserved) on the posterior part of the glabella, at its highest point, there are also two rows, each of two tubercles in front of it (in the anterior row the tubercles are closer to one another than in the posterior), and one row of five tubercles, situated close to the anterior outline of the glabella and parallel to it. The whole cheek surface is covered by pits, situated among anastomosing lines, the latter being covered by minute granulations. In addition to this, there are seven larger tubercles on every cheek, three forming a triangle in the postero-medial corner of the cheek, the other four being situated subparallel to the exterior outline of the cheek. On the cephalic margin there are small, pointed spines, perpendicular to the outline. The whole thoracic and pygidial surface is covered by different sized tubercles, the larger ones forming a row of tubercles along every thoracic ring and the posterior part of the pleura. The minute tubercles are especially well preserved on the lower side of the thoracic and pygidial spines, usually as negative impressions.

Discussion. — According to Olin (1906), *Dindymene spinulosa* Olin differs from *Dindymene ornata* Linnarsson in the shape of the pleural spines of the thorax, in the lack of ornamentation, characteristic of *D. ornata*, and in the lack of two pairs of pits on the posterior part of the glabella, which correspond to glabellar furrows. In my opinion, all these differences are a result of the state of preservation. The specimen of *D. spinulosa* figured by Olin (*l. c.*, pl. 1, fig. 22) is an internal mould, in which the ornamentation is not preserved. On the natural cast of the same specimen one can recognize traces of the characteristic ornamentation, two nodes on the dorsal furrows corresponding to pits and also the trace of a single tubercle on the rhachis of the fourth thoracic segment. Likewise on the same cast one can recognize 6 rhachial segments on the pygidium, characteristic of *D. ornata*. In my opinion, there is no doubt that *D. spinulosa* is conspecific with *D. ornata*, and is treated here as a junior subjective synonym of the latter species.

Dindymene plasi n. sp.

(pl. XXIX, fig. 1-3; text-fig. 42)

Holotype: The entire specimen figured on pl. XXIX, fig. 3.
Type horizon and locality: Middle Ordovician, Llanvirnian, Svata Dobrotivá beds of Šarka, Bohemia.
Derivation of name: plasi — in honour of the Bohemian collector Mr. Vladimir Plas from Prague.

Diagnosis. — Long and stout genal spine, directed transversely, slightly posteriorly. Irregular, different sized tubercles on glabella, more dense on its anterior part, one larger tubercle (spine?) in one-third of glabellar length with two tubercles in front of it. Cheeks pitted and granulated, with about seven larger tubercles. Pygidium with nine rhachial rings and two pleurae. Thoracic and pygidial spines thin and comparatively short.

Material. — Six almost entire specimens, up to 14 mm long, from Male Přilepy and Šarka, Bohemia, in the collections of Mr. Plas and National Museum in Prague. All the specimens preserved as internal moulds.

Description. — *Cephalon* is sub-semicircular in outline, as strongly convex transversely as longitudinally. The posterior cephalic border forms a transverse line. The dorsal furrows running from the occipital ring slightly converge at first, and then strongly diverge anteriorly. The occipital ring is slightly convex (long.), the occipital furrow wide (long.) and shallow.

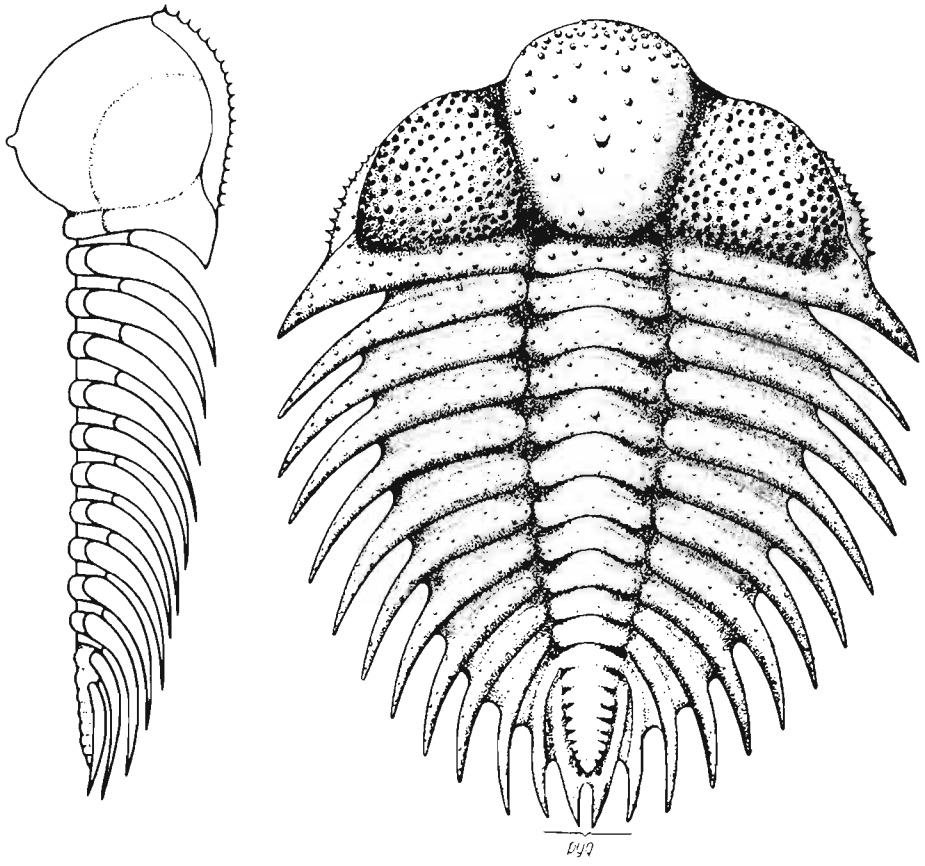


Fig. 42

Dindymene plasi n. sp. — reconstruction, in lateral and dorsal views; approx. × 7.5.

On both sides of the occipital furrow at the dorsal furrows there are deep transverse pits. In front of them, on the dorsal furrows there is a similar although smaller pair of pits. The posterior border is narrow (long.) and convex (long.) at dorsal furrow, widening peripherally. The posterior border furrow is narrow (long.) and deep. The border is comparatively flat, the border furrow shallow. The posterior border is produced into a very strong, stout, genal spine, directed transversely and slightly posteriorly. The length of the genal spine is about two-fifths that of the glabella. The facial suture cuts the cephalic margin in front of the genal spine, and runs along the inner edge of the border all around the cephalon.

Thorax. The rhachial rings are slightly convex anteriorly, wider (long.) at the dorsal furrows than in the inner part. At the dorsal furrows they are slightly bent anteriorly. The pleural segments are divided by a transverse pleural furrow into a flat anterior part and a more

convex and wider posterior. They are produced into comparatively short thin spines, directed transversely and slightly posteriorly on first segments and more posteriorly on the following segments.

Pygidium. The rhachis is narrow, composed of nine well defined rings, slightly convex anteriorly. On the pleurae there are two segments, connected respectively with the first and second rhachial rings. The pleural segments are strongly convex, divided by deep furrows, directed in an arch backwards and widening slightly posteriorly. The second pleural segment is closely pressed against side of the rhachis, but delimited from it by a distinct furrow. It meets the pleural segment of the other side behind the rhachis. Both pleural segments are produced into thin and long spines, their ends being along one straight line.

Ornamentation. On account of the bad state of preservation of all the specimens, the ornamentation is poorly known. In one-third of the glabellar length there is a spine. In front of it there are two pairs of tubercles similar to those in *Dindymene ornata.* In addition to this, the whole glabellar surface is granulated, and the tubercles are more densely spaced in the anterior part of the glabella. The cheeks are pited and granulated, it seems that there are seven larger tubercles, similar to those in *D. ornata.* The border is irregularly ornamented, its margin being denticulated. The whole thoracic and pygidial surface is irregularly tuberculated, one row of larger tubercles being recognizable along the posterior part of every rhachial and pleural segment. On the lower surface of the spines there are small tubercles, preserved as negative impressions.

Occurrence. — Middle Ordovician (Llanvirnian), Svata Dobrotivá beds of Central Bohemia, localities of Šarka and Male Přilepy.

Discussion. — In the collection of the National Museum in Prague there are some specimens from the Llanvirnian, Svata Dobrotivá beds, locality of Male Přilepy of Bohemia, identified by Kloučeк as *Dindymene heidingeri* Barrande, 1852. *D. heidingeri* was originally described by Barrande (1852, p. 819, pl. 43, fig. 25-26) from the Upper Ordovician, Králův Dvůr beds, locality of Karlova Hut' of Bohemia. The Llanvirnian specimens differ from *D. heidingeri* Barrande, as well as from all the other Upper Ordovician representatives of *Dindymene*, and represent, in my opinion, a separate new species described in the present paper as *D. plasi* n. sp. *Dindymene plasi* is so far the oldest known representative of the genus *Dindymene*, as all the other species of this genus are known only from Upper Ordovician. Among the Upper Ordovician representatives of *Dindymene*, *D. ornata* seems to be most closely related to *D. plasi*, in the shape of the genal spine (directed postero-laterally) and probably also in the pattern of the ornamentation of the cephalon (this latter feature is incompletely known in *D. plasi*). *Dindymene plasi* differs, however, from *D. ornata* in having much shorter thoracic and pygidial spines, and a longer pygidial rhachis composed of nine rhachial rings, whereas there are only 6 rhachial rings in *D. ornata.*

Dindymene longicaudata n. sp.

(pl. XXVI, fig. 5; pl. XXVIII, fig. 5; pl. XXIX, fig. 4; pl. XXX, fig. 1-3; text-fig. 43)

Holotype: The entire specimen, figured on pl. XXX, fig. 2.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: longicaudata — provided with an elongate pygidium.

Diagnosis. — Comparatively large individuals, up to 4 cm long. Genal spines short, directed antero-laterally. Glabella irregularly ornamented by different sized tubercles, one

strong spine in one-third of glabellar length. Many different sized, irregularly arranged tubercles on cheeks. Thoracic pleurae produced into short spines. Pygidium long, with 11-12 rhachial rings and 3 pleurae with pointed, but short ends.

Material. — 60 specimens (5 entire among them) from the *Staurocephalus clavifrons* zone of Poland, some pygidia from Bornholm, Scania and Västergötland.

Dimensions of 3 specimens (in mm):

Locality	Brzezinki		
IG Mus. cat. no.	2. II. 109	2. II. 110	2. II. 108
Length of entire individual	22.0	ca. 24.0	ca. 18.0
Length of cephalon	6.5	7.1	—
Width of cephalon	11.2	12.9	—
Width of glabella at the base	2.5	2.3	—
Greatest glabellar width	5.1	4.6	—
Length of pygidium with spines	6.7	—	4.5
Length of pygidial rhachis	5.0	4.1	2.9
Width of pygidium	5.2	5.1	4.5

Description. — *Cephalon.* The outline is sub-semicircular. The cephalon (glabella as well as the cheeks) are very strongly convex longitudinally and transversely. The width (tr.) of the occipital ring is equal to one-fourth of the cephalic base. The occipital ring is convex (long.), occipital furrow is shallow being as wide (long.) as the occipital ring, but transversely shorter than it. On the dorsal furrows, at the posterior part of the occipital furrow, there are round pits. There are similar pits on the dorsal furrows, slightly in front of the occipital furrow. Between these two pits, on the dorsal furrow, there is formed a small tubercle. The dorsal furrows are very deep. Running from the occipital ring, they converge slightly at first, and then diverge strongly anteriorly. The posterior border is strongly convex (long.), the posterior border furrow is deep at the dorsal furrow, shallowing peripherally. The border is wider than the posterior border and the border furrow is wide. The distal part of the posterior border curves anteriorly, forming an arch with the lateral border. In the transverse continuation of the posterior border at the point where it bends anteriorly, there is a short, pointed genal spine, directed transversely and slightly anteriorly. The cheeks are large and strongly convex. The facial suture cuts the lateral border in front of the genal spine and runs along the interior edge of the border, close to the border furrow, around the cephalon. The free cheeks cut off in such a way are very narrow.

Thorax. The rhachial width is more than half that of the pleura together with the spine. The rhachial rings are convex, slightly arched anteriorly. Deep dorsal furrows converge strongly posteriorly. Every rhachial ring is divided transversely into a flat and short (long.) anterior articulating ring and a strongly convex, wider (long.) posterior portion. The latter becomes still wider (long.) at the dorsal furrows, curving slightly anteriorly at these points. The pleural segments are divided by the pleural furrow into a short (long.) and flat anterior portion and a much wider (long.) and more convex posterior. The latter narrows peripherally, being produced into comparatively short spines. The pleural ends of the first thoracic segments are directed postero-laterally (almost transversely), those of the following segments — posteriorly.

Pygidium. The pygidial rhachis is very long and triangular, being composed of 11-12 rings. The first two or three rings are separated by deep furrows, and are recognizable across the

entire rhachial width. The furrows among the following rings are deep for only one-third of their length (tr.), at the dorsal furrows, so that the rings are clearly recognizable only at the sides being fused almost entirely with one another in the middle part. There are three pleural

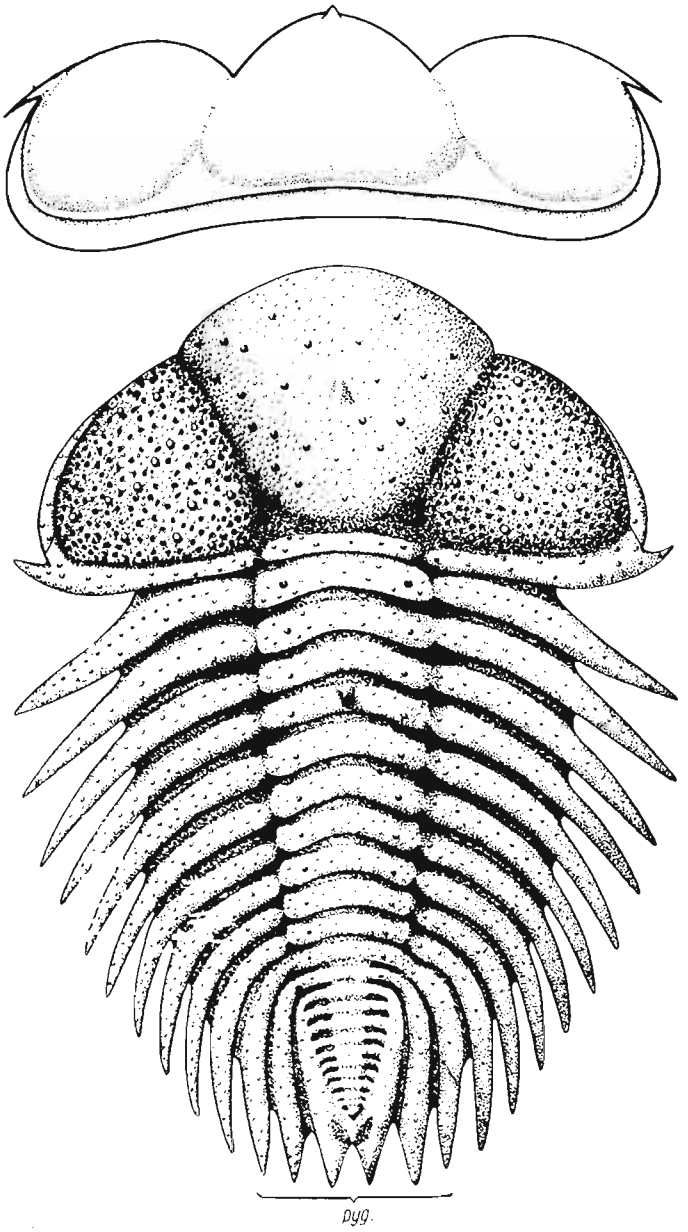


Fig. 43

Dindymene longicaudata n. sp. — reconstruction, in anterior and dorsal views; approx. × 5.

segments. The first and second are connected with the first and second rhachial rings respectively, and directed posteriorly in a strongly convex arch, distinctly delimited by deep furrows. The third pleural segment is not clearly connected with any of rhachial rings; it is flat and closely pressed against side of the rhachis, being delimited from the latter by a very shallow, indistinct

furrow. It meets the pleural segment of the other side behind the rhachis. The pleurae have free ends, extended into very short, stout spines. The ends of the two last segments lie along a straight line, the first ends a little in front of them.

Ornamentation. The glabellar surface is irregularly granulated with different sized tubercles. One can recognize at least three types of tubercles on the glabella — the minute granulation covering densely the entire glabellar surface, and smaller and greater tubercles, more closely spaced in the anterior part of the glabella. In one-third of the glabellar length there is a very strong, stout spine, with a wide base, directed upwards, but not completely preserved, however, on any of the specimens. The cheeks are pitted and granulated, and as with the glabellar ornamentation one can recognize a minute granulation and different sized, larger tubercles, densely covering the whole cheek surface. There are some scattered tubercles on the occipital ring and the posterior border. On the lateral border, along the facial suture there are two irregular rows of small tubercles. Parallel to them, on the cephalic margin there are several rows of very small denticles, one of which forms a marginal row of spines. On the thorax one can recognize a row of larger tubercles along every rhachial and pleural segment, and in addition to this a row or two of minute tubercles, along the anterior and posterior edge of the convex (posterior) part of every segment, especially well visible on the pleural ends. The spine on the fourth thoracic segment seems to be very strong and stout.

Discussion. — *Dindymene longicaudata* differs from the other representatives of this genus in having an especially strong, stout spine on the glabella, an irregularly ornamented cephalon, short, stout thoracic spines and a long pygidium with 11-12 rhachial rings and 3 pleurae. In the pygidial structure *Dindymene longicaudata* resembles *Eodindymene pulchra* (Olin), which has also a long rhachis with 8-9 rings and three pleurae. But it differs from the latter species in the different pattern of the cephalon, the ornamentation and the course of the facial suture.

Family **STAUROCEPHALIDAE** (Prantl & Přibyl, 1947)

Genus **STAUROCEPHALUS** Angelin, 1854

Staurocephalus clavifrons Angelin, 1854

(pl. XXIV, fig. 9; pl. XXVI, fig. 7-9)

Staurocephalus clavifrons Angelin from the Middle Ashgillian has been recently described in detail (Kielan, 1957). There is a mistake in that paper, concerning the date of the erection of the genus *Staurocephalus* and species *S. clavifrons* by Angelin; it is not 1878 as stated, but 1854.

Now I should like to record the occurrence of this species in the Upper Ashgillian, *Dalmanitina mucronata* zone, in the Holy Cross Mountains. 15 specimens of *S. clavifrons* were found in this zone at the locality of Zalesie.

The specimens of *S. clavifrons* from Zalesie are rather badly preserved, usually more or less depressed, so that the longitudinal profile of the cephalon, so characteristic of the species, cannot be observed on them. The general cephalic and pygidial pattern, the type of ornamentation, number of denticles on the cephalic margin and other details — are those characteristic of *S. clavifrons*, and I am of an opinion that there is no evidence for considering it a separate species or even subspecies.

Genus **OEDICYBELE** WHITTINGTON, 1938

Oedicybele kingi WHITTINGTON, 1938

(pl. XXV, fig. 4)

Oedicybele kingi from the *Staurocephalus clavifrons* zone has been recently described by KIELAN (1957). Here I shall only record its occurrence in the zone of *Dalmanitina mucronata* in Zalesie, Poland. *Oedicybele kingi* from Zalesie is represented by two fragmentary specimens. One of them is a fragmentary cheek and a part of the glabella. The ornamentation of the cheeks of *O. kingi* consists of pits, small tubercles and three larger tubercles among them. In our specimen from the *Dalmanitina mucronata* zone, although very badly preserved, traces of a similar ornamentation are visible, so it is almost certain that we are dealing here with the same species, which survived until the uppermost Ashgillian in this area.

Family **HARPIDAE** HAWLE & CORDA, 1847

Genus **HIBBERTIA** JONES & WOODWARD, 1898

Hibbertia sanctacrucensis n. sp.

(pl. XXXIV, fig. 4, 6; pl. XXXV, fig. 8; text-fig. 44)

Holotype: Cephalon figured on pl. XXXIV, fig. 6.
Type horizon and locality: Upper Ordovician, *Staurocephalus clavifrons* zone, Brzezinki, Poland.
Derivation of name: sanctacrucensis — occurring in the Holy Cross (Sanctus Crux) Mountains.

Diagnosis. — Glabella strongly pointed anteriorly. Alae small, almost entirely fused with first lateral glabellar lobes. The cheek-roll not extending onto the prolongations. Prolongations directed backwards and very slightly curved inwards.

Material. — Two almost entire cephalons, up to 12 mm long, and some cephalic fragments from the *Staurocephalus clavifrons* zone, of Brzezinki, in Poland.

All the specimens are poorly preserved and therefore the detailed measurements cannot be given.

Description. — The outline of the cephalon is oval. The width of the cephalon is about twice as great as the axial length. The occipital ring is wide (sag.), narrowing at the sides. In the anterior part of the ring, just behind the occipital furrow, there is a large occipital node. The occipital furrow is deep and distinct.

Dorsal furrows are deep and distinct, converging anteriorly. The anterior end of the glabella is rather pointed. In the posterior part of the glabella, between the occipital furrow and the first lateral glabellar furrow, the dorsal furrows almost completely disappear so that the ala is fused with the first lateral glabellar lobe. The lateral glabellar furrow is very deep and broad, it runs postero-medially, and then turns sharply and runs postero-laterally. It reaches the occipital furrow at the dorsal furrow. The length of the L_1 is less than one-third that of the glabella. The alar furrow begins at the dorsal furrow, at the same point as the first lateral glabellar furrow; it is deep at the dorsal furrow and runs laterally, slightly postero-laterally, then bends backwards and reaches the posterior border furrow as a very faint furrow. The posterior border is convex, being marked off by the presence of the distinct posterior border

furrow. It is only visible along the posterior margin of the cephalon and does not continue onto the prolongations.

The eye-tubercles form small elevations and are connected with the glabella by a distinct eye-ridge. The genal ridge is very faint, being directed postero-laterally. The cheek roll is very narrow, maintaining a constant width, anteriorly and laterally. The width (long.) of the cheek roll is equal to one-third that of the brim. The preglabellar field is still narrower (long.) than the cheek roll. The cheek roll does not continue onto the prolongation, being visible only at its base. The girder is narrow and is distinguished by the absence of an ornamentation. It reaches

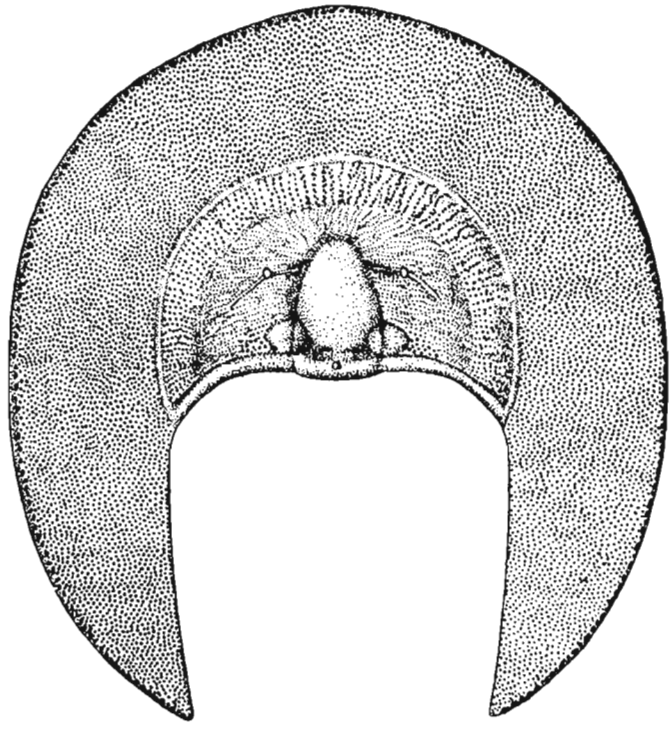


Fig. 44

Hibbertia sanctacrucensis n. sp. — reconstruction of the cephalon; approx. × 4.

the internal margin of the prolongation at its base. The brim is wide, maintaining a constant width anteriorly and laterally, and it occupies almost the entire area of the prolongation. The prolongations are large and wide, diminishing progressively in width posteriorly. The internal margins of both prolongations are almost parallel to each other, converging only very slightly.

The whole cheek surface is ornamented by small pits on the preglabellar field, and on the area of the cheeks around the glabella there are traces of very indistinct anastomosing lines.

Discussion. — The new species here described differs from the British representatives of *Hibbertia*, such as *H. flanaganni* (Portlock), *H. balclatchiensis* (Whittington) and *H. trippi* (Whittington) (cf. Whittington, 1950*b*) by smaller alae, by the almost entire fusion of the alae with the first lateral glabellar lobes, and by the more pointed anterior outline of the glabella.

In the Upper Ordovician of Bohemia harpids are unknown (PRANTL & PŘIBYL, 1954). They have not been described so far from the *Tretaspis* and *Staurocephalus* beds of Bornholm, Scania and Västergötland.

In the collection of Uppsala Museum there is one specimen (no. Ar. 2020) from the Red *Tretaspis* mudstones of Västergötland, described here as *Hibbertia* sp. This specimen shows close similarities to *Hibbertia sanctacrucensis* from Poland (cf. below).

Hibbertia sp.

(pl. XXXII, fig. 7)

In the collection of Uppsala Museum there is one almost completely preserved cephalon from the Red *Tretaspis* mudstones of Västergötland, which shows very close similarities with *Hibbertia sanctacrucensis* here described. It differs from the Polish specimens in having a comparatively narrower glabella, the alae not so completely fused with the first lateral glabellar lobes, and the ends of the prolongations more strongly bent inwards. Otherwise, it seems to be very similar to the Polish species.

On account of the rather poor state of preservation of the Polish, as well as the Swedish specimens in question, and also on account of the small number of specimens available, it is very difficult to judge to what extent these differences are due to the state of preservation. Nevertheless, they do not appear to be conspecific. They may form a different subspecies of the same species (geographical races) or even different species. The solution of this question requires more and better preserved material from both Poland and Sweden.

Family **SHUMARDIIDAE** LAKE, 1907

Genus **SHUMARDIA** BILLINGS, 1861

Shumardia polonica n. sp.

(pl. XXXII, fig. 5; text-fig. 45)

Holotype: Cephalon figured on pl. XXXII, fig. 5.
Type horizon and locality: Upper Ordovician, *Staurocephalus clavifrons* zone, Brzezinki, Poland.
Derivation of name: polonica — occurring in Poland.

Material. — Two cephalons from *Staurocephalus clavifrons* zone of Brzezinki, Poland.

Dimensions of the holotype (in mm):

Locality	Brzezinki
IG Mus. cat. no.	2. II. 321
Length of cephalon	1.6
Width of cephalon	3.0
Length of glabella	1.3
Width of glabella	1.2

Description. — The outline of the cephalon is sub-semicircular, a little narrower than a semicircle. The genal angles are nearly rectangular, but not pointed. The cephalon is as moderately convex transversely as longitudinally.

Dorsal furrows are deep, parallel from the occipital ring to first lateral glabellar furrow, then slightly convex outwards, forming a regular semicircle around the anterior part of the glabella. The occipital ring is gently convex, directed transversely, the occipital furrow is distinct. There is one lateral glabellar furrow (S_1) at one-third of the length of glabella from the occipital furrow. Leaving the dorsal furrows it runs at first transversely, for a very short distance, and then divides into two branches. The posterior branch is shallower than the anterior one and runs postero-medially to the occipital furrow. The width of the first lateral glabellar lobe cut off in such a way is less than one-fourth of the glabella. The posterior branch runs in an arch antero-medially and then anteriorly.

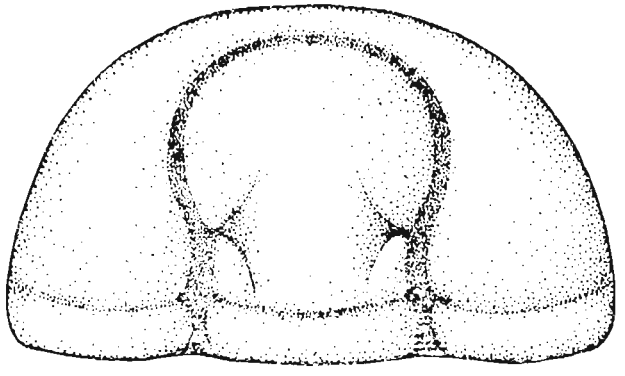


Fig. 45

Shumardia polonica n. sp. — reconstruction of the cranidium; approx. × 20.

The length (long.) of the preglabellar field is equal to that of the occipital ring.

The posterior border furrow is deep at the dorsal furrows and runs parallel to the posterior border. It becomes shallower peripherally and disappears before reaching the lateral border.

No traces of ornamentation or occipital node are preserved.

Discussion. — Several representatives of the genus *Shumardia* are known from the Lower Ordovician beds of Great Britain, Sweden, France, Canada and China (Lake, 1907; Moberg 1890; Moberg & Segerberg, 1906; Stubblefield, 1926; Troedsson, 1937). The latest known species was *Shumardia scotica* Reed, 1903, from the Caradocian beds (Whitehouse Group) of the Girvan district, Ayrshire. The specimen of *Shumardia* here described, belonging certainly to a new species, is the last representative of *Shumardia* in Ordovician times.

In the general shape of the glabella and cephalon our specimen is reminiscent of *Shumardia dicksoni* (Moberg), from the Lower Ordovician (*Shumardia* zone) of Scania. In *S. dicksoni*, however, there are two pairs of lateral glabellar furrows, S_1 being directed postero-medially and S_2 antero-medially. In our specimen the base of both furrows seems to be so close, that they form a single furrow with two branches (anterior and posterior).

The new specimen differs from *Shumardia scotica* in that, that the basal glabellar lobes (L_1) are larger. In *S. scotica* figured by Reed (1903, pl. 4, fig. 12) the lateral furrow is situated far forward and the first lateral furrow is not visible on the figure.

The specimens examined in British Museum have shown that in *S. scotica* there exists two furrows running as in our specimen, but the first furrow cutting off a slightly smaller first lateral lobe than in our specimen.

The anterior border of the glabella in our specimen is more rounded than in *S. scotica*.

The posterior portion of the glabella (across L_1) is wider in our specimen than in *S. scotica*, where there is a rather remarkable difference between the posterior (across L_1) and anterior (across L_2) parts of the glabella.

Family **DIONIDIDAE** GÜRICH, 1907, emend. RAYMOND, 1920

Genus **DIONIDE** BARRANDE, 1847

Dionide subrotundata n. sp.

(pl. XXXI, fig. 4; pl. XXXII, fig. 1-3; pl. XXXIII, fig. 7; pl. XXXV, fig. 5; text-fig. 46)

Holotype: The entire individual, figured on pl. XXXII, fig. 1.
Type horizon and locality: Upper Ordovician, *Tretaspis* beds, Bornholm, Vasagaard.
Derivation of name: subrotundata — the outline of the whole body sub-semicircular.

Diagnosis. — Small individuals, the general shape of the body nearly circular in outline. Glabella strongly convex with two pustules on median line in tandem. Cheek convex, no differentiated caeca genales, uniform ornamentation on the whole cheek surface consisting of pits in rectangles of raised lines. Genal spines large at their base, upper lamella strongly prolongated into genal spine. Pygidium very short, broad. Rhachis of 11 rings, 8-9 flat pleurae, the last pleurae gently concave anteriorly.

Material. — One nearly complete natural impression and one cephalon from Bornholm, *Tretaspis* beds; one cephalon and pygidium from Scania, Fågelsongsområdet, *Tretaspis* beds; some nearly complete individuals from Brzezinki, Poland, zone of *Staurocephalus clavifrons*.

Dimensions of 3 specimens (in mm):

Locality	Bornholm, Vasagaard	Sweden, Scania	Poland, Brzezinki
Mus. cat. no.	CM no. 1871, 1251	LM L. O. no. 3876 t	IG no. 2. II. 127
Length of entire individual	ca. 10.0	—	ca. 10.5
Length of cephalon	ca. 3.0	3.1	4.7
Width of cephalon	8.6	—	9.0
Width of glabella	3.2	—	3.0
Length of pygidium	2.0	2.5	-
Width of pygidium	6.2	7.0	6.5

Description. — The outline of the whole animal is subovate, nearly round.

Cephalon. The outline is sub-semicircular. Dorsal furrows are very deep, from the occipital furrow they run antero-laterally and then subparallel, rounding off anteriorly in a gentle curve. There are two short basal furrows, running straight forwards from the occipital furrow and cutting off the lateral lobes, which are narrower than the median part. Glabella is strongly convex both transversely and longitudinally. There are two pustules in tandem on the median line of the glabella, near its centre; the posterior pustule is a little larger than the anterior one. Occipital ring is very narrow (sag.) and short (tr.), its width (tr.) being much narrower than that of the glabella.

Cheeks are large, strongly convex, steeply sloping and fused in front of the glabella. Posterior border begins behind the basal glabellar lobes, runs transversely for half the width of the cheek, and then bends backwards and runs along the genal spine, on which it disappears. The base of the genal spine is very broad (tr.), as wide as half the cheek width. The whole cheek surface is covered by raised, anastomosing lines, with pits in rectangles among them. There is no difference between the ornamentation of the internal part of the cheek and the upper

lamella. Along the cephalic margin, on the upper lamella, there is a single row of pits, which are a little larger, than the other pits on the cheek surface. Externally to this row of pits there runs a suture, cutting off a raised girder. Fringe is produced into the genal spine, as far as the level of the fourth thoracic segment. At this point the spine becomes narrower. The spine is very long, produced beyond the pygidial end. In most specimens only the lower lamella is preserved.

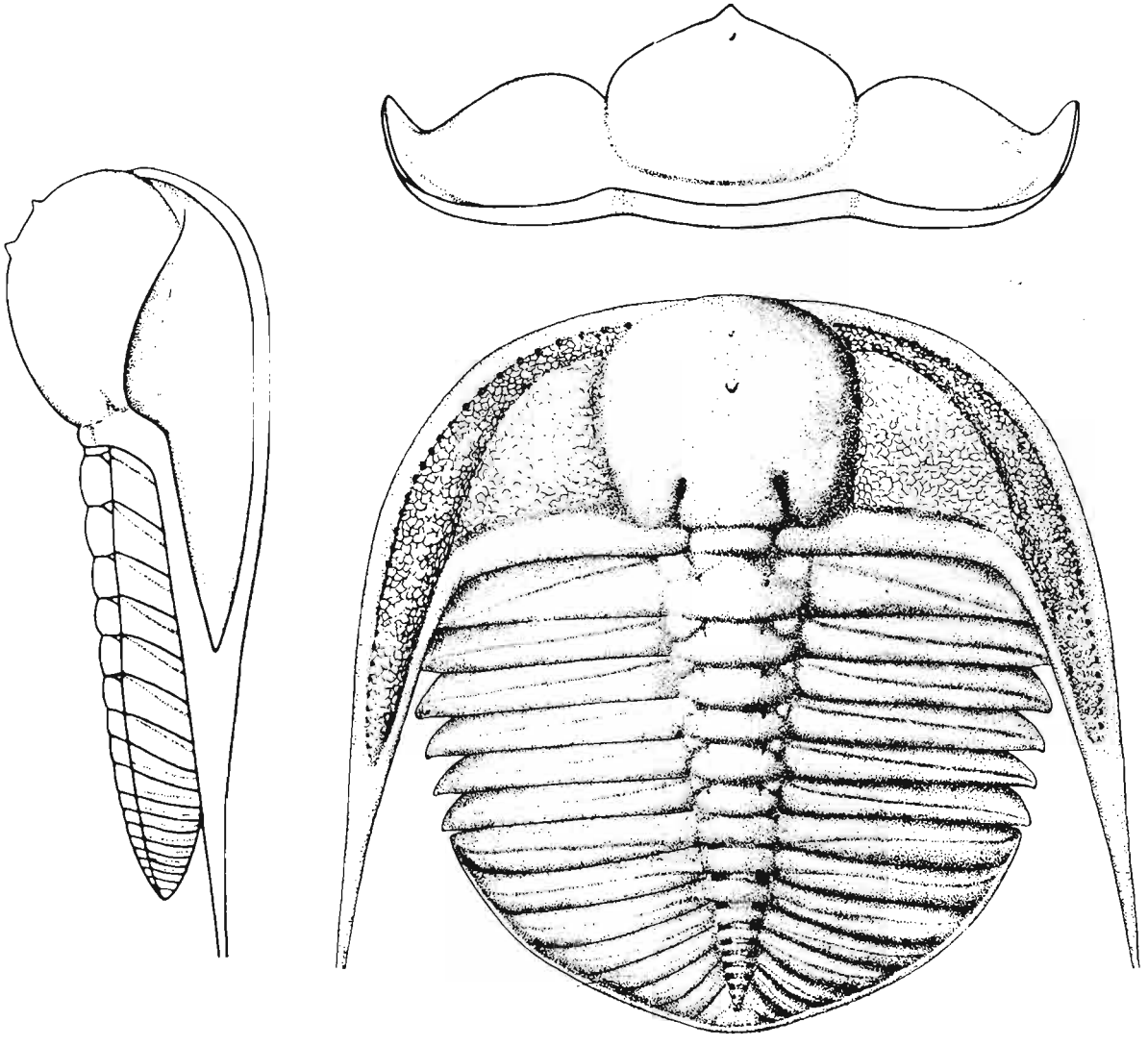


Fig. 46

Dionide subrotundata n. sp. — reconstruction, in anterior, lateral and dorsal views; approx. ×. 9.

Thorax is composed of six segments. The width (tr.) of the first thoracic rings is greater than that of the occipital ring, but narrower than that of the glabella. The dorsal furrows are very distinct, converging posteriorly. On the lateral part of every thoracic ring, at the dorsal furrow there is a small triangular surface, distinctly cut off from the rest of the ring.

Pleurae are broad (long.) and flat. Each pleura is divided (tr.) by a very distinct pleural furrow, which begins at the dorsal furrow in the anterior part of the pleura and then runs

postero-laterally, and later on laterally, dividing the pleura into a narrower (long.) anterior part and broader posterior. The ends of the thoracic segments are not preserved.

Pygidium is short and wide. The rhachis is very narrow, slightly convex, dorsal furrows distinct. There are 11 pygidial rings. The furrows among the rhachial rings are a little convex anteriorly in the middle part, and are then directed again slightly anteriorly at the dorsal furrows. There are 8-9 pygidial ribs, with very deep, distinct pleural furrows among them and with very faint, thread-like interpleural furrows on every rib. The interpleural furrow divides every rib into a wider (long.) anterior part and a narrower posterior. The first ribs are directed almost transversely, slightly posteriorly; the last ribs are directed postero-laterally, slightly convex posteriorly. The first half-segment is long (tr.) and convex.

Discussion. — *Dionide speciosa* (Hawle & Corda, 1847) has been recorded by Barrande (1852, 1872) as a synonym of *Dionide formosa* Barrande, 1846. Raymond (1925, p. 23), Kobayashi (1940, p. 205) and Whittington (1952, p. 5, 7) have recognized *D. speciosa* as an independent species, occurring in the Upper Ordovician, Králův Dvůr beds of Bohemia.

The new species described above shows some similarities with *D. speciosa*, but differs from the latter species in the absence of the developed caeca genales on the cheeks, the genal spines having a wider (tr.) base, and the upper lamella being further produced onto genal spines. The most striking differences between these two species are in the pygidial structure; there are 11 rhachial rings and 8-9 pleurae in our species, whereas 10-15 rhachial rings and 10-12 pleurae in *D. speciosa*. Moreover, the last pleural segments of our species are directed transversely, but slightly concave anteriorly, whereas they are straight in *D. speciosa*.

From *Dionide decorata* n. sp., occurring in the same beds in Poland, *Dionide subrotundata* differs in having larger genal spines, uniform ornamentation of the cheeks and shorter (long.) pygidium.

Dionide decorata n. sp.

(pl. XXXI, fig. 1-3; text-fig. 47)

Holotype: Cephalon figured on pl. XXXI, fig. 2.
Type horizon and locality: Upper Ordovician, zone of *Staurocephalus clavifrons*, Brzezinki, Poland.
Derivation of name: decorata — with beautiful ornamentation of the cephalon.

Diagnosis. — Glabella with two pustules on median line in tandem. One slightly visible caecum genalis on the inner part of cheek. Large pits in rectangles of comparatively broad, raised lines on inner part of cheek, much smaller pits in rectangles of finer raised lines on upper lamella. Base of genal spine very narrow (tr.), fringe not produced into genal spine. Posterior border transversely directed and not ornamented. Pygidium with 18 rhachial rings and 16 pleural ribs.

Material. — Some cephalons, up to 11 mm long, and some pygidia with several thoracic segments preserved, from *Staurocephalus clavifrons* zone, Brzezinki, Poland.

On account of the fragmentary preservation of all the specimens, the measurements cannot be given.

Description. — *Cephalon.* The outline is wider than a semicircle. The dorsal furrows run from the occipital ring strongly diverging and then subparallel, rounding off anteriorly in a gentle curve. Glabella is gently convex transversely, more strongly longitudinally. The short basal glabellar furrows cut off the basal lobes half as wide as the median one. There are two tubercles in tandem along the median line of the glabella, the anterior one a little

behind the middle of glabella. The posterior tubercle is a little larger than the anterior one. The occipital ring is very narrow (long.) and short (tr.). Cheeks are wide (tr.) moderately convex, fused in front of the glabella. Posterior border is wide (long.), almost flat, being directed transversely. Posterior border furrow is deep at the dorsal furrows, becoming very shallow peripherally. Cheek is produced into a long spine (not completely preserved), with a very narrow base. The fringe is not produced into a spine. The interior part of the cheek

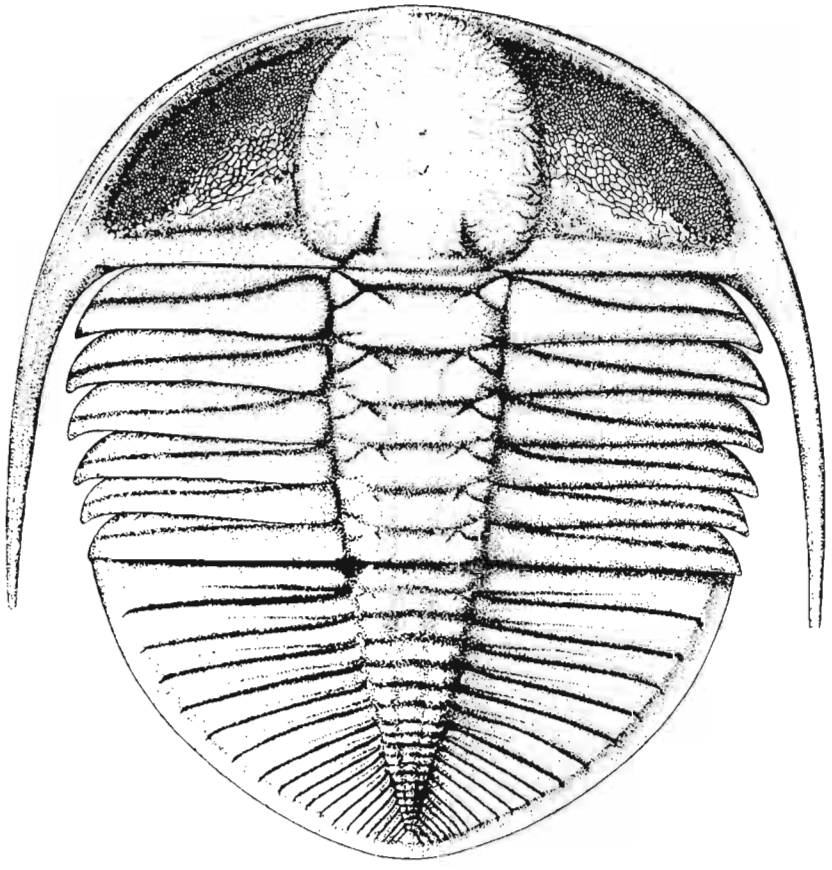


Fig. 47

Dionide decorata n. sp. — reconstruction; approx. × 3.

differs strongly from the upper lamella, being more convex. On the interior part of the cheek there are large pits in rectangles of comparatively broad, raised lines, whereas on the upper lamella the raised lines are much narrower, and the pits are several times smaller. The boundary between the interior and exterior part of the cheek is marked on the posterior border in half of its length (tr.). There is one slightly visible caecum genalis, running postero-laterally through the interior part of the cheek. Along the cephalic margin on the upper lamella there is a row of larger pits, smaller however than on the interior part. Outside of this row of pits there runs a suture, cutting off the raised girder.

Thorax is not completely preserved in any of the specimens. Dorsal furrows are very deep, slightly converging posteriorly. Thoracic pleurae are flat, long (tr.), divided by very distinct pleural furrows, which begin at the dorsal furrows in the anterior corners of pleurae,

run postero-laterally and then transversely, dividing the pleurae into anterior and posterior portions, both of the same width (long.) in the peripheral part. Thoracic pleurae are slightly bent down at their ends and bluntly rounded off.

Pygidium is wider than a semicircle. The rhachis is very narrow, strongly converging posteriorly and composed of 18 rings. There are 16 wide (tr.) ribs on the pleurae. The first half-rib runs along the whole anterior pygidial margin. All the ribs are divided by very faint (more distinct at dorsal furrows) interpleural furrows. This begins at the dorsal furrows on the posterior part of the rib, then runs along the rib, dividing it into anterior and posterior parts. The anterior part of the rib decreases in width (tr.) peripherally, the posterior one increases. The first ribs are directed transversely; the later, which are slightly convex anteriorly, are directed more posteriorly.

There are no traces of ornamentation on the thoracic and pygidial surface.

Discussion. — The new species described here is known only from Central Poland. In Scandinavia there occurs a closely related species — *Dionide euglypta* (ANGELIN). It was impossible to identify the original of ANGELIN's *Polytomurus euglyptus* in the Riksmuseum collections (Stockholm). But there is quite a number of specimens of *Dionide* from ANGELIN's type locality, from the Red *Tretaspis* mudstones of Västergötland. The examination of these specimens, as well as of the specimens of *D. euglypta* from Jämtland, described by ASKLUND (1936), has shown the following differences between these two, otherwise closely related species.

In *Dionide euglypta* the whole cheek surface is covered by an uniform ornamentation of small pits in rectangles of raised lines. In *Dionide decorata* n. sp. there are large pits on the inner parts of cheek, and much smaller ones on the upper lamella. In *D. euglypta* there are small tubercles on the posterior border of the cephalon, whereas in *D. decorata* the posterior border is smooth. Moreover, the pygidium of *D. euglypta* is longer and composed of a greater number of segments (up to 22 rhachial rings and 18 pleural ribs).

Family **RAPHIOPHORIDAE** ANGELIN, 1854

Genus **RAPHIOPHORUS** ANGELIN, 1854

Raphiophorus tenellus (BARRANDE, 1872)

(pl. XXXV, fig. 6)

1872. *Ampyx tenellus* n. sp.; J. BARRANDE, Système Silurien..., Suppl., p. 50, pl. 2, fig. 28-30.
1906. *Ampyx tenellus* BARRANDE; E. OLIN; Om de Chasmopskalken..., p. 71, pl. 4, fig. 11-12.

Material. — 9 cranidia, one almost entire specimen, one pygidium from the zone of *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland.

The representatives of *Raphiophorus tenellus* in our collection are small (the cephalic length not exceeding 6 mm). As they are usually poorly preserved, more detailed measurements cannot be given.

Description. — *Cephalon.* The cranidium is slightly longer than half its width. The glabella is oval, strongly convex longitudinally and transversely, extending for half its length beyond the cheek margin. The glabella is produced into a short, round spine directed anteriorly. The occipital ring is narrow (long.) and moderately convex. The occipital furrow is

wide (long.) with two deep pits at the dorsal furrows. The fixed cheeks are triangular. The posterior border is narrow (long.), the posterior border furrow is distinct, with a small, round pit at its distal end near the facial suture. The facial suture cuts the posterior border and runs obliquely antero-medially. The free cheeks are narrow. The genal spine is not preserved on the Polish specimens. As figured by BARRANDE (1872, pl. 2, fig. 28-30), it is very long, its length exceeding more than twice the entire body length. It is directed at first in an arch postero-laterally and then posteriorly, and in its posterior part — postero-medially. All the Bohemian specimens of *Raphiophorus tenellus* are preserved as internal moulds, and no traces of an ornamentation have been recognized (comp. BARRANDE, 1872, p. 50). On the latex casts of some of the Polish specimens one can see that the glabellar surface is minutely granulated. The surface of the cheeks seems to be smooth.

Thorax. There are five thoracic segments, the first segment being longer than the others. The rhachial rings are slightly bent anteriorly at the dorsal furrows. The pleurae are flat, with a pleural furrow dividing each pleura into the anterior and the posterior part.

Pygidium is wide and short. The rhachis occupies less than one-fourth of the pygidial width. There are 3 rhachial rings, slightly convex anteriorly. On the pleurae there are two thread-like furrows, directed postero-laterally, separating off three pleural segments which widen considerably towards the periphery. There is a wide, flat border, directed slightly obliquely downwards.

Discussion. — I have not noticed any difference between the Bohemian, Polish and Scanian representatives of this species and I treat all of them as conspecific

Raphiophorus gratus (BARRANDE, 1872)

(pl. XXXII, fig. 6; pl. XXXIII, fig. 4, 5; pl. XXXVI, fig. 7; text-fig. 48)

1872. *Ampyx gratus* n. sp.; J. BARRANDE, Système Silurien..., Suppl., p. 48, pl. 2, fig. 26-27.
1899. *Ampyx gratus* BARRANDE; J. P. J. RAVN, Trilobitfaunaen..., p. 54.
1906. *Ampyx gratus* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 69, pl. 4, fig. 4.
1906. *Ampyx globifrons* n. sp.; E. OLIN, *Ibid.*, p. 71, pl. 4, fig. 13.

Material. — One nearly entire specimen, several cranidia from the zones of *Eodindymene pulchra* and *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland.

Description. — The specimens recorded here as *Raphiophorus gratus* are fairly small individuals, the length of the cranidium being from 3 to 7 mm. As all specimens are more or less strongly compressed, more detailed measurements cannot be given.

Free cheeks are not preserved. The outline of the cranidium is narrower than a semicircle. Glabella is strongly convex (tr. and long.), not protruding over the anterior cephalic margin, or very slightly only. The dorsal furrows are very deep. Posteriorly the glabella narrows strongly. No lateral glabellar furrows are preserved. The occipital ring is narrow (long.), situated much lower than the glabella. The occipital furrow is deep, with pits at the dorsal furrows. The cheeks are large and slightly convex. The posterior border is narrow (long.), slightly convex and directed transversely. The posterior border furrow is very narrow and shallow at the dorsal furrow, becoming deeper peripherally, with a deep, round pit at the facial suture. The facial suture cuts the posterior border and runs anteriorly and slightly medially, curving in a gentle arch to form an anterior, transversely directed margin of the cranidium, to the glabella.

There are 5 thoracic segments. Pleurae are very flat, divided by an oblique pleural furrow, and not produced into spines. The pygidium is small, short (long.) with 2-3 rhachial rings and 3 pleurae, directed postero-laterally, widening peripherally and delimited from each other by a faint thread-like furrow.

Ornamentation. The whole glabellar surface is minutely granulated. The surface of the cheeks is smooth. On the thorax and pleurae no traces of an ornamentation are preserved.

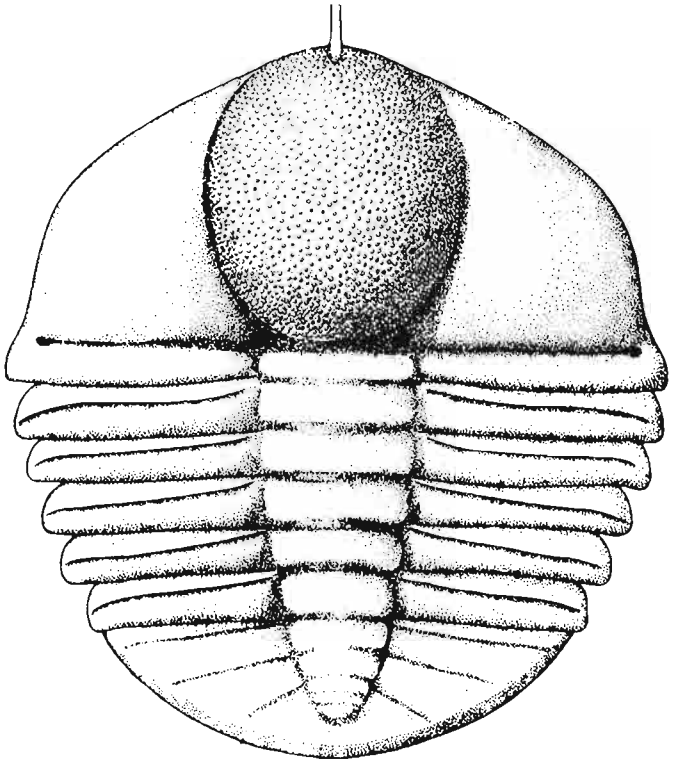


Fig. 48

Raphiophorus gratus (BARRANDE) — reconstruction (free cheeks not preserved); approx. × 6.

Discussion. — OLIN (1906) described *Ampyx gratus* BARRANDE, as well as *A. globifrons* n. sp. from the *Tretaspis* beds of Scania. The cranidium identified by OLIN as *A. globifrons* is especially well preserved in limestone and has suffered no distortion at all. The specimens identified by him as *A. gratus* are, however, preserved in mudstone as slightly depressed internal moulds. The difference between *Raphiophorus gratus* and *R. globifrons* is in the shape of the glabella and cheeks. The glabella of *R. globifrons* is much more strongly convex and rounded than in *R. gratus*, where it is oval and not so strongly convex. Moreover the cheeks in *R. globifrons* are also very strongly convex (long.), whereas they seem to be almost flat in *R. gratus*. An examination of raphiophorid material from Poland, Bornholm and Scania has proved to me, that the differences between *R. gratus* and *R. globifrons* are due simply to the state of preservation of the specimens concerned. There are all intermediate stages between oval-like and rounded glabella, the ornamentation being identical in all types. Therefore *R. globifrons* is recorded here as a junior subjective synonym of *R. gratus*.

Raphiophorus acus (TROEDSSON, 1918)

(pl. XXXII, fig. 4; pl. XXXV, fig. 7)

1918. *Ampyx acus* n. sp.; G. T. TROEDSSON, Om Skånes Brachiopodskiffer, p. 98, pl. 2, fig. 24.

Material. — 4 more or less fragmentary specimens from the *Staurocephalus clavifrons* zone of Brzezinki; 2 specimens (1 pygidium and 1 cranidium) from the *Dalmanitina mucronata* zone of Stawy, Poland.

Dimensions of 3 specimens (in mm):

Locality	Brzezinki		
IG Mus. cat. no.	2. II. 334 a	2. II. 312	2. II. 360
Length of cephalon without spine	2.9	3.8	—
Width of cephalon	4.3	5.6	—
Length of pygidium	—	1.1	1.5
Width of pygidium	—	4.8	5.2
Width of pygidial rhachis	—	0.9	1.0
Length of genal spine	more than 9.0	—	—

Description. — The outline of the entire body, excluding the protruding part of the glabella, is subcircular. The glabella extends beyond the outline of the cheeks for one-third of its length. The greatest width of the glabella is across the anterior margin of the cheeks. The anterior part of the glabella, protruding beyond the cheek margin, is semicircular, produced in front into a frontal spine, circular in section. The frontal spine is crushed in all the specimens. The glabella narrows sharply posteriorly, the dorsal furrows being wider at the posterior part. The occipital ring is flat and narrow (long.), the occipital furrow is very wide. The glabella is strongly convex, the cheeks moderately convex. The exterior outline of the cheeks is rounded and convex. The posterior border is distinct and flat, delimited by a transverse, narrow posterior border furrow. The genal angles are produced into very long genal spines, the length of which exceeds more than twice the length of the entire body. The genal spine is directed at first a short distance almost transversely, then it forms a gentle arch and runs postero-laterally, almost posteriorly. It is difficult to say, whether the genal spine is circular in section. On the ventral side of the spine there is a longitudinal groove, preserved as an internal mould. Free cheeks seem to be preserved, but the course of the facial suture cannot be traced.

Thorax is composed of 5 segments, the first one being longer than the others. The rhachis is narrow, occupying a little less than one-fourth of the segmental length (tr.). The pleurae are flat, with distinct pleural furrows, directed postero-laterally.

Pygidium is very short and transverse. The rhachis is composed of three narrow (long.) segments, convex anteriorly. On the pleurae there are two indistinct segments, delimited by thread-like furrows. They are directed postero-laterally, strongly widening peripherally. In front of the first pleural segment there is a considerably large first half-segment, its top reaching the rhachis. The second pleural segment is very small and indistinct. Around the pygidium there is a very wide border, sloping downwards. Its length along the midline is almost a half that of the pygidium.

Ornamentation. The glabellar surface is densely covered by minute granulations. On the other parts of the body the ornamentation is not preserved. There are concentric striae along the pygidial border.

Discussion. — This species was described by TROEDSSON (1918) from the *Staurocephalus clavifrons* zone of Scania (Tommarp), where only a single cranidium was found. When describing the species TROEDSSON pointed out its similarities to *Raphiophorus setirostris* ANGELIN, from the Black *Tretaspis* shales of Siljan district, Sweden. *R. setirostris* (known from a single specimen only) has been recently refigured by WHITTINGTON (1950*a*, pl. 74, fig. 1-2). This specimen has a crushed cephalon, so that the course of the facial suture and the nature of the cheeks cannot be observed. It seems that there are some differences in the course of the genal spines, but on account of the bad state of preservation of *R. setirostris* these differences cannot be stated with any certainty. Also the pygidium of our species (preserved on two specimens together with a cephalon) is provided with a very wide border which seems to be very similar to that of *R. setirostris*. The similarities between the two species in question are so great that it is not certain whether *R. acus* is not conspecific with *R. setirostris* in spite of the different geological range. In such a case *R. acus* would be a junior synonym of *R. setirostris*. This may be established, however, only if more material of both species is collected. On the other hand, *R. acus* shows close similarities to *R. rouaulti* (BARRANDE, 1852), from the Lower Silurian (Wenlock) of Bohemia, locality of Borek. It differs from *R. rouaulti* in having the genal spines directed postero-laterally, whereas in the latter species they are more arched at the beginning of their course, and are directed entirely posteriorly in the posterior part of their course. *Raphiophorus* sp., described by WHITTARD (1955) from the zone of *Nemagraptus gracilis* of Great Britain, also shows similarities to our species.

Raphiophorus acus differs from *R. tenellus* (BARRANDE) in having larger cheeks of more rounded outline, with the glabella protruding less over the cheek margin and the first thoracic segment markedly longer than is the case in *R. tenellus*. Also the genal spines of *R. tenellus* are directed in its posterior part postero-medially, whereas in our species — postero-laterally. It is also not certain whether the specimens from the *Dalmanitina mucronata* zone of Stawy are conspecific with those from the zone of *Staurocephalus clavifrons*, described above. The pygidium from *Dalmanitina* beds seems to have a narrower (long.) border than that from *Staurocephalus clavifrons* zone. The specimens from the *Dalmanitina* beds are, however, too poorly preserved to be described separately, and therefore in the collection they are recorded as *Raphiophorus* cf. *acus* (TROEDSSON).

Genus **LONCHODOMAS** ANGELIN, 1854

Lonchodomas portlocki (BARRANDE, 1846)

(pl. XXXIII, fig. 8; pl. XXXV, fig. 4)

1846*b*. *Ampyx Portlocki* n. sp.; J. BARRANDE, Nouveaux Trilobites. Suppl..., p. 9.
1847. *Ampyx bohemicus* n. sp.; J. HAWLE & CORDA, Prodrom einer Monographie..., p. 38, pl. 3, fig. 19.
1847. *Ampyx Portlocki* BARRANDE; J. HAWLE & A. CORDA, *Ibid.*, p. 38.
1851. *Ampyx tetragonus* n. sp.; N. P. ANGELIN, Palaeontologia Scandinavica, p. 20, pl. 17, fig. 2.
1852. *Ampyx Portlocki* BARRANDE; J. BARRANDE, Système Silurien..., p. 636, pl. 30, fig. 24-28.
1854. *Raphiophorus depressus* n. sp.; N. P. ANGELIN, Palaeontologia Scandinavica, p. 82, pl. 40, fig. 9.
1869*b*. *Ampyx (Lonchodomas) tetragonus* ANGELIN, var. *gigas* n. var.; J. G. O. LINNARSSON, Om Västergötlands Cambriska..., p. 89, pl. 2, fig. 49.
1884*b*. *Ampyx Portlocki* BARRANDE; O. NOVÁK, Zur Kenntnis..., p. 29.
1906. *Ampyx Portlocki* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 69, pl. 4, fig. 5-8.

Material. — About 70 more or less fragmentary specimens from the zones of *Eodindymene pulchra* and *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland; several specimens from the Red *Tretaspis* beds of Västergötland and *Tretaspis* beds of Scania; BARRANDE's original specimens from the Králův Dvůr beds of Bohemia.

Description. — The length of the entire individual (excluding spine) is only slightly greater than its greatest width.

Cephalon has a triangular shape, with the length slightly greater than half of the basal width. The glabella is convex, the cheeks moderately convex. The glabella has a trapezoidal shape. The dorsal furrows running from the occipital furrow diverge strongly anteriorly, the greatest width of the glabella being along the outline of the cheeks. The part of the glabella protruding over the contour of the cheeks is triangular, being drawn out anteriorly into a long, prismatic spine, the length of the spine being equal to, or exceeding that of the entire body. Deep, elongate anterior pits occur at the anterior end of the dorsal furrows. The occipital furrow is very shallow, the occipital ring is flat and not marked off from the posterior border by the dorsal furrows. The posterior border is also flat, the posterior border furrow deepens towards the periphery and ends in a deep transverse pit, just inside the suture line. The cheeks are triangular. The facial suture cuts the posterior cephalic margin close to the genal angles and runs anteriorly in a curve which is concave outwards. Then it runs along the lateral margin of the cephalon, and crosses the doublure in an arch anteriorly convex, dividing the ventral part of the cephalon. The doublure is long, reaching back half the glabellar length. The free cheeks are small, subtriangular, and drawn out into long, prismatic genal spines, which may be straight, directed obliquely postero-laterally, or form an arch, being directed at first postero-laterally and then posteriorly. There is a great variation in the shape of the genal spines within this species. They may be entirely straight, slightly arched and directed postero-laterally, then directed more strongly posteriorly, and in extreme cases, as figured by LINNARSSON (1869*b*) — directed entirely posteriorly. As there are, however, all the intermediate forms between the type with straight spines and the type with the spines directed posteriorly, there is no reason to treat them as different species.

Thorax consists of 5 segments. The length (long.) of the first thoracic segment is greater than the others. The rhachis occupies more than one-third of the segmental width. The rhachial rings are flat, gently convex anteriorly in the midline. The dorsal furrows are shallow, there is a small round pit on every segment, on the posterior part of the dorsal furrow. The pleurae are horizontally extended, with a wide pleural furrow, directed antero-laterally.

Pygidium is wider than a semicircle, the postero-lateral margins forming a smooth curve. The rhachial furrows are very shallow, converging posteriorly, the rhachis is gently convex and triangular. There are traces of 5 rhachial segments, defined by the presence of a pair of suboval muscle scars on each segment. On the pleurae only one pleural furrow is recognizable, directed parallel to the anterior margin of the pygidium and delimiting the first half-segment. There is a wide border sloping down, all around the pygidium.

Ornamentation. The whole body surface is densely covered by fine pits, usually better preserved on the cephalon than on the rest of the body. On one specimen, in addition to the pits, there are the small granules. On the pygidial border there are concentric terrace lines.

Discussion. — TÖRNQUIST (1884-85, p. 88) expressed the opinion that *Ampyx tetragonus* ANGELIN, 1851, and *Raphiophorus depressus* ANGELIN, 1854, were identical and that both

of them are conspecific with *Lonchodomas portlocki* (BARRANDE, 1846). An examination of the Swedish *Lonchodomas* material has led me to the same conclusion. The specimen figured by LINNARSSON (1869*b*, pl. 2, fig. 49) as *Ampyx (Lonchodomas) tetragonus* var. *gigas*, differs from the Swedish, as well as from the Polish specimens in the shape of its genal spines. In this specimen the genal spines are directed strongly backwards, running parallel to the axis of the animal, which is not the case in the other specimens. The comparison of the shape of the genal spines in very many Polish as well as Swedish specimens has shown that this character is strongly variable and that the shape of the spines does not change with the growth of the animal.

Lonchodomas drummuckensis (REED, 1903) from the Drummuck Group (U. Bala), Thraive Glen, Starfish Bed, shows striking resemblances with *Lonchodomas portlocki*. The only difference is in the shape of the glabella, which in *L. drummuckensis* is more elongate than in *L. portlocki* and reminds one of *Lonchodomas rostratus*. Otherwise the similarities between the two species in question are striking, include the general shape of the cephalon and pygidium, the ornamentation and the presence of pits on the dorsal furrows. It is highly probable that two species in question form only different subspecies (geographic races) of one species.

Family **TRINUCLEIDAE** EMMRICH, 1845
Subfamily TRETASPINAE WHITTINGTON, 1941

Genus **TRETASPIS** MCCOY, 1849

Tretaspis granulata (WAHLENBERG, 1818)

(pl. XXXIII, fig. 1-3; pl. XXXIV, fig. 1-2; pl. XXXV, fig. 1-2; pl. XXXVI, fig. 6; text-fig. 49)

1818. *Entomostracites granulatus* n. sp.; G. WAHLENBERG, Petrificata Telluris..., p. 15, pl. 2, fig. 4.
1828*b*. *Asaphus granulatus* WAHLENBERG; J. W. DALMAN, Über die Palaeaden..., p. 66, pl. 2, fig. 6.
1845. *Trinucleus granulatus* WAHLENBERG; S. L. LOVÉN, Svenska Trilobiter, p. 109, pl. 2, fig. 2.
1846*a*. *Trinucleus Bucklandi* n. sp.; J. BARRANDE, Notice préliminaire..., p. 31.
1852. *Trinucleus Bucklandi* BARRANDE; J. BARRANDE, Système Silurien..., p. 621, pl. 29, fig. 11-17; non fig. 10 and non pl. 30, fig. 14-16.
1854. *Trinucleus Wahlenbergi* ROUAULT; N. P. ANGELIN, Palaeontologia Scandinavica, p. 64, pl. 34, fig. 1, 1a.
1899. *Trinucleus Bucklandi* BARRANDE?; J. P. J. RAVN, Trilobitfaunaen..., p. 54.
1906. *Trinucleus Bucklandi* BARRANDE; E. OLIN, Om de Chasmopskalken..., p. 66, pl. 4, fig. 1.
1906. *Trinucleus elliptifrons* n. sp.; E. OLIN, *Ibid.*, p. 68, pl. 4, fig. 2.
1930. *Tretaspis granulata* (WAHLENBERG); L. STØRMER, Scandinavian Trinucleidae..., p. 69.
1930. *Tretaspis granulata* (WAHLENBERG) var. *bucklandi* (BARR.); L. STØRMER, *Ibid.*, p. 70, text-fig. 30, 31.
1945. *Tretaspis granulata* (WAHLENBERG, 1818) forma typica; L. STØRMER, Remarks on the Tretaspis..., p. 400.
1945. *Tretaspis granulata* (WAHLENBERG) var. *bucklandi* (BARRANDE); L. STØRMER, *Ibid.*, p. 401.
1955. *Tretaspis granulata bucklandi* (BARRANDE); Z. KIELAN, On the stratigraphy..., pl. 1, fig. 1-3.

Material. — Ca. 2000 fragmentary and entire specimens from the zone of *Eodindymene pulchra* and of *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland; ca. 20 specimens from the *Tretaspis* beds of Scania, from the Red *Tretaspis* mudstones and *Staurocephalus* beds of Västergötland, Sweden; some specimens from the Králův Dvůr beds of Bohemia.

Dimensions of 4 specimens (in mm):

Locality	Brzezinki	Wólka		
IG Mus. cat. no.	2. II. 299 a	2. II. 316	2. II. 288 b	2. II. 295
Length of entire animal	37.0	7.2	—	—
Length of cephalon	17.7	3.8	12.2	—
Width of cephalon	ca. 26.0	6.2	24.1	—
Width of glabella at the base	7.0	1.0	4.8	
Length of pygidium	7.9	1.5	—	5.1
Width of pygidium	20.5	4.3	—	14.0
Width of rhachis	3.8	0.7	—	2.5

Description. — *Cephalon.* The outline is semicircular, the cephalon being strongly convex longitudinally and transversely, with a broad fringe, produced into long and wide genal prolongations. The dorsal furrows are deep, being wider posteriorly than in the anterior part, running at first subparallel, and then converging around a very convex pseudofrontal lobe. The occipital ring is very narrow (long.) and flat. The occipital furrow is almost entirely missing in the middle part, but is strongly marked off at sides, where there are deep, transverse pits, directed slightly postero-medially. The posterior part of the glabella is much narrower and situated lower than the strongly convex pseudofrontal lobe. S_1 is in the form of transverse pits directed antero-medially, similar to those on the occipital furrow. S_2 forms a boundary of the frontal lobe, being shallow in the middle part, strongly marked off at the dorsal furrows, in the shape of long (tr.) postero-medially directed pits. The posterior part of the glabella is closed between the pits of the occipital furrow and the pits of the first lateral glabellar furrow and forms a slightly convex trapezium.

The cheeks are convex, sloping steeply down at the sides. The posterior border is very narrow (long.), the posterior border furrow wide, deeper at the periphery than at the dorsal furrows. The fringe is very broad, the upper lamella being composed of steeply sloping cheek-roll and a wide, horizontally directed brim. In front of the pseudofrontal lobe there are two or three rows of pits on the cheek-roll, and three to four around the antero-lateral part of the cheek. There are about eight pits on the cheek-roll in a transverse line, which is a continuation of the posterior cephalic margin. On the brim there are three rows of pits in front of the glabella, and two rows on the lateral part of the cheeks. There are from 11 to 15 pits along the inner part of the posterior margin of the cephalon. On the peripheral part of the posterior border, close to the fringe, there is a single pit. On the outer band of the lower lamella there are two rows of tubercles in front of the glabella and one along the lateral part of the cheek. On the inner band there are three to four rows of tubercles in the anterior part, and six to seven rows of tubercles along the horizontal continuation of the posterior margin of the cephalon. The girder is very distinct and prominent. The genal prolongation reaches almost half the pygidial length, then it is produced into a thin spine, reaching back far beyond the pygidium.

Thorax is composed of six segments. The rhachis is narrow, the rings being slightly convex anteriorly in the middle part. The pleura is almost twice as wide as the rhachis, the pleural segments being directed transversely. There is a wide pleural furrow running from the antero-medial corner of the rhachis, postero-laterally, dividing each pleura into two parts. The furrow is very wide, occupying the greatest part of the pleura. The pleural ends are very slightly bent posteriorly, but they are bluntly cut off, not being produced into spines.

Pygidium is wider than a semicircle and is comparatively flat. The rhachis is very narrow, occupying less than one-fifth of the pygidial width. There are eight to nine rhachial rings, their width (tr.) strongly diminishing posteriorly to the end of pygidium. The rhachis strongly converges posteriorly, reaching the end of the pygidium. On the pleurae there are five segments delimited by faint pleural furrows, seen only on very well preserved specimens. There is a narrow pygidial border, directed downwards, with concentric striae around it.

Ornamentation. There is a single median tubercle on the posterior part of the pseudofrontal lobe. The whole glabellar and cheek surface is covered by an ornamentation of ana-

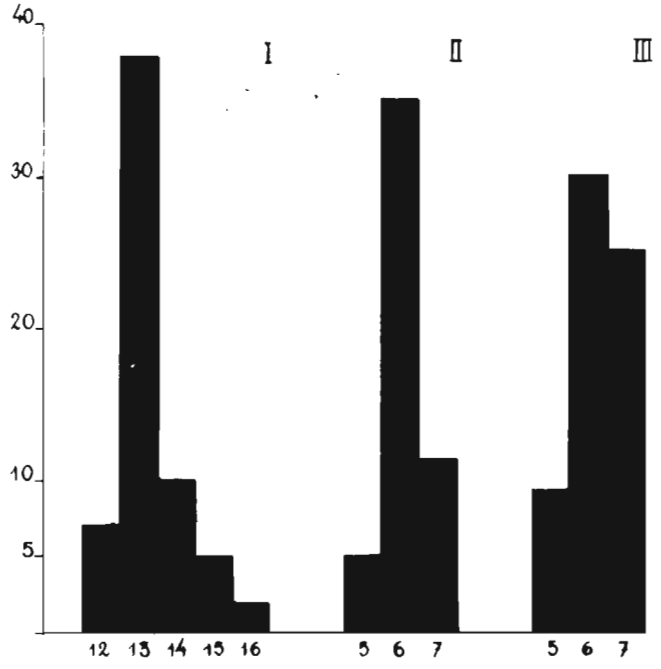


Fig. 49

Graph illustrating variation in the number of pits on the fringe of *Tretaspis granulata* (WAHLENBERG)

ordinate — number of specimens; *abscissa* — number of pits counted in three different places of frigne: *I* along the posterior margin, *II* across the fringe along midline, *III* across the fringe in the prolongation of the dorsal furrow.

stomosing raised lines. The ornamentation is well preserved on about 10 per cent of cephalons (120 specimens). On larger specimens the traces of ornamentation have been observed only in some cases. A careful examination of the external moulds of the cephalons shows that on almost all of them the traces of ornamentation are visible. STØRMER (1930, p. 69) stated that in *Tretaspis granulata* the: «Surface of shell (is) smooth or faintly reticulated», without, however, making any further comments. In my opinion, the presence or absence of ornamentation is merely a question of the state of preservation.

Discussion. — The original specimen of *Entomostracites granulatus* WAHLENBERG, 1818, is refigured in the present paper (pl. XXXV, fig. 1).

STØRMER (1930), examining the Scandinavian Upper Ordovician tretaspids, came to the conclusion that there are two subspecies within *Tretaspis granulata* (WAHLENBERG). The typical subspecies *T. granulata granulata* (including the type specimen of WAHLENBERG) occurs, according to STØRMER, in Sweden (Västergötland only) and in Great Britain (Girvan).

The second subspecies, recognized by Størmer as *T. granulata bucklandi* (Barrande), occurs together with *T. granulata granulata* in Västergötland and also in Scania, Bornholm, Bohemia (described by Barrande as *Trinucleus bucklandi*) and in Norway (represented by a single poorly preserved specimen). The difference between the two subspecies lies, according to Størmer, in the arrangement of pits on the fringe. In *T. granulata bucklandi* the fringe is narrower than in the typical subspecies. Graphs illustrating the differences in the pits were made by Størmer (1930, fig. 32) for the specimens from the three areas (Bornholm, Scania and Västergötland). Graph *a* illustrates the variation in *T. granulata bucklandi* from Bornholm, *b* — in *T. granulata bucklandi* from Scania, and *c* — indicates a mixture of the two subspecies from Västergötland. There is no graph indicating the variation in the typical subspecies *(T. granulata granulata)*. Moreover, the number of specimens examined from Bornholm, and especially from Scania (2 specimens), is very small.

Størmer (1930, p. 72) pointed out that: «The material examined and the time available for studying the collections in Denmark and Sweden have not been sufficient to decide the limits of variation of the above described morphological characters. It might perhaps be possible to find a transition between two forms, that excludes the present established variety».

After examining the original specimen of *Tretaspis granulata* (Wahlenberg) and many specimens of *T. granulata* from Västergötland, Scania, Bornholm and Poland, as well as *T. bucklandi* (Barrande) from Bohemia, I came to the conclusion that all of them are conspecific. *T. bucklandi* (Barrande) is therefore claimed here as a junior subjective synonym of *T. granulata* (Wahlenberg). An examination of the variation in the fringe structure in *T. granulata* in species from the Holy Cross Mountains, has shown a variation similar to that, which Størmer obtained for specimens from Västergötland (1930, fig. 32c; comp. our text-fig. 49). This proves that *T. granulata* shows large intraspecific variation in the fringe structure, which is fairly irregular. It is highly probable that similar variation occurs in specimens from Bornholm and Scania, but it could not be seen from the graphs of Størmer because of the small number of specimens investigated.

Scottish specimens, identified by Reed (1903, p. 10, pl. 1, fig. 10-14) as *Trinucleus bucklandi* Barrande, and considered by Størmer (1930, p. 69) conspecific with *Tretaspis granulata* (Wahlenberg), have been later recorded by Reed (1935, p. 3) as *Trinucleus cerioides* var. nov. *scotica*. In discussing this question Reed stated that it is doubtful whether the true *T. bucklandi* Barrande from Bohemia really occurs at Girvan. The specimens, figured by Reed (1914, pl. 28, fig. 6 and pl. 29, fig. 1-2) as *T. bucklandi*, in my opinion do not belong to *Tretaspis bucklandi (T. granulata)* either. Thus *T. granulata* (Wahlenberg), as far as present evidence allows, does not occur in Great Britain.

Tretaspis seticornis seticornis Størmer, 1945

(pl. XXXIII, fig. 6)

1852. *Trinucleus Bucklandi* Barrande; J. Barrande, Système Silurien..., pl. 29, fig. 10; pl. 30, fig. 14-16 only.
1945. *Tretaspis seticornis* (Hisinger, 1840) forma typica n. subsp.; L. Størmer, Remarks on the Tretaspis..., p. 401, 406, text-fig. 4, pl. 1, fig. 1.

Material. — Two incompletely preserved fragments of cephalons (natural impressions) from Wólka, Poland.

Description. — The better preserved fragment of the cephalon consists of part of the convex pseudofrontal lobe, on which the reticulation of the test is visible. Cheek is moderately convex with no ornamentation preserved. There is a small lateral eye tubercle situated rather close to the dorsal furrows. The fringe is narrow, there are 4 rows of pits in the anterior part, of which the two marginal ones are placed in radial sulci and are scarcely distinguishable from each other. Along the posterior margin the number of pits appears to be 6 or 7.

Discussion. — The specimens from Wólka seem to correspond exactly to specimens described by STØRMER (1945) as *Tretaspis seticornis* (HISINGER) forma typica, from the *Tretaspis* shale of Ringerike in Norway. It is interesting that in Poland *T. seticornis* is very rare, but occurs with *T. granulata*, which seems not to be the case in Norway. On account of the faulting of the *Tretaspis* beds in Wólka, it is difficult to recognize the exact stratigraphical position of the beds there, but the entire faunal assemblage occurring in these beds shows that they must be treated as corresponding to the zone of *Staurocephalus clavifrons*. *Tretaspis seticornis* has not been cited hitherto from Bohemia. An examination of BARRANDE's original material at the National Museum in Prague proved that a part of the specimens described by him as *Trinucleus Bucklandi (Tretaspis granulata)*, belongs in fact to *Tretaspis seticornis*, and most probably to a new subspecies of STØRMER (1945) — *Tretaspis seticornis seticornis*.

Subfamily NOVASPINAE WHITTINGTON, 1941

Genus **NOVASPIS** WHITTINGTON, 1941

Type species: Tretaspis elevata COOPER & KINDLE, 1936.

Diagnosis. — Glabella with strongly elevated pseudofrontal lobe. One pair of lateral glabellar furrows. Fringe narrow, upper lamella with two rows of pits, lower lamella with a distinct girder, one row of pits on the outer band, and one on the inner band. Thorax composed of six segments, with pleural ends tapered. Pygidium with large rhachis, composed of 8-9 segments. On the pleurae traces of the pleural segments marked. Pygidial border directed obliquely downwards with concentric lines. Pseudofrontal lobe reticulated with a single median tubercle on its posterior part.

Occurrence. — Lower and Middle Ashgillian of Quebec (Canada), Great Britain (Scotland) and Poland.

Species:

Tretaspis elevata COOPER & KINDLE, 1936
Trinucleus albidus REED, 1914.

Novaspis albida (REED, 1914)

(pl. XXXIV, fig. 3; pl. XXXVI, fig. 1-5; text-fig. 50)

1903. *Trinucleus* sp. *b*; F. R. C. REED, The Lower Palaeozoic..., Part I, p. 14, pl. 2, fig. 8, 8a.
1906. *Trinucleus* sp. *b*; F. R. C. REED, *Ibid.*, Part III, p. 160.
1912*a*. *Trinucleus* sp. *b*; F. R. C. REED, Notes on the genus Trinucleus, p. 393.
1914. *Trinucleus albidus* n. sp.; F. R. C. REED, The Lower Palaeozoic..., Suppl., p. 3, pl. 1, fig. 1, 1a, 2.

Material. — Two nearly entire (deformed) specimens, about 140 fragmentary specimens from the zones of *Eodindymene pulchra* and *Staurocephalus clavifrons*, Brzezinki and Wólka, Poland.

Dimensions of 4 specimens (in mm):

Locality	Brzezinki			
IG Mus. cat. no.	2. II. 132	2. II. 139	2. II. 148	2. II. 146
Length of entire individual	ca. 29.0	-	—	—
Length of cephalon	11.9	5.5	5.3	3.1
Width of cephalon	ca. 30.0	10.4	12.0	6.0
Width of glabella at the base	6.5	2.1	2.5	1.2
Maximal width of glabella	12.8	3.0	3.4	2.0
Length of pygidium	8.9		-	—
Width of pygidium	21.3		-	
Width of rhachis	5.9	-		—

Description. — *Cephalon* is semicircular in outline, strongly convex as longitudinally as transversely. The dorsal furrows are deep and wide, in the posterior portion they run subparallel, slightly converging anteriorly. They are deep and narrow in the anterior portion, where they diverge around the protruding, suboval, pseudofrontal lobe. The occipital ring is narrow (long.) and almost flat, the occipital furrow is not marked in the middle portion, but is deeper at the dorsal furrows. There is one lateral glabellar furrow, separating the posterior portion of the glabella from the pseudofrontal lobe. It is deep, cutting the entire width of the glabella and forming an arch together with the anterior portion of the dorsal furrows delimiting the pseudofrontal lobe. The latter is long, occupying almost three-fourths of the cephalic length. The posterior border is narrow, the posterior border furrow shallow at the dorsal furrows, deepening at the periphery. It terminates, however, before reaching the fringe, which is very narrow, gently sloping down. The upper lamella is composed of two rows of pits, around the anterior part of the cheeks and in front of the glabella. There are about 26 double pits around the anterior part of the cheeks and in front of the glabella. These two rows of frontal pits are situated so close to each other, that they are almost jointed in a single row. The fringe is produced into very short genal prolongations, reaching back to less than half the length of the first thoracic segment. In the posterior part of the fringe the number of pits on the upper lamella increases slightly, so that there is a triangular area formed of about 10-12 pits. Four or five of them are situated along the posterior margin of the fringe. On the posterior border there is a single pit, situated quite close to the fringe. On the lower lamella there is one row of pits on the outer band, a distinct girder and one row of pits on the inner band. The prolongations are produced into spines, reaching back far beyond the posterior pygidial margin.

Thorax. There are five thoracic segments. The rhachis is wider (tr.) than half the pleural width, the rhachial rings being directed transversely. Each pleura is divided by a pleural furrow, beginning in the antero-medial corner of the pleura, and running slightly postero-laterally, dividing it into a short (long.), triangular anterior portion, and much wider (long.) posterior. The ends of the thoracic pleurae are truncated.

Pygidium is broader than a semicircle. The rhachis is wide (tr.), occupying more than one-fifth of the pygidial width. There are about 8 rhachial rings, the anterior cutting the entire width of the pleura, the posterior marked off only on the sides (near the dorsal furrows). On the pleurae the first half segment is distinctly marked off, otherwise there are only traces

of indistinct ribs. There is a wide and distinct pygidial border, directed obliquely downwards, with concentric lines on it.

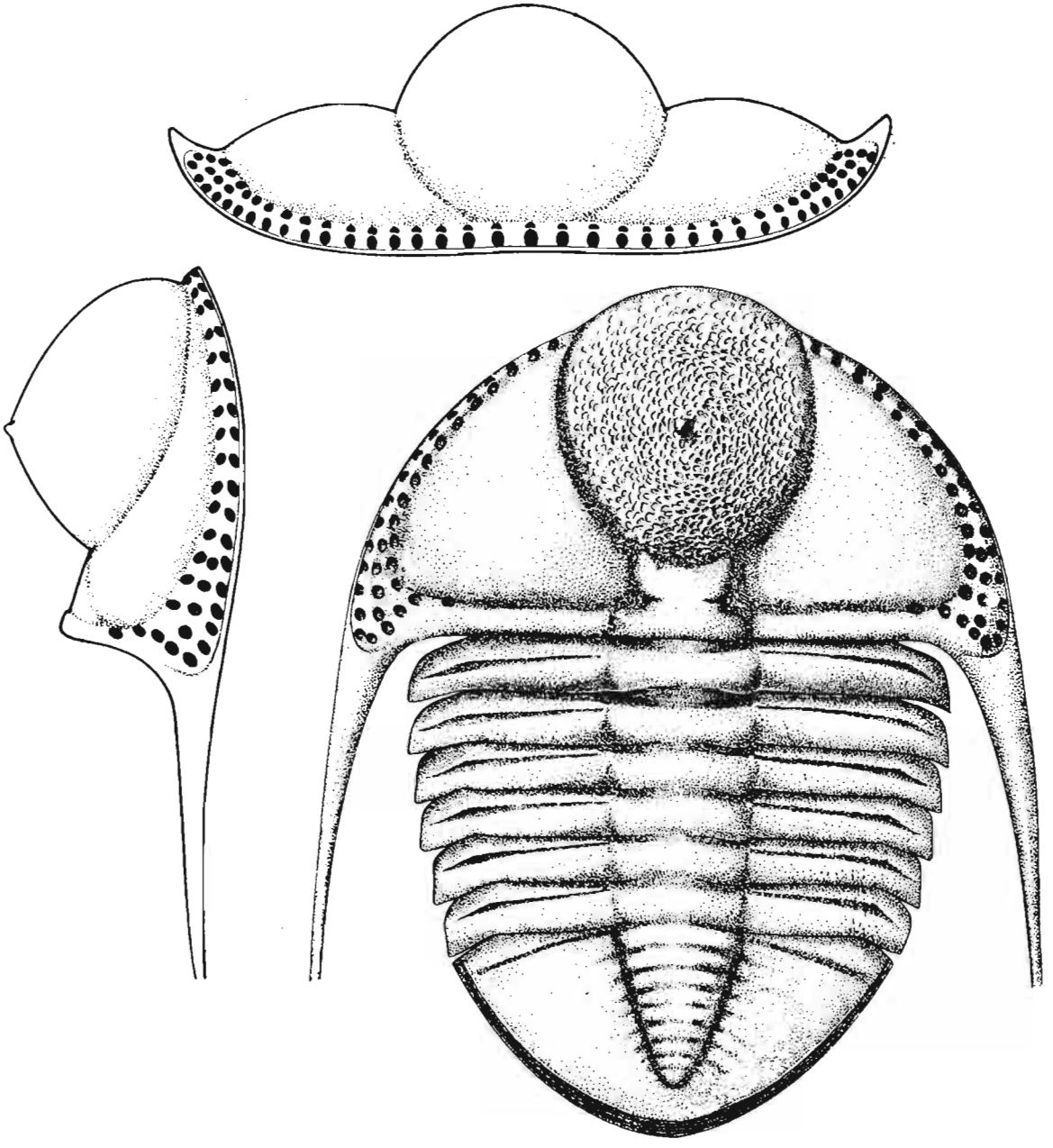


Fig. 50

Noraspis albida (REED) — reconstruction of entire individual in dorsal view, and of the cephalon in the anterior and lateral views; approx. 4.

Ornamentation. On the posterior part of the pseudofrontal lobe there is a single median tubercle. In addition to this, the whole surface of the pseudofrontal lobe is closely covered by raised, anastomosing lines, enclosing irregular, differently shaped, small fields. Otherwise the surface of the rest of the cephalon and the entire body seem to be smooth.

Discussion. — The examination of Reed's original specimens of *Novaspis albida*, housed in the British Museum (Natural History), has led me to the conclusion that the Polish specimens of *Novaspis* are conspecific with the British. The specimen figured by Reed (1914) in lateral view has the pseudofrontal lobe fairly depressed, so that this figure may lead one to the wrong conclusion that the pseudofrontal lobe of this species is rather low. The other fairly well preserved cephalons of the same species, especially the three specimens on one piece of rock (BM In 20727), two of which have been figured by Reed (1903), are not depressed and the pseudofrontal lobe is highly convex in the lateral view. On the pseudofrontal lobe on two of the above mentioned specimens there is an ornamentation of anastomosing striae, with a small central tubercle rather behind the centre of the lobe. Among the specimens of *N. albida*, housed in the British Museum, I have observed considerable variation in the shape of the frontal lobe, which may be more elongated or more rounded. A similar variation occurs also in the Polish specimens and seems to be caused at least in part by *post-mortem* deformation.

Novaspis albida differs from *N. elevata* in having the pseudofrontal lobe less inflated, more rounded outline of the cephalon (which is wider in *N. elevata*) and the posterior ends of the fringe less elongated.

Novaspis sp.

(pl. XXXV, fig. 3)

Material. — One cephalon from the zone of *Staurocephalus clavifrons*, Brzezinki, Poland.

Description. — In the collection of Brzezinki there is one cephalon, which differs from the other representatives of *Novaspis* in my collection, in having a different number of pits on the upper lamella of the fringe. In *Novaspis albida* (in the Polish, as well as the British specimens) there are about 26 pits in two rows around the cheeks and glabella. In *Novaspis* sp. there are 40 such pits. Otherwise the general pattern of the cephalon is identical with that characteristic of *Novaspis albida*.

TRILOBITAE: INCERTAE FAMILIAE, INCERTAE GENERA FROM THE **DALMANITINA MUCRONATA** ZONE OF ZALESIE, POLAND

As mentioned before (p. 2), in the zone of *Dalmanitina mucronata* in Zalesie there occurs a fairly rich trilobite fauna, containing several new forms, which on account of their fragmentary state of preservation, cannot be described as new species or genera. As no similar forms are known from any neighbouring area, I consider it worth while to figure and briefly describe some of these forms, without however naming them.

Trilobites sp.

(pl. III, fig. 4, 5; pl. XXI, fig. 3)

Material. — Several more or less fragmentary cranidia — to 6 mm long.

Description. — The cranidium is subtrapezoidal in shape, its posterior margin being approximately twice as wide as the anterior. The glabella is subtriangular in outline. The dorsal

furrows run at first subparallel, slightly converging anteriorly, cutting two-thirds of the glabellar length, they bend and converge sharply meeting each other under a distinct angle. In some of the specimens the glabella is distinctly triangular, with a very wide base (comp. pl. III, fig. 4, 5); this seems to be, however, due to the state of preservation, the wider glabellae being more flattened and less convex. The lateral glabellar furrows are very faint and indistinct, so that it is not certain whether there are only two furrows, situated far anteriorly, in front and behind the eye-ridge, or whether there is one more glabellar furrow situated posteriorly to them. The facial suture is of an olenid type, running in an almost straight line antero-medially. The fixed cheeks are very small. The eyes are small, situated far forwards, a short ocular ridge is present. The occipital ring is fairly wide (long.) in the middle part, becoming narrower at the sides, and almost entirely disappearing at the dorsal furrows. The posterior border is narrow, disappearing at the dorsal furrow. The whole cranidial surface is minutely granulated, the occipital node is present.

Discussion. — In the collection of Sedgwick Museum in Cambridge I have seen a specimen (SM no. A 43157) from the *Dalmanitina mucronata* zone of Coniston (Lake District), which seems to be conspecific with *Trilobites* sp. It is very unusual to find the form described above in the Upper Ordovician, but there are several forms characterized by a similar pattern of the cranidium, known from the Upper Cambrian. Among the different genera of the Olenidae, the facial suture has a straight antero-medial course, the eyes are small and situated far forward, the ocular ridge being present — comp. the olenid genera: *Pelturina* Henningsmoen, *Peltura* Milne-Edwards, *Protopeltura* Brögger, and *Parabolina* Salter (Henningsmoen, 1957). In all the olenids the glabella is, however, more cylindrical, whereas it is subtriangular in our form. Similar trends concerning the course of the facial suture, the position of eyes and the presence of the ocular ridge occur in some other Upper Cambrian trilobite lines, as for instance in the Nepeidae, Elrathinidae, certain Solenopleuridae and Talbotinidae. No close relation to our form can be, however, drawn. The Olenidae are known also from the Tremadocian, but at that time are characterized by forms also with a cylindric glabella. In the Lower Ordovician of the United States there occur some forms characterized by cheeks and facial suture of olenid type, as for instance *Paenebeletella* Ross (comp. Ross, 1951), but they cannot be claimed as closely related to our species. From the Kuckers beds (C_2) of Estonia, Öpik (1937) described *Panarcheognus*, tentatively placed by him within the Olenidae. It is represented in Estonia by two species. *Panarcheognus atavus* is similar to our species in the shape of the glabella and in the presence of the eye-ridge. The eyes are, however, much greater, situated much further backwards, and thus the course of the facial suture is different. None of the Ordovician forms discussed here may be claimed as ancestral or closely related to *Trilobites* sp. Our species belongs evidently to a new genus and probably new family, and represents a late descendant of the Cambrian olenids, which have survived during the Ordovician time in some as yet unknown area.

«Otarion» sp. a

(pl. VIII, fig. 6)

Material. — Two cranidia (both about 2 mm long).

Description. — The glabella is very narrow and long, its width at the base (with basal lobes) being two-thirds that of the length. The basal lobe occupies two-thirds of glabellar

length. The preglabellar field is long, occupying one-third of the cephalic length. The anterior border is narrow, the anterior border furrow comparatively shallow. The occipital ring is convex with an occipital node. The eyes are situated opposite S_1. The posterior part of the fixed cheeks is small, the anterior part fairly large, the anterior branch of the facial suture running antero-medially. The whole cranidial surface is densely covered by tubercles.

Discussion. — The cranidium here described differs from «*Otarion*» sp. *b* occurring in the same beds, and «*Otarion*» *tenuis* n. sp. from the zone of *Staurocephalus clavifrons* in the Holy Cross Mountains, chiefly in having a much narrower and longer glabella. Its similarities to «*Otarion*» *tenuis* are in this aspect greater than to «*Otarion*» sp. *b*, which is characterized by a comparatively very wide glabella.

«Otarion» sp. b

(pl. II, fig. 8-9)

Material. — 10 cranidia.

Dimensions of 3 specimens (in mm):

Locality	Zalesie		
IG Mus. cat. no.	401. II. 44	401. II. 39	401. II. 45
Length of cephalon	4.0	3.0	4.0
Length of glabella	2.3	1.6	2.2
Width of glabella (with basal lobes)	2.5	1.7	—
Length of preglabellar field	1.1	0.9	1.0

Description. — Only the cranidium is known. The dorsal furrows are wide and deep. From the occipital furrow they converge slightly at first and then run parallel, the anterior margin of the glabella being wide (tr.) and only slightly convex. The lateral glabellar furrow S_1 is as deep as the dorsal furrow and runs postero-medially from the dorsal furrow towards the occipital furrow, cutting off the large, suboval basal lobe L_1. The length of the basal lobe is more than one-third that of the glabella. The middle glabellar lobe is subcylindrical, slightly narrower at the base. The occipital furrow is deep, the occipital ring flat. In front of the glabella there is a large (long.) preglabellar field, its length with the border being more than half the glabellar length. The eyes are not preserved. The palpebral lobes are small, situated opposite the anterior part of the basal lobe. The posterior branch of the facial suture is hardly recognizable, the posterior one runs antero-laterally from the palpebral lobe towards the cephalic margin.

Ornamentation consists of small tubercles densely covering the preglabellar field and more scattered tubercles on the glabella and occipital ring. The occipital node is present.

Discussion. — The cranidium here described differs from «*Otarion*» *tenuis* n. sp. occurring in the *Staurocephalus clavifrons* zone, chiefly in having smaller eyes and a wider and shorter glabella.

«**Otarion**» sp. **c**

(pl. VII, fig. 4; pl. VIII, fig. 5)

Material. — 20 pygidia.

Dimensions of 2 specimens (in mm):

Locality	Zalesie	
IG Mus. cat. no.	401. II. 30	401. II. 28
Length of pygidium	2.0	2.1
Width of pygidium	4.6	5.0
Width of pygidial rhachis	1.8	1.8

Description. — Pygidium is very wide and short, the rhachial width being a little more than one-third the pygidial width. There are four rhachial rings, the first one only being distinct, and four pleurae with the first distinct, the remaining only recognizable on well preserved specimens. There is a wide border around the pygidium, delimited by wide and deep border furrow.

Ornamentation is not preserved.

Discussion. — The pygidium here described differs from «*Otarion*» *tenuis* n. sp., occurring in the *Staurocephalus clavifrons* zone, in having a very distinct and wide pygidial border. As there occur some otarionid cranidia in the zone of *Dalmanitina mucronata* in Zalesie, the attribution of the pygidium here described to any of these cranidia even tentatively cannot be done.

«**Proetus**» sp. **a**

(pl. III, fig. 1-2; pl. XXI, fig. 1)

Material. — Several cranidia up to 8 mm long.

Description. — The dorsal furrows are deep. Running from the occipital furrow they converge slightly anteriorly and reach the anterior, wide (tr.) and slightly convex anteriorly, rounded glabellar margin. Length of the glabella is about five-sixths its width at the base. There are three pairs of lateral glabellar furrows S_1, situated in one-third of the glabellar length, directed antero-medially; S_2 and S_3 situated in front of the eye, parallel to each other, short, directed almost transversely. Occipital ring is wide (long.) and flat; at the dorsal furrows it is directed slightly anteriorly. Occipital furrow is deep, transverse in the middle part, bent slightly anteriorly at the sides. Preglabellar field is comparatively long, the anterior furrow is very deep and distinct, the anterior border being convex. The fixed cheeks are very small. The facial suture cuts the posterior border and runs along the posterior furrow towards the dorsal furrow, then along the exterior edge of the dorsal furrow to the eye. The palpebral lobe is small, semilunar, situated opposite S_1. In front of the eye the facial suture runs at first parallel to the dorsal furrow and then, opposite L_3, it bends and runs antero-laterally towards the anterior cephalic margin.

The entire cranidium is covered by a very characteristic ornamentation of fine, anastomosing striae. On the glabella these lines are arranged in a similar way to the papillar lines

on a finger-print. On the occipital ring they are directed transversely in the middle part and bent postero-laterally at the sides. In addition to this ornamentation, there are distinct, small tubercles, arranged in the similar way, between the striae on the glabella and on the posterior part of the occipital ring. The occipital node is present.

Discussion. — The species here described as «*Proetus*» sp. *a*, may be recorded within the superfamily Proetacea. Its generic and familial attribution is difficult (it belongs evidently to a new genus). It seems to show close similarities to *Proetus (Prionopeltis?) zelesskyi* Öpik, described by Öpik (1928, 1937) from the Kuckers beds (C_2) of Estonia. The similarities concern here the very small fixed cheeks, the presence of 3 pairs of lateral glabellar furrows and the almost identical type of the ornamentation. Our species differs from the Estonian form in having the glabella wider at the base, the dorsal furrows run subparallel in Estonian species, whereas they converge distinctly in our form. The eyes of our species are much smaller than in *P. (P.?) zelesskyi*. Also the lateral glabellar furrows are differently shaped. As no other parts of the body of our form are known, it is difficult to say whether it is congeneric with *Prionopeltis*. As the generic attribution of the Estonian species to the genus *Prionopeltis* is not certain, either any further comparison or the reference of our species to a genus cannot be done at present.

«**Proetus**» sp. **b**

(pl. XXI, fig. 2)

Material. — More than 30 pygidia.

Description. — The length of pygidium is less than a half of its width. The rhachis occupies one-third of the pygidial width and gently tapers posteriorly. The dorsal furrows are very deep. There are 6 distinct rhachial rings, divided by deep furrows. The posterior ring, rounded at its end, is wider (long.) than the others. On the pleurae there are 3 to 4 pleural segments widening posteriorly. The pleural furrows delimiting them are deep, the interpleural furrows very shallow. No pygidial border is developed. On the natural impressions the traces of ornamentation of faint striae are sometimes preserved.

Discussion. — The pygidium here described is fairly frequent in the collection from the zone of *Dalmanitina mucronata* in Zalesie. No conclusions could be drawn with regard to ascertaining which of the common proetid cranidia occurring in the same beds is conspecific with it. It differs clearly from the only proetid *(Ogmocnemis)* known from the zone of *Staurocephalus clavifrons* in having a larger rhachis and less pleural segments, and seems to resemble more the late proetids, such as the Middle Devonian representatives of *Proetus*, than its contemporaries.

«**Proetus**» sp. **c**

(pl. XXV, fig. 5)

Material. — Some cranidia.

Description. — The glabella is wider than long, the dorsal furrows slightly converge anteriorly and form a wide (tr.) arch in front of the glabella. There are two pairs of lateral glabellar furrows. The presence of a third pair is not certain. S_1 is directed postero-laterally, beginning at the dorsal furrows in half of the eye length, and not reaching the occipital furrow;

S_2 is directed transversely, opposite the anterior margin of the palpebral lobe. The occipital ring is wide, slightly bent anteriorly at the dorsal furrows. The posterior part of the fixed cheek is small, the eye is situated close to the glabella and is long (the palpebral lobe occupying nearly half the glabellar length). The anterior branch of the facial suture runs antero-laterally, and the anterior part of the fixed cheek is larger than the posterior one. The preglabellar field is long, the anterior border narrow, the anterior border furrow deep.

Ornamentation. Faint traces of an ornamentation of anastomosing striae and tubercles are preserved. The ornamentation is more coarse on the preglabellar field than on the glabella.

Discussion. — «*Proetus*» sp. *c* resembles *Proetus scoticus* Reed, described by Reed (1941), from the Upper Ordovician of Girvan. It differs from the latter species in having narrower anterior border, less distinct lateral glabellar furrows and probably also somewhat different ornamentation.

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PLATES

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE I

Page

Sphaeragnostus gaspensis europeensis n. subsp. 56

(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

Fig. 1. Pygidium (IG no. 2. II. 307); × 12.
Fig. 2. Pygidium (IG no. 2. II. 393); × 6.
Fig. 3. Pygidium, holotype (IG no. 2. II. 308); × 5.

Geragnostus sp. 58

Fig. 4. Cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons zone* (IG no. 2. II. 68); × 15.

Trinodus sp. 62

Fig. 5. Pygidium. Wólka, Poland; Upper Ordovician, *S. clavifrons zone* (IG no. 2. II. 61); × 6.

Trinodus tardus (BARRANDE) 59

Fig. 6. Pygidium. Risebekken, Bornholm; Upper Ordovician, *Tretaspis* beds (CM no. 1875. 1933); × 10.
Fig. 7. Cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 47); × 5.2.
Fig. 8. Cephalon. Same locality and horizon (IG no. 2. II. 55); × 6.3.
Fig. 9. Entire individual, latex cast of the specimen figured by KIELAN (1957, pl. 1, fig. 6). Same locality and horizon (IG no. 2. II. 62); × 7.5.
Fig. 10. Pygidium, latex cast. Same locality and horizon (IG no. 2. II. 45); × 14.
Fig. 11. Entire individual. Same locality and horizon (IG no. 2. II. 64); × 10.
Fig. 12. Pygidium. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 54); × 5.
Fig. 13. Pygidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 65); × 5.6.

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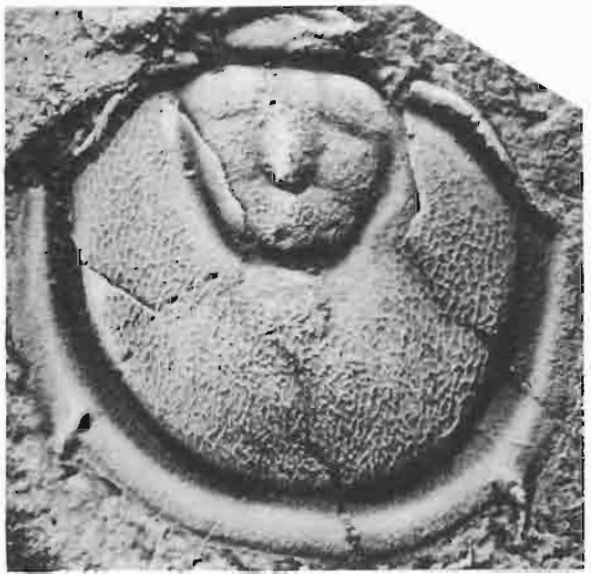

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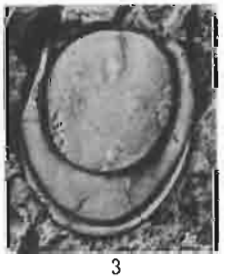

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE II

Page

«Otarion» tenuis n. sp. 63

Fig. 1. Cephalon and fragmentary thorax, latex cast, holotype. Brzezinki, Poland; Upper Ordovician, probably *Staurocephalus clavifrons* zone (IG no. 2. II. 255); × 14.
Fig. 2. Cranidium. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 254b); 7.8.

Amphitryon radians (BARRANDE) 65

(see also pl. III)

Fig. 3. Cranidium and thorax. Lejškov, Bohemia; Upper Ordovician, Králuv Dvur beds (KUM coll.); 2.
Fig. 4. Hypostome. Same locality and horizon (KUM coll.); × 6.
Fig. 5. Cranidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 167); · 2.5.
Fig. 6. Cranidium. Same locality and horizon (IG no. 2. II. 166b); × 5.
Fig. 7. Cranidium, strongly deformed laterally. Same locality and horizon (IG no. 2. II. 164); × 5.

«Otarion» sp. *b* 180

Fig. 8. Cranidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 45); × 8.
Fig. 9. Cranidium. Same locality and horizon (IG no. 401. II. 39); × 12.

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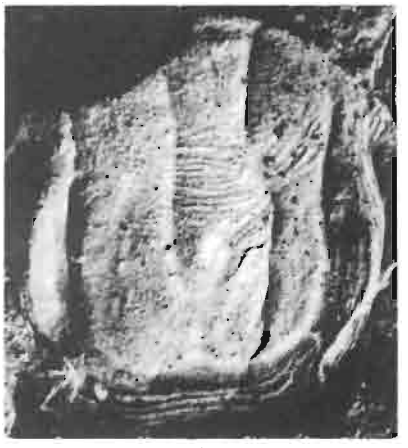

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE III

Page

«*Proetus*» sp. *a* 181

(see also pl. XXI)

Fig. 1. Fragmentary cranidium, latex cast. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 143); × 7.5.

Fig. 2. Cranidium, latex cast. Same locality and horizon (IG no. 401. II. 150); × 6.5.

Proceratocephala terribilis bituberculata n. subsp. 107

(see also pl. XVI)

Fig. 3. Cranidium. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 75); × 8.

Trilobites sp. 178

(see also pl. XXI)

Fig. 4. Fragmentary cranidium, latex cast. Zalesie, Poland; Upper Ordovician, *D. mucronata* zone (IG no. 401. II. 138); × 7.5.

Fig. 5. Fragmentary cranidium, latex cast. Same locality and horizon (IG no. 401. II. 141); × 7.5.

Ogmocnemis irregularis n. sp. 70

(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

(see also pl. IV)

Fig. 6. Pygidium (IG no. 2. II. 262); × 4.5.

Fig. 7. Cephalon (IG no. 2. II. 275); × 4.5.

Fig. 8. Cranidium and free cheek, impression, holotype (IG no. 2. II. 267); × 6.

Fig. 9. Nearly entire specimen (IG no. 2. II. 264); × 5.

Remopleurides? sp. *a* 67

Fig. 10. Cranidium and some thoracic segments. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 169); × 2.5.

Amphitryon radians (BARRANDE) 65

(see also pl. II)

Fig. 11. Pygidium. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 165 b); × 7.

Amphitryon sp. 67

Fig. 12. Cranidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 168); × 6.

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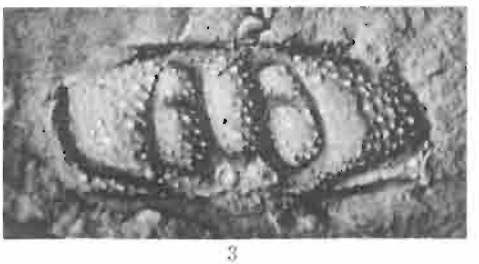

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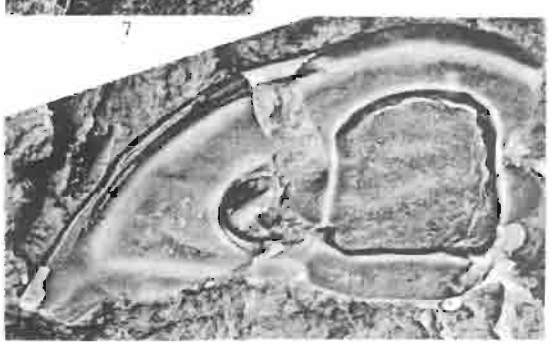

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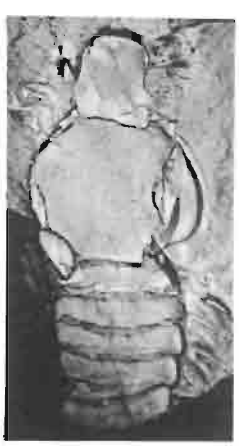

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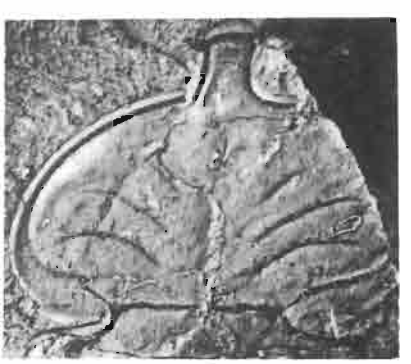

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE IV

Page

Phillipsinella parabola (BARRANDE) 72

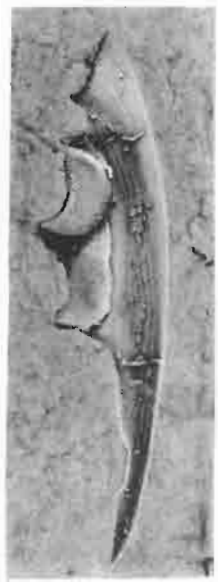
(see also pl. V)

Fig. 1. Free cheek. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 153b); × 5. 5.
Fig. 2. Cranidium. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 344); × 15.
Fig. 3. Cranidium. Same locality and horizon (IG no. 2. II. 151); × 15.
Fig. 4. Hypostome. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 343); × 13.
Fig. 5. Cranidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 57); × 5.
Fig. 6. Cranidium. Same locality and horizon (IG no. 401. II. 56); × 9.
Fig. 7. Cranidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 341a); × 15.

Ogmocnemis irregularis n. sp. 70

(see also pl. III)

Fig. 8. Nearly entire specimen. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 266a); × 5. 5.
Fig. 9. Pygidium, latex cast. Same locality and horizon (IG no. 2. II. 269); × 14.



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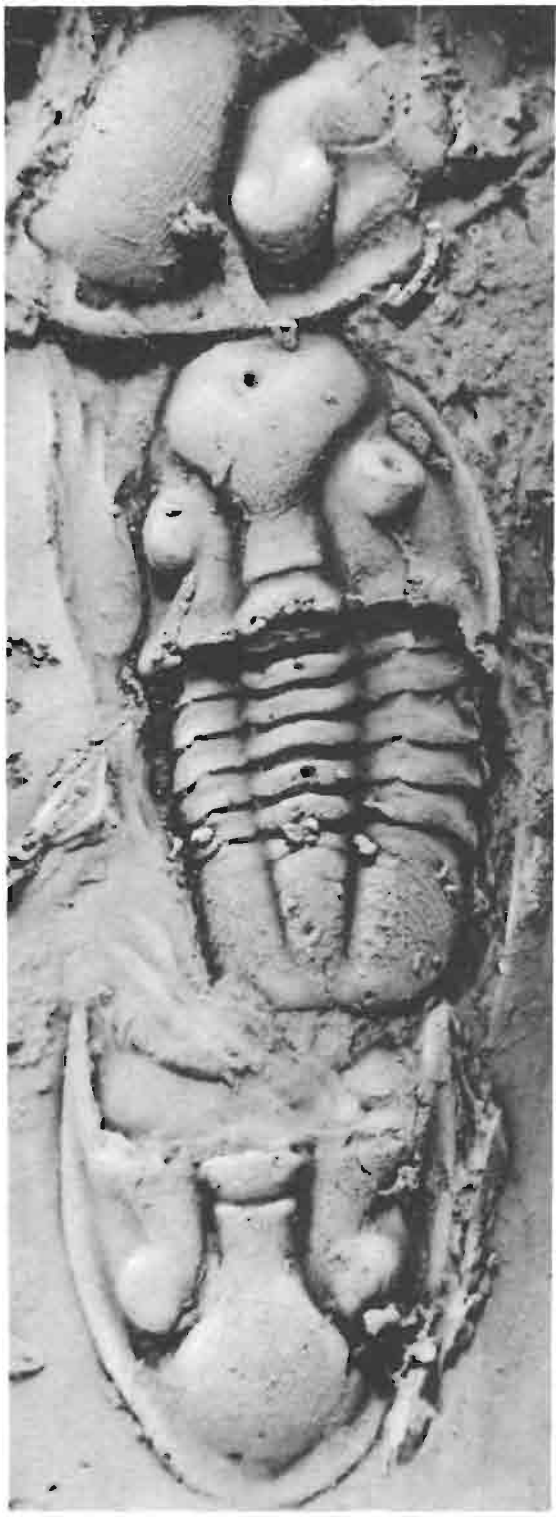
Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE V

Fig. 1. Entire individual and two cephalons, latex cast of the specimen figured by KIELAN (1957, pl. 4, fig. 1). Brzezinki, Poland; Upper Ordovician, probably *Staurocephalus clavifrons* zone (IG no. 2. II. 157); × 8.

Fig. 2. Ventral side of cephalon, showing rostrum and hypostome, latex cast. Brzezinki, Poland: Upper Ordovician. *S. clavifrons* zone (IG no. 2. II. 347a); × 7.

Fig. 3. Entire individual, latex cast of the specimen figured by KIELAN (1957, pl. 4, fig. 2). Same locality and horizon (IG no. 2. II. 150b); × 5.5.



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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE VI

Page

Opsimasaphus latus (ANGELIN) 78

(see also pl. VII and VIII)

Fig. 1. Pygidium. Skogastorp, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (UM no. Ar. 2021); × 1.5.

Fig. 2. Pygidium. Mösseberg, Västergötland, Sweden; Red *Tretaspis* mudstones (UM no. Vg. 708); × 1.5.

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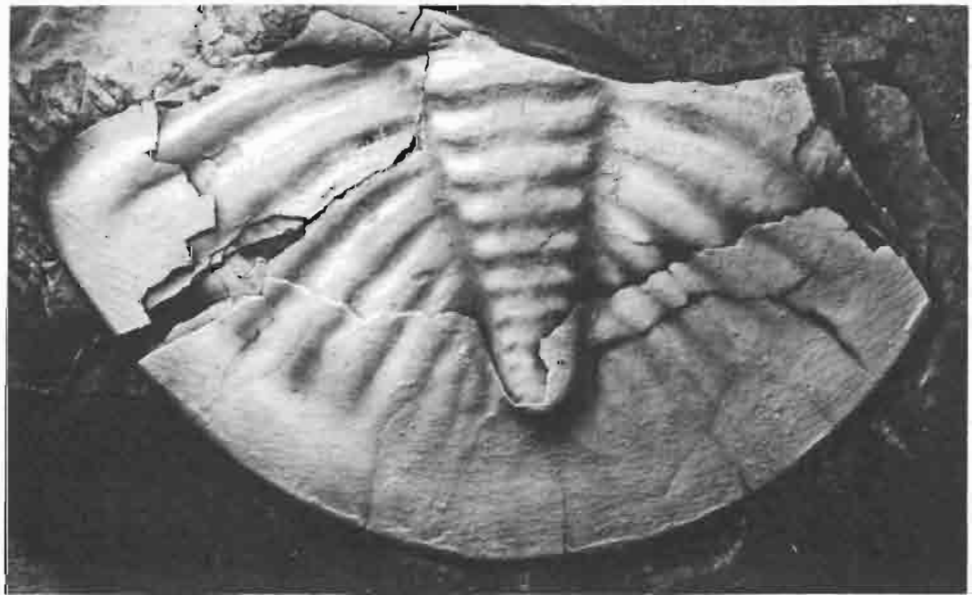

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE VII

Page

Opsimasaphus jaanussoni n. sp. 79

Fig. 1. Entire, young specimen. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 163b); × 5.5.

Fig. 2. Entire specimen, holotype. Vasagaard, Bornholm; Upper Ordovician, *Tretaspis* beds (CM no. 1884. 1512); × 4.

Opsimasaphus latus (ANGELIN) 78

(see also pl. VI and VIII)

Fig. 3. Cranidium, latex cast, lectotype; specimen figured by ANGELIN (1851, pl. 10), cranidium only. Kinnekulle, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (RM no. Ar. 14299b); × 1.5.

«*Otarion*» sp. *c* 181

(see also pl. VIII)

Fig. 4. Pygidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 30); × 12.

Leonaspis olini TROEDSSON 98

(see also pl. XIV, XV and XVIII)

Fig. 5. One thoracic segment. Locality and horizon as fig. 4 (IG no. 401. II. 20); × 4.

Fig. 6. Latex cast of specimen figured by WAHLENBERG (1818, pl. 2, fig. 4[x]) as pygidium of *Entomostracites granulatus*. Mösseberg, Västergötland, Sweden; Upper Ordovician. *Dalmanitina* beds (UM no. Ar. 2046); × 4.

«*Calymene*» sp. 115

Fig. 7. Pygidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 394); × 6.

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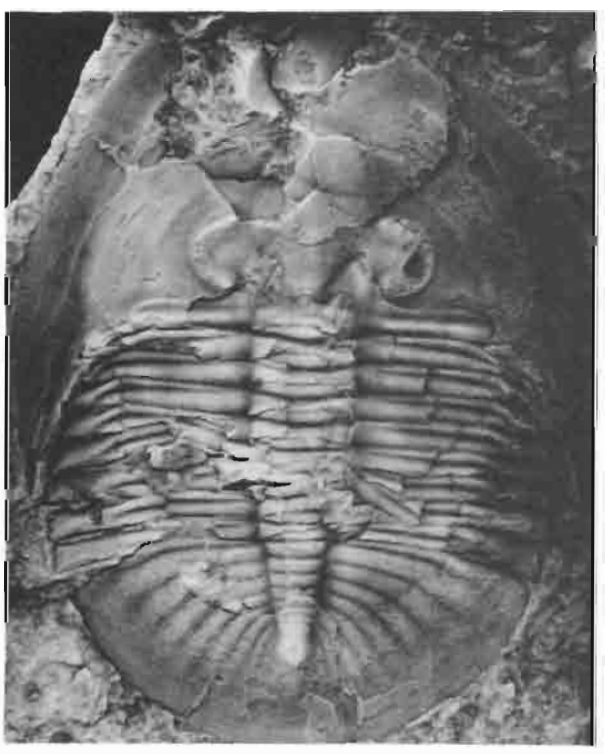

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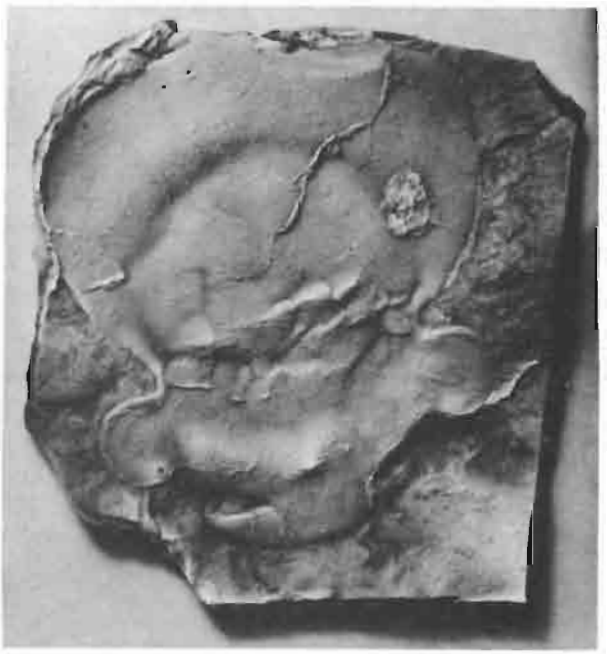

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE VIII

Page

Stygina sp. 82

Fig. 1. Cranidium. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 159); × 9.
Fig. 2. Nearly entire specimen, showing imprint of the hypostome. Brzezinki, Poland; same horizon (IG no. 2. II. 158b); × 8.1.

Opsimasaphus sp. 81

Fig. 3. Free cheek. Vasagaard, Bornholm; *Tretaspis* beds (CM no. 1884. 1545); nat. size.

Opsimasaphus latus (ANGELIN) 78
(see also pl. VI and VII)

Fig. 4. Free cheek. Västergötland, Red *Tretaspis* mudstones (RM no. Ar 14531); 1.5.

«*Otarion*» sp. *c* 181
(see also pl. VII)

Fig. 5. Pygidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 34); 12.

«*Otarion*» sp. *a* 179

Fig. 6. Cranidium. Stawy, Poland; Upper Ordovician, *D. mucronata zone* (IG no. 401. II. 122); × 12.

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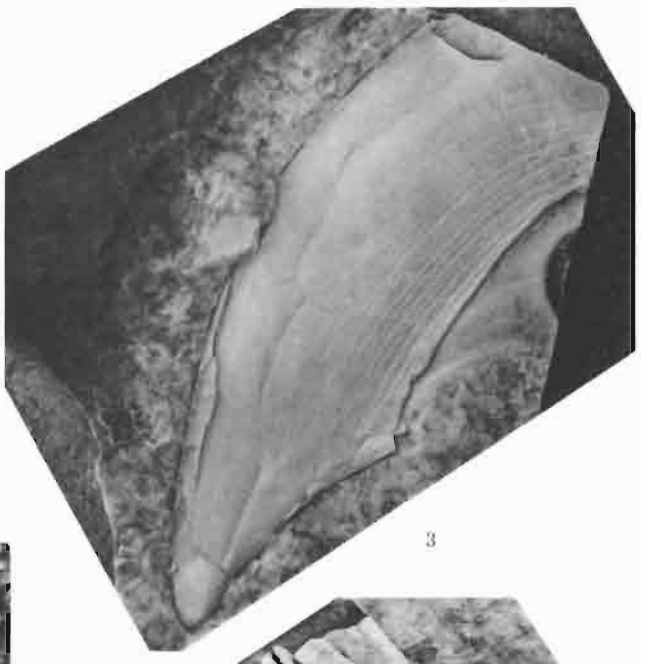

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE IX

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Cyclopyge quadrangularis n. sp. 83

(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

Fig. 1. Pygidium (IG no. 2. II. 222); × 20.
Fig. 2. Pygidium (IG no. 2. II. 234); × 15.
Fig. 3. Glabella (IG no. 2. II. 225); × 14.
Fig. 4. Pygidium, latex cast (IG no. 2. II. 235b); × 10.
Fig. 5. Glabella (IG no. 2. II. 210a); × 5.
Fig. 6. Nearly entire specimen, holotype (IG no. 2. II. 227); × 5.
Fig. 7. Cephalon with imprint of doublure (IG no. 2. II. 361); × 5.
Fig. 8. Doublure with eyes (IG no. 2. II. 232); × 4.
Fig. 9. Doublure with eyes (IG no. 2. II. 213a); × 5.

Liocnemis concinnus n. sp. 123

(see also pl. XXII)

Fig. 10. Cephalon and fragmentary thorax, holotype, specimen figured by KIELAN (1957, pl. 2, fig. 2) as *Pterygometopus recurvus*. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 172a); × 3.

Liocnemis recurvus (LINNARSSON) 121

(see also pl. XXI and XXII)

Fig. 11. Entire, damaged specimen, figured by KIELAN (1957, pl. 2, fig. 4). Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 88); × 3.
Fig. 12. Pygidium, latex cast. Wólka, Poland; same horizon (IG no. 2. II. 79b); × 7.

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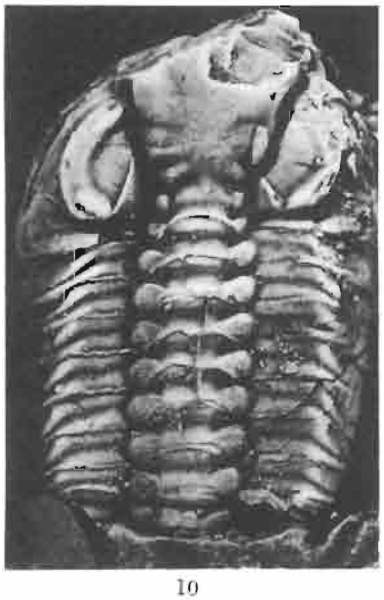

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE X

Page

Cyclopyge sp. *c* 88

Fig. 1. Doublure with eyes. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 239a); × 5.

Cyclopyge gigantea (BARRANDE) 86

Fig. 2. Fragmentary thorax and pygidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 240); × 1.5.

Cyclopyge sp. *b* 87

Fig. 3. Doublure with eyes. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 237a); × 5.

Microparia speciosa HAWLE & CORDA 88

Fig. 4. Pygidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 360); × 5.
Fig. 5. Nearly entire specimen, latex cast. Same locality and horizon (IG no. 2. II. 241a); × 5.
Fig. 6. Entire specimen. Lejškov, Bohemia; Upper Ordovician, Králův Dvůr beds (OM no. A 15072); × 6.
Fig. 7. Entire specimen — ANGELIN's type specimen of *Aeglina? oblongula* ANGELIN (1854, pl. 24, fig. 5). Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (RM no. Ar. 14822); × 7.
Fig. 8. Pygidium, figured by OLIN (1906, pl. 3, fig. 8) as *Symphysurus superstes* OLIN. Röstånga?, Koängen, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 1956t); × 6.
Fig. 9. Pygidium, figured by OLIN (1906, pl. 3, fig. 9) as *Symphysurus superstes* OLIN. Röstånga kyrkbäck, Scania, Sweden; same horizon (LM no. L. O. 1957t); × 6.

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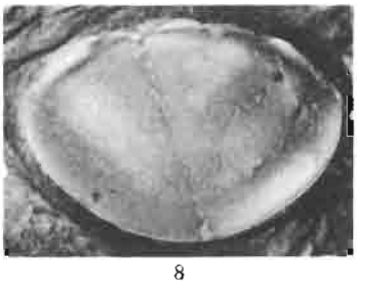

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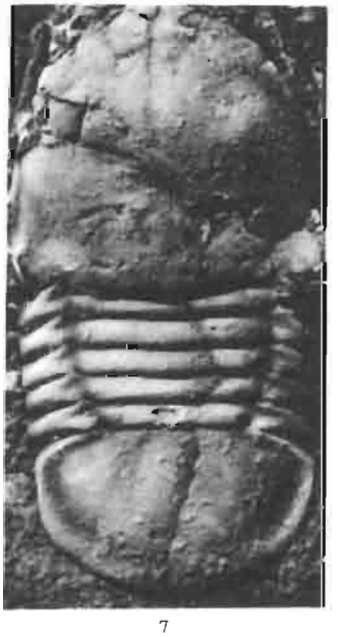

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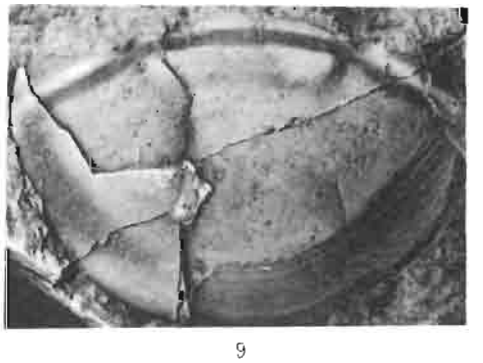

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XI

Page

Symphysops subarmata elongata n. subsp. 90

(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

Fig. 1. Pygidium (IG no. 2. II. 247a); × 4.5.
Fig. 2. Pygidium (IG no. 2. II. 249b); × 4.5.
Fig. 3. Pygidium, latex cast, holotype (IG no. 2. II. 250); × 7.5.
Fig. 4. Pygidium (IG no. 2. II. 248); × 5.

Symphysops sp. *b* 92

Fig. 5. Thoracic segment. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 252); × 5.

Symphysops sp. *a* 92

Fig. 6. Cranidium. Same locality and horizon (IG no. 2. II. 251b); × 2.5.

Cyclopyge sp. *a* 87

Fig. 7. Doublure with eyes. Same locality and horizon (IG no. 2. II. 236); × 4.5.

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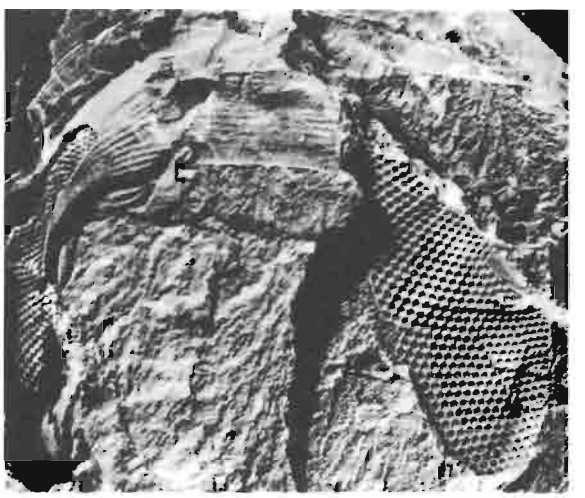

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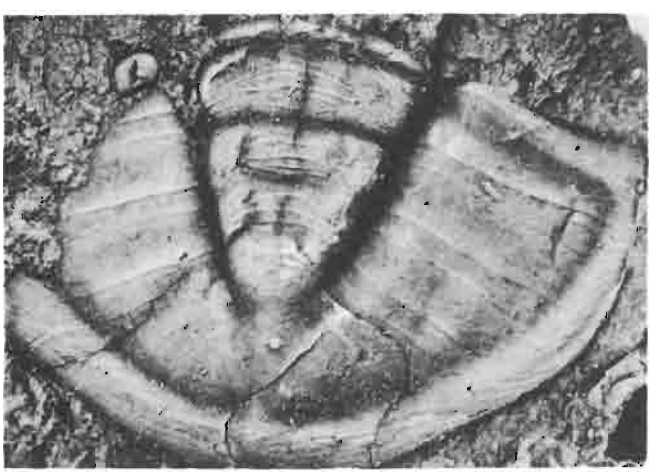

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XII

Page

Zbirovia longifrons (OLIN) 97

Fig. 1. *a-c* Cephalon, holotype, in dorsal, anterior and lateral views, figured by OLIN (1906, pl. 3, fig. 14). Koängen, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 1962t); × 12.

Fig. 2. Cephalon. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 365); × 10.

Fig. 3. Cephalon. Mösseberg, Västergötland, Sweden; Upper Ordovician, Green *Tretaspis* mudstones (UM no. Vg. 712); × 10.

Fig. 4. Pygidium, figured by OLIN (1906, pl. 3, fig. 6). Koängen, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 1964t); × 10.

Fig. 5. Cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 364a); × 10.

Panderia megalophthalma LINNARSSON 93

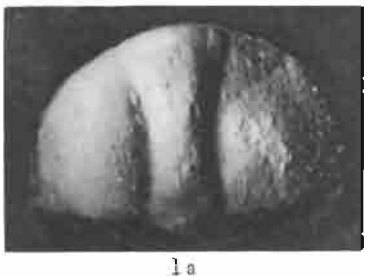
Fig. 6. Pygidium. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 205); × 8.

Zdicella bornholmiensis n. sp. 96

(see also pl. XIII)

Fig. 7. Pygidium. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 368); × 5.

Fig. 8. Cephalon, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 369a); × 6.



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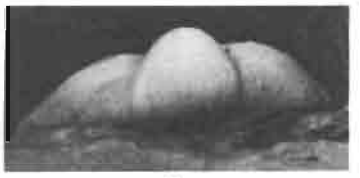

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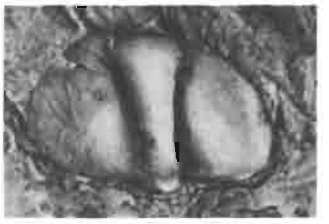

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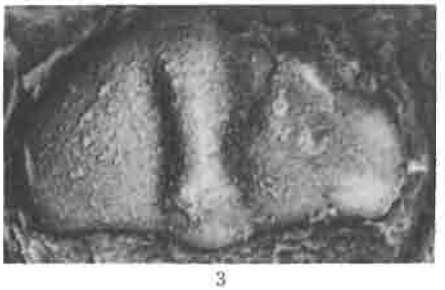

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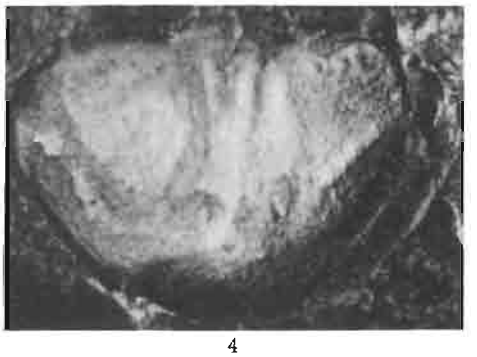

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XIII

Page

Zdicella bornholmiensis n. sp. 96
(see also pl. XII)

Fig. 1. Cephalon. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 367b); × 2. 5.
Fig. 2. Cephalon. Same locality and horizon (IG no. 2. II. 366); × 4.
Fig. 3. Nearly entire specimen. Vasagaard, Bornholm; Upper Ordovician, *Tretaspis* beds (CM no. 1884. 1518); × 6.
Fig. 4. Nearly entire specimen, holotype. Same locality and horizon (CM no. 353. 1883); × 5.

Stubblefieldia sp. 139
(see also pl. XXIV)

Fig. 5. *a-b* Cranidium, in dorsal and anterior views. Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (RM no. 15466); × 5.5.

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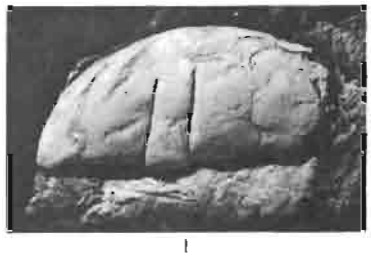

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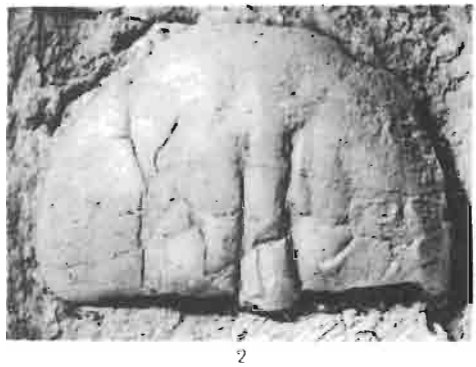

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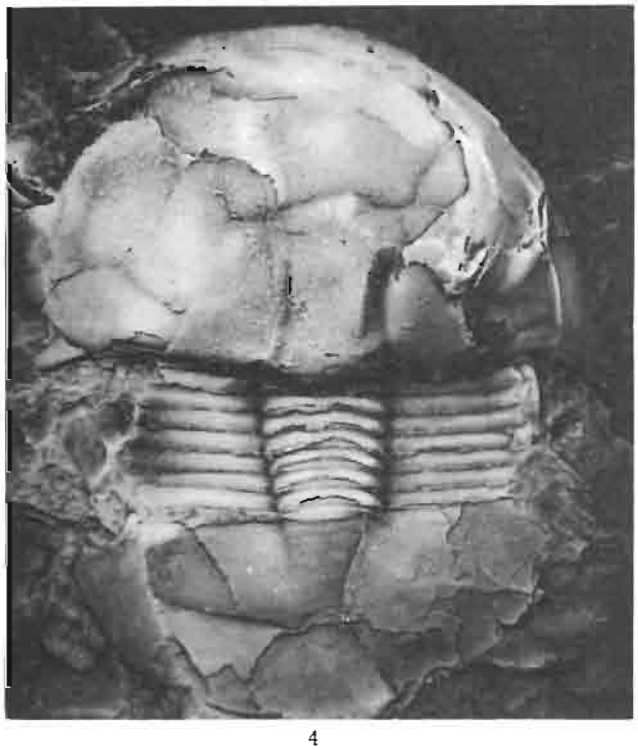

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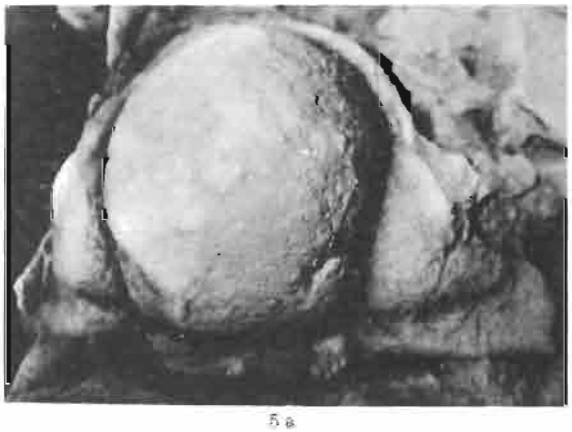

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XIV

Page

Leonaspis olini TROEDSSON 98

(see also pl. VII, XV and XVIII)

Fig. 1. Cranidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 19); × 5.
Fig. 2. Free cheek. Same locality and horizon (IG no. 401. II. 17); × 8.
Fig. 3. Cranidium. Same locality and horizon (IG no. 401. II. 23); × 12.
Fig. 4. Cranidium, specimen figured by TROEDSSON (1921, pl. 1, fig. 29). Röstånga, Scania, Sweden; Upper Ordovician, *Dalmanitina* beds (LM no. L.O. 2935t); × 12.

«*Illaenus*» sp. 95

Fig. 5. Cephalon. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 370); × 2. 5.

«*Illaenus*» *angelini* HOLM 95

Fig. 6. Entire specimen. Mösseberg, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (UM no. Ar. 2028); × 4.

«*Illaenus*» cf. *angelini* HOLM 95

Fig. 7. Fragmentary cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 375a); × 5.
Fig. 8. Pygidium. Wólka, Poland; same horizon (IG no. 2. II. 373b); × 4. 5.
Fig. 9. Pygidium, latex cast. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 372); × 6.

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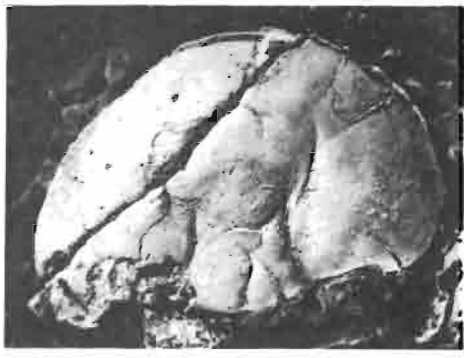

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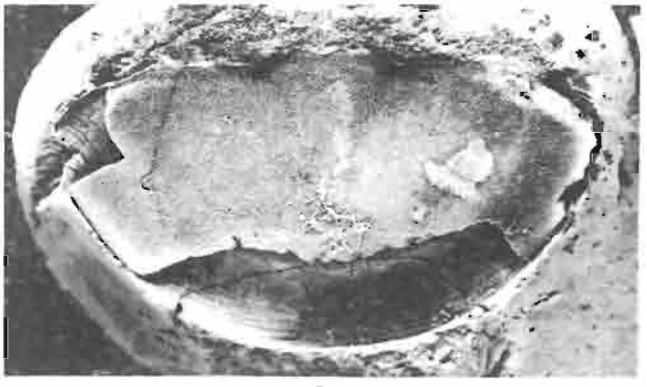

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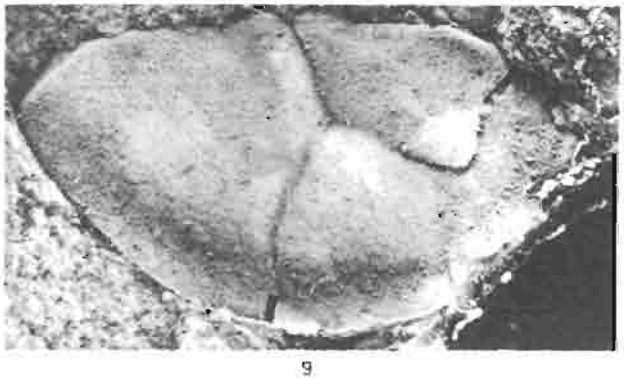

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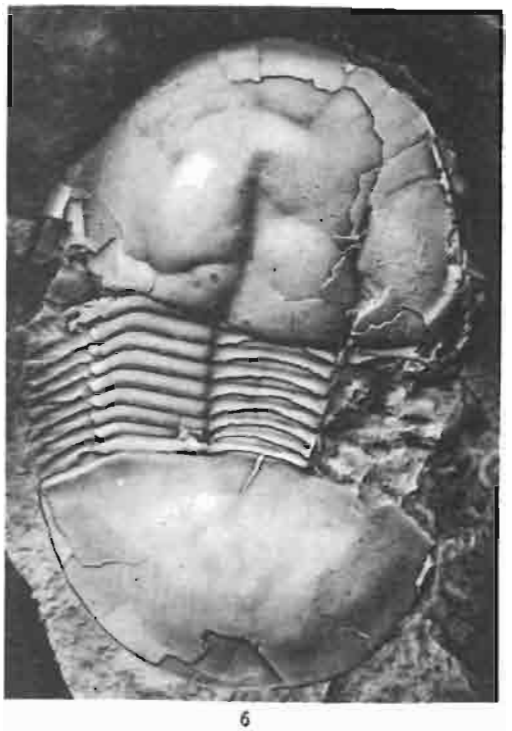

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XV

Page

Diacanthaspis decacantha (ANGELIN) 103

(see also pl. XVI and XVII)

Fig. 1. Fragmentary thorax and pygidium, lectotype — specimen figured by ANGELIN (1854, pl. 22, fig. 5) as *Cyrtometopus decacanthus* n. sp. Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (RM no. Ar. 15469); × 4.

Fig. 2. Fragmentary thorax and pygidium. Bornholm, Upper Ordovician, *Tretaspis* beds (CM no. 1871. 1243); × 5.

Fig. 3. Nearly entire specimen. Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (RM no. Ar. 15461); × 3.

Leonaspis olini TROEDSSON 98

(see also pl. VII, XIV and XVIII)

Fig. 4. Pygidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 21); × 10.

Leonaspis centrina (DALMAN) 101

Fig. 5. Nearly entire individual — latex cast of the specimen described by DALMAN (1828*a*, p. 135) as *Calymene? centrina* n. sp. Mösseberg, Västergötland, Sweden; Upper Ordovician, *Dalmanitina* beds (RM no. Ar. 15474); × 7.

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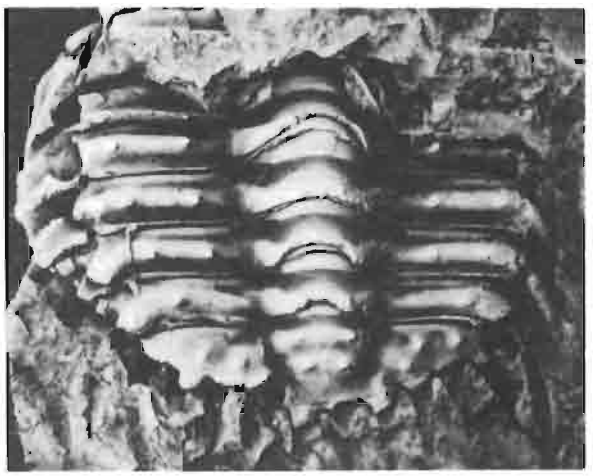

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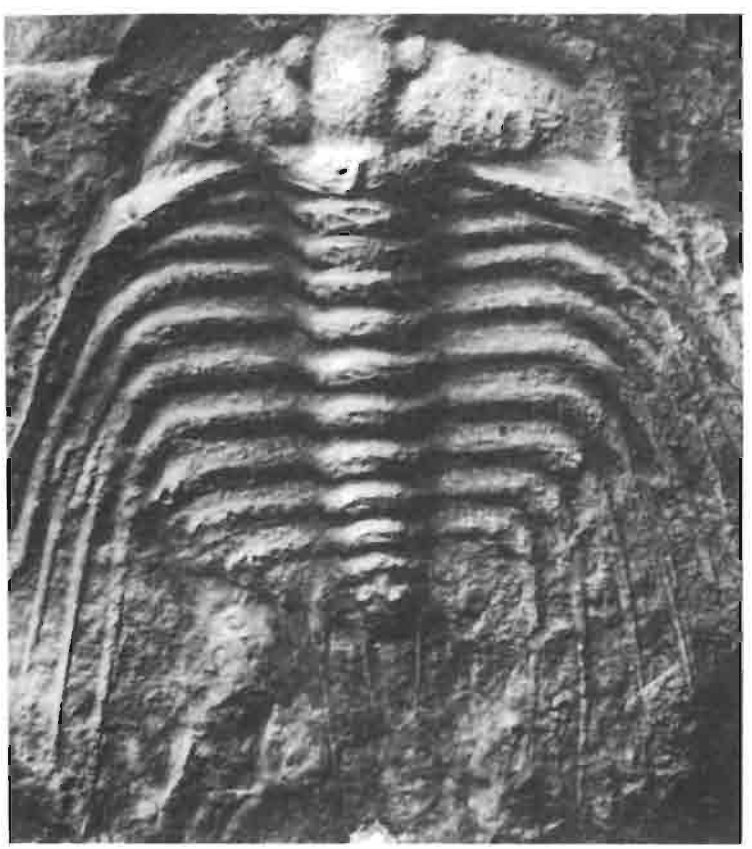

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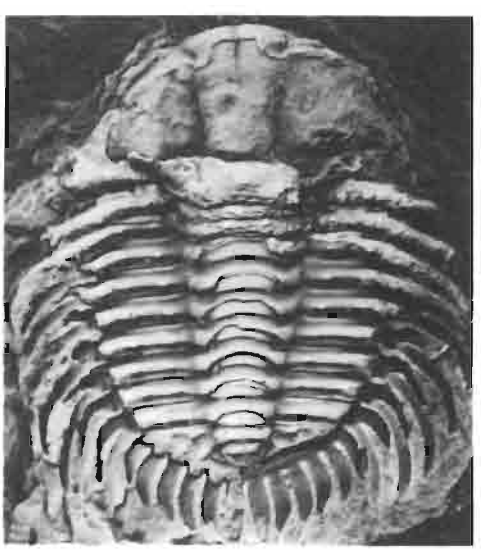

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XVI

Page

Proceratocephala terribilis bituberculata n. subsp. 107

(see also pl. III)

Fig. 1. Cranidium, free cheek and two thoracic segments, latex cast — holotype. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 29); 5.

Diacanthaspis decacantha (ANGELIN) 103

(see also pl. XV and XVII)

Fig. 2. *a* Enrolled specimen – cephalon, latex cast; *b* the same specimen, thorax and pygidium, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 9a and 9b); × 5.5.

Fig. 3. Hypostome, latex cast. Wólka, Poland; same horizon (IG no. 2. II. 392); 10.

Carmon mutilus (BARRANDE) 112

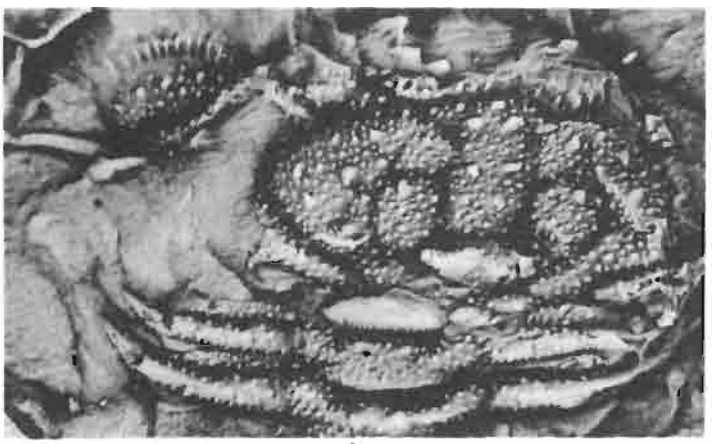
(see also pl. XVII)

Fig. 4. Entire individual, latex cast. Brzezinki, Poland; same horizon (IG no. 2. II. 39); 6.

Whittingtonia whittingtoni n. sp. 109

(see also pl. XVIII)

Fig. 5. Cheek and glabella. Wólka, Poland; same horizon (IG no. 2. II. 72); 8.



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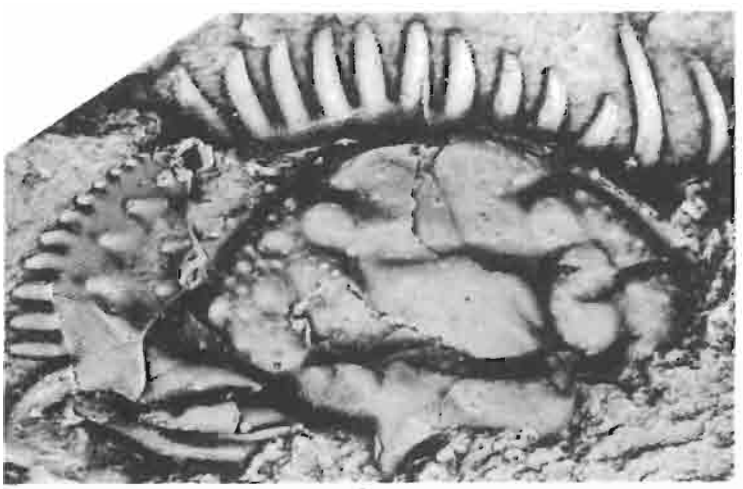

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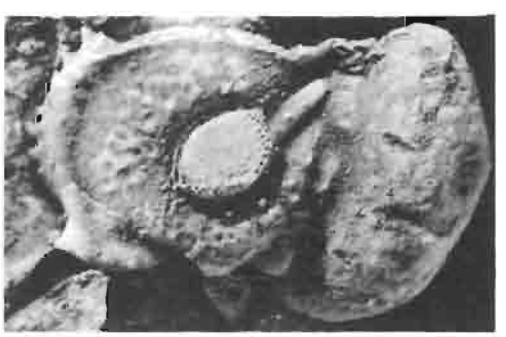

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XVII

Page

Carmon mutilus (BARRANDE) 112

(see also pl. XVI)

Fig. 1. Nearly entire specimen, latex cast. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 41); × 7.

Fig. 2. Nearly entire specimen. Same locality and horizon (IG no. 2. II. 30); × 7.

Fig. 3. Hypostome. Same locality and horizon (IG no. 2. II. 362); × 12.

Fig. 4. Cranidium. Same locality and horizon (IG no. 2. II. 353a); × 6. 5.

Fig. 5. Pygidium. Wólka, Poland; same horizon (IG no. 2. II. 32); × 14.

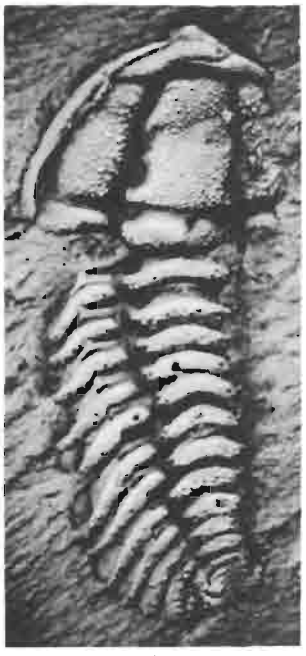
Fig. 6. Doublure showing rostral plate. Same locality and horizon (IG no. 2. II. 351a); × 8.

Diacanthaspis decacantha (ANGELIN) 103

(see also pl. XV and XVI)

Fig. 7. Fragmentary cephalon and thorax, latex cast. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 10); × 5.5.

Fig. 8. Fragmentary thorax and pygidium, latex cast. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 8); × 5.4.



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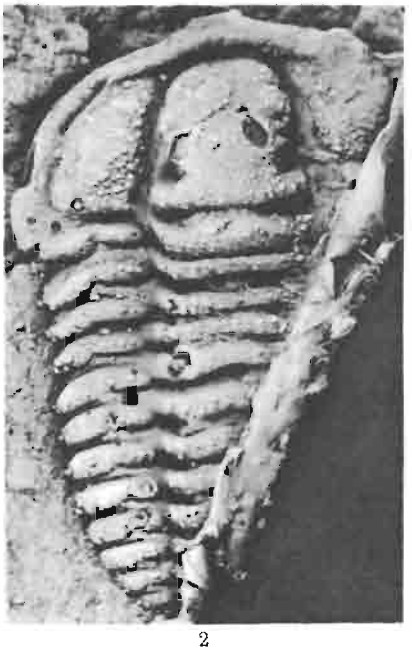

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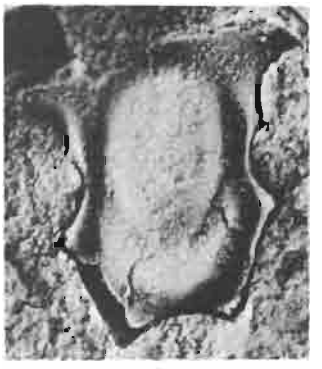

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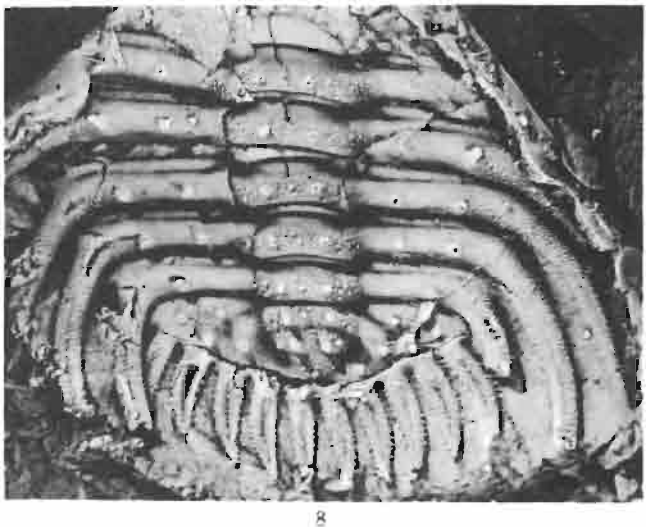

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XVIII

Page

Whittingtonia whittingtoni n. sp. 109

Fig. 1. *a-c* Cephalon, holotype, in dorsal, anterior and lateral views. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2, II, 69); × 8.

Fig. 2. Fragmentary thorax, occipital ring and pygidium, latex cast. Brzezinki, Poland; same horizon (IG no. 2, II, 73); × 6.

Fig. 3. *a-c* Damaged cephalon, in dorsal, anterior and lateral views. Wólka, Poland; same horizon (IG no. 2, II, 71); × 8.

Fig. 4. Pygidium. Brzezinki, Poland; same horizon (IG no. 2, II, 70); × 12.

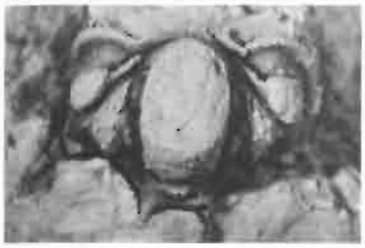
Whittingtonia sp. 112

Fig. 5. Cephalon. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401, II, 64); × 8.

Leonaspis olini TROEDSSON 98

(see also pl. VII, XIV, XV)

Fig. 6. Pygidium. Älleberg, Västergötland, Sweden; Upper Ordovician, *Dalmanitina* beds (RM no. Ar. 154575a); × 6.



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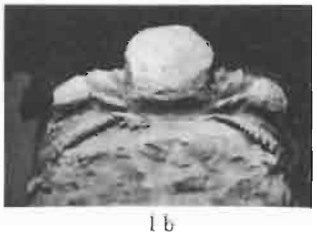

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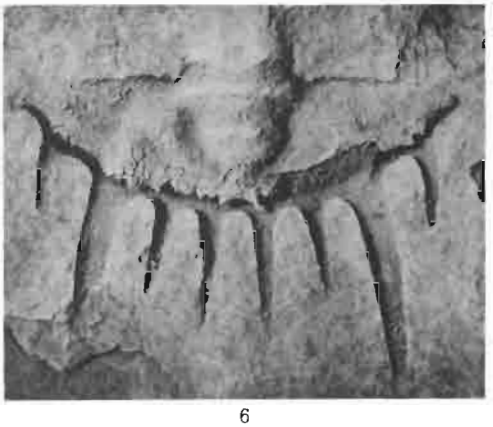

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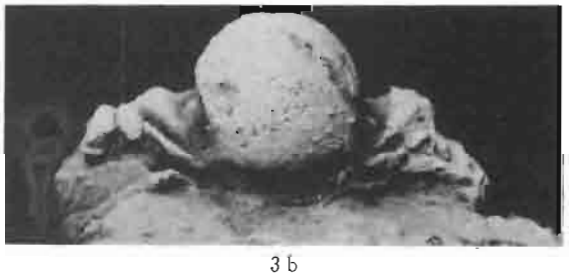

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XIX

Page

Brongniartella platynotus (DALMAN) 116

Fig. 1. Cranidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 61); × 6.
Fig. 2. *a-c* Pygidium, in dorsal, posterior and lateral views. Kinnekulle, Västergötland, Sweden; Upper Ordovician, *Dalmanitina* beds (SGU coll.); × 2.5.
Fig. 3. Cephalon. Same locality and horizon (SGU coll.); 2.5.

Dalmanitina mucronata (BRONGNIART) 118
(see also pl. XX)

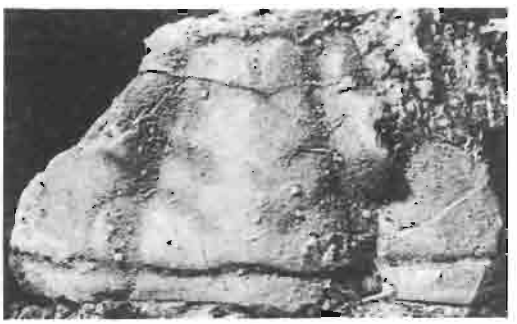
Fig. 4. Pygidium, latex cast. Stawy, Poland; Upper Ordovician, *Dalmanitina olini* zone (IG no. 401. II. 119); × 8.

Dalmanitina olini TEMPLE 119
(see also pl. XX)

Fig. 5. Pygidium. Stawy, Poland; Upper Ordovician, *D. olini* zone (IG no. 401. II. 66); 7.
Fig. 6. Fragmentary pygidium. Same locality and horizon (IG no. 401. II. 67); × 7.

Dalmanitina olini TEMPLE, or *D. mucronata* (BRONGNIART) . . . 119-120
(see also pl. XX)

Fig. 7. Young cranidium. Stawy, Poland; Upper Ordovician, *D. olini* zone (IG no. 401. II. 54); × 25.
Fig. 8. Young cranidium. Same locality and horizon (IG no. 401. II. 70); × 14.
Fig. 9. Young cranidium. Same locality and horizon (IG no. 401. II. 55); × 14.



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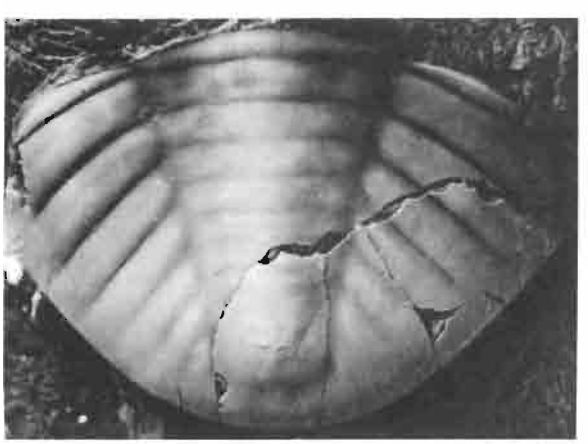

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XX

Page

Dalmanitina olini TEMPLE, OF *D. mucronata* (BRONGNIART) . . . 119-120
(see also pl. XIX)

Fig. 1. Protaspis. Stawy, Poland; Upper Ordovician, *Dalmanitina olini* zone (IG no. 401. II. 52); × 25.
Fig. 2. Protaspis. Same locality and horizon (IG no. 401. II. 53); × 25.
Fig. 3. Protaspis. Same locality and horizon (IG no. 401. II. 50); × 25.
Fig. 4. Protaspis. Same locality and horizon (IG no. 401. II. 51); × 25.

Dalmanitina mucronata (BRONGNIART) 118
(see also pl. XIX)

Fig. 5. Pygidium. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 92); × 1.5.
Fig. 6. Hypostome. Stawy, Poland; same horizon (IG no. 401. II. 131); × 8.
Fig. 7. Cephalon. Kosov, Bohemia; Upper Ordovician, upper part of the Králův Dvur beds (KUM coll.); × 2.
Fig. 8. Pygidium. Same locality and horizon (KUM coll.); × 2.
Fig. 9. Cranidium. Zalesie, Poland; Upper Ordovician, *D. mucronata* zone (IG no. 401. II. 105); × 6.
Fig. 10. Pygidium. Stawy, Poland; same horizon (IG no. 401. II. 93); × 7.
Fig. 11. Cranidium. Stawy, Poland; Upper Ordovician, *D. olini* zone (IG no. 401. II. 99); × 2.5.

Dalmanitina olini TEMPLE 119
(see also pl. XIX)

Fig. 12. Cranidium. Zalesie, Poland; Upper Ordovician, *D. mucronata* zone (IG no. 401. II. 71a); × 1.5.
Fig. 13. Pygidium. Stawy, Poland; Upper Ordovician, *D. olini* zone (IG no. 401. II. 72b); × 7.

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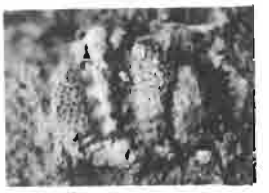

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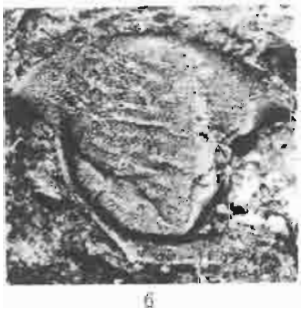

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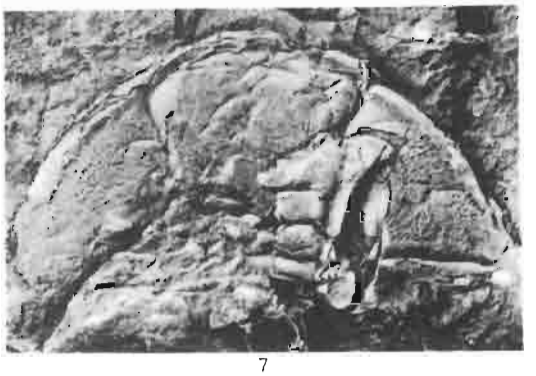

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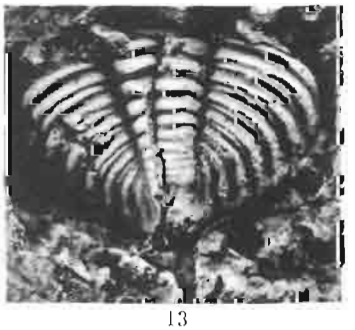

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXI

Page

«*Proetus*» sp. *a* 181
(see also pl. III)

Fig. 1. Cranidium, latex cast. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 144); × 7.5.

«*Proetus*» sp. *b* 182

Fig. 2. Pygidium, latex cast. Same locality and horizon (IG no. 401. II. 142); × 7.5.

Trilobites sp. 178
(see also pl. III)

Fig. 3. Cranidium, latex cast. Same locality and horizon (IG no. 401. II. 140); × 7.5.

Ceraurus? sp. 128
(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

Fig. 4. Young cranidium (IG no. 2. II. 380); × 14.
Fig. 5. Cranidium (IG no. 2. II. 378); × 14.
Fig. 6. Cranidium (IG no. 2. II. 377); × 8.
Fig. 7. Cranidium (IG no. 2. II. 376); × 14.

Liocnemis recurvus (LINNARSSON) 121
(see also pl. IX and XXII)

Fig. 8. Cranidium. Vasagaard, Bornholm; Upper Ordovician, *Tretaspis* beds (CM no. 1877. 2004); × 6.
Fig. 9. Cranidium. Skogastorp, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (SGU. coll.); × 3.
Fig. 10. Cephalon, latex cast. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 77a); × 10.
Fig. 11. Cephalon. Skogastorp, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (SGU. coll.); × 5.

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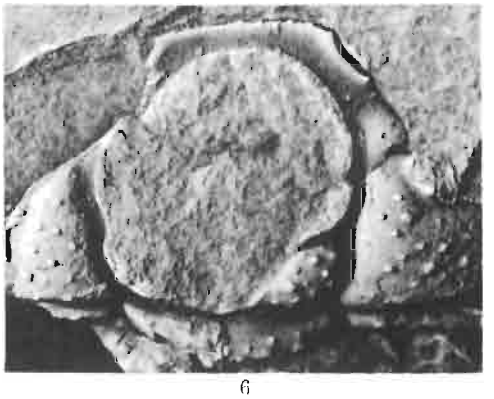

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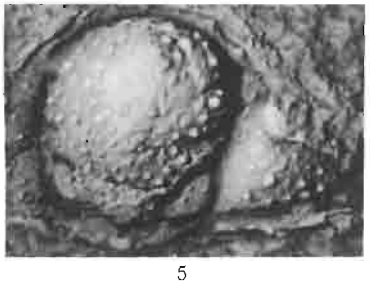

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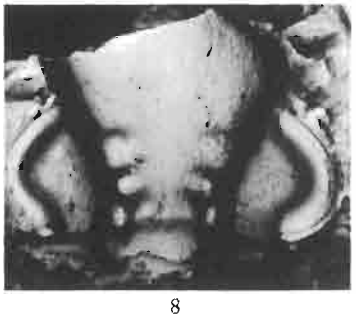

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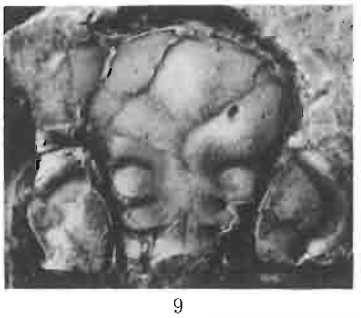

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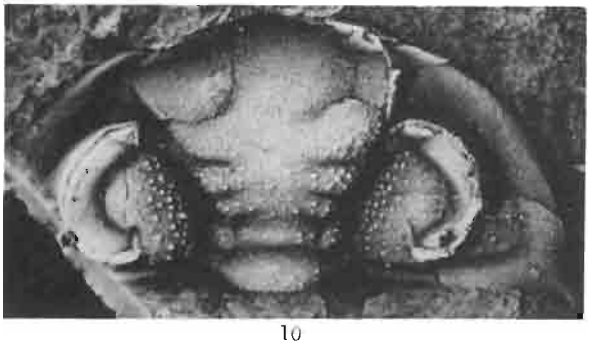

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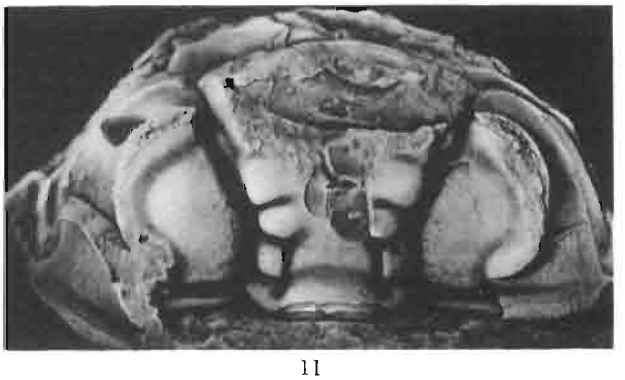

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXII

Page

Liocnemis recurvus (LINNARSSON) 121

(see also pl. IX and XXI)

Fig. 1. Entire specimen. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 84); × 3.5.

Fig. 2. Fragmentary thorax and pygidium, latex cast. Same locality and horizon (IG no. 2. II. 82); × 6.5.

Liocnemis concinnus n. sp. 123

(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

(see also pl. IX)

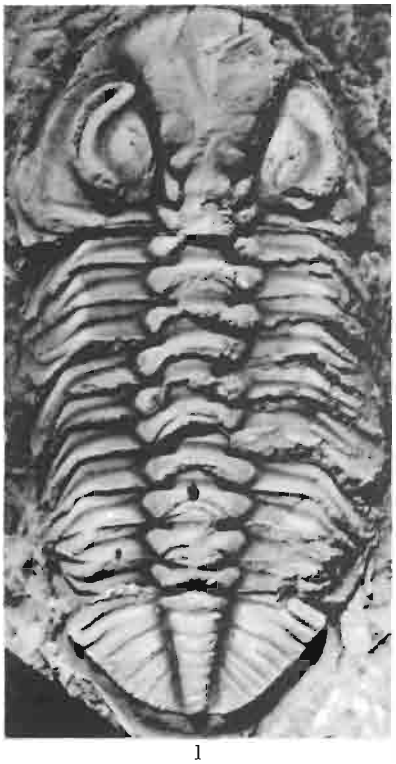
Fig. 3. Hypostome, latex cast (IG no. 2. II. 171a); × 6.

Fig. 4. Hypostome (IG no. 2. II. 385); × 4.5.

Fig. 5. Fragmentary thorax, latex cast (IG no. 2. II. 173b); × 6.

Fig. 6. Cranidium, latex cast of the specimen, figured by KIELAN (1957, pl. 2, fig. 3) as *Pterygometopus recurvus* (IG no. 2. II. 173b); × 6.

Fig. 7. Cranidium, latex cast (IG no. 2. II. 175b); × 10.



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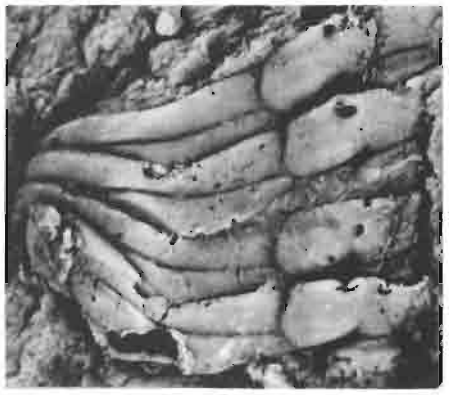

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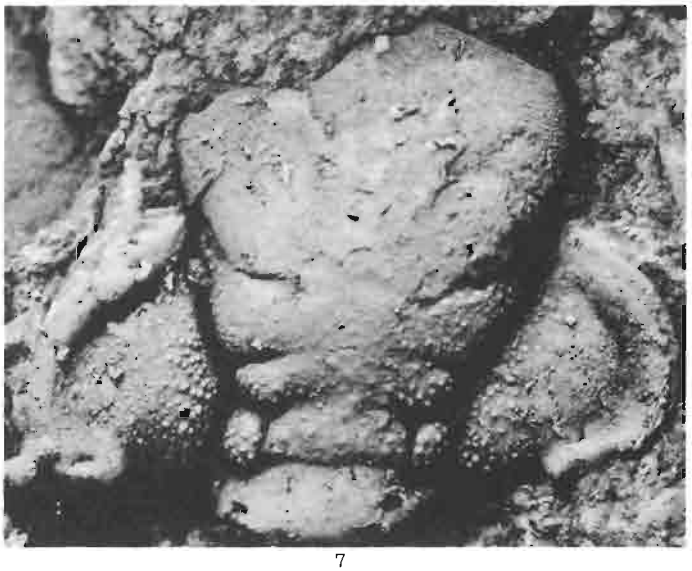

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXIII

Page

Pseudosphaerexochus sp. *c* 139

Fig. 1. Fragmentary cranidium, latex cast. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 338b); × 5.

Ceraurinella intermedia (KIELAN) 127

Fig. 2. Hypostome, latex cast. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 25); × 7.

Fig. 3. Hypostome, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 381); × 13.

Placoparia (Hawleia) prantli n. sp. 125

Fig. 4. Fragmentary thorax and pygidium, natural impression. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 329b); × 1.5.

Fig. 5. Pygidium, latex cast. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 327); × 2.

Fig. 6. Cranidium, latex cast, holotype. Same locality and horizon (IG no. 2. II. 328b); × 3.

Actinopeltis sp. *b* 133

Fig. 7. Pygidium. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 333); × 8.

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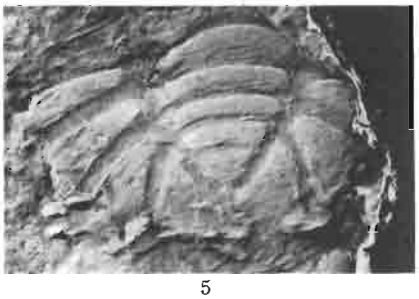

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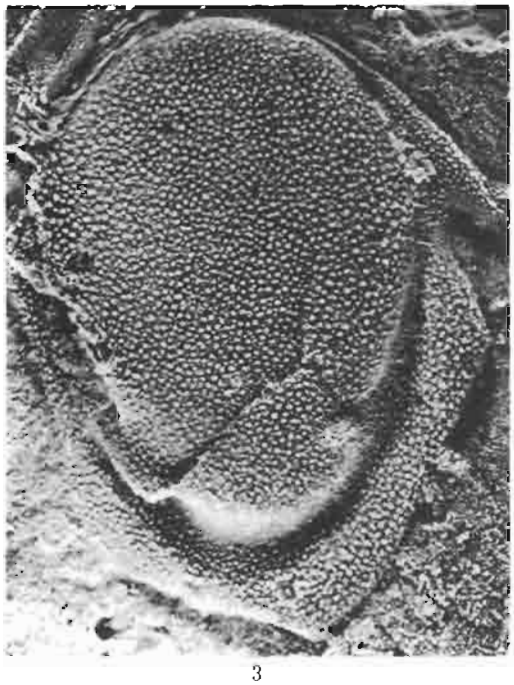

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXIV

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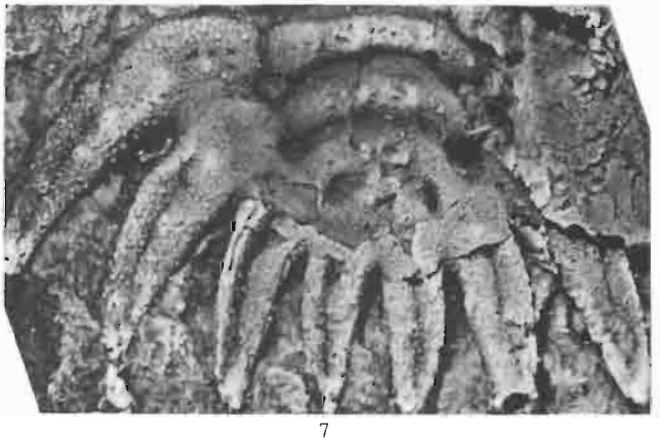

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXV

Page

Pseudosphaerexochus wolkae n. sp. 134
(see also pl. XXIV)

Fig. 1. Pygidium, latex cast. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 318); × 12.
Fig. 2. Cranidium, holotype. Wólka, Poland; same horizon (IG no. 2. II. 160); × 7.

Hammatocnemis tetrasulcatus n. sp. 141
(see also pl. XXVI and XXVII)

Fig. 3. Young cranidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons zone* (IG no. 2. II. 383); × 20.

Oedicybele kingi WHITTINGTON 157

Fig. 4. Fragmentary cheek and glabella. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 147); × 6.

«*Proetus*» sp. *c* 182

Fig. 5. Cranidium. Zalesie, Poland; Upper Ordovician, *D. mucronata* zone (IG no. 401. II. 149); × 10.

Pseudosphaerexochus sp. *b* 138

Fig. 6. *a-c* Cranidium, in dorsal, anterior and lateral views. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 317a); × 8.

Pseudosphaerexochus octacanthus (ANGELIN) 134

Fig. 7. Pygidium, holotype, specimen figured by ANGELIN (1854, pl. 22, fig. 6a) as *Cyrtometopus octacanthus* n. sp. Kinnekulle, Västergötland, Sweden; Upper Ordovician, *Chasmops* limestone (RM no. Ar. 15327); × 8.

Stubblefieldia sp. 139
(see also pl. XIII and XXIV)

Fig. 8. *a-b* Cranidium, in dorsal and lateral views. Kungslena, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (RM no. Ar. 15467); *a* × 3, *b* × 8.

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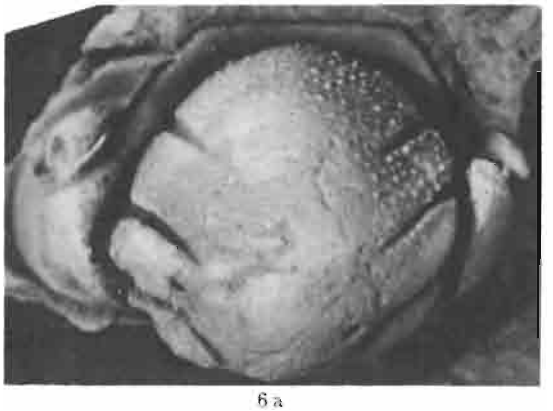

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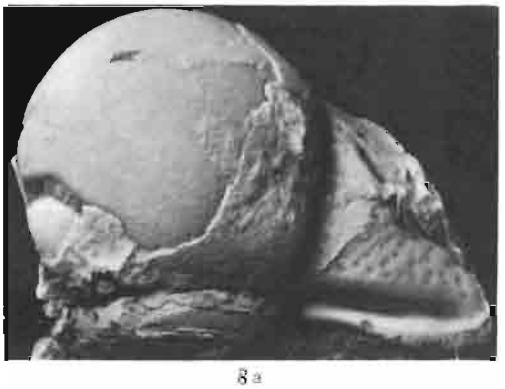

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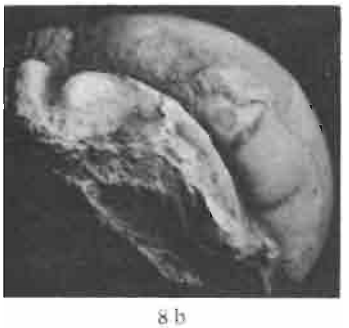

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BÖHEMIA AND SCANDINAVIA

PLATE XXVI

Page

Ogmocnemis irregularis n. sp. 70
(see also pl. IV and V)

Fig. 1. Cranidium. Kajetanów, Poland; Upper Ordovician, probably *Staurocephalus clavifrons* zone (IG no. 2. II. 358); × 7.5.

Hammatocnemis tetrasulcatus n. sp. 141
(see also pl. XXV and XXVII)

Fig. 2. Cephalon, latex cast, holotype. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 180); × 7.
Fig. 3. Pygidium, latex cast. Same locality and horizon (IG no. 2. II. 195b); × 7.
Fig. 4. Cranidium and fragmentary thorax, latex cast. Same locality and horizon (IG no. 2. II. 182); × 7.

Dindymene longicaudata n. sp. 153
(see also pl. XXVIII — XXX)

Fig. 5. Pygidium. Tommarp, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 2875t); × 8.

Dindymene ornata LINNARSSON 148
(see also pl. XXVII, XXIX and XXX)

Fig. 6. Cephalon in antero-dorsal view, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 94); × 12.

Staurocephalus clavifrons ANGELIN 156
(see also pl. XXIV)

Fig. 7. Pygidium, latex cast. Zalesie, Poland; Upper Ordovician, *Dalmanitina mucronata* zone (IG no. 401. II. 116); × 10.
Fig. 8. Cranidium. Same locality and horizon (IG no. 401. II. 13); × 6.
Fig. 9. Cranidium and thorax, latex cast. Stawy, Poland; same horizon (IG no. 401. II. 2b); × 8.

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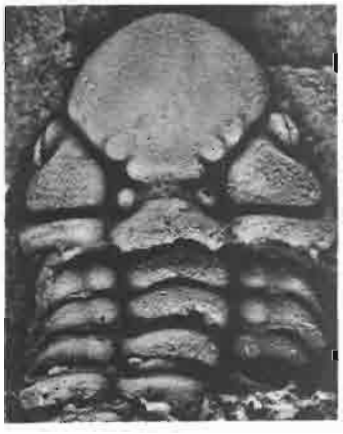

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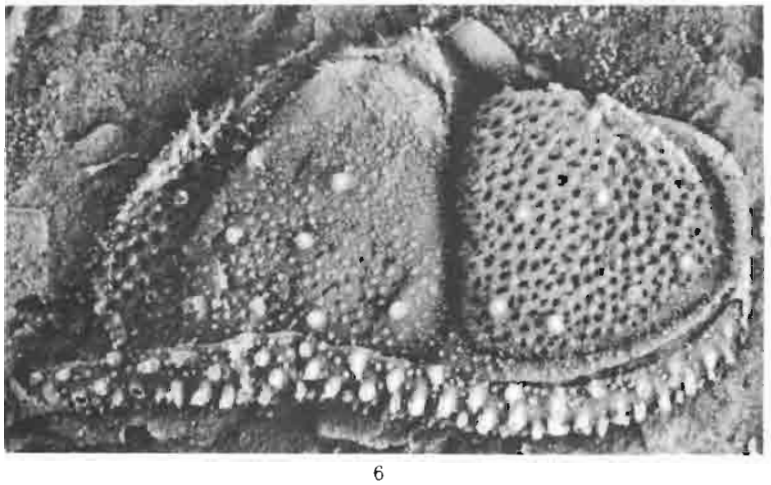

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXVII

Page

Eodindymene pulchra (OLIN) 144

(see also pl. XXVIII and XXIX)

Fig. 1. *a-b* Cephalon, in dorsal and anterior views (specimen figured by OLIN — 1906, pl. 1, fig. 21), photographed under alcohol in order to show the course of the facial suture. Tommarp, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 1915t); × 8.

Fig. 2. Pygidium, specimen figured by OLIN (1906, pl. 1, fig. 26) as *Dindymene* sp. Tosterup, Scania, Sweden; same horizon (LM no. L. O. 1920); × 8.

Dindymene ornata LINNARSSON 148

(see also pl. XXVI, XXIX and XXX)

Fig. 3. Entire specimen, figured by OLIN (1906, pl. 1, fig. 22) as *Dindymene spinulosa* n. sp. Koängen, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 1916t); × 8.

Fig. 4. Cranidium. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 104); × 7.

Fig. 5. *a-b* Entire specimen, lectotype, in dorsal and lateral views (figured by LINNARSSON, 1869*b*, pl. 1, fig. 15). Västergötland, Mösseberg, Bestorp; Upper Ordovician, Red *Tretaspis* mudstones (SGU coll.); × 12.

Hammatocnemis tetrasulcatus n. sp. 141

(see also pl. XXV and XXVI)

Fig. 6. Cranidium. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 189); × 6.

Fig. 7. Thorax. Same locality and horizon (IG no. 2. II. 382); × 12.

Fig. 8. Cranidium, latex cast. Same locality and horizon (IG no. 2. II. 194); × 5.5.

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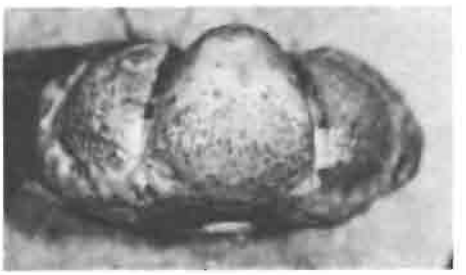

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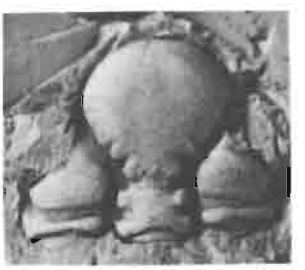

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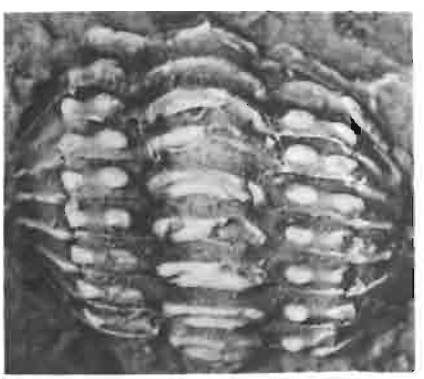

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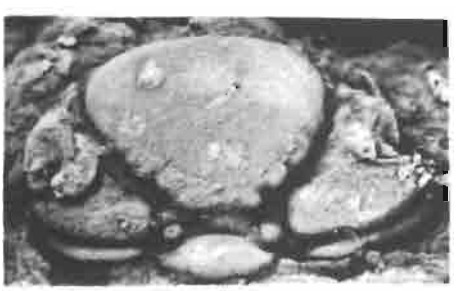

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXVIII

Page

Dindymene fridericiaugusti HAWLE & CORDA 148

Fig. 1. Cephalon in anterior view, latex cast. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 104b); × 7.

Fig. 2. Fragmentary glabella and cheek. Wólka, Poland; same horizon (IG no. 2. II. 393); × 5.5.

Eodindymene pulchra (OLIN) 144

(see also pl. XXVII and XXIX)

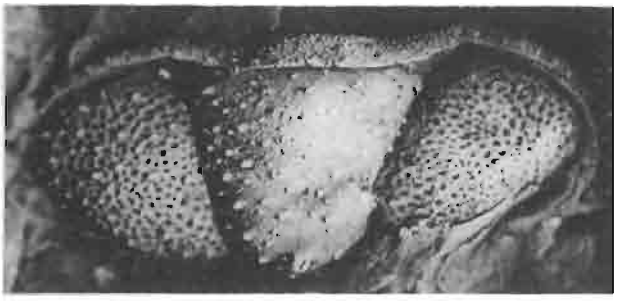
Fig. 3. Damaged cephalon, showing the course of the facial suture. Brzezinki, Poland; Upper Ordovician, probably *Eodindymene pulchra* zone (IG no. 2. II. 90); × 12.

Fig. 4. *a-b* Nearly entire individual, showing the course of the facial suture, in dorsal and lateral views. The specimen figured by KIELAN (1957, pl. 2, fig. 1). Brzezinki, Poland; Upper Ordovician, *E. pulchra* zone (IG no. 2. II. 92a); *a* × 7.4, *b* × 4.4.

Dindymene longicaudata n. sp. 153

(see pl. XXVI, XXIX and XXX)

Fig. 5. Entire, strongly depressed specimen. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 110); × 5.



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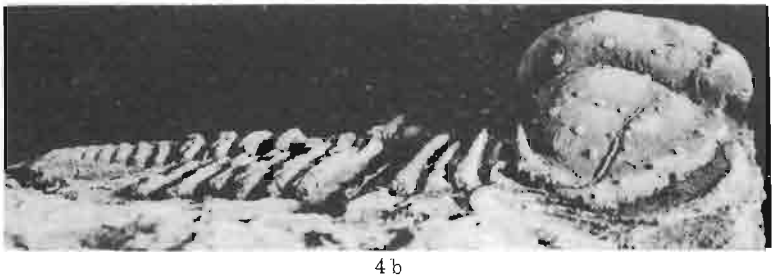

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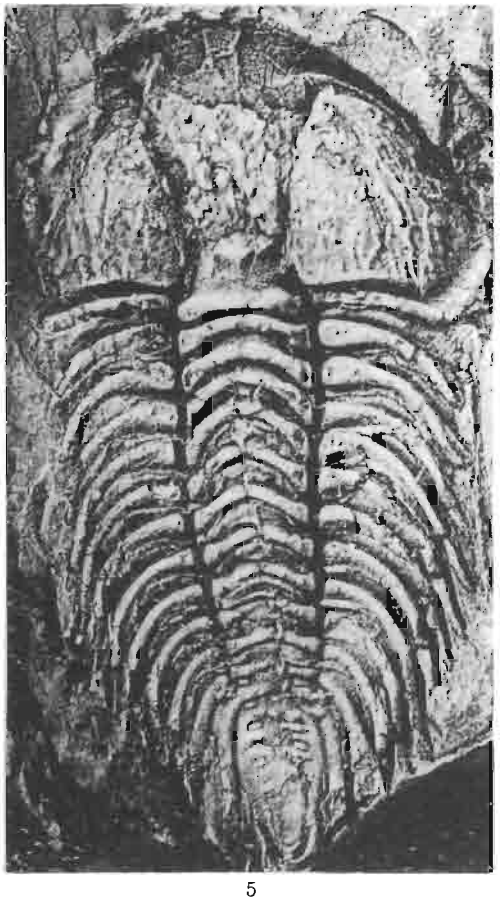

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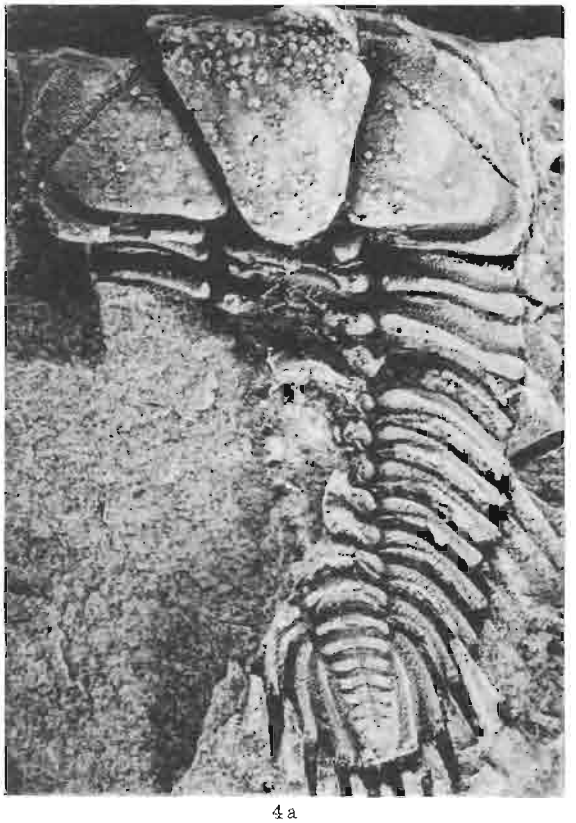

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXIX

Page

Dindymene plasi n. sp. 151

Fig. 1. *a* Entire specimen, *b* pygidium and posterior thoracic segments of the same specimen. Male Přilepy, Bohemia; Middle Ordovician, Svata Dobrotivá beds (Mr. PLAS coll.); × 7.

Fig. 2. Entire specimen. Same locality and horizon (Mr. PLAS coll.); × 7.

Fig. 3. *a-b* Entire specimen, holotype, in dorsal and lateral views. Šarka, Bohemia; same horizon (Mr. PLAS coll.); × 7.

Dindymene longicaudata n. sp. 153

(see also pl. XXVI, XXVIII and XXX)

Fig. 4. Pygidium. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 106); × 6.6.

Dindymene ornata LINNARSSON 148

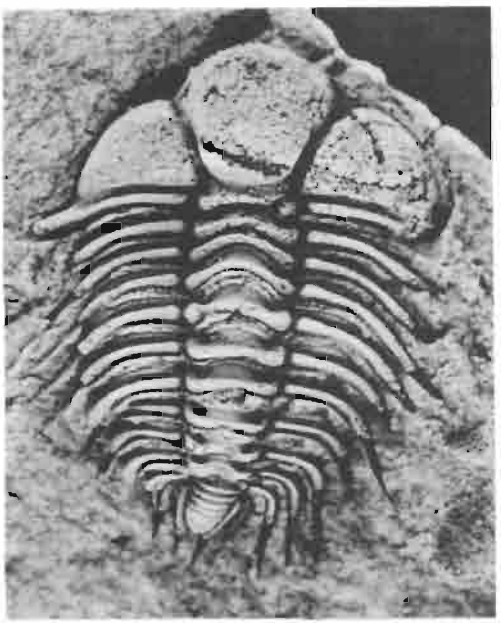
(see also pl. XXVI, XXVII and XXX)

Fig. 5. Pygidium, with broken spines. Same locality and horizon (IG no. 2. II. 100); × 6.

Eodindymene pulchra (OLIN) 144

(see also pl. XXVII and XXVIII)

Fig. 6. Pygidium. Brzezinki, Poland; Upper Ordovician, *Eodindymene pulchra* zone (IG no. 2. II. 91); × 6.



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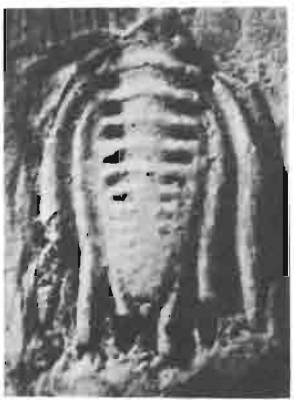

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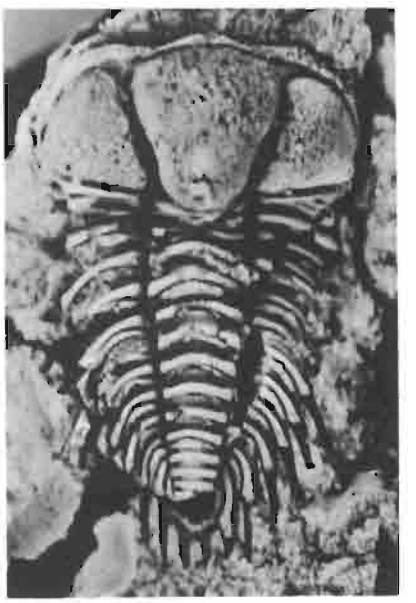

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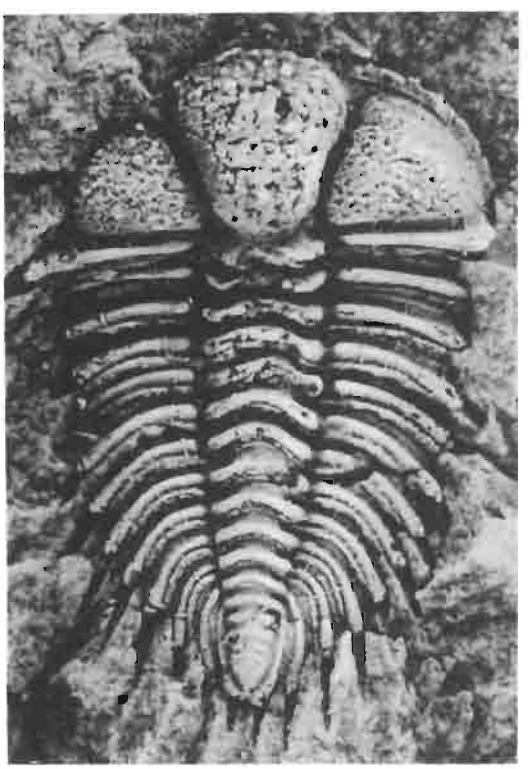

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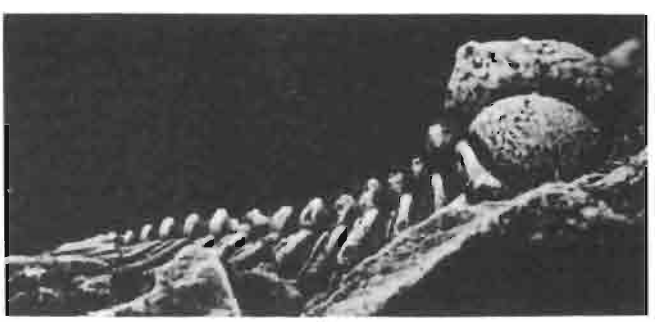

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXX

Page

Dindymene longicaudata n. sp. 153

(see also pl. XXVI, XXVIII and XXIX)

Fig. 1. Entire, damaged specimen, latex cast. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 107); × 5.

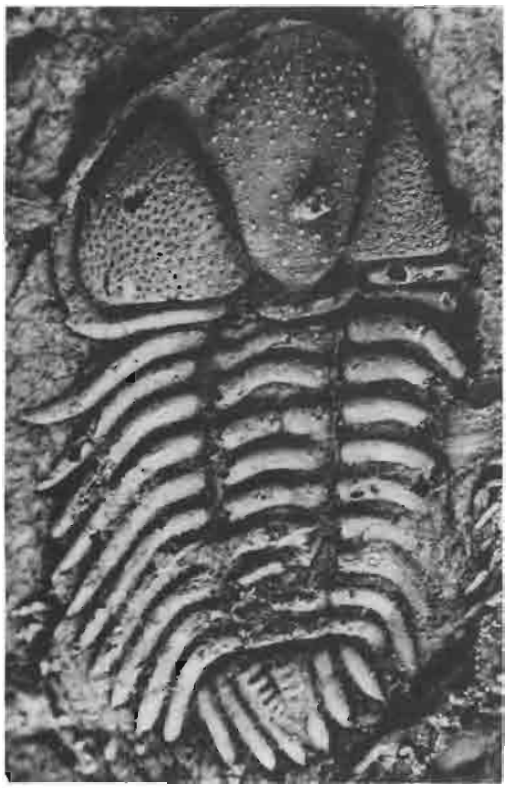
Fig. 2. Nearly entire specimen, latex cast, holotype. Brzezinki, Poland; same horizon (IG no. 2. II. 108); × 6.

Fig. 3. Cephalon and fragmentary thorax, latex cast. Same locality and horizon (IG no. 2. II. 108); × 7.

Dindymene ornata LINNARSSON 148

(see also pl. XXVI, XXVII and XXIX)

Fig. 4. Fragmentary thorax and pygidium, latex cast. Brzezinki, Poland; same horizon (IG no. 2. II. 96b); × 7.



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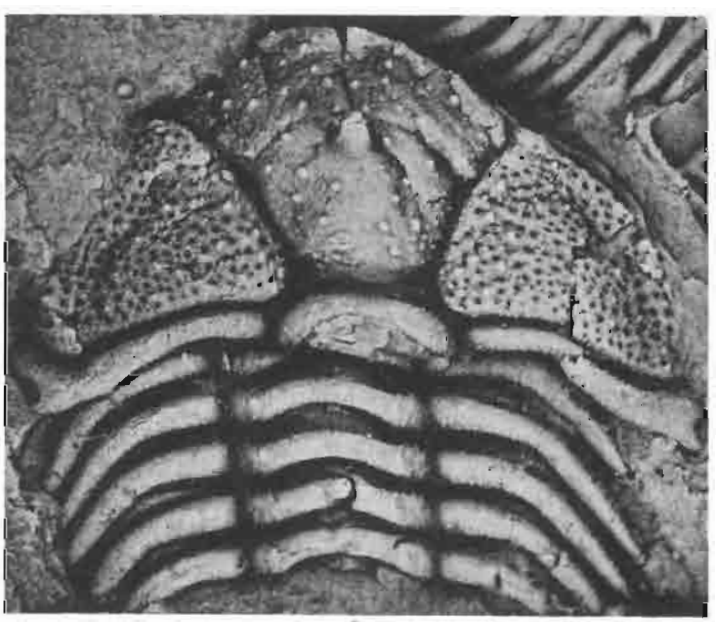

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXXI

Page

Dionide decorata n. sp. 163

(Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone)

Fig. 1. Fragmentary thorax and pygidium (IG no. 2. II. 120); × 3.5.

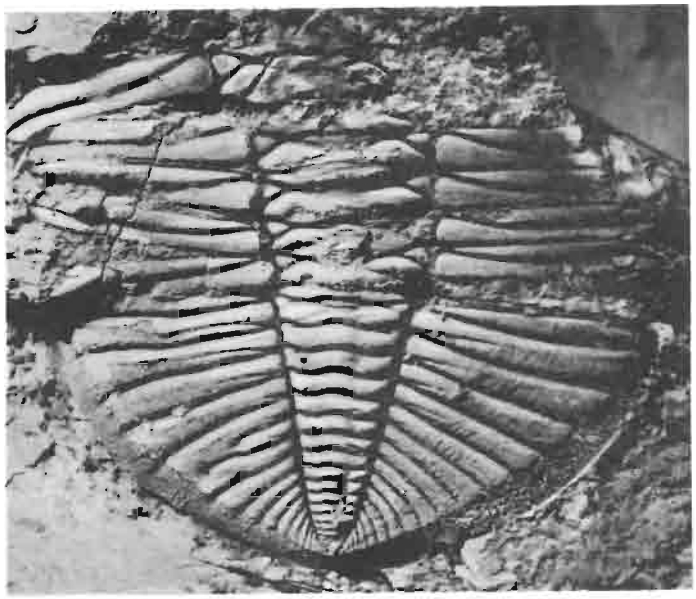
Fig. 2. *a* Cephalon, *b* latex cast of the left side of the same cephalon, showing ornamentation, holotype (IG no. 2. II. 121a, 121b); *a* × 1.8, *b* × 4.5.

Fig. 3. Entire, damaged specimen (IG no. 2. II. 122); × 5.

Dionide subrotundata n. sp. 161

(see also pl. XXXII, XXXIII and XXXV)

Fig. 4. Fragmentary cephalon in anterior view. Same locality and horizon (IG no. 2. II. 125); × 7.8.



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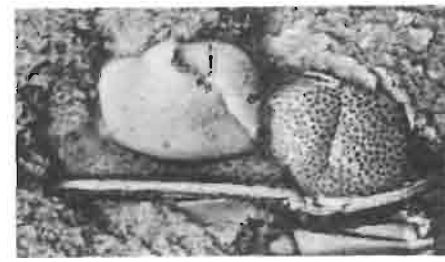

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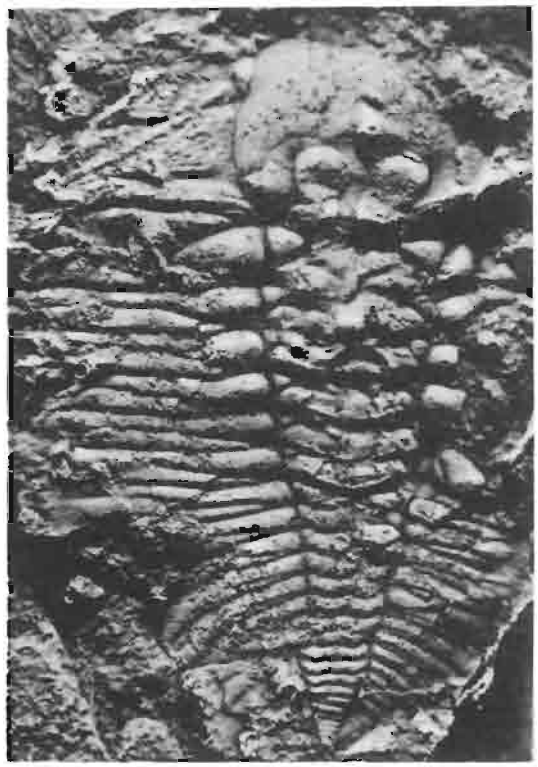

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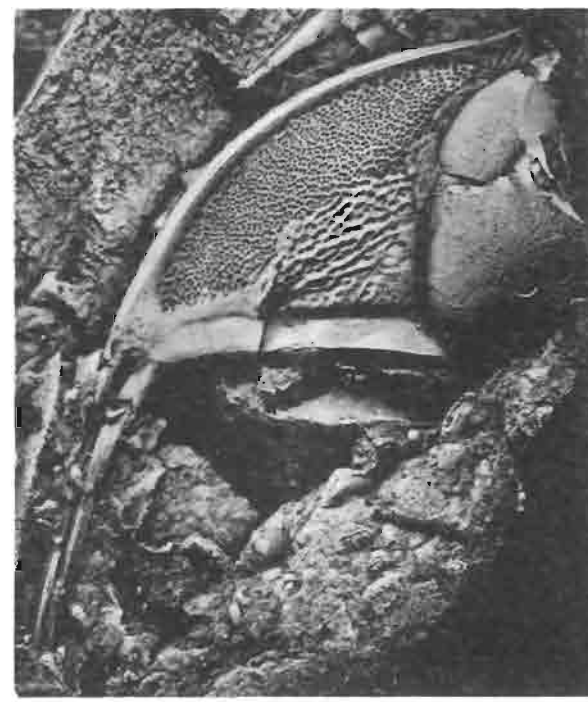

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXXII

Page

Dionide subrotundata n. sp. 161
(see also pl. XXXI, XXXIII and XXXV)

Fig. 1. Entire specimen, rubber cast, holotype. Vasagaard, Bornholm; Upper Ordovician, *Tretaspis* beds (CM no. 1871. 1251); × 8.
Fig. 2. Cephalon. Same locality and horizon (CM no. 1869. 1500); × 8.
Fig. 3. Fragmentary cephalon and thorax. Koängen, Scania, Sweden; same horizon (LM no. L. O. 3876t); × 8.

Raphiophorus acus (TROEDSSON) 168
(see also pl. XXXV)

Fig. 4. *a* Fragmentary thorax and pygidium, latex cast; *b* latex cast of the cephalon of the same specimen. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 312a, 312b); *a* × 12, *b* × 9.

Shumardia polonica n. sp. 159

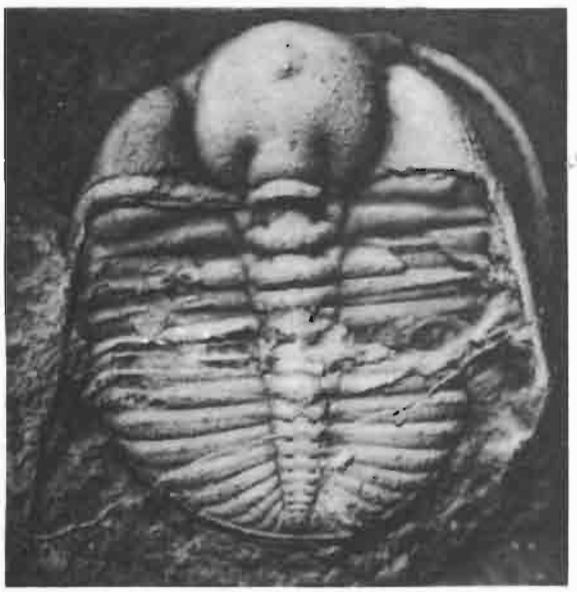
Fig. 5. Cephalon, holotype. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 321); × 14.

Raphiophorus gratus (BARRANDE) 166
(see also pl. XXXIII and XXXVI)

Fig. 6. Cephalon, specimen figured by OLIN (1906, pl. 1, fig. 23) as *Dindymene venusta* OLIN. Rästonga, Scania, Sweden; Upper Ordovician, *Tretaspis* beds (LM no. L. O. 1917); × 7.

Hibbertia sp. 159

Fig. 7. Fragmentary cephalon and thorax, latex cast. Johnston, Mösseberg, Västergötland, Sweden; Upper Ordovician, Red *Tretaspis* mudstones (UM no. Ar. 2020); × 2.



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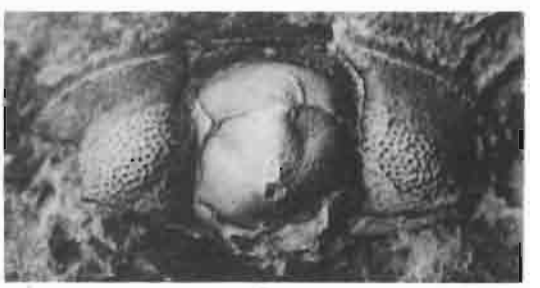

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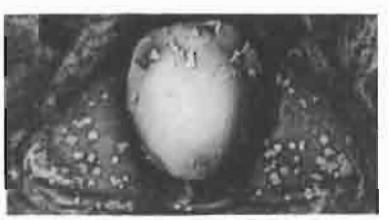

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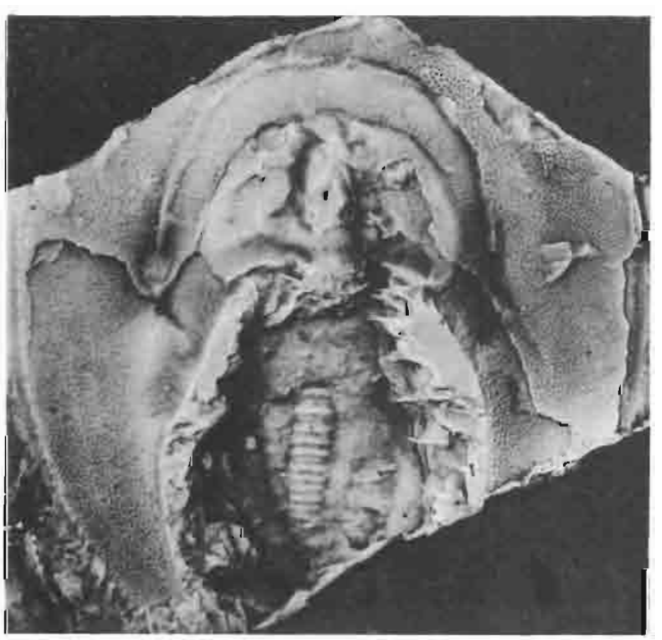

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXXIII

Page

Tretaspis granulata (WAHLENBERG) 171
(see also pl. XXXIV-XXXVI)

Fig. 1. Entire specimen, latex cast. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 315); × 8.
Fig. 2. Pygidium. Brzezinki, Poland; same horizon (IG no. 2. II. 390a); × 2.
Fig. 3. Lower lamella. Wólka, Poland; same horizon (IG no. 2. II. 296); × 1.5.

Raphiophorus gratus (BARRANDE) 166
(see also pl. XXXII and XXXVI)

Fig. 4. Fragmentary cranidium, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 279); × 7.
Fig. 5. Fragmentary cranidium, latex cast. Same locality and horizon (IG no. 2. II. 278); × 7.

Tretaspis seticornis seticornis STØRMER 174

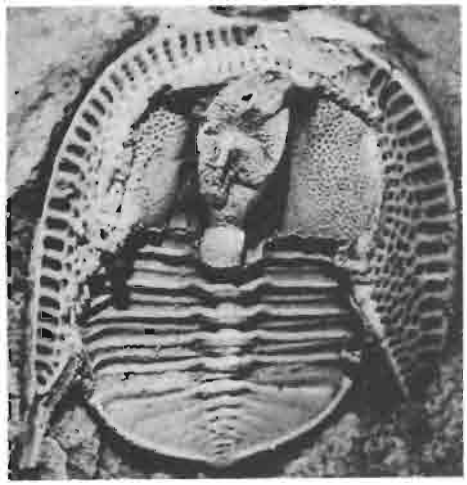
Fig. 6. Fragmentary cephalon, latex cast of the specimen figured by KIELAN (1957, pl. 2, fig. 5). Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 280); × 9.

Dionide subrotundata n. sp. 161
(see also pl. XXXI, XXXII and XXXV)

Fig. 7. Fragmentary cephalon and thorax. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 126); × 8.

Lonchodomas portlocki (BARRANDE) 169
(see also pl. XXXV)

Fig. 8. Three damaged specimens, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 115); × 7.5.



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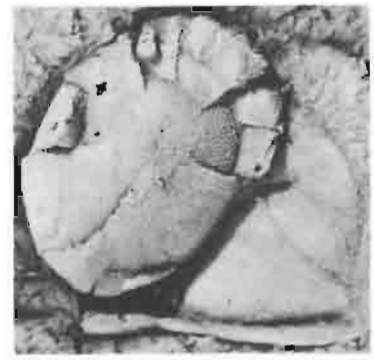

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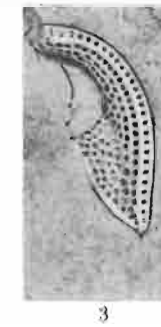

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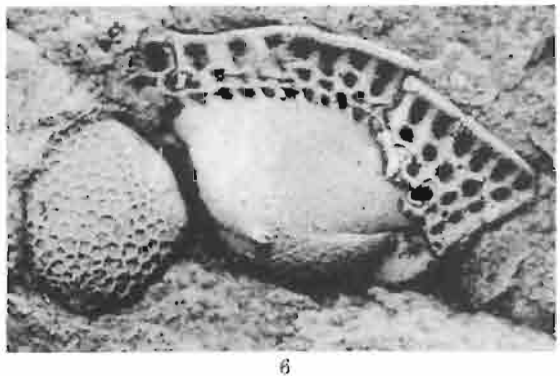

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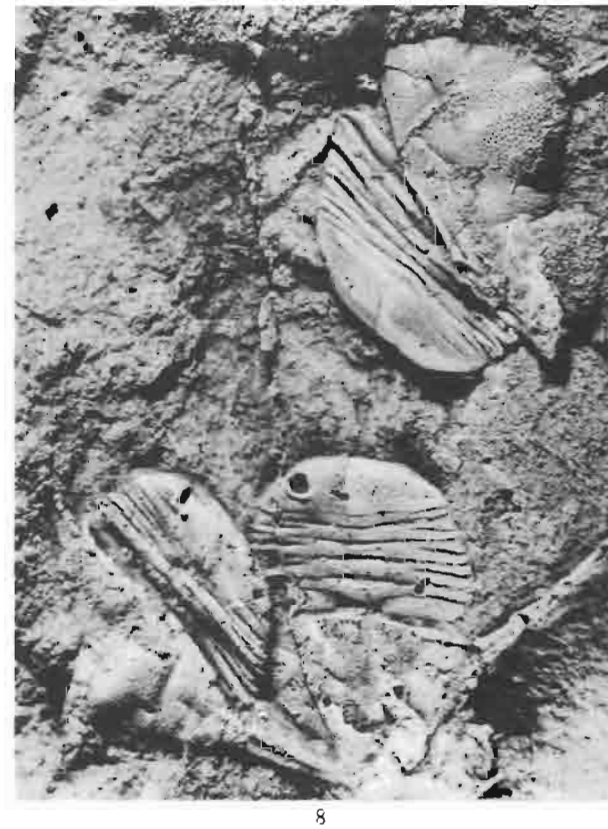

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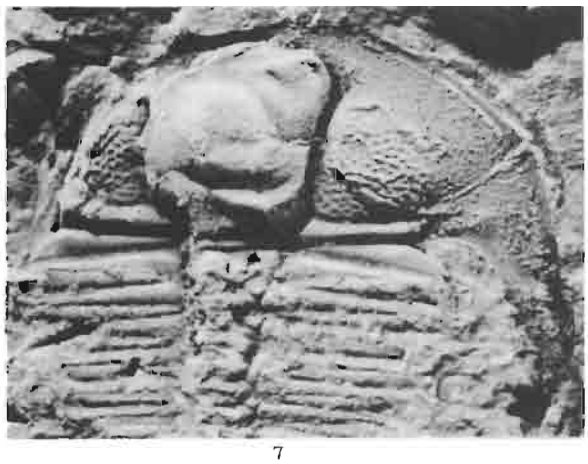

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Palaeontologia Polonica, No. 11, 1959

Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXXIV

Page

Tretaspis granulata (WAHLENBERG) 171

(see also pl. XXXIII, XXXV and XXXVI)

Fig. 1. Fragmentary cephalon, latex cast. Brzezinki, Poland; Upper Ordovician, *Eodindymene pulchra* zone (IG no. 2. II. 391); × 4.5.

Fig. 2. *a-b* Cephalon and fragmentary thorax, latex cast, in dorsal and lateral views. Wólka, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 315); × 4.

Novaspis albida (REED) 175

(see also pl. XXXVI)

Fig. 3. Lower lamella. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 131); × 7.

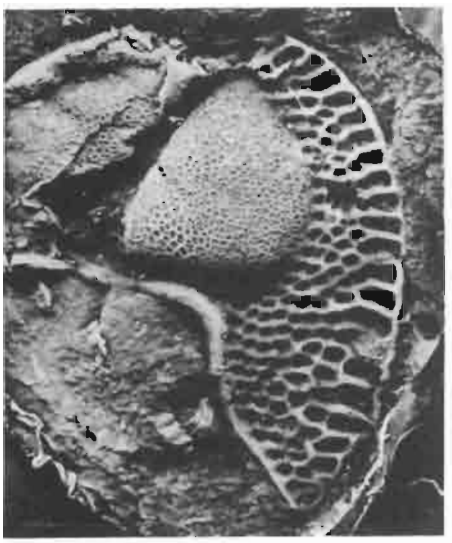
Hibbertia sanctacrucensis n. sp. 157

(see also pl. XXXV)

Fig. 4. Cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 324a); × 2.5.

Fig. 5. Genal prolongations. Same locality and horizon (IG no. 2. II. 323b); × 2.5.

Fig. 6. Cephalon and fragmentary thorax. Wólka, Poland; same horizon (IG no. 2. II. 325a); × 3.



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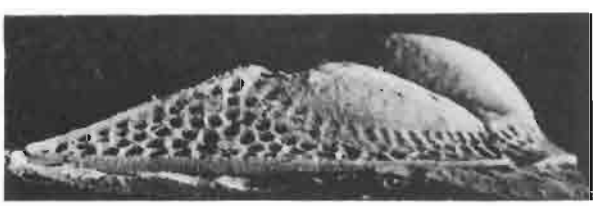

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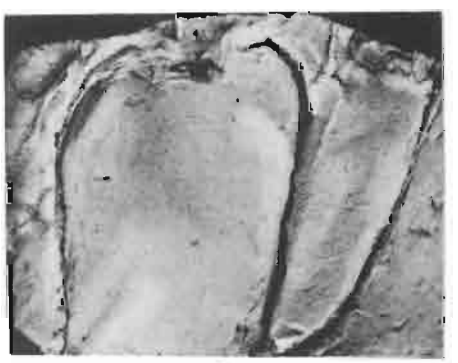

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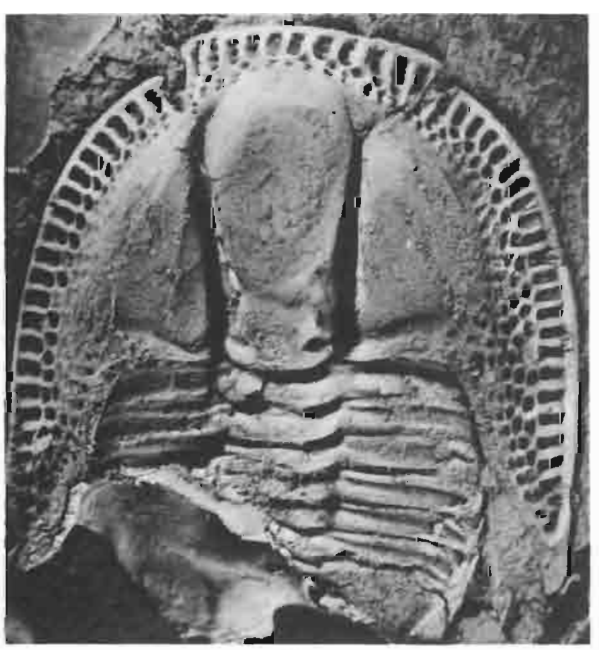

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXXV

Page

Tretaspis granulata (WAHLENBERG) 171

(see also pl. XXXIII, XXXIV and XXXVI)

Fig. 1. *a* Cephalon and fragmentary thorax showing lower lamella, type specimen (figured by WAHLENBERG—1821, pl. 2, fig. 4 — as *Entomostracites granulatus* n. sp.); *b* rubber cast of the same specimen, showing upper lamella in dorso-lateral view; *c* the same specimen, dorsal view. Ålleberg, Västergötland, Sweden; Upper Ordovician, *Staurocephalus* beds (UM no. Ar. 2000); × 3.

Fig. 2. Fragmentary cephalon. Brzezinki, Poland; Upper Ordovician, probably *Staurocephalus clavifrons* zone (IG no. 2. II. 283); × 2.5.

Novaspis sp. 178

Fig. 3. Cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 129); × 5.

Lonchodomas portlocki (BARRANDE) 169

(see also pl. XXXIII)

Fig. 4. Entire specimen. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 112); × 5

Dionide subrotundata n. sp. 161

(see also pl. XXXI-XXXIII)

Fig. 5. Entire specimen. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 127); × 2.5.

Raphiophorus tenellus (BARRANDE) 165

Fig. 6. Entire specimen, latex cast. Brzezinki, Poland; Upper Ordovician; *S. clavifrons* zone (IG no. 2. II. 388); × 8.

Raphiophorus acus (TROEDSSON) 168

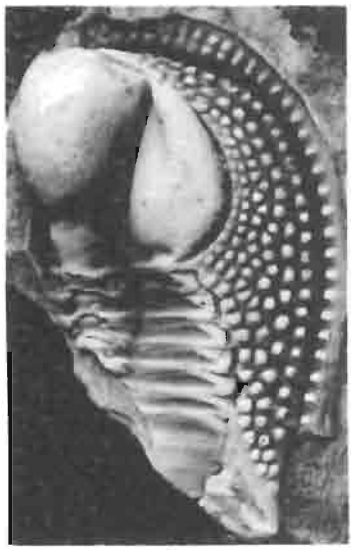
(see also pl. XXXII)

Fig. 7. Nearly entire specimen, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 334b); × 6.

Hibbertia sanctacrucensis n. sp. 157

(see also pl. XXXIV)

Fig. 8. Fragmentary cephalon. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 323a); × 2.



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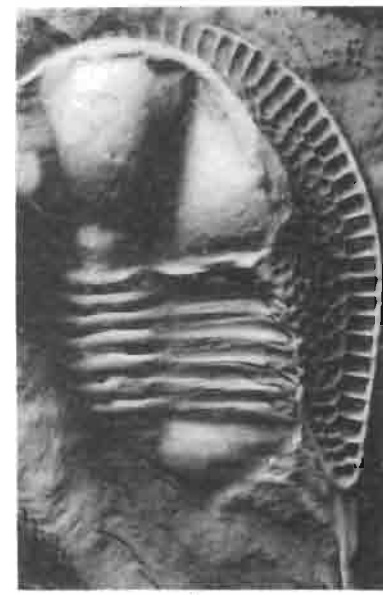

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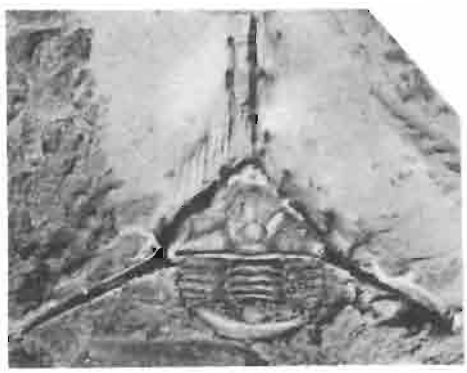

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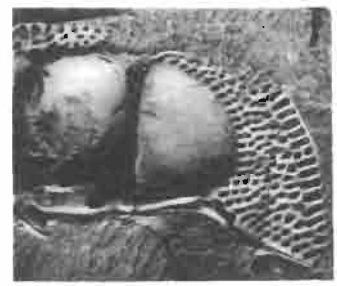

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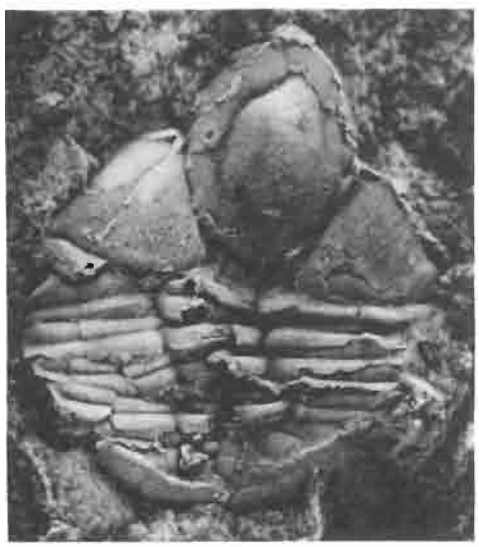

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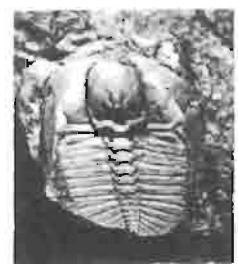

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Z. KIELAN: UPPER ORDOVICIAN TRILOBITES FROM POLAND AND SOME RELATED FORMS FROM BOHEMIA AND SCANDINAVIA

PLATE XXXVI

Page

Novaspis albida (REED) 175
(see also pl. XXXIV)

Fig. 1. Fragmentary cephalon. Brzezinki, Poland; Upper Ordovician, *Staurocephalus clavifrons* zone (IG no. 2. II. 130a); × 3.
Fig. 2. Damaged, entire specimen. Same locality and horizon (IG no. 2. II. 135); × 2.5.
Fig. 3. Damaged cephalon. Brzezinki, Poland; Upper Ordovician, probably *S. clavifrons* zone (IG no. 2. II. 139); × 7.
Fig. 4. Entire, laterally deformed specimen, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 132); × 2.
Fig. 5. Fragmentary cephalon, latex cast. Same locality and horizon (IG no. 2. II. 315); × 4.5.

Tretaspis granulata (WAHLENBERG) 171
(see also pl. XXXIII—XXXV)

Fig. 6. Fragmentary cephalon, showing upper and lower lamella. Wólka, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 275); × 1.5.

Raphiophorus gratus (BARRANDE) 166
(see also pl. XXXII and XXXIII)

Fig. 7. Entire, damaged specimen, latex cast. Brzezinki, Poland; Upper Ordovician, *S. clavifrons* zone (IG no. 2. II. 362); × 7.5.

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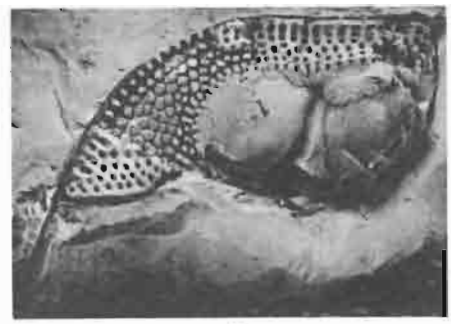

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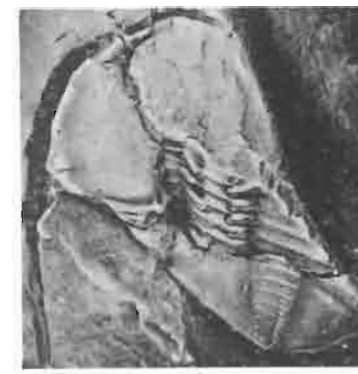

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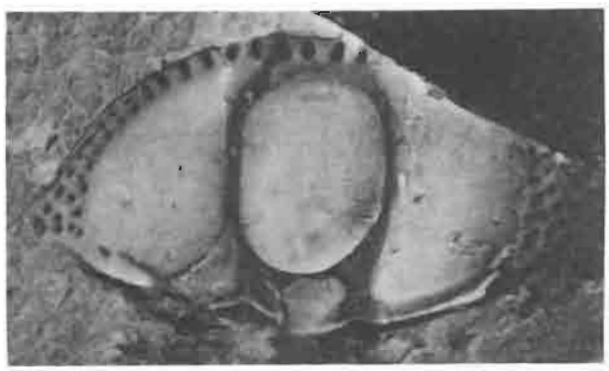

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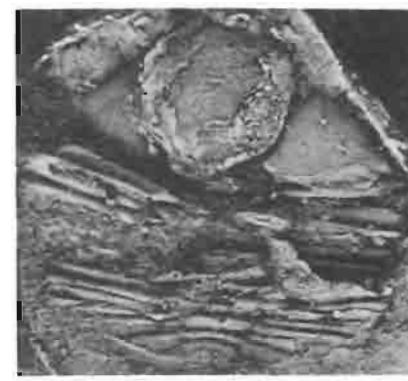

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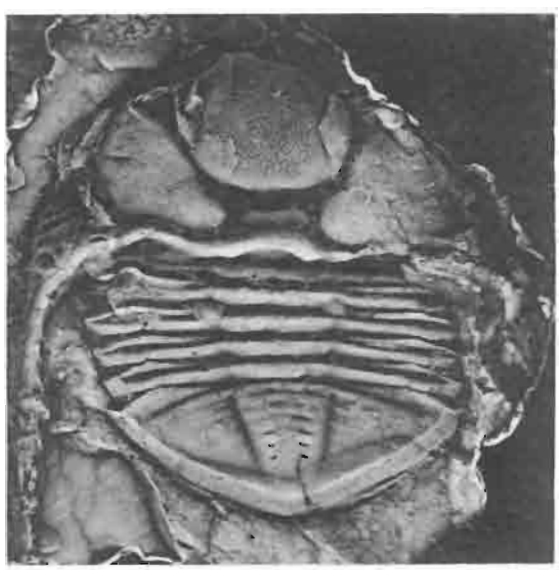

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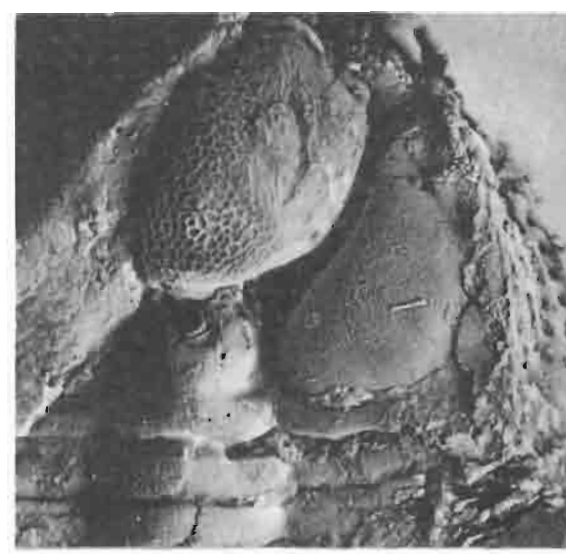

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ACHATS

Pour achat de „Palaeontologia Polonica" à l'étranger prière s'adresser à

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