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POLYCHAETE JAW APPARATUSES FROM THE ORDOVICIAN AND SILURIAN OF POLAND AND A COMPARISON WITH MODERN FORMS

(APARATY SZCZĘKOWE WIELOSZCZETÓW Z ORDOWIKU I SYLURU POLSKI I PORÓWNANIA Z FORMAMI WSPÓŁCZESNYMI)

BY
ZOFIA KIELAN-JAWOROWSKA

(WITH 12 TEXT-FIGURES, 6 TABLES AND 36 PLATES)

WARSZAWA 1966

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To Professor Roman Kozłowski –
the best of teachers

CONTENTS

INTRODUCTION

Among Recent polychaete annelids the proboscidial armature occurs in several families, however, only in the superfamily Eunicea is it developed as a differentiated jaw apparatus, which includes the ventral mandibles and dorsal maxillae, consisting of several pairs of jaws.

The isolated fossil jaws of polychaete annelids have been known in palaeontological literature since PANDER'S paper (1856) and were called by CRONEIS and SCOTT (1933) scolecodonts. Though the scolecodonts are among the most common microfossils, especially in Palaeozoic sediments from the Lower Ordovician onwards, entire jaw apparatuses are extremely rarely preserved. Joined jaws or jaw apparatuses, mostly preserved in shales or marls, have been described by EHLERS (1868) from the Jurassic of Germany, by HINDE (1896) from the Lower Carboniferous of Great Britain, by ELLER (1933, 1934*a*, 1934*b*, 1936, 1963*b*) from the Devonian of United States, by GRIES (1944) from the Ordovician of Ohio in United States, by ROGER (1946) from the Cretaceous of Lebanon, by LANGE (Portuguese edition, 1947; English edition, 1949) and (1950) both from the Devonian of Brasil, by ŠNAJDR (1951) from the Silurian of Bohemia, and by MARTINSSON (1960) from the Silurian of Gotland.

Of the species described by the above cited authors, only *Paulinites paranaensis* LANGE, from the Devonian of Brasil (LANGE, 1949), is represented by numerous specimens in a satisfactory state of preservation. The remaining specimens or joined jaws are represented by only one or two specimens, mostly poorly preserved.

In contrast to the general scarcity of polychaete jaw apparatuses in fossil materials there is a large collection of Ordovician and Silurian polychaete jaw apparatuses assembled recently in the Palaeozoological Institute of the Polish Academy of Sciences in Warsaw. This collection derives from erratic boulders scattered over northern Poland. In 1950 Professor ROMAN KOZŁOWSKI, in connection with his studies on graptolites, began to collect these limestones and dissolve them in hydrochloric and acetic acid. In addition to the graptolites and various chitinous microfossils, he obtained a collection of polychaete jaw apparatuses in an excellent state of preservation. KOZŁOWSKI (1956) described from this collection three species belonging to the genera *Polychaetaspis* KOZŁOWSKI and *Polychaetura* KOZŁOWSKI.

In 1960 Professor KOZŁOWSKI put at the writer's disposal the remaining collection of polychaete jaw apparatuses for investigation. As boulders have been continually collected since that time and systematically dissolved in acid, the collection has considerably increased and now embraces several thousand isolated jaws and more than five hundred jaw apparatuses. Since 1960 the present writer has carried out laboratory investigations on this material and during this time three papers (KIELAN-JAWOROWSKA, 1961, 1962, 1963) have been published. Seven new genera of polychaete jaw apparatuses were described (*Mochtyella* KIELAN-JAWOROWSKA, *Vistulella* KIELAN-JAW., *Xanioprion* KIELAN-JAW., *Kalloprion* KIELAN-JAW., *Rampho-*

prion KIELAN-JAW., *Atraktoprion* KIELAN-JAW., *Skalenoprion* KIELAN-JAW.) and some questions concerning the terminology and homology of fossil and Recent jaw apparatuses were discussed.

The nature of scolecodonts was long ago recognized by pioneer students of this group, such as EHLERS (1868) and HINDE (1879, 1880, 1882, 1896). These authors coined the generic names of the fossil jaws from their Recent presumed descendants, e.g. *Eunicites* EHLERS from *Eunice* CUVIER, *Lumbriconereites* EHLERS from *Lumbriconereis* GRUBE and so forth.

The generic names attributed to some scolecodonts, such as e.g. *Glycerites* HINDE and *Nereidavus* GRINNELL, suggest a relationship to the Recent families Glyceridae and Nereidae. However, the isolated jaws attributed by various authors to these genera belong in the opinion of the present writer to eunicid apparatuses, mostly to the Paulinitidae LANGE. About seventy per cent of the isolated jaws from the limestones investigated have been identified (at least to the generic level), by comparison with entire apparatuses in the same collection, as belonging to different representatives of Eunicea. There are in the collection some isolated jaws (mostly single teeth), which have never been found in any eunicid apparatus and which cannot be identified. On the other hand, neither could they be identified as belonging to any of the polychaete families besides the Eunicea. This does not necessarily mean that no other polychaete family occurred in the Ordovician and Silurian seas of the Baltic region. It does, however, mean that the teeth or jaws of polychaete annelids other than Eunicea cannot at present be identified with any certainty in Ordovician and Silurian samples.

The one weakness of the collection described in the present paper is that it was derived from boulders. After identification of the graptolites, conodonts and other fossils in some boulders yielding scolecodonts, their age may be determined. Therefore, in spite of boulder origin, the stratigraphic range of the majority of the described species may be recognized. However in certain cases the range of the described species is known only tentatively, moreover there are species or even genera (e.g. *Skalenoprion* KIELAN-JAWOROWSKA) of whose stratigraphic range nothing could be said other than «Ordovician or Silurian».

It was a common belief among palaeontologists up till very recently, that scolecodonts could have little or no stratigraphic value. It is quite obvious that the detached jaws as hitherto described in an inadequate taxonomic system (adopting various criteria for erecting the genera and paying no attention to what part of the eunicid apparatus the described jaw represented) cannot have any stratigraphic value. The present studies, though based on material from erratic boulders, change to some extent the opinion of scolecodonts as stratigraphic indicators. The studies of the species assemblages occurring in different boulders have proved that some polychaete jaw apparatus species occur only in a given faunistic assemblage. The elaborated material is too limited to give guide lines for basing Ordovician and Silurian stratigraphy on scolecodonts — but some polychaete jaw assemblages characteristic for given strata are suggested.

It is a well known fact that in Recent eunicids the individual maxillary pieces of an apparatus are separated. The question arises then how the entire apparatus could be preserved in fossil state? The preparations of the cuticular layer which covers the stomodeum, obtained by the present writer (comp. Plate I, figs. 3—5) show that the jaws of the apparatus are joined together by the cuticule which covers the stomodeum. The presence of this layer is evidently responsible for the fossil apparatuses studied by the writer, being preserved unharmed in limestone.

It has been stated above that entire jaw apparatuses have been until recently very rarely found. This may suggest that the collection of more than five hundred polychaete jaw appa-

ratuses collected by the writer derives from a very narrow stratigraphic horizon and may be from a single locality (similar to that of e.g. the Burgess Shale), where particularly good conditions favoured the preservation of numerous entire jaw apparatuses. This, however, is not the case. The jaw apparatuses here described have been found by the writer in erratic boulders ranging in age from Llandeilo to Lower Ludlow. Moreover the boulders brought by glaciers to northern Poland were derived presumably from the vast area of the Baltic Sea and may be also from Scandinavia and the vicinity of Estonia. Some (not described so far) apparatuses have also been found by the writer in the Ordovician and Silurian samples from the cores of borings in north-eastern Poland.

Moreover the jaw apparatuses are preserved in more than one type of limestone. To be sure, it should be stated that jaw apparatuses have not been found by the writer in a reef facies. Most commonly they occur in marly limestone, associated with trilobites, brachiopods, graptolites and different chitinous microfossils. They have, however, been found in coarse grained marly limestone, in organogenic fine grained marly limestone, in pure compact limestone similar lithologically to the «Baltic limestone» (Ostseekalk) and others.

This clearly shows that the polychaete jaw apparatuses could be preserved unharmed in various conditions, and that such conditions commonly occurred in Ordovician and Silurian seas in the Baltic region. It seems quite reasonable to presume that limestones, deposited in similar conditions, could be found in numerous other localities throughout the world.

The question then arises — why have polychaete jaw apparatuses been, until very recently, such a rarity in palaeontological material? There may be two possible reasons:

1. The marly Palaeozoic limestones, which provides the best opportunity for satisfactory preservation of chitinous microfossils, have been so far dissolved in acids only on a very limited scale.

2. When the limestone was dissolved for obtaining the scolecodonts, the commonly adopted method of handling the residue, as a rule, destroyed the delicate apparatuses. Usually (see ELLER, 1941*a*), after dissolving, the residue was washed and then dried. There is no doubt that almost no single jaw apparatus, such as described in the present paper, could have been preserved in a dried residue. The extremely delicate pellicle which often joins the individual jaws, disintegrates when the specimen is dried.

It is shown in the present paper that when the entire or nearly entire apparatus is described, some isolated jaws of conspecific apparatuses can also be identified (particularly left MI and basal plate).

The conclusion of the present investigation is that scolecodonts, which due to their minuteness are often found in Palaeozoic boring cores where the foraminifers are very rarely preserved, could play an important role in the stratigraphy and correlation of Palaeozoic sediments. This, however, requires, during investigation, observing the following rules:

1. Marly Palaeozoic limestones should be dissolved on a much larger scale than hitherto.

2. Chitinous fossils obtained by dissolving should be preserved as wet samples, preferably in glycerine. The residue should not be dried.

3. Fossil jaw apparatuses should be studied in comparison with Recent polychaete jaw apparatuses.

4. Isolated jaws should be described as components of entire jaw apparatuses.

* * *

The collection described in the present paper is housed in the Palaeozoological Institute of the Polish Academy of Sciences in Warsaw (Warszawa 22, Al. Żwirki i Wigury 6), for which the abbreviation *Z. Pal.* is used.

For the collections of the British Museum (Natural History) in London the abbreviation *BM* is used, for the State Museum of Natural History (Naturhistoriska Riksmuseet) in Stockholm — *RM*.

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The present investigations have been started at the suggestion of Professor R. KOZŁOWSKI, who was the first to find and describe the entire jaw apparatuses in the Ordovician erratic boulders of Poland (KOZŁOWSKI, 1956). Professor KOZŁOWSKI kindly put the remaining collection of jaw apparatuses at the writer's disposal for investigation. His helpful advise and encouragement have been of the greatest value.

The following persons and institutions provided the writer with facilities for studying the specimens in their charge: Dr. P. DOHRN (Zoological Station, Naples), Dr. N. TEBBLE (British Museum, Natural History, London), and Professor J. JANISZEWSKA (Museum of the Zoological Institute, University of Wrocław).

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Mrs. J. SKARŻYŃSKA, Mr. J. KAŹMIERCZAK M. Sc. and Mrs. E. GADOMSKA helped the author in picking out the scolecodonts from the residues and in the primary segregation. Text-fig. 5 has been made by Mrs. E. GADOMSKA and Mrs. K. BUDZYŃSKA, all the remaining drawings — by Mrs. E. GADOMSKA. Her understanding of the structure of polychaete jaw apparatuses has been of great help to the writer. The accompanying photographs have been taken by Miss M. CZARNOCKA and Dr. J. BŁASZYK.

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Palaeozoological Institute
of the Polish Academy of Sciences
Warszawa, January 1965

GENERAL PART

TAXONOMIC PROBLEMS

EHLERS who was the first to recognize the nature of scolecodonts, created new genera of fossil forms to include single pieces of jaws. Some of the genera erected by HINDE, e.g. *Oenonites* HINDE, 1879, *Glycerites* HINDE, 1879, were also based on isolated elements, while others such as *Arabellites* HINDE, 1879, were erected to include several different jaws, considered by him as belonging to the same apparatus by analogy with Recent genus *Arabella* GRUBE. This practice has caused great confusion in scolecodont literature, as particular scolecodont genera are taxonomic units of different concepts.

The students who have at their disposal entire jaw apparatuses as a rule describe them without observing the priority of names given to the detached jaws (LANGE, 1949; KOZŁOWSKI, 1956; KIELAN-JAWOROWSKA, 1961, 1962). In the opinion of the present author, the entire jaw apparatuses should be described in a taxonomic system, independent of the systematics of isolated jaws, which should be regarded as a parataxonomic system (cf. CRONEIS, 1938; SYLVESTER-BRADLEY, 1954; MOORE & SYLVESTER-BRADLEY, 1957; HEMMING, 1957). Unfortunately, MOORE and SYLVESTER-BRADLEY'S proposals on parataxa were rejected by the 15th International Congress of Zoology in 1958. However, as stated by HAAS (1962, p. W36): "the Congress did pass a resolution suggesting that the names of fragments (such as those of disjunct conodonts) should not be required to compete in synonymy with the names of genuine taxa, as would be the case under the strict interpretation of the Rules". Accordingly, HAAS (*l. c.*, p. W36) "in anticipation of its ultimate acceptance by the International Commission on Zoological Nomenclature", employed a system of dual nomenclature for conodonts. Unfortunately, the dual classification has not been employed by HOWELL (1962) in the same volume of Treatise, in the section on scolecodonts.

With regard to the scolecodonts, the dual classification has been recently criticized by ELLER (1964) and TASCH & STUDE (1965).

In connection with this, the writer wishes to point out that a combination of scolecodont parataxa with the taxonomic units erected for describing entire jaw apparatuses, would cause confusion unparallel in palaeontological literature and is in practice impossible.

It is a well known fact that LANGE (1949), when describing the Devonian entire jaw apparatus of *Paulinites paranaensis* LANGE, stated that the isolated jaws of this apparatus were assigned by various authors to 24 scolecodont species and 9 scolecodont genera. If LANGE, instead of creating a new genus and species *Paulinites paranaensis*, had retained one of the 9 previously erected parataxonomic generic names and one of the 24 specific names, then he

would have had to place the remaining 8 scolecodont genera and 23 scolecodont species into the synonymy.

ELLER (1964) placed two jaw apparatuses genera: *Mochtyella* KIELAN-JAWOROWSKA and *Vistulella* KIELAN-JAWOROWSKA into the synonymy of the scolecodont genus *Staurocephalites* HINDE, 1879. It is not quite clear to the present writer why ELLER has picked out the scolecodont genus *Staurocephalites* HINDE when there are some other scolecodont genera, older than *Staurocephalites*, erected for isolated jaws, identical with those occurring in *Vistulella* and *Mochtyella*. The anterior part of the jaw apparatuses of *Mochtyella* and *Vistulella* consists of a series of teeth, called anterior teeth. Such isolated teeth have been described in scolecodont literature under the generic name *Eunicites* EHLERS, 1868 (e.g. *Eunicites geisacanthus* ELLER, 1945, *Eunicites barbaricus* ELLER, 1945).

Thus the genera *Mochtyella* and *Vistulella* have been erected not only for forms that belong to the parataxonomic genus *Staurocephalites* HINDE (as stated by ELLER, 1964, p. 258), but also for forms that belong to *Eunicites* EHLERS, 1868. As *Eunicites* has priority, its name should be retained rather than that of *Staurocephalites*, to replace *Vistulella* and *Mochtyella*. The genera *Vistulella* and *Mochtyella* have been erected not only for jaws that belong to *Eunicites* and *Staurocephalites*, but also for jaws belonging to four other scolecodont genera (comp. KIELAN-JAWOROWSKA, 1961, pp. 252—253).

An attempt to combine the parataxonomic and taxonomic units into one system, which was done recently by TASCH and STUDE (1965), shows the confusing consequences of such a procedure. Eight polychaete jaw apparatuses genera: *Paulinites* LANGE, *Polychaetaspis* KOZŁ., *Polychaetura* KOZŁ., *Vistulella* KIELAN-JAW., *Atraktoprion* KIELAN-JAW., *Kalloprion* KIELAN-JAW., *Ramphoprion* KIELAN-JAW. and *Xanioprion* KIELAN-JAW. are regarded by TASCH and STUDE as congeneric, belonging under *Eunicites* EHLERS, while *Mochtyella* KIELAN-JAW. is regarded by these authors as belonging under *Lumbriconereites* EHLERS.

How arbitrary this procedure is, can be shown by the fact that *Vistulella* is assigned by ELLER (1964) to the parataxonomic genus *Staurocephalites*, while by TASCH and STUDE (1965) to *Eunicites*. On the other hand, *Mochtyella* is assigned by ELLER to *Staurocephalites*, while by TASH and STUDE to *Lumbriconereites*. However, it has been shown above by the present writer that *Mochtyella* could just as well be assigned to *Eunicites*.

For taxonomy, the consequences of this procedure are that numerous, well defined jaw apparatuses genera, such as e.g. *Vistulella* KIELAN-JAW., *Paulinites* LANGE and *Atraktoprion* KIELAN-JAW., which belong to separate families, and can by no means be regarded as congeneric, are assigned by TASCH and STUDE to one genus.

For the parataxonomic units the consequences of this procedure, which unfortunately have not been shown either by ELLER, or by TASCH and STUDE, are as follows:

All the parataxonomic genera, under which the individual jaws of *Vistulella*, *Paulinites*, *Atraktoprion* and of the remaining other above mentioned 9 taxonomic genera were described, should be placed in the synonymy of *Eunicites*. Among them are the parataxonomic carriers genera, e.g. *Siluropelta* EISENACK, *Orthopelta* EISENACK and *Pteropelta* EISENACK, basal plate genera, e.g. *Paleoenonites* ELLER, various MI genera, e.g. *Staurocephalites* HINDE, *Arabellites* HINDE, *Nereidavus* GRINNELL and others, numerous MII—MIV genera, e.g. *Leodicites* ELLER, *Dinoscolites* STAUFFER, and others, various lateral and anterior teeth genera, e.g. *Ungulites* STAUFFER, mandibles genera, e.g. *Diopatraites* ELLER, *Nothorites* STAUFFER, and numerous others.

As a result, a large majority of the parataxonomic species and genera will become unvalid, and so identification of isolated jaws will be practically impossible.

Therefore it is desirable to regard the parataxonomy of scolecodonts and taxonomy of jaw apparatuses as two independent systems, with a law of priority holding good within each system, but not for both systems together.

MATERIAL AND METHODS

The Ordovician and Silurian polychaete jaw apparatuses and isolated jaws described in the present paper are derived — with few exceptions — from calcareous erratic boulders. The boulder clay crops out in numerous localities all over northern Poland. The studied erratic limestones have thus been collected from along the Baltic coast (localities of Międzyzdroje, Dziwnów, Rewal, Jarosławiec, Ustka and Władysławowo), on the Pilica river (locality of Stara Warka) and on the Vistula river (localities of Mochty, Zakroczym and Wyszogród). The boulders washed out from the moraine on the bottom of the Baltic Sea are usually in the form of boulders not exceeding 1—2 kg. in weight and consequently yield a limited number of specimens. The best material has been obtained from the till outcrops on the Vistula river in the vicinity of Warsaw, where boulders up to 100 kg. in weight have occasionally been found.

The limestones were dissolved in 5—10 litre glass vessels, in samples not larger than 1 kg. The first sample from a given boulder was, as a rule, dissolved in 10—15% acetic acid. If no conodonts or other calcium phosphate microfossils were found, then hydrochloric acid was used for the remaining samples. 20% hydrochloric acid usually gave satisfactory results after 24—48 hours. The dissolved sample was washed several times in water, the residue (with water) transferred to flat bottomed vessels and chitinous elements picked out with a pipette under a binocular microscope and transferred to small plastic boxes containing glycerine. A drop of formalin was added to each box to prevent the growth of mildew. In many instances the jaw apparatuses obtained in the residue were covered with a coat of silicate and were treated with a 15% HF for 48 hours to remove it. The hydrofluoric acid was then carefully removed and the specimen washed several times to eliminate all traces of acid. Hydrochloric and hydrofluoric acids may be used in stronger concentrations, whereas concentration of acetic acid cannot exceed 15%, as it may affect the calcium phosphate of the conodonts.

The colour of the jaw apparatuses varies from yellowish, through brown to entirely black. The black apparatuses may be bleached by the use of hydrochloric acid and potassium chlorate in water (cf. also TASCH & SHAFFER, 1961). For part bleaching good results were in some cases obtained by treating the specimen for 15 minutes, then only the borders of the jaws become lighter. On the other hand, when treatment continues for several hours, complete bleaching is obtained, the jaw apparatuses becoming yellow and transparent, and so can be examined in transmitted light. However the external surface and the arrangement of the jaws, which may be superimposed upon each other, are in bleached specimens difficult to recognize.

In some boulders, in addition to detached jaws, almost complete jaw apparatuses or joined jaws have been found. The jaw apparatuses are usually in a good state of preservation, though they are very delicate and particular jaws easily become separated. For manipulating an apparatus in glycerine a single badger hair, embedded in a glass tube with Canada balsam was used.

The specimens were examined under Leitz binocular microscope using magnification of up to 216. Drawings were made using a Camera lucida with a Leitz binocular microscope.

It sometimes proved difficult to keep the jaw apparatus in a given position for a long time, while the drawing was being made. To this end, cover glasses were crushed to a coarse glass powder and put into the glycerine, to form a small pyramid on which the specimen rested.

The Recent specimens studied for comparison in the present paper derive mostly from the Gulf of Naples. Eunicid specimens, from all over the world, in the British Museum (Natural History, Annelida Section), London and in the Museum of Zoological Institute, University of Wrocław, have also been examined.

In order to free the Recent jaw apparatuses from the muscles the following method was used. The entire specimens (e.g. of *Halla parthenopeia* DELLE CHIAJE) were kept in 50% alcohol for three months, during which time all the soft parts became gradually macerated, except for the thin cuticular layer covering the body, the stomodeum and the proctodeum. The cuticular layer of the stomodeum with the maxillary apparatus and the mandibles attached, was then quite easily drawn out from the macerated soft parts.

TERMINOLOGY

(Text-figs. 1, 2, 5, 8)

The numbering of jaws in Recent and fossil apparatuses and some other related terminological problems were briefly discussed in previous publications (KIELAN-JAWOROWSKA, 1961, 1962). In the present paper several new types of jaw apparatuses are described, necessitating the introduction of some new terms. In order to elucidate these considerations it is thought desirable to repeat here some of the earlier remarks on terminology.

The buccal armature of Recent Eunicea comprises the ventral mandibles and dorsal maxillary apparatus which consists usually of the carriers (with or without ventral median piece) and four to six pairs of dorsal plates (jaws), some of which in certain genera may be single.

In Recent prionognatha and labidognatha apparatuses the dorsal maxillary pieces are usually numbered (e.g. FAUVEL, 1923, HARTMAN, 1944, and others) from back to front with successive Roman numerals (MI—MVI) (Text-fig. 1*D*). It has been stated by LANGE (1949), KOZŁOWSKI (1956) and KIELAN-JAWOROWSKA (1962) that in fossil prionognaths and labidognaths, at the base of the right MI there is a plate, designated by LANGE the basal plate. In *Polychaetaspis wyszogrodensis* KOZŁ., KOZŁOWSKI (1956) showed the presence of a single tooth in front of the basal plate, which he designated the intercalary tooth. The intercalary tooth has been found by the present writer also in the other representatives of *Polychaetaspis* (comp. Text-fig. 1*C*). It has been suggested (KIELAN-JAWOROWSKA, 1962) that names rather than successive numerals should be used when describing the basal plate and intercalary tooth. Thus the system of numbering jaws in Recent labidognaths and prionognaths can be adopted without introducing changes, for description of fossil apparatuses. Of the fossil labidognatha and prionognatha genera hitherto described, a free basal plate is lacking only in *Langeites* n. gen. and *Skalenoprion* KIELAN-JAW. (comp. Text-figs. 5*L* and 5*O*) where it is fused with right MI. Sometimes the fusion is so great that the basal plate is pronounced only as a basal ridge on MI.

In the genus *Symmetroprion* nov. the bight at the base of MI, which houses tightly the basal plate, occurs not only in the right MI, but also in the left MI. In samples yielding MI of *Symmetroprion reduplicatus* n. sp. an isolated left plate was found, which is a mirror image

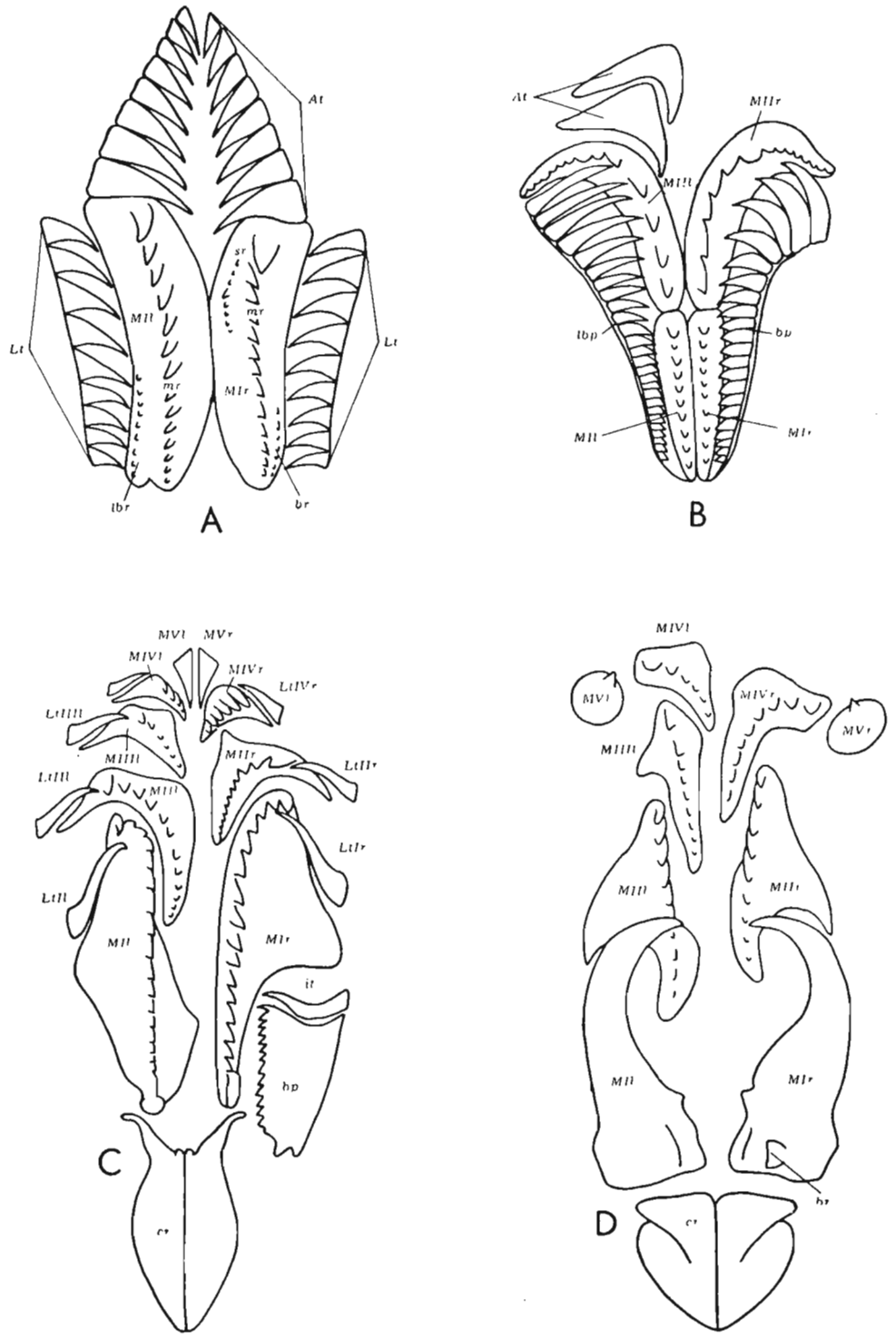

Fig. 1

Diagrammatic sketches of four eunicid jaw apparatuses, showing the numbering of the jaws
A Mochtyella polonica n. sp. (Ordovician or Silurian), *B Xanioprion borealis* KIELAN-JAW. (Middle Ordovician), *C Polychaetaspis tuberculatus* n. sp. (Middle Ordovician), *D Diopatra neapolitana* DELLE CHIAJE (Recent).
(For abbreviations — see p. 153)

of the basal plate (Text-fig. 5*J*). This plate is designated here the laeobasal plate (Gr. *laios* — left, *basis* — base), to distinguish it from the basal plate which is always found on the right side.

The present writer (KIELAN-JAWOROWSKA, 1961) when describing *Mochtyella cristata* KIELAN-JAW. and *Vistulella kozlowskii* KIELAN-JAW., numbered their jaws with Arabic instead of Roman numerals in order to avoid suggestions as to homology, which at that time was not entirely clear. The present studies have allowed the writer to draw some conclusions as to the homology of individual jaws in four recognized types of jaw apparatuses, and Roman numerals are introduced here to replace the Arabic numerals in placognatha type.

Both basal and laeobasal plates occur in all known placognatha and ctenognatha apparatuses, it should be however stressed that in these groups they are not «plates» in the morphological sense. They are strongly elongated jaws, consisting of numerous denticles, which easily become separated. Nevertheless, the name "plate" is retained for their designation, in order to show their homology with basal and laeobasal plates in labidognatha and prionognatha types (comp. Text-fig. 1*B*). In *Tetraprion* n. gen., *Xanioprion* KIELAN-JAW. and *Vistulella* KIELAN-JAW. basal and laeobasal plates are about as long as MI and cover MI somewhat dorsally. In *Pistoprion* n. gen. and *Rhytiprion* n. gen. basal and laeobasal plates are elongated longitudinally, but shorter than MI, housed in a bight on the outer margin of MI.

In *Vistulella kozlowskii* KIELAN-JAW., in front of the basal plate there is a single tooth homologous with the intercalary tooth of *Polychaetaspis*. On the left side of the same apparatus, in front of the laeobasal plate there is a tooth, representing the mirror image of the intercalary tooth and designated here the laeointercalary tooth (Text-fig. 5*C*).

The jaws provided with one ridge of denticles have been called by KIELAN-JAWOROWSKA (1961) simple, while those provided with two or more ridges were called compound. Compound jaws are characteristic of e.g. *Mochtyella* KIELAN-JAW. (comp. Text-fig. 1*A*). The right compound jaw of *Mochtyella cristata* KIELAN-JAW. (Text-fig. 5*A*) is regarded as homologous with three right simple jaws in *Pistoprion transitans* (Text-fig. 5*B*) (basal plate, right MI and right MII), the individual ridges in right MI in *Mochtyella* being thus designated: basal ridge (equivalent to the basal plate), main ridge (equivalent to MI) and second ridge (equivalent to MII). Similarly, in the left MI of *Mochtyella* there are: a laeobasal ridge and main ridge.

In some species of *Mochtyella*, e.g. in *Mochtyella* sp. *d*, in place of the second ridge, there is an undenticulated ridge. Compound jaws occur also in a prionognath *Skalenoprion* KIELAN-JAW. and a labidognath *Langeites* n. gen. (right MI).

Description of a jaw apparatus in the present paper comprises descriptions of individual jaws. These are described as detached jaws. The dorsal and ventral sides of individual jaws only vaguely correspond to those of the entire apparatus, as in an articulated apparatus some jaws (e.g. MI) are arranged as a rule dorso-laterally.

A series of denticles which extends along the dorsal side of the jaw or along the inner margin is called (after CRONEIS, 1941) the dentary. The dentary consists of denticles. Sometimes the first denticle of the dentary is very strong and much longer than the remaining ones (e.g. in the Atraktoprionidae) in which case it is called (after ELLER, 1934*a*) a hook (Text-fig. 2*B*).

In some genera, e.g. in *Polychaetaspis* KOZŁOWSKI and *Kozlowskiprion* n. gen., the jaw apparatus comprises (in addition to the carriers and maxillary plates) a series of additional lateral jaws, designated by KOZŁOWSKI (1956) lateral teeth (dents latérales), for which the notation Lt is used (Text-figs. 1*A*, *C*). Each of the numbered jaws may be associated with one lateral tooth, and the Roman numeral by the notation Lt indicates with which jaw the tooth is associated, e.g. LtIr is a tooth associated with right MI.

Sometimes, the inner border of anterior jaws is prolonged into a lamella, arranged per-

pendicularly to the dorsal surface of the jaw, called attachment lamella. In labidognatha and prionognatha apparatuses the numbered jaws in front of MI (i.e. MII-MV) are called the anterior jaws.

In placognatha and ctenognatha apparatuses, in front of the posterior plate-like jaws, there are series of simple or secondary denticulated teeth, which may be arranged in two rows and which are called the anterior teeth (Text-fig. 1 *A*).

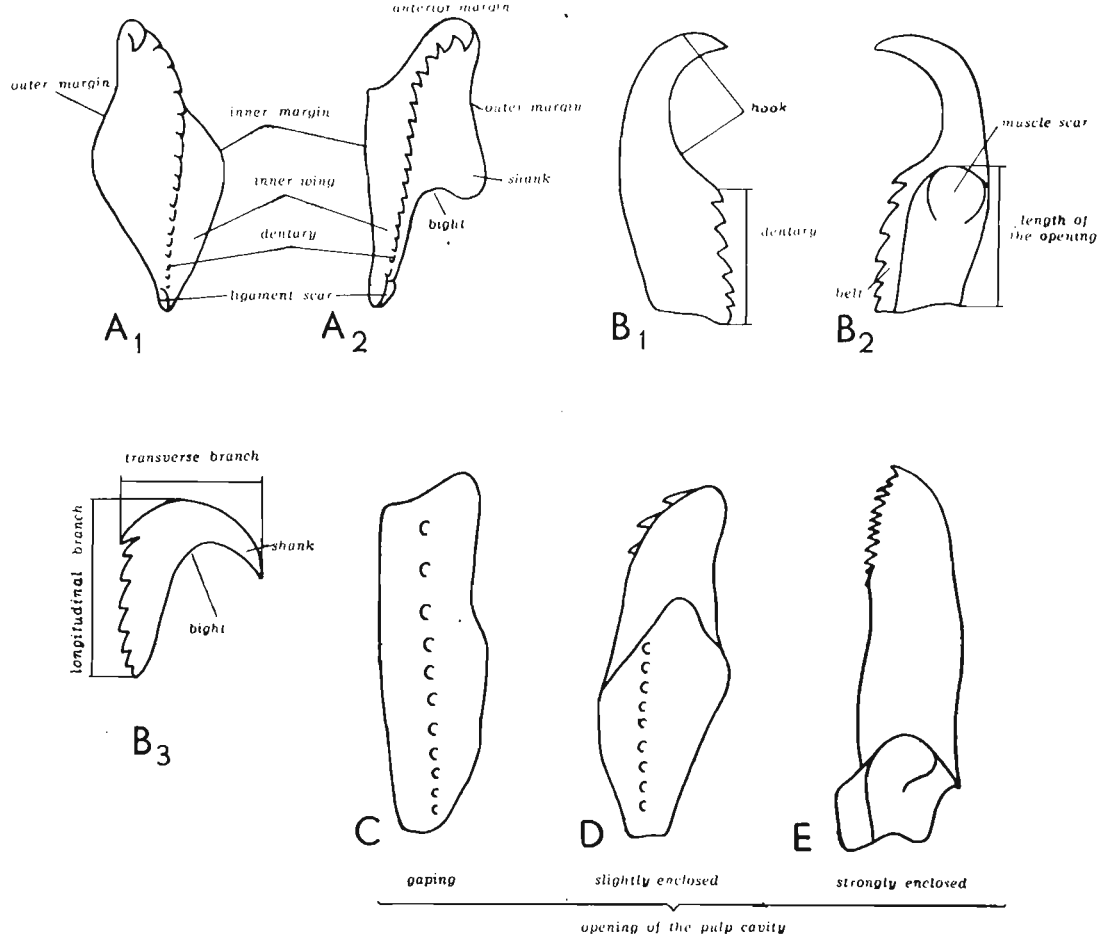

Fig. 2

Terminology. *A Polychaetaspis inconstans* n. sp.: A_1 left MI in dorsal view, A_2 right MI in dorsal view; *B Atraktoprion cornutus* KIELAN-JAW.: B_1 left MI in dorsal view, B_2 the same in ventral view, B_3 right MII in dorsal view; *C Vistulella kozlowskii* KIELAN-JAW., right MI in ventral view; *D Ramphoprion urbaneki* n. sp., left MI in ventral view; *E Paulinites polonensis* n. sp., left MI in ventral view.

The simplest type of maxillary plate in Eunicea seems to be a jaw in the form of a convex plate with a ridge of denticles on the dorsal side. The concave ventral, attachment side forms a cavity for muscular attachment, called the pulp cavity (Text-figs. 2 *C-E*). The outline of the opening of the pulp cavity coincides in such cases with the outline of the jaw. The opening of such a pulp cavity, which in the present paper is referred to as gaping, was previously called (KIELAN-JAWOROWSKA, 1961) gaped. Jaws with gaping pulp cavities are characteristic of placognatha and ctenognatha apparatuses. In prionognatha and labidognatha apparatuses

MII-MV may be provided with gaping pulp cavities, while MI are in all cases cone-like or in the form of forceps. The anterior part of the pulp cavity in such jaws is enclosed within the walls of the jaw, and at the base of the ventral side there is an opening leading to the pulp cavity. The wall of the jaw covering the ventral part of the pulp cavity is here referred to as the cover. The cover may be short or long. If it extends for less than half of the jaw length, the pulp cavity is described as slightly enclosed, whereas if it extends for more than half, it is described as strongly enclosed. In some cases the cover extends laterally as a belt, separating the opening of the pulp cavity from the dentary. A distinct belt occurs as a rule in MI of the Atraktoprionidae, in which the dentary is arranged along the inner border. When the dentary is arranged about the middle of the jaw in dorsal view (e.g. in *Ramphoprion* KIELAN-JAW., *Symmetroprion* n. gen.) then there is a slope on either side of the dentary. The inner slope corresponds to the belt of the Atraktoprionidae, but has its lustrous surface arranged more or less dorsally, whereas in the Atraktoprionidae it is arranged ventrally. Intermediate forms do occur, for the inner slope may be oriented at various inclinations to the outer slope. Sometimes the inner slope is distinctly incurved anteriorly (e.g. in left MI of *Polychaetaspis latus* n. sp.). The posterior part of the inner slope may be developed as a longitudinally elongated wing, called the inner wing, usually oriented perpendicularly to the remaining part of the slope.

The outer surface of the jaws is smooth and lustrous, the inner one, surrounding the pulp cavity, is rough and dull. In jaws provided with a gaping pulp cavity the dorsal surface is lustrous, while the ventral (corresponding to the pulp cavity) is rough. In jaws in which the pulp cavity is slightly or strongly enclosed, the cover and the belt on the ventral side are lustrous, whereas the inner surface of the wall visible in the opening of the pulp cavity, is rough.

In the representatives of *Polychaetaspis* KOZŁ. and *Kozlowskiprion* n. gen., on the dorsal side of both MI and the basal plate — to the rear of the last denticle, there is in the prolongation of the dentary a small area, which differs from the rest of the dorsal side in having a rough surface. The presence of the rough area has been shown by KOZŁOWSKI (1956) in *Polychaetaspis wyszogrodensis* KOZŁ. and *Polychaetaspis* cf. *wyszogrodensis*, and was called by him "impression de ligament". The rough area may be a muscle scar, and it is designated after KOZŁOWSKI the ligament scar (Text-figs. $2A_1$-A_2), to distinguish it from the "muscle scar", which occurs on the ventral side of the jaw in the form of a depression (Text-fig. $2B_2$). The shape of the rough area is in some species (e.g. in *Polychaetaspis aequilateralis* n. sp.) a useful specific character in the identification of isolated MI.

In the description of individual jaws the following abbreviations, showing the directions of measurements, are used: *(long.)* — longitudinal, parallel to the longitudinal axis of the animal (and of the jaw apparatus), and *(tr.)* — transversal, perpendicular to the longitudinal axis.

As the here described species are derived (with two exceptions) from the erratic boulders, and are so far unknown besides the studied collection, the paragraph "Occurrence" is omitted in the description of individual species, as it would coincide with the paragraph "Material".

STRATIGRAPHY

(Table 1)

Among the erratics dissolved between 1949 and 1964, the residues of 230 boulders yielded unquestionable Silurian graptolites and were registered in the collection "S", with the symbol S, preceding the number of the boulder. As a rule, they yielded rare and only isolated polychaete jaws, which have not been investigated by the present writer.

DISTRIBUTION OF THE DESCRIBED SPECIES IN THE ERRATIC BOULDERS OF POLAND AND THEIR PRESUMABLE STRATIGRAPHIC RANGE

Locality	O.182 Mochty	O.469 — Mochty	O.366 — Zakroczym	O.400 — Mochty	O.472 — Mochty	O.470 — Mochty	O.142 — Wyszogród-Zakroczym	O.116 — Wyszogród	O.423 — Mochty	O.148 — Wyszogród-Zakroczym	O. 29 — Stara Warka	O.188 — Mochty	O.398 — Mochty	O. 56 — Dziwnów	O. 98 — Rewal	O.308 — Międzyzdroje	O.391 — Rewal	O.439 — Ustka	O.441 — Ustka	O.442 — Ustka	O.446 — Ustka	O.161 — Wyszogród-Zakroczym	O.187 — Mochty	O.245 — Mochty	O.410 — Mochty	O.179 — Mochty	O.177 — Mochty	O.133 — Wyszogród-Zakroczym	O.213 — Zakroczym	O.505 — Mochty	O. 42 — Zakroczym	O.147 — Wyszogród-Zakroczym	O.199 — Zakroczym	O.140 — Wyszogród-Zakroczym	O.139 — Wyszogród-Zakroczym	O.344 — Mochty	O.319 — Mochty	O.279 — Mochty	O.265 — Mochty	O.174 — Wyszogród-Zakroczym	O.185 — Mochty	O.178 — Mochty	O.141 — Wyszogród-Zakroczym	O.144 — Wyszogród-Zakroczym	O.201 — Zakroczym	O.466 — Mochty	O.463 — Mochty	O.349 — Zakroczym	O.301 — Ustka	O.159 — Jarosławiec	O. 59 — Władysławowo	O.430 — Rewal	O.418 — Międzyzdroje
No. of the boulder Z. Pal. coll.																																																	
Regions																																																	
Polychaetaspis sp. *a*																																																	
Ramphoprion sp. *a*																																																	
Ramphoprion sp. *c*																																																	
Ramphoprion sp. *d*																																																	
Euryprion rarus n. sp.																																																	
Kalloprion sp. *a*																																																	
Kalloprion sp. *b*																																																	
Atraktoprion sp. *a* KIELAN-JAW.																																																	
Leptoprion artus n. sp.																																																	
"Polychaetaspis" incisus n. sp.																																																	
Ramphoprion sp. *b*																																																	
Ramphoprion urbaneki n. sp.																																																	
Mochtyella cristata n. sp.																																																	
Kalloprion ovalis n. sp.																																																	
Xanthoprion erraticus n. sp.																																																	
Atraktoprion cornutus KIELAN-JAW.																																																	
Polychaetura gracilis KOZŁ.																																																	
Tetraprion pozaryskae n. sp.																																																	
Polychaetaspis wyszogrodensis KOZŁ.																																																	
Polychaetaspis tuberculatus n. sp.																																																	
Polychaetaspis gadomskae n. sp.																																																	
Polychaetaspis varsoviensis n. sp.																																																	
Xanioprion borealis n. sp.																																																	
Rhytiprion magnus n. sp.																																																	
Polychaetaspis warkae KOZŁ.																																																	
"Polychaetura" sp. *a*																																																	
Kozłowskiprion brevialatus n. sp.																																																	
Atraktoprion robustus n. sp.																																																	
Polychaetaspis cf. *wyszogrodensis* KOZŁ.																																																	
Atraktoprion major n. sp.																																																	
Leptoprion polonicus n. sp.																																																	
Atraktoprion mirabilis n. sp.																																																	
Ramphoprion elongatus KIELAN-JAW.																																																	
Kalloprion triangularis n. sp.																																																	
Atraktoprion sp. *b*																																																	
Paulinites polonensis n. sp.																																																	
Polychaetaspis inconstans n. sp.																																																		
Polychaetaspis aequilateralis n. sp.																																																	
Kozlowskiprion longicavernosus n. sp.																																																	
Atraktoprion robustus n. sp.																																																	
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Kozlowskiprion longicavernosus n. sp.																																																	
Mochtyella trapezoidea n. sp.																																																		
Polychaetaspis cf. *aequilateralis* n. sp.																																																	
Paulinites gladiatus n. sp.																																																	
Symmetroprion reduplicatus n. sp.																																																	
Vistulella kozlowskii KIELAN-JAW.																																																	
Symmetroprion sp. *a*																																																	
Mochtyella sp. *c*																																																	
Langeites glaber n. sp.																																																	
Mochtyella sp. *d*																																																	
Mochtyella sp. *b*																																																	
Skalenoprion alatus n. sp.																																																	
Pistoprion sp. *c*																																																	
Euryprion sp. *a*																																																	
Pistoprion transitans n. sp.																																																	
Skalenoprion sp. *a*																																																	
Skalenoprion sp. *b*																																																	
Skalenoprion sp. *c*																																																	
Pistoprion sp. *a*																																																	
Pistoprion sp. *b*																																																	
Mochtyella polonica n. sp.																																																	
Mochtyella sp. *a*																																																	
Polychaetaspis latus n. sp.																																																	

BOULDERS OF UNKNOWN AGE

(A) LLANDEILO - LOWER CARADOC ASSEMBLAGE

(B) UPPER CARADOC ASSEMBLAGE

(C) SILURIAN ASSEMBLAGE

Vicinity of Warsaw

Polish western coast of the Baltic Sea

Of several thousand of dissolved boulders, the residues of 520 yielded interesting fossils, which had provisionally been identified as Ordovician. The latter boulders have been registered in another collection, with the symbol O preceding the number of the boulder. Subsequent studies have shown that part of the boulders of collection "O" are in fact of Silurian and not Ordovician age. Nevertheless, the symbol O is retained for these boulders in order to keep the collection intact. Of the 520 boulders of the collection "O", the residues of more than 300 contained scolecodonts or entire jaw apparatuses. Of these residues only the 53 yielding the best preserved and most interesting entire jaw apparatuses or isolated jaws, were taken into account in the present monograph. A large collection of isolated jaw and jaw apparatuses of unknown age from the remaining residues has been left for future elaboration.

CHARACTERISTICS OF THE BOULDERS

No. O.29, Stara Warka, province of Warsaw. Compact limestone, consisting of small (up to 1 mm.) fragments of trilobite and brachiopod exoskeletons. It yielded a rich fauna of graptolites, Hydrozoa and Chitinozoa, described by KOZŁOWSKI (1951, 1959, 1962, 1963), polychaete jaws: *Polychaetaspis warkae* KOZŁ., *Polychaetaspis tuberculatus* n. sp., and isolated, not described jaws of *Ramphoprion* sp. and *Mochtyella* sp. KOZŁOWSKI (1951) stated that the boulder yielded also fragments of *Glyptograptus dentatus* (BRONGNIART) and on this, estimated the age of the boulder as Lower Ordovician (Vaginata Limestone of Swedish sequence = Llanvirn). Subsequent investigation of the graptolite remains found in the residue, done by Dr. A. URBANEK, has shown that the graptolites in question show more similarities to *Glyptograptus vikarbyensis* JAANUSSON, than to *G. dentatus*, and they are identified as *Glyptograptus* cf. *vikarbyensis* JAANUSSON. The latter species (comp. JAANUSSON, 1963) is characteristic of the *G. teretiusculus* zone (Uhaku Stage of Estonian sequence — comp. ORVIKU, 1958; MÄNNIL, 1959). A sicula found in the residue, identified as *Gymnograptus* cf. *linnarssoni* (MOBERG), also suggests the Llandeilo (Uhaku) age of the boulder. This conclusion is also supported by the assemblage of Hydrozoa described from this boulder by KOZŁOWSKI (1959), which represents an assemblage similar to those found in the boulders O.31 and O.182. The age of the boulder O.31 is Llanvirn (*Glyptograptus teretiusculus* zone = Uhaku stage), while that of O.182 is Llandeilo (*Nemagraptus gracilis* zone, Kukruse Stage). Lastly the occurrence of *Polychaetaspis tuberculatus* n. sp. which is known from Middle Ordovician boulders (?Kukruse Stage) also indicates the Middle Ordovician age of the boulder O.29.

No. O.42, Zakroczym, province of Warsaw. Light grey, coarse grained limestone, yielding Tuboidea: *Dendrotubus erraticus* KOZŁ., Hydrozoa: *Diplohydra gonothecata* KOZŁ., *Phragmohydra articulata* KOZŁ., *Lagenohydra phragmata* KOZŁ., *Gonotheca Forma A* KOZŁ., 1959, *Gonotheca Forma B* KOZŁ., 1959 (cf. KOZŁOWSKI, 1961), Rhabdopleuroidea: *Rhabdopleuroides exspectatus* KOZŁ., polychaete jaws: *Kozlowskiprion longicavernosus* n. sp., *Skalenoprion* sp. *b*, and undescribed, isolated jaws of *Polychaetura* sp. According to KOZŁOWSKI (1963), the occurrence of *Dendrotubus erraticus* KOZŁ. indicates the Ordovician age of the boulder.

No. O.56, Dziwnów, Baltic coast. Dark grey, marly limestone, yielding flattened monograptids and a single jaw apparatus: *Polychaetaspis* cf. *aequilateralis* n. sp. Silurian.

No. O.59, Władysławowo, Baltic coast. Light grey, fine grained organogenic limestone, yielding Foraminifera: *Blastammina polymorpha* EISENACK, undescribed Chitinozoa, Crustoidea: *Bulmanicrusta latialata scutellifera* KOZŁ., polychaete jaws: *Skalenoprion alatus* KIELAN-JAW., *?Symmetroprion reduplicatus* n. sp. and not described jaws of *Polychaetaspis* sp. (? cf. *aequilateralis* n. sp.) and *Vistulella* sp. No index fossils. According to KOZŁOWSKI (1962), the presence of *Bulmanicrusta latialata scutellifera*, which is also known from boulders of Middle Ordovician age (e.g. boulders O.29 and O.31), indicates the Ordovician age of the boulder.

No. O.98, Rewal, Baltic coast. Dark grey, marly limestone, yielding polychaete jaws: *Paulinites polonensis* n. sp., *Polychaetaspis aequilateralis* n. sp., *Symmetroprion reduplicatus* n. sp., *Symmetroprion* sp. *a*, *Mochtyella* sp. *d*, and isolated undescribed jaws: *Paulinites* sp., *Mochtyella* sp., *Atraktoprion* sp. and *Falloprion* sp. The polychaete jaw assemblage, similar to those of the boulders O.410 and O.441, indicates the ?Silurian age of the boulder.

No. O.116, Wyszogród, province of Warsaw. Light grey limestone, consisting of fragments of trilobite and brachiopod exoskeletons, yielding *Desmochitina minor* EISENACK and polychaete jaws: *Polychaetaspis wyszogrodensis* KOZŁ., *P. tuberculatus* n. sp., *P. varsoviensis* n. sp., *Kozlowskiprion brevialatus* n. sp. and isolated undescribed jaws of *Rampho-*

prion sp. No index fossils. The occurrence of *Desmochitina minor* EISENACK and the assemblage of polychaete jaw apparatuses, known from the Middle Ordovician, indicate the latter as the age of the boulder (probably the same as the boulder O.366).

No. O.133, Wyszogród-Zakroczym, province of Warsaw. Light grey limestone, yielding unidentified Chitinozoa, Foraminifera: *Ordovicina* sp. and polychaete jaws of *Pistoprion* sp. *c*. Age of the boulder unknown.

No. O.139, Wyszogród-Zakroczym, province of Warsaw. Light coloured limestone, yielding *Dicranograptus* sp., unidentified Crustoidea, polychaete jaws of *Euryprion* sp. *a*, and undescribed jaws: *Xanioprion* sp. and *Ramphoprion* sp. The occurrence of *Dicranograptus* sp. indicates the Ordovician age of the boulder.

No. O.140, Wyszogród-Zakroczym, province of Warsaw. Grey, coarse grained limestone, yielding Tuboidea, unidentified climacograptids, polychaete jaws: *Pistoprion transitans* n. sp. and undescribed jaws *Mochtyella* sp. Age of the boulder unknown.

No. O.141, Wyszogród-Zakroczym, province of Warsaw. Compact limestone, similar lithologically to Baltic limestone (Ostseekalk) furnishing numerous unidentified Chitinozoa and *Vistulella kozlowskii* KIELAN-JAW. No other polychaete species have been found in the boulder. Age of the boulder unknown.

No. O.142, Wyszogród-Zakroczym, province of Warsaw. Grey, coarse grained limestone yielding *Climacograptus* cf. *uplandicus* (WIMAN) and *Climacograptus* cf. *brevis mutabilis* STRACHAN, polychaete jaws of *Xanioprion borealis* KIELAN-JAW. and *Leptoprion polonicus* n. sp. Age of the boulder (cf. KIELAN-JAWOROWSKA, 1962, p. 293) probably Middle Ordovician, ?Lower *Ludibundus* Limestone of Swedish sequence, being an equivalent of Kukruse Stage of Estonian sequence (comp. JAANUSSON, 1960).

No. O.144, Wyszogród-Zakroczym, province of Warsaw. Compact, light grey limestone, yielding Chitinozoa, polychaete jaws: *Skalenoprion* sp. *b*, and undescribed jaws of *Polychaetura* sp., *Pistoprion* sp. and *Polychaetaspis* sp. Age of the boulder unknown.

No. O.147, Wyszogród-Zakroczym, province of Warsaw. Light grey very compact limestone with *Pistoprion transitans* n. sp. Age of the boulder unknown.

No. O.148, Wyszogród-Zakroczym, province of Warsaw. Grey-yellowish limestone, yielding the remnants of *Dendrograptus* cf. *rigidus* BULMAN, polychaete jaws: *Polychaetaspis* cf. *wyszogrodensis* KOZŁ., *Rhytiprion magnus* n. sp. and isolated undescribed jaws of *Atraktoprion* sp. and *Kalloprion* sp. *Dendrograptus rigidus* BULMAN has been described from Northern Öland, Hälludden, from the beds regarded as equivalent of Lower Ordovician (Kunda Stage, zone of *Didymograptus bifidus*). However the stratigraphic range of *Dendrograptus rigidus* is unknown and the presence of *D.* cf. *rigidus* does not necessarily indicate Kunda age of the boulder. On the other hand, the occurrence of *Rhytiprion magnus* n. sp. and *Polychaetaspis* cf. *wyszogrodensis* KOZŁ. would rather indicate a ?Middle Ordovician age.

No. O.159, Jarosławiec, Baltic coast. Compact limestone, similar lithologically to Baltic limestone, yielding undescribed Foraminifera, polychaete jaws: *Kozlowskiprion longicavernosus* n. sp., *Mochtyella trapezoidea* n. sp., *Skalenoprion alatus* KIELAN-JAW., *Skalenoprion* sp. *c*, and undescribed isolated jaws: *Paulinites* sp. and *Mochtyella* sp. Age of the boulder unknown.

No. O.161, Wyszogród-Zakroczym, province of Warsaw. Dark grey, very fine grained limestone, yielding silicified Brachiopoda: *Howellella* cf. *crispa* HISINGER, polychaete jaws: *Symmetroprion reduplicatus* n. sp., *Polychaetaspis aequilateralis* n. sp., *Paulinites gladiatus* n. sp. and undescribed isolated paulinitid jaws. According to Dr. G. BIERNAT, the stratigraphic range of *Howellella crispa* (Upper Wenlock — Lower Ludlow, Island of Gotland) indicates this as the age of the boulder.

No. O.174, Wyszogród-Zakroczym, province of Warsaw. Light grey, fine grained limestone, yielding undescribed Foraminifera, polychaete jaws: *Symmetroprion reduplicatus* n. sp., *Kozlowskiprion longicavernosus* n. sp., *Skalenoprion alatus* n. sp., *Pistoprion* sp. *b*, and isolated undescribed jaws: *Atraktoprion* sp., *Paulinites* sp. and *Leptoprion* sp. No index fossils. Age of the boulder unknown.

No. O.177, Mochty, province of Warsaw. Light grey, compact, middle-grained limestone with silicified Brachiopoda (mostly *Pholidops* sp.), Tuboidea, Hydrozoa: *Calyxhydra constricta* KOZŁ., polychaete jaws: *Atraktoprion robustus* n. sp., *Pistoprion* sp. *b*, and isolated undescribed jaws of *Mochtyella* sp., *Xanioprion* sp., *Polychaetaspis* sp. and *Polychaetura* sp. Age of the boulder unknown.

No. O.178, Mochty, province of Warsaw. Grey, compact limestone, yielding silicified Brachiopoda, Tuboidea: *Idiotubus* sp., polychaete jaws: *Mochtyella* sp. *a*, *Kozlowskiprion longicavernosus* n. sp., *Pistoprion* sp. *b*, undescribed ramphoprionid jaws and *Mochtyella* sp., *Pistoprion* sp. and *Paulinites* sp. Age of the boulder unknown.

No. O.179, Mochty, province of Warsaw. Grey, compact, marly limestone, yielding unidentified graptolites, silicified Tabulata: *Proheliolites* sp., undescribed Chitinozoa, *Tasmanites* sp., Hydrozoa: *Calyxhydra gemellithecata*

KOZŁ., *Epallohydra adhaerens* KOZŁ., *Palaeotuba dichotomica* KOZŁ., and polychaete jaws: *Polychaetaspis latus* n. sp. Age of the boulder unknown. The stratigraphic range of *Proheliolites* is Upper Ordovician — Llandovery.

No. O.182, Mochty, province of Warsaw. Coarse grained, light grey limestone, with a rich fauna cited by KOZŁOWSKI (1962, p. 7) and KIELAN-JAWOROWSKA (1962, p. 293), indicating the Middle Ordovician age of the boulder (?Lower *Ludibundus* Limestone, equivalent of Kukruse Stage of Estonian sequence). The following polychaete jaws were identified from this boulder: *Ramphoprion urbaneki* n. sp., *Ramphoprion* sp. *a*, *Ramphoprion* sp. *c*, *Ramphoprion* sp. *d* and very numerous unidentified ramphoprionid jaws, "*Polychaetaspis*" *incisus* n. sp., *Rhytiprion magnus* n. sp., *Atraktoprion cornutus* KIELAN-JAW., *Atraktoprion* sp. *a* KIELAN-JAW. 1962, *Atraktoprion robustus* n. sp., *Mochtyella cristata* KIELAN-JAW., *Xanthoprion erraticus* n. sp., *Polychaetura gracilis* KOZŁ., *Kalloprion ovalis* n. sp. and *Euryprion rarus* n. sp. A very characteristic feature of the polychaete assemblage found in this boulder is the great abundance of ramphoprionids and the lack of representatives of *Polychaetaspis*.

No. O.185, Mochty, province of Warsaw. Light grey, compact limestone, with pyrite grains, consisting mostly of brachiopod detritus, Hydrozoa: *Kystodendron longicarpus* (EISENACK), *Chitinodendron bacciferum* EISENACK, *Gonotheca Forma E* KOZŁ., 1959, and polychaete jaws: *Polychaetaspis aequilateralis* n. sp., *Kozlowskiprion longicavernosus* n. sp., *Paulinites polonensis* n. sp., and not described ramphoprionid and kalloprionid jaws and *Xanioprion* sp. and a tetracoral *Kenophyllum* cf. *subcylindricum* DYBOWSKI. According to Prof. M. RÓŻKOWSKA, the presence of *Kenophyllum cylindricum* indicates the Upper Ordovician age of the boulder. On the other hand, the assemblage of jaw apparatuses is of Silurian pattern. The age of the boulder is thus an open question.

No. O.187, Mochty, province of Warsaw. A compact, dark grey limestone, yielding the polychaete jaws: *Polychaetaspis aequilateralis* n. sp., *Polychaetaspis inconstans* n. sp., *Kozlowskiprion longicavernosus* n. sp., *Mochtyella trapezoidea* n. sp., *Paulinites polonensis* n. sp. and undescribed isolated jaws of *Atraktoprion* sp. Polychaete jaw assemblage, similar to those of the boulders O.410 and O.441, indicates the ?Silurian age of the boulder.

No. O.188, Mochty, province of Warsaw. Light grey, crystalline limestone, yielding *Mastigograptus* sp., polychaete jaws: *Mochtyella cristata* KIELAN-JAW., *Polychaetaspis wyszogrodensis* KOZŁ., *Xanioprion borealis* KIELAN-JAW. and undescribed jaws of *Atraktoprion* sp., *Ramphoprion* sp. and *Polychaetaspis* sp. Polychaete jaw assemblage, similar to those of the boulders O.366 and O.182, indicates the ?Middle Ordovician age of the boulder.

No. O.199, Zakroczym, province of Warsaw. Reef limestone with *Alveolites* sp., Foraminifera, polychaete jaws *of Skalenoprion* sp. *a* and undescribed jaws of *Vistulella* sp. Age of the boulder unknown.

No. O.201, Zakroczym, province of Warsaw. Compact limestone with calcite crystals, yielding unidentified silicified Brachiopoda, Stromatoporoidea, fragmentary graptolites and polychaete jaws of *Vistulella kozlowskii* KIELAN-JAW. Age of the boulder unknown.

No. O.213, Zakroczym, province of Warsaw. Compact, fine grained limestone, similar lithologically to Baltic limestone, with Foraminifera, sponge spicules and polychaete jaws of *Pistoprion transitans* n. sp. Age of the boulder unknown.

No. O.245, Mochty, province of Warsaw. Compact, fine grained limestone, similar lithologically to Baltic limestone, with fragmentary Eurypterida, polychaete jaws: *Vistulella kozlowskii* KIELAN-JAW. (very numerous), *Polychaetaspis aequilateralis* n. sp., *Paulinites polonensis* n. sp., and isolated not described jaws of *Polychaetaspis* sp., *Mochtyella* sp. and *Paulinites* sp. (the latter very numerous). The polychaete jaw assemblage, similar to those of the boulders O.410 and O.441, indicates the ?Silurian age of the boulder.

No. O.265, Mochty, province of Warsaw. Compact, fine grained limestone, similar lithologically to Baltic limestone, furnishing *Dictyonema* sp., *Climacograptus* sp., Foraminifera, polychaete jaws: *Pistoprion transitans* n. sp., *Pistoprion* sp. *a*, *Rhytiprion magnus* n. sp. and undescribed jaws of *Xanioprion* sp., *Polychaetaspis* sp., *Polychaetura* sp. and *Kalloprion* sp. Age of the boulder unknown.

No. O.279, Mochty, province of Warsaw. Compact limestone, similar lithologically to Baltic limestone, yielding Chitinozoa, Foraminifera, ?Dasycladaceae, *Climacograptus* sp., polychaete jaws: *Xanioprion borealis* KIELAN-JAW., *Pistoprion transitans* n. sp., *Rhytiprion magnus* n. sp. and undescribed isolated jaws of *Polychaetaspis* sp. Age of the boulder unknown.

No. O.301, Ustka, Baltic coast. Light grey, coarse grained limestone, with *Mochtyella trapezoidea* n. sp., *Mochtyella* sp. *c*, *Vistulella kozlowskii* KIELAN-JAW., *Skalenoprion alatus* KIELAN-JAW., *Skalenoprion* sp. *c*, and not described isolated jaws: *Paulinites* sp., *Kozlowskiprion* sp. and *Polychaetaspis* sp. Age of the boulder unknown.

No. O.308, Międzyzdroje, Baltic coast. Light grey, fine grained limestone, which furnished silicified Lamellibranchiata, Chitinozoa, polychaete jaws: *Symmetroprion reduplicatus* n. sp., *Symmetroprion* sp. *a*, *Mochtyella* sp. *c*, and *Paulinites gladiatus* n. sp. Polychaete jaw assemblage, similar to that of the boulders O.161 and O.410, indicates ?Silurian age of the boulder.

No. O.319, Mochty, province of Warsaw. Light grey, compact limestone, yielding unidentified Dendroidea,

Chitinozoa: *Cyathochitina campanulaeformis* KOZŁ., Crustoidea, Foraminifera, sponge spicules, polychaete jaws of *Atraktoprion major* n. sp. and undescribed isolated jaws: *Ramphoprion* sp., *Leptoprion* sp. and *Mochtyella* sp. Age of the boulder unknown, ?Ordovician.

No. O.344, Mochty, province of Warsaw. Grey yellowish, middle grained limestone, yielding silificied Brachiopoda and polychaete jaws of *Mochtyella polonica* n. sp. Age of the boulder unknown.

No. O.349, Zakroczym, province of Warsaw. Fine grained limestone, similar lithologically to Baltic limestone, which furnished silicified Brachiopoda, Chitinozoa, *?Climacograptus* sp., polychaete jaws of *Pistoprion transitans* n. sp. and undescribed isolated jaws of *Polychaetaspis* sp. and *Xanioprion* sp. Age of the boulder unknown.

No. O.366, Zakroczym, province of Warsaw. Grey, coarse grained limestone, yielding a rich fauna (cited by KIELAN-JAWOROWSKA, 1962, p. 294, and KOZŁOWSKI, 1962, p. 8), of Middle Ordovician age (*?Ludibundus* Limestone of the Swedish sequence, being an equivalent of the Kukruse Stage and Idavere Stage of Estonian sequence). The extremely rich polychaete jaw assemblage (including numerous entire jaw apparatuses) consists of *Polychaetaspis wyszogrodensis* KOZŁ., *P. tuberculatus* n. sp., *P. gadomskae* n. sp., *Mochtyella cristata* KIELAN-JAW., *Atraktoprion cornutus* KIELAN-JAW., *Xanthoprion erraticus* KIELAN-JAW., *Polychaetura gracilis* KOZŁ., "*Polychaetura*" sp. *a*, *Kalloprion ovalis* KIELAN-JAW., *Leptoprion artus* n. sp., *Ramphoprion urbaneki* n. sp. and *Tetraprion pozaryskae* n. sp. Jaws of polychaetaspids predominate in the residue, ramphoprionids being very rare.

No. O.391, Rewal, Baltic coast. Fine grained, light, dull limestone, yielding polychaete jaws: *Polychaetaspis aequilateralis* n. sp., *P. inconstans* n. sp., *Paulinites polonensis* n. sp. and undescribed jaws of *Mochtyella* sp. No representatives of other groups have been found in the residue. The polychaete jaw assemblage, similar to those of the boulders O.161, O.410 and O.441 indicates ?Silurian age of the boulder.

No. O.398, Mochty, province of Warsaw. Light grey, compact limestone, yielding a rich fauna (cited by KIELAN-JAWOROWSKA, 1962, p. 294) of Caradoc age, ?Keila Stage, of Estonian sequence. The following polychaete jaws were found in the boulder: *Ramphoprion elongatus* KIELAN-JAW., *Atraktoprion mirabilis* n. sp., *Atraktoprion* sp. *b*, and *Kalloprion triangularis* n. sp.

No. O.400, Mochty, province of Warsaw. Grey, coarse grained limestone, which furnished a rich fauna (cited by KIELAN-JAWOROWSKA, 1962, p. 294). It has been stated then, on the base of the tentatively identified brachiopods, that the presumable age of the boulder is the lowermost part of the Upper Ordovician (Rakvere Stage of Estonian sequence). However, an analysis of the polychaete jaw assemblage, almost identical with that of the boulder O.366 (9 species in common), shows that without doubt the boulders O.366 and O.400 are of the same age, i.e. Middle Ordovician, ?Kukruse Stage or Idavere Stage of Estonian sequence. The following polychaete jaws (with numerous entire jaw apparatuses) were found: *Polychaetaspis wyszogrodensis* KIELAN-JAW., *P. tuberculatus* n. sp., *P. gadomskae* n. sp., *P. varsoviensis* n. sp., *Mochtyella cristata* KIELAN-JAW., *Atraktoprion cornutus* KIELAN-JAW., *Polychaetura gracilis* KOZŁ., *Kalloprion ovalis* KIELAN-JAW., *Leptoprion artus* n. sp., *Tetraprion pozaryskae* n. sp. and *Xanioprion borealis* n. sp. Within this assemblage polychaetaspids prevail in number, a characteristic feature being the lack of ramphoprionids.

No. O.410, Mochty, province of Warsaw. Grey, coarse grained, organogenic limestone with Foraminifera, Chitinozoa, scales of thelodonts: *Thelodus goebeli* PANDER and *T. schmidti* PANDER, polychaete jaws: *Polychaetaspis aequilateralis* n. sp., *Symmetroprion reduplicatus* n. sp., *Kozlowskiprion longicavernosus* n. sp., *Mochtyella* sp. *d*, *Paulinites polonensis* n. sp., *Langeites glaber* n. sp. and not described, isolated jaws: *Xanioprion* sp. and *Pistoprion* sp. On the base of thelodont scales, Dr. L. B. HALSTEAD TARLO identified the age of the boulder as Lower Ludlow (Ramsasa horizon of Scania, being an equivalent of Kaarma Stage K_I of Estonian sequence).

No. O.418, Międzyzdroje, Baltic coast. Compact, fine grained limestone, similar lithologically to Baltic limestone, with *Conotreta* sp., Conodontophoridia, Foraminifera, Chitinozoa, *?Orthoretiolites* sp., polychaete jaws of *Pistoprion* sp. *a*, and undescribed jaws of *Polychaetaspis* sp., *Ramphoprion* sp. and *Mochtyella* sp. Age of the boulder unknown.

No. O.423, Mochty, province of Warsaw. Grey, middle grained limestone, yielding silicified Bryozoa and Brachiopoda, unidentified graptolites: *Glaeocapsomorpha* sp., *Tasmanites* sp., unidentified Hydrozoa, polychaete jaws: *Mochtyella cristata* n. sp., *Xanioprion borealis* n. sp., *Polychaetaspis gadomskae* n. sp., «*Polychaetaspis*» *incisus* n. sp., *Leptoprion artus* n. sp. and not described isolated jaws: *Atraktoprion* sp., *Kalloprion* sp. and *Polychaetaspis* sp. Age of the boulder unknown. Assemblage of polychaete jaws, similar to that of the boulder O.182, indicates ?Middle Ordovician.

No. O.430, Rewal, Baltic coast. Compact limestone, similar lithologically to Baltic limestone, yielding Stromatoporoidea, Brachiopoda and polychaete jaws of *Mochtyella polonica* n. sp. Age of the boulder unknown.

No. O.439, Ustka, Baltic coast. Light, dull, fine grained limestone, yielding Chitinozoa, Algae, polychaete jaws: *Symmetroprion reduplicatus* n. sp., *Polychaetaspis aequilateralis* n. sp., *Mochtyella trapezoidea* n. sp. and *Paulinites polonensis* n. sp. Polychaete jaw assemblage, similar to that of the boulder O.410, indicates ?Silurian age of the boulder.

No. O.441, Dębina near Ustka, Baltic coast. Dark grey, fine grained limestone, yielding silicified Brachiopoda:

Schellwienella cf. *pecten* (LINNÉ), unidentified graptolites, Tabulata, Conodontophoridia, fragments of eurypterid skin — *Carcinosoma* sp., polychaete jaws: *Symmetroprion reduplicatus* n. sp., *Symmetroprion* sp. *a*, *Polychaetaspis aequilateralis* n. sp., *Kozlowskiprion longicavernosus* n. sp., *Paulinites polonensis* n. sp., *Mochtyella* sp. *b*, and undescribed jaws of *Xanioprion* sp. The occurrence of *Schellwienella* cf. *pecten* indicates, according to Dr. G. BIERNAT, Silurian (most probably Wenlock) age of the boulder. The Silurian age of the boulder is also supported by the polychaete jaw assemblage, which is similar to that of the boulder O.410.

No. O.442, Ustka, Baltic coast. Grey, middle grained limestone, with Algae, unidentified Tuboidea, polychaete jaws: *Polychaetaspis aequilateralis* n. sp., *Symmetroprion reduplicatus* n. sp., *Symmetroprion* sp. *a*, *Kozlowskiprion longicavernosus* n. sp., *Mochtyella* sp. *c*, and not described jaws: *Polychaetaspis* sp. and *Paulinites* sp. The polychaete jaw assemblage, similar to that of the boulders O.410 and O.441, indicates the ?Silurian age of the boulder.

No. O.446, Ustka, Baltic coast. Dark grey, middle grained limestone, yielding unidentified Monograptidae, fragments of eurypterid skin-*Carcinosoma* sp., Brachiopoda, pyritized Ostracoda, polychaete jaws: *Kozlowskiprion longicavernosus* n. sp., *Symmetroprion reduplicatus* n. sp., *Mochtyella* sp. *d*, and undescribed jaws of *Polychaetaspis* sp. and *Paulinites* sp. The pyritized ostracod is — as identified by Dr. A. MARTINSSON — a young tecnomorph of the subfamily Beyrichinae, and its presence shows that the boulder may have come from any level between Llandovery and Lower Ludlow. The Silurian age of the boulder is also supported by polychaete jaw assemblage, which includes species occurring in the boulders O.410 and O.441.

No. O.463, Mochty, province of Warsaw. Compact, fine grained limestone, similar lithologically to Baltic limestone, with unidentified Climacograptidae, *Polychaetaspis wyszogrodensis* n. sp. and undescribed jaws of *Polychaetaspis* sp. and *Pistoprion* sp. Age of the boulder unknown.

No. O.466, Mochty, province of Warsaw. Grey, coarse grained limestone, yielding Foraminifera, fragments of eurypterids, polychaete jaws: *Mochtyella trapezoidea* n. sp., *Mochtyella* sp. *b*, *Langeites glaber* n. sp. and undescribed jaws of *Paulinites* sp. and *Polychaetaspis* sp. Age of the boulder unknown.

No. O.469, Mochty, province of Warsaw. Grey, fine grained, plate limestone yielding Chitinozoa: *Desmochitina nodosa* EISENACK, *Cyathochitina campanulaeformis* (EISENACK), *Parachitina curvata* EISENACK, unidentified Brachiopoda, Graptolithina and very numerous polychaete jaws (including numerous entire apparatuses): *Polychaetaspis wyszogrodensis* KOZŁ., *P. tuberculatus* n. sp., *P. varsoviensis* n. sp., "*Polychaetaspis*" *incisus* n. sp., *Kozlowskiprion brevialatus* n. sp., *Mochtyella cristata* KIELAN-JAW., *Atraktoprion cornutus* KIELAN-JAW., *Polychaetura gracilis* KOZŁ., "*Polychaetura*" sp. *a*, *Kalloprion ovalis* KIELAN-JAW., *Kalloprion* sp. *a*, *Kalloprion* sp. *b*, *Leptoprion artus* n. sp., *Tetraprion pozaryskae* n. sp., *Ramphoprion urbaneki* n. sp. and *Ramphoprion* sp. *b*. The polychaete jaw assemblage, very similar to that of the boulder O.366, indicates ?Middle Ordovician.

No. O.470, Mochty, province of Warsaw. Light grey, middle grained limestone, yielding silicified Brachiopoda and Bryozoa, unidentified Tuboidea, Graptolithina, polychaete jaws: *Kalloprion ovalis* n. sp., *Mochtyella cristata* n. sp., "*Polychaetaspis*" *incisus* n. sp., *Rhytiprion magnus* n. sp., *Polychaetura gracilis* KOZŁ., *Polychaetaspis* sp. *a*, and undescribed, isolated jaws of *Mochtyella* sp., *Xanioprion* sp., *Atraktoprion* sp. and *Polychaetaspis* sp. The polychaete jaw assemblage, similar to that of the boulder O.182, indicates ?Middle Ordovician.

No. O.472, Mochty, province of Warsaw. Organogenic, coarse grained limestone with Chitinozoa, Diplograptidae, Hydrozoa, Crustoidea, Tuboidea, polychaete jaws: *Polychaetaspis tuberculatus* n. sp., *P. wyszogrodensis* KOZŁ., *P. gadomskae* n. sp., *Kozlowskiprion brevialatus* n. sp., *Polychaetura gracilis* KOZŁ., *Mochtyella cristata* KIELAN-JAW., *Xanioprion borealis* KIELAN-JAW., *Atraktoprion major* n. sp., *Leptoprion artus* n. sp., undescribed jaw apparatus of *Vistulella* sp. and isolated undescribed jaws: *Kalloprion* sp. and *Pistoprion* sp. Polychaete jaw assemblage, similar to that of the boulder O.366, indicates ?Middle Ordovician.

No. O.505, Mochty, province of Warsaw. Organogenic, light grey, coarse grained limestone, with unidentified Graptolithina, Brachiopoda, *Tasmanites* sp., polychaete jaws of *Polychaetaspis latus* n. sp. and undescribed jaws: *Atraktoprion* sp., *Polychaetaspis* sp. and *Polychaetura* sp. Age of the boulder unknown.

FAUNISTIC ASSEMBLAGES

A comparison of the assemblage of polychaete jaw apparatuses found in the investigated boulders, has enabled the writer to distinguish some, well defined faunistic groups, characteristic of boulders of different ages.

A. ?LLANDEILO—LOWER CARADOC ASSEMBLAGE

(Uhaku Stage C_{Ic}, Kukruse Stage C_{II}, and Idavere Stage C_{III} of Estonian sequence)

The boulder No. O.182 has been recognized as Middle Ordovician, Kukruse Stage, No. O.366 as Kukruse or Idavere Stage, No. O.29 as Uhaku Stage, and No. O.142 as Kukruse Stage. Of these, Nos. O.182 and O.366 were large boulders (10 kg. and 100 kg. respectively) and thus furnished a rich collection of jaw apparatuses and isolated jaws. Fourteen species have been identified in the boulder No. O.182, and 12 — in O.366, 6 of which are common to both boulders. The main difference between the two boulders is that in O.182 isolated jaws of *Ramphoprion* sp. predominate, while in No. O.366 the representatives of *Ramphoprion* are very seldom met with, the most characteristic feature of the latter fauna being a great abundance of polychaetaspid species: *P. wyszogrodensis* KOZŁ., *P. tuberculatus* n. sp. and *P. gadomskae* n. sp.

Jaw assemblage similar to that of No. O.366 have also been yielded by the large boulders O.469 (70 kg.) and O.400 (100 kg.). The assemblage of the boulder O.469 is in some respects intermediate between the boulder O.182 and O.366, as the representatives of *Ramphoprion* are here comparatively common and occur together with *P. tuberculatus* n. sp. and *P. wyszogrodensis* KOZŁ. The assemblage of the boulder O.400 is represented by 12 polychaete species, 9 of which are also common to the boulder O.366. No. O.400 contains a rich polychaetaspid assemblage (*P. wyszogrodensis* KOZŁ., *P. tuberculatus* n. sp., *P. gadomskae* n. sp. and *P. varsoviensis* n. sp.), while representatives of *Ramphoprion* are lacking.

As the age of all here discussed boulders is recognized only tentatively, on a few or single graptolite or trilobite specimens, one cannot venture an opinion as to whether the here described differences in the composition of polychaete jaw species are due to the different stratigraphic position of the boulders or to facial differences. It is probable that the discussed boulders are derived from different stratigraphic horizons (within the Middle Ordovician), as however one cannot be sure which is younger and which older, they are regarded here provisionally as of the same age, though the latter is not precisely ascertained.

Some of the species found in the four, here discussed boulders, occur also in the boulders No. O.29, O.116, O.142, O.148, O.188, O.423, O.470 and O.472. The residues of the latter boulders yielded, however, fewer identified species, which may be due to the smaller size of the boulders. On the base of faunistic similarities they are assigned tentatively to the same type of Middle Ordovician faunistic assemblage (comp. Table 1).

A comparison of the here discussed, presumable Llandeilo and Lower Caradoc species with those from Sweden, Öland, Estonia and from the bottom of the Baltic sea, i.e. the areas from which the boulders could have originated, is unfortunately impossible, as almost no Ordovician polychaete jaw apparatuses or even scolecodonts were described so far from the Baltic region.

EISENACK (1939) described from the erratic boulders of the Baltic region numerous carriers, regarded by the present writer as belonging to the genera *Polychaetaspis* KOZŁ., *Polychaetura* KOZŁ., *Kozlowskiprion* n. gen., *Kalloprion* KIELAN-JAW., *Atraktoprion* n. gen., *Ramphoprion* KIELAN-JAW. and *Paulinites* LANGE. In the collection studied by EISENACK there was a sample from Estonia (Wesenberg beds D_2 = Keila Stage, D_{II} in recent classification) (comp. ORVIKU, 1958, MÄNNIL, 1959), which yielded carriers called *Pteropelta thomsoni* EISENACK. These are very similar (cf. p. 103) to the carriers of *Polychaetura gracilis* KOZŁ.

Dr. JAANUSSON kindly sent to the writer two isolated jaws from the Kukruse beds (C_{II} of Estonia) from HOLM's collection, Riksmuseum, Stockholm. They are: a broken off right MI of *Polychaetaspis* sp., and a right MI described in the present paper as *Ramphoprion* sp. *d.*

The Estonian specimen of *Ramphoprion* sp. *d* is regarded here as conspecific with the Polish specimens from the boulder O.182 (comp. p. 112 and Plate XI, figs. 1—2). This also points to the correlation between the boulder O.182 and the Kukruse beds of Estonia.

B. ?UPPER CARADOC ASSEMBLAGE

(Keila Stage D_{II}, of Estonian sequence)

The age of the boulder O.398 has been recognized tentatively, based on the presence of *Bolbina major* (KRAUSE) (cf. KIELAN-JAWOROWSKA, 1962, p. 294) as Caradoc, ?Keila Stage. The polychaete jaw assemblage, found in the boulder, is of typical Ordovician pattern, characterized by the representatives of *Ramphoprion*, *Polychaetaspis* and *Kalloprion*, and by the lack of *Paulinites*. Its specific composition is, however, quite different from that of the boulders Nos. O.182 and O.366. *Ramphoprion elongatus* KIELAN-JAW., *Kalloprion triangularis* n. sp. and *Atraktoprion mirabilis* n. sp. are, apart from this boulder, so far unknown. The only species found here, known from other boulders, is *Pistoprion transitans* n. sp. Unfortunately, the age of the other boulders yielding *P. transitans* is unknown.

C. SILURIAN ASSEMBLAGE

The following boulders: O.56, O.161, O.410, O.441 and O.446 have been recognized as Silurian or ?Silurian, however, only the age of the boulder O.410 has been more precisely determined as Lower Ludlow. On the base of scarce and inaccurate data, the writer cannot venture an opinion as to whether all of them belong to the same, narrow stratigraphic horizon; it cannot be excluded but that some of the mentioned boulders are of the Wenlock or Llandovery age. The number of specimens and species yielded by particular Silurian boulders is much smaller than in the Middle Ordovician boulders, which is probably due in part to their smaller size. A comparison of the faunistic assemblage of the mentioned boulders with those of the boulders Nos. O.98, O.187, O.245, O. 308, O.391, O.439 and O.442 shows that presumably all of them are Silurian.

The most characteristic feature of the Silurian assemblage is the presence of very numerous isolated paulinitid jaws, mochtyellid jaws of *M. trapezoidea* group, and the lack of ramphoprionids. The polychaetaspids which were very common in the Ordovician, are somewhat less numerous here and represented by different species. Lastly there are representatives of *Symmetroprion*, which, however, cannot be regarded strictly as a Silurian genus, as uncertain, isolated symmetroprionid jaws have also been found in Ordovician boulders. With regard to *Skalenoprion* it is not certain, whether some of its representatives are of Ordovician or of Silurian age.

The Silurian polychaete jaws of the Baltic region are somewhat better known than the Ordovician ones, as the Silurian scolecodonts have been described by HINDE (1882) from Visby and Fröjel of Gotland. The fauna described by HINDE from Visby belongs, according to MARTINSSON (1960), to the Upper Visby marl (lowermost Wenlock), while that from Fröjel to the Slite Group (Upper Wenlock). More recently MARTINSSON (1960) has described the jaw apparatuses: *Paulinites burgensis* MARTINSSON from the Hemse group, Ludlow, Västlaus, parish of Burs, Gotland, and *Paulinites* sp. from the Mulde marl (uppermost Wenlock), parish of Fröjel, Gotland. Of the species described by MARTINSSON, *Paulinites burgensis* MART. has not been met with in the studied collection and as the figure of *Paulinites* sp. (MARTINSSON, 1960, Plate 1, fig. 6) is very indictinct, it cannot be compared with species described in the present paper.

In the scolecodont assemblage described by HINDE (1882) from the island of Gotland, there are jaws very similar or may be even conspecific with those found in the here discussed Silurian assemblages of the erratic boulders. Scolecodont species *Eunicites serrula* HINDE (HINDE, *l. c.*, p. 11, Plate 1, figs. 11 and 12) represents isolated MI of *Mochtyella trapezoidea* pattern. As the jaws assigned by HINDE to *E. serrula* are figured only in one view, it is impossible to venture an opinion as to whether they are conspecific with any of the Silurian mochtyellids from the erratic boulders.

Oenonites radula HINDE (1882, p. 15, Plate 2, figs. 34, 34*a*) represents a basal plate of *Polychaetaspis*, similar to that of *P. aequilateralis* n. sp. *Arabellites fastigiatus* HINDE (*l. c.*, p. 17, Plate 2, fig. 45) represents a right MI of *Skalenoprion* sp. Isolated right and left MI and MII of *Paulinites* are the most characteristic feature of the Visby fauna. They were described by HINDE under various generic and specific names. Among them, *Arabellites hamatus* HINDE (*l. c.*, p. 16, Plate 2, figs. 42—44) is very similar to MI of *Paulinites gladiatus* n. sp., while *Oenonites aspersus* HINDE (HINDE, p. 13, Plate 1, figs. 21, 22, 22*a*) reminds one of *P. polonensis* n. sp.

Lastly, *Oenonites securis* HINDE and *O. securis* var. *basalis* HINDE (*l. c.*, p. 15, Plate 2, figs. 36 and 37) and *Lumbriconereites spatiosus* HINDE (*l. c.*, p. 23, Plate 3, figs. 72, 73 and 73*a*) are respectively the laeobasal plates, and right and left MI of *Symmetroprion*, showing very close similarities to *S. reduplicatus* n. sp. In addition, HINDE described various isolated jaws (mostly MI and MII) of *Polychaetaspis* sp. and *Arabellites* sp.

As the scolecodonts described by HINDE are in most cases inadequately figured (in one or two views only), one cannot be sure of the conspecifity of the forms described by him with those from the erratic boulders. The general resemblance of the Visby and Fröjel fauna to that described in the present paper as Silurian is, however, striking.

BOULDERS OF UNKNOWN AGE

Age of the boulders Nos. O.42, O.59, O.133, O.139, O.140, O.141, O.144, O.147, O.159, O.174, O.177, O.178, O.179, O.185, O.199, O.201, O.213, O.265, O.279, O.301, O.319, O.344, O.349, O.418, O.430, O.463, O.466 and O.505 could not be ascertained. The boulders O.42, O.59, O.133, O.139, O.265, O.279 and O.319 are most probably of Ordovician age. On the other hand, the boulders O.159 and O.185 yielded some polychaete jaw species found in the Silurian boulders, and it cannot be excluded that they are not of this age. All the remaining above cited boulders may be either Ordovician or Silurian.

CONCLUSIONS

A comparison of the three faunistic groups distinguished here shows that each of them is characterized by its own specific assemblage, and that there is no single species common to any two of them. Not only are the differences between the Middle Ordovician and Silurian polychaete faunas striking, but also the particular horizons within the Middle Ordovician (e.g. assemblage A and assemblage B) are characterized by different species.

The differences between the boulders O.182, O.469, O.366 and O.400 — assigned provisionally to the same faunistic assemblage — show that it is highly probable that there are also differences in specific composition between the Uhaku, Keila and Idavere Stages.

The differences between the Middle Ordovician and Silurian assemblages concern not only the species, but also the genera. Unfortunately, the Upper Ordovician, and may be also the Llandovery polychaete jaw assemblages of the Baltic region are unknown, and one cannot

state when some "Silurian" genera made their appearance. No paulinitid jaws have been so far met with in the samples from the studied Middle Ordovician boulders. They are very common in the Silurian samples and occur also in the boulders of unknown age. However, in North America the oldest representatives of *Paulinites* have been described by ELLER as *Nereidavus angulosus* ELLER (cf. ELLER, 1945, p. 190, Plate 7, figs. 12—16) — from the Trenton series of Rockland, Ontario, which is correlated with our Middle Ordovician. The Upper Ordovician representatives of *Paulinites* (described as *Elmhurstia nodosa* POOTER), have been reported by GRIES (1944, p. 19, Plate 2, figs. 3, 4) from the Liberty Formation of Ohio, which is correlated with the Middle Ashgillian (cf. WHITTINGTON, 1954). In the Silurian and Devonian the representatives of *Paulinites* (or Paulinitidae) belong to scolecodonts most common all over the world.

On the other hand, the representatives of *Ramphoprion* or the Ramphoprionidae have not so far been met with — to judge from the scolecodont literature — higher than Ordovician. In the studied samples they are very common in the Middle Ordovician, but seem to be lacking in Silurian. This however is not entirely certain, as isolated, not described ramphoprionid jaws have been found in the boulder O.185, which is either of the Upper Ordovician or of Silurian age.

The representatives of the Skalenoprionidae have not been found in the Middle Ordovician boulders, it is not however certain if they make their appearance in the Upper Ordovician or in Silurian. Similarly, *Vistulella* is unknown so far in the Middle Ordovician. *Polychaetura* and *Tetraprion* are known only from the Middle Ordovician, but in the boulders of unknown age and in the Silurian there are so far undescribed polychaeturid jaws, as well as jaws of ctenognatha type, some of which may belong to the genus *Tetraprion*.

All the remaining here described polychaete genera are common to Ordovician and Silurian, being however represented in these systems by different species.

The above considerations point to the fact that, contrary to the common belief, the scolecodonts, if described as components of entire jaw apparatuses, could prove very useful as stratigraphic indicators for both Ordovician and Silurian strata.

DISTRIBUTION OF THE BOULDERS

Fifty three boulders studied in the present paper were found in two main regions:

1. Vicinity of Warsaw: Stara Warka on the Pilica river and three localities (Mochty, Zakroczym and Wyszogród) on the Vistula river;
2. The Polish western coast of the Baltic sea (the localities of Międzyzdroje, Dziwnów, Rewal, Jarosławiec, Ustka and Władysławowo).

The boulder clay which crops out at Warka is regarded as a deposit of the Middle Polish (Riss) glaciation (FALKIEWICZ, *in* RÓŻYCKI, 1961). Of the studied boulders, only No. O.29 has been found in this locality.

In the localities of Mochty, Zakroczym and Wyszogród, the Pleistocene deposits are exposed in the high escarpment of the Vistula valley, on the right bank of the Vistula. According to MICHALSKA (*in* RÓŻYCKI, 1961), "The main boulder clay horizon at Mochty belongs to Cracovian (Mindel) glaciation" (*l. c.*, p. 32). The series of sediments of the Middle Polish (Riss) glaciation rest on the Cracovian deposits in Mochty, but no boulder clay of this age is to be found in this locality.

In the section of Wyszogród, RUSZCZYŃSKA (*in* RÓŻYCKI, 1961) stated the occurrence

of boulder clay of both Cracovian (Mindel) and Middle Polish (Riss) glaciations. The localities cited in the present paper as Wyszogród—Zakroczym cover different places, stretched along the high escarpment of the Vistula between Zakroczym and Wyszogród (30 km.).

As the boulders studied in the present paper have been collected only at the foot of the escarpment in these localities, it is possible that at Wyszogród and Wyszogród—Zakroczym they are derived from both Cracovian and Middle Polish glaciations, while those from Mochty (at least the majority) are of Cracovian glaciation.

The boulders found on the beaches of the western coast of the Polish Baltic are derived from the moraine of the youngest — Baltic (Würm) glaciation (GALON, 1961).

As the boulders found in the vicinity of Warsaw and on the Baltic coast belong to different glaciations, the question arises whether there are not noticeable differences in the composition and age of the studied boulders. Thirteen boulders, identified in the present paper as Middle Ordovician, have been found only in the vicinity of Warsaw. No single boulder yielding the polychaete fauna assigned to the assemblage A or B is so far known from the Baltic coast. On the other hand, the boulders of unknown age and those of Silurian age have been found in both regions, in the vicinity of Warsaw and along the Baltic coast.

Without making quantitative studies of the percentage of particular boulders in these two regions, one can state provisionally that, in general, on the beaches of the western coast of the Baltic, Silurian boulders are more common than Ordovician, while in the vicinity of Warsaw the Ordovician boulders prevail over the Silurian ones.

VARIABILITY IN RECENT JAW APPARATUSES

(Plate II; Text-figs. 3, 4)

As the present paper is concerned with the study of fossil polychaete jaw apparatuses, it was necessary at the beginning of this work to pose the question, whether or not it is possible to recognize on the jaw structure good species in Eunicea. This is why the present writer has started her investigations with studies of the variation of jaw apparatuses in Recent eunicids.

INDIVIDUAL VARIATION

Tables 2—6 give the results of studies of variation in the number of denticles in five Recent species: *Eunice floridana* (POURTALÈS), *Onuphis eremita* AUDOUIN & MILNE-EDWARDS, *Diopatra cuprea* (BOSC), *Halla parthenopeia* DELLE CHIAJE and *Arabella iricolor* (MONTAGU). The tables show that variation in the number of denticles in particular jaws is considerable. It is also interesting to note (see Table 3), that while the number of denticles in a particular jaw varies, there is not necessarily a connection between the number of denticles and the size of the jaws.

SYMMETRY VARIATION

Two of the examined Recent species, viz. *Diopatra cuprea* (BOSC) and *Halla parthenopeia* DELLE CHIAJE, are subject to another type of variation, which concerns the number of jaws on each side of the apparatus and their shape (some jaws may be symmetrical in some individuals, while asymmetrical in others).

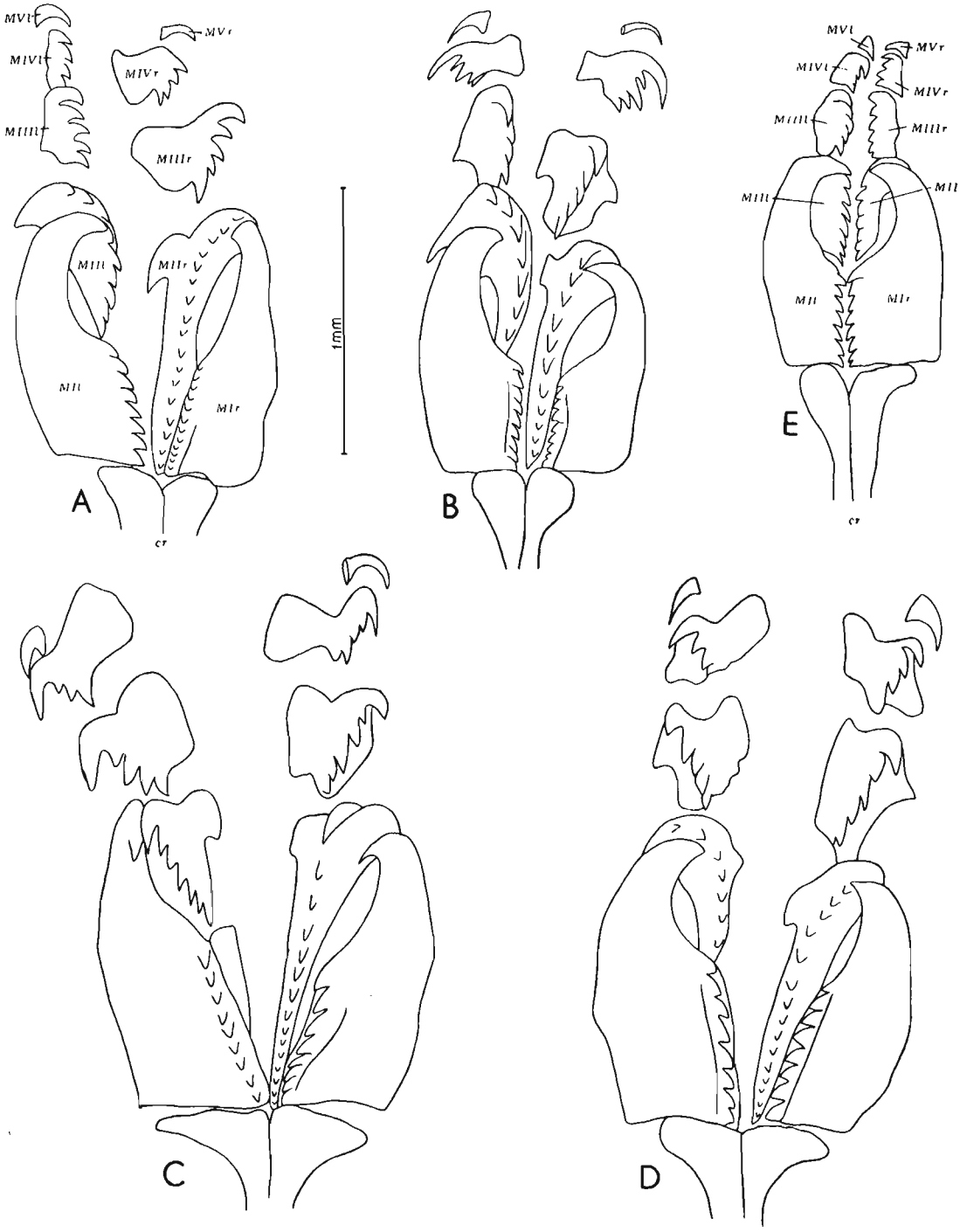


Fig. 3

Arabella iricolor (MONTAGU) — Recent

Sketches of five jaw apparatuses: *A-D* asymmetrical type, *E* symmetrical type (*A* — B.M. No. 79.62.17.6, *B* — B.M. No. 1928.4.26.23, *C* — B.M. No. 1935.2.23.26, *D* — B.M. No. 79.62.17.4, *E* — B.M. No. 1936,10.16.71).

(For abbreviations — see p. 153)

This type of variation, called here the symmetry variation, is less common and, as far as the writer knows, has been demonstrated so far in only two species: *Arabella mutans* (CHAMBERLIN), described by CROSSLAND (1924), and in *Aglaurides fulgida* SAVIGNY, described by FAUVEL (1919, 1953,) HARTMAN (1944) and others.

1. *Diopatra cuprea* (BOSC) (see Table 4 and Plate II) — is so far the only representative of labidognatha type displaying symmetry variation. The present writer examined in the collections of the British Museum (Natural History) 34 specimens of *D. cuprea*, from the "Discovery" expedition, Station No. 274, depth of net 64—65 m. Among them, 31 specimens are of the normal type of jaw structure with single left MIII (cf. Plate II, fig. 1). In two specimens (Plate II, figs. 2, 4) the jaw apparatuses were entirely symmetrical with paired MIII. In one specimen (Plate II, fig. 3) MIII was single right.

2. *Arabella iricolor* (MONTAGU) (see Table 5 and Text-fig. 3) — The present writer examined the variation of the jaw apparatuses in 13 specimens from the collections of the British Museum (Natural History). Text-fig. 3 gives the sketches of five jaw apparatuses of *Arabella iricolor* from various localities. Four of them (Text-figs. 3*A-D*) represent the asymmetrical type. Right and left MI are here almost identical, right MI being somewhat longer than left MI. The asymmetry concerns MII: the right MII is distinctly longer than the left, provided with 11—17 denticles and reaching the base of the carrier, while the left MII is half as long, reaching only half the length of MI, and provided with 7—9 denticles. MIII, MIV and MV are in these specimens more or less symmetrical. The specimen figured in Text-fig. 3*E* has all jaws symmetrical.

Table 2

Variation in the number of denticles in *Eunice floridana* (POURTALÈS)

B.M.Cat.No.	Locality	Number of denticles											
		MI		MII		MIII		MIV		MV		MVI	
		L	R	L	R	L	R	L	R	L	R	L	R
1949.2.23.12	Bay of Biscay	1	1	7	7	8	—	6	10	1	1	1	1
1949.2.23.13		1	1	5	6	7	—	5	10	1	1	1	1
1949.2.24.14		1	1	5	6	8	—	7	11	1	1	1	1
1949.2.24.15		1	1	5	5	8	—	5	10	1	1	1	1
1949.2.24.16		1	1	7	5	10	—	5	10	1	1	1	1
1949.2.24.17		1	1	6	6	8	—	5	10	1	1	1	1
1949.2.24.18		1	1	6	6	6	—	7	10	1	1	1	1
1949.2.24.19		1	1	6	6	5	—	6	9	1	1	1	1
1949.2.24.20		1	1	5	7	7	—	5	9	1	1	1	1
1949.2.24.21		1	1	6	7	9	—	5	14	1	1	1	1
1949.2.24.21*a*		1	1	6	6	6	—	5	14	1	1	1	1
1949.2.24.21*b*		1	1	7	7	9	—	7	11	1	1	1	1
1949.2.24.21*c*		1	1	6	6	4*	—	7	10	1	1	1	1
1927.5.25.21	Nicobar Island, Indian Ocean	1	1	6	6	7	—	4	11	1	1	1	1
1927.5.25.22		1	1	7	5	6	—	5	9	1	1	1	1
1927.5.25.23		1	1	6	7	8	—	5	9	1	1	1	1
1927.5.25.24		1	1	7	7	8	—	5	8	1	1	1	1
1927.5.25.25		1	1	7	6	8	—	4	8	1	1	1	1
1927.5.25.27		1	1	7	6	7	—	4	10	1	1	1	1

* Part of denticles worn.

Table 3

Variation in the number of denticles and dimensions in *Onuphis eremita* AUDOUIN & MILNE-EDWARDS from Gulf of Naples

Z. Pal. Mus. Cat. No.	Dimensions in mm.			Number of denticles							
	Length			MI		MII		MIII		MIV	
	of entire apparatus	of carriers	of forceps	L	R	L	R	L	R	L	R
An. 0. 1	1·8	0·49	1·1	1	1	10	10	10	—	6	8
An. 0. 2	1·8	0·56	1·1	1	1	12	13	13	—	7	9
An. 0. 3	1·7	0·52	1·0	1	1	13	13	14	—	10	11
An. 0. 4	1·9	0·51	0·88	1	1	11	11	9	—	8	8
An. 0. 5	1·7	0·51	1·0	1	1	12	12	14	—	8	11
An. 0. 6	1·5	0·44	0·96	1	1	12	15	12	—	9	11
An. 0. 7	1·7	0·5	0·99	1	1	12	12	13	—	9	9
An. 0. 8	2·26	0·6	1·2	1	1	15	12	13	—	9	10
An. 0. 9	1·13	0·4	0·72	1	1	12	11	12	—	10	8
An. 0.10	1·7	0·5	1·0	1	1	10	13	12	—	8	11
An. 0.11	1·72	0·55	0·98	1	1	12	13	14	—	8	11
An. 0.12	0·89	0·35	0·53	1	1	12	11	13	—	8	11
An. 0.13	1·2	0·38	0·7	1	1	14	12	11	—	11	10
An. 0.14	1·55	0·47	0·84	1	1	13	13	13	—	7	10
An. 0.15	1·16	0·42	0·62	1	1	12	14	14	—	10	11
An. 0.16	1·71	0·5	0.94	1	1	11	12	12	—	7	8
An. 0.17	1·6	0·57	0·8	1	1	12	13	12	—	8	8
An. 0.18	1·65	0·51	0·95	1	1	12	12	10	—	7	8
An. 0.19	1·8	0·48	0·88	1	1	12	12	15	—	11	11
An. 0.20	1·86	0·58	1·03	1	1	13	12	13	—	8	9
An. 0.21	1·34	0·41	0·73	1	1	11	11	11	—	9	*
An. 0.22	1·38	0·47	0·68	1	1	12	12	12	—	11	12
An. 0.23	1·5	0·54	0·8	1	1	10	11	11	—	4?	5?
An. 0.24	1·54	0·41	0·82	1	1	9	11	9	—	8	9
An. 0.25	1·88	0·59	1·1	1	1	10	11	12	—	7	13
An. 0.26	1·69	0·45	0·94	1	1	13	15	11	—	9	10
An. 0.27	1·49	0·39	0·89	1	1	12	13	12	—	8	11
An. 0.28	1·8	0·49	0·96	1	1	14	13	12	—	10	9
An. 0.29	1·4	0·44	0·75	1	1	11	12	11	—	9	11
An. 0.30	1·6	0·53	0·97	1	1	12	12	11	—	9	10

* Right MIV damaged.

Left MII is here comparatively short (7 denticles) shaped similarly as the left MII in asymmetrical specimens (Text-figs. 3*A-D*), right MII is also short with 7 denticles, representing the mirror image of left MII.

3. *Aglaurides fulgida* SAVIGNY (Text-fig. 4) — The case of this species has been widely discussed in zoological literature (EHLERS, 1887; FAUVEL, 1917, 1919, 1953; TREADWELL, 1921; CROSSLAND, 1924; MONRO, 1933; OKUDA, 1937; HARTMAN, 1944, and others). Without giving the detailed history of the investigations, one can state that three different types of jaw apparatuses were recorded in this species. The most common type is the asymmetrical one, with the first jaw on the right side (counting from behind) much smaller than the next jaw on the same side, and at the same time smaller and different in shape from the corresponding jaw

Table 4

Variation in the number of denticles in *Diopatra cuprea* (Bosc) from St. Paul de Loanda, Angola

B.M. Cat.No.	Number of denticles										Remarks
	MI		MII		MIII		MIV		MV		
	L	R	L	R	L	R	L	R	L	R	
1930. 10.8.1901	1	1	9	9	8	—	7	10	1	1	Figured on Pl. II, fig. 1.
1930. 10.8.1902	1	1	8	8	10	—	7	10	1	1	
1930. 10.8.1903	1	1	8	7	7	—	9	8	1	1	
1930. 10.8.1904	1	1	9	7	8	—	7	8	1	1	
1930. 10.8.1905	1	1	8	8	7	—	5	6	1	1	
1930. 10.8.1906	1	1	10	7	10	—	6	8	1	1	
1930. 10.8.1907	1	1	9	11	11	—	9	10	1	1	
1930. 10.8.1908	1	1	8	8	7	7	5	4	1	1	Displays symmetry variation; figured on Pl. II, fig. 4
1930. 10.8.1909	1	1	8	7	7	—	6	7	1	1	
1930. 10.8.1761	1	1	8	8	9	—	6	7	1	1	
1930. 10.8.1762	1	1	7	8	7	—	5	7	1	1	
1930. 10.8.1763	1	1	8	7	6	—	5	7	1	1	
1930. 10.8.1764	1	1	10	7	7	—	6	6	1	1	
1930. 10.8.1765	1	1	7	7	9	—	5	7	1	1	
1930. 10.8.1766	1	1	8	9	10	—	8	9	1	1	
1930. 10.8.1767	1	1	7	8	7	—	5	7	1	1	
1930. 10.8.1768	1	1	8	8	9	—	7	11	1	1	
1930. 10.8.1769	1	1	7	7	8	—	8	9	1	1	
1930. 10.8.1770	1	1	7	6	7	—	7	x)	1	1	x) Damaged.
1930. 10.8.1770*a*	1	1	8	9	8	—	6	7	1	1	
1930. 10.8.1910	1	1	8	8	8	—	6	8	1	1	
1930. 10.8.1910*a*	1	1	7	7	7	—	6	9	1	1	
1930. 10.8.1910*b*	1	1	5	8	8	—	6	8	1	1	
1930. 10.8.1910*c*	1	1	6	7	-	8	7	5	1	1	Displays symmetry variation; figured on Pl. II, fig. 3.
1930. 10.8.1910*d*	1	1	10	9	7	—	5	6	1	1	
1930. 10.8.1910*e*	1	1	6	8	7	—	5	6	1	1	
1930. 10.8.1910*f*	1	1	8	7	10	—	8	13	1	1	
1930. 10.8.1910*g*	1	1	10	10	8	—	7	10	1	1	
1930. 10.8.1770*b*	1	1	8	7	7	—	6	8	1	1	
1930. 10.8.1770*c*	1	1	10	8	8	8	6	5	1	1	Displays symmetry variation; figured on Pl. II, fig. 2.
1930. 10.8.1770*d*	1	1	7	7	8	—	9	12	1	1	
1930. 10.8.1770*e*	1	1	7	7	8	—	6	10	1	1	
1930. 10.8.1770*f*	1	1	7	10	9	—	6	7	1	1	
1930. 10.8.1770*g*	1	1	6	9	9	—	8	11	1	1	

on the left. In the second type, less common but also well known, all the jaws are symmetrical and the right side of the apparatus appears to be a mirror image of the left one in the asymmetrical type.

The third type of jaw apparatus is less known, being recorded so far in only one specimen

Table 5

Variation in the number of denticles in *Arabella iricolor* (MONTAGU)

Locality	British Museum Cat.No.	Number of denticles										Remarks
		MI		MII		MIII		MIV		MV		
		L	R	L	R	L	R	L	R	L	R	
Japan	1921-5-1-1674	1–11	1+11	10	18	7	6	6	5	1	1	
,,	1921-5-1-1675	1+ 8	1+ 8	7	12	5	6	4	4	1	1	
,,	1921-5-1-1676	1+ 9	1+ 6	9	11	6	6	4	6	1	1	
Cherbourg, France	1928-4-26-23	1+ 8	1– 9	7	11	5	5	5	5	1	1	Text-fig. 3*B*
South Africa	1935-2-23-26	1– 9	1+ 8	7	15	5	6	4	5	1	1	Text-fig. 3*C*
South Africa, Port Elizabeth	1936-10-16-71	1– 8	1+ 8	7	7	6	6	4	4	1	1	Text-fig. 3*E*; symmetrical.
Japan, Goto Islands	79-62-17-4	1+ 8	1+ 8	7	15	5	5	4	4	1	1	Text-fig. 3*D*
,, ,, ,,	79-62-17-5	1+ 8	1+12	7	16	5	5	5	3	1	1	
,, ,, ,,	79-62-17-6	1+ 8	1+12	8	17	5	5	5	4	1	1	Text-fig. 3*A*
,, ,, ,,	79-62-17-7	1+ 8	1– 9	8	16	5	6	4	5	1	1	
,, ,, ,,	79-62-17-8	1– 7	1+ 8	8	12	6	5	6	6	1	1	
,, ,, ,,	79-62-17-9	1–10	1– 7	9	15	6	6	6	5	1	1	
East Falkland Island	1930-10-8-1674	1– 8	1+ 8	7	12	5	6	4	5	1	1	

(CROSSLAND, 1924). It has symmetrical jaws, but of a different pattern. In this type the first jaws, counting from behind, are on both sides smaller than the following ones. The right side of the apparatus in this specimen is identical with the right side in the asymmetrical specimen, while the left side is its mirror image.

CROSSLAND (1924) recognized three types of jaws as a basis for creating three varieties of *Aglaurides fulgida*, called by him var. *arabelloides*, var. *diphyllida* and var. *malensis*.

The present writer has examined in the British Museum (Natural History) 10 specimens of *Aglaurides fulgida* from various localities and stated that 9 of them have asymmetrical jaw apparatuses, while one has a symmetrical apparatus, with long MI. In the latter apparatus the right side is the mirror image of the left side of the asymmetrical type. The posterior parts of six of the examined jaw apparatuses are figured in Text-fig. 4. The specimens figured in Text-figs. 4*B-F* represent the asymmetrical apparatuses, while the specimen in Text-fig. 4*A* represents the symmetrical apparatus; the mirror image of the left side of the asymmetrical type being repeated on the right side.

In all the examined specimens the carriers consisted of two pieces, without the median one. The question of the variability of the jaw apparatus in *Aglaurides fulgida* is further complicated by the fact, that HARTMAN (1944) has recorded the presence of carriers with a median unpaired piece in both symmetrical and asymmetrical types of apparatuses. If one leaves the presence of paired or unpaired carriers out of consideration, there are three different types of jaw apparatuses in this species with no intermediate forms between them.

4. *Arabella mutans* (CHAMBERLIN) — CROSSLAND (1924) erected *Arabella novecrinita* CROSSLAND and recognized 4 types of jaw apparatuses within it (see CROSSLAND, *l. c.*, Text-figs. 90, 96, 103 and 105), differing in the shape of jaws, which were symmetrical in some individuals, while asymmetrical in others. The four varieties recognized by CROSSLAND are: *Arabella novecrinita* sensu stricto, *A. novecrinita logani*, *A. novecrinita asymmetrica* and *A. novecrinita atlantica*. MONRO (1928, 1933) noted that CROSSLAND'S species and varieties are conspecific with *Arabella mutans* (CHAMBERLIN). With regard to the latter species MONRO stated (1933, p. 88): "I have examined the jaws of about half a dozen specimens and I find very little

Table 6

Variation in the number of denticles in *Halla parthenopeia* DELLE CHIAJE from Gulf of Naples

Z.Pal.Mus. Cat.No.	Bp	MI		MII		MIII		MIV		MV		Remarks
		L	R	L	R	L	R	L	R	L	R	
An. H. 1	5	8	10	6	7	5	—	5	7	1	1	
An. H. 2	6	10	11	7	6	5	—	5	5	1	1	
An. H. 3	8	11	14	8	7	6	—	5	6	1	1	
An. H. 4	8	11	12	8	7	5	—	5	5	1	1	
An. H. 5	7	8	11	8	7	8	—				1	
An. H. 6	7	9	11	7	7	6	—	6	7	1	1	
An. H. 7	6	9	13	9	7	7	—	5	7	1	1	
An. H. 8	6	9	12	8	8	5	—	5	6	1	1	
An. H. 9	7	11	13	8	8	6	—	4	5	1	1	
An. H.10	7	10	13	7	9	6	—	6	7	1	1	
An. H.11	7	10	11	8	8	7	—	6	7	1	1	Pl. I, fig. 5
An. H.12	7	10	10	6	6	6	—	5	6	1	1	Pl. I, fig. 3
An. H.13	7	9	12	7	7	7	—	5	6	1	1	Pl. I, fig. 4
An. H.14	8	11	13	9	7	6	—	5	6	1	1	
An. H.15	7	9	11	8	6	5	—	6	5	1	1	

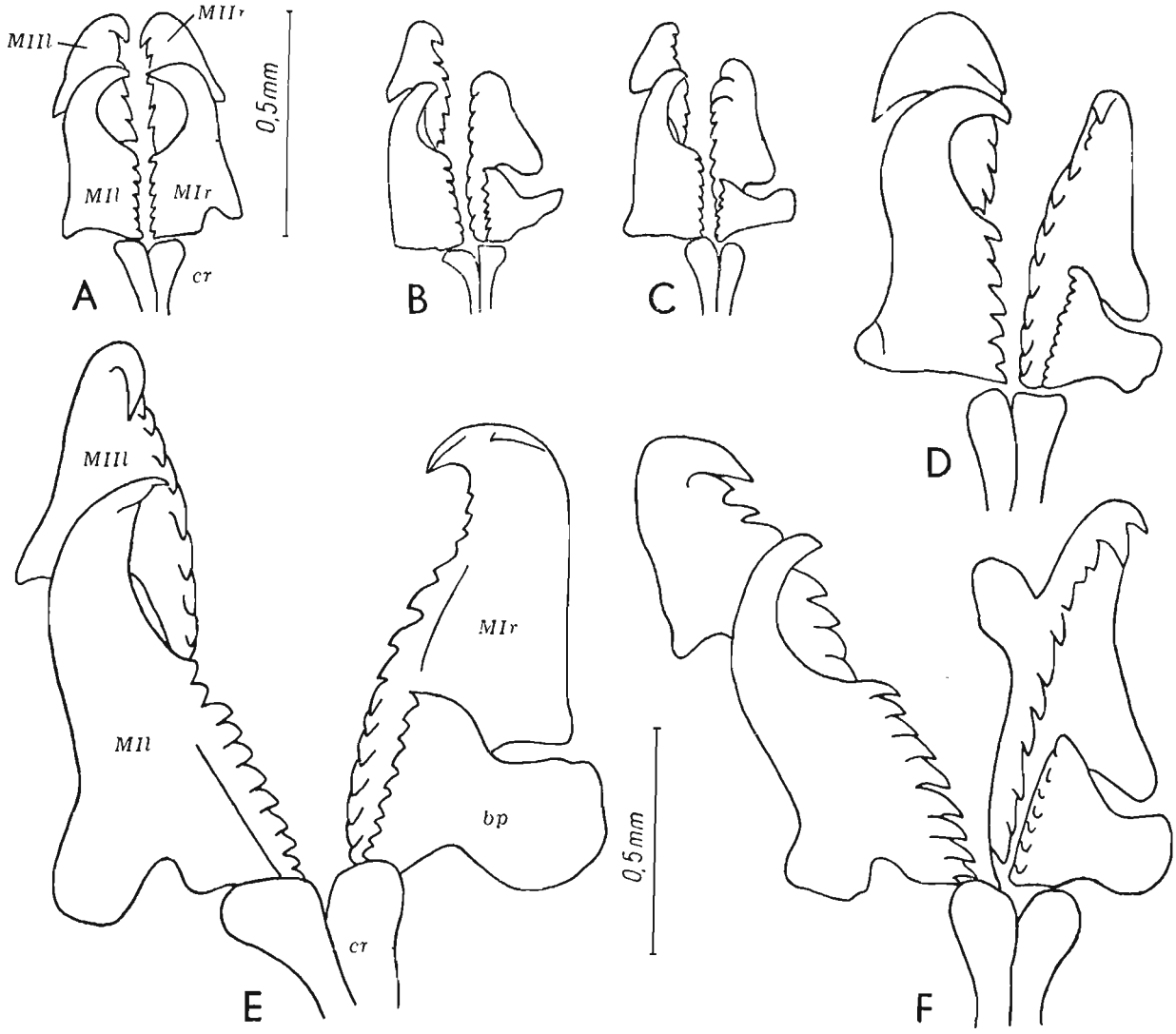


Fig. 4

Aglaurides fulgida SAVIGNY — Recent

Posterior part of the jaw apparatuses of 6 specimens: *A* symmetrical type, *B-F* asymmetrical type (*A* — B.M. No. 1926.4.30.25/1, *B* — B.M. No. 1932.12.24.401, *C* — B.M. No. 133.12.24.402, *D* — B.M. No. 1935.1.31.33, *E* — B.M. No. 1923.11.12.11, *F* — B.M. No. 1923.11.12.10).

(For abbreviations — see p. 153)

variation. They all resemble those figured by CROSSLAND for his var. *atlantica*". In this opinion he has been supported by HARTMAN (1944). As the varieties erected by CROSSLAND are poorly known, *A. novecrinita* sensu stricto has been erected on 3 specimens, and *A. novecrinita logani* on only one specimen, it is very difficult to venture an opinion as to the variability of jaw apparatus in *Arabella mutans*.

DISCUSSION

The above described examples of symmetry variation cannot be regarded as a simple individual variation, but seem to be a case of *situs inversus*, which commonly occurs in different groups of animals, e.g. in gastropods, insects and others. The jaw apparatus of *Diopatra cuprea* (BOSC), figured on Plate II, fig. 3, represents a simple type of *situs inversus*, the right side of the normal jaw apparatus occurs here on the left side, and vice versa. Cases of symmetrical jaw apparatuses, occurring in the species characterized by asymmetrical jaw apparatuses, are here interpreted as a repetition on one side of the mirror image of the other side.

The results of the above discussed observations are for palaeontological purposes of a rather negative character, as all cases of symmetry variation when found in fossil state, would be described as separate species. As however symmetry variation is very rare, the possible mistakes resulting from misinterpretation cannot have an important influence on the obtained picture of the evolution of jaw apparatuses in Eunicea.

With regard to individual variation concerning the number and shape of the denticles in Recent eunicids, it should be stressed that a similar range of variability has been stated by LANGE (1949) in Devonian *Paulinites paranaensis* LANGE and has been observed by the present writer in almost all the here described Ordovician and Silurian species.

The present writer's knowledge of the systematics of Recent eunicids is too limited to venture an opinion as to whether or not the jaw apparatuses are good taxonomic characters of specific rank. The opinions of polychaete specialists on this question vary greatly. CLAPARÈDE (1870), FAUVEL (1917, 1923), and others are of the opinion that the jaws in eunicids are of little or no taxonomic value. TREADWELL (1921, p. 7) suggests a somewhat different view: "While regarded by some students of the family as too variable in individuals and too similar in different species to be of value in classification, I have found that while such details as the number of teeth in a plate may vary, the general appearance and the arrangement of parts of these structures are decidedly characteristic in any species".

It is possible that the fossil species — as described in the present paper — based on jaw apparatuses, represent systematic units somewhat larger than the Recent species. However, this discordance between the palaeontological and zoological systematics does not concern only the polychaete annelids, but is characteristic of most animal groups recorded as fossils. If even some of the eunicid species were to be lumped into one, or, on the contrary, one species was to be split into several, the picture obtained of the evolution of jaw apparatuses in Eunicea would not be very different from that, emerging from consideration of systematic units of a different concept.

RECOGNITION OF FOUR TYPES OF JAW APPARATUSES IN EUNICEA

(Text-fig. 5)

In Recent eunicids (superfamily Eunicea) EHLERS (1864—68) recognized two types of maxillary apparatuses, which he called prionognatha and labidognatha. The jaws in both these types are in the form of cones or forceps, with an opening at the base of the ventral side leading to the pulp cavity. The majority of fossil jaws so far described belong to these two types. In the Palaeozoic collection of polychaete jaw apparatuses from Poland, two new types

of apparatuses, additional to types recognized by EHLERS, occur; they are called placognatha and ctenognatha (KIELAN-JAWOROWSKA, 1963).

In the collection studied there are intermediate forms between these four types. It should be stressed that the placognatha, ctenognatha, labidognatha and prionognatha types do not correspond to taxonomic units — their recognition seems however very useful when discussing the evolution and homology of particular plates in the maxillary apparatuses in Eunicea.

Before considering the evolution of eunicid jaw apparatuses, it seems necessary to define the recently recognized types (placognatha and ctenognatha [1]) and to discuss the already known characteristics of prionognatha and labidognatha types.

PLACOGNATHA TYPE

(Gr. *plakos* — a plate, *gnathos* — a jaw)

(Text-figs. 1*A*, *B*; 5*A-D*)

Jaw apparatus consisting of asymmetrically arranged jaws in the posterior part and two rows of teeth in the anterior part. Carriers lacking. The jaws of the posterior part are in the form of convex plates, with gaping openings of pulp cavities. Both simple and compound jaws are met with in this type.

The joined jaws or entire jaw apparatuses of placognatha type are known so far only from the Ordovician and Silurian of Poland, the detached jaws which can be attributed to this type have been reported from Ordovician through Upper Devonian of United States. No Recent representatives of this type are known. Placognatha apparatuses, restricted so far to Palaeozoic beds, seem to be very primitive Eunicea.

The following genera are regarded as placognaths: *Mochtyella* KIELAN-JAW., 1961, *Pistoprion* n. gen., *Vistulella* KIELAN-JAW., 1961, *Xanioprion* KIELAN-JAW., 1962, and *Rhytiprion* n. gen.

CTENOGNATHA TYPE

(Gr. *ktenos* — a comb, *gnathos* — a jaw)

(Text-figs. 5*E-F*)

Jaw apparatus consisting of small, symmetrically arranged jaws in the posterior part and four rows of very numerous teeth in the anterior part, arranged in longitudinal series, extending for more than half the length of the apparatus. Carriers lacking. Jaws of the posterior part with gaping or narrowly open pulp cavities.

This type is erected to include the Recent family Dorvilleidae and the Ordovician genus *Tetraprion* nov. Numerous Ordovician and Silurian jaw apparatuses and isolated jaws of this type, which have to remain in the author's collection undescribed, show that the ctenognaths were strongly diversified in the early Palaeozoic. As jaw apparatuses of ctenognatha type consist mostly of individual teeth, their chances of preservation as fossils are less than in other types. The detached teeth of this type when pre-

[1] The names placognatha and ctenognatha were introduced by the present writer (KIELAN-JAWOROWSKA, 1963) in an abstract, where only very brief definitions were given.

served, cannot be distinguished from the isolated teeth of the anterior part of placognatha apparatuses, and even sometimes from the lateral and anterior teeth of labidognatha apparatuses.

LABIDOGNATHA AND PRIONOGNATHA TYPES

(Text-figs. 5 *G-P*)

EHLERS (1864—68) when recognizing two types of maxillary apparatuses in Eunicea, defined them as follows (p. 273): "In der einen Gruppe *(Eunicea labidognatha)* sind die vorstülpbaren einzelnen Stücke jeder Oberkieferhälfte sehr ungleich gestaltet und so gestellt dass in der Ruhelage die beiden grösseren Stücke in einer nischenförmig Vertiefung der Wand stehen, und um ihre Enden die kleineren Stücke auf dem Vorderrande der Nische im Halbkreise angeordnet sind. In anderen Gruppe *(Eunicea prionognatha)* sind die vorstülpbaren Kieferstücke in jeder Oberkieferhälfte mehr oder weniger gleichartig geformt und stehen auf Langswülsten hinter einander".

The main difference between labidognatha and prionognatha apparatuses, as originally defined by EHLERS, is thus in the arrangement of the jaws, which in the labidognatha type are disposed (when retracted) in a semicircle, whereas in the prionognatha type they are disposed in two parallel rows.

EHLERS regarded the structure of the proboscidial armature in eunicids as a good taxonomic feature at higher levels, dividing the family Eunicidae sensu lato, into two major groups: *Eunicea labidognatha* and *Eunicea prionognatha*. His scheme was neglected by subsequent authors, but more recently HARTMAN (1944) has adopted its general outline. She recognized within the superfamily Eunicea 6 families, 3 of which (the Onuphidae, Eunicidae and Lumbrineridae) represent the labidognatha pattern and are characterized as having (HARTMAN, 1944, p. 5): "carriers short, broad, embedded in pharyngeal tissue or absent".

Within the prionognatha type HARTMAN placed three remaining Recent families: the Arabellidae, Lysaretidae and Dorvilleidae, however pointing out that (p. 2): "The dorvilleids depart more widely from any of the others than these among themselves". As the Dorvilleidae are recorded here as belonging to ctenognatha type, only two Recent families (the Arabellidae and Lysaretidae) are left within prionognatha type. These two families are defined by HARTMAN (1944, p. 5) as having: "carriers long, slender, usually with unpaired ventral piece" and "maxillary parts typically include 5 paired elements".

Recent prionognatha and labidognatha apparatuses differ not only in the arrangement of the jaws in retracted position and in the shape of the carriers, but also in the structure of the forceps (MI) which in the labidognatha type lack teeth, whereas in the prionognatha type

---

Fig. 5

Comparison of basic types of Palaeozoic and Recent polychaete jaw apparatuses

A Mochtyella cristata KIELAN-JAW., *B Pistoprion transitans* n. sp., *C Vistulella kozlowskii* KIELAN-JAW., *D Rhytiprion magnus* n. sp., *E Dorvillea rubrovittata* (GRUBE) (after EHLERS, 1864-68, and MCINTOSH, 1908-10), *F Tetraprion pozaryskae* n. sp., *G Lumbrineris californiensis* HARTMAN (after HARTMAN, 1944), *H Marphysa sanguinea* (MONTAGU), *I Onuphis eremita* AUDOUIN & MILNE-EDWARDS, *J Symmetroprion reduplicatus* n. sp., *K Polychaetaspis wyszogrodensis* KOZŁ., *L Paulinites polonensis* n. sp., *M Drilonereis nuda* MOORE (after HARTMAN, 1944), *N Aglaurides fulgida* (SAVIGNY), *O Skalenoprion alatus* KIELAN-JAW., *P Atraktoprion cornutus* KIELAN-JAW.

Basal and laeobasal ridges in compound MI are of the same colour as basal and laeobasal plates; second ridge in compound MI — the same colour as MII.

PALAEOZOIC

PALAEOZOIC

RECENT

PLACOGNATHA

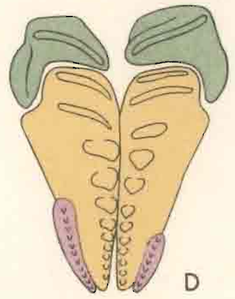
CTENOGNATHA

LABIDOGNATHA

PRIONOGNATHA

A

Mochtyellidae



D

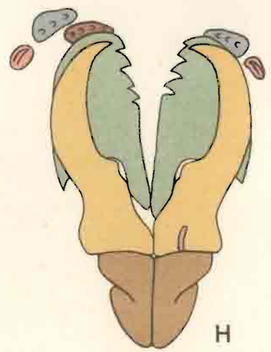
Rhytiprionidae

E

Dorvilleidae

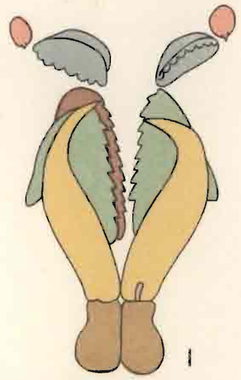
G

Lumbrineridae



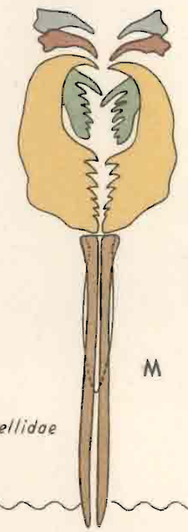
H

Eunicidae



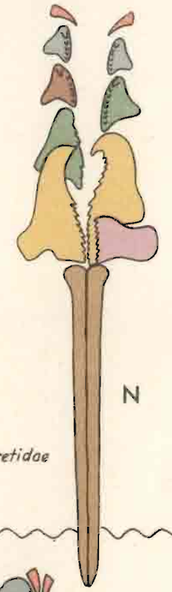
I

Onuphidae



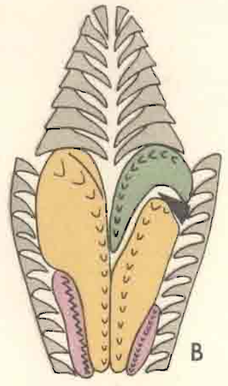
M

Arabellidae



N

Lysaretidae



B

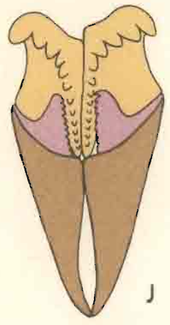
Mochtyellidae

C

Mochtyellidae

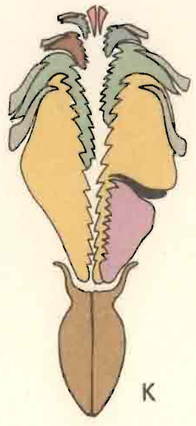
F

Tetraprionidae



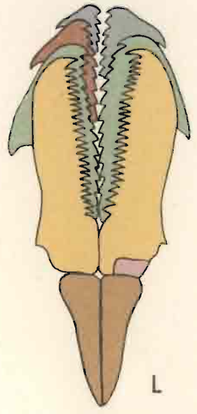
J

Symmetroprianidae



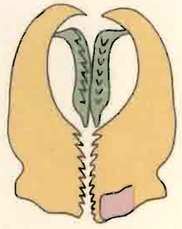
K

Polychaetaspidae



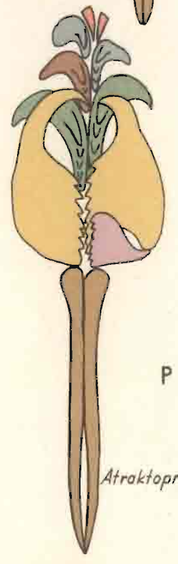
L

Paulinitidae



O

Skalenoprionidae



P

Atraktoprionidae

carriers

basal plate and leobasal plate

intercalary tooth and leointercalary tooth

MI

MII

MIII

MIV

MV

lateral and anterior teeth

L. Cadomska & K. Budzyńska, del.

they are denticulated. It has been generally accepted that in Recent labidognatha type (except the Lumbrineridae) one jaw (MIII) is single, and occurs on the left side only, while in prionognatha type all jaws are paired.

The structure of the Palaeozoic jaw apparatuses studied by the present writer shows, however, that the latter difference is not valid, and that the differences between the fossil labidognatha and prionognatha apparatuses are much smaller than between the modern representatives of these groups.

In all the known Palaeozoic labidognatha genera the forceps (MI) are denticulated, and at the base of the right MI there is a basal plate, which is lacking in all the Recent labidognaths. In the majority of fossil labidognatha families (in the Polychaetaspidae, Polychaeturidae, Kalloprionidae, Ramphoprionidae and Paulinitidae), MIII is single, left, as is characteristic of the Recent Onuphidae and Eunicidae[2]. In this respect, nothing can be said about the Palaeozoic Symmetroprionidae, as in this family only the posterior part of the apparatus is known. In the Recent Lumbrineridae all jaws are paired.

A comparison of Palaeozoic and Recent prionognatha apparatuses shows that here, similarly as in the case of labidognatha, MIII may be single or paired. In the Atraktoprionidae at the base of the right MI there is a basal plate, and MIII is single, left. In Recent *Aglaurides fulgida* SAVIGNY and other Lysaretidae, the first (numbered from behind) jaw on the right side is evidently homologous with the basal plate of the Atraktoprionidae, and consequently one of the jaws on the left side (MII or MIII) is single, left. Among Recent prionognaths the Arabellidae have, in contrast to the Lysaretidae, symmetrical jaw apparatuses, with the basal plate lacking. A similar condition was probably characteristic of the Palaeozoic Skalenoprionidae, where the basal plate is fused with right MI, and MII are symmetrical (cf. *Skalenoprion alatus* KIELAN-JAW., 1962). Unfortunately, only MI and MII of *Skalenoprion* are known, their arrangement is, however, similar to that in the Recent Arabellidae.

Though in both Recent prionognaths and labidognaths the symmetrical and asymmetrical apparatuses (with single MII or MIII) occur, there are no difficulties in distinguishing the Recent representatives of these types because of the structure of the carriers and MI, and because of the arrangement of the jaws in the retracted position. Recognition of both types in Palaeozoic material is more difficult, as in the collection studied there are some intermediate forms between both types (e.g. the Kalloprionidae). Moreover MI, which are smooth in Recent labidognaths and are a good feature distinguishing both groups, are denticulated in all the Palaeozoic genera so far known. The carriers are long and slender in the Recent prionognaths, and short and broad in labidognaths. This is also characteristic of the majority of fossil genera, with the exception of the Kalloprionidae and Polychaeturidae, where the carriers (though unlike each other) are, with regard to their length and slenderness, intermediate between prionognatha and labidognatha patterns.

Neither is the presence or absence of the basal plate a good feature for distinguishing both types as the basal plate occurs in all known Ordovician, Silurian and Devonian prionognatha and labidognatha genera (in *Skalenoprion* KIELAN-JAW. and *Langeites* nov. being fused with the right MI).

[2] HARTMAN (1944) believes that the occurrence of single MIII in the Onuphidae and Eunicidae has been caused by the fusion of maxillary parts MIII and MIV on the right side. As far as the present writer knows, there are no data to support such an interpretation, as no traces of fusion have been preserved in MIII, and no fusion has been observed in the embryological development of the eunicids. Besides, the palaeontological evidence is against such an interpretation, as in the Palaeozoic labidognaths regarded as the ancestral forms of the Recent families in question, MIII is also single.

The above comparison shows that the primary arrangement of the maxillary plates, in both the primitive labidognatha and prionognatha types, was evidently very similar and that is why it is difficult in some cases to attribute fossil genera to one or other group. Not taking into account the forms intermediate between both groups, one can state that the main difference between the Palaeozoic labidognaths and prionognaths concerns the structure of the carriers (which are long and slender in prionognaths and comparatively short and broad in labidognaths), and the structure of MI, which in prionognatha type are usually provided with a hook, much longer than the remaining denticles, whereas in labidognatha type the first denticle is usually insignificantly longer than the remaining ones, which are arranged behind it without any interval. Another difference lies in the fact that the basal plate usually has in prionognatha type a wide base and is subtriangular in shape, while in labidognatha type the basal plate is subrectangular or subtriangular, tapering posteriorly.

However none of the cited characters can be regarded as a good feature for definite assignment of a particular fossil genus to either prionognaths or labidognaths.

PHYLOGENY

(Text-figs. 5—7)

EVOLUTION OF PLACOGNATHA AND CTENOGNATHA TYPES

Comparison of fossil and Recent jaw apparatuses shows that the placognatha and ctenognatha apparatuses are the most primitive Eunicea. It is presumed that the primitive jaw apparatus in pre-Ordovician eunicids first developed as thickenings of pharyngeal cuticule, which were in the form of thin and later thicker chitinous plates. On these plates, folds and ridges subsequently developed and became denticulated ridges.

This primitive type is more or less retained in the placognatha and ctenognatha groups, where the posterior jaws are plate-like, with one or more ridges of denticles, the anterior jaws being developed as series of teeth.

The Ordovician placognatha (Text-figs. 5 *A-D*) and ctenognatha (Text-fig. 5 *F*) apparatuses are constructed according to a similar pattern: carriers are lacking, the posterior part of the apparatus consists of paired MI, a basal plate and laeobasal plate. MI are elongated, plate-like, with the openings of pulp cavities gaping. Basal and laeobasal plates are elongated, adhering to the outer margins of MI, and covering MI somewhat dorsally. In placognatha type MI extend for more than half the length of the apparatus, in front of MI there is a series of anterior teeth; MII, if present, is single right. MIII and MIV have never so far been met with in the placognatha type. The posterior part of jaw apparatus is asymmetrical, the asymmetry concerning mainly the presence of a single right MII, the left MI being consequently longer than the right MI.

The Ordovician ctenognatha apparatuses, in contrary to the placognatha, are subsymmetrical. MI are here almost of the same length, in front of them there are paired MII, and in front of MII — paired MIII. Anterior teeth are here more strongly developed than in placognatha type, extending in two rows on each side, for more than half the length of the apparatus.

In placognatha group one may distinguish two types of jaw apparatuses: *Mochtyella* type — with compound jaws in the posterior part of the apparatus, and *Pistoprion* or *Vistulella* type, with single jaws. It is interesting to compare the jaw apparatuses of these two types,

e.g. that of *Mochtyella cristata* KIELAN-JAW. and *Pistoprion transitans* n. sp. (Text-figs. 5*A*, *B*). The posterior part of the jaw apparatus of *M. cristata* consists of two compound jaws arranged internally, while externally, on either side, there is a row of denticulated teeth, with their bases joined. The anterior part of the apparatus consists of two rows of denticulated teeth, decreasing in size anteriorly. The compound right MI is provided with 3 ridges of denticles, while the compound left MI with 2 ridges. *Pistoprion transitans* n. sp. shows close similarities to *Mochtyella cristata* KIELAN-JAW. The main difference here concerns the fact that instead of two compound jaws arranged internally in the posterior part of *M. cristata*, there are five simple jaws in *P. transitans*, three of which are arranged on the right side, two on the left. The arrangement of these simple jaws in *P. transitans* is identical with the arrangement of the ridges in the compound jaws of *M. cristata*, each simple jaw of *P. transitans* being an equivalent of the denticulated ridge in a compound jaw. The right compound jaw of *Mochtyella cristata*, provided with three ridges of denticles, is regarded here as homologous with the three simple jaws on the right side of *Pistoprion transitans*, the left compound jaw of *M. cristata* is regarded as homologous with the two left simple jaws of *P. transitans*. The anterior part of the apparatus in *P. transitans* is very similar to that in *M. cristata* and consists of subtriangular teeth; also the lateral rows of teeth, characteristic of *M. cristata*, occur in *P. transitans*.

The phylogenetic relations between the types represented by *M. cristata* and *P. transitans* may be interpreted in one of two ways:

1. One may assume that the *Mochtyella* type is more primitive than that of *Pistoprion*. In evolution, the primary compound jaws of *M. cristata* became divided along the furrows between the ridges into two or three simple jaws, giving rise to the apparatus of *Pistoprion* type.

2. One may assume that the compound jaws of *Mochtyella* developed secondarily, through the fusion of simple jaws of *Pistoprion*.

The following facts seem to support the first hypothesis:

The young specimens of *P. transitans* are hardly distinguishable from those of *Mochtyella*, as the simple jaws are in young *P. transitans* almost entirely fused. Similarly in *Vistulella kozlowskii*, where the arrangement of simple jaws is different from that in *Mochtyella cristata*, the simple jaws are also somewhat fused in young specimens. The young stages of *Pistoprion* and *Vistulella* repeat thus the *Mochtyella* stage, and the separation of jaws occurs later in the ontogeny. Moreover three simple jaws, which can move independently of each other, are more effective than a compound jaw with three ridges of denticles.

Within the representatives of *Mochtyella*, there are species with right MI provided with three ridges of denticles: basal ridge, main ridge and second ridge (e.g. *Mochtyella cristata* KIELAN-JAW.), and others with a simpler built MI, provided with only two ridges: basal ridge and main ridge (e.g. *Mochtyella trapezoidea* n. sp.). When one compares some of the mochtyellid species here described, they can be placed in order, in a morphological range, with gradual changes from one species to another in the following way: *Mochtyella cristata* → *Mochtyella* sp. *c* → *Mochtyella* sp. *d* → *Mochtyella trapezoidea*. (In *Mochtyella* sp. *c* the second ridge is present, but it is undenticulated, in *Mochtyella* sp. *d* it is also undenticulated, but shorter than in *Mochtyella* sp. *c*). One cannot be sure whether the morphological line here described is also an evolutionary line and if the morphological changes did not go in the other direction, e.g. from *M. trapezoidea* → to *M. cristata*. As however *M. cristata* occurs in the Middle Ordovician, and *M. trapezoidea* group is known mostly from the Silurian, one can presume that in the evolution of the mochtyellids at that time, the disappearance of the second ridge took place. *M. cristata* cannot however, by any means, be regarded as an ancestor of *M. trapezoidea*. In both the Ordovician and Silurian samples investigated, there are numerous so far undescribed

mochtyellid species, and it is presumed that when all of them are investigated, it will be possible to find more complete morphological lines, showing the evolutionary changes of the discussed structures.

Jaw apparatuses of placognatha type were strongly differentiated in the Ordovician through Devonian, represented by numerous species and genera. This group has not, however, its representatives among the modern eunicids and it appears that it became extinct at the end of Palaeozoic era.

In contrary to the placognaths, the ctenognatha type has survived until modern times. Palaeozoic ctenognatha apparatuses are comparatively poorly known, mostly due to the fact that their delicate apparatuses seldom could be satisfactorily preserved as fossils. In modern seas the ctenognaths are represented by the Dorvilleidae.

The jaw apparatus of Recent *Dorvillea* PARFITT consists of two small, elongated jaws in the posterior part (provided with gaping pulp cavities) and numerous anterior teeth, arranged in longitudinal series, in two parallel rows on each side (comp. EHLERS, 1864—68, and MCINTOSH, 1908—10). The evolution from the Ordovician *Tetraprion* to Recent *Dorvillea*, involved the entire disappearance of basal plate, laeobasal plate, MII and MIII, and a considerable development of series of anterior teeth (Text-figs. 5*E*, *F*).

EVOLUTION OF PRIONOGNATHA AND LABIDOGNATHA TYPES

Labidognatha and prionognatha apparatuses differ from the placognatha and ctenognatha in the presence of the carriers and in having MI and often also the anterior jaws cone-like, with the openings of pulp cavities slightly enclosed or strongly enclosed, whereas in the placognatha and ctenognatha apparatuses MI are plate-like, with gaping openings of pulp cavities. The jaw apparatus in labidognatha and prionognatha type consists of carriers and 5 pairs of jaws, one of which may be in certain forms single, left. Basal and laeobasal plates, developed in all Palaeozoic placognaths and prionognaths as elongated jaws, are here differently shaped, the laeobasal plate being so far known only in *Symmetroprion*, the basal plate present in all the Palaeozoic labidognatha and prionognatha genera is smaller than in placognatha and ctenognatha, subtriangular, in some instances *(Skalenoprion, Langeites)* fused with MI.

The similarities between the placognatha type on the one side, and prionognatha and labidognatha types on the other, concern only the posterior part of the apparatus, the presence of MI and basal and laeobasal plates.

Palaeozoic labidognaths and prionognaths show more similarities to the Ordovician ctenognaths *(Tetraprion)* than to any known placognatha genera. In *Tetraprion pozaryskae* n. sp. in front of the basal plate there is an intercalary tooth, which is characteristic also of some representatives of a labidognath *Polychaetaspis* (Text-figs. 5*F*, *K*). (Both intercalary and laeointercalary teeth are to be found in a placognath *Vistulella kozlowskii* KIELAN-JAW. — Text-fig. 5*C*). In *T. pozaryskae* in front of MI there are paired MII and MIII, regarded as homologous with respective plates in labidognatha and prionognatha genera. In *Tetraprion*, MII and MIII are surrounded by numerous anterior teeth, regarded as homologous with a few lateral teeth occurring in *Polychaetaspis*, *Kozlowskiprion* and *Ramphoprion*.

On the base of the above presented comparison one can assume that all the four recognized types of jaw apparatuses arose from a common ancestor. It is highly probable that the presumable pre-Ordovician ancestral form had jaws provided with gaping openings of pulp cavities, arranged in a pattern similar to that in *Tetraprion* n. gen. The subsequent evolution

of the majority of known labidognatha and prionognatha forms involved changing of the jaws from plate-like into cone-like, development of the carriers, disappearance of the laeobasal plate, development of MIV and MV and the reduction in the number of anterior teeth.

Modern labidognaths are represented by three families: the Onuphidae, Eunicidae and Lumbrineridae (Text-figs. 5*G, H, I*). Jaw apparatuses of the Onuphidae and Eunicidae are constructed according to the same pattern. In both families the carriers are comparatively short, the basal plate is absent, MI is developed as smooth forceps, MII comparatively large, denticulated, MIII single, left, MIV small, denticulated, MV single teeth. Pulp cavities in both MI and MII are strongly enclosed.

The Lumbrineridae differ from the Onuphidae and Eunicidae in having MIII paired, otherwise the jaw apparatus is of the same pattern.

Of six known Palaeozoic labidognath families only the Paulinitidae show strong similarities to the representatives of Recent labidognaths and can be regarded as their possible ancestors. The Paulinitidae have a small opening of the pulp cavity in MI (as is characteristic of modern labidognaths) and a very small basal plate, provided with an undenticulated ridge. The shape of MI and MII in the Paulinitidae is similar to that in modern labidognaths. In particular, the Silurian genus *Langeites* nov. reminds one of the Recent Eunicidae and Onuphidae. MI of *Langeites* are identically shaped with those of the Eunicidae and Onuphidae, the differences concern the disappearance of the denticulation in MI in Recent forms (rudimentary in *Langeites*) and the fusion of the basal plate with right MI. These similarities are still greater in the light of the fact, stated by the present writer, that the remnant ridge of the basal plate occurs in Recent onuphids and eunicids (comp. Text-fig. 6).

An examination of a number of Recent eunicid and onuphid species from the collection of GRUBE, at the Zoological Museum in Wrocław, has shown to the present writer that in all the studied species of Eunicea, at the posterior part of the right MI there are two longitudinal ridges, the right one shorter (*long.*) than the left. In left MI, on the contrary, there is only one longitudinal ridge, which in occlusion bites into the furrow between the two ridges of the right jaw. Within the studied species very prominent ridges in right MI have been found in *Eunice collaris* EHRBG.[3] from Philippines (Text-fig. 6*D*), in *Eunice torquata* QUATREFAGES, *E. cingulata* GRUBE (*?Eunice rousseaui* QUATREFAGES) (Text-fig. 6*C*), both from Adriatic sea, and in others. A comparison of the right and left MI of the above mentioned species with those of *Langeites glaber* n. sp. shows that left and right longitudinal ridges in the representatives of *Eunice* are homologous respectively with the undenticulated ridge and the ridge of the basal plate in *Langeites glaber* n. sp. (Text-fig. 6*A*). Similarly the single ridge in left MI in *Eunice* is homologous with the undenticulated ridge in the left MI in *L. glaber*. In the representatives of *Diopatra* AUDOUIN & MILNE-EDWARDS and *Marphysa* QUATREFAGES a similar arrangement of longitudinal ridges in MI has been also stated, but e.g. in *Diopatra neapolitana* DELLE CHIAJE (Text-fig. 6*B*) the ridges are much shorter than in *Eunice*, being tubercule-like. In the Onuphidae the ridges are less prominent, but still present. In the Lumbrineridae, which have the symmetrical jaw apparatuses, there is no trace of the remnant ridge of the basal plate in right MI.

These comparisons show that the basic type of the jaw apparatus characteristic of the Recent Eunicidae and Onuphidae evolved long ago in the Ordovician or Silurian and the subsequent evolution from the Silurian to Recent involved only small morphological changes:

[3] The old identifications (mostly done by GRUBE) of the Recent eunicids from the Zoological Museum of the University in Wrocław, have not been verified by the present writer.

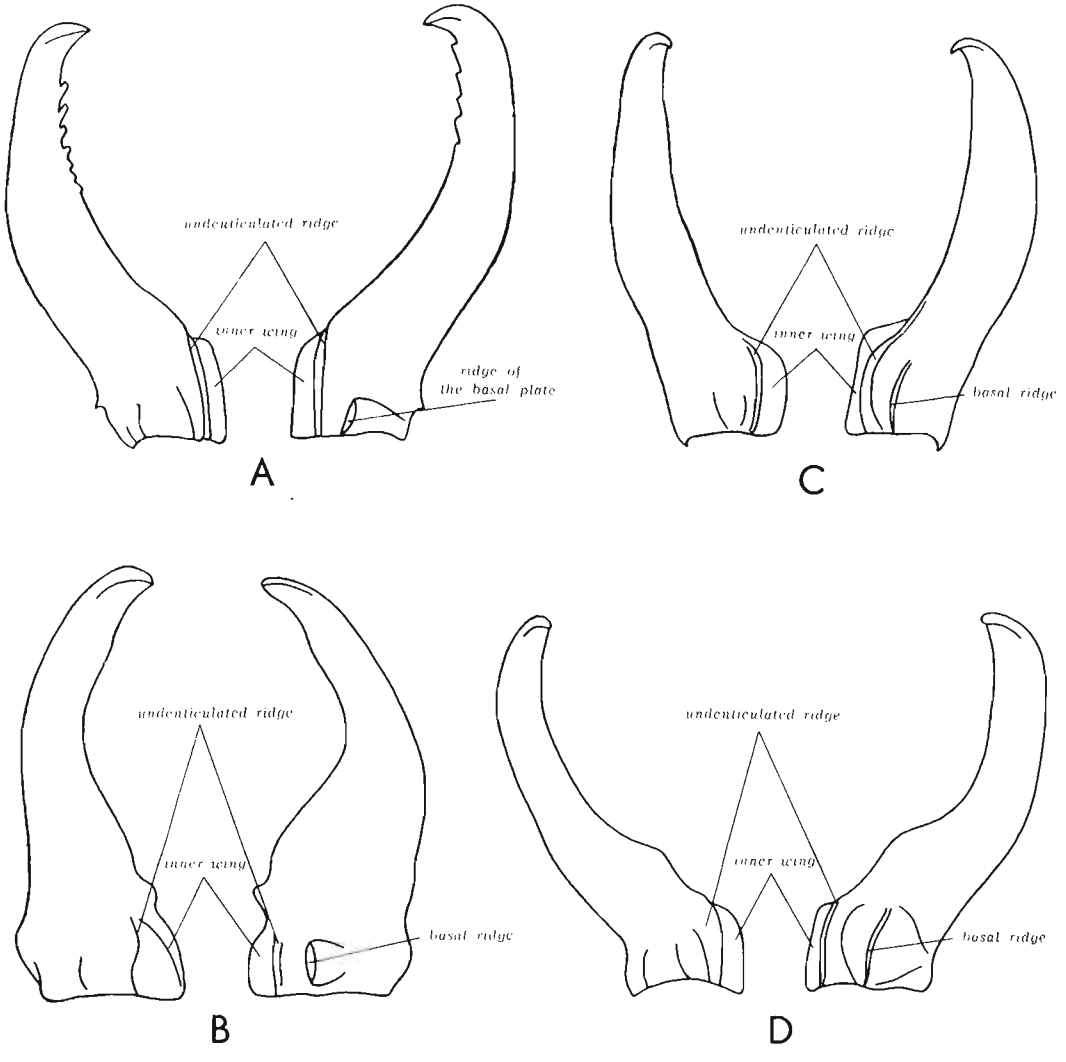


Fig. 6

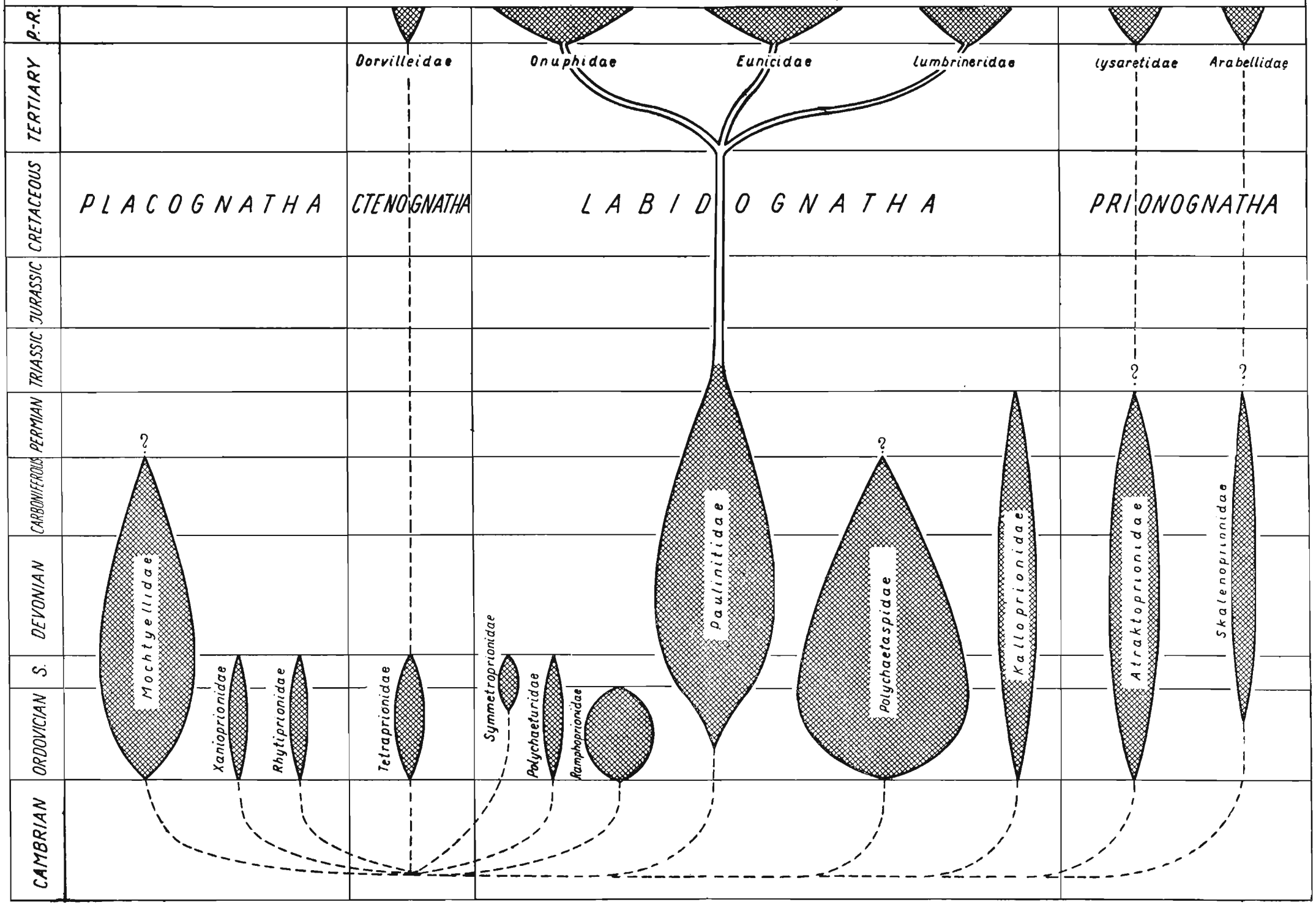
Diagrammatic sketches of the right and left MI in: *A Langeites glaber* n. sp. (Ordovician or Silurian), *B Diopatra neapolitana* DELLE CHIAJE (Recent), *C Eunice cingulata* GRUBE (Recent), *D Eunice collaris* EHRBG. (Recent).

fusion of the basal plate with right MI and the complete disappearance of the denticles in MI

The question arises whether any of the Palaeozoic labidognatha families besides the Paulinitidae may be regarded as possibly ancestral to Recent Lumbrineridae. The symmetrical anterior part of the jaw apparatus (paired MIII) characteristic of the Lumbrineridae has not been found so far in Palaeozoic labidognaths. It is possible to assume that the Lumbrineridae evolved from the Paulinitidae. The evolution in this case involved the disappearance of one jaw on the left side or the appearance of one extra jaw on the right side.

The conclusion to be drawn from the above considerations is that three modern families of labidognatha type arose from the early Palaeozoic Paulinitidae. All the remaining Palaeozoic labidognatha families viz. the Symmetroprionidae, Kalloprionidae, Ramphoprionidae, Polychaetaspidae and Polychaeturidae appear to have no descendants among the modern labidognaths (see Text-fig. 7).

TENTATIVE PHYLOGENY OF THE EUNICEA



S.—Silurian, P.-R. — Pleistocene-Recent

Studies of the evolutionary changes in the labidognatha jaw apparatuses between Ordovician and Recent, assuming that labidognaths arose from primary pre-Ordovician placognaths, allow the author to conclude which characters of the labidognath apparatus are to be regarded as primitive:

Primitive characters:	Advanced characters:
Laeobasal plate present	—
Pulp cavities in MI almost gaping or slightly enclosed	Pulp cavities in MI strongly enclosed
Intercalary tooth present	—
MI tapering posteriorly	MI with transverse posterior margin
Basal plate elongated, large	Basal plate small, about to disappear or lacking
MI denticulated	MI smooth

In the light of the above comparison, one can state that the Symmetroprionidae (Text-fig. 5*J*), which are so far the only labidognatha group with a laeobasal plate present (otherwise known only in placognatha and ctenognatha groups), are very primitive labidognaths.

Long pulp cavities in MI and a comparatively large, elongated basal plate are characteristic of the Polychaeturidae. In the Polychaetaspidae, which are most varied among the lines studied, the openings of pulp cavities in MI vary from being almost gaping (e.g. in *Kozlowskiprion brevialatus* n. sp.) to much smaller in *Polychaetaspis tuberculatus* n. sp., *P. wyszogrodensis* KOZŁ. and others. In all the polychaetaspid species they are, however, longer than half the jaw length. In this family the left MI and the basal plate taper posteriorly.

In the genus *Ramphoprion* the opening of the pulp cavity in MI varies around half the jaw length, and left MI is provided with a transverse posterior margin. Thus *Ramphoprion* seems to be more advanced in this respect than *Polychaetaspis*.

True prionognatha forms are represented by three fossil genera: *Atraktoprion* KIELAN-JAW., *Xanthoprion* n. gen. and *Skalenoprion* KIELAN-JAW. *Atraktoprion* is characterized by long, slender carriers, identical with those occurring in Recent prionognaths, the basal plate is present, MI are falcate with a long hook, MII paired, symmetrical, MIII single, left, MIV small, paired, MV single teeth. An almost identical pattern of jaw apparatus prevails in the Recent family Lysaretidae (comp. Text-figs. 5*N*, *P*), where it occurs e.g. in the genera *Aglaurides* EHLERS and *Halla* COSTA. The same type of maxillary apparatus is, however, also met with in some representatives of the Recent Arabellidae, where it is characteristic of the genus *Notocirrus* SCHMARDA, and also of some species of *Arabella* GRUBE, e.g. *A. geniculata* (CLAPARÈDE). Otherwise the Recent family Arabellidae is characterized by the symmetrical type of jaw apparatuses, without the basal plate and with four to five pairs of jaws (Text-fig. 5*M*). Such symmetrical apparatuses occur in *Drilonereis* CLAPARÈDE, in some species of *Arabella*, e.g. in *A. iricolor* (MONTAGU) and in endoparasitic *Labidognathus* CAULLERY. Lastly, in some genera of both Recent families the maxillary apparatuses are absent or greatly reduced.

The symmetrical type of jaw apparatus, characteristic of the majority of Recent Arabellidae, occurs in Ordovician *Skalenoprion* KIELAN-JAW. (Text-fig. 5 *O*). Unfortunately, *Skalenoprion* is comparatively poorly known. The basal plate is in *Skalenoprion* almost

entirely reduced, fused with the right MI, MI thus being nearly symmetrical, MII are symmetrical, while the remaining jaws and the carriers are unknown.

The reduction of the basal plate, observed in the prionognath Skalenoprionidae, is very similar to that occurring in the labidognath Paulinitidae. In both families the basal plate is almost entirely fused with right MI, being developed as a smooth ridge, MI becoming symmetrical.

It is not impossible that *Skalenoprion*, or forms similar to it, gave rise to Recent prionognatha genera with symmetrical jaw apparatuses. It is difficult to find the direct Palaeozoic ancestors of all the Recent prionognaths, one may however presume that the Lysaretidae, with prevailing asymmetrical type of jaw apparatuses, arose from the Ordovician *Atraktoprion*, whereas the Arabellidae, in which the symmetrical type of jaw apparatuses prevail, as a rule arose from *Skalenoprion*.

Lastly, the Ordovician family Kalloprionidae, which includes the genera *Kalloprion*, *Leptoprion* and *Euryprion*, displays some features intermediate between the prionognatha and labidognatha types, showing that both lines derive from common ancestors. None of the Recent labidognaths or prionognaths are regarded as probable descendants of the Kalloprionidae, but the representatives of this family (comp. p. 113) occur in the Devonian and Permian of Europe and North America.

CONCLUSIONS

The above considerations allow the author to draw the tentative phylogenetic tree of polychaete jaw apparatuses in Eunicea from Ordovician to Recent (Text-fig. 7).

Compound jaws, provided with one or more ridges of denticles and with gaping pulp cavities, occur in placognatha apparatuses and are regarded as primitive (e.g. in *Mochtyella*). It is accepted that the evolution from *Mochtyella* to *Pistoprion* involved the dividing of a compound jaw into simple jaws. On the other hand, the compound jaws occur also in more advanced types of jaw apparatuses in the genera *Langeites* and *Skalenoprion*, where right MI (with enclosed pulp cavity) is fused with the remnant basal plate, thus becoming a compound jaw. In this case, contrary to the evolutionary line *Mochtyella* — *Pistoprion*, fusion of the jaws took place, so causing the disappearance of one jaw. In neither case are there any embryological data to favour one interpretation above the other, however careful morphological observation, and comparison of fossil forms with Recent ones, led the author to the conclusion that in the evolution of the jaw apparatuses in Eunicea, both fusion and division of maxillary plates may have taken place.

An especially intriguing fact and one difficult to understand is that only very few traces of scolecodonts have so far been reported from Mesozoic and Tertiary deposits in spite of the extensive micropalaeontological researches in these beds.

If one takes into consideration the fact that modern polychaete annelids are a highly successful and abundant group occurring in waters of all latitudes, and that the scolecodonts are very common microfossils in the Palaeozoic sediments, their rarity in Mesozoic and Tertiary formations appears at first sight mysterious.

The present investigation seems to shed some new light on this question. Though, among the modern annelids, the proboscidial armature occurs in several families, practically only the Eunicea give the opportunity for the jaws to be preserved and identified in the fossil state. A comparison of early Palaeozoic eunicid jaw apparatuses with Recent ones shows that the Palaeozoic eunicids have been much more differentiated and probably more abundant than

the Eunicea are today. Eighteen eunicid Ordovician and Silurian genera are described in the present paper. To judge from the diversity of isolated jaws which remain for the time being undescribed in the author's collection and from the differentiation of the detached jaws described in the scolecodont literature, it appears that the 18 genera represent but a small fraction of all the eunicid genera which lived in early Palaeozoic. Of 18 described genera, only four (*Skalenoprion* KIELAN-JAW., *Atraktoprion* KIELAN-JAW., *Langeites* n. gen. and *Tetraprion* n. gen.) may be regarded as possible ancestors (or related to possible ancestors) of modern families.

Three modern labidognatha families: the Onuphidae, Eunicidae and Lumbrineridae, arose from the Palaeozoic Paulinitidae. The large majority of jaws in Ordovician and Silurian samples investigated by the present writer, belong to the Polychaetaspidae. This family appears to have no descendants among modern eunicids. The same applies to the Palaeozoic Symmetroprionidae, Polychaeturidae and Kalloprionidae. The not numerous Recent family of the Dorvilleidae appears to be the only descendant of the highly abundant (though poorly recognized so far) ctenognatha genera. All Palaeozoic placognatha genera have become entirely extinct.

Lastly, from the Atraktoprionidae, comparatively rare in Ordovician time, arose the Recent Arabellidae and Lysaretidae.

The large majority of Palaeozoic eunicid lines, after their "virescence period" in the Ordovician-Devonian, have disappeared without any descendants. The palaeontological record of these groups is far too small to draw any conclusion as to when major extinction took place. If one however presumes that it occurred successively in the second half of the Palaeozoic era, simultaneously with the successive extinction of trilobites, numerous brachiopod lines, graptolites and others marine invertebrates — the pattern of eunicid evolution obtained would explain the enigmatic lack of scolecodonts in Mesozoic and Tertiary deposits.

Another reason, which may help to explain the scarcity of scolecodonts in Mesozoic and Tertiary formations is that as in the case of Palaeozoic deposits, the Mesozoic marly limestone has so far been dissolved in acids only on a very limited scale. The writer believes that if more Mesozoic and Tertiary marly limestones are dissolved in acids in search of chitinous microfossils, our knowledge of eunicid evolution during that time will be greatly increased.

MOULTING OF JAW APPARATUSES

(Plate I, figs. 1—2)

Although the development of numerous Recent species of polychaete annelids has been studied, observations on the ontogeny of the jaw apparatuses have been made only rarely. The larval jaws of the Onuphidae, Eunicidae and Lumbrineridae have been mentioned or described by KROHN and SCHNEIDER (1867), CLAPARÈDE and METSCHNIKOV (1869), WILSON (1882), BORRADAILE (1901), MONRO (1924), HERPIN (1926), AIYAR (1930), KRISHNAN (1936), OKUDA (1946), ALLEN (1951, 1953, 1959) and others. The common feature of jaw development in all the studied cases is the sequence of the appearance of particular elements: first to appear are the mandibles, then MII and MIII, and later the carriers, MIV, MV and lastly MI.

As far as the writer knows there are no observations on the development of jaw apparatuses in the Arabellidae and Lysaretidae. With regard to the Dorvilleidae, the embryology of *Ophryotrocha puerilis* CLAPARÈDE & METSCHNIKOV has been studied by various authors; KORSCHELET (1893) and BONNIER (1893) dealt with the jaw development in detail. Both authors observed that in the ontogeny of this species occasionally occurs the biramous type of maxillae,

different from that which usually occurs in *O. puerilis*. KORSCHELET has regarded these biramous jaws as an example of atavism (Rückschlag). BONNIER on the contrary was of the opinion that the biramous jaws represent the mode of growth. As a new (posterior) branch appears, the individual loses the older one (anterior). Unfortunately, as the jaw apparatus of *Ophryotrocha* differs strongly from those in other Eunicea, the observations on its mode of growth cannot be relevent for understanding the mode of growth of other eunicid lines.

Only few and inaccurate observations have been made on the growth of the jaws, once they are complete. EHLERS (1864—68) stated that in one adult specimen of *Eunice harassii* AUDOUIN & MILNE-EDWARDS, the jaws were entirely transparent, white, soft and vesiculate, and interpreted this as a result of the moulting process. Similarly HERPIN (1926) when describing the larval development of *Eunice harassii*, and recording great differences in the jaw apparatus of the larval and adult forms, stated (p. 140): "De telles modifications dans des pièces chitineuses éveillent l'idée d'une mue". HEIDER (1922, 1924) studied the change of the jaws in *Dorvillea*, recorded by him as *Staurocephalus*, and observed that this occurs in a different way than in *Eunice*. The difference has been summarized by him as follows (1924, p. 259): "Im einzelnen besteht zwischen dem Zahnersatz bei *Staurocephalus* und bei *Eunice* der Unterschied, dass bei ersterer Form die neuen Zähnchen in förmlichen Zahnsäckchen unter den alten Zähnen ausgebildet werden, nach deren Verlust sie offenbar sofort emporrücken, während bei Eunice nach der Abwerfung der alten Kiefer die neuen erst gebildet werden müssen".

The present writer has seen in the collections of the British Museum (Natural History) one specimen from Capetown (B.M. No. 1959. 4. 1. 95) determined by DAY as *Aglaurides fulgida* and then reidentified by Dr. N. TEBBLE, during the writer's stay in the Museum, as belonging to *Halla parthenopeia* DELLE CHIAJE. This specimen has soft, brown jaws, without the rows of additional chitinous plates, usually occurring on both sides of the jaws in *Halla parthenopeia*. Within 15 specimens of the same species from the Gulf of Naples, examined by the present writer, one figured on Plate I, fig. 4, has the jaw apparatus incompletely differentiated (Z.Pal. No.An.H.13). The carriers and additional lateral plates are lacking. Only the denticulated ridges of individual jaws are brown and prominent, otherwise the shape of the jaws is not defined, and they are not differentiated from the transparent cuticular layer which covers the stomodeum. A completely formed jaw apparatus of the same species is figured on Plate I, fig. 5 for comparison.

The above discussed specimens of *Halla parthenopeia* with soft and incompletely differentiated jaw apparatuses, as well as the specimen of *Eunice harassii* described by EHLERS, are recognized by the present writer tentatively as a result of the moulting process. This however is only indirect evidence of the moulting of the jaw apparatuses and as far as the writer knows, the true moulting process has so far not been observed in Recent Eunicea.

Within the numerous representatives of Ordovician and Silurian labidognatha and prionognatha species described in the present paper, the writer has examined jaw apparatuses or detached jaws (MI), which show a considerable range in size. For example, in *Paulinites polonensis* n. sp. the length of MI vary between 0.2 mm. and 2 mm., in *Langeites glaber* n. sp. between 0.81—3.25 mm. and in *Polychaetaspis tuberculatus* n. sp. between 0.37—2.10 mm. The smallest jaws are, however, entirely formed and, as a rule, of the same pattern as the largest ones, and do not bring any new data on the mode of growth of the jaw apparatuses in these types. No evidence of moulting in labidognatha and prionognatha types has been offered by fossil material.

In contradistinction to the fossil labidognatha and prionognatha apparatuses there is some evidence of moulting in placognatha type. In the collection of jaw apparatuses and de-

tached jaws of placognatha type studied in the present paper, sporadically specimens have been found consisting of two jaws of identical shape, arranged one under the other in the form of a cone in cone. Half a dozen of such specimens (mostly single jaws) were found, two of them are figured on Plate I, figs. 1 and 2.

The specimen figured on Plate I, fig. 1, is an incomplete apparatus of *Mochtyella cristata* KIELAN-JAW. consisting of right and left MI, somewhat depressed, joined together, each having a jaw of similar shape in the pulp cavity. The apparatus is brown-yellowish, somewhat transparent and the denticulated ridges of the incipient jaws are clearly seen in the photograph taken in a transmitted light.

Specimen figured on Plate I, fig. 2, is the left MI of *Mochtyella* sp. with an incipient jaw in the pulp cavity.

The above described examples show that the jaw apparatuses of *Mochtyella* and probably of all the representatives of placognatha type underwent a process of moulting.

SYSTEMATIC PART

Superfamily **EUNICEA** GRUBE

Family MOCHTYELLIDAE nov.

Diagnosis. — Asymmetrical jaw apparatuses of placognatha type, consisting of jaws with gaping openings of the pulp cavities in the posterior part and two rows of teeth in the anterior part. Series of lateral teeth forming two chains on both sides of the posterior part of the apparatus are, as a rule, present (unknown in *Vistulella*). Carriers lacking. Basal and laeobasal plates are elongated jaws, shorter (*long.*) than MI; MII if present is single right. Intercalary and laeointercalary teeth sometimes present. In *Mochtyella* posterior part consists of compound jaws, in *Vistulella* and *Pistoprion* of simple jaws.

Discussion. — The family is erected to include the genera: *Vistulella* KIELAN-JAW., 1961, *Mochtyella* KIELAN-JAW., 1961, and *Pistoprion* nov. The differences between the here attributed genera are comparatively great, and concern in the first place the occurrence of compound jaws in the posterior part of the apparatus of *Mochtyella*, while in *Pistoprion* and *Vistulella* instead of two compound jaws there are respectively five and six simple jaws. The differences between some representatives of the genera in question, e.g. *Mochtyella trapezoidea* n. sp. and *Vistulella kozlowskii* KIELAN-JAW. are very great indeed and a case could be made for their attribution to separate families. However the structure of *Pistoprion* n. gen., which in some respects is intermediate between the genera *Mochtyella* and *Vistulella*, indicates a close relationship of the here assigned genera. The parataxonomic species, regarded as congeneric with *Mochtyella* or *Vistulella*, described by HINDE (1879, 1880), STAUFFER (1933, 1939), ELLER (1941*b*, 1942, 1944, 1945, 1946, 1955) from the Ordovician-Devonian of North America and Europe, have been previously discussed by the present writer (KIELAN-JAWOROWSKA, 1961). In addition, some representatives of the parataxonomic genus *Staurocephalites*, considered as congeneric with *Vistulella* or *Pistoprion* have been described recently by ELLER (1964) from the Devonian of Ohio.

Genus **MOCHTYELLA** KIELAN-JAWOROWSKA, 1961

Type species: Mochtyella cristata KIELAN-JAWOROWSKA, 1961.

Diagnosis. — Jaw apparatus consisting of two compound jaws in the posterior part (right and left MI), chains of lateral teeth covering somewhat MI dorsally and 5—8 pairs of anterior teeth. Right MI provided, as a rule, with three ridges of denticles: basal ridge, main ridge and second ridge. Basal ridge denticulated or smooth, main ridge denticulated, second

ridge denticulated, smooth or lacking. Left MI provided with two ridges of denticles: laeobasal ridge and main ridge. Laeobasal ridge longer than the basal ridge.

Species:

Group of *Mochtyella cristata*
- *Mochtyella cristata* KIELAN-JAW.
- *Mochtyella polonica* n. sp.
- *Mochtyella* sp. *a*
- *Mochtyella* sp. *b*

Group of *Mochtyella trapezoidea*
- *Mochtyella trapezoidea* n. sp.
- *Mochtyella* sp. *c*
- *Mochtyella* sp. *d*

Stratigraphic and geographical range. — Ordovician-Carboniferous; Europe, North America. It has been stated by the present writer (KIELAN-JAWOROWSKA, 1961) that *Mochtyella* is restricted to the Ordovician. However, further investigations have shown that some representatives of *Mochtyella* (the *M. trapezoidea* group) occur in presumable Silurian boulders. Moreover, *Staurocephalites alterostris* ELLER and *S. aequilateralis* ELLER, described by SYLVESTER (1959) from the Upper Devonian and Mississippian of Central Missouri, are in the light of the present investigations probably compound right MI of *Mochtyella* sp. (*M. trapezoidea* group). To judge from SYLVESTER's figures (l. *c.*, Plate 6, figs. 27 and 32) they are provided with basal ridges. The original specimens of *S. aequilateralis* ELLER and *S. alterostris* ELLER, described by ELLER (1955) from the Devonian of Michigan, are — as it appears from ELLER's figures — simple jaws, and so cannot be regarded as congeneric with *Mochtyella*.

Discussion. — *Mochtyella* KIELAN-JAWOROWSKA differs from the remaining representatives of the Mochtyellidae in having compound jaws in the posterior part of the apparatus, whereas in *Vistulella* and *Pistoprion* the posterior part consists of simple jaws (comp. Text-figs. 5*A*, *B*, *C*). The right compound jaw of *Mochtyella*, provided with three ridges of denticles (in *M. trapezoidea* two ridges), is regarded as homologous with the three simple right jaws of other genera, basal ridge being homologous with the basal plate, main ridge with right MI, and the second ridge with right MII. Similarly left MI of *Mochtyella* is regarded as homologous with the two simple left jaws of *Pistoprion* and *Vistulella*, laeobasal ridge being homologous with the laeobasal plate and the main ridge with left MI.

Within the representatives of *Mochtyella* the writer has recognized two groups of species. In the *Mochtyella cristata* group, MI are comparatively flat, right and left slopes of both MI moderately steep, while in the *M. trapezoidea* group MI are strongly compressed laterally, provided with very steep slopes, in lateral views wide and subtrapezoid. In both groups there is a tendency in the right MI towards the disappearance of some ridges. In the first group of species, the most prominent ridges in right MI occur in the Middle Ordovician *Mochtyella cristata*. In *Mochtyella polonica* both the basal ridge and second ridge are denticulated and distinct, but comparatively shorter than in *M. cristata*. In *Mochtyella* sp. *a*, the basal ridge is developed as an undenticulated ridge, while the second ridge is denticulated, but is very short. Lastly, in *Mochtyella* sp. *b*, the second ridge is smooth, developed as a fold at the anterior part of the jaw, while the basal ridge is almost smooth, only very indistinctly crenulated. Unfortunately, the stratigraphic ranges of *Mochtyella polonica* and *Mochtyella* sp. *a* are unknown. As *Mochtyella* sp. *b* is presumably of Silurian age, one can tentatively assume that the observed morphological changes are in accordance with the stratigraphic succession. The representatives of the *Mochtyella trapezoidea* group are presumably of Silurian age. Here the

reduction of particular ridges was greater than in the *M. cristata* group. In *Mochtyella* sp. *c*, the second ridge is developed as a longitudinal, comparatively long, straight, smooth ridge, while the basal ridge is denticulated. In *Mochtyella* sp. *d*, the second ridge is smooth, but shorter than in *Mochtyella* sp. *c*, and basal ridge indistinctly crenulated. Lastly, in *M. trapezoidea*, the second ridge is lacking and the basal ridge is almost smooth (see also p. 43).

Mochtyella cristata KIELAN-JAWOROWSKA, 1961

(Plate I, fig. 1; Text-fig. 5*A*)

1961. *Mochtyella cristata* n. sp.; Z. KIELAN-JAWOROWSKA, On two Ordovician polychaete..., p. 248, Pls. 5—7.

Discussion. — *Mochtyella cristata* has been described in detail by the writer in 1961, and its jaws were numbered by Arabic numerals. The new notations for individual jaws are identical with those given for *M. polonica* on Text-fig. 1*A*. According to the present investigations, *M. cristata* is restricted to the Middle Ordovician (?Kukruse Stage or Idavere Stage of Estonian sequence).

Mochtyella polonica n. sp.

(Plate III, fig. 1; Text-fig. 1*A*)

Type specimen: Incomplete jaw apparatus: right and left MI, incomplete chain of left lateral teeth and 8 left anterior teeth, No. O.344/1, figured on Plate III, fig. 1.

Type horizon and locality: Erratic boulder No. O.344 of unknown age (Ordovician or Silurian), Mochty, province of Warsaw.

Derivation of the name: polonica — occurring in Poland.

Diagnosis. — MI pointed anteriorly. In right MI: basal ridge minutely denticulated, extending for 0.17 of jaw length, second ridge arranged in front of mid-length of the jaw, convex outwards, equal to 0.18 of jaw length, with very small denticles. In left MI: laeobasal ridge extending for less than half of jaw length. Right MI shorter *(long.)* than the left MI. Unestablished (?9) number of smooth, slender, lateral teeth, arranged into chains. Unestablished (?8) number of anterior teeth decreasing in size anteriorly. First anterior tooth fits tightly into the anterior margin of MI, remaining ones fitting each other tightly for half their lengths. Openings of pulp cavities of the anterior teeth subrectangular.

Denticle formula:

Left MI:		Right MI:	
Laeobasal ridge	11	Basal ridge	9
Main ridge	12	Main ridge	10—13
		Second ridge	7

Material. — In addition to the type specimen, there is one incomplete jaw apparatus from the boulder No. O.344 and one right MI with fragmentary anterior teeth from the boulder No. O.430. Age of both boulders unknown (Ordovician or Silurian).

Description. — Length of MI varies between 0.6—1.0 mm.

Right MI in dorsal view is a strongly elongated jaw, four times longer than wide, with pointed anterior margin. Outer and inner margins are directed subposteriorly, posterior margin rounded. A series of 10—13 denticles decreasing in size posteriorly extends along the mid-line

of the jaw. In front of the first denticle there is a subtriangular area, directed obliquely downwards. Basal ridge is very narrow and faint, provided with 9 indistinct, very small denticles. The length of the basal ridge is 0.17 that of the jaw. To the rear of the last denticle of the basal ridge there is a short, undenticulated ridge, directed postero-medially towards the main ridge. The second ridge is arranged on the left slope, just in front of mid-length of the jaw. It is directed subposteriorly, somewhat convex outwards. The length of the second ridge is 0.18 that of the jaw. It is provided with 7 denticles, which are longer and more distinct than those of the basal ridge.

In the type specimen (Plate III, fig. 1*j*), the right margin of the right MI is poorly defined, and the jaw gradually passes into a strip of cuticule which is attached to it.

In left lateral view, the jaw is longer distally than proximally, the anterior margin being directed postero-medially, the main ridge running subparallel to the outer margin, the posterior margin being rounded. The second ridge appears in this view straight, directed posteriorly. In right lateral view, the anterior and outer margins are prolonged anteriorly into a pointed end, the anterior margin is directed obliquely postero-medially, main ridge running subparallel to the outer margin, posterior margin being rounded. Basal ridge is directed subposteriorly, arranged closer to the outer margin than the main ridge.

In ventral view: along the middle of the jaw there is a furrow with deep pits associated with the denticles of the main ridge; the furrows associated with the basal and second ridges are narrow and shallow.

Left MI is somewhat longer than the right MI. In dorsal view its anterior part is slightly bent outwards. A series of 12 denticles, decreasing in size posteriorly, extends nearly the full length of the jaw. To the rear of the last denticle there is a small, flat space. The laeobasal ridge is longer than the basal ridge, provided with 11 denticles. The denticles of the laeobasal ridge are longer than those of the second and basal ridges. The laeobasal ridge extends for almost half of the jaw length. In the type specimen (Plate III, fig. 1*b*) in front of the laeobasal ridge there is an irregular strip of the cuticule, attached to the jaw. In right lateral view, the anterior margin is directed obliquely postero-medially, the jaw somewhat tapering posteriorly, the posterior margin being rounded. On the right slope there are some longitudinal thread-like lines. In left lateral view the anterior margin is directed obliquely, the jaw tapering somewhat posteriorly, the posterior margin rounded. In ventral view, the boundary between the furrows of the main ridge and laeobasal ridge is developed as a prominent rounded ridge. The laeobasal ridge is more distinctly separated from the main ridge, than individual ridges in the right MI.

Lateral teeth: In the type specimen, an incomplete left chain of lateral teeth is preserved, adhering to the left slope of left MI, in front of the basal ridge. Nine lateral teeth are preserved in this chain. They are comparatively long, subtriangular, adhering to each other at their bases. Some imperfectly preserved lateral teeth have also been preserved in specimen No. O.344/2; the exact number of lateral teeth is unknown.

Anterior teeth are preserved in the type specimen, associated with left MI. They are comparatively large teeth, decreasing in size anteriorly. The first tooth from behind fits tightly into the anterior margin of the left MI (comp. Plate III, fig. 1*d*), the remaining ones fitting each other tightly at outer margins for half the length of the teeth, the tips remaining free. In ventral view (comp. Plate III, fig. 1*c*) one can see wide subrectangular openings of pulp cavities of particular teeth. The exact number of teeth is undefined (?8).

Discussion. — *Mochtyella polonica* n. sp. differs from *M. cristata* KIELAN-JAW. in having both right and left MI more strongly pointed anteriorly, and in having smaller and less prominent basal and second ridges in right MI. The greatest similarities concern the left MI which, however,

has a laeobasal ridge comparatively smaller and not so distinctly separated from the main ridge. Further differences concern the lateral teeth, which in *M. polonica* are smooth and more elongated, while in *M. cristata* they are denticulated. The number of anterior teeth is not established in any of the here discussed species, but it appears that there were 5 pairs of anterior teeth in *M. cristata* and ?8 in *M. polonica*. Anterior teeth of *M. polonica* are smooth, and in *M. cristata* denticulated.

Mochtyella sp. **a**

(Plate IV, fig. 1)

Material. — Single right MI, No. O.178/10, from the erratic boulder No. O.178 of unknown age (Ordovician or Silurian), Mochty, province of Warsaw.

Description. — Right MI is an elongated jaw, 0.7 mm. long, which slightly widens posteriorly in dorsal view. Anterior margin is pointed, outer and inner margins subparallel, posterior margin rounded, notched opposite the left slope. In main ridge there are 18 denticles decreasing in size posteriorly. Basal ridge is undenticulated, prominent, directed posteriorly, extending for 0.21 of jaw length up to the posterior margin. Between the basal ridge and the posterior part of the main ridge there is a deep, longitudinal furrow, delimited on the left side by a sharp, longitudinal edge. Second ridge extends in the middle of the anterior half of the left slope, for a distance of 0.2 of the jaw length. It is directed subposteriorly and expressed only by the presence of 9 minute denticles. In right lateral view, the distal part is strongly elongated anteriorly into a pointed end, the anterior margin being directed obliquely postero-medially. The boundaries between the denticles in the anterior part of the jaw are prolonged onto the right slope. The basal ridge and posterior furrow are very prominent. In left lateral view the distal part is strongly prolonged anteriorly, the main ridge subparallel to the outer margin, posterior margin directed transversally. In ventral view the furrow of pits associated with the denticles of the main ridge runs along the mid-line of the jaw, the furrows associated with the basal and second ridges are very faint.

Discussion. — *Mochtyella* sp. *a* differs from *M. polonica* n. sp. in having the basal ridge undenticulated and associated with the furrow on its left side, and in the presence of an edge close to the posterior part of the dentary. The second ridge is arranged more anteriorly than in *M. polonica* and is somewhat longer.

Mochtyella sp. **b**

(Plate IV, fig. 2; Plate V, fig. 4)

Material. — Several isolated right MI from the boulders Nos. O.441 and O.466. Age of the boulder O.441 is determined tentatively as Silurian.

Description. — Length of the right MI varies between 0.7 and 1.9 mm. Right MI in dorsal view narrows posteriorly. Anterior margin is arched. Outer and inner margins converge somewhat posteriorly, being slightly incurved in the middle of the jaw length. Posterior margin is rounded, with a notch opposite the left slope. A series of 16—18 denticles, decreasing in size posteriorly, extends along the middle of the jaw. To the rear of the last denticle there is a prominent rounded ridge, directed postero-laterally. Basal ridge is equal to 0.18—0.20 of the jaw length. It is prominent, directed subposteriorly, somewhat convex outwards, indistinctly

crenulated or undenticulated. Between the basal ridge and the posterior part of the main ridge there is a longitudinal furrow, delimited on the left side by a sharp edge. Second ridge is very small and indistinct, developed as a short fold on the left slope, directed postero-laterally. In the left lateral view the anterior margin is pointed, posterior margin directed transversally, outer margin subparallel to the main ridge, basal ridge very prominent. In left lateral view, the second ridge is more visible than in dorsal view, the posterior margin broadly rounded. In ventral view, the furrow with pits associated with the denticles of the main ridge, is deep and distinct, the furrows associated with the basal and second ridges are very faintly marked.

Discussion. — *Mochtyella* sp. *b* differs from *M. polonica* n. sp. in having a smooth and indistinct second ridge, developed as a short, obliquely arranged fold and in having an indistinctly crenulated or undenticulated basal ridge. It reminds one of *Mochtyella* sp. *a* in the structure of the basal ridge, but differs from the latter in having a differently shaped second ridge and a somewhat different outline of the right MI (narrowing posteriorly).

Mochtyella trapezoidea n. sp.

(Plate V, figs. 1-3)

Type specimen: Joined right and left MI, separated, while they were being drawn, No. O.178/15, figured on Plate V, fig. 1.

Type horizon and locality: Erratic boulder No. O.187, ascertained tentatively as Silurian, Mochty, province of Warsaw.

Derivation of the name: Gr. *trapeza* — a four legged table, *trapezoidea* alludes to the subtrapezoid shape of the right and left MI in inner lateral views.

Diagnosis. — Right and left MI strongly compressed laterally with steep slopes. In inner lateral views both right and left MI narrowing posteriorly, with straight anterior margins directed postero-medially. Basal ridge equal to 0.28 of the jaw length, undenticulated or indistinctly crenulated. Second ridge lacking. Laeobasal ridge prominent, denticulated, equal to half the length of left MI. Anterior teeth imperfectly known, provided with two tips.

Denticle formula:

Left MI:	Right MI:
Laeobasal ridge 9	Basal ridge indistinctly crenulated
Main ridge 12	Main ridge 12—13

Material. — In addition to the type specimen, joined right and left MI have been found in the boulder O.439, and isolated right and left MI in the boulders O.187, O.159, O.301 and O.466 (with fragmentary anterior teeth).

Description. — Length of the right MI of the type specimen is 0.78 mm., length of the isolated right and left MI varies between 0.6—1 mm.

Right MI is a jaw strongly compressed laterally, comparatively narrow in dorsal view, wide in right and left lateral views. In dorsal view the jaw is rounded anteriorly, outer and inner margins are directed posteriorly, subparallel, the posterior margin is directed transversally. First denticle is longer than the remaining ones, which decrease in size posteriorly. A series of denticles decreasing in size towards the posterior, extends for 0.9 of the jaw length. First denticle is definitely longer than the remaining ones. To the rear of the last denticle a short

(*long.*) ridge runs up to the posterior margin. Basal ridge is equal to 0.25 of the jaw length, very prominent, smooth or indistinctly crenulated. Between the basal ridge and the posterior part of the main ridge, there is a very deep furrow. Second ridge is lacking. In left lateral view the jaw is very wide in the anterior part and tapers somewhat posteriorly. The anterior margin is straight, directed postero-medially, posterior margin rounded. In right lateral view the jaw is similarly shaped as in left lateral view, to the rear of the first denticle the jaw is somewhat deepened, basal ridge is directed subposteriorly, very prominent. In ventral view the opening of the pulp cavity is comparatively narrow, the pulp cavity very deep, the furrow associated with the basal ridge well visible.

Left MI is somewhat longer than the right MI, strongly compressed laterally. In dorsal view, the anterior margin is arched, outer and inner margins run subparallel, converging somewhat posteriorly, the posterior margin rounded. A series of 12—13 denticles extends along the mid-line of the jaw. First denticle is the longest and twisted out of alignment with the other denticles. To the rear of the last denticle, a rounded ridge runs up to the posterior margin. The length of this ridge is equal to 0.14 that of the jaw. The laeobasal ridge, provided with 9 denticles, extends for half of the jaw length. In right lateral view the jaw is similarly shaped as the left MI, wide anteriorly, tapering posteriorly with straight, anterior margin directed postero-laterally, posterior margin rounded. In left lateral view the laeobasal ridge and posterior part of the main ridge are arranged parallel, the base of the first denticle is prolonged as a rounded ridge along the anterior margin. To the rear of the first denticle the jaw is somewhat deepened. In ventral view the opening of the pulp cavity is comparatively narrow, the pulp cavity very deep, the furrows associated with the main and laeobasal ridges well defined, separated by a rounded ridge.

Anterior teeth: In the pulp cavity of the right MI of specimen No. O.466/1, figured on Plate V, fig. 3, three (third one broken off) anterior teeth are housed. They are poorly preserved, one may, however, recognize that they are comparatively long. Each tooth is provided with one longer and one (or two) shorter tips.

Discussion. — *Mochtyella trapezoidea* n. sp. differs from *M. cristata* and *M. polonica* in the first place in the shape of the right and left MI, which are strongly compressed laterally, in the presence of an undenticulated basal ridge and in the lack of the second ridge. In the shape of right MI *M. trapezoidea* recalls the imperfectly known species, described here as *Mochtyella* sp. *c* and *Mochtyella* sp. *d*, differing from them only in details (comp. pp. 43 and 59).

Mochtyella sp. **c**

(Plate IV, fig. 3)

Material. — Isolated right MI from the boulders O.301, O.308 and O.442; the boulders No. O.308 and O.442 are presumably of Silurian age.

Description. — Length of the right MI varies between 0.8 and 3.0 mm. Right MI is a jaw strongly compressed laterally, provided with 13—17 denticles in the main ridge, and 8 denticles in the basal ridge. Basal ridge extends for 0.23 of the jaw length. The second ridge is developed as an undenticulated, straight, very narrow ridge, extending for 0.3 of the jaw length. Anterior margin is arched, posterior one provided with a notch opposite the left slope and a rounded process in the prolongation of the dentary. In some specimens the denticles of the basal ridge are worn, while the second ridge is indistinctly crenulated. In lateral views the jaw is very wide anteriorly, somewhat tapering posteriorly, anterior margin is straight, directed postero-

medially. In ventral view, the furrows associated with the main and basal ridges are distinctly separated.

Discussion. — *Mochtyella* sp. *c* reminds one of *M. trapezoidea* n. sp. in having MI strongly compressed laterally. It differs from *M. trapezoidea* in having a longer and denticulated basal ridge and in the presence of a comparatively long, undenticulated second ridge, which is lacking in *M. trapezoidea.*

Mochtyella sp. **d**

(Plate IV, fig. 4)

Material. — Isolated right MI from the boulders Nos. O.98, O.410 and O.446. Age of the boulder O.410 has been recognized as Silurian (Lower Ludlow).

Description and comparisons. — Right MI is similar to *M. trapezoidea* and *Mochtyella* sp. *b*, but differs from *M. trapezoidea* in the presence of a short second ridge, extending for 0.14 of the jaw length and in the presence of a shorter basal ridge. From *Mochtyella* sp. *c* it differs in having a definitely shorter second ridge and indistinctly crenulated basal ridge. It is wider in relation to the length than MI of *M. trapezoidea* and *Mochtyella* sp. *c*.

Genus **Pistoprion** nov.

Type species: Pistoprion transitans n. sp.
Derivation of the name: Gr. *pistos* — authentic, pure, *prion* — a saw.

Diagnosis. — Jaw apparatus consisting of a basal plate, laeobasal plate, right and left MI, single right MII, about 8 pairs of anterior teeth and poorly known chains of lateral teeth. Intercalary tooth present, laeointercalary tooth (in the type species) lacking. Basal plate extending for 0.2—0.5 of the length of the right MI, arranged in an incurvature of the outer margin of right MI. Laeobasal plate longer than the basal plate. Left MI equal in length to a joined right MI and MII.

Stratigraphic and geographical range. — Known from the erratic boulders of unknown age (Ordovician or Silurian) of Poland.

Species:

Pistoprion transitans n. sp.
Pistoprion sp. *a*
Pistoprion sp. *b*
Pistoprion sp. *c*

Discussion. — *Pistoprion* n. gen. is very similar to *Mochtyella* in the arrangement of the jaws in the posterior part of the apparatus, and particularly to *M. cristata* KIELAN-JAW. In the case of young specimens of e.g. *Pistoprion transitans* n. sp. and *M. cristata* KIELAN-JAW. it is sometimes difficult to decide, to which of the mentioned species they should be assigned. If the delicate pellicle which joins the jaws of the apparatus of *P. transitans* is preserved, and if the chitin of the jaws is very fine and transparent, then the laeobasal plate and left MI joined together or the joined basal plate, right MI and right MII resemble respective jaws in *M. cristata*, i.e. the compound left MI and right MI. However, the adult specimens of *P. transitans* and *M. cristata* differ distinctly in that in *Pistoprion* each jaw is provided with its own pulp cavity, whereas in *Mochtyella* instead of separate jaws there are only ridges of denticles in one compound jaw, provided with one common pulp cavity.

Pistoprion, on the other hand, resembles *Vistulella* (comp. Text-figs. 5*A-C*) in the presence in the posterior part of the apparatus of simple jaws, provided with gaping pulp cavities. It differs from *Vistulella* in the arrangement of jaws. Basal plate and laeobasal plate are in *Pistoprion* comparatively small, arranged in the incurvatures of the outer margins of right and left MI respectively, and distinctly shorter than right and left MI, while in *Vistulella* the basal and laeobasal plates are almost as long as right MI, are provided with comparatively long denticles and cover right and left MI somewhat dorsally. Moreover, right MII is in *Pistoprion* a single arcuate jaw, arranged in front of the anterior margin of the right MI, whereas in *Vistulella*, in place of the right MII, there are two separate jaws, called right MIIa and right MIIb, and regarded as homologous with right MII in *Pistoprion*. Chains of lateral teeth, which occur in *Pistoprion* have so far never been found in *Vistulella*. Further differences concern the number of anterior teeth and the lack of a laeointercalary tooth in *Pistoprion*. As however the anterior teeth and the left side of the apparatus are so far known in *Pistoprion* only in the type species, one cannot be sure whether these differences are in fact of taxonomic character.

Pistoprion transitans n. sp.

(Plate III, fig. 2; Plate VI, fig. 2; Plate VII, figs. 2-3; Text-fig. 5*B*)

Type specimen: Incomplete jaw apparatus (without basal plate and lateral teeth), No. O.213/1, figured on Plate VI, fig. 2.

Type horizon and locality: Erratic boulder No. O.213, of unknown age (Ordovician or Silurian), Zakroczym, province of Warsaw.

Derivation of the name: Lat. *trans* — prefix meaning across, *transitans* — intermediate between the genera *Vistulella* and *Mochtyella*.

Diagnosis. — Basal plate extends for 0.4 of the length of the right MI. Right MI subrectangular, tapering posteriorly. Right MII arcuate, with deep bight on the posterior margin and a narrow shank directed posteriorly. Intercalary tooth present. Laeobasal plate extends for half the length of left MI. Laeointercalary tooth lacking. Left MI bent anteriorly outwards. A subtransversal, arcuate, undenticulated ridge arranged in the anterior part of left MI, in front of the ridge of denticles. Openings of pulp cavities of all the jaws (including basal and laeobasal plates) gaping. Eight pairs of anterior teeth increasing in size anteriorly. The length of the series of anterior teeth equal to about three quarters that of the posterior jaws. Unestablished number of triangular, lateral teeth, joined into longitudinal chains.

Denticle formula:

Laeobasal and basal plates	14	12
MI	14—16	12—14
MII	—	12

Material. — In addition to the type specimen, there are incomplete jaw apparatuses and joined jaws from the boulders Nos. O.140, O.147, O.265, O.279 and O.349.

Description. — Comparatively small apparatuses; length of the entire apparatus with anterior teeth of the type specimen is 0.54 mm., the maximum length of MI reaching 0.6 mm.

The entire apparatus is widest across the most anterior part of the left MI and right MII, and then tapers both anteriorly and posteriorly. In occlusion the ridge of the laeobasal plate bites into the furrow between the ridges of the basal plate and right MI, while the ridge of the left MI bites between the ridges of the right MI and right MII.

Basal plate is a suboval, elongated jaw, extending for 0.4 of the length of the right MI. A series of very small denticles extends posteriorly for 0.9 of the jaw length. The denticles decrease in size posteriorly. To the rear of the posterior denticle there is a smooth ridge, directed postero-medially.

Right MI is a subrectangular jaw, somewhat tapering posteriorly, with an incurvature along the anterior part of the inner margin, into which the longitudinal branch of the right MII fits tightly. Anterior margin is straight, directed subtransversally, somewhat postero--laterally. The outer margin is directed subposteriorly, in the posterior half it is provided with a shallow *(tr.)* incurvature to fit the basal plate. In the type specimen (Plate VI, fig. 2), in dorsal view, this incurvature is not visible. The posterior margin is narrower than the anterior, directed transversally. A series of denticles decreasing in size posteriorly extends nearly the full length of the jaw. The first or the first two denticles are twisted out of alignment with the others.

Right MII is an arcuate jaw with a deep bight on the posterior margin, prolonged proximally into a long and slender longitudinal branch directed posteriorly. Distally the jaw is prolonged into a slender, subposteriorly directed shank, the length of which is equal to about one third that of the longitudinal branch. A series of 12 denticles (in the type specimen) extends along the transverse branch and in an arch to the posterior extremity of the longitudinal branch. The denticles decrease in size posteriorly.

In the type specimen right MII does not fit tightly the anterior extremity of the right MI, there is a space between them, partly filled by a thin pellicle.

Intercalary tooth had been preserved in the type specimen, but was broken off. It is a comparatively large tooth with a wide base, arranged between the anterior margin of the right MI and posterior margin of MII.

Laeobasal plate is longer than the basal plate, extending for half the length of the left MI. A series of 13—14 denticles runs posteriorly along the middle of the jaw, and in the most anterior part postero-medially.

Left MII is a strongly elongated jaw, rounded anteriorly, tapering posteriorly, with an incurvature at the posterior part of the outer margin, for the laeobasal plate. Anterior margin is rounded, inner margin directed posteriorly. A series of 14—16 denticles decreasing in size posteriorly extends in an arch almost the full length of the jaw. At the anterior part of the jaw, in front of the denticulated ridge, there is an undenticulated ridge, which runs in an arch, subparallel to the anterior margin and the anterior part of the inner margin.

In ventral view: all the jaws of the posterior part of the apparatus are provided with gaping openings of pulp cavities, the boundaries between individual jaws being very distinct.

Anterior teeth: In the type specimen a series of 8 pairs of anterior teeth is preserved. They are conical, elongated teeth, decreasing in size anteriorly. On the right side the teeth are comparatively well preserved, arranged close to one another. On the left side they are poorly seen, covered by a cuticular layer which joins individual teeth.

Lateral teeth: In one specimen figured on Plate III, fig. 2*F*, along the outer slope of the right MI, there is a chain of ?6 poorly preserved, triangular teeth. The chain is arranged at the anterior part of the right slope, two teeth protruding in front of the anterior margin of the jaw. The teeth are very small and poorly preserved, it is impossible to say whether or not they were denticulated. The exact number of teeth is unknown.

Discussion. — Isolated jaws, particularly right and left MI of the pattern characteristic of *Pistoprion transitans* are comparatively common in the studied collection. However the

writer hesitates to assign all of them to this species, as there are comparatively few morphological elements, characteristic of each jaw; that they belong to different species, cannot be excluded.

Pistoprion sp. **a**

(Plate VI, fig. 3)

Material. — Two right sides of the jaw apparatuses No. O.265/4 and O.418/2. Age of the boulders Nos. O.265 and O.418 is unknown (Ordovician or Silurian).

Description and comparisons. — Right side of the jaw apparatus is very much alike *P. transitans* n. sp., differing from the latter species in having the basal plate comparatively shorter with regard to the length of the right MI and provided with 8—9 small denticles. Right MI is similar to that in *P. transitans*, while right MII differs in having on the outer slope, in front of the denticulated ridge, two subparallel, undenticulated ridges. The anterior part of the outer slope is comparatively longer than in *P. transitans*.

Pistoprion sp. **b**

(Plate VI, fig. 1)

Material. — Right side (basal plate, MIr, MIIr) from the boulder No. O.177, basal plate and MIr from the same boulder, incomplete right sides from the boulder O.174. Age of the boulders O.174 and O.177 is unknown (Ordovician or Silurian).

Description. — Comparatively large apparatuses, the length of the joined right MI and MII varies around 1.5 mm. The chitin of the jaws is dark brown and very thick, the particular jaws closely fitting into each other.

Basal plate is comparatively short, extending for one third of the length of the right MI, provided with 8 sharply pointed denticles.

Right MI is an elongated jaw with a deep *(tr.)* incurvature at the posterior part of the outer margin — for the basal plate, and another incurvature at the anterior part of the inner margin — for the longitudinal branch of the right MII. Posterior margin is transverse, comparatively short *(tr.)*, the jaw tapering posteriorly. The anterior margin is strongly arched, the proximal part being more elongated anteriorly than the distal. A series of 13—16 stout denticles decreasing in size posteriorly extends along the middle of the jaw to the posterior extremity.

Right MII is an arcuate jaw with 9 stout denticles extending to the posterior extremity of the longitudinal branch. In front of the ridge of denticles there are some irregular ripples, subparallel to the outer margin, not forming however distinct ridges. Distally the jaw is prolonged into a rounded, suboval shank.

Discussion. — *Pistoprion* sp. *b* differs from *P. transitans* in greater dimensions and a stouter structure. The denticles are larger, the chitin is thicker and particular jaws fit closely into each other. The number of denticles in individual jaws is smaller than in *P. transitans*. Right MI differs from that in *P. transitans* in having a strongly arched anterior margin, whereas in *P. transitans* it is directed subtransversally. Right MII differs in having the denticles arranged more proximally, whereas in *P. transitans* the first denticle is arranged very close to the outer margin of the jaw. Moreover, right MII differs in having a less slender shank and in the presence of ripples on the outer slope. It could be assumed that *P. transitans* and *Pistoprion* sp. *b*, which

differ in dimensions, are different ontogenetic stages of the same species. This, however, does not seem to be the case, as *Pistoprion* sp. *b*, which is represented by larger specimens, has a smaller number of denticles in particular jaws than *P. transitans*.

Pistoprion sp. **c**

(Plate VII, fig. 1)

Material. — Single specimen No. O.133/1, consisting of a basal plate, right MI and right MII, all joined together. Age of the boulder O.133 is unknown (Ordovician or Silurian).

Description. — The length of joined right MI and MII is 0.35 mm. The right side consisting of three jaws is comparatively wide and rounded anteriorly, tapering posteriorly.

Basal plate is a comparatively small and very delicate jaw extending for 0.26 of the length of MIr. It does not protrude laterally over the outer margin of the right MI. It is provided with ?12 very fine denticles (crenulations), extending for the full length of the plate.

Right MI is rounded anteriorly, strongly tapering posteriorly. It is provided with a deep incurvature along the inner margin, extending for one third of the jaw length. Outer margin is directed postero-medially, with an incurvature at the posterior part for the basal plate. The posterior margin is short, directed transversally. A series of 11 denticles, decreasing in size posteriorly, extends the full length of the jaw.

Right MII is an arcuate jaw, prolonged proximally into a longitudinal branch, and distally into a comparatively short shank, directed postero-laterally. A series of 11 small, sharply pointed denticles extends the full length of the longitudinal branch. The denticles are restricted to the longitudinal branch. In the transversal prolongation of the first denticle, a prominent, undenticulated ridge, directed transversally, runs along the transverse branch.

Discussion. — *Pistoprion* sp. *c* differs from all the other representatives of *Pistoprion* in the presence, on the transverse branch of the right MII, of an undenticulated ridge which is a continuation of the ridge of denticles. In all the other representatives of this genus this ridge is denticulated. Moreover, it differs from *P. transitans* n. sp. in having a much shorter *(long.)* basal plate, a differently shaped right MI, right MII provided with a comparatively shorter longitudinal branch and a much less prominent shank in right MII.

Genus **VISTULELLA** KIELAN-JAWOROWSKA, 1961

Type species: Vistulella kozlowskii KIELAN-JAWOROWSKA, 1961.

Diagnosis. — Jaw apparatus consisting of a basal plate, laeobasal plate, intercalary tooth, laeointercalary tooth, right and left MI, right MIIa, right MIIb, and four pairs of denticulated anterior teeth. Basal plate strongly elongated, equal in length to right MI, covering it somewhat dorsally. Pulp cavity of basal plate narrowly open, denticles very long anteriorly, decreasing in size posteriorly. Right MI subrectangular, intercalary tooth arranged in front of the basal plate. Two right jaws in front of the right MI (right MIIa and MIIb), regarded as homologous with the right MII of other mochtyellid genera. Right MIIa small, subrectangular, arranged in front of the intercalary tooth and the anterior margin of the right MI. Right MIIb bent, elongated, arranged along the anterior part of the inner margin of right MI and the inner margin

of right MIIa. Laeobasal plate and laeointercalary tooth are mirror images of basal plate and intercalary tooth, and partly cover left MI dorsally. Lateral teeth unknown (?lacking).

Stratigraphic and geographical range. — Ordovician — Devonian; Europe, North America.

Vistulella kozlowskii KIELAN-JAWOROWSKA, 1961

(Text-fig. 5*C*)

1961. *Vistulella kozlowskii* n. sp.; Z. KIELAN-JAWOROWSKA, On two Ordovician polychaete..., p. 243, Pls. 1-4, Text-fig. 2.
1962. *Vistulella kozlowskii* KIELAN-JAW.; Z. KIELAN-JAWOROWSKA, New Ordovician genera..., Text-fig. 4*b*.

Discussion. — *Vistulella kozlowskii* has been described in detail by the writer in 1961, its jaws being numbered by Arabic numerals. The new notations for the jaws of *V. kozlowskii* are given on Text-fig. 5*C*. In the studied collection there are numerous incomplete jaw apparatuses, assigned to *V. kozlowskii*, displaying a considerable range of variability (cf. KIELAN-JAWOROWSKA, 1961, Text-fig. 2). It is highly probable that the specimens assigned to *V. kozlowskii* belong in fact to three or more separate species. As however the material is comparatively incomplete (right and left sides are preserved, as a rule, separately) — recognition of these species is impossible. Thus *Vistulella* remains, for the time being, a monotypic genus.

The stratigraphic range of *V. kozlowskii* is uncertain, as the majority of boulders yielding this species is of unknown age. The age of the boulder O.245 has been recognized as ?Silurian.

Family XANIOPRIONIDAE nov.

Diagnosis. — Symmetrical jaw apparatuses of placognatha type. Carriers lacking; MI elongated longitudinally, subrectangular; MII arcuate, large jaws, arranged in front of MI; basal and laeobasal plates strongly elongated, consisting of numerous denticles which are very long in anterior part, decreasing in size posteriorly. Basal and laeobasal plates adhere to the outer margins of MI and MII covering them dorsally. In front of MII an unestablished number of anterior teeth are present.

Discussion. — The new family is monotypic, erected to include *Xanioprion* KIELAN-JAW. with a single species *Xanioprion borealis* KIELAN-JAW.

Genus **XANIOPRION** KIELAN-JAWOROWSKA, 1962

Type species: Xanioprion borealis KIELAN-JAWOROWSKA, 1962.

Diagnosis. — As for the family.

Stratigraphic and geographical range. — Ordovician-Silurian erratic boulders of Poland, Ludlow of Canada. (Parataxonomic species *Leodicites sublunatus* WALLISER, described by WALLISER (1960) from the Ludlow of Canadian Arctic Archipelago, is congeneric with *Xanioprion* KIELAN-JAW.).

Xanioprion borealis KIELAN-JAWOROWSKA, 1962

(Text-fig. 1*B*)

1962. *Xanioprion borealis* n. sp.; Z. KIELAN-JAWOROWSKA, New Ordovician genera..., p. 321, Pls. 11-13, Text-fig. 4*A*.

Discussion. — *Xanioprion borealis* has been described in detail by the writer in 1962, its jaws being numbered by Arabic numerals. The new notations for the jaws of *X. borealis* are given on Text-fig. 1*B*. According to the present investigation, *X. borealis* is restricted to the Middle Ordovician (Kukruse Stage or Idavere Stage of the Estonian sequence). In the studied collection there are numerous isolated jaws of *Xanioprion* sp., two entire apparatuses (of unknown age) among them. In the apparatuses in question there is on each side, instead of two jaws (MI and MII), one jaw equal in length to a joined MI and MII. It is a new species of *Xanioprion* which is, however, insufficiently known to be described. It is also impossible to venture an opinion as to whether the evolution of *Xanioprion* was by way of fusion of MI and MII (*X. borealis* being ancestor of a new, undescribed species) or vice versa — by way of the division of MI (in that case *X. borealis* being an offshoot of a new species).

Family RHYTIPRIONIDAE nov.

Diagnosis. — Subsymmetrical jaw apparatuses of placognatha type. ?Carriers lacking. Right and left MI compound jaws provided with main ridges and basal or laeobasal ridges. In main ridge there are two or three transverse smooth ridges in the anterior part, followed by denticles decreasing in size posteriorly. Basal and laeobasal ridges extending for less than half the length of MI, provided with minute denticles. MII simple jaws with one transverse, prominent ridge, provided in distal part with shanks directed posteriorly. Pulp cavities in MI and MII gaping. Jaws or teeth in front of MII unknown.

Discussion. — The family is monotypic, erected to include *Rhytiprion* n. gen. In the arrangement of the main, basal and laeobasal ridges in MI, *Rhytiprion* reminds one of *Mochtyella*, however distinctly differing from it in the presence of transverse, smooth ridges in the anterior part of the main ridge. The structure of MII (lacking in *Mochtyella*) is different from that characteristic of all the known eunicid genera. In many instances MII in Eunicea are bevel square shaped, with a longitudinal branch arranged proximally, while in *Rhytiprion*, MII consists of two branches: transversal and longitudinal, the longitudinal being however arranged distally. The phylogenetic relations of the Rhytiprionidae with other placognatha families are not clear.

Genus **RHYTIPRION** nov.

Type species: Rhytiprion magnus n. sp.

Derivation of the name: Gr. *rhytis* — a wrinkle, *prion* — a saw, alludes to the transverse ridges (wrinkles) in MI and MII.

Diagnosis. — As for the family.

Stratigraphic and geographical range. — Middle Ordovician — ?Silurian of the Baltic region.

Rhytiprion magnus n. sp.

(Plate VIII; Text-fig. 5*D*)

Type specimen: Left MI and MII joined together, figured on Plate VIII, fig. 5, No. O.265/12.
Type horizon and locality: Erratic boulder No. O.265 of unknown age (?Ordovician), Mochty, province of Warsaw.
Derivation of the name: Lat. *magnus* — great.

Diagnosis. — As for the genus.
Denticle formula:

	Left MI:	Right MI:
Main ridge	2 (tr. ridges)+9—12	3 (tr. ridges)+9—12
Basal or laeobasal ridge	9—11	unknown

Material. — In addition to the type specimen, there is a single MII from the boulder O.182 and numerous isolated right and left MI from the boulders O.148, O.182, O.265, O.279 and O.470. The majority of the jaws derive from the boulders O.182 and O.265. Of the boulders which yield *R. magnus*, the age of O.182 has been recognized as Middle Ordovician (?Kukruse Stage of Estonian sequence), and that of boulders O.148 and O.470 tentatively also as Middle Ordovician. In all the right MI the basal ridge is broken off. The reconstruction (Text-fig. 5*D*) is based on comparison with the right MI of *Rhytiprion* sp. *a*. Only in the type specimen were the two jaws of the apparatus preserved together, all the remaining specimens being isolated jaws. All of them are, however, so characteristic and unique in the studied collection, and the right side occludes so perfectly with the left one that there is no doubt about all the jaws here recorded being congeneric. Their conspecifity is not entirely certain and they are assigned to one species only provisionally.

Description. — Length of MI here assigned varies between 0.6 and 1.6 mm. The apparatus is subsymmetrical, right and left MI being arranged opposite each other, right and left MII in front of MI. In occlusion the transverse ridge of the right MII is arranged in front of that of the left MII and behind them alternate the subsequent transverse ridges and the denticles of the main ridges of right and left MI.

Left MI is a compound jaw, 2.2—2.35 longer than wide, tapering somewhat backwards. Anterior margin runs in the proximal part transversally, at three quarters of the jaw width it bends at a right angle, runs posteriorly, bends once more and then continues transversally to the outer margin. In the anterior, distal corner of the jaw there is an elongated incurvature, which houses the shank of MII. The main ridge of denticles runs on the left side of the jaw. In the anterior part there are two, very prominent, smooth ridges, directed subtransversally, with a deep and wide *(long.)* furrow between. To the rear of the right half of the second ridge, a series of 9—12 denticles (main ridge) decreasing posteriorly, extends nearly the full length of the jaw. First two or three denticles are larger than the remaining ones, particularly the first, which forms a large node, and in some specimens is developed as a transverse ridge, shorter *(tr.)* and less prominent than the two anterior ridges. The laeobasal ridge extends for one third of the jaw length from behind, left of the main ridge. It is directed longitudinally, in the posterior part bending somewhat inwards. In the laeobasal ridge there are 9—11 small denticles, slightly decreasing in size posteriorly. The furrow between the main and laeobasal ridges is deep, the

chitin in the bottom part being very fine and transparent, often slitting to form a fissure between the two ridges. In front of the laeobasal ridge, to the rear of the second transverse ridge, there is a longitudinal swelling, sometimes crescent like, subparallel to the main ridge. The jaw is plate-like, provided with a gaping pulp cavity, but the dorsal wall of the jaw is somewhat bent downwards along the anterior and inner margins, to form a very narrow rim, covering the very border of the pulp cavity. In ventral view in the anterior part of the jaw there are two very deep transverse depressions, associated with the anterior ridges, and posteriorly two series of pits, associated with the denticles of the main and laeobasal ridges.

Right MI is an elongated jaw, three times longer than wide. The basal ridge is broken off in all the specimens, the outer margin being somewhat ragged. The anterior margin runs in the proximal part subtransversally, at three fourth of the jaw width it bends, runs posteriorly, and then transversally again. The anterior, lateral incurvature is here narrower *(tr.)* than in the left MI. In the anterior part of the jaw there are two prominent, transverse, smooth ridges, arranged close to each other with a deep furrow between. In occlusion the first transverse ridge of the left jaw bites into this furrow. Behind the second ridge there is a very wide *(long.)* furrow, to which the second transverse ridge of the left MI bites. Behind it there is a third much shorter *(tr.)* transverse ridge, developed sometimes as a node, in the backward prolongation of which there is a series of 9—12 denticles, decreasing posteriorly and extending the full length of the jaw. First two denticles are larger than the remaining ones. In some specimens the outer surface of the denticles is abraded and they form flat nodes. In ventral view the narrow rim of the dorsal wall is bent downwards to form a very narrow cover surrounding the anterior margin and the anterior part of the outer margin.

Left MII is a simple jaw, consisting of a proximal, anterior transverse part and a distal shank, directed longitudinally. The transverse part is subsemicircular, with a convex anterior and concave posterior margins. The shank forms a longitudinal prolongation of the postero-lateral corner of the transversal part. Its outer margin is slightly convex outwards, anterior end reaching for half the length of the transverse part. The inner margin of the shank is slightly convex outwards, the posterior margin rounded. Across the transverse part runs a prominent, smooth ridge, directed obliquely from the postero-medial corner to the antero-lateral. On the anterior slope of this ridge there is a faint fold, subparallel to the main ridge, running across its central one third. In the jaw apparatus the transverse ridge of the left MII is arranged subparallel to the first smooth ridge of MI.

Along the shank runs a longitudinal swelling, directed posteriorly, less prominent than the ridge in the transversal part. The pulp cavity is gaping. In ventral view, along the transversal part, there runs a deep furrow associated with the transverse ridge and a comparatively shallow furrow along the shank, associated with the swelling.

Right MII is more or less a mirror image of the left MII. The single specimen of the right MII in the studied collection has a shank of almost equal width all along its length, with outer margin less convex than in the left MII.

Variation. — The isolated jaws here described differ considerably not only in the number of denticles, but also in proportions. The left MI from the boulder O.182 (e.g. Plate VIII, fig. 2) are comparatively shorter with regard to length than those from the boulder O.265 (e.g. Plate VIII, fig. 5). Similar range of variation concerns the right MI, and it is not excluded that the jaws assigned here to *R. magnus* do not belong in fact to two separate species. As however they are so far very poorly known, represented by isolated jaws, recognition of these species is for the time being impossible.

Rhytiprion sp. **a**

(Plate IX, fig. 1)

Material. — Single right MI (with basal ridge) from the boring core of Mielnik on Bug (1118—1124 m.) of ?Upper Ordovician age (equivalent of the Harjuan Stage of Estonian sequence).

Description and discussion. — In the samples from the boring of Mielnik, several jaw apparatuses and isolated jaws have been found, which have been left for future elaboration. The writer has considered it reasonable to describe a rhytiprionid right MI from this boring — as it is provided with a basal plate, which is unknown in *Rhytiprion magnus*. Right MI is shorter with regard to length than the right MI of *R. magnus* and is provided with a smaller number of denticles in the main ridge (two transverse ridges, followed by 8 denticles decreasing in size posteriorly). Basal ridge is very short, equal to 0.2 of the jaw length, provided with 10 minute denticles. In the described specimen the basal ridge has been shifted rearwards from its natural position. Otherwise right MI of *Rhytiprion* sp. *a* is similar to that of *R. magnus*.

Family TETRAPRIONIDAE nov.

Diagnosis. — Symmetrical jaw apparatuses of prionognatha type, consisting of a basal plate, laeobasal plate, right and left MI, right and left MII, right and left MIII and numerous anterior teeth. Carriers lacking. MI simple elongated jaws. Basal and laeobasal plates comparatively long, with narrowly open pulp cavities, covering MI somewhat dorsally. MII and MIII narrow, elongated, MI, MII and MIII aranged in a longitudinal row, MII in front of MI, MIII in front of MII. Openings of pulp cavities in MI, MII and MIII gaping. Anterior teeth arranged in two rows. Outer row arranged in front of MI consists of large teeth in the posterior part, strongly decreasing in size anteriorly. Inner row, much shorter consisting of small teeth arranged in front of MII between the outer row and MIII.

Discussion. — The new family is monotypic, erected to include *Tetraprion* n. gen. with a single species *Tetraprion pozaryskae* n. sp. In the studied collection there are numerous jaw apparatuses of prionognatha type, similar to *Tetraprion*. As however the prionognatha apparatuses are extremely delicate, they often become deformed or damaged and so cannot be studied. Two dozen such apparatuses belonging to different species and genera, have to remain for the time being undescribed. Of the prionognatha species in the author's collection, only the structure of *Tetraprion pozaryskae* n. sp. represented by 20 jaw apparatuses could be examined in all its detail.

The Tetraprionidae are close to the Mochtyellidae. The similarities concern the presence in the posterior part of the jaw apparatus of a longitudinal MI, covered somewhat dorsally by elongated basal and laeobasal plates. They differ from the Mochtyellidae in having a symmetrical posterior part and in the presence of more numerous and more strongly differentiated anterior teeth. In the Mochtyellidae MII if present is developed as a single right jaw, arranged opposite left MI, while in the Tetraprionidae MII are developed as symmetrical, very narrow jaws, arranged in front of MI.

The Tetraprionidae reminds one also of the Xanioprionidae in the presence of elongated basal and laeobasal plates which cover MI dorsally. However MII in the Xanioprionidae are quite differently shaped, and the anterior part of the apparatus is too poorly known, to be compared with that of the Tetraprionidae.

Genus **TETRAPRION** nov.

Type species: Tetraprion pozaryskae n. sp.

Derivation of the name: Gr. *tetra* — four, *prion* — a saw, alludes to the presence of four pairs of jaws (basal and laeobasal plate, MI, MII and MIII).

Diagnosis. — As for the family.

Stratigraphic and geographical range. — Middle Ordovician of the Baltic region (erratic boulders). Uncertain representatives of this genus occur also in the Silurian erratic boulders of Poland.

Tetraprion pozaryskae n. sp.

(Plates: IX, figs. 2-3; X; XI, fig. 3; Text-fig. 5*F*)

Type specimen: Almost entire, somewhat deformed jaw apparatus, figured on Plate X, fig. 2, No. O.400/62.

Type horizon and locality: Erratic boulder of ?Middle Ordovician age, Mochty, province of Warsaw.

Derivation of the name: Named in honour of my colleague Professor KRYSTYNA POŻARYSKA.

Diagnosis. — MI wide anteriorly, strongly narrowing posteriorly, with anterior margin in dorsal view incurved in the middle, in inner left lateral views directed postero-laterally. First denticle in MI longer than the remaining ones. Left MI somewhat shorter than the right MI. Basal and laeobasal plates with sharp, long denticles. Laeobasal plate longer than the basal plate. Intercalary tooth present, laeointercalary tooth lacking. MII narrow, elongated jaws, equal to half the length of MI. MIII similar in shape to MII but shorter. Outer row of anterior teeth consists of 7 large, subtriangular teeth decreasing in size anteriorly, in front of which there is a series of unestablished number of very thin, sharp teeth. Inner row consists of 5 subtriangular anterior teeth.

Denticle formula:

Laeobasal and basal plates	13—14	13—14
MI	10—14	10—13
MII	?	9—11
MIII	13	15

Material. — Twenty jaw apparatuses (some incomplete) from the boulders Nos. O.366, O.400 and O.469; age of the boulder O.366 has been ascertained as Middle Ordovician (?Kukruse Stage or Idavere Stage).

Description. — The length of entire apparatus varies around 0.5 mm., the longest apparatus being 0.75 mm. long.

Basal plate is a very narrow, strongly elongated jaw, with a series of 13—14 sharply pointed denticles, extending for 0.8 of the jaw length. Right slope is very narrow, while the left one, which adheres to MI, is twice as wide. Left slope is directed steeply downwards in the anterior part, posteriorly it enlarges, becoming arranged more horizontally. Denticles somewhat decrease in size posteriorly. As the jaw is somewhat compressed laterally, the opening of the pulp cavity, which extends its full length, is narrowly open. In front of the basal plate there is a sharp, triangular intercalary tooth, somewhat longer than the first denticle of the basal plate.

Laeobasal plate is almost a mirror image of the basal plate, being however somewhat longer, equal to the length of the basal plate and intercalary tooth or even longer. The left slope is comparatively narrow, the right one (adhering to MI) is twice as wide. In the anterior part, the right slope is directed steeply downwards, posteriorly it enlarges and is arranged more

horizontally. A series of sharp denticles extends for 0.7 of the jaw length. Laeointercalary tooth is lacking.

Right MI is an elongated jaw, with a series of 12 denticles extending for 0.9 of the jaw length, in the middle of the jaw. In dorsal view the anterior margin directed subtransversally is provided with a distinct, sharp incurvature in the middle. Into this incurvature the first tooth of the outer row of anterior teeth fits tightly. In this view the inner and outer margins are directed subparallel, converging somewhat posteriorly to the rounded posterior end. In left lateral view the jaw is subtriangular. Anterior margin is directed postero-laterally and passes into the anterior margin of the first denticle. Outer and inner margins converge posteriorly. In right lateral view the jaw is similarly shaped, subtriangular. In ventral view the opening of the pulp cavity is gaping, a furrow with deep pits associated with the denticles extends along the mid-line of the jaw.

Left MI is somewhat shorter *(long.)* than the right MI, in dorsal view it strongly tapers posteriorly. Anterior margin is directed subtransversally, somewhat postero-laterally, with an incurvature in the middle. Inner margin is somewhat convex outwards. Posteriorly the inner and outer margins converge strongly. First denticle is longer than the remaining ones. In dorsal view it is twisted somewhat out of alignment with the other denticles. In right lateral view the anterior margin is directed obliquely postero-laterally, passing into the outer margin of the first denticle. In right lateral view the jaw is subtriangular. Anteriorly a large part of the pulp cavity is seen in this view. In ventral view the opening of the pulp cavity is gaping, a furrow with pits associated with the denticles runs along the middle of the jaw.

Right MII is a very narrow, elongated, somewhat arcuate jaw, with narrow steep slopes and a gaping opening of the pulp cavity. A series of 9—11 sharply pointed denticles extends the full length of the jaw.

Left MII appears to be a mirror image of the right MII, in all the specimens, where it is preserved, it is however poorly seen, hidden under the left outer row of the lateral teeth.

Right MIII is similarly shaped as the right MII, elongated, arcuate, narrow jaw. It appears from the specimen figured on Plate IX, fig. 3 that the number of denticles in MIII is somewhat greater than in MII, the denticles being smaller.

Left MIII, which is imperfectly known, appears to be a mirror image of the right MIII.

Anterior teeth. Outer row: In front of MI there is a series of 7 large, roughly subtriangular teeth, the first of which (the largest) fits tightly into the anterior margin of MI, the rest fitting tightly into each other. The teeth strongly decrease in size anteriorly. In dorsal view each tooth appears subrectangular, with a sharp, long spine protruding from the middle. In outer lateral view the teeth are roughly setsquare shaped, with a pointed transverse branch (a spine) and a wide *(tr.)* and short *(long.)* longitudinal branch, which is rounded posteriorly and fits tightly into the anterior margin of the preceding tooth. In more ventral view the teeth appear subtriangular. Each tooth is provided with a very large subrectangular opening of the pulp cavity. In ventral view the openings of pulp cavities of successive teeth form a chain, which narrows anteriorly. In front of these seven teeth, there is a series of very small, narrow, sharp teeth, the exact number of which cannot be established. They form the most anterior part of the apparatus, and the two chains of these spine-like teeth converge anteriorly. It appears from the type specimen figured on Plate X, fig. 2, that the row of spine-like teeth is arranged on the left side subparallel to the anterior part of the outer margin, and only in the most anterior part does it extend anteriorly beyond the chain of seven large teeth. This is however not entirely certain, as the jaws of the type specimen had been removed from their natural position. Anterior teeth of the outer row of the left side are a mirror image of those of the right side.

Inner row: In front of MII there is a series of 6 subtriangular teeth, decreasing somewhat anteriorly, disposed between the outer row of teeth and MIII. The first tooth of this row fits tightly into the anterior margin of MII. Inner rows of teeth are arranged symmetrically on both sides of the apparatus.

Mandibles: Length of the mandibles is equal to about 1.7 that of MI. They are comparatively strong, with the anterior striped area extending for one third of the length of the mandible. Anterior margin is directed postero-medially, somewhat crenulated, provided with two tips, the outer one higher, situated distally, the inner one — lower — proximally. To the rear of the striped area a mandible forms a stout shank, directed posteriorly, with a rounded posterior end.

Variation. — As the specimens assigned here are in most cases deformed, and the individual jaws are poorly seen, it is difficult to decide whether the differences observed among them are due to the state of preservation, or to individual variation. In addition to the variability in the number of denticles, the length of MII may vary considerably. In the type specimen (Plate X, fig. 2) it appears to be longer with regard to the length of MI, than in the specimen figured on Plate IX, fig. 3.

Family SYMMETROPRIONIDAE nov.

Diagnosis. — Symmetrical jaw apparatuses of labidognatha type. Right and left MI provided with bights along posterior margins. Basal and laeobasal plates present, subtriangular, with concave anterior margins. Intercalary and laeointercalary teeth lacking. Carriers long, subtriangular, tapering posteriorly. Anterior jaws and mandibles unknown.

Discussion. — The family is monotypic, erected to include *Symmetroprion* n. gen.

Genus **SYMMETROPRION** nov.

Type species: Symmetroprion reduplicatus n. sp.

Derivation of the name: Gr. *symmetros* — symmetrical, *prion* — a saw; an apparatus with jaws arranged symmetrically.

Diagnosis. — Jaw apparatus with a symmetrical posterior part (anterior part unknown). Basal plate subtriangular, tapering posteriorly, with a strongly concave anterior margin. Laeobasal plate a mirror image of the basal plate. Carriers anteriorly fused with basal and laeobasal plates, posteriorly bent downwards. MI symmetrical, with broadly rounded anterior margins and bights in the posterior part. Large rounded denticles along anterior margins, smaller denticles along inner margins. Openings of pulp cavities in MI equal to 0.8 or more of the jaw length.

Stratigraphic and geographical range. — Silurian erratic boulders of Poland, Silurian of the Island of Gotland.

Discussion. — *Symmetroprion* is comparatively poorly known, erected to include *Symmetroprion reduplicatus* n. sp. and *Symmetroprion* sp. *a*.

Symmetroprion n. gen. differs from all the known fossil and Recent labidognatha and prionognatha genera in the presence of a laeobasal plate and in having left MI provided with a bight. Of the fossil prionognaths and labidognaths so far described, left MI provided with a bight presumably occurs also in *Ildraites bipennis* ELLER, as reconstructed by ELLER (1936,

Plate 11, fig. 1) from the Upper Devonian of New York. A more detailed comparison cannot be, however, based on ELLER's figure, as it is not certain whether this reconstruction is correctly made. The jaws described by ELLER as MI are disposed in his reconstruction under MII in dorsal view, which does not occur in any fossil or Recent jaw apparatus.

Symmetroprion reduplicatus n. sp.

(Plate XII, figs. 9-11; Text-fig. 5)

Type specimen: Left MI, No. O. 98/9b, figured on Plate XII, fig. 9.
Type horizon and locality: Erratic boulder No. O. 98, of ?Silurian age, Rewal, Baltic coast.
Derivation of the name: Lat. *re* — again, *duplicare* — to repeat; right side repeated on the left.

Diagnosis. — Only MI known, the diagnosis of MI as for the genus.

Material. — Numerous isolated right and left MI from the boulders Nos. O. 98, O. 161, O. 174, O. 308, O. 410, O. 439, O. 441, O. 442, O. 446 and uncertain from the boulder O. 59. Age of the boulder O. 410 has been recognized as Silurian (Lower Ludlow), that of the boulder O. 441 as ?Wenlock. It is probable that S. *reduplicatus* is restricted to the Silurian.

Description. — Length of MI varies between 0.4—1.1 mm.

Right MI is a longitudinally elongated jaw, twice as long as wide, with a rounded anterior margin, 10—15 denticles decreasing in size posteriorly. The first three denticles, arranged along the anterior margin, are rounded, longer than the others, which are more sharply pointed and arranged along the inner margin. The denticles disappear before reaching the posterior extremity of the jaw, the posterior part of the inner margin, to the rear of the last denticle, forms a short *(long.)* ridge. The bight, which extends for one quarter of the jaw length, is wide, with a sigmoid anterior outline. In front of the proximal part of the bight, close to the dentary there is a subtriangular deepening, for the inner shank of the basal plate. The anterior rim of the bight passes in an arch into the outer margin of the jaw, which in dorsal view is directed longitudinally, while in left lateral view it is concave.

The inner wing extends for three quarters of the jaw length from behind. The anterior margin of the belt is concave, its distal anterior end being prolonged into a pointed spine, directed anteriorly. The inner wing is comparatively wide anteriorly, in the posterior third of its length it strongly tapers posteriorly, the most posterior part of the jaw being very narrow.

In ventral view: the opening of the pulp cavity extends for 0.8 of the jaw length, the posterior rim of the cover being strongly concave. The anterior margin of the inner wing lies in a transversal prolongation of the posterior rim of the cover, together forming a sigmoid curve. Along the middle of the opening there is a deep furrow with pits, associated with the denticles. In front of the bight there is a small subtriangular inflation, associated with the deepening on the dorsal side.

Left MI is almost a mirror image of the right MI, the only difference being that the bight in left MI is somewhat longer than in the right MI. Consequently the laeobasal plate associated with left MI was somewhat longer than the basal plate.

Variation. — In numerous right and left MI the denticles are strongly worn. This concerns in particular the first three denticles in MI, which in such jaws do not overhang the anterior margin, but look like large, flat, suboval tubercules. MI may be wider or narrower in proportion to the length, this however may be connected with the varying degrees of flattening of the jaws.

Discussion. — *Symmetroprion reduplicatus* n. sp. is erected to include only the isolated right and left MI. These jaws have not been found joined, but as the right MI is a mirror image of the left one, and as they occur in samples from the same boulders, there is no doubt that they are conspecific. In samples from the same boulders the isolated basal plate and numerous laeobasal plates, often joined with left and right carriers respectively have also been found. There is no doubt that these plates are congeneric with *S. reduplicatus*, as left MI of *S. reduplicatus* is in the entire collection the only left MI of labidognatha type provided with a bight; moreover the laeobasal plates, which could fit tightly into the bight of the left MI, are the only labidognath laeobasal plates in the studied collection. The basal plate in question is the mirror image of the laeobasal plate. The laeobasal plates here discussed are, however, a subject of considerable variation (comp. Plate XII, figs. 1—7), and probably belong to at least two or three separate species. As however none of them have been found joined with MI, one cannot venture an opinion as to which of them is conspecific with *S. reduplicatus*. That is why the laeobasal plates and the basal plate (single specimen) of *Symmetroprion* type are described here as *Symmetroprion* sp. *a*. The structure of the basal and laeobasal plates of *Symmetroprion* sp. has allowed the author to draw a tentative reconstruction of *S. reduplicatus* n. sp. The parataxonomic species *Lumbriconereites spatiosus* HINDE from the Silurian Wisby marls of Gotland (Wisby) (HINDE, 1882, p. 23, Plate 3, figs. 72—73) represents right and left MI of *Symmetroprion*. The differences between MI of *S. reduplicatus* and *L. spatiosus* are very small and concern the structure of the posterior part of the dentary. Otherwise, the jaws are very similar and no doubt congeneric. In the same paper HINDE (1882) described *Oenonites securis* HINDE (p. 15, Plate 2, fig. 26) and *O. securis* var. *basalis* HINDE (p. 16, Plate 2, fig. 37), both of which are laeobasal plates of *Symmetroprion* type. No other detached jaws so far described could be regarded as congeneric with *Symmetroprion reduplicatus*.

Symmetroprion sp. **a**

(Plate XII, figs. 1-8)

Material. — A dozen isolated laeobasal plates, two of which are joined with left carriers, from the boulders Nos. O.98, O.308, O.442, one basal plate joined with a right carrier from the boulder O.441. Age of the boulder O.441 has been recognized as Silurian (?Wenlock).

Description. — *Carriers*: comparison of the proportions of MI in *S. reduplicatus* with the basal and laeobasal plates (with carriers), which could fit into the bights of MI, shows that the carriers are more than one and a half times longer than MI. The anterior margin of the right carrier is directed obliquely antero-laterally. The proximal part of the anterior margin (about one fourth of the carrier width at this level) is free — in a jaw apparatus it fitted tightly into the posterior margin of the right MI — which lies in the prolongation of the dentary. The remaining (distal) part of the anterior margin of the carrier is associated with the basal plate, which in its proximal part fits the carrier tightly and distally is entirely fused with the carrier. Sometimes the carrier is fused with the basal plate along the entire length of the posterior margin of the plate. In the anterior part and along the inner margin the carrier is thicker and darker (less transparent), than along the outer margin. In the middle of the most anterior part of the carrier, there is a small inflation, associated with the depression on the ventral side. The carrier tapers posteriorly to a pointed end, its inner margin is concave, outer somewhat convex. The posterior end of the carrier is strongly bent downwards. The left carrier fused with the laeobasal plate is a mirror image of the right carrier. Left and right carriers have not

been found joined, but it seems from their structure that they could only fit tightly together in the anterior part and probably also at the end.

Laeobasal plate is subtriangular, tapering posteriorly, with a strongly concave anterior margin. The anterior margin, beginning with the inner corner, runs postero-laterally, then bends and continues antero-laterally. The inner, denticulated margin runs posteriorly, the outer margin postero-medially. On account of the concave course of the anterior margin, the plate is provided anteriorly with two shanks, the inner one, usually shorter, associated with the anterior part of the dentary and the outer one, narrow, sometimes strongly elongated anteriorly. A series of 6—11 denticles extends for two thirds of the length of the inner margin. The posterior part of the inner margin, to the rear of the last denticle, forms a ridge directed subposteriorly, somewhat postero-laterally. Below the undenticulated, posterior part of the inner margin a part of the belt is visible in dorsal view, forming a small bow. A posterior furrow, subparallel and close to the inner margin, extends for one third to a half of the length of the plate.

Basal plate — represented in the studied collection by a single specimen, is more or less a mirror image of the laeobasal plate.

Variation. — Variation of the laeobasal plates, described here as *Symmetroprion reduplicatus*, is considerable and concerns the course of the anterior margin which may be variously incurved, the length of the anterior shank, associated with the anterior part of the dentary and the length to width ratio. Also the carriers may be shorter or longer with regard to the associated basal and laeobasal plates. The right carrier associated with the basal plate (Pl. XII, fig. 8) is in proportion to the size of the plate significantly longer that the left carriers figured on Pl. XII, figs. 3 and 7. The range of the variability of the laeobasal plates figured on Pl. XII indicates that the basal and laeobasal plates, described here as *Symmetroprion* sp. *a*, belong to some separate species.

Family POLYCHAETASPIDAE nov.

Diagnosis. — Asymmetrical jaw apparatuses of labidognatha type. Carriers (with antero-lateral processes) suboval or subrectangular, shorter than the length of MI. MI tapering both anteriorly and posteriorly, no transverse posterior margin. Right MI with a bight extending for one third to a half or somewhat more of the jaw length. Openings of pulp cavities in MI extending for 0.8 to 0.9 of the jaw length. Laeobasal plate lacking. Basal plate subtrapezoid, narrowing posteriorly, subtriangular or club-like. Intercalary tooth present or lacking. MII paired, subbevel square shaped. MIII single, left, similar to left MII, but smaller. MIV subtriangular, denticulated. MV single teeth. Lateral teeth present. Mandibles (known only in *Polychaetaspis*) with a large, stripped anterior area and anterior margin slit into three tips.

Genera: *Polychaetaspis* KOZŁOWSKI, 1956, and *Kozlowskiprion* n. gen.

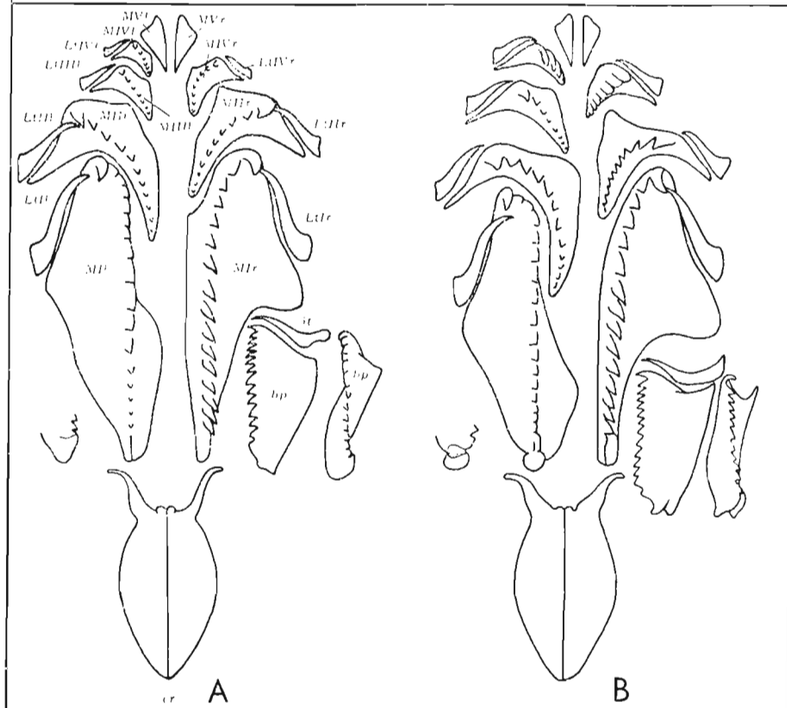
Genus **POLYCHAETASPIS** KOZŁOWSKI, 1956

Type species: Polychaetaspis wyszogrodensis KOZŁOWSKI, 1956.

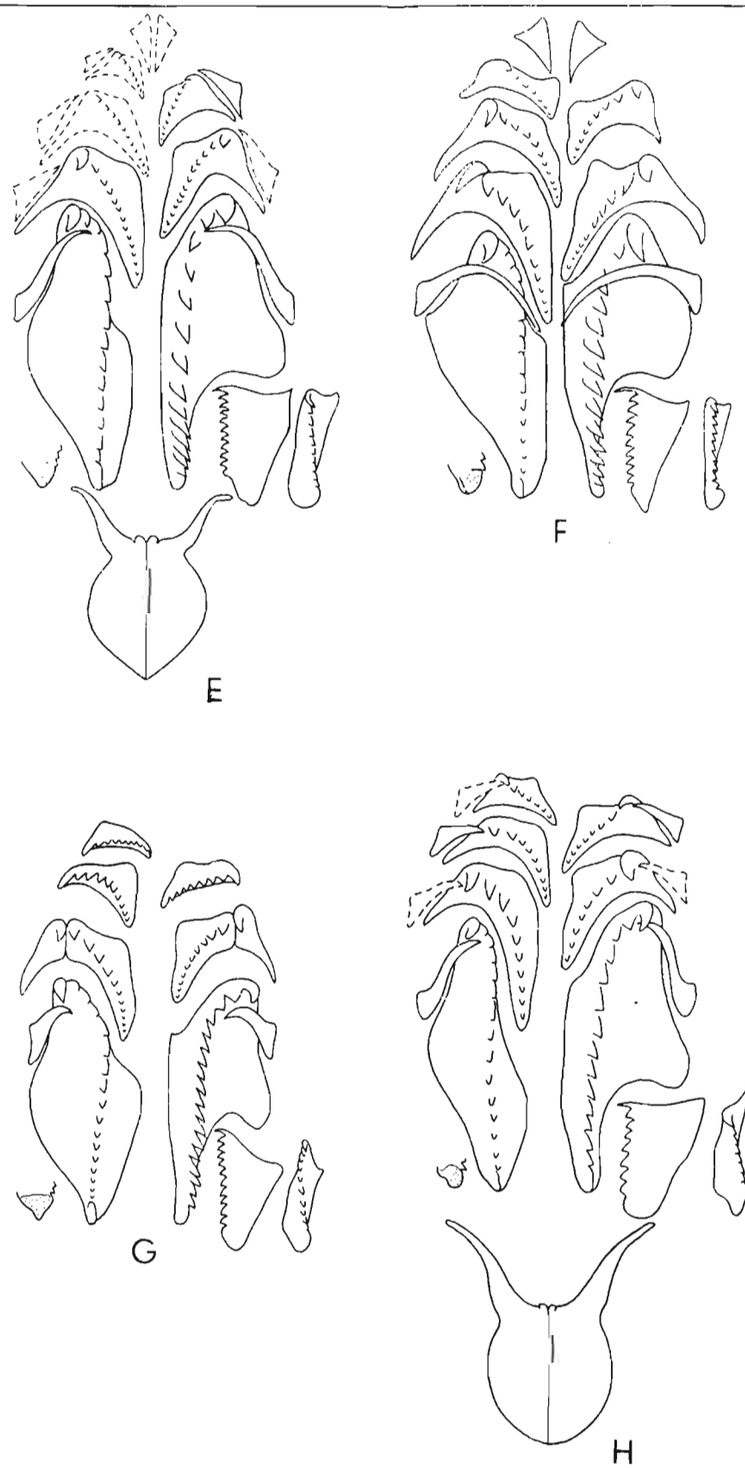
Diagnosis. — Carriers suboval or subrectangular. Left MI subtriangular in left lateral view, outer margin of left MI directed postero-laterally, bent at about half of the jaw length and directed postero-medially. Basal plate subtriangular or subtrapezoid.

DIAGRAMMATIC SKETCHES OF THE JAW APPARATUSES IN THE POLYCHAETASPIDAE AND POLYCHAETURIDAE

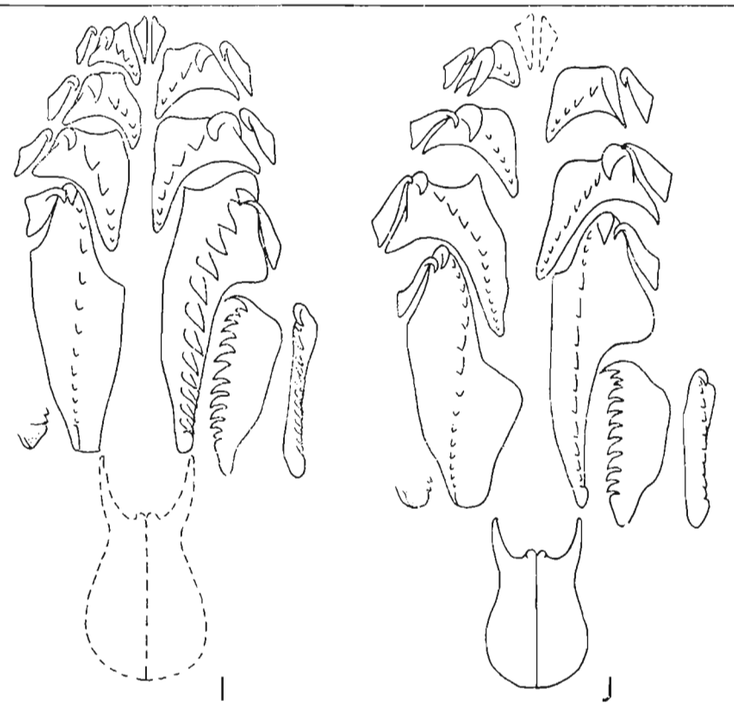
Group of *Polychaetaspis wyszogrodensis* Kozłowski



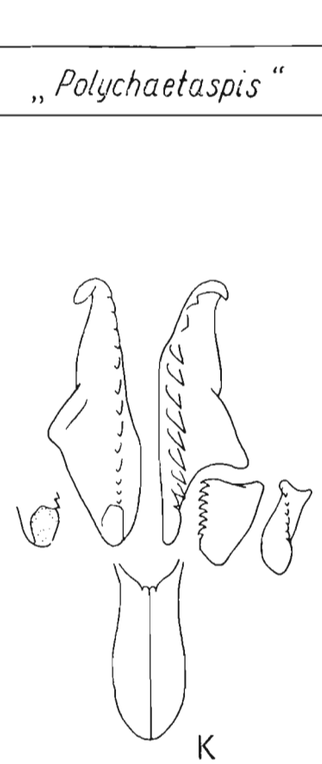
Group of *Polychaetaspis warkae* Kozłowski



Kozlowskiprion n.gen.



„ *Polychaetaspis* "



Polychaetura Kozłowski

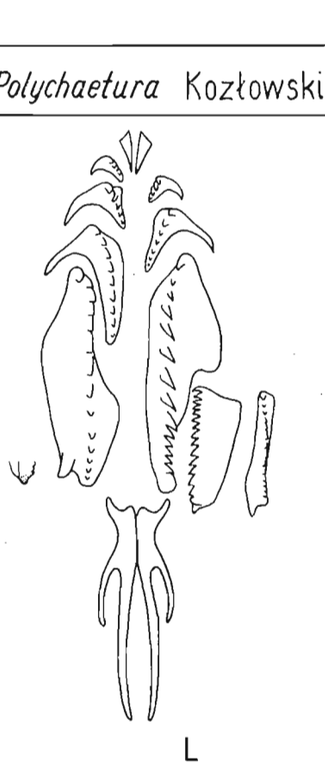


Fig. 8

A — *Polychaetaspis wyszogrodensis* Kozłowski, *B* — *P. tuberculatus* n. sp., *C* — *P. gadomskae* n. sp., *D* — *P. aequilateralis* n. sp., *E* — *P. warkae* Kozłowski, *F* — *P. latus* n. sp., *G* — *P. inconstans* n. sp., *H* — *P. varsoviensis* n. sp., *I* — *Kozlowskiprion longicavernosus* n. sp., *J* — *K. brevialatus* n. sp., *K* — *"Polychaetaspis" incisus* n. sp., *L* — *Polychaetura gracilis* Kozłowski

(For abbreviations — see p. 153)

Stratigraphic and geographical range. — Ordovician-Carboniferous; Europe, North America.

Species:

Group of *Polychaetaspis wyszogrodensis*

- *Polychaetaspis wyszogrodensis* KOZŁOWSKI, 1956 — type species
- *Polychaetaspis* cf. *wyszogrodensis* KOZŁOWSKI,
- *Polychaetaspis tuberculatus* n. sp.
- *Polychaetaspis gadomskae* n. sp.
- *Polychaetaspis aequilateralis* n. sp.
- *Polychaetaspis* cf. *aequilateralis* n. sp.

Group of *Polychaetaspis warkae*

- *Polychaetaspis warkae* KOZŁOWSKI, 1956
- *Polychaetaspis latus* n. sp.
- *Polychaetaspis inconstans* n. sp.
- *Polychaetaspis varsoviensis* n. sp.
- *Polychaetaspis* sp. *a*
- *Polychaetaspis* sp. (the specimen figured by KOZŁOWSKI, 1956, Fig. 5, as *Polychaetaspis wyszogrodensis*)

"*Polychaetaspis*" *incisus* n. sp.

Discussion. — Isolated right and left MI of *Polychaetaspis* are the most common scolecodonts in the samples from nearly all the boulders examined. The variability in their shape and size indicates that throughout the Ordovician and Silurian the polychaetaspids were a very successful and diversified line, represented in the Baltic region by some dozen species. The detached MI of *Polychaetaspis*, though belonging without doubt to several new species, remain in the writer's collection undescribed. Among the representatives of *Polychaetaspis* described here, two groups of species are recognized, called *Polychaetaspis wyszogrodensis* group and *Polychaetaspis warkae* group.

In the *P. wyszogrodensis* group the carriers are comparatively long, suboval, the intercalary tooth is present, bight in right MI extends for half of the jaw length or more, the basal plate is long. In the *P. warkae* group the carriers are shorter, subcircular or subrectangular, the intercalary tooth is lacking, bight in right MI extends for about one third of the jaw length and the basal plate is short.

The differences between the above discussed groups seem to be of generic rank, and a new genus for the *P. warkae* group should eventually be erected. This is not done here as both groups are still comparatively poorly known, particularly so, the structure of the anterior jaws and the lateral teeth associated with them.

"*Polychaetaspis*" *incisus* n. sp. is assigned only provisionally to *Polychaetaspis* as it is poorly known (single specimen) and differs from other representatives of this genus in many features.

The descriptions of isolated jaws of *Polychaetaspis* sp. are to be found in almost all the papers dealing with palaeozoic scolecodonts, MI being assigned mostly to the scolecodont genera: *Oenonites* HINDE, *Grubia* CRONEIS & SCOTT, *Lumbriconereites* EHLERS and *Nereidavus* GRINNELL, basal plates to: *Clelandia* CRONEIS & SCOTT, *Paleoenonites* ELLER and *Oenonites* HINDE, and carriers to: *Diopatraites* ELLER and *Siluropelta* EISENACK.

Polychaetaspis wyszogrodensis KOZŁOWSKI, 1956

(Plates: XIII, figs. 1-3; XIX, fig. 4; Text-figs. 5*K*, 8*A*)

1956. *Polychaetaspis wyszogrodensis* n. sp.; R. KOZŁOWSKI, Sur quelques appareils masticateurs..., pp. 175, 176, Figs. 3, 4, non Assemblage A, p. 180, Figs. 5, 6.

Type specimen: The jaw apparatus from the boulder No. O.116, figured by KOZŁOWSKI (1956, Fig. 3), consisting of carriers, basal plate, intercalary tooth, left MI, left MII (with the shank broken off), right MI, right MII (with the shank broken off), right MIV moved rearwards, right LtI hidden in part under right MIV. This specimen has been described in full detail by KOZŁOWSKI (1956) who gave to the particular jaws an interpretation somewhat different from that accepted in the present paper.

Type horizon and locality: Erratic boulder No. O.116 of ?Middle Ordovician age. Wyszogród, province of Warsaw.

Diagnosis. — Carriers longer than the basal plate, with long anterior processes. Intercalary tooth present. Basal plate subtrapezoid, narrowing posteriorly, with anterior and posterior margins subparallel, directed postero-laterally, posterior margin three times shorter *(tr.)* than the anterior. Right MI with a bight extending for about half the jaw length. Openings of pulp cavities in MI equal to 0.8 of the jaw lengths. Ligament scar in right MI elongated, somewhat inflated, in left MI flat with transversal anterior margin, occupying the most posterior part of the left slope. Inner wing in left MI extending for half the jaw length, provided with a transversal anterior margin. Lateral teeth slender, bent, one lateral tooth to each jaw.

Denticle formula:

Basal plate	—	9—13
MI	13—17	12—16
MII	7—10	9—12
MIII	5—7	—
MIV	5—6	7—8

Material. — In addition to the type specimen there are 3 incomplete jaw apparatuses from the boulder O.366, 7 incomplete apparatuses from the boulder O.400, one from the boulder O.463, 4 from the boulder O.469, isolated jaws from all these boulders, as well as from the boulders O.188 and O.472. Of the boulders yielding *P. wyszogrodensis* the age of No. O.366 has been ascertained as Middle Ordovician (?Kukruse Stage or Idavere Stage of Estonian sequence), the boulders O.400, O.469, O.188 and O.472 — on the base of the scolecodont assemblages are presumably also of this age. Age of the boulder O.463 is unknown.

Description. — Length of MI of the here assigned specimens vary between 0.33 and 1.37 mm. The entire apparatus (without carriers) is twice as long as wide, the greatest width being across the middle of MI.

Carriers have been described in detail by KOZŁOWSKI (1956). The carriers figured in the present paper (Plate XIII, figs. 2*a*, *b*) have the posterior part broken off, while those on Plate XIX, fig. 4 and Plate XIII, fig. 1*n* have the borders partly broken off.

Basal plate is in dorsal view subtrapezoid, narrowing strongly posteriorly, the posterior margin being three times shorter than the anterior one. Often, when preserved in an articulated jaw apparatus the basal plate appears subtriangular in dorsal view (e.g. Plate XIII, fig. 2*a*) as the posterior margin is directed obliquely inwards with regard to the dorsal surface of the apparatus and is not seen in this view. The posterior part of the dentary is somewhat bent.

Intercalary tooth fits tightly into the anterior margin of the basal plate.

Right MI in dorsal view is 2.8 times longer than wide, with or without a very narrow inner wing. A series of denticles decreasing in size posteriorly extends for 0.9 of the jaw length.

Behind the last denticle on the right slope there is a somewhat inflated ligament scar. The bight extends for half or less of the jaw length. The outer margin runs at first posteriorly, then turns and continues postero-laterally, around a comparatively prominent shank. The posterior margin of the shank is directed transversally. In left lateral view: the boundaries between the denticles are prolonged somewhat on the left slope, the inner wing extends for two thirds of the jaw length from behind. Anterior margin of the inner wing is directed transversally. The inner wing tapers posteriorly. In right lateral view the anterior and outer margins form an arch, the posterior part of the right slope, opposite the bight tapers strongly. In ventral view the opening extends for 0.8 of the jaw length. A furrow with pits associated with the denticles runs along the inner margin. Subparallel to the outer margin there is a furrow, which in the anterior part of the opening enlarges into a small and indistinct muscle scar.

Left MI is a comparatively narrow, elongated jaw. In dorsal view the outer margin is directed at first postero-laterally, in front of mid-length it bends and runs postero-medially. Anterior part of the inner margin is hidden under the dentary. Posteriorly the right slope widens into a prominent inner wing, which extends for about half of the jaw length. A series of denticles extends for about 0.9 of the jaw length. To the rear of the last denticle, there is a ligament scar, poorly seen in this view. In left lateral view the jaw is widest at about one third of the jaw length from the front and tapers posteriorly. The boundaries between the denticles are prolonged on the left slope. The posterior triangular part of the right slope, beyond the last denticle, is occupied by a poorly defined ligament scar. The anterior part of the ligament scar is directed subtransversally. In right lateral view the anterior part of the right slope is very narrow, posteriorly it enlarges into the inner wing. In ventral view the opening of the pulp cavity extends for 0.8 or somewhat less of the jaw length. The muscle scar is small and poorly defined, seen in some specimens at the anterior part of the opening, to the right of the furrow with pits.

Left MII is a jaw rounded anteriorly, with a series of denticles extending the full length of the jaw. Laterally the transverse branch is produced into a slender, sharply pointed shank, directed postero-laterally. In the type specimen figured by KOZŁOWSKI (1956, Fig. 3) the shank in left MII is broken off. Opening of the pulp cavity is almost gaping.

Right MII is somewhat smaller than the left one, otherwise being its mirror image. In the type specimen the shank, similarly as in left MII, is broken off.

Left MIII is similar in shape to left MII, but smaller.

Right and left MIV are small, subtriangular jaws, with slender shanks, directed subtransversally.

Lateral teeth: LtI comparatively short, bent teeth, adhering to MI dorsally just beyond the first denticle. Each anterior jaw is associated with one lateral tooth, which adheres to it dorsally.

Mandibles: Imperfectly preserved mandibles have been found in some specimens of *P. wyszogrodensis*. No differences between them and those of *P. tuberculatus* have been stated.

Variation. — Basal plate: variation concerns the shape of the anterior margin, which may be sigmoid (as in the type specimen) or concave (e.g. Plate XIX, fig. 4). The proximal part of the anterior margin in some specimens is more strongly extended anteriorly (e.g. Plate XIII, fig. 2*a*) and recalls that of *P. gadomskae*. Variation of the right MI concerns the shape of the inner wing, which in some specimens (e.g. Plate XIII, fig. 1*b*) is wide anteriorly, whereas in others it is much more narrow. In addition, the length of the bight and the shape of the shank may vary. Left MI may be elongated to different degrees, the length and width of the inner wing, and the distinctness of the ligament scar are also subject to variation. Anterior margin

of the ligament scar in some specimens is directed transversally, while in others it is distinctly concave.

Discussion. — KOZŁOWSKI (1956) assigned to *P. wyszogrodensis*, in addition to the type specimen (KOZŁOWSKI, 1956, Text-figs. 3, 4), an incomplete jaw apparatus from the boulder No. O.31, figured by him in Text-figs. 5 and 6, as "Assemblage A". In the present writer's opinion, the "Assemblage A" is not conspecific with *P. wyszogrodensis*. It has a differently shaped right MI, with a bight extending for about one third of the jaw length (in *P. wyszogrodensis* it extends for almost half the length of right MI), and the shank in right MI is more strongly pronounced. Left MI of "Assemblage A" recalls that of *P. wyszogrodensis*, but differs from it in having a smaller inner wing and a larger and more distinct ligament scar. The shape of right MI of "Assemblage A" invites a comparison with the species of *Polychaetaspis warkae* group. However no jaw apparatus which could be regarded as conspecific with "Assemblage A", has been found in the writer's collection, and KOZŁOWSKI'S "Assemblage A" is called for the time being *Polychaetaspis* sp.

Polychaetaspis cf. **wyszogrodensis** KOZŁOWSKI, 1956

(Plate XIII, fig. 4)

Material. — Joined right and left MI and a basal plate separated during the drawing, five isolated left MI and one right MI — all from the boulder O. 148 (of ?Middle Ordovician age).

Description and comparison. — *Polychaetaspis* cf. *wyszogrodensis* reminds one of *P. wyszogrodensis* in the general shape of the basal plate and MI, differing however from the later species in its dimensions and in details. Length of MI in *P. wyszogrodensis* varies between 0.33 and 1.37 mm., while in *P.* cf. *wyszogrodensis* it is 1.5—3.0 mm. The outer and inner margins in the basal plate are subparallel, slightly converging posteriorly, while in *P. wyszogrodensis* they converge more strongly posteriorly. Bight in the right MI is longer with regard to the jaw length than in *P. wyszogrodensis*. Ligament scars in right and left MI, which in *P. wyszogrodensis* are comparatively poorly defined, are here larger and better defined. Left MI has somewhat different proportions, the incurvature of the outer margin being situated more posteriorly than in *P. wyszogrodensis*. The dentary is more strongly bent outwards in the anterior part, the first denticles being more strongly twisted out of alignment with the other denticles than in *P. wyszogrodensis*.

Polychaetaspis tuberculatus n. sp.

(Plate XIV; Text-figs. 1*C*, 8*B*)

1956. *Polychaetaspis* sp.; R. KOZŁOWSKI, Sur quelques appareils masticateurs..., p. 182, Assemblage D, Fig. 7.
1956. cf. *Polychaetaspis wyszogrodensis* n. sp.; R. KOZŁOWSKI, *Ibid.*, Figs 9*B-F*, 10, 11*B*.

Type specimen: Entire apparatus No. O.469/33, figured on Plate XIV, fig. 2.
Type horizon and locality: Erratic boulder No. O.469 of ?Middle Ordovician age, Mochty, province of Warsaw.
Derivation of the name: Lat. *tuber* — a knob, alludes to a knob-like projection at the posterior part of left MI.

Diagnosis. — Carriers comparatively narrow, longer than the basal plate. Intercalary tooth present. Basal plate with concave anterior margin and a short *(tr.)*, incised posterior margin. Posterior part of the dentary bent to fit a large, bulbous ligament scar of right MI. Left MI with a truncate posterior, ending in a knob-like projection; ligament scar small, subtriangular, situated beyond the knob. The opening of the pulp cavity in right MI extending

for 0.8 of the jaw length, in left MI for 0.7. Inner wing in left MI equal to one third of the jaw length, sigmoid.

Denticle formula:

Basal plate	—	11—14
MI	15—20	13—16
MII	10—14	9—12
MIII	7	—
MIV	4	4—5
MV	1	1

Material. — Nine incomplete jaw apparatuses or joined jaws from the boulder O.366, 38 — from the boulder O.400, 5 — from the boulder O.469; numerous isolated right and left MI and basal plates from these boulders, as well as from the boulders O.29 (single basal plate), O.116 (single left MI) and O.472 (several isolated MI and a basal plate). From among the boulders yielding *P. tuberculatus*, the age of No. O.366 has been ascertained as Middle Ordovician (?Kukruse Stage or Idavere Stage of Estonian sequence), and the age of No. O.29 as Middle Ordovician (?Uhaku Stage of Estonian sequence); on the base of faunistic similarities the remaining boulders are regarded tentatively as Middle Ordovician.

Description. — Comparatively large apparatuses, length of MI varying between 0.37 and 2.10 mm.

The entire apparatus (without carriers) is in dorsal view 1.8 times longer than wide, tapering both anteriorly and posteriorly, the greatest width being across MI, just in front of the basal plate.

Carriers are suboval, elongated, longer than the basal plate, antero-lateral corners being prolonged into moderately long, pointed processes.

Basal plate: The length of the basal plate is equal to about 0.45 that of the right MI. In dorsal view it is subtrapezoid, strongly narrowing posteriorly. Anterior margin is concave or somewhat sigmoid, the posterior margin is very short *(tr.)*, incised. The first denticle is the longest, the next five are the smallest, the remainder again very gradually increasing in size. The series of denticles extends for about 0.8 the length of the inner margin. The very posterior part of this margin is developed as a rounded ridge, bent upwards and outwards to fit the large ligament scar of the right MI. The posterior part of the basal plate is arranged obliquely, the outer margin being situated lower than the inner one. In some specimens on account of this inclination of the posterior part of the plate, the posterior margin is invisible in dorsal view and the basal plate appears subtriangular. In ventral view: the belt extends anteriorly for half the jaw width, in the posterior part it inclines downwards and its width decreases.

Intercalary tooth tightly fits the anterior part of the basal plate; it is bent, concave anteriorly. Proximal part of the tooth is twice as narrow *(long.)* as the distal one. In some specimens the tooth protrudes laterally over the basal plate. In ventral view: the opening extends for one third or more of the length *(tr.)* of the tooth.

Right MI is 2.5 times longer than wide. In dorsal view the outer margin runs at first postero-laterally in a somewhat concave course, then turns around a prominent shank. The bight extends for about one half of the jaw length. The anterior margin of the bight is directed transversally, not incurved into the jaw. The right slope, opposite the bight at first tapers posteriorly, then it widens to from a large, knob-like ligament scar with a dull surface. The inner margin runs posteriorly — there is no inner wing. A series of 13—16 denticles decreasing in size posteriorly, extends up to the knob-like ligament scar. In dorsal view the two first den-

ticles are twisted out of the alignment with the other denticles. In left lateral view the jaw is widest at a quarter of the length from the front, then tapers posteriorly. The denticles are sharply pointed. In ventral view the cover extends for 0.2 of the jaw length. There is no belt. A series of pits associated with the denticles extends along the inner margin. In the middle of the opening there is a subtriangular inflation, which prolongs posteriorly, delimited by a furrow with pits and by a furrow which runs along the outer margin. No distinct muscle scar is visible.

Left MI is a comparatively elongated jaw, length to width ratio in dorsal view being 2.7. The greatest width of the jaw is slightly in front of mid-length. The outer margin runs at first postero-laterally in a somewhat concave course, a little in front of half of the jaw length, it turns and continues postero-medially, to the prominent, knob-like process at the posterior extremity of the jaw. The left slope is arranged more or less horizontally. The anterior part of the right slope is very narrow, directed downwards and invisible in dorsal view. Posteriorly it enlarges into the inner wing, with somewhat sigmoid anterior and outer margins. The greatest width of the inner wing is at about three quarters of the jaw length from the front — from this point the wing strongly narrows anteriorly. The length of the wing does not exceed one third that of the jaw. A series of 15—20 denticles extends for about 0.9 of the jaw length. The three first denticles are twisted out of alignment with the other denticles. The first one is the longest, next 3—4 are small, then the denticles increase in size to near midpoint, decreasing again posteriorly. To the rear of the last denticle a short *(long.)* rounded ridge runs posteriorly and enlarges into a tubercule. In front of the tubercule, on the left slope, there is a small, irregular and indistinct ligament scar, delimited anteriorly by a transverse rounded ridge. In front of this ridge there is a depression on the jaw. In left lateral view, the jaw is subtriangular, widest at mid-length, with posterior tubercule very distinct. In right lateral view the right slope is wide posteriorly, narrowing anteriorly. In ventral view: the cover extends for 0.3 of the jaw length or somewhat more. The furrow with pits is very deep. On the right and beyond the posterior extremity of the furrow, there is a small inflation, associated with the depression of the muscle scar. The posterior tubercule is much less distinct in this view than dorsally.

Left MII is a comparatively large jaw, roughly bevel square shaped, with a series of 10—14 denticles, extending in an arch the full length of the jaw. The transverse branch is produced distally into a spine-like process, directed postero-medially. In ventral view the cover is small, triangular, occupying only the very anterior part (with first denticle) of the jaw.

Right MII is similarly shaped as left MII, but smaller, shorter and with a smaller number of denticles.

Left MIII is subtriangular, produced laterally into a slender pointed shank. A series of denticles extends the full length of the jaw.

Right MIV is arcuate in shape, with bent denticles. The boundaries between the individual denticles are prolonged on the left and right slopes.

Left MII is a mirror image of the right one, but smaller and with a smaller number of denticles.

MV — single teeth.

Lateral teeth: The number of lateral teeth presumably corresponds to the number of jaws, each jaw being associated with one tooth. LtI are comparatively strong teeth, arranged obliquely across MI, beyond the first denticle of MI. Lateral teeth presumably tightly fitted the outer margins of the corresponding jaws.

Mandibles: Each mandible — in ventral view — consists of a large, suboval anterior area, extending for somewhat less than one half of the mandible length and of a strong shank, tapering posteriorly. The anterior area is indistinctly striped with thread-like lines, subparallel

to the outer margin. Anterior margin, directed postero-medially, is slit, to form three tips. The outer tip is very strong, much longer and wider than the remaining ones, the inner ones being the smallest. On the posterior shank a very faint ornamentation of thread-like lines is visible.

Discussion. — *Polychaetaspis tuberculatus* differs from all the other representatives of *Polychaetaspis* in having a knob-like posterior projection in the left MI. The subtrapezoid shape of the basal plate is shared with *P. wyszogrodensis* and *P. gadomskae*, but it differs from these species in having an incised posterior margin and strongly bent posterior part of the dentary, which fits the bulbous ligament scar of the right MI. The inner wing in left MI in *P. tuberculatus* is shorter and differently shaped than in other representatives of the *P. wyszogrodensis* group.

Detached left MI, described by GRIES (1944, p. 25, Plate 1, figs 19, 20) as *Grubia nodosa* GRIES from the Ordovician (Liberty-Richmond formations) of Ohio, USA, recalls strongly *Polychaetaspis tuberculatus* n. sp. It has a distinct tubercule at the posterior extremity, 16 denticles, an inner wing and all proportions identical to those in left MI of *P. tuberculatus* n. sp. None of the right MI figured by GRIES can be regarded as conspecific with our species, though *Grubia bifurca* GRIES (GRIES, 1944, p. 23, Plate 1, figs. 3, 4) is of *Polychaetaspis* type.

An isolated left MI with a distinct tubercule at the posterior extremity has also been described by ELLER, from the Trenton Series of Ontario, as *Lumbriconereites tuberosus* ELLER (ELLER, 1945, p. 135, Plate 1, figs. 34—36). *L. tuberosus* has quite different proportions from the left MI of our species, is more elongated with regard to the width and has a differently shaped and more elongated inner wing.

Polychaetaspis gadomskae n. sp.

(Plate XV; Text-fig. 8*C*)

Type specimen: The apparatus No. O.400/61, figured on Plate XV, fig. 1, consisting of the carriers, which are arranged obliquely with regard to the dorsal surface of the apparatus, basal plate with the anterior proximal part broken off, intercalary tooth, right and left MI, right and left MII, ?fragmentary left MIII, right MIV, right and left LtI and fragmentary mandibles.

Type horizon and locality: Erratic boulder No. O.400 of ?Middle Ordovician age, Mochty, province of Warsaw.

Derivation of the name: Named in honour of Mrs. EWA GADOMSKA, who made the drawings of the present monograph.

Diagnosis. — Carriers suboval, longer than the basal plate. Intercalary tooth present. Basal plate with proximal part strongly elongated anteriorly, sigmoid anterior margin, and short *(tr.)* posterior margin directed postero-laterally. Right MI 2.3 times longer than wide, with prominent, short *(long.)* shank and a bight extending for less than half the jaw length. Left MI more than twice as long as wide, the greatest width across mid-length, with a prominent left protuberance at the middle of the jaw length. Ligament scar poorly defined or lacking. MII comparatively large jaws with shanks directed postero-laterally, almost posteriorly and strongly concave posterior margins.

Denticle formula:

Basal plate	—	10—13
MI	11—15	11—16
MII	9—12	9—10
MIII	8—9	—
MIV	unknown	unknown
MV	,,	,,

Material. — Two incomplete jaw apparatuses from the boulder No. O.366, 18 — from the boulder O.400, isolated right and left MI from these boulders, as well as from the boulders O.423 and O.472. Of the boulders yielding *P. gadomskae* — age of No. O.366 has been ascertained as Middle Ordovician (?Kukruse Stage or Idavere Stage of Estonian sequence).

Description. — Length of MI varies between 0.27 and 0.70 mm.

The entire apparatus (without carriers) strongly tapers both posteriorly and anteriorly, the greatest width being across the mid-length of MI.

Carriers are suboval, longer than the basal plate, with short anterior processes, 1.5 times longer than wide. In all the specimens the carriers are poorly preserved.

Basal plate is comparatively long in the proximal part, the length of the inner margin is equal to half that of the right MI. The proximal part is strongly elongated anteriorly, the anterior margin sigmoid. In the proximal part it is directed postero-laterally, then turns and continues subtransversally. The outer margin is directed postero-medially, the inner posteriorly. There is a short posterior margin directed postero-laterally, somewhat downwards with regard to the dorsal surface of the apparatus. In an articulated apparatus the posterior margin of the basal plate is hidden in dorsal view and the plate appears subtriangular. A series of 10—13 denticles extends for 0.9 of the jaw length. The first denticle is the longest, the next two very small, the remaining ones slightly increasing in size posteriorly. The posterior part of the inner margin is arranged somewhat higher than the anterior one. In ventral view a belt extends anteriorly for more than half the width of the plate, narrowing posteriorly. In left lateral view the belt appears of equal width all along the jaw length. In the dorso-lateral view of the basal plate, when the posterior margin is directed downwards, the posterior part of the belt is visible as a crescent-shaped wing.

Intercalary tooth fits tightly into the anterior margin of the basal plate. It is strongly sigmoid, arranged in the proximal part postero-laterally, in the distal part subtransversally.

Right MI is 2.3 times longer than wide, the greatest width being somewhat beyond mid-length. The bight extends for about 0.4 of the length of the right MI. There is no distinct inner wing on the inner border. The outer margin runs almost posteriorly, then turns and continues postero-laterally. The shank is moderately prominent. The posterior margin, opposite the bight is directed subtransversally. A series of 11—16 denticles decreasing in size posteriorly, extends for 0.9 of the jaw length. To the rear of the last denticle the undenticulated ridge continues to the end of the jaw. In right lateral view the right slope beyond the last denticle looks somewhat dull, but there is no defined ligament scar. In left lateral view the jaw is the widest at one third of the length from the front, and from this point tapers posteriorly. The boundaries between the denticles are indistinctly seen on the left slope. In ventral view the opening of the pulp cavity extends for 0.8 of the jaw length. There is a furrow subparallel to the outer margin, which anteriorly enlarges somewhat into a very indistinct and poorly defined muscle scar. The surface enclosed between this furrow and the furrow with denticles is somewhat inflated.

Left MI in dorsal view is 2.3—2.5 times longer than wide, the greatest width being at mid-length. A series of 11—15 denticles, decreasing in size posteriorly, extends for 0.9 of the jaw length. The outer margin is directed postero-laterally to about mid-length, at this level it turns, continues a short distance transversally and then postero-medially. At half length there is a distinct protuberance on the left border. The inner margin runs postero-laterally and then posteriorly for one third of the jaw length, at which point the right slope enlarges

into a prominent inner wing, which tapers posteriorly. The anterior margin of the inner wing is directed subtransversally or obliquely postero-laterally. A series of 11—15 denticles decreasing in size posteriorly extends for 0.9 of the jaw length. Beyond the last denticle the prominent ridge extends to the end of the jaw. This short *(long.)* ridge is strongly compressed laterally at the anterior part, in some specimens it widens somewhat posteriorly. There is no ligament scar, however in some specimens the most posterior part of the left slope is somewhat dull. In left lateral view the jaw is widest at about one third of the length from the front and then narrows posteriorly to the rounded posterior end. The surface of the jaw is uniformly shining in the posterior part. In right lateral view the boundaries between the denticles indistinctly continue on the right slope. The jaw is rounded posteriorly, the inner wing marked on the inner margin, which in front of the wing is somewhat concave and then forms an arch together with the anterior margin.

Left MII is a comparatively large and strong jaw with a series of 9—12 denticles strongly decreasing in size posteriorly. It is arched anteriorly, with a concave posterior margin. The inner (denticulated) branch is twice as long as the outer one, which is produced postero-laterally into a spine-like process. This outer spine-like branch, together with the first denticle is often broken off, and the jaw become bevel square shaped. The pulp cavity is gaping.

Right MII is similarly shaped as the left one, but smaller. In the specimen, figured on Plate XV, fig. 3*h*, the distal spine-like branch, together with the first denticle is broken off, and arranged in an unnatural position, dorsally covering the proximal branch of the jaw.

Left MIII is imperfectly known, presumably of similar shape as left MII, but smaller.

Right MIV fragmentary, preserved in two specimens, is imperfectly known. *Left MIV* is unknown.

Lateral teeth: LtI are comparatively small, sigmoid teeth covering MI dorsally. Anterior lateral teeth are unknown.

Mandibles: Only fragmentary mandibles are preserved in some specimens, no differences in their structure can be stated in comparison with those of *P. tuberculatus*.

Variation concerns the shape of the basal plate, which may have the proximal part more elongated anteriorly or shorter, and consequently the anterior margin is variously sigmoid. The proportions of both MI (length to width ratio), as well as the length of the bight in right MI may also vary. The inner wing in left MI may have the anterior margin transversal or directed obliquely.

Discussion. — *Polychaetaspis gadomskae* is very similar to *P. wyszogrodensis*; as both species occur in the samples from the same boulders, their recognition in poorly preserved specimens sometimes proves difficult. The main difference concerns the shape of the basal plate, which in *P. wyszogrodensis* has the anterior margin directed subtransversally, while in the here described species it is strongly sigmoid. The bight in right MI in *P. wyszogrodensis* extends for half the jaw length, whereas in *P. gadomskae* for 0.4. Both MI are in *P. gadomskae* wider with regard to length than in *P. wyszogrodensis*. Left MI in *P. gadomskae* is provided with a lateral protuberance. The ligament scar, poorly defined but present in *P. wyszogrodensis*, is in *P. gadomskae* lacking. MII is narrow *(tr.)* and strongly arched anteriorly, the distal part being directed almost posteriorly, while in *P. wyszogrodensis* it is comparatively wide *(tr.)*, the distal part being directed postero-laterally.

Polychaetaspis aequilateralis n. sp.

(Plate XVI, figs. 3-5; Text-fig. 8*D*)

Type specimen: Joined right and left MI, No. O.187/19, figured on Plate XVI, fig. 4.

Type horizon and locality: Erratic boulder No. O.187 of ?Silurian age, Mochty, province of Warsaw.

Derivation of the name: Lat. *aequilateralis* — with equal sides, alludes to the shape of the basal plate, which has anterior and posterior margins of almost equal lengths.

Diagnosis. — Carriers suboval, with long anterior processes. Basal plate long, triangular, tapering both anteriorly and posteriorly, the greatest width being somewhat in front of mid-length. Intercalary tooth present. Bight in right MI extending for 0.5—0.6 of the jaw length. Shank in right MI directed postero-laterally. Left MI subtriangular, with a prominent protuberance at half of the jaw length. Ligament scar in left MI subrhomboid, large and well defined.

Denticle formula:

Basal plate	—	9—11
MI	11—14	12—14
MII	11—12	?11
MIII	?8	—
MIV—MV	unknown	unknown

Material. — In addition to the type specimen there is one pair of joined jaws from the boulder O.187, incomplete right side from the boulder O.185, basal plate with intercalary tooth and carriers from the boulder O.391, numerous isolated right and left MI, or basal plates from these boulders, as well as from the boulders O.98, O.161, O.245, O.391, O.410, O.439, O.441 and O.442. Of the boulders yielding *P. aequilateralis*, the age of the boulder O.410 has been ascertained as Silurian (Lower Ludlow) and the boulder O.441 as Silurian (?Wenlock). It is probable that the stratigraphic range of *P. aequilateralis* is restricted to the Silurian.

Description. — Length of MI varies between 0.23—1.42 mm.

Carriers, preserved in one specimen figured on Plate XVI, fig. 3, are suboval, strongly tapering posteriorly. Antero-lateral corners are prolonged into very long and thin anterior processes. Outer margin is in the anterior part strongly incurved, then it runs postero-laterally to mid-length and continues postero-medially. The greatest width of the carriers is about mid-length.

Basal plate is triangular, 2.7 times longer than wide, tapering both anteriorly and posteriorly. The greatest width is somewhat in front of mid-length. Anterior margin, directed postero-laterally, is somewhat shorter than the outer margin directed postero-medially. A series of 9—11 denticles, insignificantly decreasing in size posteriorly, extends for 0.8 of the length of the inner margin. In some specimens first denticle is much longer than the remaining ones. The inner margin to the rear of the last denticle, is thickened and bent somewhat upwards and outwards. In ventral view the belt is comparatively large, extending for more than half the jaw width anteriorly, the boundaries between the denticles are in some specimens prolonged onto the belt. Posterior part of the belt is directed downwards with regard to the dorsal surface of the basal plate, and the belt narrows somewhat posteriorly in ventral view. In left lateral view the belt is of equal size all along its length, in the very posterior part being somewhat concave. The opening of the pulp cavity is comparatively small, fissure-like, tapering posteriorly. Intercalary tooth fits tightly into the anterior margin of the basal plate.

Right MI is 2.5 times longer than wide. A series of 12—14 denticles decreasing in size posteriorly extends for 0.9 of the jaw length. The greatest width of the jaw is somewhat in

front of mid-length. The three first denticles (the longest) are twisted out of alignment with the other denticles. To the rear of the last denticle there is a somewhat inflated, elongated *(long.)* ligament scar. The left slope is directed downwards with regard to the dorsal surface of the jaw and there is no inner wing in dorsal view. The inner margin runs at first postero-laterally, and then continues posteriorly. The outer margin is directed postero-laterally (somewhat concave). The shank is prominent, comparatively narrow. The posterior margin, surrounding the bight, incurves into the jaw. Length of the bight varies between 0.5—0.6 that of the jaw. In left lateral view the left slope slightly narrows posteriorly. In right lateral view the jaw is widest at a third of its length from the front. The anterior margin forms an arch together with the outer one. The posterior part of the right slope, opposite the bight, narrows posteriorly.

In ventral view the opening of the pulp cavity extends for 0.8 of the jaw length. There is no belt. In the anterior part of the opening there is a poorly defined, suboval muscle scar, a trace of which is seen on the dorsal side only in bleached specimens. A deep furrow with pits associated with the denticles is seen in ventral view.

Left MI is in dorsal view 2.4 times longer than wide, the greatest width being about mid-length. Outer margin is somewhat concave and runs postero-laterally to a prominent protuberance, then curves and continues postero-medially, being somewhat concave. Anterior part of the right slope is hidden under the dentary in dorsal view. Posteriorly it enlarges into a prominent inner wing, which extends for half of the jaw length. Anterior margin of the inner wing is directed somewhat obliquely, the wing tapering posteriorly. A series of 11—14 denticles, decreasing in size posteriorly, extends for 0.8—0.9 of the jaw length. To the rear of the last denticle there is a thickening of the ligament scar, which is best seen in left lateral view. In left lateral view the jaw is subtriangular, widest at a third of its length from the front. At the most posterior part there is a very large, well defined ligament scar, subrhomboid, tapering both anteriorly and posteriorly. In right lateral view the anterior margin forms an arch. The right slope is comparatively wide anteriorly and enlarges posteriorly into a prominent inner wing. In ventral view the cover extends for 0.8 or somewhat less of the jaw length. The muscle scar is poorly defined and indistinct, seen after bleaching on the dorsal surface of the jaw as an indistinct spot. The furrow with pits associated with the denticles is distinctly seen.

Right MII is a jaw in form of a bevel square, with a transverse branch prolonged postero--laterally into a pointed end. Posteriorly the jaw tapers strongly. A series of 11 denticles extends nearly the full length of the jaw. In ventral view the pulp cavity is gaping.

Right MIV is subtriangular, small jaw with a series of 6 small denticles, equal in size, extending along the inner margin. Laterally it is prolonged into a spine-like process. The opening of the pulp cavity is gaping.

Left MII, MIII, MIV and MV, right MV and anterior teeth are unknown.

Discussion. — *Polychaetaspis aequilateralis* n. sp. is comparatively poorly known, the writer decided however to describe it as a separate species, as it is well defined, and even the separate MI are identifiable, due to the characteristic shape of the jaws and ligament scars. In the shape of the carriers and the presence of intercalary tooth *P. aequilateralis* recalls *P. wyszogrodensis* and *P. tuberculatus*. It differs from the latter species in having a triangular basal plate and a longer bight in right MI. Left MI of *P. wyszogrodensis* and *P. aequilateralis* have an inner wing, similar in shape. *P. aequilateralis* has, however, a more prominent lateral protuberance than *P. wyszogrodensis*, and a differently shaped ligament scar, which in *P. wyszogrodensis* is smaller and has a transverse anterior margin, while in *P. aequilateralis* it tapers both anteriorly and posteriorly. The basal plate of *P. aequilateralis* recalls that of *P. inconstans*,

from the latter species *P. aequilateralis* differs in the stucture of MI. The right MI has in *P. inconstans* a much shorter bight, there is no lateral protuberance in left MI. In addition, *P. inconstans* has much deeper and larger muscle scars, and smaller and differently shaped, poorly defined ligament scars. The intercalary tooth characteristic of *P. aequilateralis*, is lacking in *P. inconstans*.

Polychaetaspis cf. **aequilateralis** n. sp.

(Plate XVI, fig. 6)

Material. — One apparatus No. O.56/1 consisting of carriers, basal plate, intercalary tooth, right and left MI, right and left MII, left MIII, right and left LtI and LtII, uncertain right LtIV. Erratic boulder No. O.56 of Silurian age, Dziwnów, Baltic coast.

Description and comparisons. — As the specimen O.56/1 is very similar to *P. aequilateralis* n. sp. its description is confined to pointing out the differences with *P. aequilateralis*.

Carriers in specimen No. O.56/1 are subrectangular, of the same width all along the length, while in *P. aequilateralis* they are very narrow anteriorly, widening towards mid-length and tapering posteriorly. It is possible that the posterior part of the carriers in *P.* cf. *aequilateralis* has been broken off, and that it was rounded.

Basal plate is very similar to that in *P. aequilateralis*, differing only in having a more transversally directed anterior margin.

Right and *left MI* are of the same general pattern as in *P. aequilateralis*, the only difference concerns the shape of the ligament scar in left MI, which in *P. aequilateralis* is large and pointed anteriorly, whereas in the here described specimens it is smaller and has a transverse anterior margin.

Right MII in *P.* cf. *aequilateralis* is similar to that in *P. aequilateralis*. Left MII is somewhat larger than right MII, otherwise being its mirror image.

Left MIII is poorly preserved, similar in shape to MII left, but smaller.

Lateral teeth, unknown in *P. aequilateralis*, are preserved in the described specimen. LtI are bent teeth, shorter *(tr.)* than the width of MI. LtII are subtriangular teeth with wide bases, adhering to MII dorsally. An uncertain, poorly preserved LtIV is present in front of the right MII.

Polychaetaspis warkae Kozłowski, 1956

(Plate XVII, fig. 1; Text-fig. 8*E*)

1956. *Polychaetaspis warkae* n. sp.; R. Kozłowski, Sur quelques appareils masticateurs..., p. 189, Figs 14-16.

Type specimen: Jaw apparatus from boulder No. O.29, figured by Kozłowski (1956, Fig. 14), consisting of carriers, basal plate, right and left MI, right MII, right MIV, left and right LtI and right LtIV. The jaws of the apparatus became separated after they were drawn by Kozłowski and are figured in the present paper on Plate XVII, fig. 1.

Type horizon and locality: Erratic boulder No. O.29 of Middle Ordovician age (?Uhaku Stage of Estonian sequence), Warka, province of Warsaw.

Diagnosis. — Carriers small, somewhat longer than the basal plate, arranged vertically in the anterior part, horizontally in the posterior part, appearing bulbiform in dorsal view.

Basal plate small, subtriangular, tapering posteriorly. Intercalary tooth lacking. Bight in right MI extends for 0.4 of the jaw length. Left MI — a comparatively narrow jaw, its length being three times its width, with an inner wing extending for 0.58 of the jaw length in dorsal view. Openings in MI extending for about 0.8 of the jaw length, at the anterior part of pulp cavities very deep subtriangular muscle scars. Ligament scars in both MI and basal plate comparatively large, poorly defined.

Denticle formula:

Basal plate	—	10
MI	14	14
MII	unknown	13
MIII	,,	—
MIV	,,	9

Material. — Type specimen only.

Description. — KOZŁOWSKI (1956) described *Polychaetaspis warkae* by comparing it with *P. wyszogrodensis*. In the large collection of polychaetaspid jaw apparatuses studied by the present writer, none can be regarded with certainty as conspecific with KOZŁOWSKI's type specimen. Separation of this specimen into individual parts has shown the details of the structure of detached jaws, hidden in the articulated apparatus and previously not observed. For this reason it is considered desireable to repeat the description of *P. warkae* in the present paper.

Carriers are longer than the basal plate. When arranged in the articulated jaw apparatus, the anterior part of each carrier is directed nearly vertically, while the posterior one horizontally, this gives the carriers a bulbiform appearance in the dorsal view (comp. KOZŁOWSKI, 1956, Fig. 14A_1). Isolated right carrier, figured in the present paper (Plate XVII, fig. 1*g*) is subrectangular, with concave anterior margin, moderately long antero-lateral process and broadly rounded postero-lateral corner.

Basal plate is subtriangular in dorsal view, twice as long as wide, strongly tapering posteriorly. Anterior margin is concave; outer margin, directed postero-medially, is in the posterior part insignificantly incurved. A series of ten small denticles extends for three quarters the length of the inner margin. First denticle is twice the size of the remaining ones. Posterior part of the inner margin, beyond the last denticle, is thickened and there is a poorly defined ligament scar. In ventral view the belt occupies half of the jaw width anteriorly and strongly narrows posteriorly.

Right MI is 2.2 times longer than wide, the greatest width being behind the mid-length and just in front of the bight. In dorsal view the outer margin runs postero-laterally in a somewhat concave course and then proceeds around a prominent shank. The inner margin runs postero-laterally, then posteriorly, and in the very posterior part postero-medially. The inner wing is very narrow. First denticle is the largest. In dorsal view first two denticles are twisted out of the alignment with other denticles, which increase in size towards the middle and then decrease again posteriorly. To the rear of the last denticle there is a small area of a poorly defined ligament scar, which passes onto the right slope.

In the type specimen here described (Plate XVII, fig. 1*d*) the jaw in front of the bight is somewhat bent inward (almost fractured). In ventral view the opening extends for about 0.85 of the jaw length; there is no belt. In the anterior part of the opening there is a deep teardrop shaped muscle scar.

Left MI is 2.2 times longer than wide, the greatest width being about its mid-length. In the dorsal view the outer margin proceeds postero-laterally being somewhat concave; it

arches about its mid-length and continues postero-medially, its posterior part being somewhat incurved. The inner margin is in this view hidden under the dentary. A prominent inner wing occupies 0.58 of the jaw length. There is a series of 14 denticles, the first two of which are twisted out of the alignment with other denticles. First denticle is the largest, the succeeding ones small, then the denticles increase in size towards the middle of the dentary and decrease again posteriorly. To the rear of the last denticle there is a comparatively small ligament scar, poorly visible in dorsal view. In left lateral view the jaw is subtriangular, widest in the middle. A comparatively large subtrapezoid muscle scar, with poorly defined margins is seen at the posterior extremity. In right lateral view the inner wing appears longer than in dorsal view. In ventral view the cover is somewhat longer than in the right MI, the opening extends for 0.82 of the jaw length. A comparatively large muscle scar, similar in shape to that in the right MI, is present.

Right MII is broken off in the type specimen and arranged in an unnatural position. It is a subtriangular jaw strongly tapering posteriorly, with a somewhat convex anterior margin, directed postero-laterally. A series of 13 denticles, decreasing in size posteriorly, extends the full length of the jaw. First denticle is distinctly longer than the remaining ones, which in the type specimen are strongly worn. The boundaries between the denticles continue onto the wall of the jaw. Laterally the jaw is produced outwards as a sharply pointed shank, as an extension of the first denticle.

Right MIV is similar in shape to right MII, but smaller, bearing 9 small denticles. The inner denticulated margin is strongly convex, the outer one concave.

Right and *left LtI* are comparatively narrow and long teeth, arranged obliquely across MI, just beyond the first denticle. The basis of the teeth fit the incurvatures at the anterior part of the outer margins in MI.

Right LtIV is a triangular tooth with a wide base. The tip of the tooth lies in alignment with the denticles of MIV. The posterior margin of the tooth fits tightly into the anterior margin of MIV.

Discussion. — Right MII of *Polychaetaspis* type, found in the sample from the boulder yielding the type specimen of *Polychaetaspis warkae* (No. O.29), was figured by KOZŁOWSKI (1956, Fig. 16) as cf. *Polychaetaspis warkae*. It is somewhat similar in shape to the right MII in the type specimen, but differs from the latter in its greater size and in the fact that the boundaries between the denticles are not visible on the jaw wall. Its conspecifity with *P. warkae* cannot be established.

P. warkae differs from *P. wyszogrodensis*, *P. tuberculatus* and *P. aequilateralis* in having a shorter bight in the right MI, differently shaped basal plate, and shorter carriers. Short bight in right MI is characteristic of *Polychaetaspis latus* n. sp.; *P. warkae* differs from *P. latus* in having a less slender basal plate, and narrower and differently shaped MI, particularly right MI. Right MI similar to that in *P. warkae* occurs in *P. wyszogrodensis*, *P. aequilateralis* and *Polychaetaspis* sp. *a*. In all these species the inner wing is similarly shaped, somewhat longer than half the jaw length, and the greatest width of the jaw is about mid-length. The differences in the structure of left MI among these species are very small indeed and concern mainly the shape of the ligament scar and small differences in proportions. In *P. warkae* the ligament scar is subtrapezoid and poorly defined, in *P. aequilateralis* it is of similar shape, but larger and well defined, while in *P. wyszogrodensis* it is small, elongated transversally.

Polychaetaspis latus n. sp.

(Plate XVII, figs. 2-4; Text-fig. 8*P*)

Type specimen: The apparatus No. O.179/6, figured on Plate XVII, fig. 4, consisting of right and left MI, right and left MII, left MIII, right and left MIV, left LtIII, and right and left LtIV.

Type horizon and locality: Erratic boulder No. O.179, of unknown age (Ordovician or Silurian), Mochty, province of Warsaw.

Derivation of the name: Lat. *latus* — broad, alludes to the structure of MI, which is very broad anteriorly.

Diagnosis. — Carriers unknown. Basal plate subtriangular, 2.2 times longer than wide. Intercalary tooth lacking. Left MI wide anteriorly, strongly tapering posteriorly, with inner wing extending for 0.6 of the jaw length. Right MI very wide anteriorly, strongly compressed posteriorly, with an inner wing extending for a distance of about 0.4 of the jaw length, in the middle of the jaw. Bight extends for 0.4 of the jaw length. MII like a bevel square, MIII—MIV arcuate. LtI very long, slender, longer *(tr.)* than the greatest width of MI; LtII crescent-like, LtIII subtriangular or crescent-like, fitting tightly into the outer margins of respective jaws.

Denticle formula:

Basal plate	—	8—10
MI	12—14	12—13
MII	9—10	9—10
MIII	8	—
MIV	6	8

Material. — Six incomplete jaw apparatuses from the boulder No. O.179, one apparatus from No. O.505. Age of both these boulders unknown (Ordovician or Silurian).

Description. — Length of MI varies between 0.4—0.53 mm. Entire apparatus is widest at anterior part of MI, tapering strongly to the posterior.

Basal plate is subtriangular and narrow, 2.2 times longer than wide, tapering posteriorly. Anterior margin is somewhat concave, directed subtransversally. Outer margin is directed postero-medially, somewhat incurved in the middle. Inner margin is directed posteriorly. A series of 8—10 denticles extends for three quarters the length of the inner margin. In ventral view half of the jaw width is covered by a belt which slightly tapers posteriorly. The outer margin of the belt is somewhat concave.

Right MI in dorsal view is a comparatively wide jaw, 2.5 times longer than wide. The greatest width is somewhat in front of mid-length. The outer margin is slightly concave in the anterior part, then convex, surrounding in a broad arch a comparatively large shank. Inner wing extends for 0.38—0.42 of the jaw length, in the middle of the jaw. It has a transverse anterior margin, posteriorly tapers strongly. In the very posterior part of the jaw the inner wing is directed vertically and hidden in dorsal view. On account of the compression of the right and left slopes in the posterior part, the posterior quarter of the jaw appears in dorsal view extremely narrow. A series of 12—13 sharply pointed denticles, decreasing in size posteriorly extends for 0.9 of the jaw length. To the rear of the last denticle there is a somewhat inflated ligament scar. In transmitted light a muscle scar is visible on the dorsal side — as a light spot in the anterior part of the jaw. In left lateral view the anterior margin together with the first denticle forms a broad arch. A part of the pulp cavity is visible anteriorly in this view. Left and right margins are subparallel, the jaw somewhat narrows posteriorly. In right lateral view the anterior margin forms a broad arch. The posterior part of the right slope is of the same width all along the length of the bight. In ventral view the cover extends for about 1.5 of the jaw length.

Along the inner margin there is in some specimens a very narrow belt, in others the belt is lacking. A deep furrow with pits associated with the denticles extends along the inner margin. At the anterior part of the opening there is suboval, elongated muscle scar.

Left MI — in dorsal view the outer margin is directed at first postero-laterally, at a third of the jaw length it forms a broad arch and continues postero-medially. The left slope is wide anteriorly and strongly tapers posteriorly, which is connected with the lateral compression of the jaw in the posterior part. The anterior part of the right slope is in dorsal view hidden under the dentary, the posterior part enlarges into an inner wing, which extends for 0.6 of the jaw length. The anterior margin of the inner wing is directed transversally, the wing tapering towards the posterior. A series of 12—14 denticles extends for 0.9 of the jaw length. The first denticle is the longest, the next two or three smaller, then they increase in size towards the middle, decreasing again posteriorly. A poorly defined, somewhat inflated ligament scar is visible to the rear of the last denticle. In a transmitted light a suboval muscle scar is visible on the dorsal side as a light spot at the anterior part of the jaw. In left lateral view the anterior margin is directed almost transversally, somewhat convex; the outer margin is directed posteriorly, at about 0.4 of the jaw length it swings outwards and continues postero-medially to the rounded posterior end. In right lateral view the jaw is widest at mid-length, the outer margin is subparallel to the dentary, the posterior margin rounded. In ventral view the opening extends for about 0.8 of the jaw length, on the left side it prolongs into a short belt, which tapers posteriorly and disappears entirely at about one third of the jaw length. Anterior margin of the pulp cavity continues on the left side as the anterior margin of the inner wing.

Right MII is bevel square shaped, with a very strong *(tr.)* and wide *(long.)* transverse branch and with a straight outer margin directed postero-laterally, almost posteriorly. The longitudinal branch is long, tapering posteriorly. A series of about 10 denticles, decreasing in size to the posterior, extends nearly the full length of the jaw. In ventral view: the pulp cavity is slightly enclosed, almost gaping, a very narrow *(long.)* crescent like cover is present anteriorly.

Left MII is somewhat larger than the right one, otherwise being its mirror image.

Left MIII is arcuate in shape, with a series of 7—8 small denticles, extending the full length of the jaw, having a gaping pulp cavity.

Left MIV is smaller than MIII, arcuate in shape, with a series of 6 denticles extending the full length of the jaw, and with a gaping pulp cavity.

Right MIV is a mirror image of the left one, with 8 denticles.

Lateral teeth: The number of lateral teeth presumably corresponds to the number of jaws, each jaw being associated with one tooth. Should this be the case, there are 4 lateral teeth on the left side, three on the right. It is however possible that there is one additional lateral tooth on the right side.

Right and *left LtI*, associated with MI, are arranged just beyond the first denticle. They are very long, slender and bent, their length exceeding the greatest width of MI.

Right and *left LtII* are crescent-shaped or subtriangular teeth, fitting tightly into the outer margin of MII.

LtIII—IV are subtriangular teeth, fitting the outer margins of respective jaws.

Variation. — The greatest range of variability concerns the structure of the anterior lateral teeth (LtII—LtIV), which in the type specimen (Plate XVII, fig. 4) are subtriangular, cone-like, moderately elongated, while in other specimens (e.g. Plate XVII, fig. 3) they are comparatively longer and crescent-like. As no other differences are observed, these specimens are considered here as conspecific.

Discussion. — See pp. 88 and 93.

Polychaetaspis inconstans n. sp.

(Plate XVIII, figs. 2, 3; Text-fig. 8*G*)

Type specimen: The apparatus No. O.391/3, figured on Plate XVIII, fig. 3, consisting of a basal plate, right and left MI, right and left MII, left MIII, right and left MIV, right LtII.

Type horizon and locality: Erratic boulder No. O.391 of ?Silurian age, Rewal, Baltic coast.

Derivation of the name: Lat. *inconstans* — unsteady, alludes to the variability of the species.

Diagnosis. — Carriers unknown. Basal plate triangular with anterior margin directed postero-laterally. Intercalary tooth lacking. Right MI 2.5 times longer than wide, with a prominent shank. Bight in right MI extends for 0.35 to 0.40 of the jaw length, inner wing extends in the middle of the jaw for a length equal to half that of the jaw. Left MI 2.3 times longer than wide, with an inner wing extending for 0.6 of the jaw length. MII like a bevel square, with very short transverse branches. MIII and MIV arcuate, with dentaries arranged perpendicularly to the length of the apparatus.

Denticle formula:

Basal plate	—	9—10
MI	13—15	13—16
MII	9—11	9—10
MIII	7—8	—
MIV	7	7

Material. — Eight incomplete jaw apparatuses or joined jaws and several isolated right and left MI from the boulder O.391, one incomplete jaw apparatus from the boulder O.187. Age of the boulders O.187 and O.391 has been ascertained as ?Silurian.

Description. — Comparatively small apparatuses, length of MI varying between 0.25 and 0.43 mm.

Basal plate is subtriangular, twice as long as wide, tapering both anteriorly and posteriorly. The greatest width is somewhat in front of mid-length. Anterior margin is directed obliquely postero-laterally, sometimes in a somewhat sigmoid curve. Outer margin, longer than the anterior margin, is directed postero-medially. Anterior margin may be directed obliquely in varying degrees, and in connection with this the point of contact of the anterior and outer margins may be situated at various levels. The inner margin is directed posteriorly. A series of 9—10 small denticles, equal in size, extends for 0.85—0.90 of the jaw length. The inner margin, to the rear of the last denticle, is thickened, and somewhat bent outwards, to fit tightly the inflated ligament scar of the right MI. In ventral view the belt is comparatively narrow, extending anteriorly for less than half the width of the plate and tapering posteriorly.

Right MI in dorsal view is 2.5 times longer than wide. Anterior margin forms an arch. Outer margin is straight, directed postero-laterally, nearly posteriorly to the shank, which is prominent in longitudinal direction, but does not protrude laterally. In some, not figured specimens, the shank is directed postero-laterally and protrudes both posteriorly and laterally. The bight which extends for 0.32 to 0.40 of the jaw length, is strongly incurved. Along the inner margin there is a small inner wing tapering posteriorly, extending in the middle of the jaw for a distance of half the jaw length. Anterior margin of the inner wing is concave, the left slope to the rear of the wing is very narrow. A series of 13—16 denticles decreasing in size posteriorly, extends for 0.9 or more of the jaw length. To the rear of the last denticle there is an inflated, but small ligament scar. In right lateral view the jaw is triangular, anterior margin is directed in an arch postero-laterally, outer margin directed postero-medially. The greatest

width of the jaw is at one third of the jaw length from the front. In ventral view the cover extends for nearly 0.2 of the jaw length. The muscle scar is teardrop shaped, very large and deep. It extends for almost the entire area of the inner wall of the jaw, enclosed between the bight and the furrow with denticles. In transmitted light the muscle scar is also seen in dorsal view as a light spot.

Left MI, in dorsal view, is 2.1 times longer than wide, the greatest width being across mid-length. Anterior part of the right slope is hidden under the dentary. Posteriorly it enlarges into a prominent inner wing, which extends for 0.6 of the jaw length. Anterior margin of the inner wing is directed postero-laterally. Posteriorly the inner wing narrows. Outer margin is directed at first postero-laterally, at half of the jaw length it turns and continues postero-medially, being somewhat sigmoid. The very posterior part of the left slope is extremely narrow in this view. A series of 13—15 denticles decreasing in size posteriorly, extends for 0.9 of the jaw length. To the rear of the last denticle there is a somewhat inflated ligament scar. In left lateral view the jaw is subtriangular, the greatest width being at a third of the jaw length from the front. In this view the ligament scar appears flat, it is larger than in dorsal view and poorly defined. In right lateral view the anterior part of the inner wing protudes laterally, anterior margin is strongly arched. In ventral view the cover extends for 0.9 of the jaw length, the muscle scar is teardrop shaped, large but less distinct than in right MI. The muscle scar is hardly seen on the dorsal side in transmitted light.

Right MII is in the form of a bevel square, with a very short transverse branch. Longitudinal branch strongly tapers posteriorly. Anterior margin is rounded, outer margin directed postero-laterally, almost posteriorly. A series of 9—10 denticles, the first being the longest, extends the full length of the jaw. In ventral view, there is a very small cover, otherwise the opening of the pulp cavity is almost gaping.

Left MII is somewhat larger (longer) than the right MII, otherwise being its mirror image.

Left MIII is an arcuate jaw, with a gaping opening of the pulp cavity and a series of 7—8 small denticles, equal in size. The jaw is arranged almost perpendicularly to the length of the apparatus, the dentary being arranged postero-medially. The outer (anterior) slope of the jaw is convex, the inner (posterior) concave.

Right and *left MIV* recall in shape left MIII, but are somewhat smaller, and arranged more transversally with regard to the length of the apparatus. In the type specimen, figured on Plate XVIII, fig. 3, MIII and MIV are bent upwards and arranged perpendicularly with regard to the dorsal surface of MI (as visible on Plate XVIII, fig. 3*b*), in the left lateral view of the apparatus.

Lateral teeth are poorly known. Right LtI is preserved in the specimen figured on Plate XVIII, fig. 2. It is a comparatively small, strongly bent tooth, adhering to the right MI dorsally, just beyond the first denticle. In the type specimen right and left LtII are preserved in an unnatural position. They are triangular teeth which probably fitted tightly into the outer borders of MII.

Variation. — Variation concerns the length of the bight in right MI, which may vary from 0.32 to 0.40 of the jaw length, the shape of the shank in right MI and the shape of the basal plate. The anterior margin of the basal plate in some specimens is directed postero-laterally, more posteriorly, in others postero-laterally, more transversally.

Discussion. — *Polychaetaspis inconstans* n. sp. differs from all the remaining representatives of *Polychaetaspis* in having MII provided with very short transverse branches, not prolonged laterally into pointed ends. It is not, however, entirely certain, whether lateral teeth (right and left LtII) found in the type specimen (comp. Plate XVIII, fig. 3) are the true lateral

teeth, or rather broken off lateral spine-like prolongations of MII. *P. inconstans* recalls *P. latus* n. sp., especially the left MI are similar, though left MI in *P. inconstans* is wider in relation to the length than in *P. latus*. *P. inconstans* differs from *P. latus* and *Polychaetaspis* sp. *a* in the shape of the basal plate, which in *P. inconstans* tapers both anteriorly and posteriorly, while in *P. latus* and *Polychaetaspis* sp. *a* it has a transverse anterior margin. The shank in the right MI of *P. inconstans* is directed posteriorly, the bight being strongly incurved into the jaw, whereas in *P. latus* the posterior margin of the right MI opposite the bight is directed subtransversally, while the shank is broadly rounded, protruding laterally. The shape of the inner wing in the right MI is in both species similar. Lastly *P. inconstans* has MIII and MIV arranged transversally with regard to the length of the apparatus, while in *P. latus* they are arranged postero-medially. The basal plate which narrows both anteriorly and posteriorly, is also characteristic of *P. aequilateralis* n. sp. *P. inconstans* differs from the latter species by the lack of an intercalary tooth, a shorter bight in right MI, a smaller, not so well defined ligament scar in left MI, and a differently shaped MIII and MIV.

Polychaetaspis varsoviensis n. sp.

(Plate XIX, figs. 1-3; Text-fig. 8*H*)

Type specimen: The apparatus No. O.400/239, figured on Plate XIX, fig. 1. It consists of somewhat deformed carriers, a basal plate, right and left MI, right and left MII, left MIII, right and left MIV, right and left LtI, left LtIII, right LtIV and fragmentary mandibles. The apparatus, after it was drawn, was separated into individual jaws, in order to show the structure of each jaw, which is hidden in an articulated apparatus.

Type horizon and locality: Erratic boulder No. O.400, of Middle Ordovician age (?Kukruse Stage or Idavere Stage of Estonian sequence), Mochty, province of Warsaw.

Derivation of the name: varsoviensis — found in the province of Warsaw.

Diagnosis. — Carriers short, subrectangular, very slightly longer than the basal plate, with long anterior processes. Basal plate small, with a concave anterior margin and broadly rounded posterior. Right MI a comparatively broad jaw, the greatest width being beyond mid-length. Bight in right MI extends for 0.35 of the jaw length. Ligament scar in right MI distinct, inflated. Left MI with a sigmoid inner wing, and the posterior extremity produced into a very small tubercule. Ligament scar in left MI in front of the posterior tubercule very small, poorly defined. MII arcuated, produced distally into distinct spine-like processes. MIII—MIV similarly shaped but smaller.

Denticle formula:

Basal plate	—	7—8
MI	16—20	14—16
MII	10—11	8
MIII	9	—
MIV	9	8

Material. — In addition to the type specimen, there are four incomplete jaw apparatuses from the boulders O.400 and O.469, isolated MI from these boulders and from the boulder O.116. Age of the boulders Nos. O.116, O.400 and O.469 has been ascertained as ?Middle Ordovician.

Description. — Length of MI varies between 0.26—0.87 mm. The entire apparatus without carriers tapers both anteriorly and posteriorly, the greatest width being at mid-length of MI.

Carriers preserved in two specimens are in both cases somewhat damaged. They are subrectangular, broadly rounded posteriorly, with very long anterior processes.

Basal plate is comparatively small and wide, the length to width ratio being 1.1—1.3. A series of 7 or 8 small denticles extends two thirds or three fourths the length of the inner margin. The anterior margin is concave, outer margin directed postero-medially, the posterior margin comparatively wide, rounded. In ventral view the belt extends anteriorly for less than half the jaw width and narrows posteriorly. In left lateral view the belt is narrow anteriorly, widening posteriorly.

Right MI — length to width ratio is about 2.7. Right MI of the type specimen, figured on Plate XIX, fig. 1, is somewhat depressed and appears wider in relation to the length. The outer margin is directed posteriorly, at about one third of the jaw length it bends and continues postero-laterally, around a comparatively long and prominent shank. The bight extends for about one third of the jaw length. The outer margin opposite the bight is directed transversally. The inner margin runs posteriorly, there is no inner wing. A series of 14—16 denticles insignificantly decreasing in size posteriorly extends for 0.9 of the jaw length. To the rear of the last denticle on the right slope there is a distinct tubercule-shaped ligament scar. In left lateral view the jaw slightly narrows posteriorly, the boundaries between the denticles are seen on the left slope. In right lateral view the posterior tubercule is very distinct, the right slope opposite the bight tapers posteriorly. In ventral view the opening of the pulp cavity extends for 0.75 of the jaw length. At the anterior part of the pulp cavity there is a comparatively large muscle scar.

Left MI — length to width ratio is about 3.2. In specimen figured on Plate XIX, fig. 3, left MI is compressed in the middle. A series of 16—20 small denticles, increasing in size towards the middle and decreasing again posteriorly, extends for 0.9 of the jaw length. The outer margin is directed postero-laterally, in the middle it swings and continues postero-medially, being somewhat concave. The anterior part of the right slope appears very narrow in dorsal view, the inner margin running subparallel to the dentary. At mid-length, the inner margin swings outwards around the prominent inner wing and then bends postero-medially. The posterior extremity of the jaw is developed as a small tubercule-like process. In front of this tubercule, on the left slope there is a poorly defined ligament scar. In left lateral view the jaw is widest slightly beyond mid-length and tapers both anteriorly and posteriorly. In right lateral view, the anterior part of the right slope is comparatively wide, about mid-length it enlarges into a prominent inner wing. In ventral view, the opening extends for 0.8 of the jaw length, at the anterior part of the opening to the right of the furrow with pits there is a distinct muscle scar.

Left MII is a comparatively elongated jaw with 10—11 denticles, extending the full length of the jaw. The transverse branch is comparatively short *(tr.)* in comparison with the length of the longitudinal branch *(long.)*. The transverse branch is produced laterally into a short, sharply pointed spine. In right lateral view the jaw appears comparatively wide, the boundaries between the denticles visible on the right slope. In ventral view the pulp cavity is gaping.

Right MII is smaller than the left MII. The longitudinal branch is short *(long.)*, provided with 8—9 denticles which extend the full length of the jaw. The spine-like projection of the transverse branch easily became separated, thus imitating the lateral tooth.

Left MIII, and *right* and *left MIV* are small, arcuate jaws with transverse branches produced laterally into spine-like projections, which easily became broken off. The openings of pulp cavities are gaping.

Lateral teeth: Only right and left LtI, left LtIII and right LtIV are preserved. LtI are comparatively short, bent teeth. Left LtIII preserved in the type specimen, adhers dorsally to the left MIII, while right LtIV fits tightly into the outer margin of the right MIV.

Variation. — The specimens assigned to *P. varsoviensis* are somewhat deformed, and it is difficult to ascertain whether the differences between them are connected with variation or with the various degrees of deformation. It appears that the proportions of the basal plate (length to width ratio) may vary; the length of the bight in right MI varies between 0.30—0.33 that of the jaw. The distinctness of the muscle scar in the right MI varies.

Discussion. — *Polychaetaspis warkae* KOZŁOWSKI invites comparison. *P. varsoviensis* recalls *P. warkae* in the shape and size of the carriers and right MI. However the basal plate which in *P. warkae* is triangular, in *P. varsoviensis* has a wide, rounded posterior end. Left MI differs from that in *P. warkae* in the presence of a small posterior tubercule and in having a sigmoid inner wing.

Polychaetaspis sp. **a**

(Plate XVIII, fig. 1)

Material. — One apparatus No. O.470/2, figured on Plate XVIII, fig. 1, consisting of carriers, a basal plate and right and left MI. Erratic boulder No. O.470 is of ?Middle Ordovician age, Mochty, province of Warsaw.

Denticle formula:

Basal plate	—	9
MI	15	16?

Description. — A single carrier is subrectangular, with concave anterior margin and long antero-lateral process. When preserved in an articulated apparatus, the anterior parts of the carriers are arranged vertically, the posterior parts horizontally (as in *P. warkae*) and the carriers appear bulbiform in dorsal view. The intercalary tooth is lacking.

Basal plate is subtriangular, 1.2 times longer than wide, strongly tapering posteriorly. A series of 9 small denticles extends along the inner margin. First denticle is somewhat longer than the remaining ones.

Right MI, 0.31 mm. long, is a comparatively wide jaw, 2.5 times longer than wide, the greatest width being somewhat beyond mid-length. The bight extends for 0.4 of the jaw length. The outer margin is directed postero-laterally, the shank not very prominent, the posterior margin (delimiting the bight) is concave. A series of 16 denticles extends almost the full length of the jaw. The muscle scar is visible in dorsal view, even in reflected light, as a light spot at the anterior part of the jaw. In ventral view the opening of the pulp cavity extends for 0.88 of the jaw length. At the anterior part of the opening there is a very distinct muscle scar in the shape of a teardrop. Almost the entire surface of the ventral wall, particularly the proximal part of the jaw, is covered by a characteristic reticulation, which is also seen on the dorsal side in transmitted light.

Left MI is a subtriangular jaw, the greatest width being somewhat in front of mid-length. Length to width ratio is 2.3. A series of 15 sharply pointed denticles, decreasing in size posteriorly, extends almost the full length of the jaw. The ligament scar is indistinct, poorly defined. In ventral view the opening extends for about 0.75 of the jaw length, the teardrop shaped muscle scar is very distinct, the internal surface of the wall, similarly as in the right MI, is reticulated.

Discussion. — The here described specimen recalls *P. latus*, in having a broad MI and a small, triangular basal plate. However, the basal plate in *P. latus* is more elongated, and MI, particularly the right MI is somewhat differently shaped. The greatest width of the right MI

in *P. latus* is in front of mid-length, while in *Polychaetaspis* sp. *a* the greatest width is behind mid-length. *Polychaetaspis* sp. *a* recalls also *P. inconstans* n. sp., but differs from the latter species in having a less prominent shank in MI, smaller and less distinct ligament scars in both MI and a basal plate with a transversal anterior margin which in *P. inconstans* is directed postero-laterally.

"Polychaetaspis" incisus n. sp.

(Plate XVI, figs. 1-2; Text-fig. 8*K*)

Type specimen: An incomplete right side of jaw apparatus, No. O.423/1, figured on Plate XV[I], fig. 1, which consists of carriers, a basal plate and a left MI.

Type horizon and locality: Erratic boulder No. O.423, of ?Middle Ordovician age, Mochty, province of Warsaw.

Derivation of the name: Lat. *incisus* — alludes to the incurved outer margin of the right MI.

Diagnosis. — Carriers suboval, broadly rounded posteriorly, equal to half the length of right MI. Intercalary tooth lacking. Basal plate small, subtriangular, rounded posteriorly, with denticles extending only for 0.58 of the jaw length. Right MI narrows anteriorly, with strongly incurved outer margin, and small, prominent shank, protruding laterally. Bight extends for 0.33 of the jaw length. Left MI narrow, elongated jaw with an incurved outer margin; inner wing extends for half the jaw length, ligament scar very large. Anterior jaws unknown.

Denticle formula:

Basal plate	—	6
MI	12—15	12—14

Material. — The here described right and left MI have not been found together in an articulated apparatus, they are however regarded tentatively as conspecific, as they occur together in samples from the same boulders, and have similar, incurved outer margins, the same length of openings of pulp cavities, the same number and shape of denticles and large ligament scars. In addition to the type specimen, detached right and left MI have been found in the boulders Nos. O.423, O.182, O.469 and O.470, the boulder O.182 having been ascertained as Middle Ordovician (?Kukruse Stage) of Estonian sequence.

Description. — Length of MI varies between 0.43—0.84 mm.

Carriers: The length of the carriers is equal to half that of the right MI. Length to width ratio (of both carriers together) is 1.6. They are fused all along the inner margins — in the type specimen here described the line of fusion is partly fractured. The anterior margin of each carrier is incurved, antero-lateral corners are produced into moderately long processes, which in the type specimen are probably partly broken off. Posteriorly the carriers narrow insignificantly to a broadly rounded posterior margin.

Basal plate is subtriangular, with a transverse (somewhat concave) anterior margin. Posteriorly it tapers to a rounded posterior end. A series of six small, equal in size denticles extends for 0.58 of the length of the inner margin. To the rear of the last denticle, the inner margin is thickened and somewhat bent upwards. In ventral view the belt occupies half of the jaw width anteriorly, in the posterior part it is arranged almost vertically, and appears very narrow in dorsal view. In left lateral view the belt is of equal width all along the jaw length. At the posterior part of the belt, the thickened inner ridge has on the ventral side a somewhat dull surface.

Right MI in dorsal view strongly narrows anteriorly. It is three times longer than wide. A series of 14 denticles, decreasing in size posteriorly, extends for 0.9 of the length of the inner margin. To the rear of the last denticle, on the right slope there is a subtriangular, flat ligament

scar. There is no inner wing. The outer margin runs postero-laterally (almost posteriorly) in a somewhat sigmoid curve, being incurved at mid-length. A prominent, subtriangular shank, strongly protrudes over the outer margin. The bight is short, extending for about 0.33 of the jaw length. The posterior margin of the jaw surrounding the bight is directed transversally. In left lateral view, anterior margin forms a long arch together with the first denticle. The jaw is widest at a quarter of its length from the front. Left slope, comparatively wide at this level, strongly tapers posteriorly. In right lateral view, the anterior margin forms an arch together with the outer margin. The right slope opposite the bight tapers posteriorly. In ventral view, the opening of the pulp cavity extends for 0.7 of the jaw length. There is no belt. At the anterior part of the opening there is a comparatively small muscle scar.

Left MI is almost three times longer than wide, the greatest width is slightly in front of the last third of the jaw length. Outer margin is directed subposteriorly in a sigmoid curve. In front of mid-length it is strongly incurved, proceeds postero-laterally to a prominent protuberance and then continues postero-medially. Anterior part of the right slope is in this view hidden under the dentary. Posteriorly the right slope enlarges into the inner wing which extends for half of the jaw length. Anterior and posterior margins of the inner wing are rounded. A series of 12—14 denticles, slightly decreasing in size posteriorly, extends for 0.82 of the jaw length. To the rear of the last denticle there is a very large, flat muscle scar. The first denticle, which is three times longer than the remaining ones, is twisted out of alignment with the other denticles. In left lateral view the outer margin is directed at first postero-laterally, at mid-length it is deeply incurved and then continues postero-medially. Ligament scar appears very large in this view. In right lateral view, the right slope appears the same width all along the jaw length, except for an incurvature at mid-length. Inner wing does not protrude laterally in this view. In ventral view the opening of the pulp cavity extends for 0.7 of the jaw length. There is no belt. A furrow with pits associated with the denticles runs along the middle of the jaw and terminates at 0.18 of the jaw length from the posterior end.

Discussion. — The attribution of the here described species to the genus *Polychaetaspis* KOZŁOWSKI is only provisional. It differs from all the known species of *Polychaetaspis* in the shape of MI which are strongly elongated, the right MI narrowing anteriorly. The openings of pulp cavities in MI in "*P*". *incisus* extend for 0.7 of the jaw length, while in other representatives of *Polychaetaspis* their length varies between 0.8—0.9. In the slenderness of MI, in the comparatively small openings of pulp cavities and in the shape of right MI, which narrows anteriorly, "*P*". *incisus* recalls *Ramphoprion* KIELAN-JAW. It differs from *Ramphoprion* in the lack of a transverse posterior margin in the left MI, in the shape of the basal plate which is subtriangular, while in *Ramphoprion* it is subrectangular, and in having longer carriers. "*Polychaetaspis*" *incisus* evidently belongs to a separate genus, intermediate in some respects between the genera *Polychaetaspis* and *Ramphoprion*. The erection of this genus cannot be made, for the time being, on account of the scanty material.

Genus **KOZLOWSKIPRION** nov.

Type species: Kozlowskiprion longicavernosus n. sp.
Derivation of the name: Named in honour of Professor ROMAN KOZŁOWSKI.

Diagnosis. — Carriers subrectangular with long anterior processes. Intercalary tooth lacking. Basal plate long, club-like. Left MI with anterior and posterior incurvatures on the left margin, in left lateral view club-like. In dorsal view anterior part of left MI very narrow. Bight in right MI extending for 0.5—0.7 of the jaw length. Ligament scars in MI and basal

plate poorly defined. MII with comparatively short shanks, MIII and MIV subtriangular. Lateral teeth present, presumably forming two chains surrounding the anterior part of the apparatus, one lateral tooth to each jaw. Mandibles unknown.

Stratigraphic and geographical range. — Middle Ordovician-Silurian; Europe, ?North America.

Discussion. — *Kozlowskiprion* n. gen. is erected to include *K. longicavernosus* n. sp. — type species, and *K. brevialatus* n. sp.

Kozlowskiprion differs from *Polychaetaspis* KOZŁOWSKI in the following characters:

	Polychaetaspis KOZŁ.	*Kozlowskiprion* n. gen.
Carriers	Suboval or subrectangular	Subrectangular
Basal plate	Subtriangular or subtrapezoid	Club-like
MI left	Subtriangular in left lateral view	Club-like in left lateral view
Left outer margin in MI	Directed postero-laterally, bent in a half of the jaw length and directed postero-medially	Directed postero-laterally, bent in one fourth of the jaw length from the front and directed posteriorly, at the posterior one fourth of the jaw length bent again and directed postero-medially in a concave line
The greatest width of the apparatus	Across MI	Across MII

Of the detached jaws, described in the scolecodont literature, only the basal plate of *Paleoenonites castigatus* ELLER (ELLER, 1945, p. 171, Plate 5, figs. 21—24) reminds one of the basal plate of *Kozlowskiprion* and is congeneric with it. No detached MI which could be regarded as congeneric with *Kozlowskiprion* have, as far as the writer knows, ever been figured.

Kozlowskiprion longicavernosus n. sp.

(Plate XX; Text-fig. 8*I*)

Type specimen: The apparatus No. O.187/1, figured on Plate XX, fig. 2, consisting of a basal plate, right and left MI, right and left MII, left MIII, right MIV, 3 right lateral teeth and one left lateral tooth.

Type horizon and locality: Erratic boulder No. O.187, of ?Silurian age, Mochty, province of Warsaw.

Derivation of the name: Lat. *longus* — long, *cavernosus* — hollow; provided with a long opening of the pulp cavity.

Diagnosis. — Outer margin of the basal plate and left MI moderately incurved posteriorly. Inner wing in left MI extends for two thirds of the jaw length; left MII comparatively short, strongly protruding over left MI anteriorly.

Denticle formula:

Basal plate	—	9—12
MI	12—14	12—14
MII	8—9	8—9
MIII	5—6	—
MIV	7	7
MV	?1	1

Material. — In addition to the type specimen there are 15 incomplete jaw apparatuses from the boulder No. O.187, MIr with basal plate from the boulder O.185, joined right and left MI and basal plate from the boulder O.174, isolated right and left MI or basal plates from these boulder, as well as from the boulders O.42, O.159, O.410, O.441, O.442 and O.446. Of these boulders the age of No. O.410 has been ascertained as Lower Ludlow, while those of the boulders No. O.441 and O.446 as ?Wenlock. It is probable that *K. longicavernosus* is restricted to the Silurian.

Description. — Length of MI of the here attributed specimens varies between 0.63—1.33 mm. The entire apparatus (without carriers) is in dorsal view elongated, about 2.7 times longer than wide, tapering posteriorly, the greatest width (including the lateral teeth) being across MII.

Carriers: Only small fragments of the left carrier are preserved in two specimens, not figured (Nos. O.187/9 and O.187/10). The remnants preserved show that the carriers were provided with long and thin antero-lateral projections, fitting tightly into the incurvatures of the posterior part of the left MI and of the basal plate.

Basal plate: The length of the basal plate is equal to about 0.6 that of the right MI. It is an elongated, slender jaw, ratio length to maximum width being about 3:1. First denticle is about one and a half times longer than the remaining ones, which are disposed behind it without any interval. The denticles are sharply pointed, slender, almost not decreasing in size posteriorly, extending for about four fifths of the inner margin length. Anterior margin is directed subtransversally, slightly posteriorly. Outer margin, directed postero-medially is strongly incurved in the most posterior part, causing the club-like shape of the plate. On the most posterior, undenticulated part there is an irregular ligament scar, with a poorly defined outline.

In ventral view, the belt is comparatively wide, occupying more than half of the jaw width, tapering posteriorly. A small dull spot occurs also on the ventral belt in the very posterior part of the jaw.

Right MI is somewhat longer than left MI, in occlusion protruding over it anteriorly. Ratio length to width is 2.3:1. There are 12—14 denticles, the first is the longest, twisted out of the alignment with other denticles, next two or three usually very small, then the denticles increase in size towards the middle and again decrease posteriorly. A poorly defined ligament scar lies in a direct prolongation of the dentary and occupies about one ninth of the jaw length. In dorsal view the anterior margin runs from the proximal end transversally, through one fourth of the jaw width, then it turns and runs antero-medially, surrounding the anterior end of the dentary and passing into the outer margin. The latter runs postero-laterally (somewhat concavely), turns around the subquadrangular shank and continues transversally, then postero-medially, surrounding the bight, the length of which varies from 0.52 to 0.7 of the jaw length. The inner margin is straight, directed postero-laterally. In the left lateral view there is a small incurvature in the left anterior corner of the jaw, anterior margin is broadly rounded, the left slope slightly tapers posteriorly. In the right lateral view the posterior part of the right slope, opposite the bight, tapers posteriorly. The ligament scar is visible in this view. In ventral view there is no belt, the cover is very small, extending for 0.1—0.15 of the jaw length, otherwise the outline of the jaw corresponds to the outline of the opening of the pulp cavity. In the jaw apparatus figured on Plate XX, fig. 2, in ventral view the cover in MI is prolonged along the inner margin to form a belt. However it should be mentioned that in this specimen, when the entire apparatus is seen in ventral view, the

right and left MI are arranged somewhat laterally. Along the inner margin there runs a deep furrow with pits associated with the denticles.

Left MI is an elongated jaw in dorsal view tapering both anteriorly and posteriorly. A series of 12—14 denticles extends for nine tenth of the jaw length. First denticle is the longest, next two or three very small, then the denticles increase towards the middle, decreasing again posteriorly. To the rear of the last denticle there is a small ligament scar. The outer margin is directed at first postero-laterally. At one fourth of the jaw length it turns to form an angle and runs postero-medially, being slightly incurved, in most posterior part. The inner margin runs subparallel to the dentary, at one third of the jaw length it turns outwards and continues along the inner wing which slightly tapers posteriorly. The length of the inner wing is about two thirds that of the jaw. In left lateral view the jaw is broadly rounded anteriorly, somewhat tapering posteriorly, with an incurvature in the most posterior part of the outer margin. In right lateral view the outer margin is parallel to the dentary, then it turns around the inner wing and continues posteriorly, parallel to the dentary, to the rounded posterior end. In ventral view the cover is very short and narrow, covering only the uppermost part of the jaw, otherwise the outline of the jaw corresponds to the opening of the pulp cavity. A deep furrow with distinct pits runs along the middle of the opening.

Right MII consists of a short *(tr.)* transversal part and a comparatively long, longitudinal part. The transversal part is prolonged into a short, pointed shank. The anterior margin is rounded, inner — directed posteriorly, the outer surrounds a long bight. A series of 8—9 denticles extends for almost the full length of the jaw. The first one is twice, or even more, as long as the remaining ones, which decrease in size posteriorly. In left lateral view the jaws strongly taper posteriorly. In ventral view a crescent-like cover extends in the most anterior part of the jaw. Along the middle of the jaw there is a deep furrow with pits associated with the denticles.

Left MII is longer than the right MII, otherwise being its mirror image.

Left MIII is an arcuate jaw, similar in shape to left MII, but shorter. A series of 8—9 denticles extends almost the full length of the jaw. The first denticle is longer than the remaining ones. In ventral view the opening of the pulp cavity is gaping.

Right MIV is a subtriangular, small jaw, prolonged laterally into a very short *(tr.)* pointed shank with a series of 7—8 denticles, the first of which is somewhat longer than the remaining ones. The opening of the pulp cavity is gaping. Left MIV is a mirror image of the right MIV.

Lateral teeth: Presumably each jaw (beginning with MI) was associated with one lateral tooth. LtI right is a comparatively small tooth, subconical, bent, with a large opening at the base, arranged transversally in the anterior part of MI, beyond the first denticle. Its length *(tr.)* does not exceed that of the right slope of the jaw. Left LtI is similarly shaped, arranged with its base in the anterior incurvature of the outer margin, longer *(tr.)* than the width of the left slope at this level. Lateral teeth associated with anterior jaws are somewhat smaller than LtI, the base of each tooth adhering to the anterior margin of the shank, the tooth being directed subtransversally, covering dorsally the most anterior part of each jaw.

The exact number of lateral teeth is not known. In specimen No. O.187/2, figured on Plate XX, fig. 1, four lateral teeth were preserved on the right side, three associated with right MI, two of which are in abnormal position. In the same specimen there are three lateral teeth on the left side, all associated with left MIII. The teeth presumably touch at their bases, forming two chains surrounding the anterior part of the apparatus. It is also possible that the number of lateral teeth vary within this species.

Kozlowskiprion brevialatus n. sp.

(Plate XXI; Text-fig. 8*J*)

Type specimen: The apparatus No. O.469/32, figured on Plate XXI, fig. 5, consisting of carriers, a basal plate, right and left MI, right and left MII, left MIII, right and left MIV and right LtI.

Type horizon and locality: Erratic boulder No. O.469, of ?Middle Ordovician age, Mochty, province of Warsaw.

Derivation of the name: Lat. *brevis* — short, *ala* — wing; alludes to the short inner wing in left MI.

Diagnosis. — Carriers subrectangular with long anterior processes. Basal plate and left MI distinctly club-shaped in lateral views, very strongly incurved in posterior part. Inner wing in left MI short, extending to half, or less, the jaw length. Left MII comparatively long, extending below left MI for half of MI length. Anterior lateral teeth large, with wide bases.

Denticle formula:

Basal plate	—	11—14
MI	14—18	14—18
MII	10—13	6—8
MIII	7—8	—
MIV	4	5

Material. — In addition to the type specimen, there are two jaw apparatuses and 8 detached jaws in the sample from the boulder No. O.469, 1 apparatus and 2 left MI from the boulder O.472, and isolated MI from the boulders Nos. O.116 and O.400. Age of these boulders was ascertained as ?Middle Ordovician.

Description. — As *Kozlowskiprion brevialatus* is very close to *K. longicavernosus*, it was not thought necessary to describe it in full detail, confining the description to pointing out only the structures not known in the former species and the differences between them.

Carriers, not known in *K. longicavernosus*, are here well preserved in two specimens. Each carrier is subrectangular, 2.6 times longer than wide, somewhat convex dorsally. Inner margin is concave, with antero-lateral corner prolonged into a pointed, long process, inner margin directed backwards, the outer margin subparallel to the inner, very slightly directed outwards. The postero-lateral corner is rounded, posterior margin directed subtransversally. The carriers fit tightly together along the inner margins. In ventral view the surface of the carriers is somewhat concave.

Basal plate: It could be assumed from the specimen figured on Plate XXI, fig. 4, that *K. brevialatus* is provided with an intercalary tooth. This however is not the case, as in the discussed specimen, it is the anterior part of the basal plate which is broken off and separated, imitating an intercalary tooth. Basal plate is somewhat shorter than in *K. longicavernosus*, and wider in relation to the length. It has the posterior part of the outer margin more strongly incurved.

Right MI differs from that in *K. longicavernosus* in having a somewhat shorter bight and a shorter inner wing.

Left MI differs from that in *K. longicavernosus* in having a much shorter and more prominent inner wing, which extends for half or less of the jaw length, and in having the outer margin more strongly incurved at the posterior end.

Right MII is in *K. brevialatus* somewhat longer than in *K. longicavernosus*, what is connected with the shorter inner wing in right MI.

Left MII is in *K. brevialatus* longer than in *K. longicavernosus*, extending for half the length of left MI, up to the inner wing.

No important differences, except for the number of denticles, are observed in the structure of MIII and MIV.

Lateral teeth are in *K. brevialatus* poorly known. Judging from the specimen figured on Plate XXI, fig. 4, they are somewhat stronger and provided with wider bases than the respective teeth in *K. longicavernosus*.

Family POLYCHAETURIDAE nov.

Diagnosis. — Asymmetrical jaw apparatuses of labidognatha type. Laeobasal plate, intercalary tooth and lateral teeth lacking. Carriers long, bifurcate, with inner branches longer than outer. Basal plate subrectangular. Left MI subrectangular, with transverse posterior margin and with a posterior furrow. Openings of pulp cavities in MI large. MII rounded anteriorly, produced distally into narrow shanks. MIII single, left, subtriangular, MIV subtriangular, smaller than MIII. MV and MVI developed as single anterior teeth. Mandibles with large, striped anterior area and slit anterior margin.

The family is monotypic, erected to include the genus *Polychaetura* KOZŁOWSKI, 1956.

Genus **POLYCHAETURA** KOZŁOWSKI, 1956

Type species: Polychaetura gracilis KOZŁOWSKI, 1956.

Diagnosis. — As for the family.

Stratigraphic and geographical range. — Ordovician of the Baltic region.

Discussion. — The genus *Polychaetura* was erected by KOZŁOWSKI (1956) to include *P. gracilis* KOZŁOWSKI. In the collection described in the present paper, numerous apparatuses were found, which in spite of considerable variability in the size of the basal plate are assigned to *P. gracilis*. In addition to the apparatuses of *P. gracilis* there are in samples from very numerous boulders isolated right and left MI of *Polychaetura* type, which remain for the time being undescribed. The detached left MI, which are described here as "*Polychaetura*" sp. *a*, differ distinctly from those in *P. gracilis* and are attributed to the genus *Polychaetura* tentatively only. Thus *Polychaetura* KOZŁOWSKI continues for the time being to be a monotypic genus.

Polychaetura differs from all the known fossil and Recent jaw apparatuses in having bifurcate carriers. Similar isolated carriers have been described by EISENACK (1939) under the generic name *Pteropelta*. EISENACK described three species of *Pteropelta*, among which *Pteropelta thomsoni* EISENACK (from the Wesenberg beds = Keila Stage DII in recent classification) of Estonia appears to be conspecific with *Polychaetura gracilis* KOZŁOWSKI. Not knowing the entire apparatuses to which the remaining "carriers species" of EISENACK belong (*Pteropelta gladiata* EISENACK and *Pteropelta glossa* EISENACK), it is impossible to venture an opinion as to whether they fall within the range of individual variation of *Polychaetura gracilis*, or represent separate species.

Within the Ordovician labidognatha genera, *Polychaetura* seems to be the nearest to *Polychaetaspis* KOZŁOWSKI. The greatest similarities concern the structure of the right MI, which in both genera has a considerably large opening of pulp cavity and a similarly shaped bight. The jaws in question differ in, that in *Polychaetura* there is no inner wing visible in dorsal view, which is characteristic of *Polychaetaspis*. The remaining jaws are differently shaped in both genera.

Left MI and basal plate in *Polychaetura* reminds one in some features of those in *Ramphoprion*. In both genera the basal plate is subrectangular. Moreover, left MI in *Ramphoprion* is provided with a transverse posterior margin, which is characteristic also of *Polychaetura*. However left MI in *Ramphoprion* strongly tapers anteriorly, while it is rather wide at the anterior part in *Polychaetura*. Lastly, the openings of pulp cavities in MI of *Polychaetura* are very large, whereas they occupy only about one half the jaw length in *Ramphoprion*. The remaining jaws in *Polychaetura* are differently shaped than in *Ramphoprion*. No other labidognath genus invites a comparison with *Polychaetura*. Long carriers of *Polychaetura* would suggest some similarities to prionognatha genera, however all the jaws in *Polychaetura* are of labidognatha type, and no comparison with prionognatha type can be made. Also the mandibles of *Polychaetura* are more similar to those in *Polychaetaspis* than in prionognatha forms.

Polychaetura gracilis KOZŁOWSKI, 1956

(Plate XXII; Plate XXIII, figs. 3-7; Text-fig. 8*L*)

1956. *Polychaetura gracilis* n. sp.; R. KOZŁOWSKI, Sur quelques appareils masticateurs..., p. 192, Figs. 17, 18.
1956. *Polychaetura* sp.; R. KOZŁOWSKI, *Ibid.*, p. 195, Fig. 19.

Denticle formula:

Basal plate	—	8—15
MI	10—14	12—16
MII	8—12	6—8
MIII	4—7	—
MIV	3—4	3—4
?MV—MVI	?two pairs of single teeth	

Material. — In addition to the type specimen, described by KOZŁOWSKI from the boulder O.116, there are 31 incomplete jaw apparatuses from the boulders O.182, O.366, O.400, O.469, O.470, and O.472, as well as numerous isolated jaws (right and left MI, basal plates, carriers and mandibles) from the same boulders. Of these boulders, the age of No. O.182 has been ascertained as Middle Ordovician (?Kukruse Stage of Estonian sequence) and No. O.366 as Middle Ordovician (?Kukruse Stage or Idavere Stage).

Description. — Comparatively small apparatuses, average length of entire apparatus with carriers being 0.5—0.8 mm. The smallest detached MI measures 0.2 mm., the largest 1 mm.

Carriers: Length of the carriers is approximately equal to that of MI. Each carrier consists of an anterior subquadrangular part which extends for about one third the carrier length, and two slender posterior branches, the inner about three times longer than the outer. The antero-lateral corner is prolonged into a comparatively short process, which in the left carrier fits tightly into the incurvature on the posterior margin of the left MI, in the right carrier into the posterior margin of the basal plate. The anterior subquadrangular parts of the carriers are strongly fused together, posteriorly the inner branches diverge, being joined by a very fine, transparent pellicle, which forms a subtriangular or subovate area between them.

Basal plate is subrectangular, with a somewhat concave anterior margin, which is directed subtransversely. A series of 8—15 small denticles of equal size extends the full length

of the inner margin. Outer margin is directed posteriorly, parallel to the inner margin. Posterior margin (beginning with the dentary) is directed antero-laterally, with a slight incurvature along its course. In ventral view: the belt is comparatively wide anteriorly, extends for two thirds of the jaw width and tapers posteriorly. The opening of the pulp cavity is comparatively narrow, fissure-like.

Left MI is subrectangular, with a series of 10—14 denticles, extending nearly the full length of the jaw. Beyond the last denticle, left of it, a poorly defined ligament scar is visible. In dorsal view, the first 2—3 denticles are arranged along the anterior border and twisted out of the alignment with other denticles. Denticles increase in size to the sixth, then decrease again posteriorly. The outer margin runs postero-laterally, at about one third of the jaw length it turns and continues posteriorly or postero-medially. Along the anterior part of the outer margin and parallel to it there is a furrow, delimiting the rounded border. The left slope tapers slightly posteriorly. The outer part of left slope is somewhat shorter *(long.)* than the inner one. The posterior margin is directed postero-medially, with a distinct, deep incurvature in the middle. In the anterior prolongation of this incurvature a posterior furrow runs for about one fifth of the jaw length, subparallel to the dentary. The posterior part of the left slope, left of the posterior furrow is developed as a rounded ridge, parallel to the furrow. The anterior part of the right slope is in dorsal view entirely hidden under the dentary. The posterior part is developed as an inner wing, more rounded or less, extending for one half or more of the jaw length. In left lateral view the jaw is of almost equal width all along its length, with a slightly incurved outer border. In front of the incurvature and behind it the outer border is thick, developed as rounded ridges (anterior and posterior). In left lateral view the anterior part of the right slope is narrow, in the middle of the jaw the inner margin curves outwards around a prominent posterior wing. In ventral view the cover is small, extending for about one seventh of the jaw length. A deep furrow with pits associated with the denticles, runs along the middle of the opening; in the posterior part, on the right side of the dentary, there is a rounded ridge, associated with the posterior furrow.

Right MI: A series of 12—16 denticles increasing in size towards the middle and then decreasing again, extends the full length of the jaw. In dorsal view: first one or two denticles are twisted out of the alignment with other denticles. The inner margin forms a convex bow. There is no inner wing. Outer margin is directed postero-laterally, then it turns and runs transversely across half of the right slope, and then postero-medially. The bight extends for 0.5—0.6 of the jaw length. In left lateral view the left margin runs posteriorly, then bulges strongly outwards and then curves inwards. In this view the width of the posterior part of the jaw is three to four times narrower than across the middle of the jaw. In right lateral view the denticulated margin is directed posteriorly, the right slope is comparatively wide across the anterior part of the bight and then tapers posteriorly. In ventral view: the cover extends for about one seventh of jaw length, the belt is lacking. A deep furrow with a row of pits runs along the right margin of the jaw. In the anterior part of the opening there is a subtriangular swelling.

Left MII is a comparatively elongated jaw, rounded anteriorly, tapering posteriorly. Laterally it is produced into a slender shank, directed postero-laterally. The boundaries between the denticles are prolonged along the whole width of the jaw. In ventral view, half the width *(long.)* of the anterior, transverse part of the jaw, or less, is covered by a cover, which is prolonged along the inner margin. In ventral view, however, no belt is visible.

Right MII is shorter than the left one, otherwise being its mirror image.

Left MIII is an arcuate jaws with 4—7 denticles, produced laterally into a slender shank,

directed postero-laterally. The boundaries between the denticles are prolonged along the whole width of the jaw, and the jaw readily becomes separated into individual denticles.

Left MIV is a comparatively small, subtriangular jaw with 3—4 denticles. The boundaries between the denticles are prolonged along the whole width of both slopes of the jaw. The jaw readily becomes separated into individual denticles. First denticle, which together with the spine-like lateral prolongation of the jaw often become separated from the remaining part of the jaw is sickle-shaped.

Right MIV is a mirror image of the left MIV.

MV — single teeth. Poorly preserved teeth (?MVI or anterior teeth) are present in some specimens in front of MV. On account of the bad state of preservation of the specimens in question, their presence is not entirely certain.

Mandibles: Each mandible (in ventral view) consists of a large, suboval anterior area, which extends for half or less of the mandible and of a strong shank, which tapers posteriorly. The anterior area is striped with very delicate thread-like lines, subparallel to the postero-outer margin. Anterior margin, directed postero-medially is slit, with three irregular tips. Interior margin of this area is comparatively short *(long.)*. Right and left mandibles are fused only along the short, inner margin. The posterior part of the mandible is irregularly ornamented with thread-like lines.

Variation. — In the type specimen, described by KOZŁOWSKI (1956), the length of the basal plate is equal to about half that of the right MI. The same condition is characteristic of the specimens figured in the present paper on Plate XXIII, figs 5*a*, *f* and 7, and numerous others not figured. In the specimen figured on Plate XXII, fig. 1, in spite of the considerably long bight in the right MI, equal to nearly half of the jaw length, the basal plate is small, equal to about one third that of the right MI. In the specimen figured on Plate XXII, fig. 2*a*, the length of the basal plate is equal to 0.6 that of the right MI.

The considerable range of variability applies also to the structure of mandibles, where the length of the anterior area may be equal to 0.4 or 0.5 of the mandible length.

Discussion. — It is quite probable that the specimens assigned here to *Polychaetura gracilis* belong in fact to three or four separate species. The recognition of these species is, however, on the studied material impossible, as there are intermediate forms between the discussed specimens, and the differences between them are comparatively small (they concern only the changes in length to width ratio in left MI and the size of the basal plate). Therefore the writer considered, for the time being, all the here discussed specimens as conspecific.

"Polychaetura" sp. **a**

(Plate XXIII, figs. 1-2)

Material. — Several isolated left MI from the boulders O.366 and O.469, of which the age of the boulder No. O.366 has been ascertained as Middle Ordovician (?Kukruse Stage or Idavere Stage).

Description. — Length of the here assigned jaws varies around 0.6 mm. Left MI is an elongated jaw with 13—16 denticles. Three first denticles are arranged along the anterior margin and twisted out of the alignment with the other denticles. Outer margin is directed at first postero-laterally, then protrudes to form a fang and continues postero-medially. Inner margin runs at first along the dentary, at about one third of jaw length it swings outwards and runs along the inner wing, which extends for two thirds of the jaw length. Posterior margin

is straight, directed subtransversally. Posterior furrow is comparatively long, equal to 0.4 of jaw length, tapering anteriorly, surrounded on left side by a narrow, rounded ridge directed antero-medially. On the bottom of the posterior furrow there is a row of indistinct pits, caused evidently by the denticles of the basal plate, biting into this furrow in occlusion. In left lateral view the jaw is of equal width all along its length. In right lateral view, anterior part of the right slope is comparatively wide, the inner wing large anteriorly, tapering posteriorly. Along the dentary there is a very shallow furrow (invisible in dorsal view) extending from the posterior, nearly the full length of the jaw, with a series of about 9 pits, increasing in size and shallowing anteriorly. The pits were evidently made by the denticles of the right MI, which bit into this furrow in occlusion. In ventral view the cover extends for about 0.15—0.20 of the jaw length. There is no belt.

Discussion. — The here described jaw reminds one of the left MI of *P. gracilis* in the arrangement of the dentary, in the presence of posterior furrow and in the outline of the jaw. It differs from *P. gracilis* in being comparatively wider, in having a straight posterior margin, without any incurvature, in having longer inner wing, a distinct angle along the course of the outer margin, and a longer posterior furrow with pits. On the other hand, *"Polychaetura"* sp. *a* resembles left MI of *Ramphoprion* KIELAN-JAW., especially of *R. urbaneki* n. sp., in having a transverse posterior margin, as well as a posterior furrow and inner wing. It differs, however, from MI in *Ramphoprion* in being shorter in relation to width, and in having longer opening of the pulp cavity.

Family RAMPHOPRIONIDAE nov.

Diagnosis. — Asymmetrical jaw apparatuses of labidognatha type. Laeobasal plate and intercalary tooth lacking. Carriers small, shorter than half the length of MI, provided with transversal anterior margin. Basal plate subrectangular or subtrapezoid, narrowing posteriorly. Left MI and basal plate with transversal posterior margins. Opening of pulp cavities in MI varying from 0.5 to 0.7 of the jaw length. MII comparatively large jaws with rounded anterior and concave posterior margins. MIII single, left, similar to left MII, but smaller. MIV imperfectly known, MV unknown. Lateral teeth present (poorly known). Mandibles unknown.

Discussion. — The family is monotypic, erected to include *Ramphoprion* KIELAN-JAW., 1962.

The nearest family of the Ramphoprionidae are the Polychaetaspidae. Common features to both families are: similar arrangement of the jaws, the presence of a single MIII, similar shape of the right MI and the presence of lateral teeth (poorly known so far in the Ramphoprionidae). The differences are as follows: the carriers in the Ramphoprionidae are shorter than in the Polychaetaspidae, the openings of pulp cavities in MI are also shorter. The posterior margins of the left MI and of the basal plate, as well as the anterior margin of the carriers in Ramphoprionidae form a transversal line, while in the Polychaetaspidae left MI and the basal plate taper posteriorly and the anterior margin of the carriers fitting into them is concave, with antero-lateral corners produced into processes. *"Polychaetaspis" incisus* n. sp. is in some respects intermediate between the Ramphoprionidae and the Polychaetaspidae (comp. p. 97).

Short carriers and the transversal posterior margin of the left MI and basal plate are characteristic of the Paulinitidae LANGE. The Ramphoprionidae differ from the Paulinitidae in having differently shaped MI, particularly right MI which has a long bight for the basal plate, in having longer openings of pulp cavities in MI, much larger and differently shaped basal plate and differently shaped MII.

Genus **RAMPHOPRION** KIELAN-JAWOROWSKA, 1962

Type species: Ramphoprion elongatus KIELAN-JAWOROWSKA, 1962.

Diagnosis. — As for the family.

Stratigraphic and geographical range. — Ordovician; Europe, North America.

Species:

Ramphoprion elongatus KIELAN-JAWOROWSKA, 1962
Ramphoprion urbaneki n. sp.
Ramphoprion sp. *a*
Ramphoprion sp. *b*
Ramphoprion sp. *c*
Ramphoprion sp. *d*
Ramphoprion sp. (the jaw apparatus described by GRIES (1944, p. 11, Fig. 3) as "an Ordovician jaw assemblage", from the basal Liberty formation, Ohio, USA).

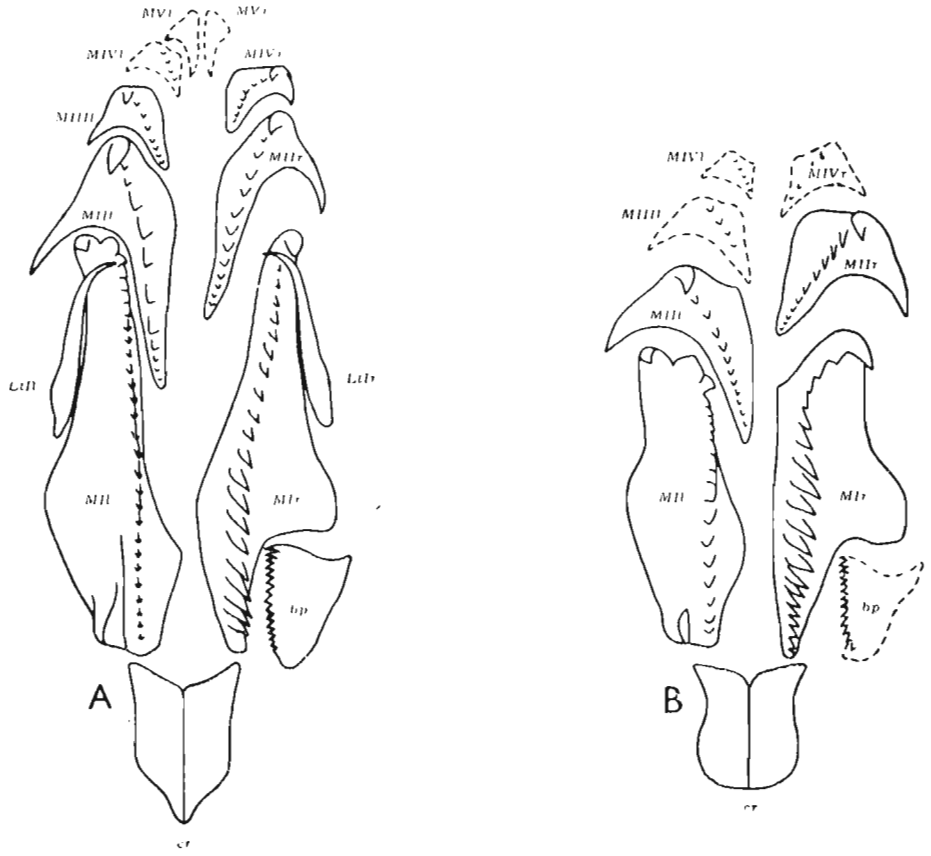


Fig. 9

Diagrammatic sketches of the jaw apparatuses in the Ramphoprionidae
A Ramphoprion elongatus KIELAN-JAW., *B Ramphoprion urbaneki* n. sp.
(For abbreviations — see p. 153)

Discussion. — The ramphoprionid detached right and left MI and basal plates belong to the common fossils in the investigated samples, the entire jaw apparatuses or joined jaws are, however, very rare. Therefore the majority of ramphoprionid species have to remain for the time being in the author's collection undescribed.

Detached ramphoprionid right and left MI and basal plates belong to the more common scolecodonts described from the Ordovician strata of North America. MI are assigned mostly to the genera *Nereidavus* GRINNELL, and *Protarabellites* STAUFFER, e.g. *Nereidavus alatus* ELLER (ELLER, 1945, p. 189, Plate 7, figs. 9—11), *Nereidavus procurvus* ELLER (ELLER, 1942, p. 247, Plate 1, figs. 22, 23), *Protarabellites glenwoodensis* STAUFFER (STAUFFER, 1933, p. 1191, Plate 61, figs. 19, 24) and numerous others; basal plates are assigned mostly to the genera: *Arabellites* HINDE, *Paleoenonites* ELLER and *Grinnellia* CRONEIS & SCOTT, e.g. *Arabellites scutellatus* HINDE (HINDE, 1879, p. 379, Plate 19, fig. 16), *Grinnellia scutellata* (HINDE) (GRIES, 1944, p. 21, Plate 2, figs. 34, 35), *Paleoenonites edentulus* ELLER (ELLER 1942, p. 251, Plate 2, figs. 15—16) and numerous others.

Ramphoprion elongatus KIELAN-JAWOROWSKA, 1962

(Plate XXV, fig. 3; Text-fig. 9*A*)

1962. *Ramphoprion elongatus* n. sp.; Z. KIELAN-JAWOROWSKA, New Ordovician genera..., p. 315, Pls. 8, 9, 10, fig. *B*; Text-fig. 2*B*, non Pl. 10, fig. *A*.

Description and discussion. — *Ramphoprion elongatus* has been described in detail and figured by the writer (KIELAN-JAWOROWSKA, 1962). As the specific differences in studied labidognatha genera in many instances concern the structure of the inner wings in MI, the writer decided to separate the type specimen of *R. elongatus* (No. O.398/1, previously figured by KIELAN-JAWOROWSKA, 1962, Plate 8) in order to show the details of the inner slopes of right and left MI. The coat of silicate, covering the anterior part of the basal plate in this specimen has been removed at the same time. MIVr hidden in the articulated apparatus, has been separated and is figured on Plate XXV, fig. 3*h*. Both right and left MI of the type specimen are somewhat compressed. In dorsal view, the anterior part of the right slope of left MI is very narrow, posteriorly it enlarges into a prominent inner wing, which extends for about 0.42 of the jaw length. The anterior part of the inner wing has been broken off in the type specimen. In right MI there is no inner wing, the left slope is very narrow at the anterior part, the inner margin being directed posteriorly, at about mid-length the left slope enlarges, the inner margin swings outwards, then turns and continues postero-medially. The first denticle of the basal plate is longer than the next two. The inner branch of the left MII is very long, and it is doubtful whether the isolated left MII, previously assigned (KIELAN-JAWOROWSKA, 1962, Plate 10, fig. *A*) to *Ramphoprion elongatus*, does belong in fact to this species.

The difference between right MI of the type specimen and the single right MI assigned to this species (figured by KIELAN-JAWOROWSKA, 1962, Plate 9 and Plate 10, fig. *B*) is considerable. Both right and left MI in the type specimen are strongly elongated, the anterior parts being slender and very long. Length to width ratio of the right MI of the type specimen (in dorsal view) is 3, while in other specimens it varies between 2.6—2.8. The very anterior part of right MI in the type specimen is much more slender than in the jaws figured in *l. c.*, Plates 9 and 10. Due to the scanty material from the boulder O.398, which yielded all the discussed specimens, the author cannot venture an opinion as to whether they are conspecific or not.

It is possible that the left MI figured by the writer (KIELAN-JAWOROWSKA, 1962, Plates 9 and 10*B*) are not conspecific with the type specimen of *R. elongatus*, this question may only be elucidated when more material of articulate jaw apparatuses of the forms in question is available.

Ramphoprion urbaneki n. sp.

(Plate XXIV, figs. 1-3; Text-fig. 9*B*)

Type specimen: The jaw apparatus No. O.469/30, figured on Plate XXIV, fig. 3. It consists of right and left MI, damaged left MII, right MII in unnatural position and carriers, preserved upside down against the pulp cavity of left MI.

Type horizon and locality: The erratic boulder No. O.469, of ?Middle Ordovician age, Mochty, province of Warsaw.

Derivation of the name: Named in honour of my colleague Dr. ADAM URBANEK.

Diagnosis. — Carriers subrectangular, broadly rounded posteriorly, length equal to a third that of MI. Basal plate unknown. Left MI comparatively broad jaw, widest at mid-length, with a sigmoid inner wing, extending for half the length of the jaw. Right MI comparatively wide with a prominent shank and a bight extending for 0.33 of the jaw length. Opening of pulp cavity in left MI equal to 0.66 of the jaw length, in right MI to 0.8. MII imperfectly known. Mandibles, MIII, MIV and lateral teeth unknown.

Denticle formula:

Basal plate	—	unknown
MI	19—24	18—22
MII	?	15

Material. — In addition to the type specimen there are several isolated right and left MI from the boulders O.182, O.366 and O.469. Of these boulders the age of No. O.182 was ascertained as Middle Ordovician (?Kukruse Stage of Estonian sequence) and that of the boulder O.366 as Middle Ordovician (?Kukruse Stage or Idavere Stage).

Description. — Comparatively large apparatuses, length of MI varying between 1.75—2.2 mm.

Carriers are subrectangular, broadly rounded posteriorly. Length to width ratio of a single carrier is 2.7. Anterior margin is directed transversally, antero-lateral corners rounded. Outer margins are directed posteriorly, slightly incurved in the anterior part. On the dorsal surface of the carriers there is a very faint, indistinct ornamentation of thread-like lines.

Right MI in dorsal view is 2.7 times longer than wide. A series of 18—22 long denticles extends the full length of the jaw. The first denticle is the longest, next five smaller, then the denticles increase in size towards the middle, again decreasing posteriorly. The outer margin is concave, directed postero-laterally, at about mid-length it turns and continues posteriorly, around a prominent shank. The posterior margin surrounding the bight is directed transversally. Length of the bight varies around 3.4 of the jaw length. The inner margin is directed postero--laterally, then posteriorly. There is a very small, inner wing. In left lateral view the anterior margin forms an arch passing into the outer margin. At one third of the jaw length from the front the outer margin bends, continues transversally for a short time, bending once more to continue postero-medially. The jaw is widest at one third of the length from the front and then tapers posteriorly. The boundaries between the denticles are prolonged onto the left slope. In right lateral view the anterior margin forms an arch with the outer margin, the posterior part of the outer margin, opposite the bight, runs posteriorly and then in an arch postero-medially. In ventral view the length of the opening of the pulp cavity varies around 0.8 of the jaw length. A deep furrow with pits associated with the denticles runs along the inner margin, a somewhat

shallower sigmoid furrow runs subparallel to the outer margin. The area between the furrows is inflated. No distinct muscle scar.

Left MI in dorsal view is a comparatively wide jaw, the greatest width being across mid-length. A series of 19—24 denticles extends almost the full length of the jaw. The three first comparatively stout denticles are twisted out of alignment with other denticles. Behind them there is a series of about 5 very small denticles, then the denticles increase in size towards the middle, decreasing again posteriorly. The outer margin is somewhat concave, directed postero-laterally, at about mid-length it bends and continues postero-medially. The posterior margin is directed transversally, being about 2.3 times shorter *(tr.)* than the greatest width of the jaw. The anterior part of the right slope is hidden under the dentary. At about mid-length the right slope widens into an inner wing, which has a sigmoid outline. The very posterior part of the inner wing is almost entirely hidden under the dentary. At the posterior part of the left slope, there is a short *(long.)* posterior furrow, parallel to the dentary, extending for one tenth of the jaw length, shallowing anteriorly. Left of the posterior furrow there is a short *(long)* rounded ridge, delimiting the furrow, directed antero-medially. In left lateral view the jaw is subtriangular, widest at mid-length, narrowing both anteriorly and posteriorly. The posterior margin is short *(tr.)*, directed transversally, the rounded ridge at the posterior part of the jaw is well seen in this view and is directed postero-medially. In right lateral view the dentary has a sigmoid outline, the first denticle is very long, the right slope widest in the middle. At the posterior part of the right slope, there is a deep furrow, parallel to the dentary. In ventral view the opening of the pulp cavity extends for 0.66 of the jaw length, a very deep furrow with pits associated with the denticles runs along the left side of the opening. At the anterior part of the opening, right to the furrow with pits, there is a rounded, poorly defined muscle scar.

Right MII (preserved in a type specimen only) is an arcuated jaw with convex anterior and concave posterior margins with a series of 15 denticles, decreasing in size posteriorly, extending the full length of the jaw. The anterior part of the jaw is produced laterally into a pointed end, which in the type specimen is strongly bent.

Left MII preserved in a type specimen is strongly damaged, and the exact number of denticles cannot be ascertained. It is of the same shape as left MII, but larger.

Variation. — On account of the small number of specimens not much can be said as to the variability of this species. There is considerable variability in the number and size of denticles.

Discussion. — *Ramphoprion urbaneki* n. sp. differs from *Ramphoprion elongatus* KIELAN-JAW., in having carriers subrectangular broadly rounded posteriorly, while in *R. elongatus* they are subtriangular, tapering posteriorly. Right and left MI in the new species, are shorter with regard to length than in *R. elongatus*, the greatest width of left MI in the new species is at mid-length, while in *R. elongatus* it is beyond mid-length. The openings of the pulp cavities in the new species are much longer than in *R. elongatus*.

Ramphoprion sp. **a**

(Plate XXIV, fig. 6)

Material. — Left MI, MII and MIII joined together, from the boulder No. O.182. The boulder found in Mochty, province of Warsaw, is Middle Ordovician (?Kukruse Stage).

Description and discussion. — The left side of the jaw apparatus here described shows some similarities to *R. urbaneki* n. sp., and its description is confined to just pointing out the differences between it and *R. urbaneki.*

Left MI: A series of 18 denticles decreasing in size posteriorly extends almost the full length of the jaw. The inner wing is somewhat shorter and more prominent than in *R. urbaneki.* Another difference concerns the ventral side of the jaw, as the opening of the pulp cavity extends here for 0.52 of the jaw length while in *R. elongatus* for 0.66.

Left MII is an arcuated jaw with 13 denticles decreasing in size posteriorly, extending the full length of the jaw. The posterior border is strongly concave, the anterior part of the jaw produced laterally into a pointed process, directed almost posteriorly, somewhat postero-laterally.

Left MIII is an arcuated jaw, similar in shape to left MII, but smaller, with 9 denticles.

Ramphoprion sp. **b**

(Plate XXIV, fig. 4)

Material. — Detached left MI from the boulder No. O.469 (of ?Middle Ordovician age).

Description and discussion. — Left MI figured on Plate XXIV, fig. 4 is very similar in shape to left MI from the boulder O.182 described above as *Ramphoprion* sp. *a.* It has 21 denticles decreasing in size posteriorly, a more strongly convex outer margin and a less prominent, sigmoid inner wing. The greatest difference concerns the shape of the opening, which in *Ramphoprion* sp. *b* extends for 0.47 of the jaw length and has a broadly rounded anterior margin, while in *Ramphoprion* sp. *a* the opening is longer, provided with an arcuate anterior margin. As the left MI, described here as *Ramphoprion* sp. *a* and *Ramphoprion* sp. *b*, have not been found in more complete joined jaw apparatuses, and as the majority of the ramphoprionid material in the writer's collection are detached jaws, one cannot venture an opinion as to whether the here described forms *(Ramphoprion* sp. *a* and *Ramphoprion* sp. *b)* are conspecific and if the differences between them are within the specific variation, or whether they represent separate species.

Ramphoprion sp. **c**

(Plate XXIV, fig. 5)

Material. — Basal plate from the boulder No. O.182 of Middle Ordovician age (?Kukruse Stage).

Description. — A subrectangular basal plate, narrowing posteriorly, with concave anterior margin. Antero-lateral corner is produced into a shank, directed anteriorly. Outer margin is directed postero-medially, posterior margin transversally. A series of 15 denticles extends nearly the full length of the jaw. First denticle is the longest, next insignificantly smaller, the remaining ones somewhat increasing in size posteriorly. Width of the basal plate across the posterior margin is half that across the anterior margin. In ventral view the belt extends anteriorly for less than half the jaw width, narrowing posteriorly. In left lateral view anterior part of the belt is hidden under the dentary, the posterior part arranged at a different angle from the anterior part, is well seen, arched in outline.

Discussion. — In the samples from the boulders O.182 and O.469 there are detached basal plates of ramphoprionid type, accompanying isolated left and right MI of *Ramphoprion*

urbaneki, *Ramphoprion* sp. *a*, *Ramphoprion* sp. *b* and *Ramphoprion* sp. *d*. One of these plates is described here as *Ramphoprion* sp. *c*. One cannot venture an opinion as to which of the above discussed species the basal plate, here described, belongs. The majority of isolated basal plates of ramphoprionid type from different boulders remains for the time being undescribed. The variation of shape within the ramphoprionid basal plates is quite significant, and concerns changes in the length to width ratio, degree of narrowing of the plate and development of shanks, which may be longer or shorter.

Ramphoprion sp. **d**

(Plate XI, figs. 1-2)

Material. — Single right MI from the Kukruse beds C_{II} of Estonia, numerous isolated right MI from the boulder No. O.182, of Middle Ordovician age (?Kukruse Stage).

Description. — Length of the right MI here assigned varies between 0.5 and 2.8 mm. Strongly elongated jaw, 2.8—2.9 times longer than wide, with a bight extending for 0.28—0.31 of the jaw length. A series of 20—25 denticles extends for almost the full length of the jaw. First denticle is the largest, next few are the smallest, then the denticles increase towards the middle, decreasing again posteriorly. In dorsal view the jaw is the widest at one third of its length from behind. Inner margin is directed postero-laterally for two thirds of the jaw length, then forms an arch and continues postero-medially. Outer margin is directed subposteriorly, then forms a concave arch and continues postero-laterally to surround a prominent shank, directed subtransversally. The outer margin of the shank is directed postero-medially. The posterior margin of the shank is directed subtransversally and in a broad, convex arch passes into the posterior part of the outer margin which is directed longitudinally. In right lateral view the jaw is narrow, widest in the middle, tapering both anteriorly and posteriorly. The first denticle, directed at right angles to the length of the jaw is sharp and long. In left lateral view the jaw is very narrow, widest in the middle, tapering both anteriorly and posteriorly. A part of the pulp cavity is seen in the posterior half of the jaw. In ventral view the opening of the pulp cavity extends for about half of the jaw length. The anterior margin of the opening is rounded. In the middle of the opening, to the left of the furrow with pits, there is a suboval, longitudinal inflation, delimited on the left side by the furrow, subparallel to the furrow with pits.

Variation. — The specimen from Estonia differs in small details from those of the boulder O.182, having a somewhat longer bight (0.3 of the jaw length), which in Polish specimens is 0.28 of the jaw length and a more slender anterior part of jaw. Further differences concern the opening of the pulp cavity which in the Estonian specimen is somewhat longer and more strongly incurved anteriorly. It is difficult to say whether these differences could be regarded as lying within the range of specific variability or not. The conspecifity of the Estonian and Polish specimens could be proved, however, only if entire jaw apparatuses of the species in question were found in both places.

Family KALLOPRIONIDAE nov.

Diagnosis. — Asymmetrical jaw apparatuses intermediate between labidognatha and prionognatha types. Laeobasal plate, intercalary tooth and lateral teeth lacking. Carriers (known only in *Kalloprion)* arrow like, comparatively long, equal in length to MI. Basal plate subtrian-

gular, left MI and basal plate with transverse posterior margins. First denticle in MI longer than the remaining ones, which are disposed behind it without a long interval. Sometimes a small hook developed. One of the anterior jaws (MII or MIII) single, left, the remaining anterior jaws paired. Mandibles unknown.

Discussion. — The family is erected to include the following genera:

Kalloprion KIELAN-JAWOROWSKA, 1962
Leptoprion n. gen.
Euryprion n. gen. (assigned here tentatively).

All the genera here attributed, though recorded as labidognaths, display some features characteristic of prionognatha type. The wide *(tr.)* posterior margin of left MI and of the basal plate, are characteristic of prionognatha type. In some labidognatha genera, e.g. in *Ramphoprion*, *Paulinites* and *Polychaetura*, left MI is provided with a transverse posterior margin, this margin is however shorter in respect to the jaw length, than in the Kalloprionidae. In labidognatha genera the basal plate is subtriangular, narrowing posteriorly or subrectangular, in the Kalloprionidae it is subtriangular, but widens posteriorly as in the prionognatha type. In the labidognatha type the carriers (except of *Polychaetura*) are shorter than the length of MI, suboval, subrectangular or subtriangular. In Recent and fossil prionognatha types the carriers are long and arrow-like, longer than the length of MI.

In the Kalloprionidae (in *Kalloprion*) while the carriers are arrow like, they are wider and shorter than in *Atraktoprion* and in Recent prionognaths. The prionognatha genera have the first denticle in MI developed as a strong hook, much longer than the rest of the denticles, which are disposed behind it after an interval. In the Kalloprionidae the first denticle is somewhat longer than the rest and if the hook is developed it is comparatively short, and does not exceed one fourth of the jaw length.

Isolated kalloprionid jaws are comparatively rare in the studied collections and their descriptions are also rarely met with in the scolecodont literature. Basal plate described by GRIES (1944, p. 22, Plate 2, figs. 32, 33), as *Grinnellia varians*, shows some similarities to the basal plates in *Kalloprion* and is probably congeneric with it. *Arabellites cornutus* HINDE, described by GRIES (1944, p. 16, Plate 1, figs. 13—14), is the left MI, showing some similarities to the left MI described in the present paper as *Kalloprion* sp. *a*. The parataxonomic species *Arabellites comis* ELLER, cited by ELLER (1938), STAUFFER (1939) and LORANGER (1963) from the Devonian of North America, as well as various representatives of *Arabellites*, described by SEIDEL (1959) from the Zechstein of Thüringen, e.g. *Arabellites biconvexus* SEIDEL, *A. ?magnidentatus* SEIDEL, *A.? robustus* SEIDEL and others, show similarities to MI of *Kalloprion* and *Leptoprion*.

Similarly, an incomplete jaw apparatus, described by TASCH and STUDE (1965) as *Eunicites* sp. undet., shows in the structure of MI similarities to *Kalloprion* and *Leptoprion*, while MII are bevel square shaped, similar to those of *Leptoprion*. *Eunicites* sp. undet. TASCH& STUDE belongs to a separate genus which differs from the here described Ordovician and Silurian kalloprionids in the lack of a basal plate and a bight in the right MI. It is not clear from the figures given by TASCH and STUDE (1965, Plate 1, fig. 1), whether there is a remnant basal ridge in the right MI. The occurrence of these forms assigned tentatively to the Kalloprionidae shows that it is probable that the Kalloprionidae survived until Permian.

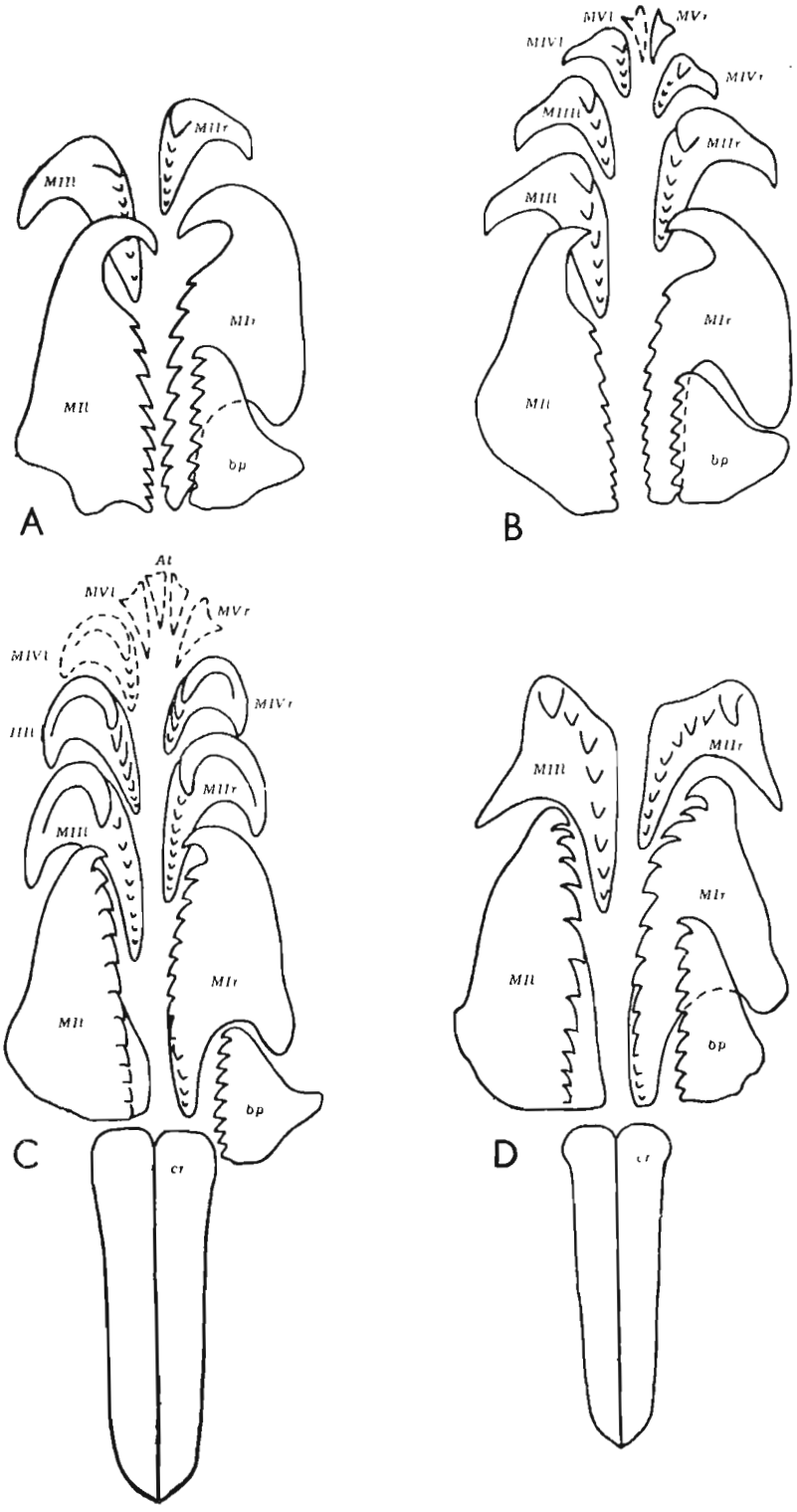


Fig. 10

Diagrammatic sketches of the jaw apparatuses in the Kalloprionidae

A ***Leptoprion artus*** n. sp., *B Leptoprion polonicus* n. sp., *C Kalloprion ovalis* KIELAN-JAW., *D Kalloprion triangularis* n. sp.

(For abbreviations — see p. 153)

Genus **KALLOPRION** KIELAN-JAWOROWSKA, 1962

Diagnosis and discussion. — See KIELAN-JAWOROWSKA, 1962.
Stratigraphic and geographical range. — Ordovician-Silurian; Europe, ?North America.
Species:

Kalloprion ovalis KIELAN-JAWOROWSKA, 1962 — type species
Kalloprion triangularis n. sp.
Kalloprion sp. *a*
Kalloprion sp. *b*.

Kalloprion ovalis KIELAN-JAWOROWSKA, 1962

(Text-fig. 10*C*)

1962. *Kalloprion ovalis* n. sp.; Z. KIELAN-JAWOROWSKA, New Ordovician genera..., p. 311, Pls. 5-7.

Discussion. — *Kalloprion ovalis* has been described in detail in previous publication (KIELAN-JAWOROWSKA, 1962); now the writer wishes to introduce some emendations concerning its stratigraphic range. It has been stated (*l. c.*, p. 311) that *K. ovalis* ranges from Middle Ordovician (Kukruse Stage) to Upper Ordovician (Rakvere Stage). The occurrence of *K. ovalis* in the Upper Ordovician has been based on its occurrence in the boulder No. O.400, its age presumed as Upper Ordovician. Now it seems more probable (cf. p. 24) that the boulder No. O.400 is of the Middle Ordovician age, thus the stratigraphic range of *K. ovalis* is restricted to the Middle Ordovician (?Kukruse Stage or Idavere Stage).

Kalloprion triangularis n. sp.

(Plate XXVI; Text-fig. 10*D*)

Type specimen: The jaw apparatus No. O.398/4 figured on Plate XXVI, fig. 3. It consists of a basal plate, left and right MI and left MII.

Type horizon and locality: Erratic boulder No. O.398 of Middle Ordovician age, ?Keila Stage of Estonian sequence; Mochty, province of Warsaw.

Derivation of the name: Lat. *triangularis* — alludes to the triangular shape of the basal plate.

Diagnosis. — Basal plate subtriangular, narrow, strongly elongated proximally, twice as long as wide. Bight in right MI shallow, shank prominent. Inner wing in left MI equal to half the length of the jaw, subtriangular, tapering anteriorly, MII with large, subtriangular inner slopes, and bights moderately incurved.

Denticle formula:

Basal plate	—	8—10
MI	11—13	10—13
MII	7—10	9
MIII, MIV	unknown	unknown

Material. — In addition to the type specimen there are: one incomplete jaw apparatus with carriers, right MI joined with the basal plate and one single right MI, all from the boulder O.398.

Description. — Length of MI varies between 0.35—0.96 mm. The entire apparatus without carriers is suboval, the greatest width being across the posterior part of MI. Right MI is longer than left MI.

Carriers preserved in one specimen only, are equal in length to about 0.8 that of right MI. They form two arrows widest anteriorly, somewhat tapering posteriorly. Posterior ends are rounded.

Basal plate is subtriangular, with proximal part strongly elongated anteriorly and with a transverse posterior margin. It is about as long as wide. A series of 8—10 denticles extends nearly the full length of the inner margin. The first denticle is somewhat longer than the remaining ones. Anterior margin runs from the first denticle postero-laterally, at about the mid-length of the jaw it turns and continues postero-laterally, more transversally. Outer margin is short *(long.)*, directed subposteriorly. The chitin of the distal part is thin and transparent and easily broken off, thus giving rise to the variable shape of the distal part of the jaw. The greatest width of the jaw is to the rear of mid-length. The length *(tr.)* of the outer margin is equal to half the greatest width. In ventral view the opening of the pulp cavity extends for half the length of the jaw, a large cover passes proximally into a comparatively wide belt.

Right MI in dorsal view is a subtriangular jaw with a wide bight along the posterior margin. The greatest width of the jaw is across the most anterior part of the bight. Length to width ratio is 2.2. The outer margin runs from the first denticle postero-laterally, and turns around a slender shank which is directed postero-laterally. The posterior border surrounding the shank forms a wide arch. The inner margin is directed postero-laterally, at one third of the jaw length from the front it turns and continues postero-medially. A series of 10—13 denticles decreasing in size posteriorly extends the full length of the jaw. The right slope opposite the bight is very narrow, enlarged at the posterior end. In left lateral view the width of the left slope increases, reaching its maximum at one third of the jaw length from the front and then again decreasing posteriorly. In ventral view the opening of the pulp cavity extends for 0.77 of the jaw length. A comparatively large teardrop shaped muscle scar is visible at the anterior part of the opening. Middle part of the jaw in front of the bight is somewhat inflated. Along the inner margin a deep furrow with pits associated with the denticles is well visible.

Left MI, in dorsal view, is 2.3 times longer than wide. A series of 11—13 denticles decreasing in size posteriorly extends the full length of the jaw. The outer margin is directed postero-laterally, at about one third of the jaw length from behind (where the jaw is widest) it turns and continues postero-medially. Anterior part of the right slope is hidden in this view under the dentary. The inner wing extends for half the length of the jaw, it is comparatively wide posteriorly (with a transverse posterior margin), tapering anteriorly. On the left slope, along the dentary a posterior furrow extends for about 0.35 of the jaw length. On the left side of this furrow there is a small, rounded ridge, directed postero-laterally.

Right MII is a comparatively large jaw, with a series of 9 denticles decreasing in size posteriorly, extending the full length of the jaw. The outer margin is directed postero-laterally and at about half of the jaw length produced into a narrow, sharply pointed shank. Along the posterior margin there is a bight extending for half of the jaw length. Anterior margin of the bight is moderately incurved into the jaw. The left slope is comparatively large, subtriangular, widest at about one third of the jaw length from the front and tapering both anteriorly and posteriorly. In ventral view the cover is comparatively long, extending distally in an arch to reach the shank.

Left MII is somewhat longer than right MII, otherwise being its mirror image.

Variation. — Within the small number of specimens attributed to *K. triangularis*, variability

concerns the shape of the basal plate, which may be wider or narrower in relation to the length of the jaw and the shape of the shank in right MI, which may be slender or more wide.

Discussion. — *Kalloprion triangularis* n. sp. differs from *K. ovalis* KIELAN-JAW. in the shape of the basal plate, which is here narrower in relation to the length, more strongly elongated proximally and provided with a larger cover on the ventral side. Right MI in *K. triangularis* has a distinctly triangular left slope wider than in *K. ovalis*. Left MI is very similar to that in *K. ovalis*. The greatest differences concern the shape of MII, which in the new species are larger, with wide subtriangular inner slopes and bights not so strongly incurved into the jaw as in *K. ovalis*.

Kalloprion sp. **a**

(Plate XXV, fig. 1)

Material. — Left MI joined with left MII, from the boulder No. O.469, of ?Middle Ordovician age, Mochty, province of Warsaw.

Description. — *Left MI* is a large (1.5 mm long), elongated jaw, twice as long as wide, with a series of 13 denticles extending the full length of the jaw. The first denticle which is longer than the remaining ones, extends for one fifth of the jaw length. The second denticle is very small, the remaining ones increase in size towards the middle, and then decrease posteriorly. The postero-lateral corner of the jaw is broken off and reconstructed on Plate XXV, fig. 1*c*. The outer margin runs posteriorly, then postero-laterally. Anterior part of the right slope is hidden in dorsal view under the dentary. The inner wing extends for a little over half the jaw length. It is prominent, widest anteriorly and narrowing posteriorly. A short and indistinct posterior furrow extends for one sixth of the jaw length. Left of the posterior furrow there is a faint rounded ridge, directed postero-laterally. The posterior margin is directed transversally. The right slope is directed downwards with regard to the dorsal surface of the jaw, then it bends and its posterior part enlarges into an inner wing. In right lateral view the inner wing, directed vertically, is almost invisible, the right slope appears the same width all along its length. In left lateral view the first denticle is prominent and bent, the dentary is directed at first postero-laterally then posteriorly, the jaw to the rear of the first denticle is almost the same width all along its length. In ventral view the opening extends for 0.66 of the jaw length. The furrow with pits associated with the denticles is very deep, with the pits almost invisible. The jaw is very narrow in front of the inner wing, strongly enlarging posteriorly.

Left MII is an elongated jaw with a series of 10 denticles extending the full length of the jaw. First denticle is longer than the remaining ones, which decrease in size posteriorly. The left slope is directed downwards, in the anterior part it enlarges into a prominent inner wing. Right slope is similarly steep, at half the jaw length produced into a long and thin shank, directed postero-laterally. The bight along the posterior margin of the right slope extends for half the length of the jaw. In left lateral view the jaw is rounded anteriorly, the shank directed almost posteriorly and the bight deeply incurved into the jaw. In ventral view the opening of the pulp cavity extends for about 0.85 of the jaw length, the furrow associated with the dentary being very deep.

Discussion. — *Kalloprion* sp. *a* differs from *K. ovalis* and *K. triangularis* in having a distinct (though small) hook in MI. The presence of a hook in MI is characteristic of *Leptoprion* n. gen. *Kalloprion* sp. *a*, however, reminds one more of *Kalloprion* than *Leptoprion* in the structure

of MII, which (left MII) is here comparatively large, rounded anteriorly, with a shank directed postero-laterally, almost posteriorly, while in *Leptoprion* MII are bevel square shaped, smaller, with shanks directed transversally.

Kalloprion sp. **b**

(Plate XXV, fig. 2)

Material. — One right side of the apparatus (Bp, MIr, MIIr, MIVr) from the boulder No. O.469, of ?Middle Ordovician age, Mochty, province of Warsaw.

Description. — *Basal plate* is an elongated jaw with a series of 11 denticles extending the full length of the jaw, decreasing in size posteriorly. The jaw is widest at about mid-length, where a small *(tr.* and *long.)* shank is developed, and then narrows both anteriorly and posteriorly. The short *(tr.)*, transverse posterior margin is equal to 0.35 of the jaw width.

Right MI is an elongated jaw 0.45 mm. long. A series of 13 denticles extends the full length of the jaw. First denticle is longer than the remaining ones, but not developed as a hook. The denticles decrease in size posteriorly. The bight is long, extending for almost half of the jaw length, not incurved into the jaw anteriorly. Shank not prominent. In front of the bight there is a subtriangular depression. No inner wing. In ventral view the opening of the pulp cavity extends for 0.8 of the jaw length.

Right MII is of *Kalloprion* type with a series of 9 denticles decreasing in size posteriorly, with a rounded anterior margin and strongly incurved posterior margin. At about half of the jaw length there is a slender shank, directed posteriorly.

Right MIV is a jaw with 7 denticles, strongly decreasing in size posteriorly, similar in shape to right MII but smaller.

Discussion. — *Kalloprion* sp. *b* differs from *K. ovalis* and *K. triangularis* in the structure of the right MI. In *Kalloprion* sp. *b* the shank in right MI is not developed and the bight not incurved into the jaw — which is characteristic of *K. ovalis* and *K. triangularis*. The structure of right MII and MIV is however of the *Kalloprion* type.

Genus **LEPTOPRION** nov.

Type species: Leptoprion polonicus n. sp.
Derivation of the name: Gr. *leptos* — slender, small; *prion* — a saw.

Diagnosis. — Hooks in MI extending for one seventh to one quarter of the jaw length. Basal plate roughly subtriangular, extended distally into a short *(long.)* shank. MII bevel square shaped. MIII single left, similar to left MII but smaller. MIV subtriangular. MV single teeth (only the right one known). Carriers and mandibles unknown.

Stratigraphic and geographical range. — Ordovician-?Silurian of the Baltic region.

Species:

Leptoprion polonicus n. sp. — type specimen
Leptoprion artus n. sp.

Discussion. — *Leptoprion* is in some respects intermediate between the genera *Kalloprion* and *Atraktoprion*; MI, particularly the right MI, is very much like that in *Kalloprion*. *Leptoprion*

differs from *Kalloprion* in having a definite (though short) hook in MI, while in *Kalloprion* the first denticle hardly differs from the remaining ones. The main difference between *Leptoprion* and *Kalloprion* concerns the structure of MII, which in *Leptoprion* are bevel square shaped, while in *Kalloprion* they are rounded anteriorly with a posteriorly directed shanks. In the structure of MII and in the arrangement of the anterior jaws, *Leptoprion* reminds one of the Atraktoprionidae.

Leptoprion polonicus n. sp.

(Plate XXVII, fig. 1; Text-fig. 10*B*)

Type specimen: Incomplete jaw apparatus No. O. 142/1, consisting of a basal plate, right and left MI, right and left MII, single left MIII, right and left MIV, right MV.

Type horizon and locality: Erratic boulder No. O. 142 of Middle Ordovician age (?Kukruse Stage of Estonian sequence). Wyszogród-Zakroczym, province of Warsaw.

Derivation of the name: polonicus — found in Poland.

Diagnosis. — Basal plate subtriangular, as wide as long, moderately extended anteriorly. Hook in left MI extends for one fourth of the jaw length, in right MI for one seventh. Denticles in MI comparatively small. Bight in right MI deeply incurved anteriorly, extending for almost a half of the jaw length. Distinct, circular muscle scars in the anterior part of the opening in both MI. Anterior jaws characteristic of the genus.

Denticle formula:

Basal plate	—	7
MI	1+10	1+11?
MII	6	7
MIII	4	—
MIV	4	4
MV	?1	1

Material. — Only the type specimen is known.

Description. — *Basal plate* is subtriangular, as wide as long, with 7 denticles insignificantly decreasing in size posteriorly. Anterior margin somewhat sigmoid, directed postero-laterally. Posterior margin is directed at first transversally, then antero-medially. Posterior and anterior margins meet to form an arch in the middle of the jaw length. Distal part of the jaw decidedly shorter *(long.)* than the proximal one, forming a rounded shank. The distal part is thinner and more transparent than the remaining part of the jaw, and it seems that it could easily be broken off. On the ventral side a narrow belt runs along the inner margin, otherwise the remaining part of the jaw is occupied by the opening of the pulp cavity.

Right MI is two and a half times longer than wide, with a moderately incurved hook, which extends for one seventh of the jaw length. To the rear of the hook, a series of 10-11 denticles (in the type specimen partly hidden under the basal plate) extends the full length of the jaw. The denticles decrease in size posteriorly. Bight is longer than wide, extending for almost half of the jaw length; it is strongly incurved into the jaw. In ventral view the belt is moderately wide, the opening extends for 0.8 of the jaw length. In the anterior part of the opening there is a rounded, small muscle scar, with a diameter equal to about 0.2 of the length of the opening. In the middle of the opening there is a subtriangular inflation, delimited by two furrows, which meet anteriorly.

Left MI has a hook somewhat longer than in the right jaw, and a series of 10 denticles decreasing in size posteriorly. Posterior margin is directed at first transversely, then bends and continues antero-laterally to meet the outer margin at one third of the jaw length, counting from behind, the jaw being widest at this level. The chitin of this distal part of the jaw is somewhat lighter and more transparent than in the remaining parts. In ventral view the belt is comparatively wide *(tr.)*, the opening somewhat shorter *(long.)* than in the right jaw, extending for two thirds of the jaw length. Muscle scar, arranged in the anterior part of the opening, is of similar shape and size as in right MI. Under the belt a series of pits associated with the denticles is visible.

Right MII is a bevel square shaped jaw, provided with a comparatively wide *(long.)* and long *(tr.)* shank, directed almost transversely, somewhat posteriorly. The shank is somewhat shorter *(tr.)* than the longitudinal part of the jaw. In respect to the surface of the whole apparatus the shank is somewhat concave, its distal end being curved upwards. A series of 7 denticles extends the full length of the longitudinal part of the jaw, the first denticle directed somewhat upwards is longer than the remaining one. In ventral view, except for the very small and short crescent like cover in the anterior part of the jaw, the opening of the pulp cavity is gaping.

Left MII is a mirror image of the right one, provided with 6 denticles and a shank somewhat thinner *(long.)* than in the right jaw. In the type specimen left MII is arranged more posteriorly than right MII.

Left MIII is bevel square shaped, smaller than left MII, with 4 sharp denticles, the first being the largest. Length of the shank *(tr.)* is equal to that of the longitudinal part of the jaw *(long.)*. In ventral view the opening of the pulp cavity is gaping.

Right MIV is a small subtriangular jaw, with concave posterior margin and a row of 4 denticles along the inner margin. First denticle is longer than the remaining ones. Pulp cavity is gaping.

Left MIV is a mirror image of the right one, in the type specimen arranged more anteriorly than right MIV.

Right MV is a small, sharp, elongated tooth.

Left MV is unknown.

In the type specimen MII—MIV are provided with large attachment lamellas, arranged perpendicularly to the jaw surface, and fused together, standing out anteriorly in front of MV.

Leptoprion artus n. sp.

(Plate XXVIII, figs. 2-5; Text-fig. 10*A*)

Type specimen: Right and left MI joined together, No. O.469/56, figured on Plate XXVIII, fig. 4.
Type horizon and locality: Erratic boulder No. O.469, of ?Middle Ordovician age, Mochty, province of Warsaw.
Derivation of the name: Lat. *artus* — compact.

Diagnosis. — Basal plate subtriangular, longer than wide, extended anteriorly. Hook in right MI extending for one eight of the jaw length, in left MI for one fourth. Denticles in MI comparatively large. Bight in right MI moderately incurved anteriorly, extending for about one third of the jaw length. Muscle scars at the anterior part of the opening in MI comparatively indistinct. Inner wing in right MI, extending for three fourth of the jaw length, provided in its anterior part with a triangular process. Inner wing in left MI extending for half of the jaw length.

Denticle formula:

Basal plate	—	8
MI	1+7—9	1+7—10
MII	8	6
MIII—MV	unknown	—

Material. — In addition to the type specimen there are joined left MI, right MII and left MII; right MI with a basal plate and left MI with a basal plate, — all from the boulder No.O.469, numerous isolated right and left MI from the boulders O.366, O.400, O.423 and O.472. Of the boulders yielding *L. artus*, the age of No. O.366 has been ascertained as Middle Ordovician (?Kukruse Stage or Idavere Stage).

Description. — Length of MI varies between 0.33—1.3 mm. *Basal plate* is subtriangular, somewhat longer than wide, with transverse, comparatively short *(tr.)* posterior margin. Anterior margin is directed postero-laterally in a sigmoid curve and meets the posterior margin at one third of the jaw length from behind. The distal part of the basal plate is elongated into a transversely directed shank. The shank has a chitin more transparent and fine than the remaining part of the jaw and may be easily broken off. A series of 8 denticles extends the full length of the inner margin. First denticle is somewhat stronger than the remaining ones. In ventral view in the anterior part of the basal plate there is a cover, which passes into a belt.

Right MI in dorsal view is provided with a hook, extending for one eighth of the jaw length. First denticle (behind the hook) is as a rule very small, next two larger, the remaining ones decrease in size posteriorly. The bight extends for about one third of the jaw length and is moderately incurved into the jaw. The shank surrounding the bight is rounded, directed postero-laterally. On the left side of the dentary there is a very narrow inner wing, which extends for three quarters of the jaw length. Anteriorly inner wing is enlarged, provided with a subtriangular process. In ventral view the cover extends for 0.16 to 0.2 of the jaw length. Its outer margin is thickened. In the most anterior part of the opening there is an indistinct muscle scar. In the middle of the opening there is a subtriangular inflation, delimited by furrows meeting in the anterior part of the opening.

Left MI in dorsal view is shorter than right MI, provided with a hook, which extends for one fourth of the jaw length. First denticle behind the hook is usually small, next two are the largest, the remaining ones decrease in size posteriorly. The outer margin runs at first transversely, then bends and continues in a sigmoid curve around the shank. The chitin of the shank is very fine and can easily be broken off. On account of this, the posterior part of the jaw may vary in shape, e.g. in the specimen figured on Plate XXVIII, fig. 3 the shank is entirely broken off and the posterior part of the outer margin has a concave outline, while in the specimen figured on Plate XXVIII, figs. 2 and 4, only a part of the shank is broken off. In the posterior part of the jaw, parallel to the dentary, a posterior furrow runs for about one fifth of the jaw length. The posterior part of the left slope, on the outer side of the posterior furrow, is developed as a short *(long.)* rounded ridge, directed antero-medially. The anterior part of the right slope is very narrow, insignificantly enlarging posteriorly, the posterior part is developed as an inner wing, extending for about a half of the jaw length.

Right MII, preserved in the specimen figured on Plate XXVIII, fig. 2, No. O.469/36, is arranged more anteriorly than the left jaw. It is bevel square shaped, with a comparatively

short *(tr.)* pointed shank, the first denticle is longer than the remaining ones. In ventral view the opening of the pulp cavity is gaping.

Left MII is more or less a mirror image of the right jaw, but larger. In the specimen figured on Plate XXVIII, fig. 2, the shank of the left MII is broken off.

Genus **EURYPRION** nov.

Type species: Euryprion rarus n. sp.
Derivation of the name: Gr. *eurys* — broad, *prion* — a saw, alludes to the broad MI.

Diagnosis. — Left MI broad, with wide *(tr.)* posterior margin, broadly rounded anterior margin. Right MI very broad, with subtransversal anterior margin, very prominent shank and wide bight along the posterior margin. Basal plate subtriangular, with transversal posterior margin. Left MII single, elongated transversally, with a wide bight along the posterior margin. Right MIII strong tooth, provided with transversal, long *(tr.)* shank and anterior wing. Left MII similarly shaped, somewhat smaller. Carriers, MIV and mandibles unknown.

Stratigraphic and geographical range. — Middle Ordovician erratic boulders of Poland.
Species:

Euryprion rarus n. sp.
Euryprion sp. *a*

Discussion. — *Euryprion* n. gen. is assigned to the Kalloprionidae only tentatively. It reminds one of the genera *Kalloprion* nov. and *Leptoprion* nov. in the structure of the posterior part of MI and of the basal plate. It differs from *Leptoprion* and *Kalloprion* considerably in having MI broadly rounded anteriorly and in the structure of MII and MIII. The latter jaws of *Euryprion* are unique among all the known fossil prionognatha and labidognatha genera. *Euryprion* is so far the only genus in which MII (not MIII) is a single jaw, and in which MII differs considerably from MIII. In *Kalloprion*, *Leptoprion*, *Atraktoprion*, *Polychaetaspis*, and others, MII are in the shape of a bevel square, or subtriangular, rounded anteriorly, while in *Euryprion* the single MII is strongly elongated transversally, with a concave anterior margin. Moreover, in all these genera MII is similar in shape to MIII, but smaller. In *Euryprion*, MIII (paired) are quite differently shaped, provided with one strong tooth and an inner lamella, perpendicular to the jaw surface. While these differences are sufficient to place *Euryprion* in a separate family, the present writer, due to the scanty material, considers it more reasonable to place *Euryprion* provisionally for the time being in the Kalloprionidae.

Euryprion rarus n. sp.

(Plate XXVII, figs. 2, 3)

Type specimen: A somewhat depressed jaw apparatus, No. O.182/4, figured on Plate XXVII, fig. 3. It consists of a basal plate, right and left MI, left MII (single), right and left MIII.

Type horizon and locality: Erratic boulder No. O.182 of Middle Ordovician age, (?Kukruse Stage of Estonian sequence), Mochty, province of Warsaw.

Derivation of the name: Lat. *rarus* — rare.

Diagnosis. — As for the genus.

Denticle formula:

Basal plate	—	7
MI	11	9—10
MII	4	—
MIII	1	1

Material. — In addition to the type specimen there is one single right MI from the boulder No. O.182.

Description. — Length of the right MI varies between 0.28—0.52 mm.

Basal plate is subtriangular, with transverse posterior margin, somewhat longer than wide, with 7 denticles decreasing in size posteriorly. Anterior margin is directed postero-laterally. Posterior margin runs transversally, turns forwards and then runs transversally again to reach the short *(long.)* outer margin. The length of the outer margin is equal to one third that of the dentary. In ventral view at the anterior part of the jaw there is a narrow *(long.)* cover, which passes into the narrow belt. Otherwise the remaining part of the jaw is occupied by the opening of the pulp cavity. Along the belt a row of pits associated with the denticles is well visible.

Right MI is a comparatively wide jaw, length to width ratio in a somewhat depressed type specimen is 1.22, in specimen figured on Plate XXVII, fig. 2 it is 1.37. A series of 9—10 denticles extends the full length of the jaw. First denticle is the longest, second small, third large again, the remaining decrease in size posteriorly. Anterior margin, directed subtransversally, forms an arch slightly convex anteriorly and passes into the outer margin, which runs in a sigmoid curve postero-laterally. The bight extends for about one third of the jaw length. Anterior border of the bight forms a comparatively high arch. The distal part of the jaw is developed as a sub-rectangular shank, directed postero-laterally. In front of the bight there is a subtriangular depression. In ventral view the opening of the pulp cavity extends for 0.8—0.85 of the jaw length. The crescent-like cover prolongs into a narrow belt, running along the inner margin of the jaw. Along the belt a furrow with pits associated with the denticles is visible. In the middle part of the jaw, in front of the bight, there is a subtriangular inflation.

Left MI is somewhat narrower than right MI, its length to width ratio being 1.7. A series of 11 denticles extends the full length of the jaw. The first denticle is longer than the remaining ones, which are arranged behind it after an interval. The denticles decrease in size posteriorly. Anterior margin runs at first subtransversally, then passes into the outer margin directed postero-laterally in a sigmoid curve. At one third of the jaw length from behind, where the jaw is widest, the outer margin turns and continues postero-medially, towards the transversal posterior margin. The length *(tr.)* of the posterior margin is equal to half the greatest width of the jaw. In ventral view the opening extends for 0.8 of the jaw length. The crescent like cover prolongs into the longitudinal belt, along which a row of pits associated with the denticles is well visible.

Left MII is a single jaw, elongated transversally, with a long bight on the posterior border. The anterior margin forms a concave arch, then turns and runs postero-laterally. Outer and inner margins are directed posteriorly. The inner part of the jaw prolongs posteriorly into an elongated part, tapering posteriorly. There are 4 denticles along the inner border, the first one somewhat longer than the remaining ones, disposed behind it after an interval. The outer part of the jaw is elongated posteriorly into a shank, shorter *(long.)* than the inner prolongation. In ventral view, in the anterior part of the jaw, there is a short *(long.)* cover, passing into a narrow belt, tapering posteriorly. Pits associated with the denticles are distinctly visible in a furrow along the belt.

Right MIII is elongated transversally, with a single, strong denticle arranged in its antero-medial corner. The denticle is directed postero-medially, much larger than the denticles of MII and MIII. The anterior margin is directed subtransversally, slightly convex outwards, the posterior margin is concave. The distal part is produced into a small subquadrangular shank, directed postero-laterally. The inner part of the jaw forms a narrow *(tr.)* lamella, arranged perpendicularly to the surface of the jaw, extending both anteriorly — in front of

the tooth, and posteriorly — behind and below the tooth. In ventral view the pulp cavity is almost gaping, except for a narrow *(tr.)* cover along the anterior border. In the inner part there is a very deep, rounded depression, associated with the tooth.

Left MIII is somewhat smaller than the right MIII, similarly shaped. It differs from the right jaw in having the posterior border only very slightly concave, being shorter *(tr.)* without a distinct shank in the distal part. Otherwise it is more or less a mirror image of right MIII.

Variation. — Right MI of the type specimen differs somewhat in proportions from that of the specimen No.O.182/43, being wider in relation to the length and in having a differently shaped shank. As the type specimen is somewhat depressed, it might be possible that these differences are due to the state of preservation.

Euryprion sp. **a**

(Plate XXVIII, fig. 1)

Material. — Single right MI from the boulder No. O. 139 of unknown age, Ordovician or Silurian, Wyszogród—Zakroczym, province of Warsaw.

Right MI of *Euryprion* sp. *a* differs from that of *Euryprion rarus* in having a longer bight, extending for almost half the jaw length, while in *E. rarus* it varies around one third that of the jaw length, in having a more slender shank, and inner margin provided with a small wing. Otherwise it is very similar to *E. rarus*, but due to the scanty material one cannot venture an opinion as to whether it represents a separate species or falls within the individual variability of *E. rarus*.

Family PAULINITIDAE LANGE, 1947

Diagnosis. — Asymmetrical jaw apparatuses of labidognatha type. Laeobasal plate, intercalary tooth and lateral teeth lacking. Carriers small, slender, tapering posteriorly. Left MI and basal plate with transverse posterior margins. MII extends far backwards below MI. Basal plate very small, subrectangular, elongated transversally, undenticulated, sometimes fused with the right MI. Anterior parts of inner margins in MI denticulated, posterior parts developed as undenticulated ridges. Inner wing extending along undenticulated ridge. Bight in right MI equal to 0.1—0.2 of the jaw length. Pulp cavities in MI strongly enclosed. MII large, elongated longitudinally, with slender shanks at mid-length and deep bights on posterior margins. MIII single left, subtriangular, MIV small, arcuate. Lateral teeth and intercalary tooth lacking. Mandibles with anterior area striped, equal to one third of mandible length, posterior shanks directed postero-laterally.

Genera:

Paulinites LANGE, 1947
Langeites nov.

Discussion. — The family Paulinitidae was erected by LANGE (1947) to include *Paulinites* LANGE. ŠNAJDR (1951) assigned to the Paulinitidae *Kettnerites* ŽEBERA, from the Silurian (Ludlow) of Bohemia. *Kettnerites* has been erected by ŽEBERA (1935) for right MII, ŠNAJDR (1951) gave an emended diagnosis of *Kettnerites*, based on new material of entire jaw apparatuses of *Kettnerites kosoviensis* from the Silurian of Bohemia. The differences between the genera *Paulinites* LANGE and *Kettnerites* ŽEBERA emend. ŠNAJDR, as defined by ŠNAJDR (1951, p. 261)

are insignificant and concern only the number, shape and the arrangement of denticles in MI and MII and the shape of MIV. In the present writer's opinion, the above discussed differences cannot be regarded as of generic rank, and *Kettnerites* ŽEBERA, 1935, emend. ŠNAJDR, 1951 is regarded here a junior subjective synonym of *Paulinites* LANGE.

The descriptions of isolated MI of *Paulinites* (or Paulinitidae) are to be found in almost all the papers dealing with the Silurian-Carboniferous scolecodonts of North America, South America and Europe, assigned mostly to the parataxonomic genus *Nereidavus* GRINNELL (cf. e.g. ELLER, 1940). The representatives of *Paulinites* have not been found by the writer in the samples from definite Ordovician boulders, they are, however, reported from the Ordovician of North America. *Elmhurstia nododentata* POTTER, described by GRIES (1944) from the Middle Ordovician (Liberty formation) of Cincinnati (p. 19, Plate 2, figs. 3—4) is the right MI of *Paulinites* sp. Similarly *Nereidavus angulosus* ELLER, described by ELLER (1945, p. 190, Plate 7, figs. 12—16) from the Ordovician (Trenton Series) of Ontario, is a paulinitid right MI. These data indicate that the stratigraphic range of the Paulinitidae is Ordovician-Carboniferous (?Permian). The descriptions of the detached paulinitid right and left MII are less common than those of MI. MII are described mostly under the generic names: *Lumbriconereites* EHLERS, e.g. *Lumbriconereites expansus* STAUFFER (STAUFFER, 1939, p. 507, Plate 57, fig. 4), *Eunicites* EHLERS, e.g. *Eunicites grandis* STAUFFER (*l. c.*, p. 505, Plate 57, fig. 8), or *Arabellites* HINDE, e.g. *Arabellites priscus* STAUFFER (*l. c.*, p. 504, Plate 58, fig. 18) and numerous others.

Genus **PAULINITES** LANGE, 1947

Diagnosis. — MI strongly elongated, with inner and outer margins directed posteriorly all along the jaw lengths. Denticulation in MI extends for 0.7—0.8 of inner margins. Bight in right MI equal to 0.15—0.2 of the jaw length, openings of pulp cavities in MI equal to 0.3—0.4 of the jaw length. Basal plate more or less strongly fused with the right MI.

Stratigraphic and geographical range. — Ordovician-Carboniferous (?Permian) of Europe and North America, Devonian of South America.

Species:

Paulinites paranaensis LANGE, 1947 — type species
Paulinites caniuensis LANGE, 1950
Paulinites kosoviensis (ŽEBERA, 1935, emend. ŠNAJDR, 1951)
Paulinites burgensis MARTINSSON, 1960
Paulinites sp. MARTINSSON, 1960
Paulinites polonensis n. sp.
Paulinites gladiatus n. sp.

Discussion. — The isolated jaws of *Paulinites*, particularly MI, belong to very common fossils in the Silurian boulders of the writer's collection. They are strongly diversified, showing that *Paulinites* represented a large and successful line throughout early Palaeozoic in the Baltic region. As the joined jaws or jaw apparatuses of *Paulinites* are very rare in the writer's collection, a large majority of paulinitid species, represented by detached jaws, has to remain for the time being undescribed. Within the representatives of *Kettnerites*, described by ŠNAJDR (1951) from the Silurian of Bohemia, only *Kettnerites kosoviensis* (recte *Paulinites kosoviensis*) is known as an entire apparatus. The remaining representatives of *Kettnerites*: *Kettnerites langei* ŠNAJDR and *K. hebes* ŠNAJDR, are represented by detached jaws, and cannot be included in the list of species of *Paulinites*.

Paulinites polonensis n. sp.

(Plate XXIX; Plate XXX, figs. 7-8; Text-figs. 5*L* and 11)

Type specimen: The apparatus No. O.439/3, figured on Plate XXIX, fig. 2 (a basal plate, right and left MI, right and left MII, left MIII).

Type horizon and locality: Erratic boulder No. O.439 of ?Silurian age, Ustka, Baltic coast.

Derivation of the name: polonensis — occurring in Poland.

Diagnosis. — MI moderately narrowing anteriorly, with numerous small denticles. Right MI with a small shank, bight extends for 0.15 of the jaw length. Posterior furrow in left MI narrow, equal to 0.18 of the jaw length. Carriers and mandibles unknown.

Denticle formula:

Basal plate	—	smooth
MI	20—39	17—34
MII	14—17	13—18
MIII	10—11	—
MIV	9	10

Material. — In addition to the type specimen, there is one more jaw apparatus (Bp, MIr, MIl, MIIr MIII) from the boulder No. O.439, one apparatus (MIl, MIIl, MIIIl, MIVr) from the boulder O.391, several isolated right and left MI and MII, some right MI with basal

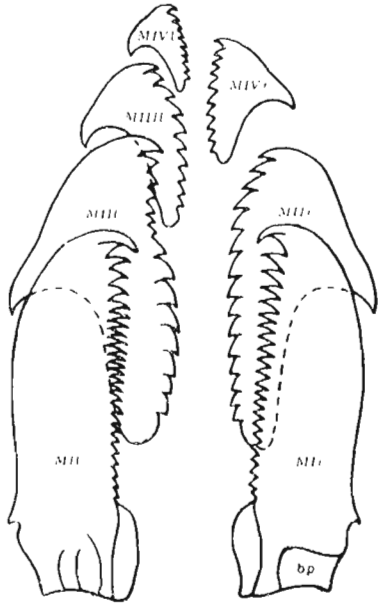


Fig. 11

Paulinites polonensis n. sp., diagrammatic sketch of the jaw apparatus.

plates from the same boulders and from the boulders Nos. O.98, O.185, O.187, O.410 and O.441. Of the boulders yielding *P. polonensis*, the age of No. O.410 was ascertained as Silurian (Lower Ludlow), that of the boulder No. O.441 as ?Wenlock.

Description. — The three apparatuses are very small, the length of MI varying around 0.2—0.3 mm., the largest isolated MI, here assigned, are 2 mm. long. The apparatus (right

and left MI and right and left MII) is somewhat longer than wide, MII protrudes over MI both laterally and anteriorly.

Basal plate is very small, subrectangular, elongated transversally, about 1.5 times wider *(tr.)* than long, partly fused with the right MI. Anterior margin is directed subtransversally. Inner and outer margins are subparallel, directed nearly posteriorly, somewhat postero-medially. The inner margin is somewhat longer than the outer. Posterior margin is directed subtransversally, somewhat concave. The inner margin is thickened, developed as a smooth, prominent ridge.

Right MI is a strongly elongated jaw, 3.1 times longer than wide, the greatest width being at the very posterior part in front of the bight.

The outer and inner margins are subparallel, directed posteriorly, anterior margin is rounded, forming an arch together with the first denticle. At about one third of the jaw length, counting from behind, the outer margin is slightly incurved, to the rear of the incurvature a short transverse spine protrudes over the margin. Along the posterior margin there is a bight which extends for 0.15 of the jaw length. The posterior margin delimiting the bight is somewhat concave.

The inner margin is directed posteriorly, a series of 17—34 denticles extends for 0.75 of its length. First denticle is longer than the remaining ones, which are disposed behind it without an interval. The denticles, in general, decrease in size posteriorly, the most posterior ones being very small, indistinct, developed as small crenulations of the inner margin. The denticulated ridge prolongs posteriorly as a smooth, rounded ridge, somewhat sigmoid, reaching the posterior margin of the jaw. Left of the smooth ridge, the jaw enlarges into an inner wing, which extends for 0.26 of the jaw legth. The inner wing is subrectangular, with transverse anterior and posterior margins, the inner margin directed postero-medially. On the right slope, opposite the posterior smooth ridge there is a longitudinal furrow, subparallel to it. In left lateral view the jaw strongly narrows anteriorly, the first denticle is very prominent, the jaw is widest at the very posterior part in front of the bight.

In ventral view the opening of the pulp cavity extends for 0.31 of the jaw length, the anterior margin of the opening is thickened, moderately convex anteriorly, laterally produced into the transverse spine, which is visible in dorsal view in front of the shank. On the right side of the opening a longitudinal furrow associated with the undenticulated ridge, delimites the inner wing from the remaining part of the opening.

Left MI is a strongly elongated jaw with rounded anterior and transverse posterior margins. The jaw is 3.1 times longer than wide, greatest width being at about one third of the jaw length from behind. The outer margin is directed at first postero-laterally, bending at one third of the jaw length from the front to form a very broad arch and continues postero-medially. At about one third of the jaw length from behind the margin curves outwards, being directed for a short while transversally to form a short, transversally directed spine. Behind the spine it runs postero-medially. A series of 20—39 denticles, decreasing in size posteriorly extends for 0.75 of the jaw length. First denticle is longer than the remaining ones, disposed behind it without an interval. There is a series of 5—12 comparatively large denticles, while the next series consists, as a rule, of very small denticles, variously worn, appearing as crenulations of the inner margin. The denticulated ridge prolongs posteriorly, to the rear of the last denticle, as a smooth rounded ridge, which reaches the posterior margin. The inner wing is prominent, subrectangular, extending for 0.26 of the jaw length. Left of the undenticulated ridge there is a very deep and wide posterior furrow, subtriangular in shape, tapering anteriorly. It extends for about 0.18 of the jaw length. In right and left lateral views the first

denticle appears larger than in the dorsal view and is very prominent, the jaw being narrow, widening somewhat posteriorly. In ventral view the opening of the pulp cavity extends for about 0.3 of the jaw length, anterior margin of the opening being thickened, prolonging laterally into a short, transverse spine, visible in dorsal view. The inner wing is delimited from the remaining part of the opening by a deep furrow, associated with the undenticulated ridge on the dorsal side. Right of this furrow, at the anterior part of the opening there is a rounded, deep muscle scar.

Right MII is a comparatively large, elongated jaw, extending in the articulated apparatus, below — to the inner wing of right MI. It is twice as long as wide, with a large bight along the posterior margin, extending for 0.57 of the jaw length. A series of 13—18 denticles, decreasing in size posteriorly extends almost the full length of the inner margin. The inner margin is directed postero-laterally. Anterior margin forms an arch together with the outer margin, directed postero-laterally, and produced into a comparatively slender spine-like shank, surrounding the bight laterally. The posterior part of the right slope, opposite the bight is comparatively wide, equal in width to 0.4 maximum jaw width. Left slope is entirely hidden under the dentary in the dorsal view. In left lateral view the left slope is subtriangular, the inner margin is directed postero-laterally, at one third of the jaw length from the front bending and continuing postero-medially.

There is no distinct inner wing. In ventral view the cover extends for 0.35 of the jaw length. Along the inner border the cover prolongs into a compratively narrow belt, which tapers posteriorly. Otherwise the remaining part of the ventral side is occupied by the opening of the pulp cavity.

Left MII is somewhat smaller than right MII, with a sigmoid inner wing which extends for half the jaw length. Otherwise it is a mirror image of right MII.

Left MIII (preserved in two specimens only) is an arcuate jaw with a series of 10—11 denticles of almost equal size, extending the full length of the inner margin. The longitudinal branch of the jaw is narrow, tapering posteriorly, the transversal branch is produced laterally into a short, pointed shank. In ventral view, the anterior part is occupied by a crescent-like cover, the remaining part forming the opening of the pulp cavity. Right and left MIV (preserved in one specimen only) are similar in shape to left MIII but smaller. In the specimen figured on Plate XXIX, fig. 3 the shanks of both right and left MIV have been broken off.

Variation. — The variability within this species is considerable and concerns in the first place the shape, size and number of denticles. In the small apparatuses (MI about 0.3 mm. long) both right and left MI are provided at the anterior part with sharply pointed denticles. Posteriorly the denticles are more worn. Largest isolated MI (up to 2 mm. long) from the same samples, have more worn denticles, particularly at the posterior part of the jaw where they have the appearance of indistinct crenulations of the inner margin. Also the relation between the number of larger and smaller denticles in the jaw may vary. The length of the inner wing in both MI varies in smaller specimens being 0.2 of the jaw length, in larger 0.26. The openings of pulp cavities in MI are comparatively shorter in smaller specimens than in larger ones. MII are subject to a similar range of variability in the size and shape of the denticles. Similar range of variability has also been observed by LANGE (1949) in *Paulinites paranaensis*.

Discussion. — *Paulinites polonensis* n. sp. differs from the Devonian *Paulinites paranaensis* LANGE in having a more elongated MI, with subparallel inner and outer margins, while in *P. paranaensis* the inner margin in the anterior part is distinctly incurved; the bight in right MI of our species, and consequently the basal plate is shorter, extending for 0.15 of the jaw length, while in *P. paranaensis* for 0.2. Inner wing in right MI of *P. polonensis* is more prominent,

openings of pulp cavities comparatively shorter. Our species differs from *Paulinites kosoviensis* (ŽEBERA, emend. ŠNAJDR) in having a shorter *(long.)* and wider *(tr.)* basal plate, MI more elongated with regard to the width, inner wing in right MI differently shaped, with transverse anterior and posterior margins, while it is arranged obliquely in *P. kosoviensis*; the posterior furrow in left MI is narrower and longer. Further differences concern the shape of MII which in our species are wider with regard to the length and have larger (both *tr.* and *long.*) bights.

From *Paulinites burgensis* MARTINSSON our species differs in having a longer MI, less strongly tapering anteriorly and a wider MII. Further comparison cannot be made as the photographs of *Paulinites burgensis* (MARTINSSON, 1960, Plate 1, figs. 1—5) are very indistinct.

For comparisons with *Paulinites gladiatus* n. sp. — see p. 130.

Isolated right and left MII, from the boulder O.98 (which is presumably of Silurian age), figured by KOZŁOWSKI (1956, Fig. 12) as cf. *Polychaetaspis* sp. belong without doubt to the genus *Paulinites*. They differ somewhat in proportions from those of *Paulinites polonensis* n. sp., but their specific identification cannot be made for the time being.

Paulinites gladiatus n. sp.

(Plate XXX, figs. 5-6)

Type specimen: Right MI, No. O.308/14a, figured on Plate XXX, fig. 5.
Type horizon and locality: Erratic boulder No. O.308 of ?Silurian age, Międzyzdroje, Baltic coast.
Derivation of the name: Lat. *gladius* — a sword, alludes to the sword-like shape of MI.

Diagnosis. — MI elongated, strongly tapering anteriorly, with a S-shaped dentary in lateral view. Inner wing in right MI subtriangular, tapering posteriorly, in left MI subrectangular. Posterior furrow in left MI short, triangular, with wide base, tapering anteriorly. Right MI without shank, with a bight extending for 0.14 of the jaw length. Openings of pulp cavities in MI extending for 0.4 of the jaw lengths. Basal plate, carriers, mandibles and anterior jaws unknown.

Material. — Fifteen right and left MI from the boulder No. O.308, 30 right and left MI from the boulder O.161. Right and left MI assigned here to *Paulinites gladiatus* n. sp. have not been found joined. As their shape and denticulation are very characteristic (left MI, except for the lack of the bight is a mirror image of right MI) and as they occur in the same samples, there is no doubt about them being conspecific. Of these boulders the age of No. O.161 was ascertained as Silurian (?Upper Wenlock, ?Lower Ludlow).

Description. — Length of the here assigned jaws varies between 0.55—1.5 mm.

Right MI (dorsal view) is 3.3 times longer than wide, strongly tapering anteriorly. First denticle is longer than the others. It forms together with anterior margin an arch which passes into the outer margin. The outer margin runs at first posteriorly, at a little over one third of the jaw length it is incurved and then continues subposteriorly, in a somewhat convex curve. There is no shank. The inner margin behind the hook is curved inwards, then swings outwards and continues posteriorly. A series of 16—18 small, indistinct denticles extends to the undenticulated ridge. The first 6—8 denticles are, as a rule, more worn and smaller than the remaining ones, which increase towards the middle and decrease again posteriorly. Last denticle is situated at three quarters of the jaw length from the front. The undenticulated ridge is prominent and occupies the last quarter of the jaw length in the prolongation of the denticles.

The bight extends for 0.14 of the jaw length. It is longer in the proximal part than distally, the posterior margin which surrounds it anteriorly is directed subtransversally, somewhat postero-laterally. The right slope opposite the bight narrows posteriorly. The inner wing extends for a quarter of the jaw length and is directed obliquely with regard to the dorsal surface of the jaw; in dorsal view it appears subtriangular, tapering posteriorly. On the posterior part of the right slope there is a longitudinal furrow, parallel to the undenticulated ridge, situated close to it. In left lateral view the inner wing is more prominent than in dorsal view, the ridge of the denticles forms an S-like line, the jaw strongly tapers anteriorly. In ventral view the opening of the pulp cavity extends for 0.4 of the jaw length being longer distally than proximally. The anterior margin of the opening is thickened. At the posterior part of the opening, in front of the bight there is a subtransversal rounded ridge, in front of which there is a large deepening occupying the anterior part of the opening. On the outer border, to the rear of the incurvature of the outer margin, the jaw is somewhat depressed, and there is a shallow, oblique furrow, which runs from the outer margin antero-medially and then disappears.

Left MI is similar in shape to the right MI, elongated, 3.6 times longer than wide. The outer margin is incurved at about half the length of the jaw, the inner margin sigmoid, the jaw strongly tapering anteriorly. A series of small variously worn denticles extends three fourths of the jaw length. To the rear of the last denticle there is a rounded undenticulated ridge, which runs postero-laterally to the posterior margin of the jaw. The posterior margin is directed subtransversally, postero-medially. A comparatively wide, subtriangular posterior furrow, extending for two thirds of the length of the undenticulated ridge, is situated on the left slope, close to the ridge. The inner wing is more prominent than in the right MI, subrectangular, somewhat narrowing posteriorly, arranged postero-medially, parallel to the undenticulated ridge.

In left lateral view the inner wing is very prominent, the undenticulated ridge sigmoid, the jaw strongly narrows anteriorly. In ventral view the outer border of the jaw is somewhat depressed at about half the jaw length, opposite the incurvature of the outer margin. The opening extends for 0.4 of the jaw length. The borders of the openings are thickened. A deep furrow associated with the undenticulated ridge delimits the inner wing from the remaining part of the opening. At the anterior part of the opening there is a very large, rounded muscle scar, visible in transmitted light as a light spot.

Variation. — The variability concerns the shape, size and number of denticles. In numerous specimens the anterior denticles in MI are almost entirely worn and have the appearance of indistinct crenulations.

Discussion. — *Paulinites gladiatus* n. sp. differs from *P. polonensis* n. sp. in having MI more strongly tapering anteriorly, provided with longer openings of pulp cavities. Posterior furrow in left MI in *P. gladiatus* is short, subtriangular, very wide posteriorly, while in *P. polonensis* the furrow is longer and narrow all along its length. The dentary in *P. gladiatus* forms a line, while in *P. polonensis* it is straight. Lastly the inner wing in right MI of *P. gladiatus* is subtriangular while in *P. polonensis* subrectangular. *P. gladiatus* reminds one of the parataxonomic species *Nereidavus digitus* ELLER, described by ELLER (1963 *a*, p.161, Plate I, fig. 14) from the Upper Devonian Sheffield Shale of Iowa. The jaw figured by ELLER is the left MI in ventral view. Our species differs from *N. digitus* in having a longer opening of the pulp cavity, a series of 16—18 denticles extending up to denticulated ridge, while in *N. digitus* a series of 12 denticles extends about to the mid-point of the jaw and in having the inner margin more strongly incurved. *Nereidavus exploratus* ELLER, described

by ELLER (1963*b*, p. 177, Plate 1, figs. 20—21) from the Devonian of Michigan, is right MI and MII of a *Paulinites*, reminding one in the shape of MI of *Paulinites gladiatus* n. sp.

Genus **LANGEITES** nov.

Type species: Langeites glaber n. sp.
Derivation of the name: Named in honour of Dr. F. W. LANGE from Brasil.

Diagnosis. — MI arcuate, convex outwards, with rudimentary denticulation at the anterior part of the inner margins. Inner margins in the posterior quarter of MI directed longitudinally, developed as undenticulated ridges. Anterior parts of the inner margins concave, twisted out of alignment with the undenticulated ridges. Opening of pulp cavities in MI equal to 0.25 of the jaw length. Basal plate very small, wider than long, ?fused with the right MI. Carriers, mandibles and anterior jaws unknown.

Stratigraphic and geographical range. — Known from the Silurian erratic boulders of Poland.

Discussion. — The new genus is monotypic, erected to include *Langeites glaber* n. sp. *Langeites* n. gen. differs from *Paulinites* LANGE in having MI strongly arched outwards, with rudimentary denticulation restricted to the anterior part of the inner margins, while in *Paulinites* the inner and outer margins of MI are directed longitudinally all along the length of the jaws, and the denticulation extends for 0.7—0.8 of the jaw length until the undenticulated ridge. *Langeites* n. gen. shows close similarities to the Recent representatives of the Onuphidae and Eunicidae. For a comparison of *Langeites* with Recent labidognaths — see p. 45.

Langeites glaber n. sp.

(Plate XXX, figs. 1-4; Text-fig. 6*A*)

Type specimen: Right MI with basal plate, No. O.466/13b, figured on Plate XXX, fig. 2.
Type horizon and locality: Erratic boulder No. O.466, of unknown age (Ordovician or Silurian), Mochty, province of Warsaw.
Derivation of the name: Lat. *glaber* — smooth, alludes to the poor denticulation of MI.

Diagnosis. — As for the genus.
Denticle formula:

MI 6—10 6—8

Material. — Three right MI with basal plates and 2 left MI from the boulder O.466, 6 left MI and 1 right MI from the boulder O.410, some damaged. Right and left MI assigned to *Paulinites glaber* n. sp. have not been found joined. As however left MI, except for the lack of a bight, is a mirror image of the right MI, and as they occur in the samples from the same boulders, there can be no doubt about them being conspecific. Of the boulders yielding *L. glaber*, age of No. O.410 was ascertained as Silurian (Lower Ludlow).

Description. — Comparatively large apparatuses, the length of MI assigned to this species varies from 0.8—3.3 mm.

Basal plate is a small plate, elongated transversally, about two times wider than long, with a transversal anterior margin, outer and inner margins subparallel, directed posteriorly. Inner margin is developed as a rounded ridge. Posterior margin subtransversal, concave. In some specimens it appears to be fused with the right MI.

Right MI is a narrow, elongated jaw, strongly bent outwards, narrowing anteriorly, four times longer than wide. First, comparatively long denticle forms an arch with the anterior

margin, which passes into the convex outer margin. The inner margin is strongly concave, runs behind the first denticle in an arch postero-medially, then postero-laterally, at three quarters of the jaw length it bends and runs in a straight line subposteriorly, somewhat postero-medially. In the posterior quarter of the jaw length the inner margin is developed as an undenticulated rounded ridge. Left of this ridge there is a subrectangular inner wing, directed postero-medially, parallel to the undenticulated ridge. On the right slope there is a posterior furrow, enclosed between the undenticulated ridge and the ridge of the basal plate. The bight is short, extending for 0.12 of the jaw length, the posterior margin surrounding the bight being somewhat concave. In front of the bight there is a slight subtransversal swelling on the jaw. Along the anterior part of the inner margin a series of 6—8 small, variously worn denticles, directed antero-medially, extends for 0.35 of the length of the inner margin. The remaining part of the inner margin is smooth. In some specimens only the first and second denticles are retained, the remaining ones are entirely worn and appear as indistinct crenulations on the inner margin. In left lateral view the inner wing is very prominent and the ridge of the basal plate is well visible. On the posterior part of the outer margin, somewhat in front of the bight, a short spine-like process — a prolongation of the thickened margin of the opening of the pulp cavity is visible.

In ventral view the opening of the pulp cavity extends for 0.25 of the jaw length. The border surrounding the opening is thickened. In the lateral prolongation of this border there is a small spine-like process. The outer border of the jaw is somewhat compressed just behind mid-length. In the opening, in front of the bight, there is a subtransversal furrow associated with the swelling on the dorsal side. In front of this furrow a comparatively small muscle scar, partly hidden inside the walls of the jaw, is visible. The outline of the basal plate joined with right MI is different in ventral view from that in dorsal view, connected with the fact that the basal plate partly covers right MI dorsally.

Left MI — the general outline of left MI, particularly its anterior part is the mirror image of the right MI. The number of denticles varies from 6 to 10 and they are similarly shaped and usually worn as in right MI. The posterior margin is subtransversal, somewhat concave. The undenticulated ridge at the posterior part of the jaw is directed subposteriorly, insignificantly sigmoid. The inner wing on the right side of the undenticulated ridge is somewhat larger than in right MI, otherwise similarly arranged. The posterior furrow is subtriangular, wide *(tr.)*, extending for half the length of the undenticulated ridge. In ventral view the opening, with thickened margins, extends for 0.25 of the jaw length. In front of the subtriangular posterior furrow (seen in this view as an inflation) there is an indistinct muscle scar.

Family ATRAKTOPRIONIDAE nov.

Diagnosis. — Jaw apparatuses of prionognatha type, laeobasal plate, intercalary tooth and lateral teeth lacking. Basal plate present, subtriangular with transverse posterior margin. Carriers longer than MI, filiform, paired. MI with strong, curved hooks. MII symmetrical, bevel square shaped. MIII subtriangular, single left or paired. MIV subtriangular, denticulated or single teeth. MV single teeth or lacking. Mandibles with smooth anterior edges; anterior area subcircular, reticulated.

Genera:

Atraktoprion KIELAN-JAWOROWSKA, 1962
Xanthoprion nov.

Discussion. — The present writer when describing *Atraktoprion* (KIELAN-JAWOROWSKA, 1962, p. 303) stated: "There is some evidence that in one so far undescribed species of *Atraktoprion*, MIII is paired". In the present paper genus *Atraktoprion* is restricted to the forms with single MIII, while the name *Xanthoprion* n. gen. is proposed for the species with MIII paired.

Isolated right and left MI of the Atraktoprionidae have been described in the scolecodont literature from beds ranging from the Ordovician to Devonian, assigned mostly to the genera *Arabellites* HINDE, *Protarabellites* STAUFFER, and *Ildraites* ELLER, while MII are assigned to *Leodicites* ELLER. The arrow-like atraktoprionid carriers were described by EISENACK (1939) as *Orthopelta mucronata* EISENACK and *Orthopelta synclinalis* EISENACK.

Genus **ATRAKTOPRION** KIELAN-JAWOROWSKA, 1962

Diagnosis. — See KIELAN-JAWOROWSKA, 1962.

Stratigraphic and geographical range. — Ordovician-?Permian; Europe, North America.

Species:

Atraktoprion cornutus KIELAN-JAW., 1962 — type species
Atraktoprion robustus n. sp.
Atraktoprion mirabilis n. sp.
Atraktoprion major n. sp.
Atraktoprion sp. *a* KIELAN-JAW., 1962

Discussion. — Atraktoprionid detached right and left MI belong to the more common fossils in the writer's collection, showing that the Atraktoprionidae were represented in the Ordovician and Silurian of the Baltic region by at least two dozen species. The majority of isolated MI of *Atraktoprion* remain in the writer's collection undescribed.

Atraktoprion cornutus KIELAN-JAWOROWSKA, 1962

(Plate XXXI; Text-figs. 5*P* and 12*B*)

1962. *Atraktoprion cornutus* n. sp.; Z. KIELAN-JAWOROWSKA, New Ordovician genera..., p. 304, Plate I, Text-fig. 3*B*)

Material. — *Atraktoprion cornutus* KIELAN-JAW. has been described by the writer (KIELAN-JAWOROWSKA, 1962) in detail. The new material which has been examined, particularly that from the boulders Nos. O.366, O.400 (which yielded the type specimen) and O.469, has enriched the studied collection by a number of jaw apparatuses assigned to this species. The material of *A. cornutus* at the writer's disposal consists of one uncertain incomplete jaw apparatus from the boulder No. O.182 (Plate XXXI, fig. 1), 3 variously complete apparatuses from the boulder No. O.366, 5 apparatuses from the boulder No. O.400 (including the type specimen) and 6 apparatuses from the boulder No. O.469.

Of the boulders yielding *A. cornutus*, age of No. O.182 was ascertained as Middle Ordovician (?Kukruse Stage) and age of No. O.366 as Middle Ordovician (?Kukruse Stage or Idavere Stage).

Variation. — In addition to the variation in the number of denticles, the variability concerns the degree of curvature of the hook in MI and the small differences in the length of the bight in the right MI and in the openings of the pulp cavities in both right and left MI. The greatest range of variability concerns the structure of the anterior jaws, which in the type

specimen are provided with very long first denticles (about three times longer than the remaining ones), while in other specimens they may be two and a half times longer, twice as long, or even one and a half times longer than the remaining ones.

Discussion. — It cannot be excluded that the type specimen (see KIELAN-JAWOROWSKA, 1962, Plate 1), and the specimen No. O.182/42, identified as *?A. cornutus* (present paper, Plate XXXI, fig. 1), which is characterized by the shortest first denticles in the anterior jaws, do not belong in fact to different species. As however in the studied collection there are intermediate forms between the above discussed specimens, and as no other constant morphological differences are observed, they are regarded tentatively as conspecific.

Atraktoprion robustus n. sp.

(Plate XXXVI, figs. 1-2; Text-fig. 12*A*)

Type specimen: Incomplete jaw apparatus No. O.177/1 consisting of a basal plate, right and left MI, right and left MII, left MIII, right and left MIV, left MV, separated into parts while they were being drawn, figured on Plate XXXVI, fig. 1.

Type horizon and locality: Erratic boulder No. O.177 of unknown age (Ordovician or Silurian), Mochty, province of Warsaw.

Derivation of the name: Lat. *robustus* — strong; alludes to the strong structure of MI.

Diagnosis. — Basal plate subtriangular with a protuberance on the posterior margin. MI with stout comparatively short hooks, provided with wide bases. Inner margin of hook, in front of the first denticle somewhat inflated. Muscle scars in both MI very large, suboval with outer borders well defined. MIII left comparatively long.

Denticle formula:

Basal plate	—	5—6
MI	1+7	1+8—9
MII	6	6
MIII	4	—
MIV	3	3
MV	1	unknown

Material. — In addition to the type specimen, there is one right MI with a basal plate. from the boulder No. O.182, which has been ascertained as Middle Ordovician (?Kukruse Stage).

Description. — Comparatively large apparatuses, length of MI varying between 0.3 and 0.5 mm.

Basal plate is roughly subtriangular, wider than long, with 5—6 denticles, the first being somewhat longer than the remaining ones. Inner margin is directed posteriorly. Posterior margin is directed at first transversally, up to the distinct protuberance situated at one third of the width of the basal plate, and continues antero-laterally. Anterior margin is directed postero-laterally. The distal part of the jaw is elongated into a prominent, spine-like process, directed transversally. As in both specimens the basal plates are preserved together with the right MI, they cannot be examined in left lateral and ventral views.

Right MI is a moderately elongated jaw, about 2.1 times longer than wide, with a stout and moderately bent, comparatively short hook, extending for one third or less of the jaw length.

On the inner margin of the hook, in front of the first denticle there is an inflation, and the base of the hook is very wide. The outer margin of the jaw is directed posteriorly, subparallel to the inner margin. A series of denticles increasing in size towards the middle and decreasing again posteriorly extends the full length of the inner margin. The postero-lateral corner is rounded, and there is no shank protruding over the outer margin of the jaw. The margin surrounding the bight is sigmoid, the greatest length of the bight being equal to about 0.3 of the jaw length. In ventral view the opening of the pulp cavity extends for about 0.63 of the jaw length. Opposite the anterior part of the opening there is a very large, suboval muscle scar, with a well defined outer margin and poorly defined inner margin. In left lateral view the left slope is narrow, of equal width all along the jaw length, the denticles sharply pointed, directed to the right.

Left MI is in dorsal view about 2.4 times as long as wide. The hook is longer than in the right MI, extending for almost half the jaw length. The hook is stout and moderately bent, its base is narrower *(tr.)* than in the right MI. A series of denticles, insignificantly decreasing in size towards the posterior, extends the full length of the inner margin. The right slope as seen in the dorsal view is very narrow, tapering both anteriorly and posteriorly. The outer margin is directed at first postero-laterally, nearly posteriorly, at about two thirds of the jaw length it bends outwards and then continues postero-medially. The posterior margin is directed transversally. Left of the dentary there is a posterior furrow, tapering anteriorly, which extends for half the dentary length. Left of the posterior furrow, the posterior part of the jaw is somewhat inflated to form a longitudinal rounded ridge. In ventral view the opening of the pulp cavity extends for 0.6 of the jaw length. Opposite the anterior part of the opening there is a very large, rounded muscle scar, with a well defined outer margin and poorly defined inner one. A deep furrow with pits associated with the denticles extends along the inner margin. In right lateral view the right slope appears wider than in the dorsal view, tapering anteriorly, the denticles are sharply pointed, directed (as the hook) to the left.

Right MII is a bevel square shaped jaw with a comparatively narrow *(long.)* transverse branch, with a pointed distal end, strongly bent upwards. In dorsal view the longitudinal branch is comparatively narrow *(tr.)*, tapering posteriorly, in right lateral view it appears wide. A series of denticles decreasing in size posteriorly extends the full length of the longitudinal branch. The first denticle is longer that the remaining ones. In ventral view, there is a small crescent-like cover, and the opening of the pulp cavity is almost gaping.

Left MII is somewhat longer than the right MII, otherwise it is the mirror image.

Left MIII is similarly shaped as left MII but smaller, with fewer denticles.

Right and *left MIV* are comparatively small, bevel square shaped jaws, with first denticles longer than the other two. The transverse, pointed branch is the same length *(tr.)* as the longitudinal branch *(long.)*.

Right MV is a single, elongated tooth.

Variation. — On account of the very small number of specimens assigned to this species, the range of variability cannot be stated.

Discussion. — *Atraktoprion robustus* n. sp. differs from *A. cornutus* KIELAN-JAW. in having the hooks in both right and left MI stouter, less strongly bent and provided with wider basis. Basal plate differs from that in *A. cornutus* in having a distinct protuberance on the posterior margin. The muscle scars in both MI are comparatively larger and better defined in the new species than in *A. cornutus*. For comparisons with *A. mirabilis* and *A. major* — see p. 138 and p. 141, respectively.

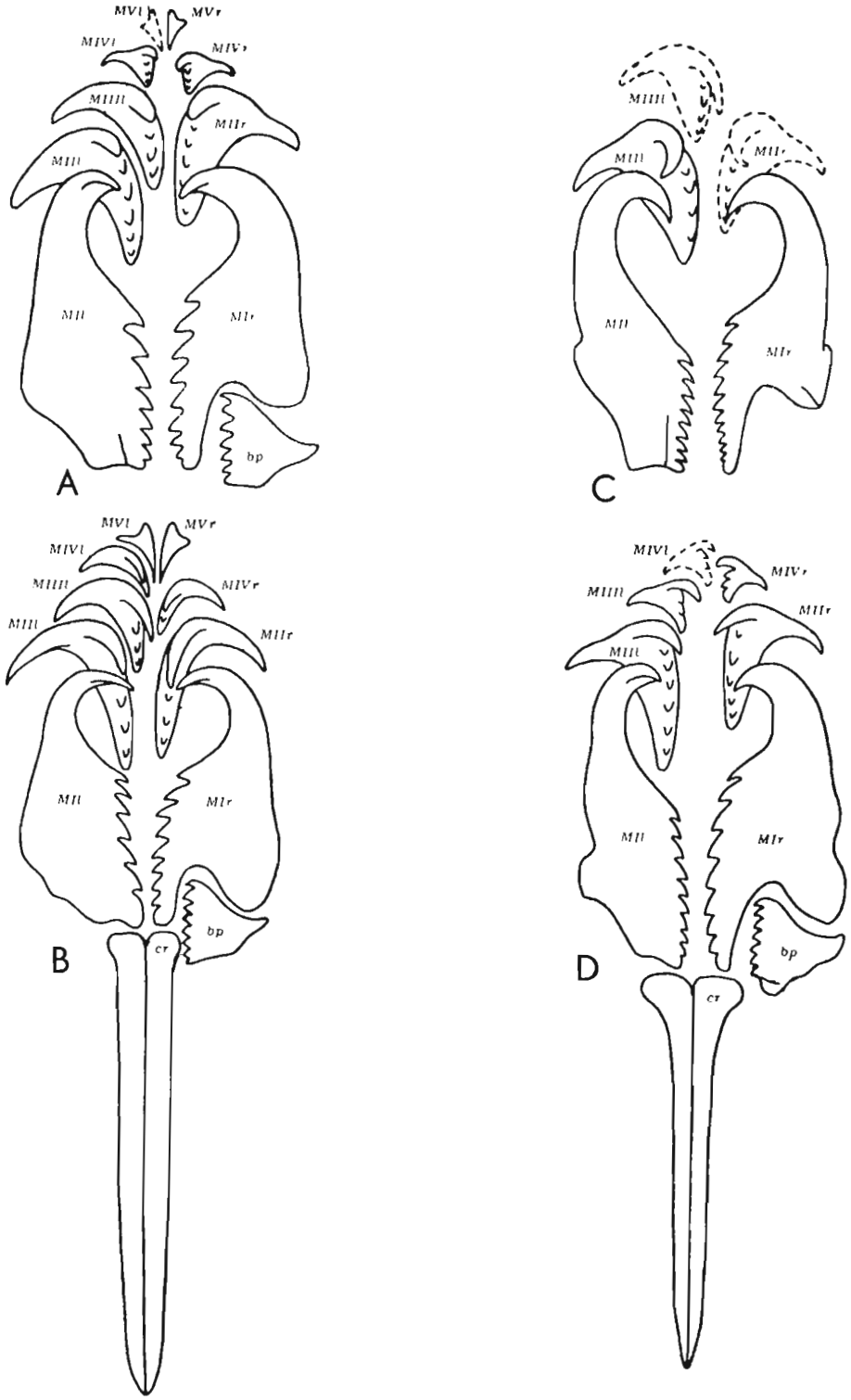


Fig. 12

Diagrammatic sketches of the jaw apparatuses in the Atraktoprionidae

A Atraktoprion robustus n. sp., *B Atraktoprion cornutus* KIELAN-JAW., *C Atraktoprion mirabilis* n. sp., *D Atraktoprion major* n. sp.

(For abbreviations — see p. 153)

Atraktoprion mirabilis n. sp.

(Plate XXXII, figs. 3-4; Plate XXXIII; Text-fig. 12*C*)

Type specimen: Incomplete jaw apparatus consisting of right and left MI and left MII, No. O.398/8, figured on Plate XXXIII, fig. 2.

Type horizon and locality: Erratic boulder No. O.398, of Middle Ordovician age (?Keila Stage of Estonian sequence), Mochty, province of Warsaw.

Derivation of the name: Lat. *mirabilis* — astonishing, alludes to unusual curvature of the hook in MI.

Diagnosis. — Hooks in MI slender, long (0.41—0.46 of the jaw length), with tips strongly bent at various angles with regard to the jaw surface. In both MI a small, crescent-like wing present on the outer borders. Postero-lateral corner of right MI pointed. Bight in right MI extending for one third or less of the jaw length. Muscle scars in both MI small, very deep and well defined, circular.

Denticle formula:

Basal plate	—	unknown
MI	1+7—9	1+9—11
MII	6—7	unknown
MIII	?5	—
MIV	unknown	unknown

Material. — In addition to the type specimen there are: two joined left MI and MII, two single right MI, and one single left MIII assigned tentatively to this species, all from the boulder No. O.398.

Description. — Length of MI vary between 0.35 and 0.65 mm.

Right MI is an elongated jaw, 2.5 times longer than wide, with a hook extending for 0.41—0.46 of the jaw length. The bight extends for one third or somewhat less of the jaw length. The hook is strongly bent at various angles with regard to the jaw surface. A faint ridge subparallel to the outer margin runs along the transverse part of the hook. The outer margin is directed subposteriorly. At the posterior part of the outer margin there is very narrow, indistinct, crescent-like wing. The postero-lateral corner is pointed. The posterior margin, delimiting the bight is directed antero-medially, then bends at a right angle and continues postero-medially towards the end of the jaw. The inner part of the hook is strongly concave. Behind the hook the inner margin forms a straight line directed posteriorly. A series of 9—11 sharply pointed denticles extends along the straight part of the inner margin. The first two denticles are small, the others increase in size towards the middle and then decrease posteriorly. The left slope is directed steeply downwards, it tapers and disappears entirely posteriorly. On the right slope there is a deepening in front of the bight situated close to the dentary, to the right of it, the jaw is somewhat inflated. In front of the deepening on the right slope there is extremely fine thread-like subtransversal furrow, giving off indistinct longitudinal ripples. In right lateral view the hook appears longer than in dorsal view, the small wing along the outer margin shows a dull surface and does not protrude over the margin, the denticles appear very sharp. In left lateral view the tip of the hook is bent to the right. In ventral view the opening of the pulp cavity extends for 0.66 of the jaw length, the anterior border of the opening is thickened, the belt very narrow. At the anterior part of the opening there is a very deep, comparatively small, round, well defined muscle scar, with very short thread-like furrows radially surrounding its posterior border. At the posterior part of the opening, in the postero-lateral corner there is a deep subtriangular depression. Along the belt a series of pits associated with the denticles is visible.

Left MI is an elongated jaw, 2.5 times longer than wide, with a hook extending for half the jaw length, similarly shaped as in right MI, strongly bent. A faint ridge runs along the

hook, subparallel to the anterior margin. The dentary is somewhat shorter *(long.)* than in the right MI and consists of 7—9 sharply pointed denticles. The outer margin is directed at first posteriorly, being slightly incurved at mid-length. Behind the incurvature there is a very small crescent-like wing, similar to that in right MI. To the rear of the wing the outer margin runs postero-medially, bends and continues posteriorly. The transverse posterior margin is twice as short *(tr.)* as the greatest width of the jaw. On the left slope there is a comparatively shallow posterior furrow, arranged close to the dentary, extending for three quarters of the length of the dentary from behind. The inner wing is wider than in right MI, beyond the mid-length of the dentary it strongly tapers posteriorly. In left lateral view at the level of the outer wing, the shining surface of the jaw is strongly bent inwards, and the subcircular dull surface of the wing is visible. In right lateral view the inner wing appears the same width all along its length and is wider than in dorsal view. In ventral view the opening of the pulp cavity extends for 0.59 of the jaw length. At the anterior part of the opening there is a very deep, well defined, rounded muscle scar. A longitudinal furrow with pits associated with the denticles is well visible. At the postero-lateral corner there is a longitudinal deepening, which extends for half the length of the opening.

Left MII is a bevel square shaped jaw with a series of 6—7 denticles extending the full length of the inner margin. The first denticle is longer than the remaining ones and somewhat bent. The transverse branch is comparatively narrow *(long.)* with its distal end bent. In ventral view the cover extends (proximally) for one quarter of the jaw length, distally it covers half the width *(long.)* of the transversal branch. At the antero-medial corner of the opening, there is a rounded, well defined muscle scar.

Left MIII is a subtriangular jaw with 5 denticles and with a pointed shank strongly bent upwards. The first denticle, somewhat bent, is longer than the remaining ones. In ventral view, at the anterior part of the opening, there is a deep, well defined, rounded muscle scar. Left MIII here described has not been found in a joined apparatus, it is assigned tentatively to *A. mirabilis* on account of its characteristic structure, similar in general pattern to MI and MII of *A. mirabilis*. These similarities mainly concern the shape of the first denticle (long and bent) and the presence of a rounded, well defined muscle scar.

Variation. — In addition to the variation in the number and shape of denticles, the variability also concerns the shape of the hook in MI and the first denticle in MII which may be bent at various angles and in different directions.

Discussion. — *Atraktoprion mirabilis* n. sp. differs from *A. cornutus* KIELAN-JAW. and *A. robustus* n. sp. in having a longer (both *long.* and *tr.*) and more strongly bent hook in MI and longer and more sharply defined bight in MI. Further differences lie in the presence of a small wing along the outer margins of both MI in *A. mirabilis* and in the presence of a very well defined, deep, comparatively small, round muscle scar at the anterior parts of the openings of MI, MII and MIII. For comparisons with *A. major* — see p. 141.

Atraktoprion sp. **a**

Description. — See KIELAN-JAWOROWSKA, 1962, p. 306, Pl. 2.

Atraktoprion sp. **b**

(Plate XXXII, figs. 1, 2)

Material. — Two isolated right MI from the boulder No. O.398, which is of Middle Ordovician age (?Keila Stage).

Description. — Two jaws described here as *Atraktoprion* sp. *b* differ somewhat in pro-

portions, the one figured on Plate XXXII, fig. 1 is twice as long as wide, the other (Plate XXXII, fig. 2) is 1.6 times longer than wide. Both jaws are provided with comparatively stout and short hooks, very strongly bent downwards, and with shanks in the postero-lateral corners. In the specimen figured on Plate XXXII, fig. 1 the shank is small, while in the specimen figured on fig. 2 it is very prominent. On the dentary (behind the hook) there are 10—11 denticles. The dentary is directed at first posteriorly, opposite the bight, the proximal part of the jaw curves postero-laterally and the dentary follows this direction. In ventral view on the anterior part of the opening there is a rounded muscle scar.

Discussion. — The differences between the two described here specimens are considerable and it is not certain whether they are conspecific. In the author's collection there are numerous MI of *Atraktoprion* which remain undescribed and unfigured. The writer decided to figure and briefly describe two right MI of *Atraktoprion* sp. *b*, on account of their unusual shape, and because their age is well defined.

Atraktoprion major n. sp.

(Plate XXXIV; Text-fig. 12 *D*)

Type specimen: Incomplete jaw apparatus, No. O.319/7, consisting of carriers, basal plate, right and left MI, right and left MII, left MIII and right MIV. The apparatus was compressed, the individual jaws being preserved in an unnatural position and poorly visible. The specimen was separated intentionally by the writer and its individual jaws are figured on Plate XXXIV, fig. 4.

Type horizon and locality: Erratic boulder No. O.319 of unknown age, Ordovician or Silurian, Mochty, province of Warsaw.

Derivation of the name: Lat. *major* — greater, alludes to its comparatively large dimensions.

Diagnosis. — MI strongly elongated with stout hooks. Transversal posterior margin in left MI comparatively short. Postero-lateral corner in right MI developed as a suboval shank. Bight in right MI extending for 0.3 or less of the jaw length. A suboval wing on the outer margin of left MI. Anterior margin of the opening in MI sigmoid, the cover extending distally to the outer wing. No well defined muscle scars. Basal plate subtriangular — no transverse posterior margin.

Denticle formula:

Basal plate	—	7
MI	1+8—10	1+7—10
MII	7	6
MIII	4	—
MIV	unknown	4

Material. — In addition to the type specimen there is a dozen isolated right and left MI from the boulder No. O.319, one right MI and one left MI from the boulder No. O.472. Age of the boulder No. O.319 is unknown, the boulder No. O.472 has been ascertained as ?Middle Ordovician.

Description. — Comparatively large apparatuses, length of MI varying between 0.3 and 1 mm.

Carriers are somewhat longer than MI, enlarged and rounded anteriorly, tapering posteriorly.

Basal plate is in dorsal view subtriangular, with a sigmoid, concave anterior margin. The inner margin is directed posteriorly, the postero-lateral margin is directed antero-laterally.

A series of 6 (7th indistinct) denticles equal in size extends three quarters of the length of the inner margin. The antero-lateral corner is elongated somewhat anteriorly and bent downwards. In ventral view, the belt extends in the anterior part for less than one third the width of the jaw. Posteriorly the belt is bent upwards and appears very narrow in ventral view. Along the belt there is a furrow, left of the furrow the jaw is somewhat inflated and then again deepens at the postero-lateral part. In left lateral view the belt appears wide, rounded posteriorly and strongly tapering anteriorly.

Right MI is an elongated jaw, in dorsal view 2.2—2.5 times longer than wide, with a bight extending for about 0.3 of the jaw length. The hook is comparatively stout and moderately bent, extending for 0.3—0.35 of the jaw length. The outer margin is directed subposteriorly, beyond mid-length of the jaw it curves inwards and then swings outwards around the prominent suboval shank. The postero-lateral corner is rounded. The posterior margin delimiting the bight is sigmoid, the bight being deeper proximally than distally. The inner margin beyond the hook is directed posteriorly, there is no inner wing. A series of 7—10 sharply pointed denticles, decreasing in size posteriorly extends to the posterior extremity of the jaw. In ventral view the opening of the pulp cavity extends for 0.68—0.7 of the jaw length. The anterior rim of the opening is sigmoid, the opening being longest at the proximal part of the jaw, close to the furrow with pits. From this point the rim of the opening runs postero-laterally to reach the anterior part of the outer wing, the opening of the pulp cavity being in this part very short *(long.)*. Along the inner margin there is a furrow with pits. Left of the furrow there is a longitudinal inflation, while left of the inflation the jaw is deepened, however one cannot recognize a defined muscle scar. In left lateral view a left slope is visible, the denticles are sharply pointed, directed to the right.

Left MI is an elongated jaw, in dorsal view 2.6—2.8 times longer than wide. A comparatively stout and moderately curved hook extends for about O.4 of the jaw length. The outer margin is directed posteriorly, beyond mid-length it swings outwards around a suboval, very prominent outer wing and continues postero-medially, somewhat bent inwards. The posterior margin is comparatively short, its length *(tr.)* being equal to about half the greatest width of the jaw. A series of 8—10 sharply pointed denticles decreasing in size posteriorly extends nearly the full length of the inner margin. The right slope is comparatively narrow, the part which is visible in dorsal view is crescent like, disappearing at the most posterior part of the jaw. On the left slope there is a short posterior furrow, arranged very close to the dentary, extending for one quarter of the dentary length. Left to the posterior furrow there is a longitudinal rounded ridge, extending for about one third of the length of the dentary.

In ventral view, the opening of the pulp cavity is comparatively shorter than in the right MI, extending for 0.54—0.6 of the jaw length. Anterior margin of the opening is less strongly curved than in right MI. A deep furrow with pits associated with the denticles extends along the inner margin, delimited from the margin by the somewhat inflated ventral side of the right slope. To the right of the furrow with pits there is an inflated, longitudinal, rounded ridge, in front of which, at the most anterior part of the opening there is a rounded muscle scar(?).

In right lateral view the right slope appears of the same width all along the jaw length, the denticles are sharply pointed, directed to the left, at the posterior part, to the rear of the dentary a part of the rounded ridge is visible.

Right MII is a bevel square shaped jaw with a very narrow *(long.)*, sharply pointed transverse branch. The longitudinal branch is comparatively wide *(tr.)*, tapering posteriorly. A series of 5 denticles extends the full length of the longitudinal branch. First denticle is somewhat longer than the remaining ones disposed behind it without an interval. In ventral view a narrow

belt extends along the antero-inner corner of the jaw and tapers posteriorly, the opening is almost gaping.

Left MII is somewhat longer than the right MII, otherwise being its mirror image.

Left MIII is a comparatively small, subtriangular jaw, with a strongly elongated, pointed, antero-lateral corner. The first denticle is longer than the remaining three. At the anterior part of the inner margin there is a distinct angle. In ventral view the opening of the pulp cavity is almost gaping.

Right MIV is almost a mirror image of the left MIII, but smaller, with an elongated, pointed antero-lateral corner and the first denticle longer than the remaining ones.

Variation. — In addition to the variability in the number of denticles, variation in the right and left MI also concerns differences in proportions, shape of the bight, which may have an inner margin more strongly curved or less, shape of the shank, and length of the opening of the pulp cavity.

Discussion. — *Atraktoprion major* n. sp. differs from *A. cornutus* KIELAN-JAW., *A. robustus* n. sp. and *A. mirabilis* n. sp. in having MI more elongated, with very prominent wing-like shanks in both right and left MI, and a comparatively narrow *(tr.)* posterior margin in left MI. Besides, MII differs in having comparatively narrow *(long.)* transverse branches. In this respect MII of *A. major* reminds one more of *Skalenoprion alatus* KIELAN-JAW. than any representative of *Atraktoprion*. Also MI of *Atraktoprion major* shows some similarities to those of *Skalenoprion alatus*, particularly in the presence of prominent, wing-like shanks.

As the anterior jaws of *Atraktoprion major* are preserved so far only in one incomplete specimen, it is not certain, whether or not they are symmetrical. If they were symmetrical, the anterior jaws, described in the present paper as right and left MII, left MIII and right MIV, should obtain the notations of right and left MII and right and left MIII. As however there are no data pointing towards one interpretation more than the other, the writer regarded it safer — to number the preserved jaws in the manner figured on Text-fig. 12*D*, as it is characteristic of the majority of the Atraktoprionidae.

Genus **XANTHOPRION** nov.

Type species: Xanthoprion erraticus n. sp.

Derivation of the name: Gr. *xanthos* — yellow, *prion* — a saw; alludes to the yellow colour of the type specimen of *Xanthoprion erraticus*.

Diagnosis. — Jaw apparatus of prionognatha type, with symmetrical anterior part. Carriers, basal plate and right MI unknown, probably of the pattern characteristic of *Atraktoprion*. Left MI with strong curved hook. MII paired, bevel'square shaped, MIII paired, subtriangular, MIV paired, single teeth. MV lacking(?).

Stratigraphic and geographical range. — Middle Ordovician of the Baltic region.

Discussion. — The genus is monotypic, erected to include *Xanthoprion erraticus* n. sp. Basal plate and right MI in *Xanthoprion* are unknown, but the writer assumes, on the base of the structure of the left MI, that they were of the same pattern as in *Atraktoprion*. Otherwise *Xanthoprion* differs from *Atraktoprion* in having MIII paired, MIV developed as single teeth and MV lacking. The structure of the anterior part of the apparatus in *Xanthoprion* could also be interpreted otherwise: that MIII, which in *Atraktoprion* was single, left, has here disappeared, while MIV and MV are of the same pattern in both genera. As however there is no evidence to support this interpretation, it seems more reasonable to number the particular jaws in the manner shown on Plate XXXV.

Xanthoprion erraticus n. sp.

(Plate XXXV)

Type specimen: Incomplete jaw apparatus consisting of a left MI, right and left MII, right and left MIII, right and left MIV, figured on Plate XXXV, fig. 2, No. O.366/23.

Type horizon and locality: Erratic boulder No. O.366, of Middle Ordovician age (?Kukruse Stage or Idavere Stage), Mochty, province of Warsaw.

Derivation of the name: erraticus — found in erratic boulder.

Diagnosis. — As for the genus.

Denticle formula:

Basal plate	—	unknown
MI	1+8	unknown
MII	7	6—7
MIII	3—4	3—4
MIV	1	1

Material. — In addition to the type specimen there is the anterior part of a jaw apparatus from the boulder No. O.182. Age of boulder O.182 is Middle Ordovician (?Kukruse Stage).

Description. — Carriers, basal plate and right MI unknown.

Left MI: In dorsal view the hook is moderately bent, extending for just a little less than half the jaw length. The outer margin is directed in an arch subposteriorly, in the posterior quarter of the jaw length, postero-medially. It is provided with a small, crescent-like wing, situated at about three quarters of the jaw length. There are seven denticles, the first two being smaller than the remaining ones. The right slope is developed as an inner wing tapering posteriorly, with rounded anterior margin. Posterior margin is directed subtransversally, slightly notched in the middle. Close to the dentary there is an indistinct posterior furrow, left of the furrow the jaw is somewhat inflated. In ventral view the opening of the pulp cavity extends for half the jaw length, the belt is comparatively wide. Opposite the anterior part of the opening there is a large, well defined muscle scar, rounded anteriorly, tapering posteriorly.

Left MII is a bevel square shaped jaw with a comparatively narrow *(long.)* transversal branch, pointed and bent upwards distally. The first denticle is only very slightly longer than the remaining ones, which decrease in size towards the posterior. In ventral view there is a very small, crescent-like cover, otherwise the opening of pulp cavity is almost gaping.

Right MII which is arranged more forward than the left MII, is its mirror image.

Left MIII is a subtriangular jaw with a series of 3—4 small denticles along the inner margin, the first being slightly longer than the remaining ones. The opening of the pulp cavity is gaping.

Right MIII is somewhat smaller than the left MIII, otherwise being its mirror image. It is arranged in the jaw apparatus somewhat more anteriorly than the left MIII.

Right and *left MIV* are single teeth, variously elongated. MII—MIV are provided with large attachment lamellae, fused together, standing out in front of MIV.

Family SKALENOPRIONIDAE nov.

Diagnosis. — Subsymmetrical jaw apparatuses of prionognatha type. Basal plate very small, fused with the right MI, developed as a smooth or denticulated basal ridge, arranged parallel to the main ridge in the posterior part of MI. Hooks in MI very long and bent,

extending for about half the jaw length. Large muscle scars in MI. MII symmetrical, bevel square shaped, with very narrow *(long.)* pointed transverse branches. Carriers, MIII—MV and mandibles unknown. Laeobasal plate, intercalary tooth and lateral teeth lacking.

The family is monotypic, erected to include *Skalenoprion* KIELAN-JAWOROWSKA, 1962.

Genus **SKALENOPRION** KIELAN-JAWOROWSKA, 1962

Type species: Skalenoprion alatus KIELAN-JAWOROWSKA, 1962.

Diagnosis. — As for the family.

Stratigraphic and geographical range. — Ordovician-?Permian; Baltic region and North America.

Discussion. — *Skalenoprion* is a rare genus represented in the studied collection by *Skalenoprion alatus* KIELAN-JAWOROWSKA and some skalenoprionid isolated right MI, described here as *Skalenoprion* sp. *a*, *Skalenoprion* sp. *b* and *Skalenoprion* sp. *c*. It is possible that the described isolated MI belong to apparatuses differing in the arrangement and number of the anterior jaws, and represent not only separate species but different genera. The material is, however, incomplete and new taxonomic units cannot be, for the time being, erected.

Some parataxonomic species which could be regarded as congeneric with *Skalenoprion* have been discussed previously (KIELAN-JAWOROWSKA, 1962, p. 308). In addition, *Arabellites commendabilis* ELLER, described by ELLER (1961, p. 32, Plate 1, figs. 22—23) from the Devonian of Michigan, is probably the left MI of *Skalenoprion*, while *Drilonereisites longicusculus* ELLER, described by ELLER (1964, p. 233, Plate 3, figs. 1—4) from the Delaware Limestone, Devonian of Ohio and Ontario, is the right MI of *Skalenoprion*.

Skalenoprion alatus KIELAN-JAWOROWSKA, 1962

(Text-fig. 5 *O*)

1962. *Skalenoprion alatus* n. sp.; Z. KIELAN-JAWOROWSKA, New Ordovician genera..., p. 309, Plates 3—4.

Description. — See KIELAN-JAWOROWSKA, 1962, p. 308.

Skalenoprion sp. **a**

(Plate XXXVI, fig. 4)

Material. — Single right MI from the boulder O.199, of unknown age (Ordovician or Silurian).

Description. — Right MI is an elongated, narrow jaw, 0.6 mm. long. The hook is stout, overhanging laterally the outer margin of the jaw, extending for more than half the jaw length. A series of 8 denticles decreasing in size posteriorly extends along the inner margin, behind the hook. The posterior part of the jaw (to the rear of the hook) tapers posteriorly. Basal ridge is indistinct, marked only by the presence of four small granulations, forming a row parallel to the main ridge, without an elevation. Fusion furrow is lacking. No furrow between

the main ridge and the basal ridge. Posterior margin is directed postero-laterally. The outer margin is convex, in the most posterior part provided with a small postero-lateral wing.

In ventral view the opening extends for more than half the jaw length. At the anterior part of the opening there is a large, suboval depression. The wall of the jaw is very thick.

Skalenoprion sp. **b**

(Plate XXXVI, fig. 3)

Material. — Three right MI from the boulders O.42 and O.144, of unknown age (Ordovician or Silurian).

Description. — Right MI is a moderately narrow jaw, with a hook extending for one third or a little more of the jaw length. The main ridge is provided with 7—9 denticles, basal ridge with 3—5 denticles, the fusion furrow is short *(tr.)*, directed obliquely antero-laterally. A deep, longitudinal furrow between the main ridge and the additional ridge. Posterior margin (beginning with the main ridge) is directed at first transversally, then antero-laterally. On the outer margin there is a small incurvature, the postero-lateral corner forming a long, crescent-like wing.

In ventral view: The opening of the pulp cavity extends for more than half of the jaw length. In the anterior part of the opening there is an oval or subcircular muscle scar, partly hidden in the hook. A furrow associated with the basal ridge is well visible on the ventral side.

Skalenoprion sp. **c**

(Plate XXXVI, fig. 5)

Material. — One right MI from the boulder O.159 and one from the boulder O.301. Age of the boulders O.159 and O.301 unknown (Ordovician or Silurian).

Description. — Right MI is a very narrow, strongly elongated jaw, with a hook extending for half (or less) the jaw length. A series of 11 denticles decreasing in size posteriorly extends the full length of the inner margin beyond the hook. Basal ridge is short *(long.)*, prominent but undenticulated, fusion furrow short *(tr.)*, directed antero-laterally. Posterior margin is directed antero-laterally, somewhat sigmoid. The outer margin is directed posteriorly, with a small crescent-like wing in the postero-lateral corner. In ventral view the opening of the pulp cavity extends for more than half the jaw length.

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II. PALÄEONTOLOGICAL INDEX

Systematic names cited only are indicated by *italic*, and names accompanied by description are indicated by roman letters.

Numerals which indicate the page, on which the species is cited only, are standard; numerals, which indicate pages with description, are **bold**.

Numerals denoted with asterisks (*) indicate pages with figures.

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PLATES

ABBREVIATIONS

al — attachment lamella
At — anterior teeth
bp — basal plate
br — basal ridge
cr — carriers
it — intercalary tooth
ir — incipient ridge
l — left
lbp — laeobasal plate
lbr — laeobasal ridge
lit — laeointercalary tooth
Lt — lateral teeth (*LtIr* — lateral tooth associated with MIr, etc.)
MIl-MVl — left maxillae MI-MV
MIr-MVr — right maxillae MI-MV
Mdb — mandibles
mr — main ridge
Mx — maxillae
r — right
sr — second ridge

PLATE I

Page

Mochtyella cristata KIELAN-JAWOROWSKA 54

Fig. 1. Joined, somewhat damaged right and left MI, in ventral view, showing the incipient jaws in pulp cavities of the old ones. Photograph taken in transmitted light, slightly retouched. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/6); × 68.

Mochtyella sp. 51

Fig. 2. Left MI in left lateral view, showing the incipient jaw in the pulp cavity of the old one. Mochty, province of Warsaw, erratic boulder of unknown age — Ordovician or Silurian. Photograph retouched (Z. Pal. No. O.463/3); × 68.

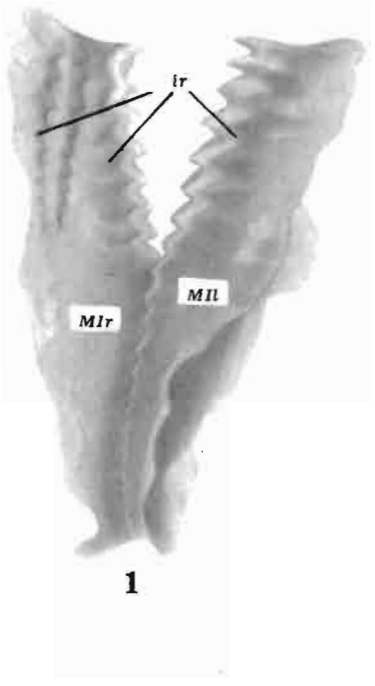
Halla parthenopeia DELLE CHIAJE 50

(Gulf of Naples, Recent)

Fig. 3. Preparation of the cuticular layer covering the stomodeum, with attached maxillary apparatus and mandibles (Z. Pal. No. An.H.12); × 12.

Fig. 4. Preparation of the cuticular layer covering the stomodeum, with incipient maxillae. Carriers and lateral plates lacking. The individual jaws pronounced only as soft denticulated ridges (Z. Pal. No. An.H.13) × 15.

Fig. 5. Preparation of the cuticular layer covering the stomodeum, with maxillary apparatus fully developed. The specimen bleached (Z. Pal. No. An.H.11); × 20.



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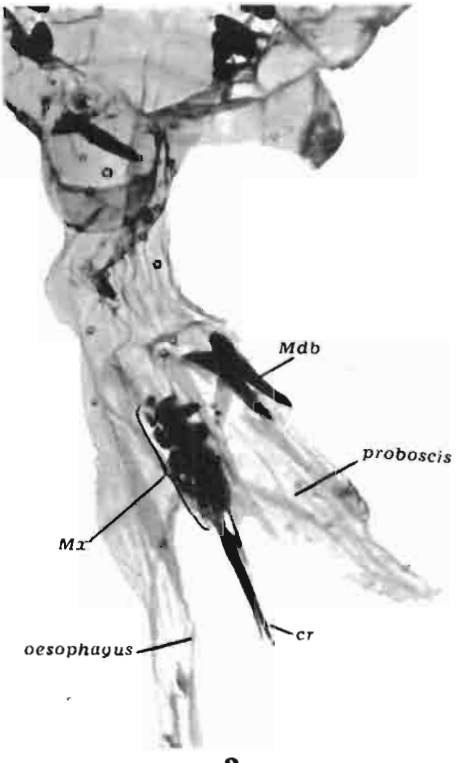

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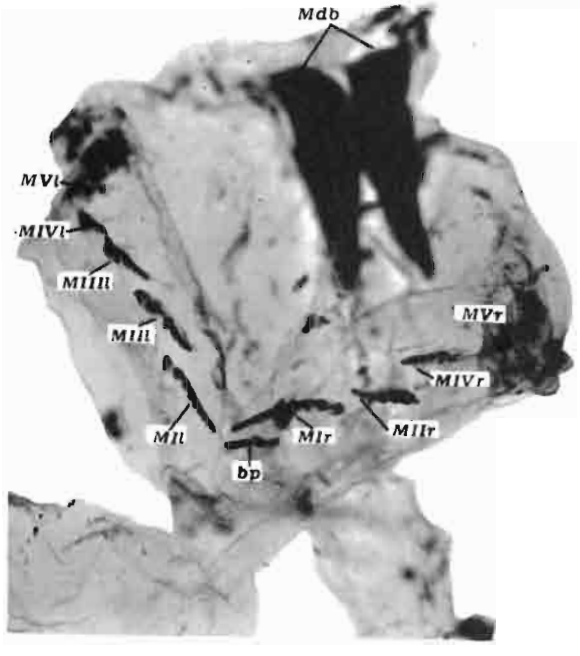

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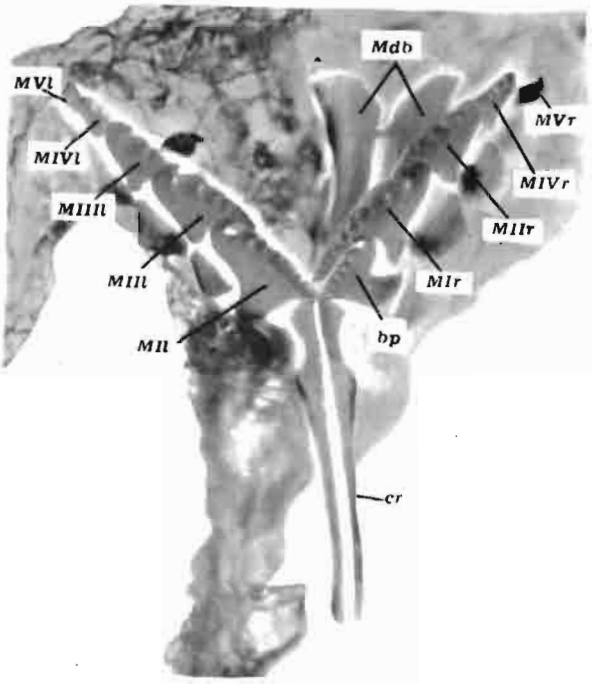

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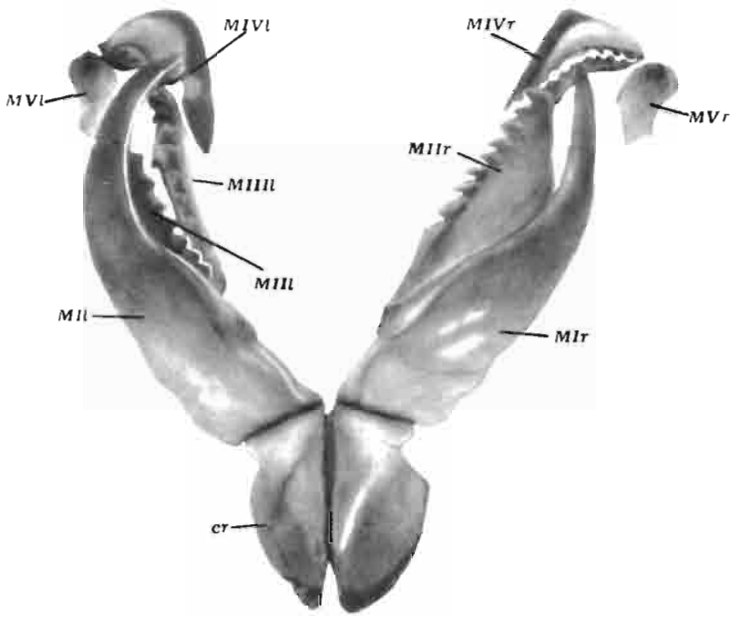
Photo: M. Czarnocka & J. Blaszyk

PLATE II

(St. Paul de Loanda, Angola, Recent)

Fig. 1. Normal type of the jaw apparatus, with a single MIII on the left side (B.M. No. 1930. 10. 8. 1901); × 37.
Fig. 2. Jaw apparatus displaying symmetry variation, with MIII paired (B.M. No. 1930. 10. 8. 1770c); × 42.
Fig. 3. Jaw apparatus displaying symmetry variation, with a single MIII on the right side (B.M. No. 1930. 10. 8. 1910c); × 37.
Fig. 4. Jaw apparatus displaying symmetry variation, with MIII paired (B.M. No. 1930. 10. 8. 1908); × 45.



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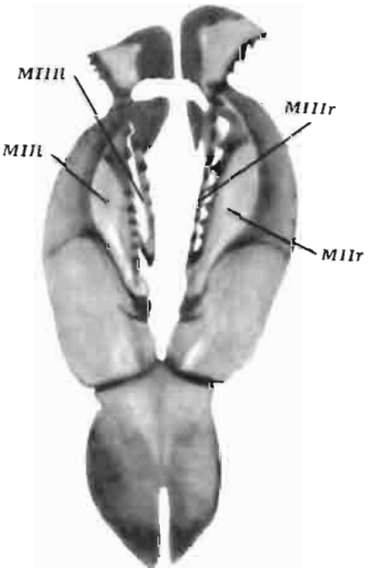

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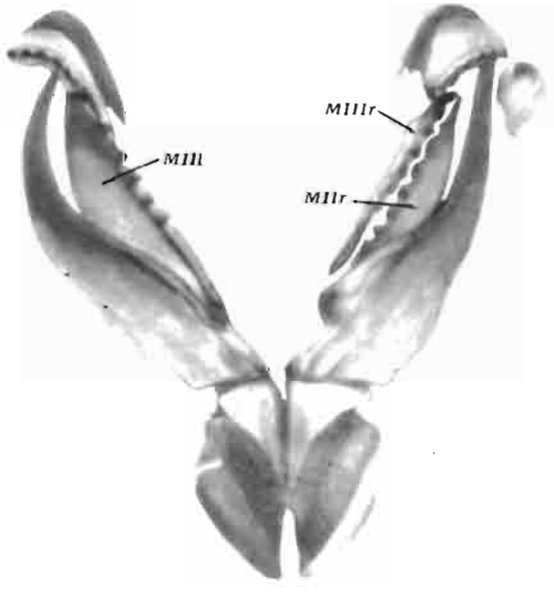

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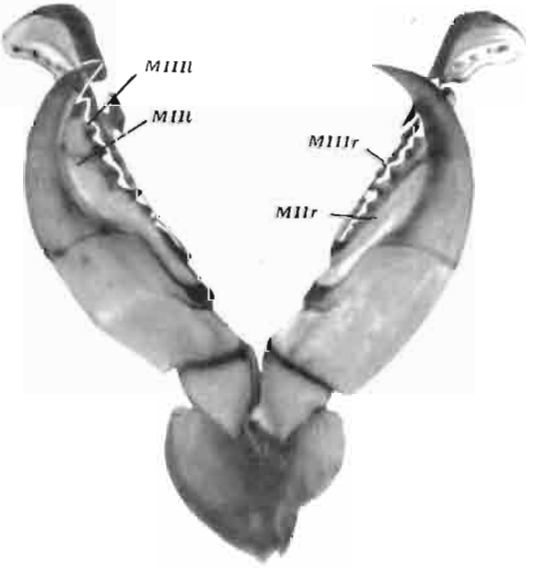

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Photo: M. Czarnocka

PLATE III

Page

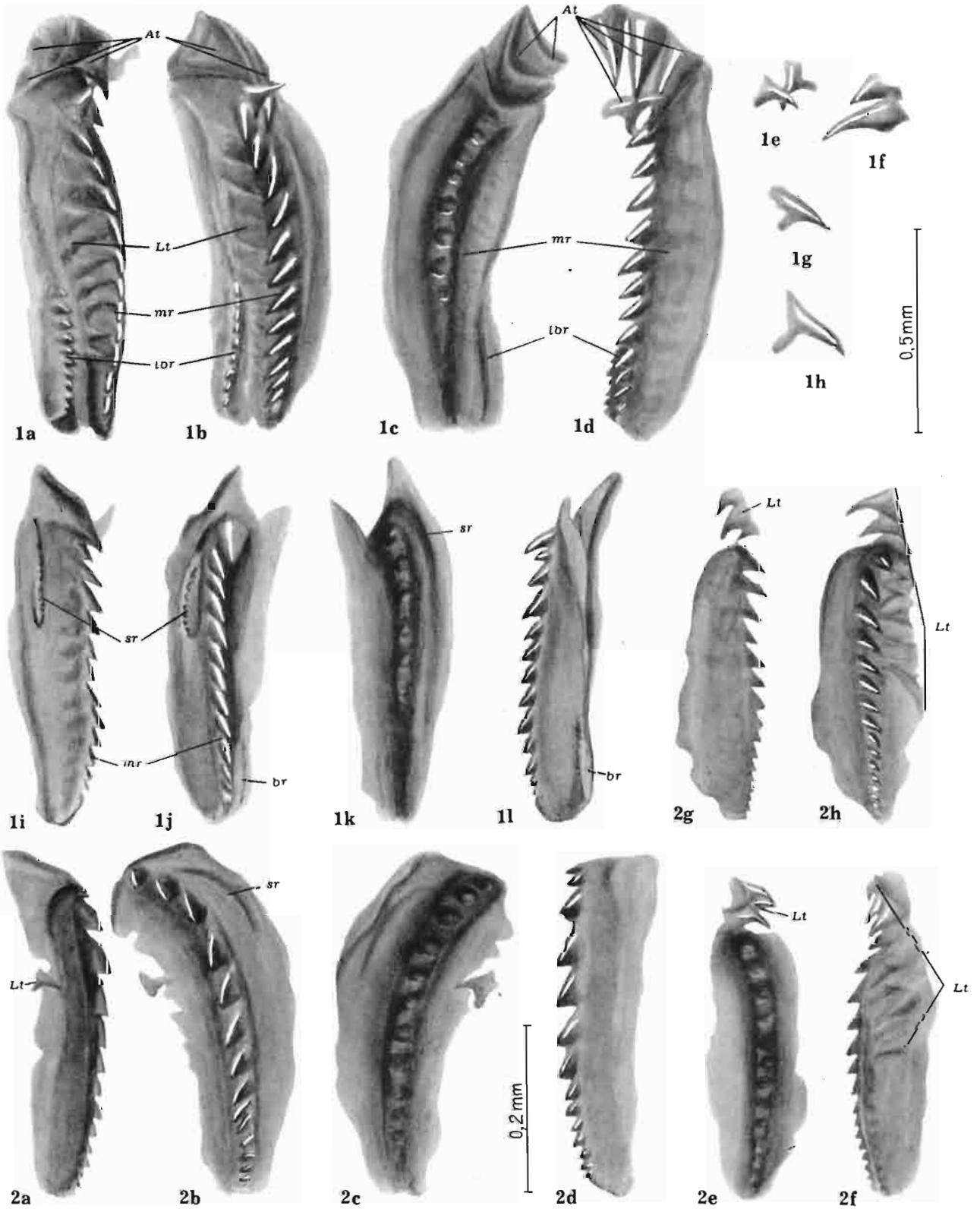
Mochtyella polonica n. sp. 54

Fig. 1. Type specimen, left and right MI, with a chain of left lateral teeth and left anterior teeth, previously joined together: *a-d* left MI with lateral teeth and 3 anterior teeth in left lateral, dorsal, ventral and right lateral views; *e-h* detached most anterior and may be also lateral teeth of the same apparatus; *i-l* right MI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z.Pal. No. O.344/1).

Pistoprion transitans n. sp. 60

(see also Plate VI, fig. 2 and Plate VII, figs. 2 and 3)

Fig. 2. Right and left MI, previously joined together, with incomplete chain of right lateral teeth, and one left tooth: *a-d* left MI in left lateral, dorsal, ventral and right lateral views; *e-h* left MI with lateral teeth, in ventral, right lateral, and dorsal views. Zakroczym, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z.Pal. No. O.349/9).



E. Gadomska, del.

PLATE IV

Page

Mochtyella sp. *a* 56

Fig. 1*a-d*. Right MI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z.Pal. No. O.178/10).

Mochtyella sp. *b* 56

(see also Plate V, fig. 4)

Fig. 2*a-d*. Right MI in left lateral, dorsal, ventral and right lateral views. Ustka, Baltic coast; erratic boulder of ?Silurian age (Z.Pal. No. O.441/26).

Mochtyella sp. *c*. 58

Fig. 3*a-d*. Right MI in left lateral, dorsal, ventral and right lateral views. Międzyzdroje, Baltic coast; erratic boulder of ?Silurian age (Z.Pal. No. O.308/2).

Mochtyella sp. *d* 59

Fig. 4*a-c*. Right MI in left lateral, dorsal and right lateral views. Ustka, Baltic coast; erratic boulder of ?Silurian age (Z.Pal. No. O.446/14).

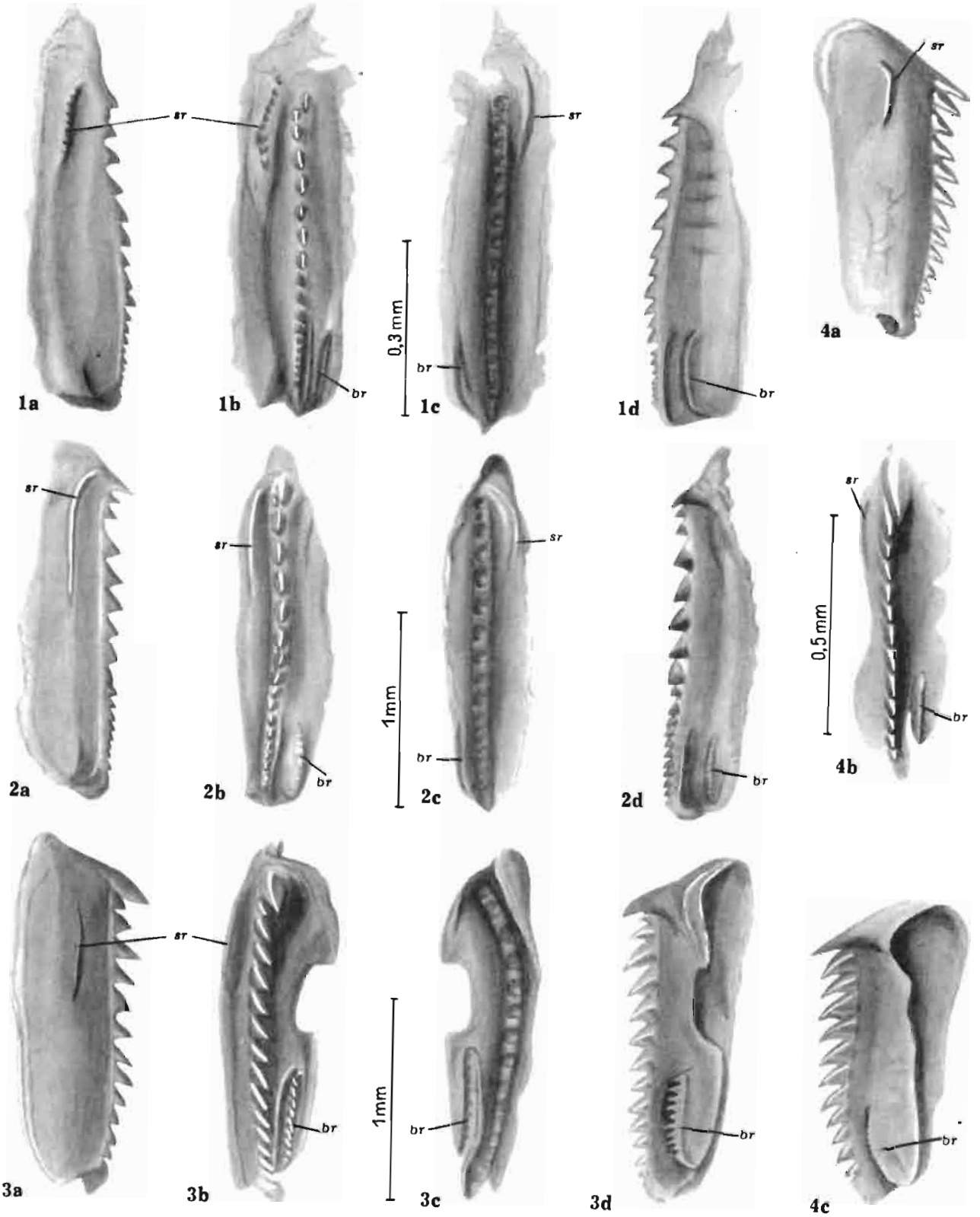


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PLATE V

Fig. 1. Type specimen (right and left MI, previously joined together): *a-d* left MI in left lateral, dorsal, ventral and right lateral views; *e-h* right MI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Silurian age (Z.Pal. No. O.187/15).

Fig. 2. Incomplete right and left MI, previously joined together: *a-b* left MI, with anterior part of the laeobasal ridge broken off, in left lateral and dorsal views; *c-d* right MI (somewhat fractured), in dorsal and right lateral views. Ustka, Baltic coast; erratic boulder of ?Silurian age (Z.Pal. No. O.439/2).

Fig. 3. Right MI with three anterior teeth, housed in the pulp cavity: *a* in dorsal view; *b* in ventral view. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z.Pal. No. O.466/1).

(see also Plate IV, fig. 2)

Fig. 4*a-b*. Right MI in left lateral and right lateral views. Ustka, Baltic coast; erratic boulder of ?Silurian age (Z.Pal. No. O.441/28).

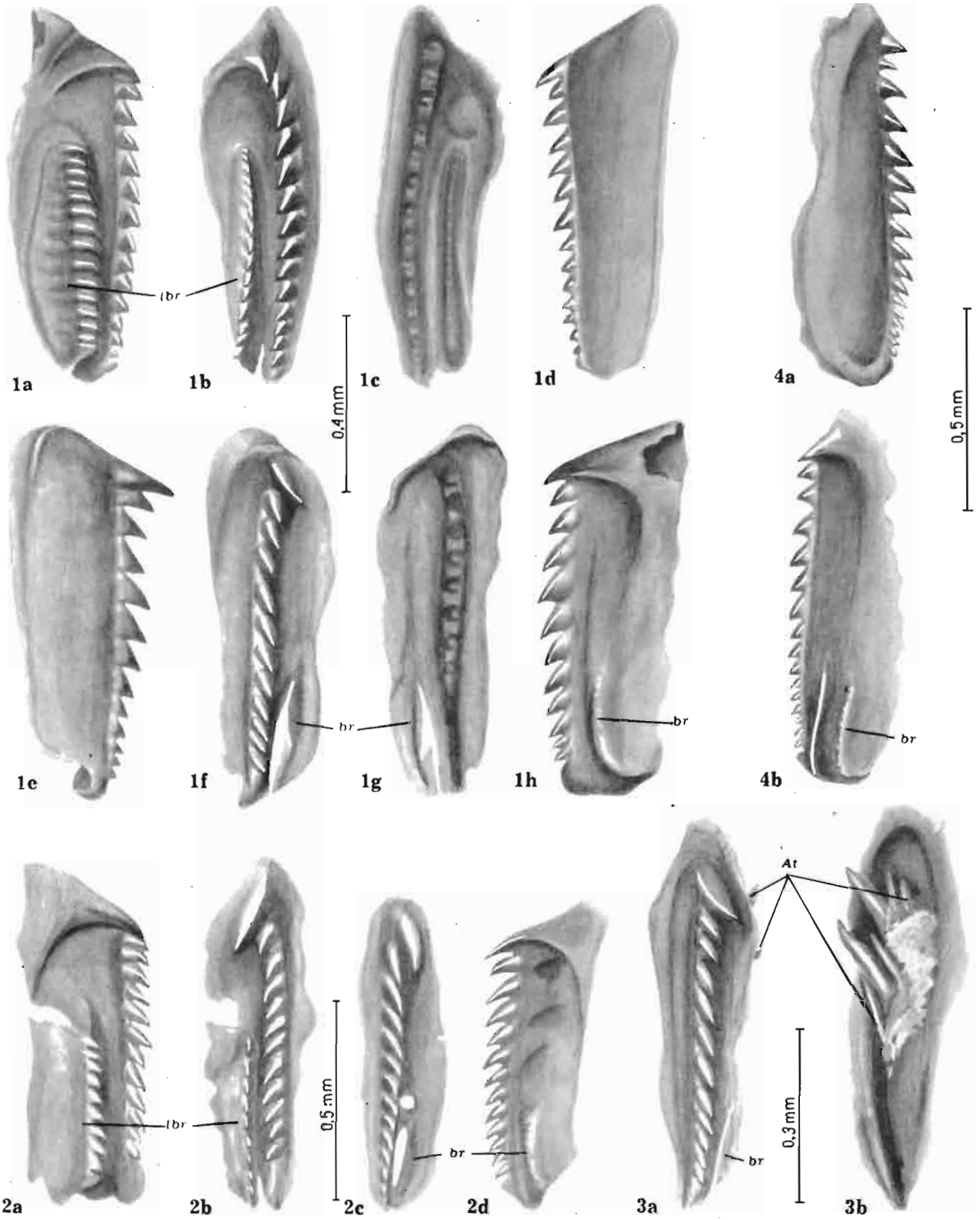

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PLATE VI

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Pistoprion sp. *b* 62

Fig. 1*a-d*. Right side of the posterior part of jaw apparatus (bp, MIr, MIIr) in dorsal, left lateral, right lateral and ventral views. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z.Pal. No. O.177/2).

Pistoprion transitans n. sp. 60

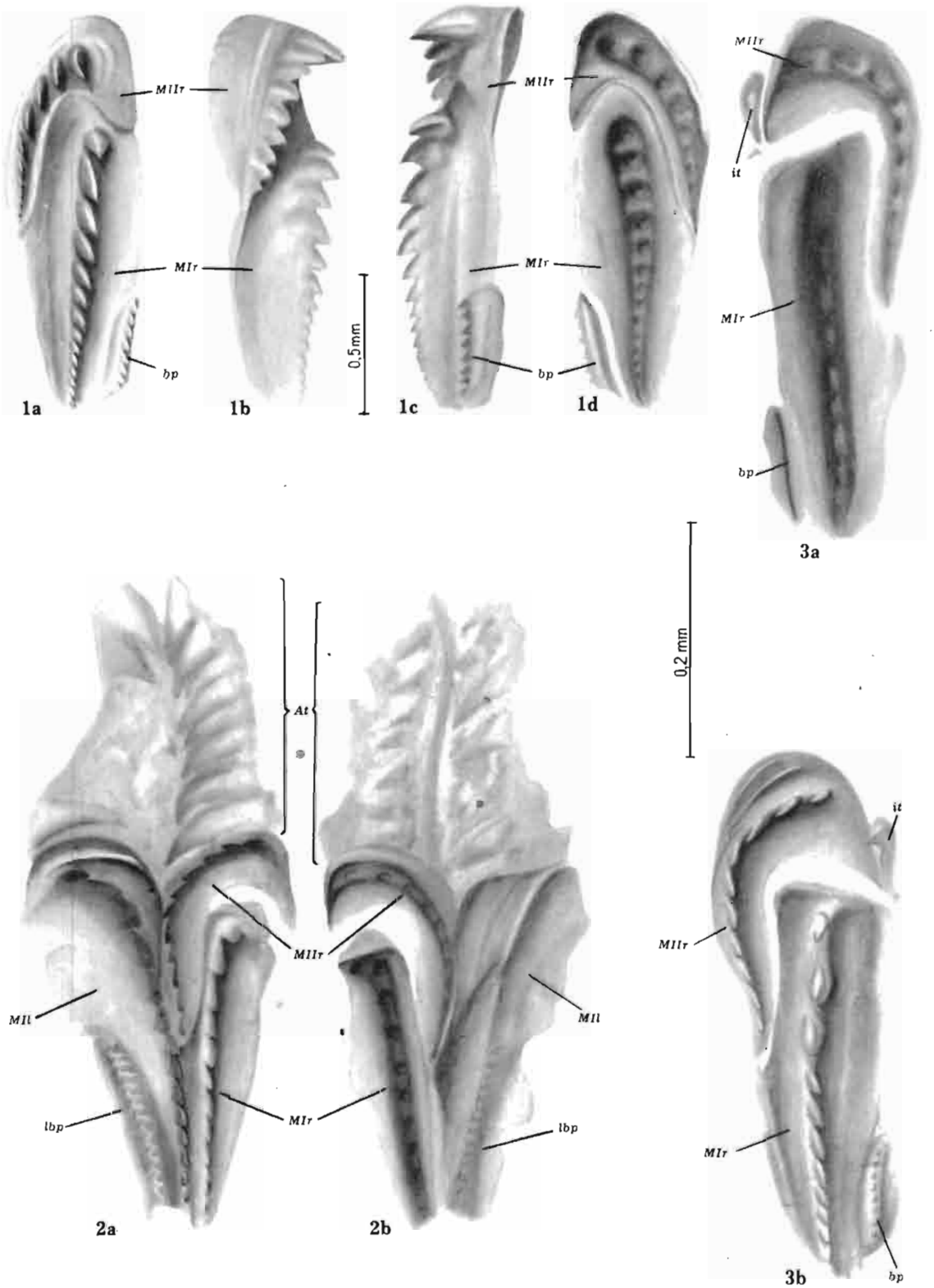
(see also Plate III, fig. 2 and Plate VII, figs. 2, 3)

Fig. 2*a-b*. Type specimen. Incomplete jaw apparatus (MIr, MIIr, 1bp, MII and series of anterior teeth) in dorsal and ventral views. Zakroczym, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.213/1).

Pistoprion sp. *a* 62

Fig. 3*a-b*. Right side of the posterior part of jaw apparatus (bp, MIr, MIIr, it) in ventral and dorsal views. Międzyzdroje, Baltic coast; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.418/2).

Figs. 2 and 3 — in the same scale



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Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE VII

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Pistoprion sp. *c* 63

Fig. 1*a-c*. Right side of the posterior part of jaw apparatus (bp, MIr, MIIr), in dorsal, right lateral and ventral views. Wyszogród, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.133/1).

Pistoprion transitans n. sp. 60

(see also Plate III, fig. 2 and Plate VI, fig. 2)

Fig. 2*a-c*. Left side of the posterior part of jaw apparatus (lbp and MIl), in dorsal, left lateral and ventral views. Wyszogród-Zakroczym, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.140/2).

Fig. 3*a-b*. Incomplete posterior part of jaw apparatus, separated during the drawing (bp, MIr, MIl), in dorsal and ventral views. Wyszogród-Zakroczym, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.147/1).

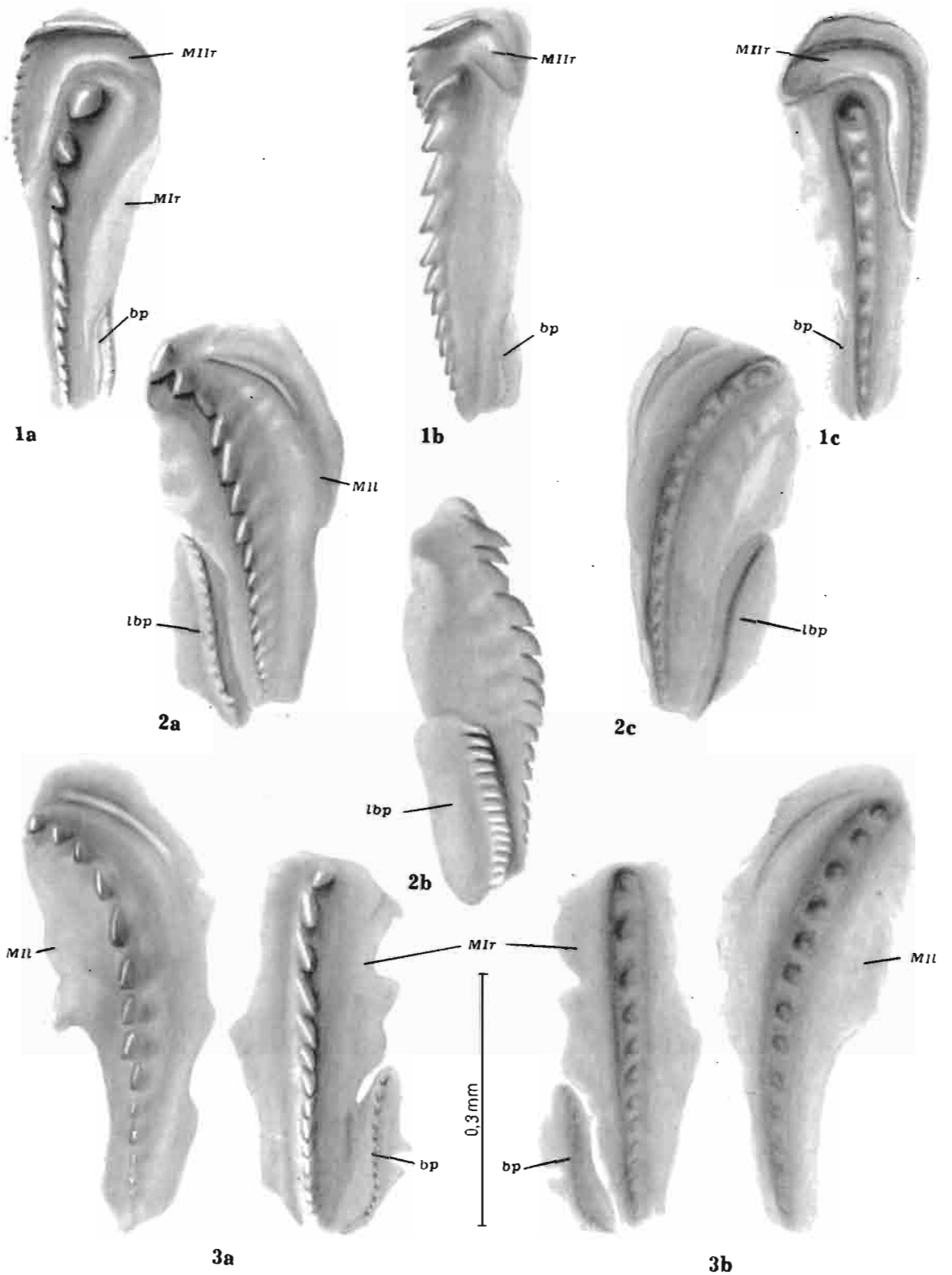

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PLATE VIII

Fig. 1*a-b*. Right MII in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/50).

Fig. 2*a-b*. Left MI in dorsal and ventral views. Horizon and locality — as Fig. 1 (Z. Pal. No. O.182/25).

Fig. 3. Left MI in dorsal view. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.265/3).

Fig. 4*a-b*. Incomplete right MI in right lateral and dorsal views. Horizon and locality — as Fig. 3 (Z. Pal. No. O.265/14).

Fig. 5*a-b*. Incomplete left MI and MII joined together, in dorsal and ventral views. Type specimen. Horizon and locality as fig. 3 (Z. Pal. No. O.265/12).

Fig. 6*a-b*. Incomplete right MI in dorsal and ventral views. Wyszogród-Zakroczym, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.148/1).

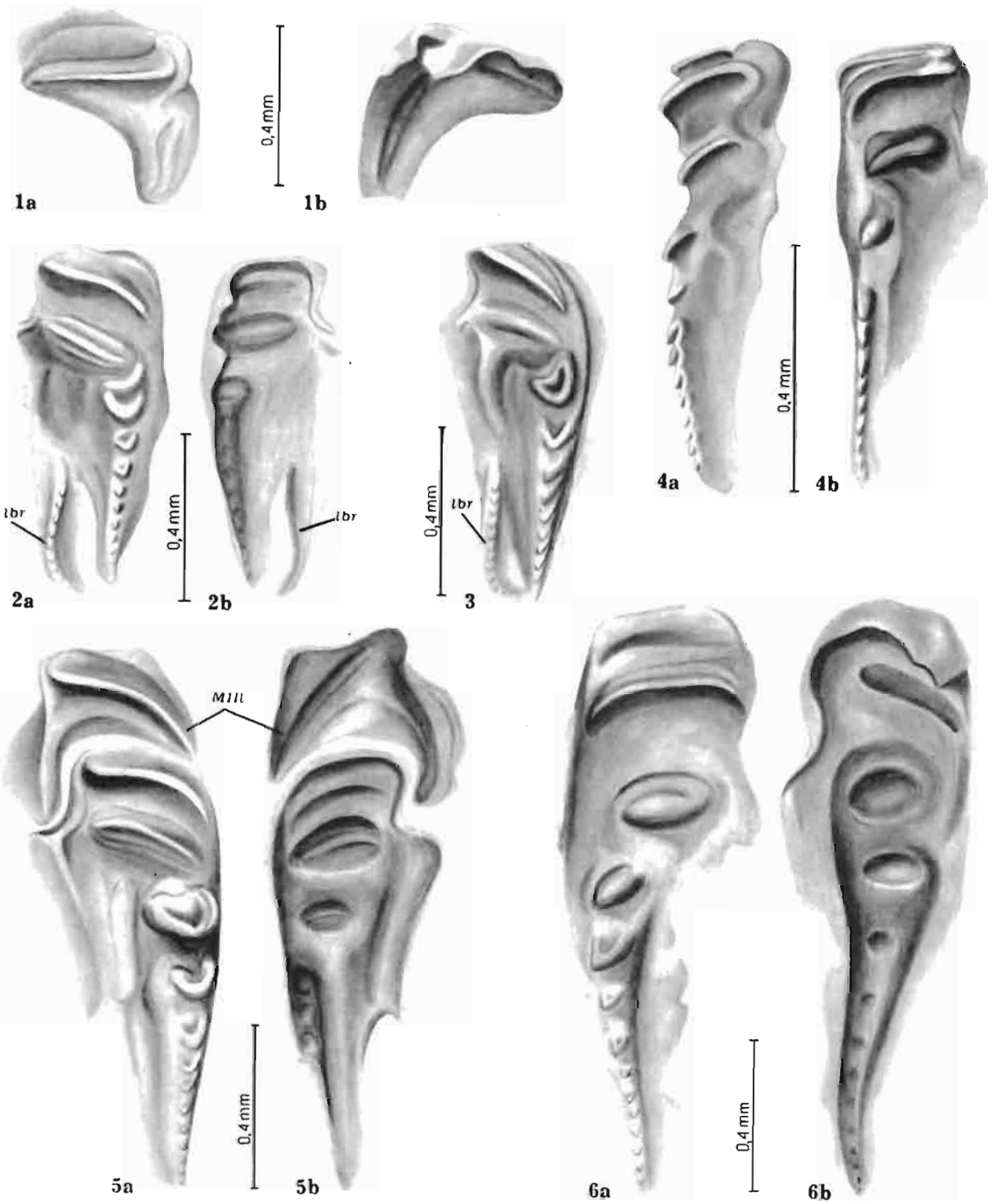

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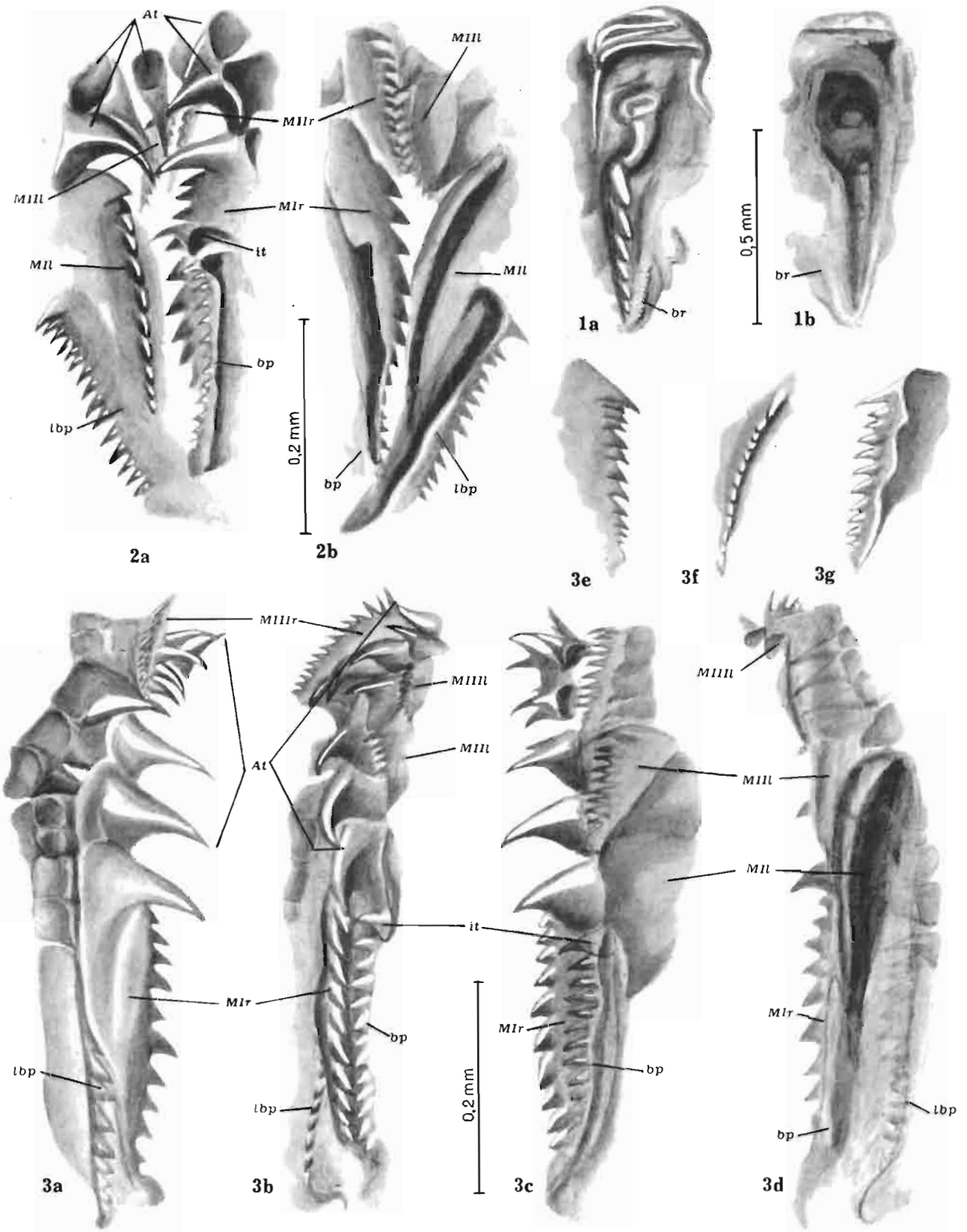
PLATE IX

Fig. 1*a-b*. Right MI (with basal ridge somewhat removed rearwards), in dorsal and ventral views. Boring in Mielnik, 1118-1124 m.; ?Upper Ordovician — Harjuan Stage (Z. Pal. An. Miel. 1).

(see also Plate X and Plate XI, fig. 3)

Fig. 2*a-b*. Incomplete jaw apparatus (bp, lbp, it, MIr, MII, MIII, and six outer anterior teeth), in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/64).

Fig. 3. Almost entire apparatus, somewhat deformed (bp, lbp, it, MIr, MIIr, MIIIr, MII, MIII, MIIII and incomplete chains of outer and inner anterior teeth): *a-d* the apparatus in four views, *e-g* right MII of the same apparatus, in left lateral, dorsal and ventral views. Horizon and locality — as Fig. 2 (Z. Pal. No. O.400/297).



E. Gadomska, del.

PLATE X

(see also Plate IX, figs. 2-3 and Plate XI, fig. 3)

Fig. 1*a-b*. Posterior part of the apparatus (bp, lbp, it, MIr, MIIr, MII, MIII, Mdb), in dorsal and ventral views; right mandible overturned. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/61).

Fig. 2*a-c*. Almost entire, somewhat deformed jaw apparatus — type specimen, in dorsal, ventral and right lateral views (bp, lbp, it, MIr, MIIr, MIIIr, MII, MIII, MIIII and almost complete chains of outer and inner rows of anterior teeth). Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/62).

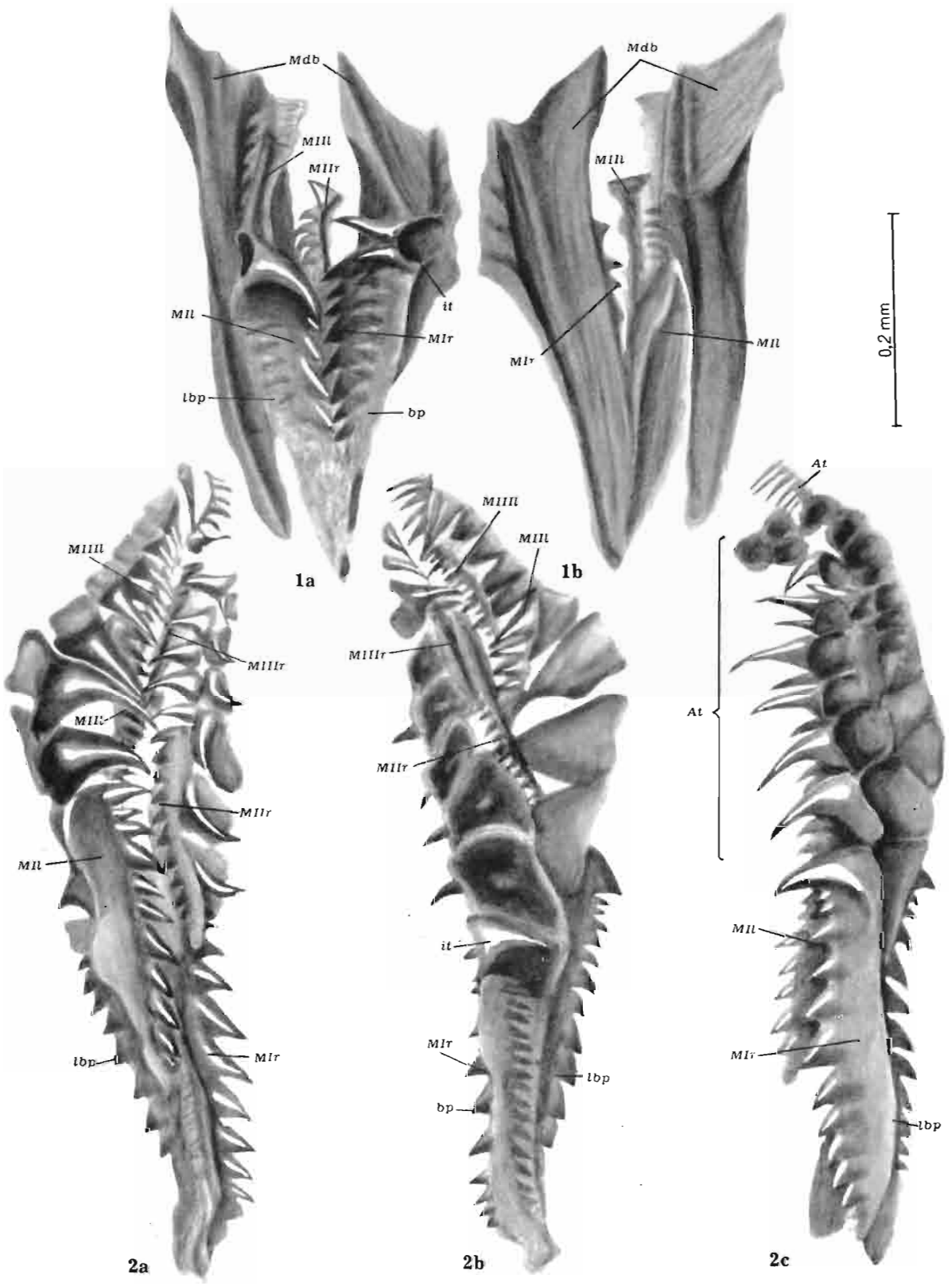


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PLATE XI

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Ramphoprion sp. *d* 112

Fig. 1*a-c*. Right MI in dorsal, left lateral and ventral views. Estonia, Kukruse beds, G. HOLM's coll. (R. M. No. An. 2629).

Fig. 2*a-c*. Right MI in dorsal, right lateral and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/67).

Tetraprion pozaryskae n. sp. 69

(see also Plate IX, figs. 2-3 and Plate X)

Fig. 3. Posterior part of the jaw apparatus, separated intentionally; *a-d* laeobasal plate in dorsal, left lateral, ventral and right lateral views; *e-h* left MI in left lateral, dorsal, ventral and right lateral views (posterior part of the right slope broken off); *i-l* right MI with basal plate, in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/148).

Figs. 1 and 2 — in the same scale

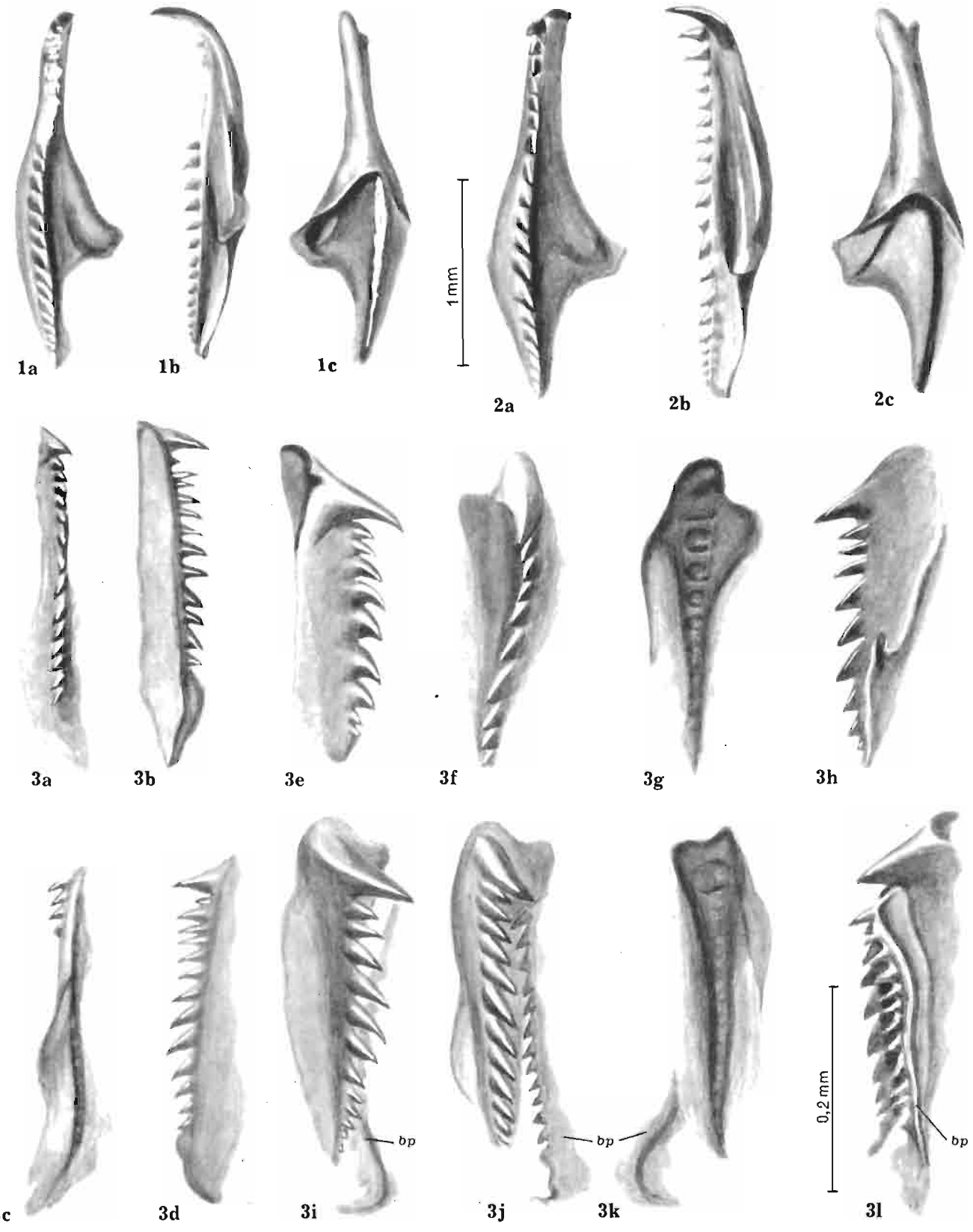

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PLATE XII

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Symmetroprion sp. *a* 73

Fig. 1*a-b*. Laeobasal plate in dorsal and ventral views. Rewal, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.98/4*a*).

Fig. 2*a-b*. Laeobasal plate, in dorsal and ventral views. Horizon and locality — as Fig. 1 (Z. Pal. No. 98/8*a*).

Fig. 3*a-b*. Laeobasal plate and left carrier, in dorsal and ventral views. Horizon and locality — as Fig. 1 (Z. Pal. No. O.98/8*b*).

Fig. 4*a-b*. Laeobasal plate in dorsal and ventral views. Horizon and locality — as Fig. 1 (Z. Pal. No. O.98/4*b*).

Fig. 5*a-b*. Laeobasal plate in dorsal and ventral views. Horizon and locality — as Fig. 1 (Z. Pal. No. O.98/4*c*).

Fig. 6*a-c*. Laeobasal plate in dorsal, ventral and right lateral views. Ustka, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.442/1).

Fig. 7*a-c*. Laeobasal plate with left carrier, in dorsal, ventral and right lateral views. Międzyzdroje, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.308/9).

Fig. 8*a-b*. Basal plate and right carrier of the same specimen, broken off during the drawing, in ventral and dorsal views. Dębina near Ustka, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.441/7).

Symmetroprion reduplicatus n. sp. 72

Fig. 9*a-c*. Left MI — type specimen, in dorsal, ventral and right lateral views. Horizon and locality — as fig. 1 (Z. Pal. No. O.98/9*b*).

Fig. 10*a-c*. Left MI in dorsal, left lateral and ventral views. Horizon and locality — as Fig. 7 (Z. Pal. No. O.308/8).

Fig. 11*a-c*. Right MI in dorsal, ventral and left lateral views. Horizon and locality — as Fig. 1 (Z. Pal. No. O.98/10*a*).

Figs. 1-5, 7 and 8 — in the same scale
Figs. 10 and 11 — in the same scale

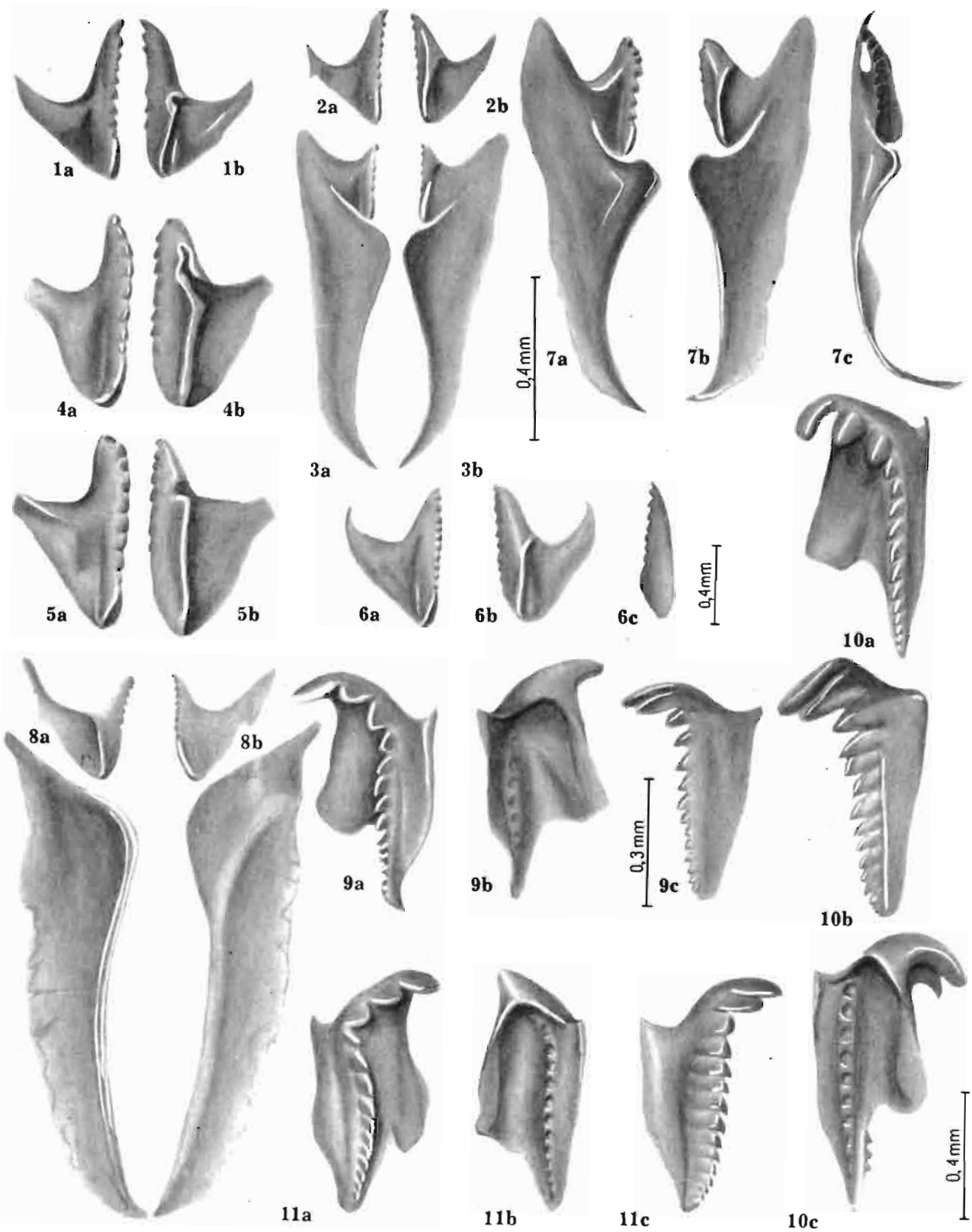

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PLATE XIII

(see also Plate XIX, fig. 4)

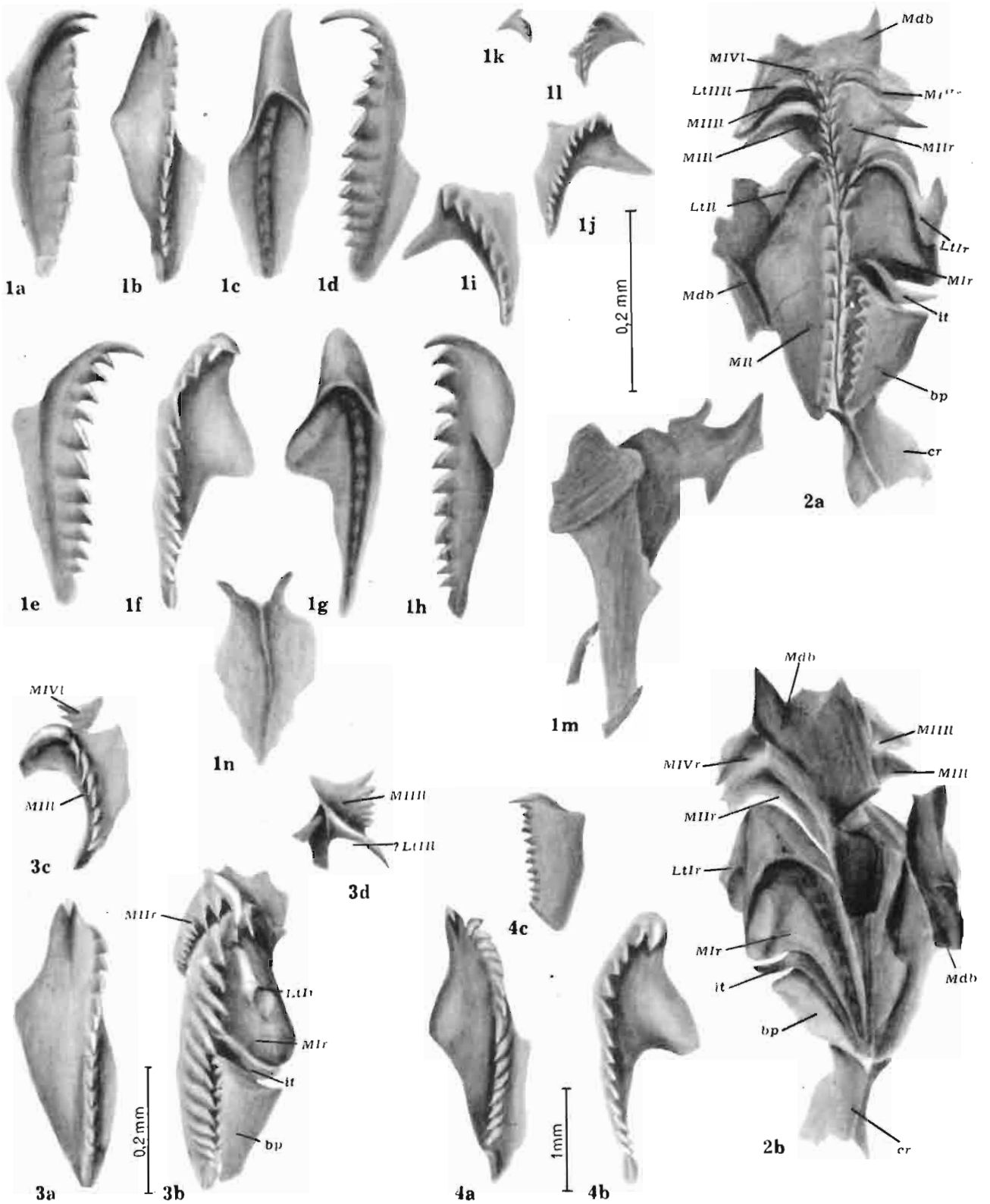
Fig. 1. Incomplete jaw apparatus, intentionally separated into parts. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.463/1): *a-d* left MI in left lateral, dorsal, ventral and right lateral views; *e-h* right MI in left lateral, dorsal, ventral and right lateral views; *i* left MII, dorsal view; *j* right MII, dorsal view; *k* left ?MIV, dorsal view; *l* right MIV, dorsal view; *m* damaged mandibles; *n* carriers.

Fig. 2. Nearly entire apparatus (cr, bp, it, MIr, MII, MIIr, MIII, MIIII, fragmentary MIVl, MIVr, LtIr, LtII, LtIIII, damaged mandibles): *a* dorsal view, *b* ventral view. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/41).

Fig. 3. Incomplete jaw apparatus, intentionally separated into parts: *a* left MI in dorsal view; *b* incomplete right side (bp, it MIr, MIIr, LtIr), in dorsal view; *c* left MII associated with fragmentary left MIV, in dorsal view; *d* left MIII associated with left lateral tooth, presumably LtII, in dorsal view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/83).

Fig. 4. Incomplete jaw apparatus, separated into parts: *a* left MI, *b* right MI, *c* basal plate — all in dorsal view. Wyszogród-Zakroczym, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.148/4).

Figs. 1 and 2 — in the same scale



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Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XIV

Page

Polychaetaspis tuberculatus n. sp. 78

Fig. 1. Incomplete left side of the apparatus (MII, MIII, LtII,): *a* dorsal view, *b* ventral view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.366/25).

Fig. 2. Entire apparatus — type specimen (Mdb, cr, bp, it, MIr, MII, MIIr, MIII, MIIII, MIVl, MVr, MVl; right lateral teeth: LtI, LtII, LtIV; left lateral teeth: LtI, LtII, LtIII, LtIV). Carriers arranged at nearly right angle with regard to the dorsal surface of the apparatus, left mandible with posterior broken off: *a* dorsal view, *b* ventral view, *c* damaged carriers of the same apparatus, in dorsal view. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/33).

Fig. 3. Incomplete right side (bp, it, MIr, MIIr, MIIIr, LtIr): *a-d* in dorsal, left lateral, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/161).

Fig. 4. Incomplete left side with carriers, arranged upside down on the ventral side (cr, MII, MIII, MIIII, MIVl, LtI, LtII, LtIV): *a-d* in dorsal, left lateral, ventral and right lateral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.469/50).

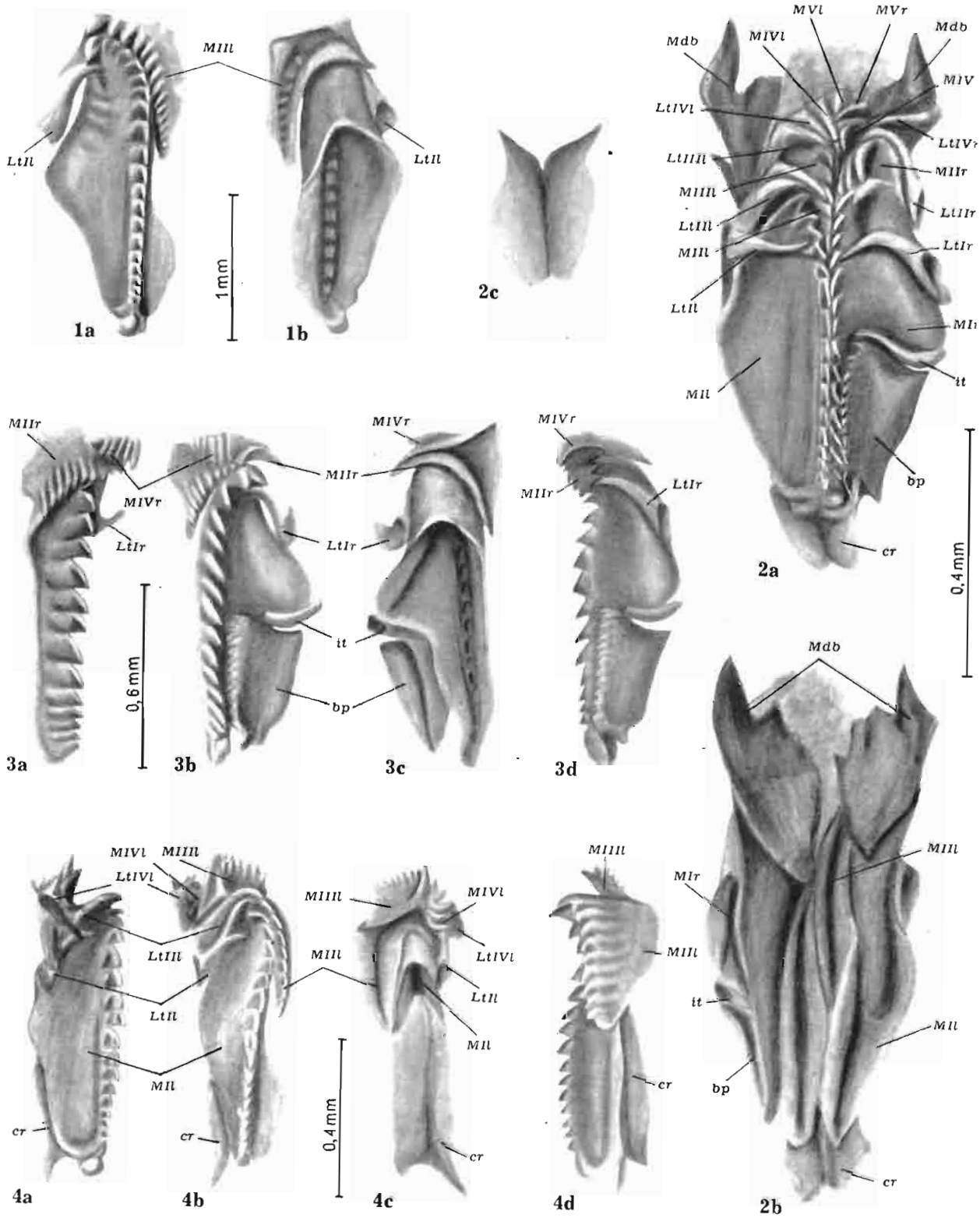

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PLATE XV

Fig. 1. Almost entire apparatus — type specimen (cr, bp, it, MIr, MIIr, MIVr, MIl, MIIl, MIIIl, right and left LtI and fragmentary mandibles): *a* dorsal view, *b* ventral view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/61).

Fig. 2. Joined right and left MI, intentionally separated: *a-d* left MI in dorsal, left lateral, ventral and right lateral views; *e-h* right MI in dorsal, left lateral, ventral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.400/16).

Fig. 3. Incomplete jaw apparatus, intentionally separated: *a* left MI with lateral tooth, in dorsal view; *b* right MI with lateral tooth, in dorsal view; *c* basal plate and intercalary tooth, in dorsal view; *d* the same, in ventral view; *e* left MII in dorsal view; *f* the same, in ventral view; *g* left MIII; *h* right MII with shank broken off and arranged in unnatural position, associated with incomplete right MIV; *i* the same, in ventral view; *j* carriers. Locality and horizon — as Fig. 1 (Z. Pal. No. O.400/18).

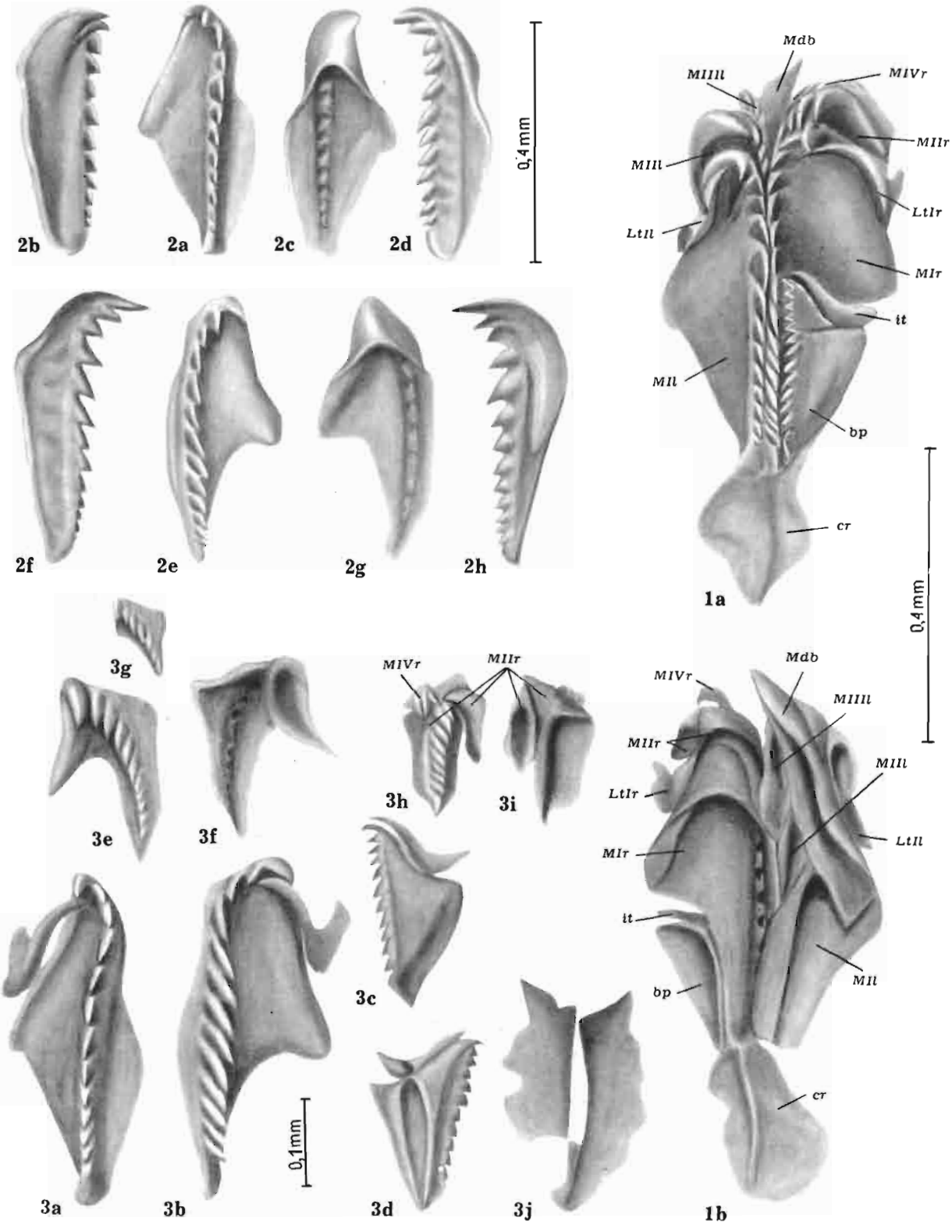

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PLATE XVI

Fig. 1*a-d*. Incomplete right side — type specimen, in dorsal view (cr, bp, MIr). Carriers arranged obliquely upside down, basal plate obliquely with regard to the dorsal surface of MI; in dorsal, ventral, left lateral and right lateral views. Mochty, province of Warsaw; erratic boulder of unknown age — ?Middle Ordovician (Z. Pal. No. O.423/1).

Fig. 2*a-d*. Left MI, assigned tentatively to "*Polychaetaspis*" *incisus*, in dorsal, ventral, left lateral and right lateral views. Horizon and locality — as Fig. 1 (Z. Pal. No. O.423/6).

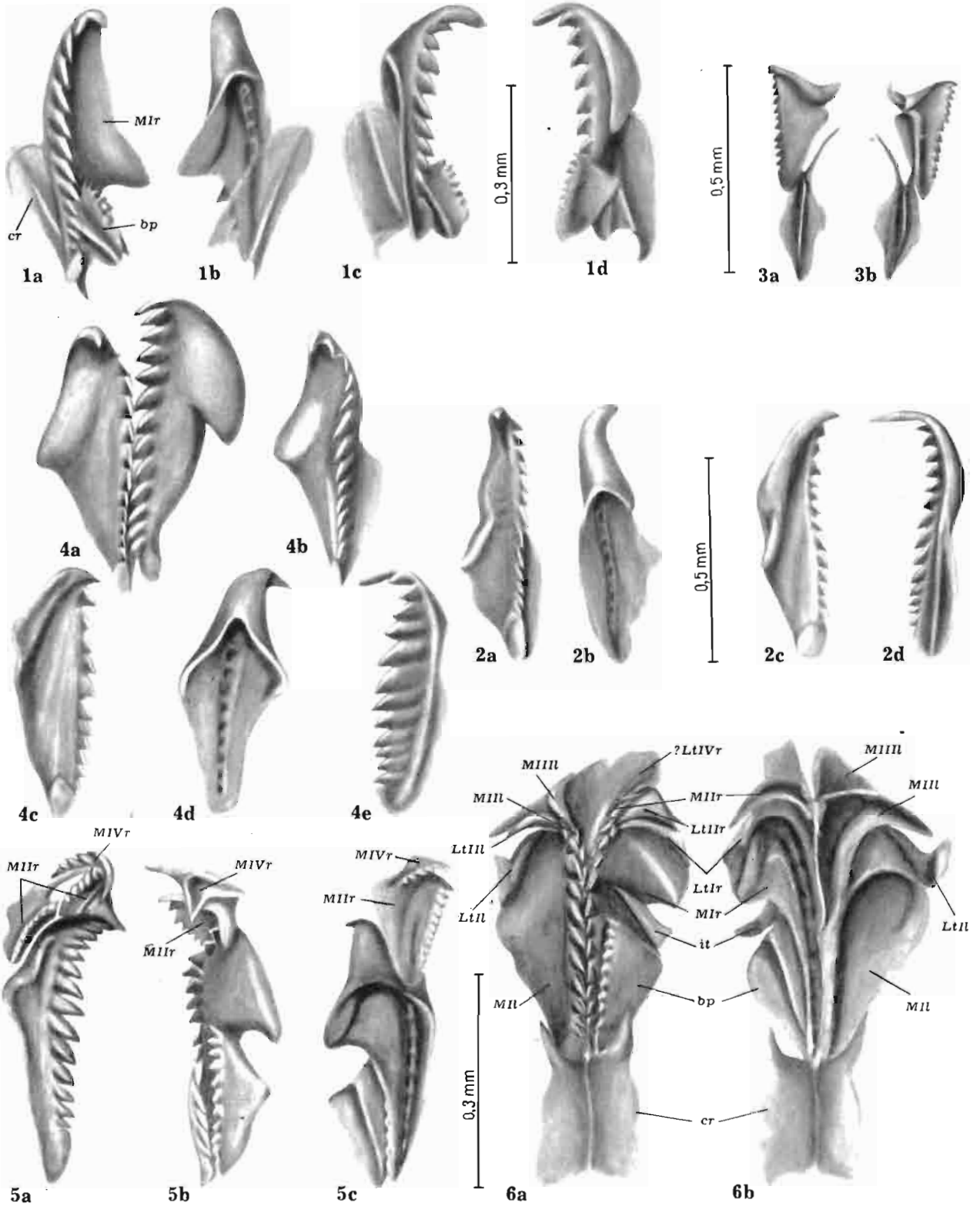
Fig. 3*a-b*. Carriers, basal plate and intercalary tooth joined together, in dorsal and ventral views. Rewal, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.391/1).

Fig. 4. Joined right and left MI — type specimen: *a* in dorsal view; *b-e* isolated left MI of the same apparatus in dorsal, left lateral, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Silurian age (Z. Pal. No. O.187/19).

Fig. 5*a-c*. Incomplete right side (bp, MIr, MIIr, MIVr), intercalary tooth not preserved, MII and MIV arranged in abnormal position, MII fractured; in dorsal, right lateral and ventral views. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.185/3).

Fig. 6*a-b*. Incomplete apparatus (cr, bp, it, MIr, MII, MIIr, MIII, MIIII, right and left LtI and LtII, uncertain right LtIV), in dorsal and ventral views. Dziwnów, Baltic coast; erratic boulder of Silurian age (Z. Pal. No. O.56/1).

Figs. 4, 5 and 6 — in the same scale



E. Gadomska, del.

Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XVII

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Polychaetaspis warkae KOZŁOWSKI 86

Fig. 1. Incomplete jaw apparatus — type specimen, figured by KOZŁOWSKI (1956, Fig. 14), separated into parts after it was drawn by KOZŁOWSKI: *a-c* left MI and left LtI in left lateral, dorsal and right lateral views; *d-e* basal plate, right MI, right (MII in unnatural position) and right LtI in dorsal and right lateral views; *f* right MIV and right LtIV in dorsal view; *g* right carrier in dorsal view. Warka, province of Warsaw; erratic boulder No. O.29 of Middle Ordovician age — ?Uhaku Stage (Z. Pal. KOZŁOWSKI's collection, 1956).

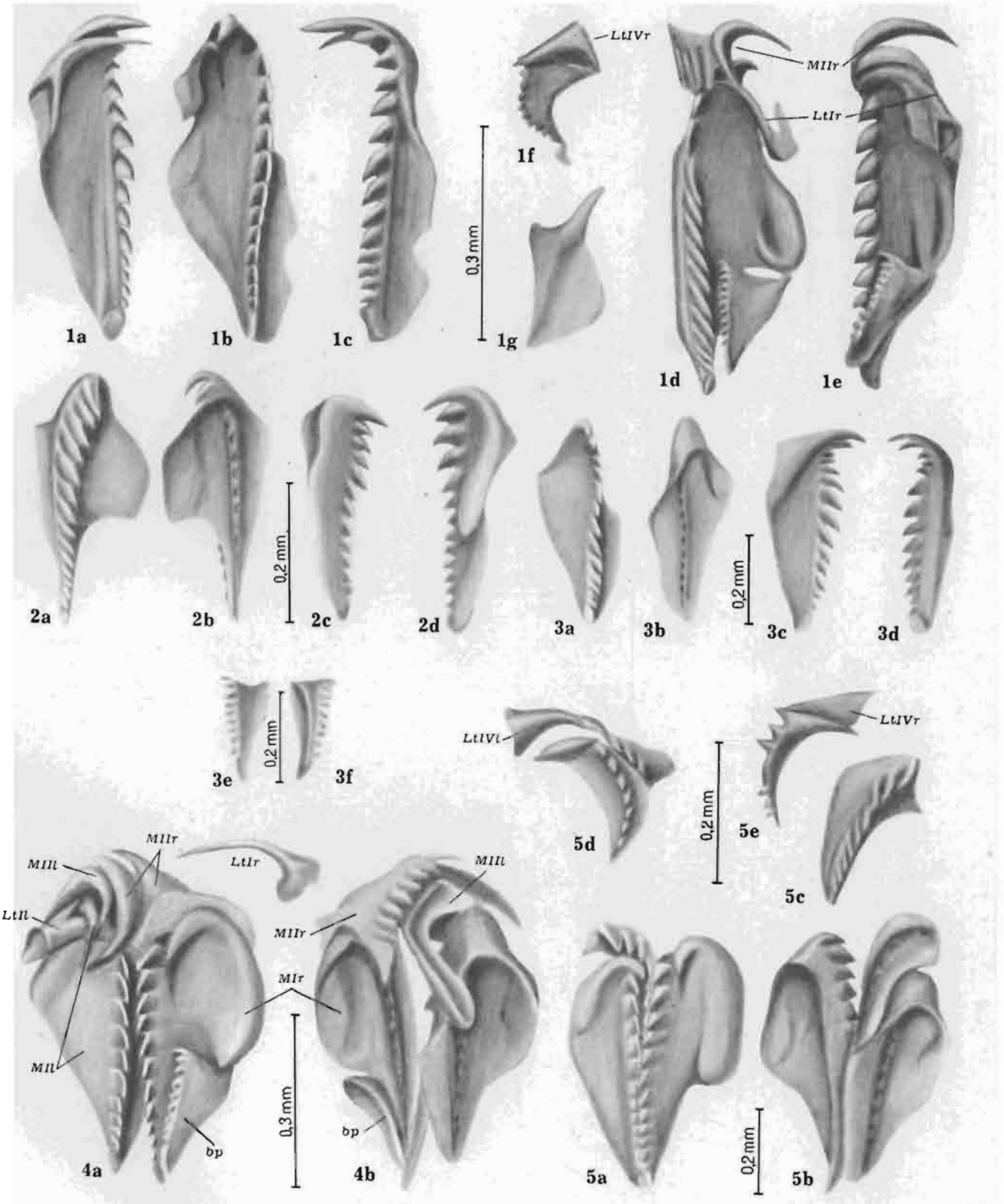
Polychaetaspis latus n. sp. 89

Fig. 2*a-d*. Right MI in dorsal, ventral, left lateral and right lateral views. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.179/5).

Fig. 3. Left MI and the basal plate, preserved together and intentionally separated: *a-d* left MI in dorsal, ventral, left lateral and right lateral views; *e-f* basal plate in dorsal and ventral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.179/8).

Fig. 4. Incomplete jaw apparatus (bp, MIr, MII, MIIr, MIII, LtI right and left): *a* dorsal view, *b* ventral view, *c* detached right LtI of the same apparatus. Locality and horizon — as Fig. 2 (Z. Pal. No. O.179/4).

Fig. 5. Incomplete jaw apparatus — type specimen (MIr, MII, MIIr, MIII, MIIII, MIVl, right LtIV, left LtIII and LtIV): *a* right and left MI and left MII in dorsal view, *b* the same in ventral view; *c-e* anterior jaws of the same apparatus in larger magnification, in dorsal view: *c* right MII, *d* left MIII and MIV associated with left LtIII and LtIV, *e* right MIV associated with right LtIV. Locality and horizon — as Fig. 2 (Z. Pal. No. O.179/6).



E. Gadomska, del.

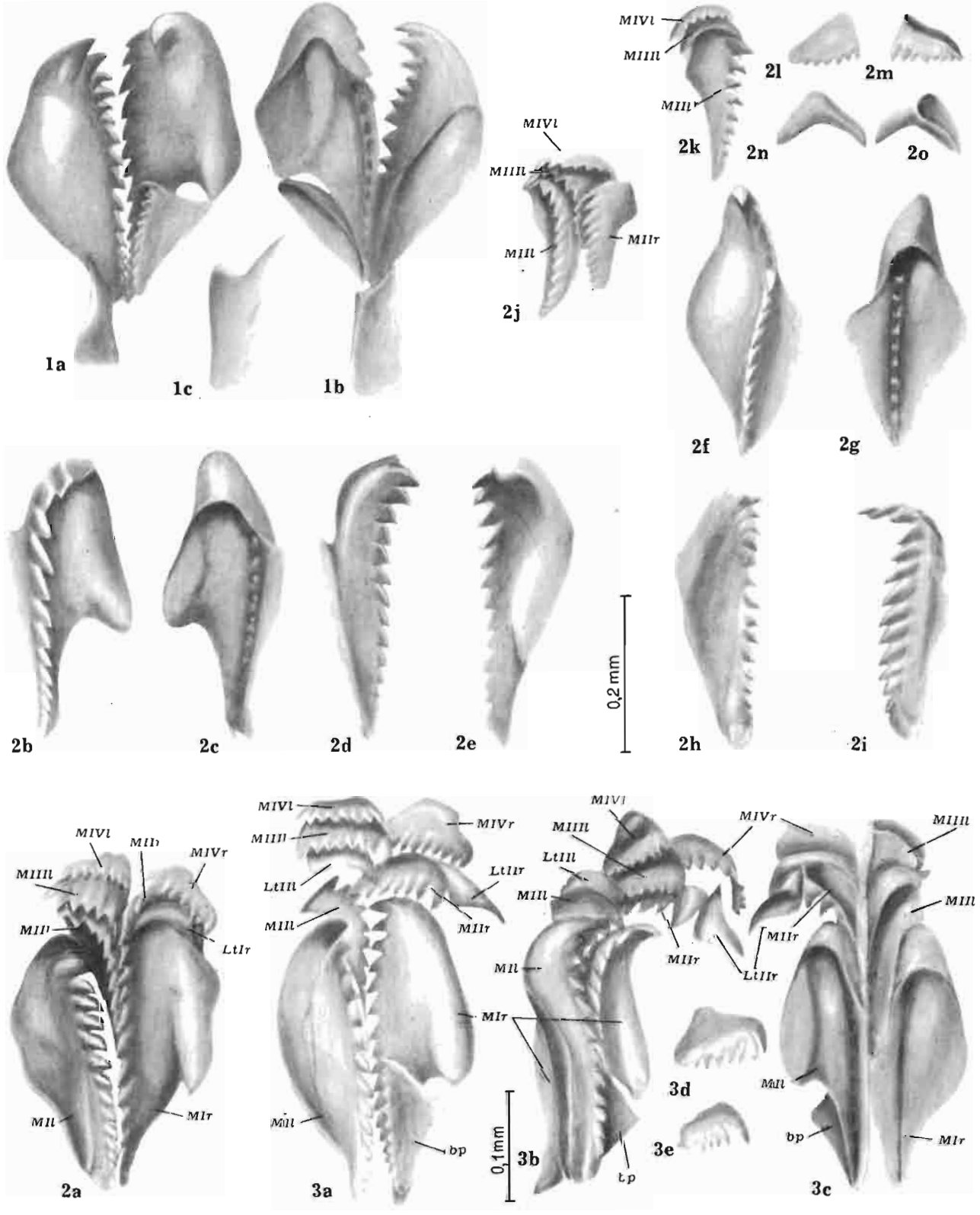
PLATE XVIII

Fig. 1. Incomplete jaw apparatus (cr, bp, MIr, MII): *a* dorsal view (right carrier separated), *b* ventral view, *c* separated left carrier in ventral view. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.470/2).

Fig. 2. Incomplete jaw apparatus (MIr, MII, MIIr, MIII, MIIII, MIVr, MIVl, right LtI): *a* the apparatus in dorsal view; *b-o* individual jaws of the same apparatus, intentionally separated, after the apparatus (Fig. 2*a*) was drawn: *b-e* right MI in dorsal, ventral, left lateral and right lateral views, *f-i* left MI in dorsal, ventral, left lateral and right lateral views, *j-k* anterior jaws in dorsal and left lateral views, *l-m* right MIV in dorsal and ventral views, *n-o* right LtI in two views. Rewal, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.391/2).

Fig. 3. Incomplete jaw apparatus, type specimen (bp, MIr, MII, MIIr, MIII, MIIII, MIVr, MIVl, right and left LtII). Anterior jaws of the apparatus are strongly bent upwards, what is well seen on Fig. 3*b*: *a* dorsal view, *b* left lateral view, *c* ventral view, *d* isolated right MIV, *e* isolated left MIV of the same apparatus. Locality and horizon — as Fig. 2 (Z. Pal. No. O.391/3).

Figs. 1 and 2 — in the same scale.



E. Gadomska, del.

PLATE XIX

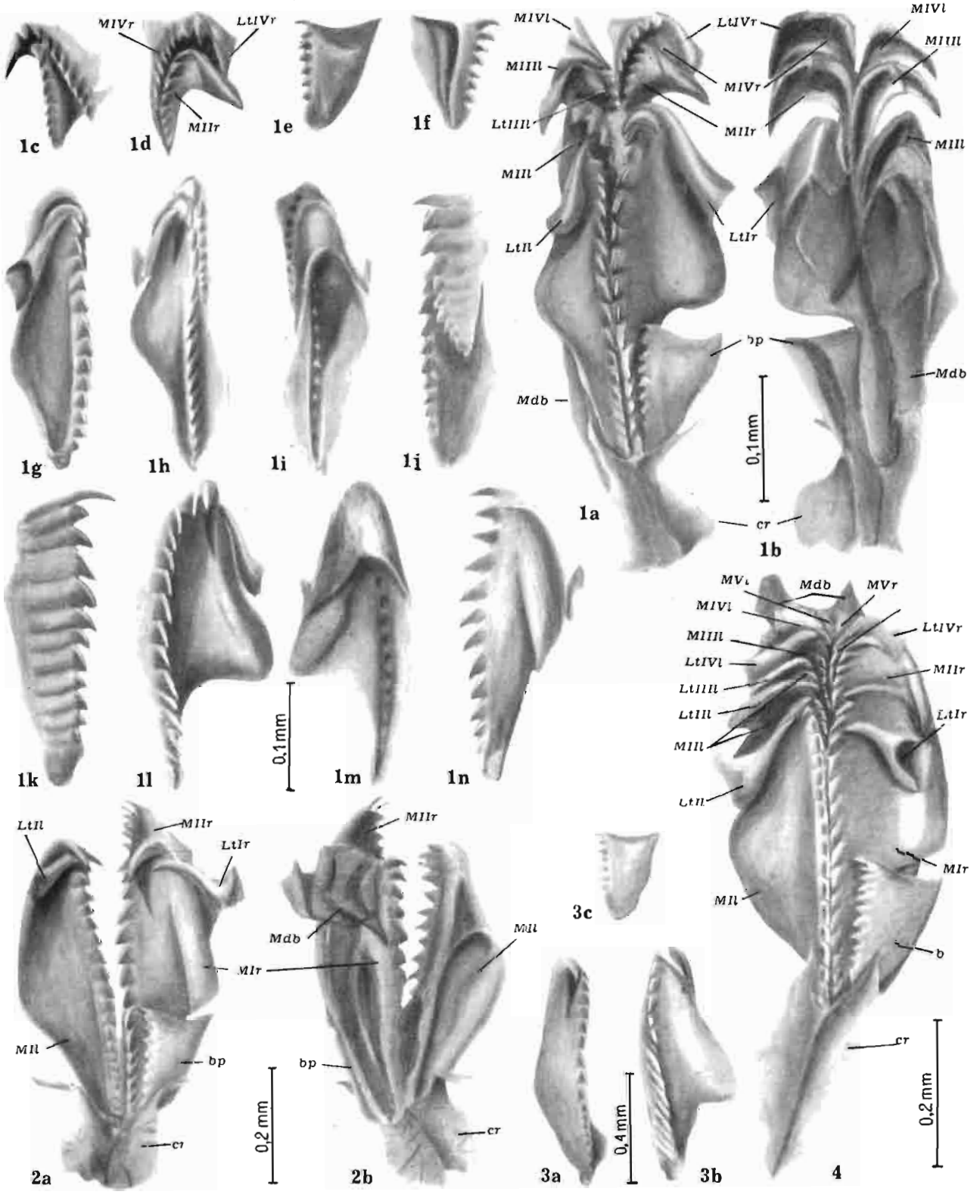
Fig. 1. Almost entire jaw apparatus — type specimen (cr, bp, MIr, MII, MIII, MIIII, MIVr, MIVl, LtIr and LtIVr, LtIl and LtIIIl, fragmentary mandibles): *a-b* entire apparatus in dorsal and ventral views; *c-n* individual jaws of the same apparatus, separated after entire apparatus was drawn: *c* left MIII and MIV in dorsal view, *d* right MII and MIV in dorsal view, *e-f* basal plate in dorsal and ventral views, *g-j* left MI, MII and left LtI in left lateral, dorsal, ventral and right lateral views, *k-n* right MI and right LtI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/239).

Fig. 2. Incomplete jaw apparatus (cr, bp, MIr, MII, MIIr-in unnatural position, right and left LtI, fragmentary mandibles): *a* dorsal view, *b* ventral view. Locality and horizon — as Fig. 1 (Z. Pal. No. O.400/188).

Fig. 3*a-c*. Compressed right and left MI and basal plate, previously joined, in dorsal view. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/23).

(see also Plate XIII, figs. 1-3)

Fig. 4. Almost complete jaw apparatus (cr, bp, MIr, MIIr, MIVr, MII, MIII, MIIII, MIVl, right lateral teeth LtI, LtIV, left lateral teeth LtI, LtII, LtIII, LtIV, Mdb.), in dorsal view. Mochty, province of Warsaw. Locality and horizon — as Fig. 1 (Z. Pal. No. O.400/175).



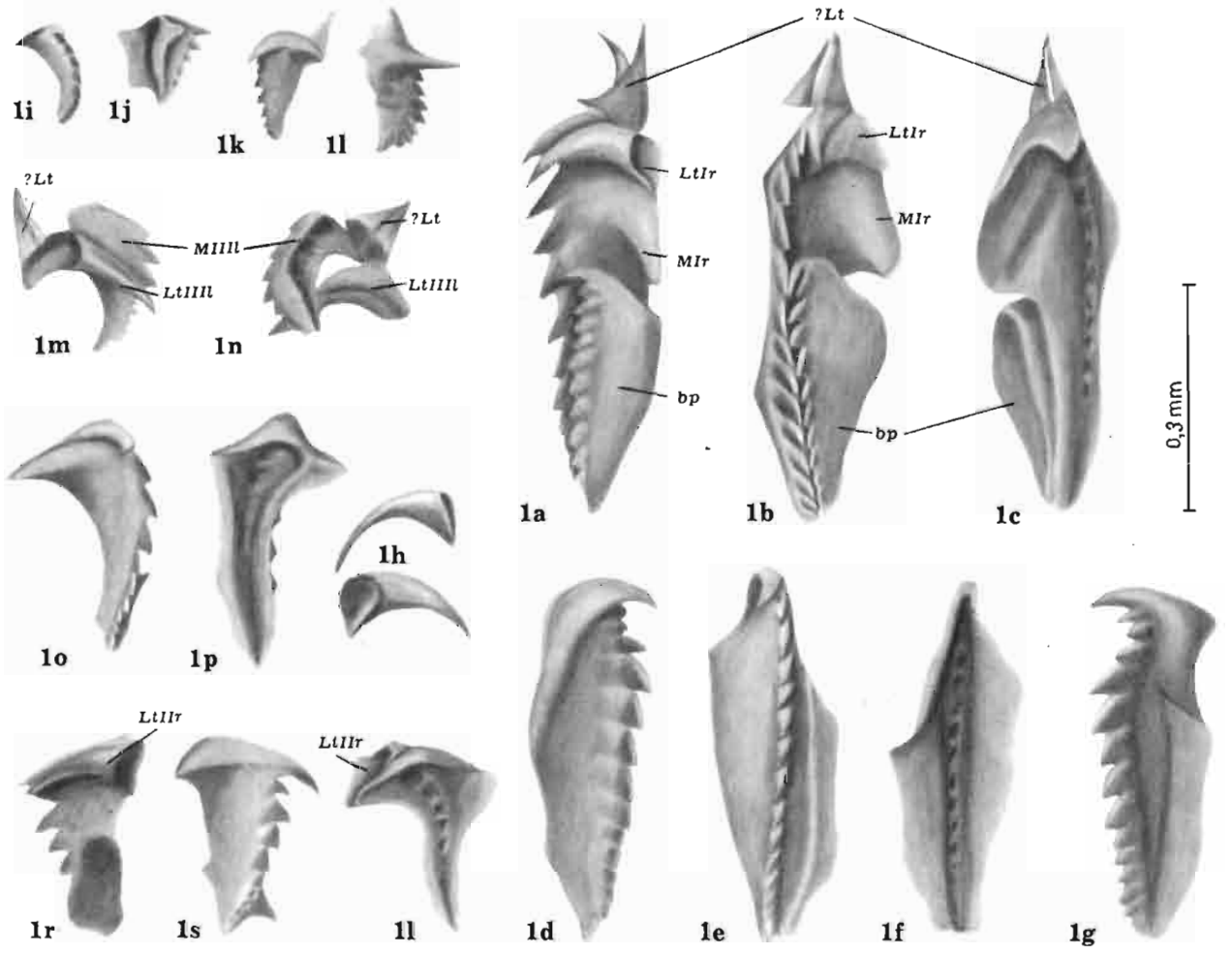
E. Gadomska, del.

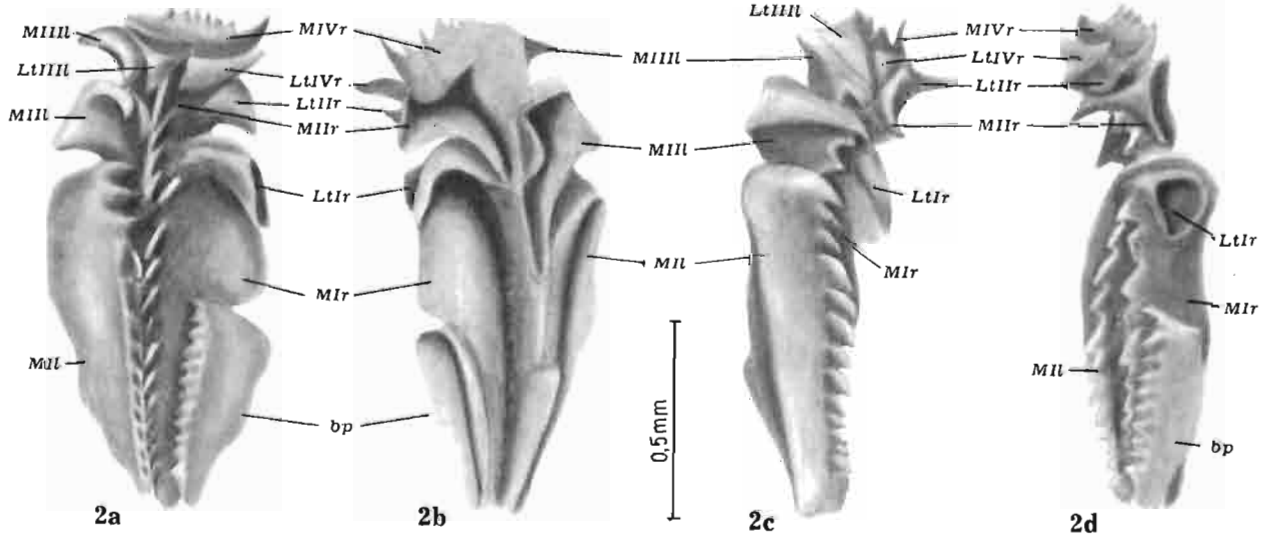
Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XX

Fig. 1. Almost entire jaw apparatus, intentionally separated into parts (bp, MIr, MII, MIIr, MIII, MIIII, MIVr, MIVl, right lateral teeth LtI, LtII and two unidentified additional teeth preserved with right MI, left lateral teeth LtI and LtII and two unidentified teeth, preserved with LtIII): *a-c* basal plate, right MI, LtI and two unidentified lateral teeth, in right lateral, dorsal and ventral views; *d-g* left MI in left lateral, dorsal, ventral and right lateral views; *h* left LtI in two views, *i-j* left MIV in dorsal and ventral views, *k-l* right MIV in dorsal and left lateral views; *m-n* left MIII, associated with LtIII and two unidentified lateral teeth, in dorsal and ventral views; *o-p* left MII in dorsal and ventral views, *r-t* right MII associated with LtII, in dorsal, left lateral and ventral views. Mochty, province of Warsaw; erratic boulder of ?Silurian age (Z. Pal. No. O.187/2).

Fig. 2. Almost entire apparatus — type specimen (bp, MIr, MII, MIIr, MIII, MIIII, MIVr — in unnatural position, right LtI, LtII and LtIV, left LtIII): *a-d* the apparatus in dorsal, ventral, left lateral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.187/1).





E. Gadomska, del.

PLATE XXI

Fig. 1*a-d*. Left MI in dorsal, ventral, left lateral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/113).

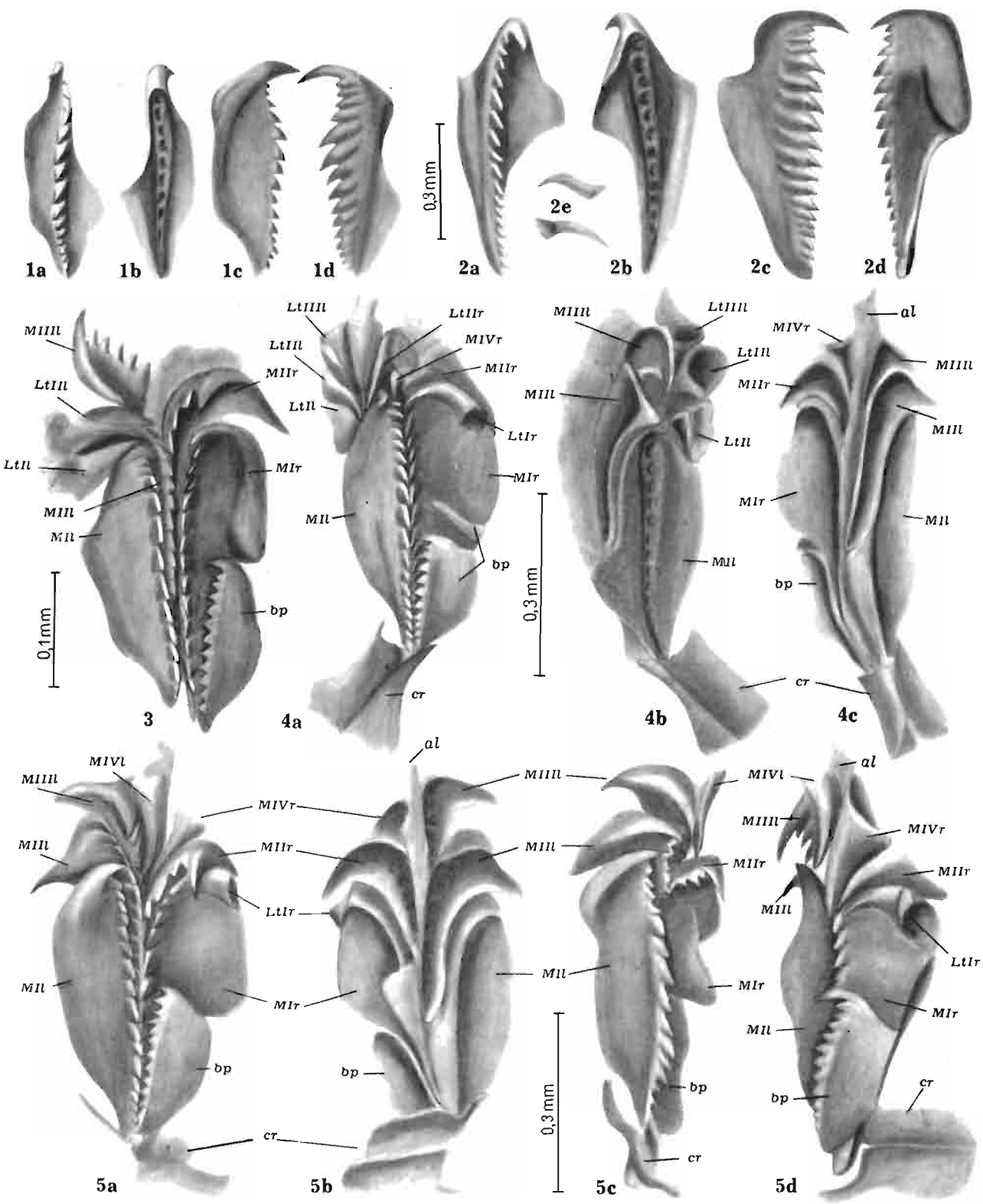
Fig. 2*a-d*. Right MI in dorsal, ventral, left lateral and right lateral views; *e* right LtI of the same apparatus, in two views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/114).

Fig. 3. Incomplete jaw apparatus in dorsal view (bp, MIr, MIl, MIIr, MIIl, MIIIl — in unnatural position, left LtI, LtII). Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.472/2).

Fig. 4. Almost entire apparatus with anterior part of the basal plate broken off and imitating intercalary tooth (cr, bp, MIl, MIr, MIIr, MIIl, MIIIl, MIVr, right LtI, LtII, left LtI, LtII, LtIII): *a* dorsal view, anterior jaws are in this view partly hidden under left lateral teeth; *b* left ventral view, showing large openings of lateral teeth; *c* ventral view. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/67).

Fig. 5. Almost entire apparatus — type specimen (cr, bp, MIr, MIl, MIIr, MIIl, MIIIl, MIVr, MIVl and right LtI). Carriers preserved in unnatural position: *a* dorsal view, only the first large denticles of right MIV and left MIV are visible in this view; *b* ventral view, left MIV is hidden under the large attachment lamella; *c* left lateral view; *d* right lateral view. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/32).

Figs. 1 and 2 — in the same scale



E. Gadomska, del.

Palaeontologia Polonica, No. 16, 1966

PLATE XXII

(see also Plate XXIII, figs. 3-7)

Fig. 1*a-b*. Incomplete jaw apparatus with left anterior jaws in abnormal position (bp, MIr, MIIr, MIII, MIIII, MIVl, MVl) in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/14).

Fig. 2*a-b*. Incomplete jaw apparatus, in dorsal and ventral views (bp, MIr, MIl, MIII, MIIII, MIVl). Mochty, province of Warsaw; erratic boulder of Middle Ordovician age, ?Kukruse Stage (Z. Pal. No. O.182/12).

Fig. 3. Almost entire apparatus (cr, MIr, MIl, MIIr, MIII, MIIII, MIVl, MVl, Mdb): *a* the apparatus in dorsal view; *b* separated left side of the same apparatus without carriers, in dorsal view, showing the mandibles; *c* the same in ventral view; *d-e* isolated right side of the same apparatus with carriers, in ventral and dorsal views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.400/195).

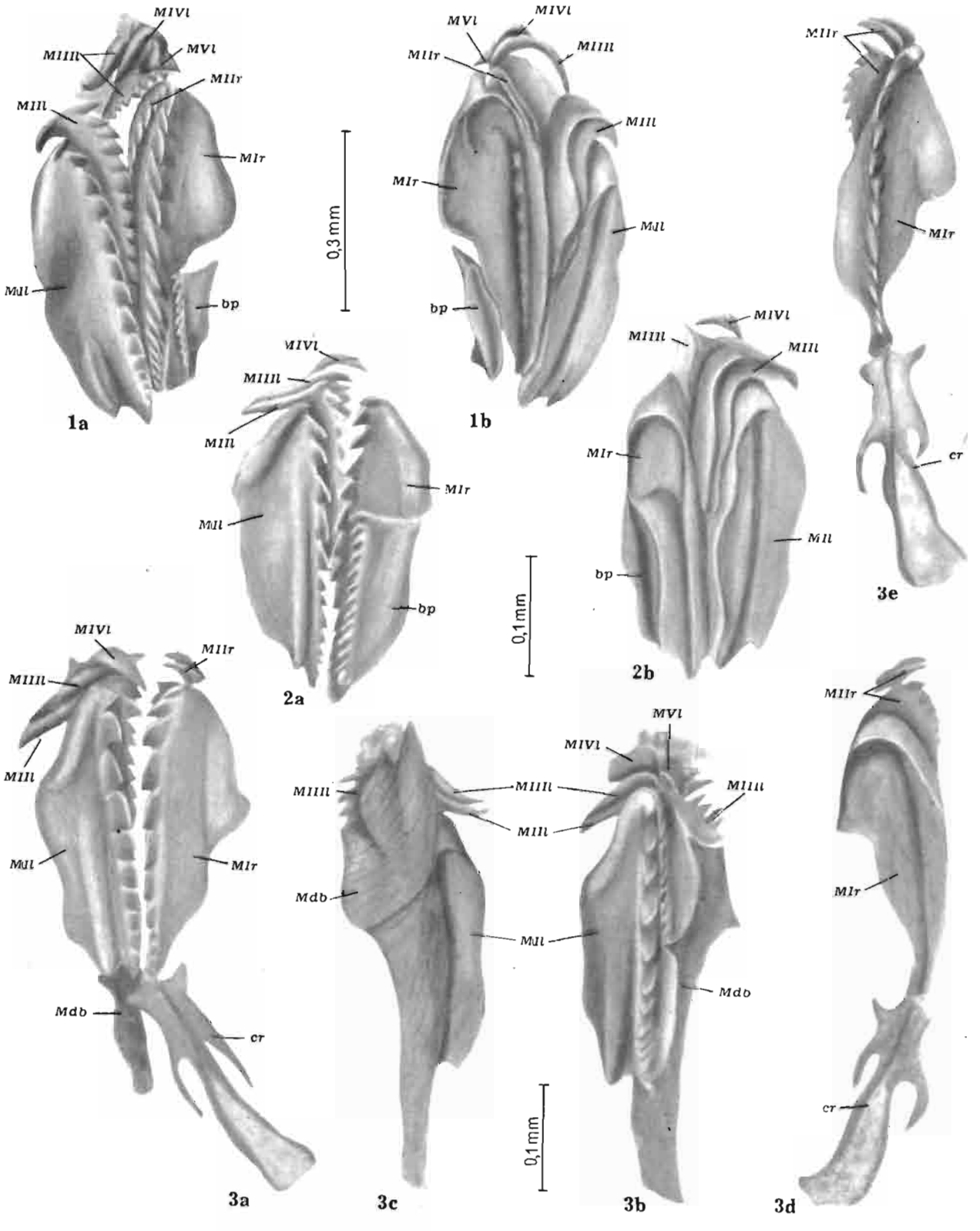


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PLATE XXIII

Page

"Polychaetura" sp. *a* 105

Fig. 1*a-d*. Left MI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/89).

Fig. 2*a-b*. Left MI in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.366/63).

Polychaetura gracilis KOZŁOWSKI 103

(see also Plate XXII)

Fig. 3*a-d*. Left MI in left lateral, dorsal, ventral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/92).

Fig. 4*a-d*. Right MI in left lateral, dorsal, ventral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/93).

Fig. 5. Nearly entire jaw apparatus (bp, MIr, MIl, MIIl, MIIIl, MIVl, MVl, fragmentary MIIr, fragmentary MIVr): *a* the apparatus without the basal plate and right anterior jaws in dorsal view; *b* the same in ventral view; *c* anterior jaws of the same specimen, from above; *d-e* fragmentary right anterior jaws of the same specimen, in dorsal and ventral views; *f-g* basal plate of the same specimen, in dorsal and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/3).

Fig. 6*a-b*. Right MI and the right mandible, in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/52).

Fig. 7*a-b*. Incomplete jaw apparatus (bp, MIr, MIl, MIIr, MIIl), in dorsal and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/19).

Figs. 1, 2, 3 and 4 — in the same scale

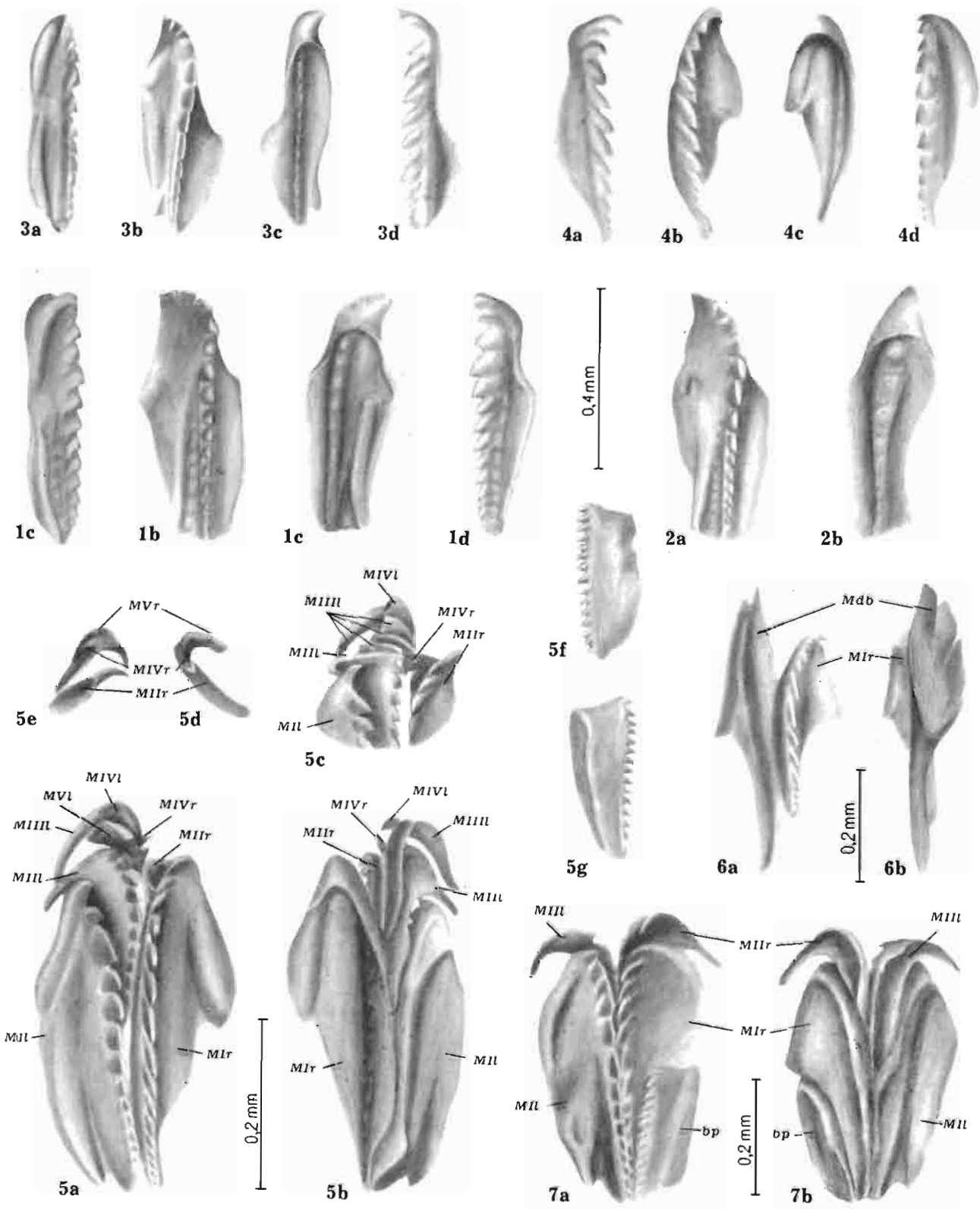

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PLATE XXIV

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Ramphoprion urbaneki n. sp. 109

Fig. 1*a-d*. Right MI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/68).

Fig. 2*a-d*. Left MI in left lateral, dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/108).

Fig. 3. Incomplete jaw apparatus — type specimen (cr, MIr, MII, MIIr, MIII), carriers and MIIr in unnatural positions: *a* dorsal view, *b* ventral view. Locality and horizon — as Fig. 2 (Z. Pal. No. O.469/30).

Ramphoprion sp. *b* 111

Fig. 4*a-d*. Left MI in left lateral, dorsal, ventral and right lateral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.469/97).

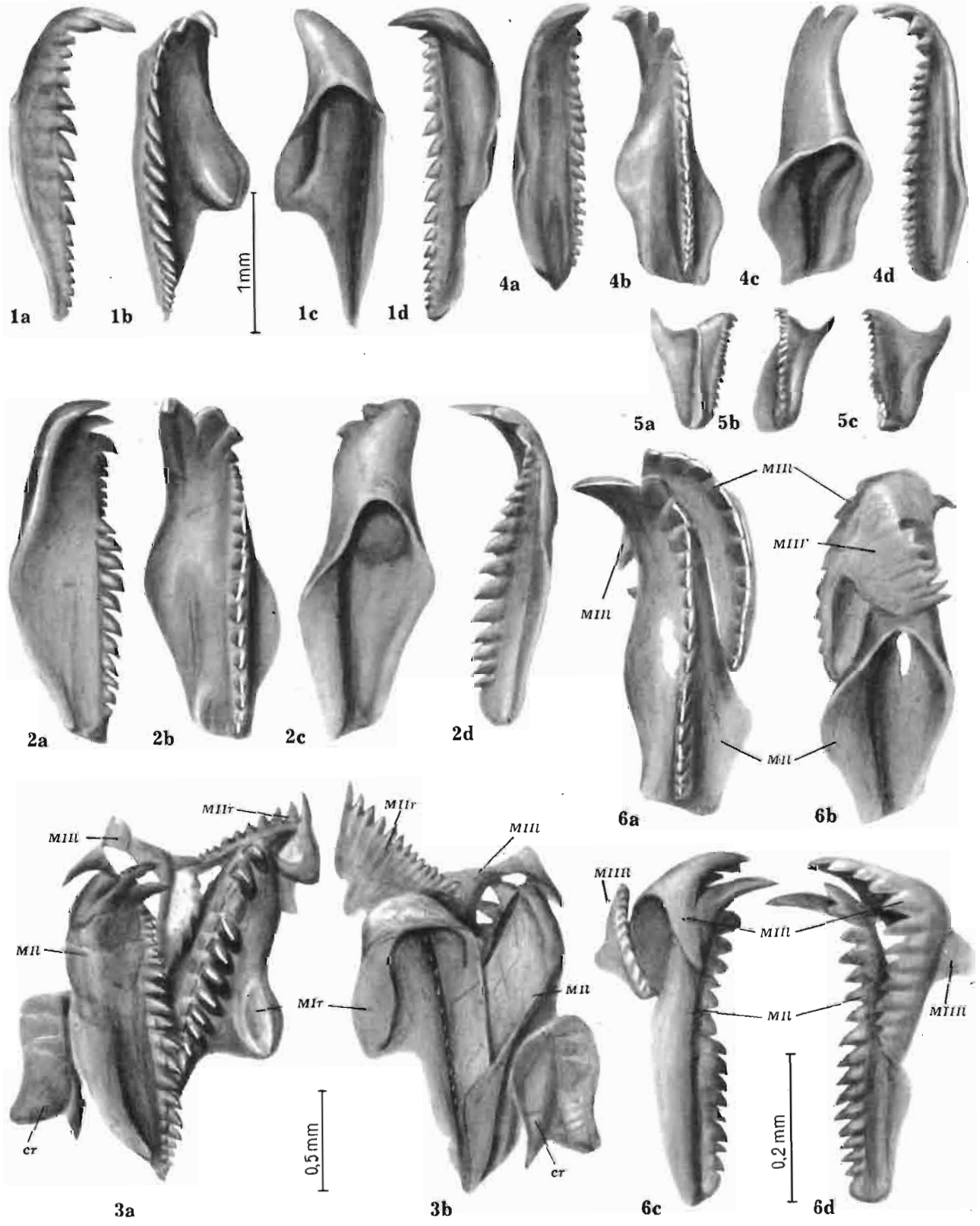
Ramphoprion sp. *c* 111

Fig. 5*a-c*. Basal plate in ventral, left lateral and dorsal views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.182/66*a*).

Ramphoprion sp. *a* 110

Fig. 6*a-d*. Incomplete left side of an apparatus (MII, MIII, MIIII — in unnatural position) in dorsal, ventral, left lateral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.182/18).

Figs. 1, 4 and 5 — in the same scale
Figs. 2 and 3 — in the same scale



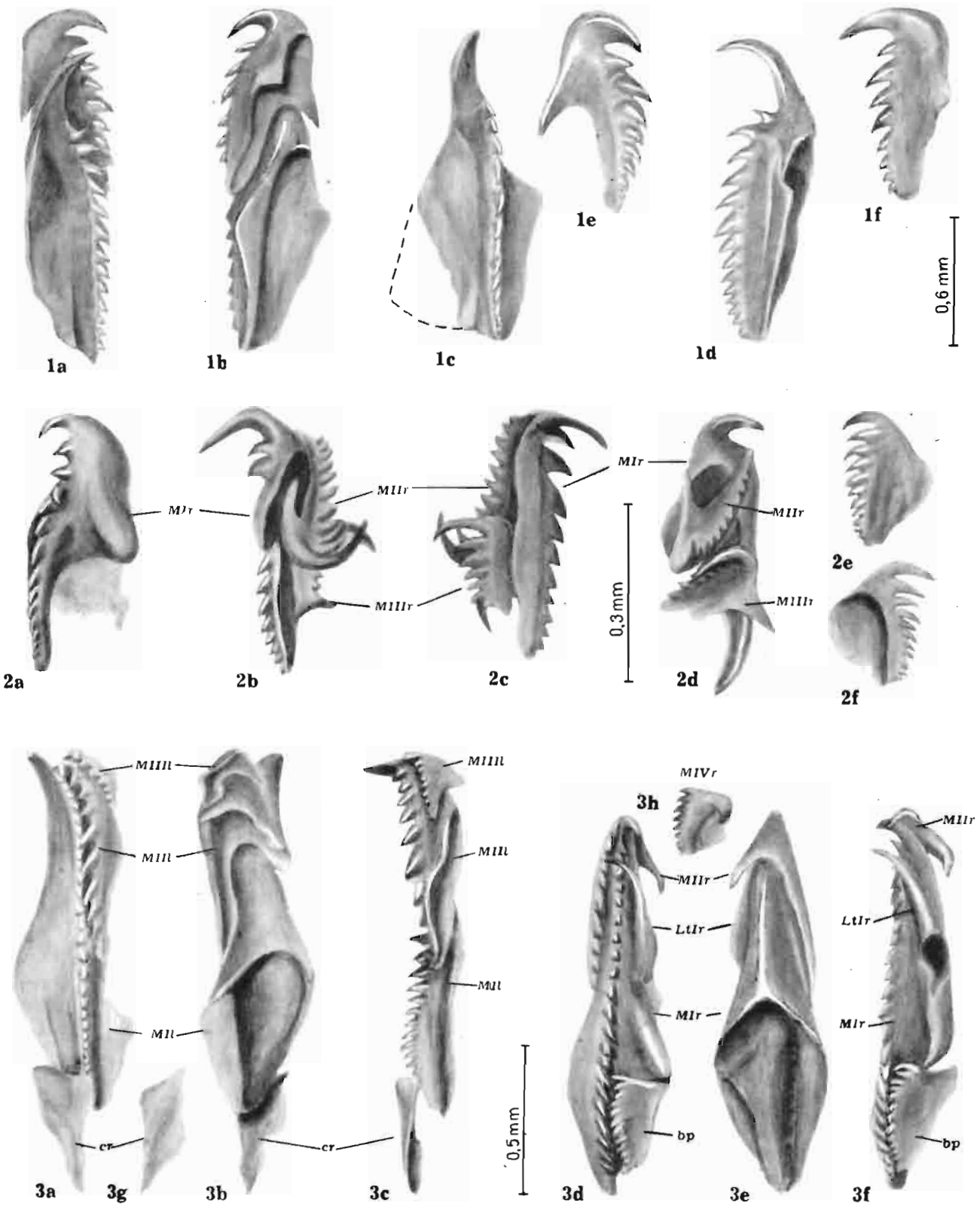
E. Gadomska, del.

PLATE XXV

Fig. 1*a-b*. Joined left MI and MII in ventral, left lateral and right lateral views; *c-d* left MI of the same apparatus, in dorsal and left lateral views; *e-f* left MII of the same apparatus in left lateral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/34).

Fig. 2*a-d*. Right MI with right MII and right MIII preserved on the ventral side in abnormal position, in dorsal, right lateral, left lateral and ventral views; *e-f* basal plate of the same apparatus, in dorsal and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.469/35).

Fig. 3*a-h*. Type specimen figured by KIELAN-JAWOROWSKA, 1962, Plate 8, separated intentionally into parts: *a-c* left side of the apparatus, in dorsal, ventral and right lateral views; *d-f* right side of the apparatus, in dorsal, ventral and right lateral views; *g* isolated right carrier, in dorsal view; *h* isolated right MIV, in dorsal view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Keila Stage (Z. Pal. No. O.398/1).



E. Gadomska, del.

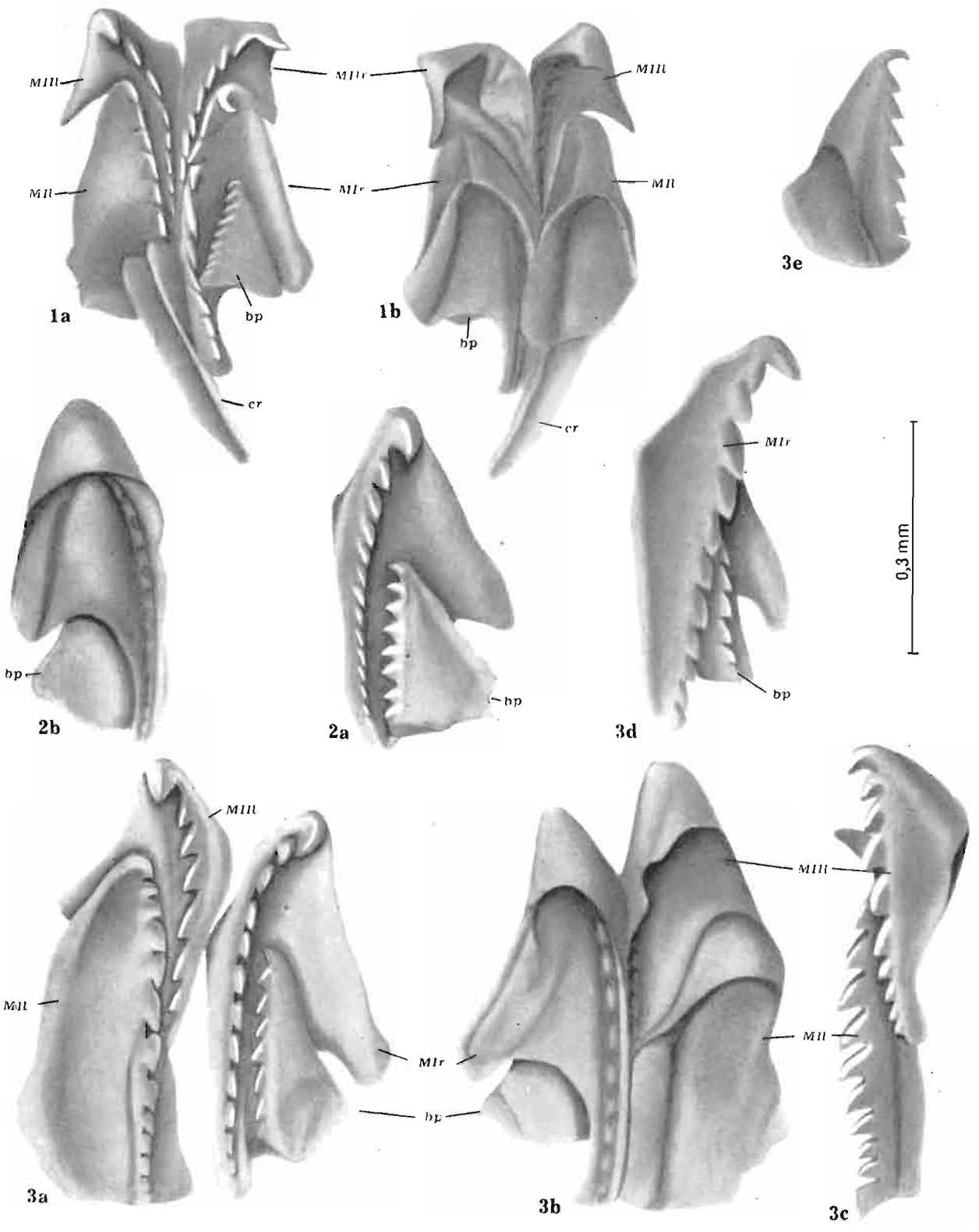
Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XXVI

Fig. 1*a-b*. Incomplete jaw apparatus (cr, bp, MIr, MII, MIIr, MIII), in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Keila Stage (Z. Pal. No. O.398/3).

Fig. 2*a-b*. Right MI and basal plate, in ventral and dorsal views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/18).

Fig. 3. Incomplete jaw apparatus (bp, MIr, MII, MIII), separated into two parts: *a-b* right and left sides, in dorsal and ventral views; *c* left side, in right lateral view; *d* right side, in left lateral view; *e* isolated basal plate of the same apparatus, in ventral view. Locality and horizon — as Fig. 1. Type specimen (Z. Pal. No. O.398/4).



E. Gadomska, del.

PLATE XXVII

Fig. 1. Type specimen, almost entire apparatus (bp, MIr, MIl, MIIr, MIIl, MIIIl, MIVr, MIVl, MVr): *a-c* anterior jaws, in dorsal, right lateral and ventral views; *d-e* basal plate and right and left MI of the same specimen, in ventral and dorsal views. Wyszogród-Zakroczym, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.142/1).

Fig. 2*a-c*. Right MI in right lateral, dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/43).

Fig. 3*a-b*. Type specimen. Incomplete jaw apparatus (bp, MIr, MIl, MIIl, MIIIr, MIIIl), in dorsal and ventral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.182/4).

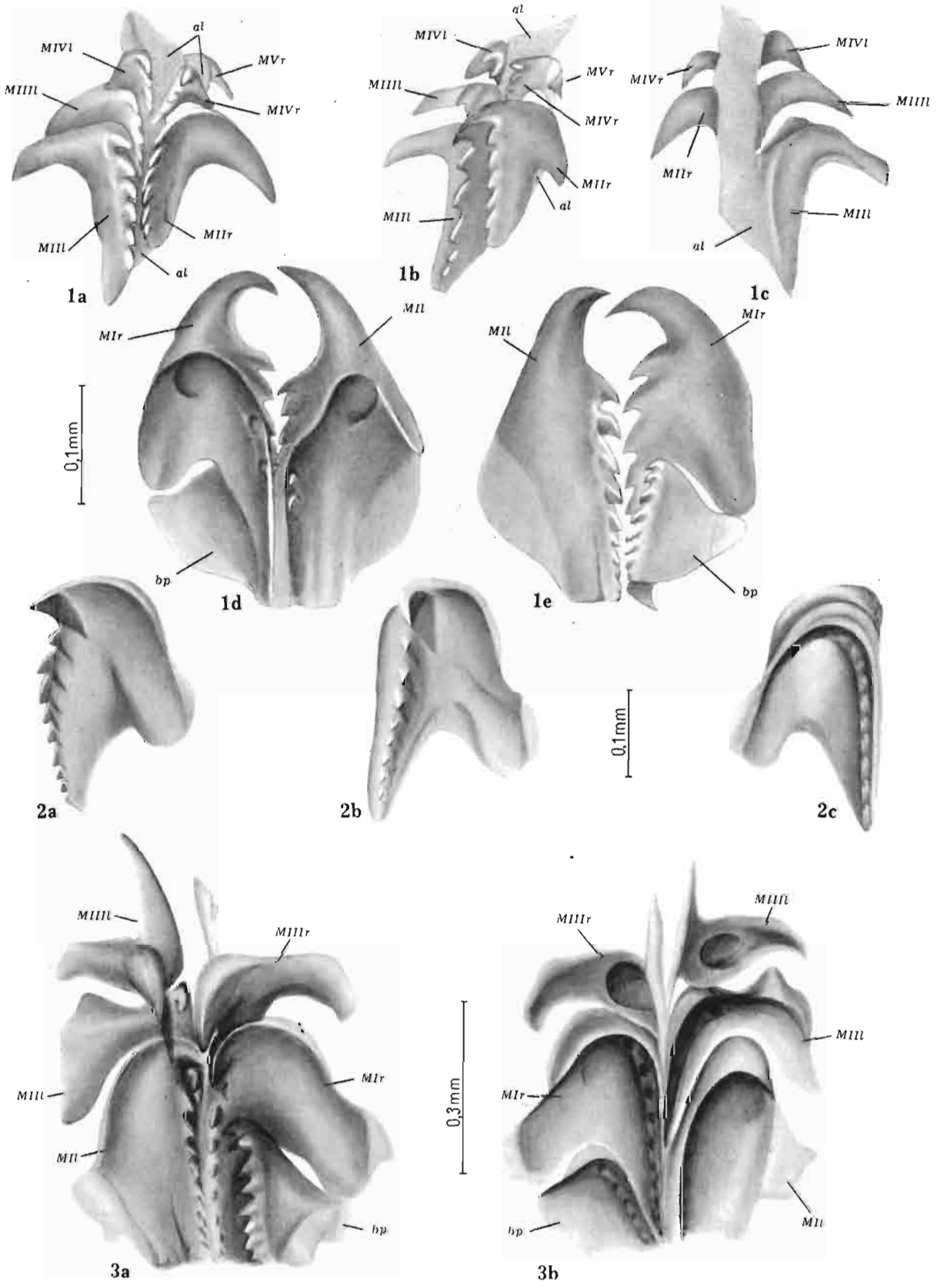


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PLATE XXVIII

Page

Euryprion sp. *a* 124

Fig. 1*a-d*. Right MI in dorsal, right lateral, ventral and left lateral views. Wyszogród-Zakroczym, province of Warsaw; erratic boulder of unknown age — ?Ordovician (Z. Pal. No. O.139/6).

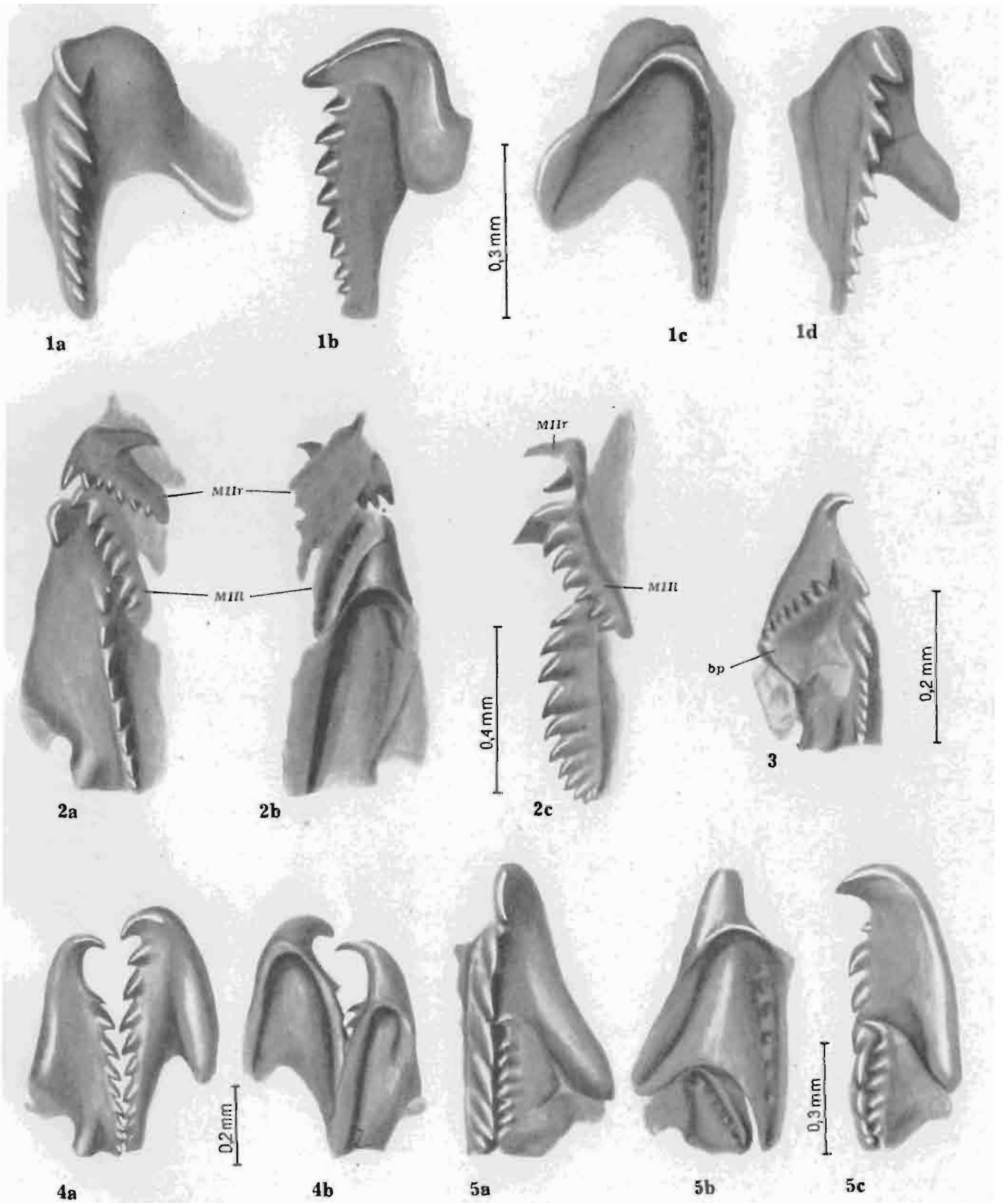
Leptoprion artus n. sp. 120

Fig. 2*a-c*. Incomplete left side (MII, MIII and MIIr), in dorsal, ventral and right lateral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/36).

Fig. 3. Left MI and basal plate, in dorsal view. Locality and horizon — as Fig. 2 (Z. Pal. No. O.469/73*a*).

Fig. 4*a-b*. Type specimen, right and left MI joined together, in dorsal and ventral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.469/56).

Fig. 5*a-c*. Right MI and basal plate, in dorsal, ventral and right lateral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.469/55).



E. Gadomska, del.

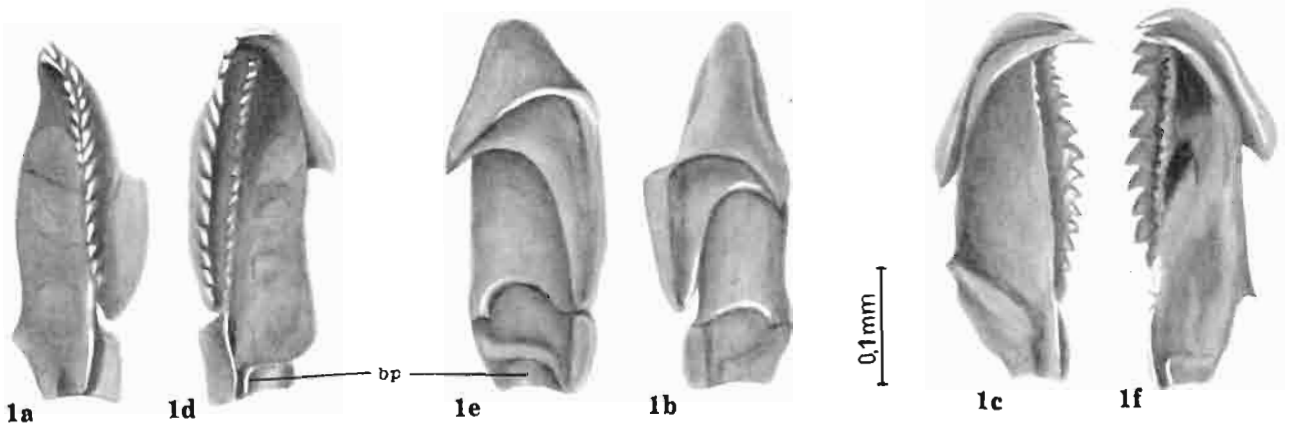
PLATE XXIX

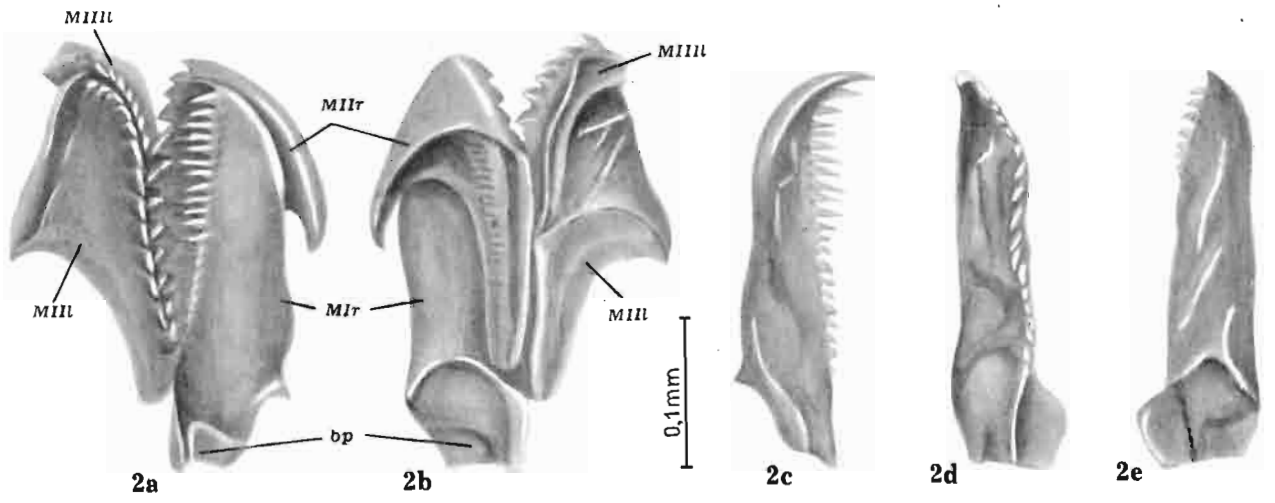
(see also Plate XXX, figs. 7-8)

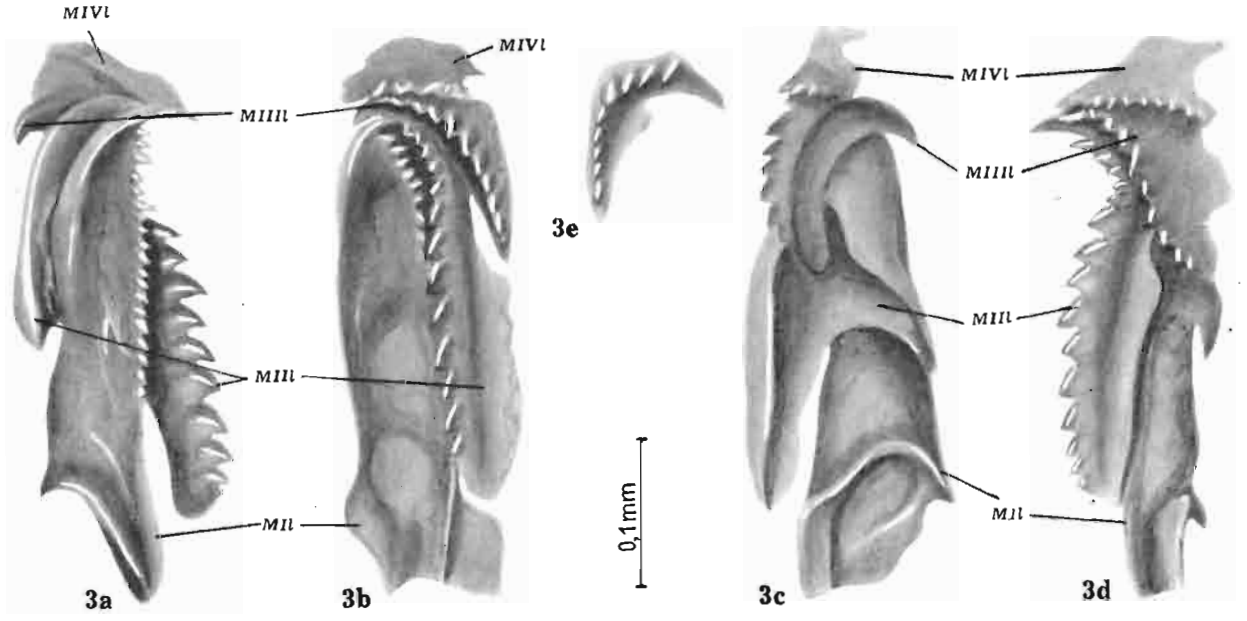
Fig. 1. Incomplete jaw apparatus somewhat damaged, with the openings of pulp cavities partly covered by a coat of a silicate: *a-c* isolated left side of the apparatus (MIl, MIIl), in dorsal (somewhat right lateral), ventral and left lateral views; *d-f* isolated left side of the same apparatus (bp, MIr, MIIr), in dorsal (somewhat left lateral), ventral and right lateral views. Ustka, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.439/1).

Fig. 2*a-b*. Incomplete jaw apparatus — type specimen (bp, MIr, MIIl, MIIIl and MVr), in dorsal and ventral views; *c-e* left MI of the same apparatus in left lateral, dorsal and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.439/3).

Fig. 3*a-d*. Left side of the apparatus (MIl, MIIl, MIIIl, MIVl), in left lateral, dorsal, ventral and right lateral views; *e* right MIV of the same apparatus. Rewal, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.391/23).







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Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XXX

Page

Langeites glaber n. sp. 131

Fig. 1*a-c*. Left MI in left lateral, dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.466/13*a*).

Fig. 2*a-c*. Right MI with basal plate — type specimen, in ventral, dorsal and left lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.466/13*b*).

Fig. 3. Left MI (with broken inner wing), in dorsal view. Mochty, province of Warsaw; erratic boulder of Silurian age — Ludlow (Z. Pal. No. O.410/12*a*).

Fig. 4. Right MI in dorsal view. Locality and horizon — as Fig. 3 (Z. Pal. No. O.410/12*b*).

Paulinites gladiatus n. sp. 129

Fig. 5*a-c*. Left MI in dorsal, ventral and left lateral views. Międzyzdroje, Baltic coast; erratic boulder of ?Silurian age (Z. Pal. No. O.308/14*a*).

Fig. 6*a-c*. Right MI — type specimen, in ventral, dorsal and left lateral views. Locality and horizon — as Fig. 5 (Z. Pal. No. O.308/14*b*).

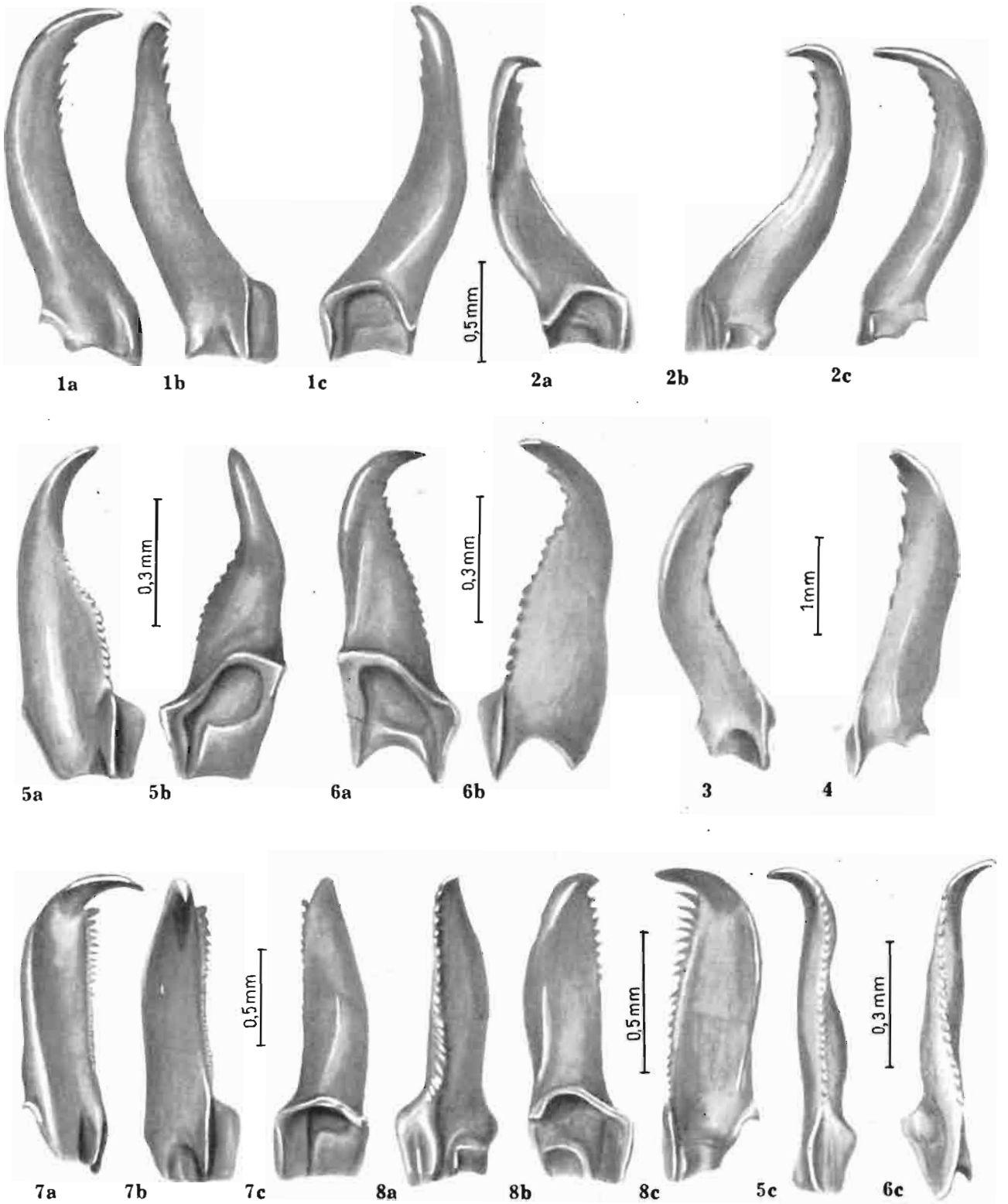
Paulinites polonensis n. sp. 126

(see also Plate XXIX)

Fig. 7*a-c*. Left MI in left lateral, dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of ?Silurian age (Z. Pal. No. O.187/24*a*).

Fig. 8*a-c*. Right MI in left lateral, ventral and dorsal views. Locality and horizon — as Fig. 7 (Z. Pal. No. O.187/24*b*).

Figs. 1 and 2 — in the same scale
Figs. 3 and 4 — in the same scale
Figs. 5 and 6 — in the same scale



L. Gadomska, del.

Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XXXI

Page

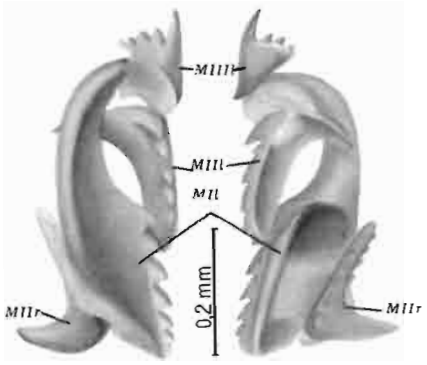
Atraktoprion ?cornutus KIELAN-JAWOROWSKA 134

Fig. 1. Incomplete left side of the jaw apparatus (MIl, MIIl, MIIIl), with MIIr preserved upside down along the pulp cavity of the left MI: *a* dorsal view, *b* ventral view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/42).

Atraktoprion cornutus KIELAN-JAWOROWSKA 133

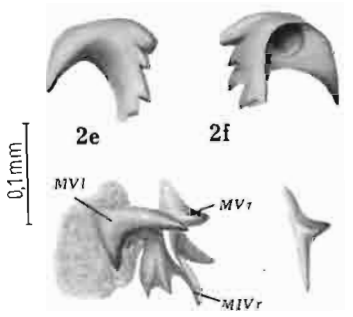
Fig. 2. Entire jaw apparatus with MI preserved in abnormal position, basal plate fasten to the dorsal surface of the MIl, MIIIl, partly hidden below the MIIl: *a-c* maxillary apparatus as originally preserved, in three different views; *d* broken carriers of the same apparatus, in the same scale; *e-h* most anterior jaws of the same apparatus, in larger magnification, isolated after they were drawn in entire apparatus; *e-f* MIIIl in dorsal and ventral views; *g* MIVr, MVr and MVl in left lateral view; *h* detached MVl. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.366/2).

Fig. 3. Entire jaw apparatus with carriers somewhat broken off, preserved along the dorsal side of the left MI: *a* dorsal view, *b* ventral view, *c* anterior part of the apparatus in top view. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.469/22).

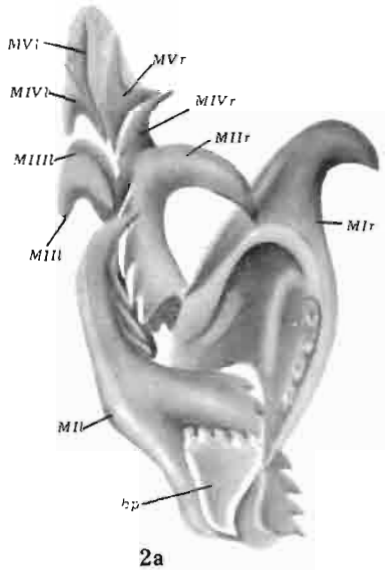


1a 1b

2d



2e 2f 2g 2h



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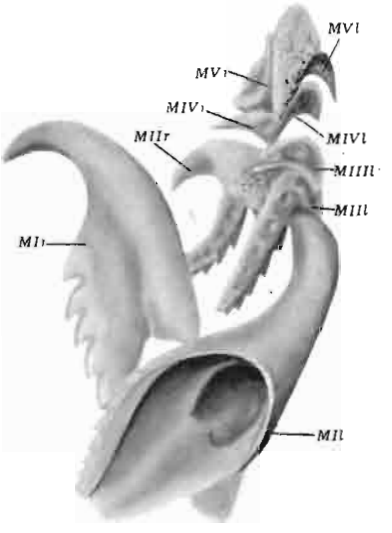

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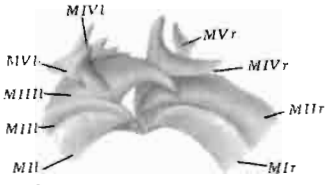

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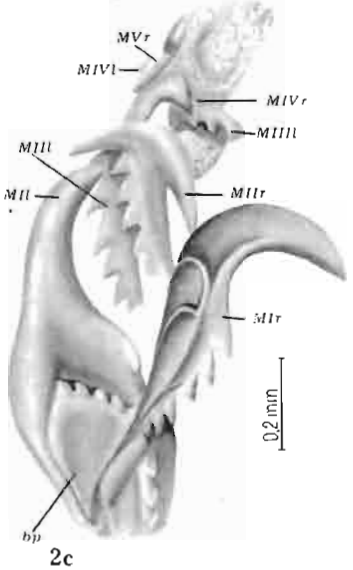

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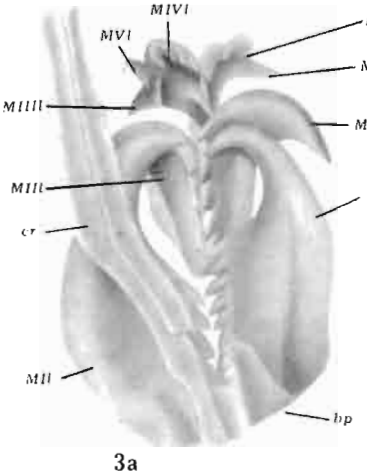

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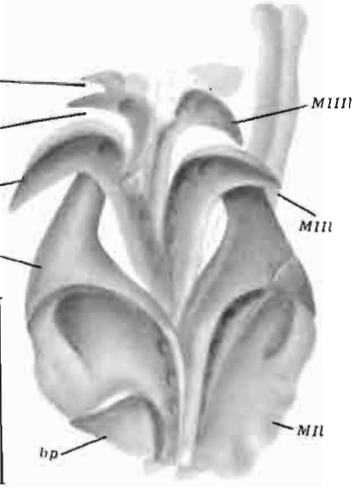

3b

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PLATE XXXII

Page

Atraktoprion sp. *b* 138

Fig. 1*a-c*. Isolated right MI in dorsal, right lateral and ventral views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Keila Stage (Z. Pal. No. O.398/19).

Fig. 2*a-c*. Isolated right MI in dorsal, ventral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/24).

Atraktoprion mirabilis n. sp. 137

(see also Plate XXXIII)

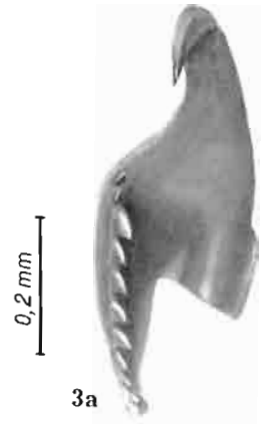
Fig. 3*a-c*. Right MI in dorsal, ventral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/25).

Fig. 4*a-c*. Right MI in dorsal, ventral and right lateral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/23).

1a

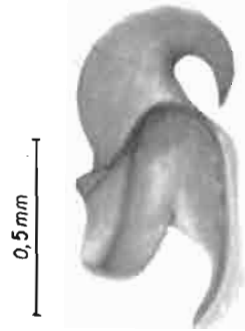
1b

1c



3a

2a



2b

2c

3b

4a

4b

4c

3c

E. Gadomska, del.

PLATE XXXIII

Fig. 1*a-c*. Joined left MI and MII in lateral, dorsal and ventral views (left MII in abnormal position). Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Keila Stage (Z. Pal. No. O.398/21).

Fig. 2*a-c*. Joined right and left MI and MII — type specimen, in dorsal, right lateral and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/8).

Fig. 3*a-d*. Joined left MI and MII, in dorsal, left lateral, right lateral and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/7).

Fig. 4*a-c*. Left MIII in left lateral, right lateral and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.398/20).

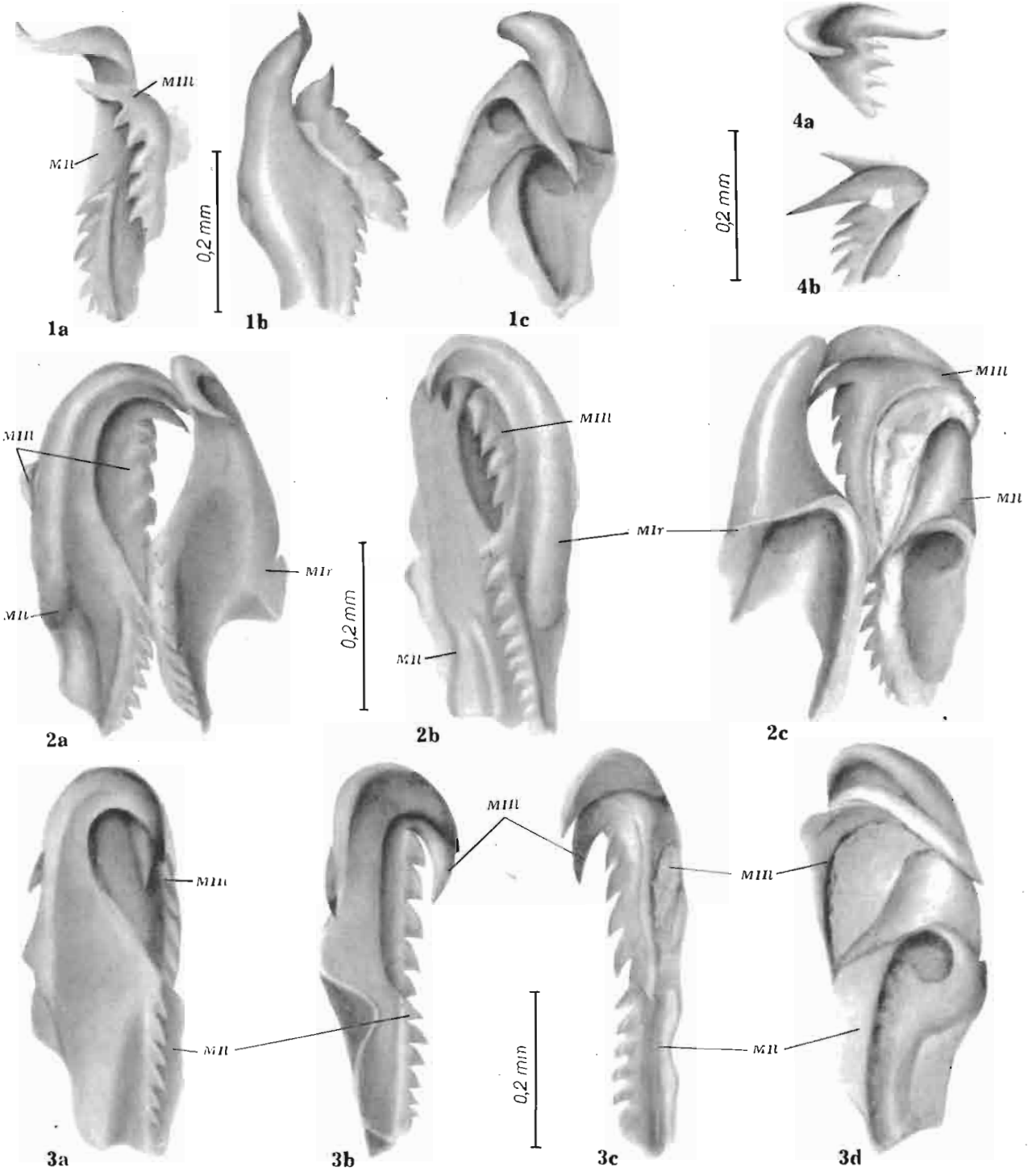


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PLATE XXXIV

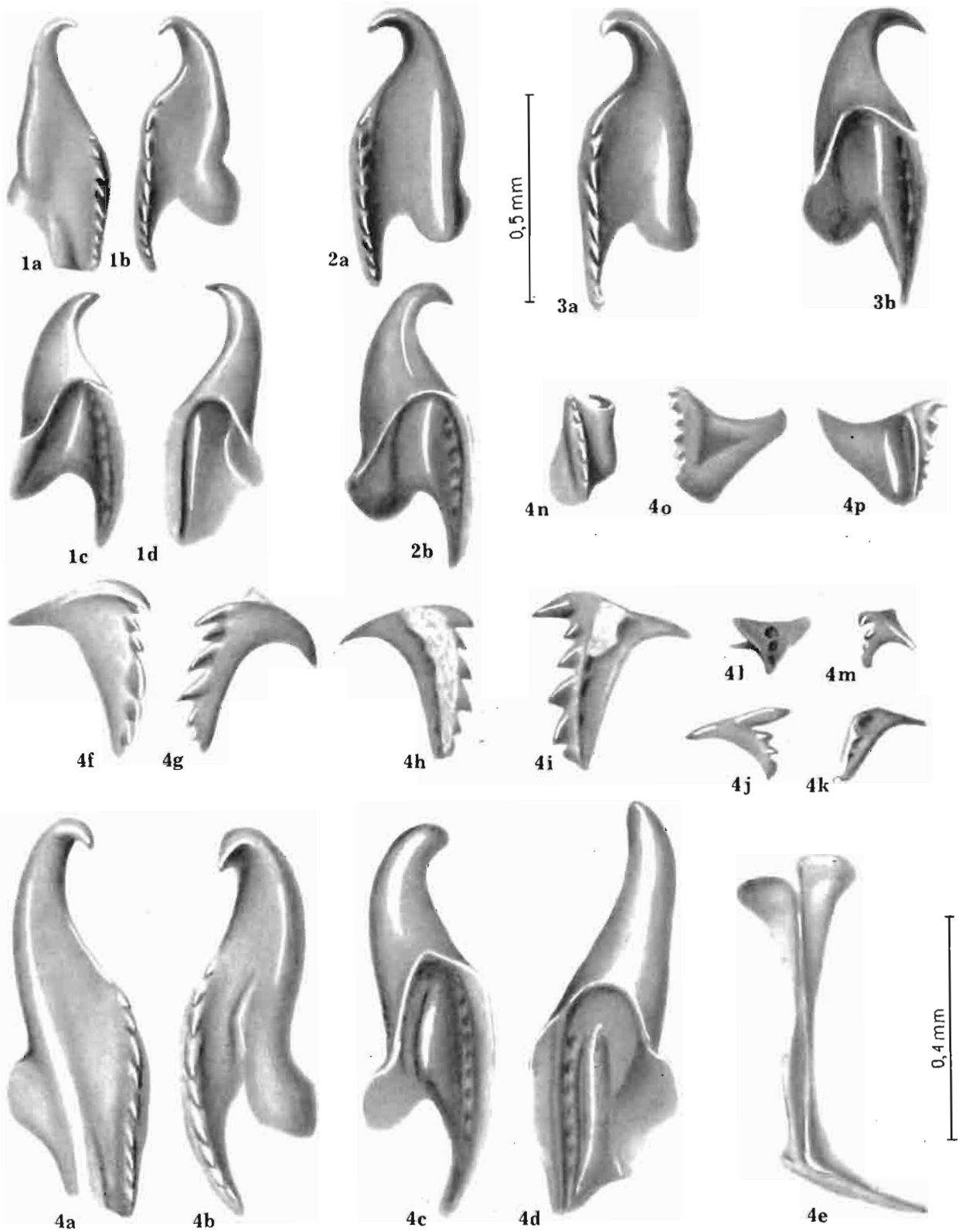
Fig. 1*a-d*. Right and left MI of the same apparatus, in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of unknown age — ?Ordovician (Z. Pal. No. O.319/4*a*).

Fig. 2*a-b*. Right MI in dorsal and ventral views. Mochty, province of Warsaw; erratic boulder of ?Middle Ordovician age (Z. Pal. No. O.472/16*a*).

Fig. 3*a-b*. Right MI in dorsal and ventral views. Locality and horizon — as Fig. 2 (Z. Pal. No. O.472/16*b*).

Fig. 4*a-p*. Almost entire apparatus, separated into individual jaws — type specimen: *a-d* left and right MI, in dorsal and ventral views; *e* damaged carriers; *f-i* left and right MII, in dorsal and ventral views; *j-k* left MIII in dorsal and ventral views; *l-m* right MIV in ventral and dorsal views; *n-p* basal plate in left lateral, dorsal and ventral views. Locality and horizon — as Fig. 1 (Z. Pal. No. O.319/7).

Figs. 1, 2 and 3 — in the same scale



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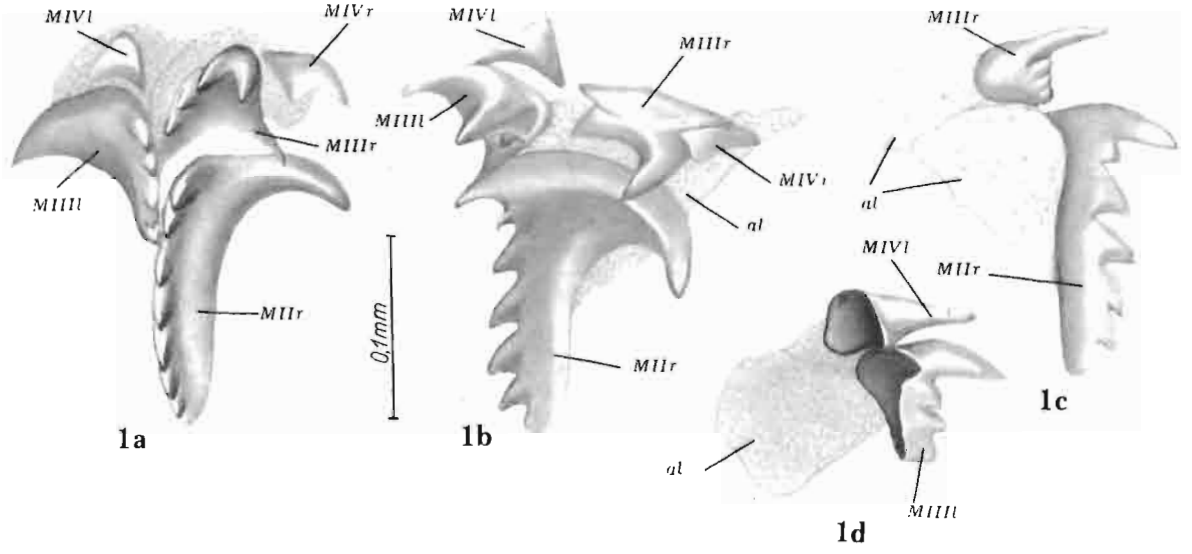
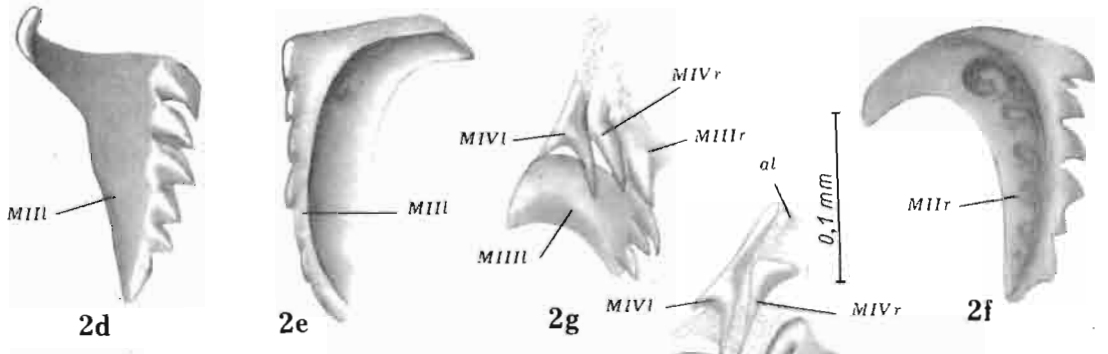
Z. KIELAN-JAWOROWSKA: POLYCHAETE JAW APPARATUSES

PLATE XXXV

Fig. 1. *a* Incomplete anterior part of the jaw apparatus, in dorsal view; *b* the same in right lateral view; *c* isolated right side of the same apparatus, in left lateral view; *d* isolated left jaws of the same apparatus, in ventral-lateral view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/3).

Fig. 2. Incomplete jaw apparatus — type specimen, separated into parts: *a-b* left MI in dorsal and ventral views; *c* anterior jaws in dorsal view, with MIII in abnormal position; *d-e* left MII isolated after it was drawn in the apparatus, in dorsal and ventral views; *f* right MII in ventral view; *g-h* isolated right and left MIII and right and left MIV, in left lateral and dorsal views. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage or Idavere Stage (Z. Pal. No. O.366/23).





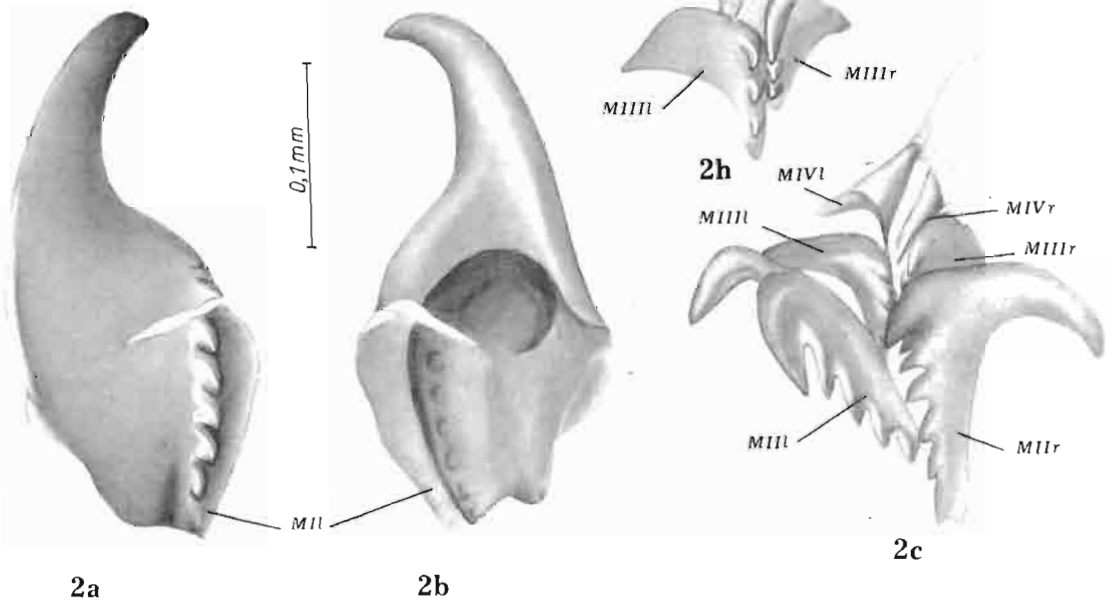


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PLATE XXXVI

Page

Atraktoprion robustus n. sp. 134

Fig. 1. Nearly entire apparatus (without carriers and left MV), separated into parts: *a-b* left side (MII, MIII, MIIII), in ventral and dorsal views; *c-d* basal plate and MIr, in ventral and dorsal views; *e-g* MIVr, MIVl and MVr, in right lateral, top and dorsal views; *h* right MII in right lateral view. Mochty, province of Warsaw; erratic boulder of unknown age — Ordovician or Silurian (Z. Pal. No. O.177/1).

Fig. 2. Basal plate and right MI, in dorsal view. Mochty, province of Warsaw; erratic boulder of Middle Ordovician age — ?Kukruse Stage (Z. Pal. No. O.182/60).

Skalenoprion sp. *b* 144

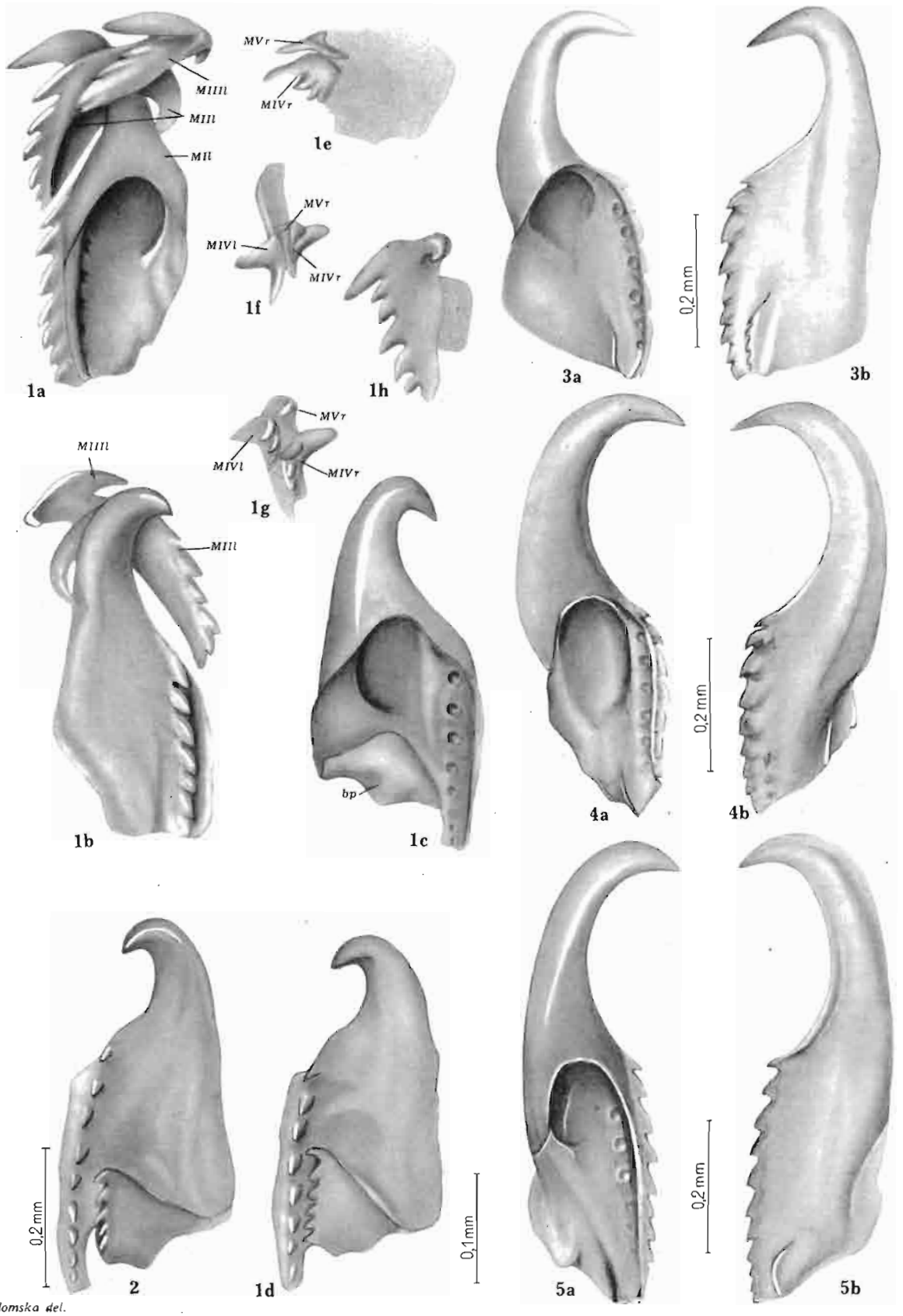
Fig. 3*a-b*. Right MI in ventral and dorsal views. Zakroczym, province of Warsaw; erratic boulder of ?Ordovician age (Z. Pal. No. O.42/1).

Skalenoprion sp. *a* 143

Fig. 4*a-b*. Right MI in ventral and dorsal views. Zakroczym, province of Warsaw; erratic boulder of unknown age — ?Ordovician or Silurian (Z. Pal. No. O.199/2).

Skalenoprion sp. *c* 144

Fig. 5*a-b*. Right MI in ventral and dorsal views. Jarosławiec, Baltic coast; erratic boulder of unknown age — ?Silurian (Z. Pal. No. O.159/2).



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