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UPPER DEVONIAN FISHES FROM THE HOLY CROSS MOUNTAINS  
(POLAND)

*Abstract.* — The present paper deals with fossil fish remains (Placodermi, Elasmobranchii) from the Upper Devonian of the Holy Cross Mountains. The following new forms have been described: *Malerosteus gorizdroae* n. gen., n. sp.; *Tomaosteus grossi* n. gen., n. sp.; *Dinichthys denisoni* n. sp.; *D. ceterus* n. sp.; *Titanichthys koźłowskii* n. sp., *Deveonema obručevi* n. gen., n. sp.; *Operchallosteus vialowi* n. gen., n. sp.; *Alienacanthus malkowskii* n. gen., n. sp.; *Sentacanthus żelichowskiae* n. gen., n. sp. The presence of *Dinichthys pustulosus*, *D. cf. tuberculatus*, *Pachyosteus bulia*, *Holonema radiatum*, *Anomalichthys ingens*, *Plourdosteus* sp., *Oxyosteus* sp., *Stenosteus?* sp., *Ctenacanthus* sp., as well as of some detached teeth of *Cladodus* and *Dittodus*, has been recorded. On the base of the investigated material the author agrees with the opinions postulating that in Brachytheraci there has occurred the disappearance of dentine and its substitution by osseous tissue. In the brachytheracids this process had taken place at a considerably earlier evolutionary stage than in the Crossopterygii and the Dipnoi and it had, moreover, progressed farther, having affected the jaw denticles too. The structure of the parasphenoid in genus *Pachyosteus*, problems relating to the position of the gill slit, and changes in the outline of bones during ontogeny are discussed and some cursory remarks on the systematics of Brachytheraci are given. The final chapter contains notes on the stratigraphic distribution and geographical range of the described brachytheracid forms.

## INTRODUCTION

This paper is concerned with placoderm remains from Frasnian and Famennian deposits in the Holy Cross Mountains.

In accordance with information published by J. Czarnocki (1947), two sedimentation zones may be differentiated within the region of the Holy Cross Mountains. Their boundary line runs approximately conformably to the axis of the Kielce syncline. The northern Łysa Góra region differs from the southern Kielce region in more complete development of the paleozoic series, in facial differences and in considerably greater thickness of sediments which are frequently of Flysch character.

All of the Upper Devonian fish material has been recovered from the Kielce region, namely from the localities of Wietrznia, Psie Górki and Kadzielnia, and from the village of Gałęzice lying south-west of Kielce.

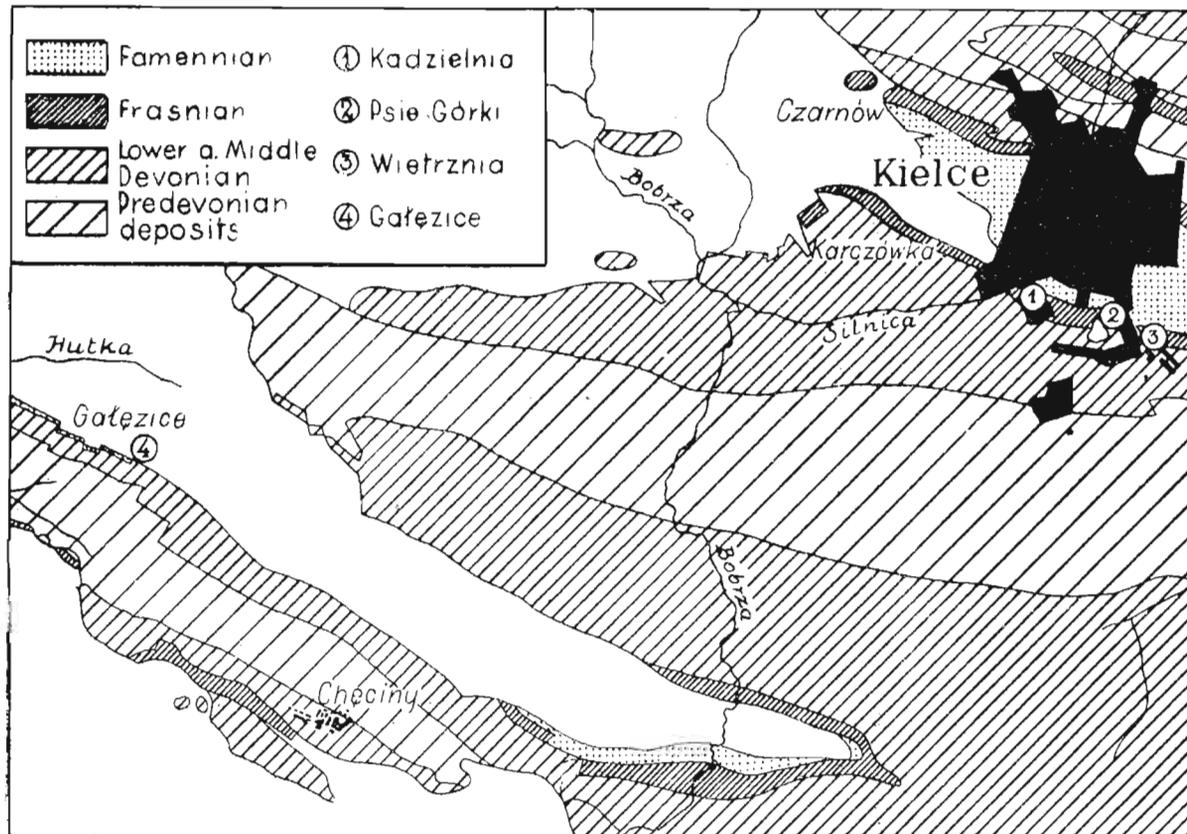


Fig. 1. — Distribution of localities of fish remains finds.  
Geology simplified, after a map, by J. Czarnocki, Scale 1 : 100 000

In the adjacent hills of Wietrznia and of Psie Górki the Frasnian beds are similarly developed. They are represented here by layered limestones and thin layers of shales. The following three horizons have been differentiated by Czarnocki (1947 and 1950; see also Rózkowska, 1953) on the recorded brachiopod fauna:

- Upper Frasnian — horizon III with *Hypothyridina cuboides* and *Manticoceras intumescens*,  
 Middle Frasnian — horizon II with *Hypothyridina coronula*,  
 Lower Frasnian — horizon I with *Hypothyridina procuboides*.

The specimens of fishes have been recovered from all Frasnian horizons in the Wietrznia hill. In Psie Górki the fishes have been yielded by horizon III only.

In the Kadzielnia hill are developed the three Frasnian horizons and a considerable part of the Famennian. The Lower and Middle Frasnian beds consist here of reef limestones. Fish remains have been found in Upper Frasnian and Famennian beds only. The Upper Frasnian here is developed as thick bedded limestones with *Hypothyridina cuboides* and *Manticoceras intumescens*. The Lower and Upper Frasnian consist of shales and marls with a fauna of cephalopods represented by the genera *Cheiloceras* and *Tornoceras*.

In the fourth locality situated at the village of Gałęzice (about 15 km to the south-west of Kielce) there are no Frasnian or Lower Famennian beds. Upper Famennian beds, reduced to a thickness of 3 to 4 m, rest directly on the Givetian. They are represented by limestones from horizons containing *Prolobites*, *Platyclymenia*, *Orthoclymenia*, *Goniclymenia*, and *Wocklumeria*, the latter underlying Carboniferous deposits.

The material described in the present paper is composed of two different collections:

1) the specimens collected by the late J. Czarnocki before the war and partly destroyed through war activities. This collection is housed in the Geological Institute (I. G.) in Warsaw;

2) the specimens collected by the late Prof. Z. Gorizdro-Kulczycka and by the present author between the years 1947 to 1952 on behalf of the Muzeum Ziemi (Museum of the Earth) in Warsaw. Work at further enlargement of the collection was continued by the writer during 1953 to 1955 on behalf of the Paleozoological Institute of the Polish Academy of Sciences in Warsaw. This collection is housed in the Museum of the Earth (M. Z.) in Warsaw.

The material was mostly prepared by treatment in acetic acid and saturation in paraffin. Before being photographed the specimens were whitened with ammonium chloride.

The laboratory work has been carried out in the years 1953—1956 at the Paleozoological Institute of the Polish Academy of Sciences in Warsaw. Throughout the investigation most helpful advice and assistance were given to the writer by the Head of the above mentioned Institute, Prof. Roman Kozłowski. In the course of the field work the most friendly kindness and help were shown to the writer by the Managers of the Museum of the Earth — Prof. St. Małkowski and Prof. A. Halicka. Dr. M. Żelichowska, chief of the Department of Documentation of the Geological Institute in Warsaw, has provided the author with the opportunity for studying the specimens in her charge.

In 1955 and 1956 the author spent two months at the Geol.-Paleontological Institute of the Humboldt University in Berlin. Prof. W. Gross has provided the author with the facilities for studying at this Institute and offered very useful criticism. Much valuable information and advice was obtained by the writer, in the way of correspondance, from Prof. D. V. Obruchev of Moscow and Dr R. H. Denison of Chicago. Miss A. Illner, the librarian of the Paleontological Institute of the Humboldt University in Berlin, has taken pains in supplying the author with the required literature. The accompanying photographs have been taken by Miss M. Czarnocka. The paper has been translated by Mrs. J. Humnicka.

To all these persons the writer wishes to express his deepest gratitude.

#### DESCRIPTIONS

##### Order **Arthrodira**

##### Infraorder **Brachythoraci**

##### Genus *Plourdosteus* Ørvig, 1951

##### *Plourdosteus* sp.

(pl. I, fig. 1, 2)

*Material.* — A fragmentary posterior ventrolateral and a complete marginal (pl. I, fig. 1). These two elements were found lying beside one another on a small rock fragment and display a similar ornamentation pattern suggesting their appurtenance to the same individual.

*Description.* — Posterior ventrolateral relatively large, the preserved fragment being 38 mm long and 28 mm wide. Its anterior lateral portion shows the base of a broken off process, which in this genus is commonly connected with the posterior lateral. The outer surface densely covered by minute tubercles, somewhat larger along the margin, more so in the posterior portion. The associated marginal is markedly small. Its shape (pl. I, fig. 1) indicates that it was not united with the central, this being

a characteristic feature of genus *Plourdosteus*. The course of suture with the postorbital and the paranuchal show the same indentures as in *Plourdosteus trautscholdi* (Eastman) (Obručeva, 1954, fig. 1), except for the side edge being more arched so that on the whole the marginal is more quadrangular. The width of this element measured from the point of juncture with the postorbital and the paranuchal is 15 mm. The same is its maximum length measured normally to the line of the previous dimension. The sensory line groove transversing the marginal produces a rather sharp bend from which branches off a blind ramification. As compared with *Plourdosteus trautscholdi* this ramification is placed more anteriorly and has a more distinctly lateral direction. Judging from the shape of the marginal the head shield may be supposed to have been markedly short, with its posterior side corners extending far to the sides. The lack of a margin joining the central refers this specimen to the genus *Plourdosteus*.

In the same bed as the above mentioned specimens was also found the left infragnathal (pl. I, fig. 2) which, perhaps, may have belonged to the same form. Its entire length is 34 mm, of which 16 mm are assignable to the functional anterior portion. The posterior „blade“ is fairly broad, attaining centrally a width of 8 mm. The upper margin nearly rectilinear, while the lower one is gently arcuate. On the outer surface the lower and the posterior portions are clearly separated from the smoother, upper-front portion; the latter passes into the anterior functional portion of the infragnathal. During the life-time this had probably been covered by the mucous lining only. Both the lower and upper margins of the functional portion are damaged, but it seems doubtless that the latter was provided with a number of denticles. Two of these are preserved within the symphyseal part. Two such complete denticles are also observable at the back of the functional portion. They are conical and 2 to 3 mm in height. At the base of each of them there is a slight convexity on the outside of the jaw. These convexities reveal that in the functional portion there were five such denticles over a distance of 7 mm.

*Occurrence.* — The Frasnian, horizon II, Wietrzna hill in Kielce.

Brachythoraci gen. et sp. indet. ( $\alpha$ )  
(text-fig. 2; pl. I, fig. 3 a-b)

*Material.* — A median dorsal (pl. I, fig. 3 a-b), in a fairly satisfactory state of preservation, has been recovered from the same beds as the above described specimens.

*Description.* — It is elongate, being 41 mm long and about 28 mm wide. Transversally it is rather strongly arched. The maximum width is

attained at the anterior, arcuate margin. The side margins are first gently concave and then convex, running obliquely posteriorly towards the median part to converge at a nearly right angle. The outer surface is densely covered by minute tubercles arranged on the circumference in concentric rows. On the ventral surface the hind portion of this element is limited from the front portion by an arched elevation running transversally at a distance of 8 mm from the hind end of the median dorsal. Medially this elevation constitutes the rounded base of the carinal process.



Fig. 2. — *Brachythoraci* gen. et sp. indet. (a); longitudinal section of the median dorsal with discernible crest outline.

This base continues anteriorly into the crest running over a distance of 13 mm. The described median dorsal with a broken off crest may be taken for this element of *Coccosteus* or of *Plourdosteus* but lacking the hind spine-like process, as is the case in *Coccosteus fletti* (Watson, 1932). However, the crest (fig. 2) preserved in the cast ascends very gently to

the hind, in opposition to what we observe in these genera. It attains its maximum height of 6 mm very near the base of the carinal process. The latter descends at an angle of ca.  $70^\circ$  in relation to the median dorsal blade and basally shows a spoon-like impression. Thus, in what the shape of the carinal process and of the crest is concerned, our specimen is more like genus *Pholidosteus*, differing from it in smaller height of the crest and in a terminally pointed hind end of the crest. Hence, the carinal process not only did not protrude beyond the posterior margin of the element, as is the case in *Pholidosteus*, but was deeply concealed under it. At the present moment the systematic position of the studied median dorsal may be only tentatively established, although it is possible that we are dealing here with a new form.

*Occurrence.* — The Frasnian, horizon II. Wietrznia hill in Kielce.

#### Genus *Malerosteus*<sup>1</sup> n. gen.

*Diagnosis.* — *Brachythoraci* with head shield broad, with rounded side margins separating the descending lateral portions from the flattened vault. The large orbital cavity is bounded by the suborbital, preorbital and postorbital. The structure of the cheek part is as in *Pholidosteus* or *Brachyosteus*. Postpineal opening lacking. The jaw apparatus is of the crushing type. The infragnathal has a moderately large crushing surface of the upper margin and a tooth-like process at the front of the functional portion. The posterior supragathal is broad, with a lateral process

<sup>1</sup> The generic name is an allusion to the crushing jaw apparatus, being derived from the Greek *μαλερος*, meaning crushing.

and a well developed crushing surface provided with two tubercles: one placed more or less medially, the other at the top of the lateral process. The anterior supragnathal of the catching type attached to a tooth-like process behind which mesially there is an depression to accomodate the tooth-like infragnathal process.

*Remarks.* — This genus is monotypic, erected to include *Malerosteus gorizdroae* n. sp. In the disposition of the skull bones this form resembles *Pholidosteus* from which it differs in the stronger development of the crushing jaw apparatus bringing it closer to Mylostomidae and still more so to *Dinomylostoma*. From the latter genus, however, it differs in the less developed infragnathal crushing surface, a lower and more conspicuously limited hind portion of this element and in different pattern and degree of development of the posterior supragnathal tubercles.

*Malerosteus gorizdroae*<sup>2</sup> n. sp.

(text-fig. 3-6; pl. I, fig. 4-7; pl. II; pl. III, fig. 1-3).

*Material.* — A large skeletal fragment of one individual, found in the Psie Górki hill. It comprises the preorbitals, suborbital, marginal, paranuchal, infragnathal, posterior supragnathal, anterior supragnathal, parasphenoid as well as fragments of the dermal and endocranial bones. The suborbital and postsuborbital found in the Wietrznia hill are referable to the same species.

*Holotype.* — Incomplete head shield and the anterior dorsolateral of one individual (M. Z.) (pl. I, fig. 4-7; pl. II).

*Diagnosis.* — *Malerosteus gorizdroae* is thus far the only known species of this genus so that the specific and generic diagnosis are the same. We may add here that our species is characterized by an ornamentation pattern consisting of rounded tubercles of various size, the whole rather large, particularly so in the hind part of the head. These tubercles are arranged densely and irregularly.

*Description.* — The preserved parts indicate that they belong to a broad-headed form, with a blunt snout and distinctly marked side edges („Dorso-lateralkanten“ of Gross, 1932), produced by the angular disposition of the lateral and dorsal parts of the skull. At the front of the orbital fenestra this angle is about 120°, while in the portion corresponding to the paranuchal it is as much as 130 to 140°. From a side view this skull resembles that of *Pholidosteus friedeli* Jaekel as reconstructed by Jaekel (1907) or by Gross (1932). The similarity also concerns the position and relative dimensions of the orbital fenestra with a diameter

<sup>2</sup> This species is named in honour of the late Prof. Z. Gorizdro-Kulczycka who initiated research work on the Devonian fishes from the Holy Cross Mountains.

of 60 mm in the specimen here considered. Similarly as in *Pholidosteus* and the majority of brachythoracids from Wildungen the marginal here extends into the cheek area, while the suborbital and the postsuborbital are not free, this being a feature characteristic for example of *Dinichthys* and *Cocosteus*. The entire outer surface is covered by relatively large, roundish tubercles varying in size from 0.5 to 2 mm, on the whole larger in the posterior part of the head. Where the superficial layer of the bone has been worn off, the tubercles are considerably smaller, suggesting that their size was dependent on dimensions and age of the individual.

The central is preserved as a rather small fragment of the anterior process united with the mesial margin of the right preorbital. This process was less slender than that in *Pholidosteus friedeli* Jaekel.

The pineal has been preserved as fragments lying quite close to the anterior process of the central indicating that these two bones touched each other. The pineal foramen is open. A shallow groove is indicated at one side of it only, this asymmetry suggests the presence of another pineal foramen, as is the case in *Pholidosteus friedeli* Jaekel (Stensiö, 1934a).

The preorbitals (pl. II, fig. 1) are broad (70 mm), their length is one and a half times as large as the width, being over 100 mm. The mesial margins have been destroyed but the fact of the preservation of the pineal and the central suggests that the preorbitals of both sides were not in contact. The posterior portions of these bones dorsally overlapped the centrals and the postorbitals. The anterior part of the preorbitals forms the anterior margin of the orbital cavity. It is provided with a notch. From the top and inside of the orbital cavity a groove runs downwards onto the outer surface terminating within the anterior angle of the orbital fenestra. From the end of that groove, another, less distinctly marked, with a number of foramina, runs vertically, and extends to the supraorbital line („preorbital”, according to the terminology of Heintz, 1932), without, however, reaching it. The supraorbital line is indicated ca. 5 mm above the eventual point of juncture with the prolongation of the mentioned groove. The absence of traces of the supraorbital line below that sector cannot be ascertained quite doubtlessly owing to the bad state of preservation of that portion of the surface. In the anterior part of the preorbital, the supraorbital line runs closer to the margin of the orbital fenestra than it is the case in *Pholidosteus friedeli*. On the ventral side a crest is visible on the preorbital, corresponding to the boundary of the „lateral consolidated part” (Heintz, 1932), separating the median part which coats the endocranium from the lateral part which constitutes the vault of the orbit.

The suborbital (pl. II, fig. 1, 2) is provided with a high posterior blade (over 55 mm) whose preserved portion constitutes the margin of the orbital fenestra and with a slender anterior part, the „handle“ of Heintz. In this „handle“ we may distinguish the upper ornamented part and the lower list constituting what Heintz (1932) calls the „tongue shaped part of handle“. According to Stensiö (1934a) it is connected by its lower edge with the palatoquadrate. As is the case in other Brachythoraci, both these parts are separated here too by an incision which Stensiö (1934a) calls „*incisura maxillaris buccalis*“. From the mesial side of the anterior part of the suborbital runs a broad horizontal list limiting the orbit at the base. The infraorbital canal runs on the outside with the fore-part of the supramaxillar line arising somewhat above the point of junction of the postorbital and suborbital parts. This branching is particularly conspicuous on the specimen of the suborbital from Wietrzna (pl. II, fig. 2).

The postsuborbital (pl. III, fig. 1) recorded from the same beds of the Wietrzna hill belongs to another individual, probably of larger dimensions. In the antero-posterior direction and normally to it the postsuborbital is curved, its convexity being directed outwards. This is associated with the box-like shape of the shield characteristic of the here studied form, though to a smaller degree than it is of *Pholidosteus*. At the base of the anterior part, the postsuborbital is provided with a process whose margin is overlapped by the suborbital. The anterior and upper margins limit a projection which most likely penetrates between the suborbital and the postorbital. The length of this element measured along its free margin is 90 mm. Measured normally to it the height of the outer ornamented surface is 55 mm.

The marginal (fig. 3; pl. II, fig. 4) is preserved on the right side only. From behind and top it bounds the paranuchal, from the front the postorbital. It is elongated, with the longer axis somewhat obliquely traversing the head shield. Its lower end considerably approaches the posterior margin of the skull. Nevertheless, since this portion has not been preserved, it cannot be ascertained whether the marginal reached to the free margin of the head shield or was separated from it by the postmarginal, as it does in *Pholidosteus*. Near to the upper margin adjacent to the paranuchal this bone is traversed by the sensory line groove which branches off from the side downwards somewhat posteriorly, similarly as is shown in Jaekel's reconstruction of *Pholidosteus*. The width of the marginal ranges from 32 to 41 mm, the length of the preserved part is 50 mm.

By its shape the paranuchal (fig. 4; pl. II, fig. 4) closely resembles the corresponding element in *Pholidosteus* and anteriorly it was most

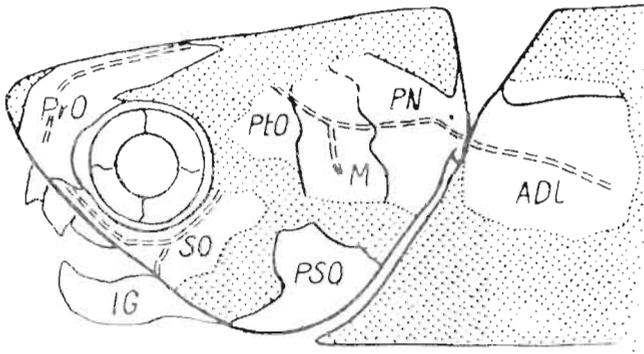


Fig. 3. — *Malerosteus gorizdroae* n. gen., n. sp.: diagrammatical reconstruction of skeleton, side view; missing parts dotted. ADL anterior dorsolateral, IG infragnathal, M marginal, PN paranuchal, PrO preorbital, PSO postsuborbital.

likely connected with the postorbital thus separating the marginal from the central. Similarly as in Jaekel's reconstruction of *Pholidosteus* there are no traces here of the posterior portion of the occipital line (called so after the nomenclature of Gross, but by Stensiö referred to as the „po-

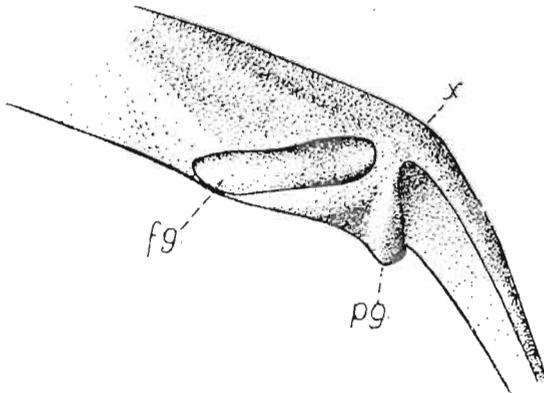


Fig. 4. — *Malerosteus gorizdroae* n. gen., n. sp.: posterior margin of paranuchal; fg joint socket, pg joint process, x lateral edge.

sterior pit-line“), whose presence in *Pholidosteus* has, however, been mentioned by Gross (1932 b, p. 14). The portion forming a sheath for the postero-lateral ends of the nuchal (Heintz's „hind thickening“) is not so conspicuously arched ventrally as may be observed in *Dinichthys*. In consequence, the posterior lateral impression, as it is called by Heintz, is not so clearly limited. At the same time, in *Malerosteus* we can distinguish that part which forms the joint thickening. The joint socket

is relatively longer (31 mm) and narrower, and displays greater uniformity of diameter than in *Dinichthys*, being here 7 mm laterally and 6 mm mesially. The lower and upper „joint processes“, as called by Heintz, are not developed. The position of the top of the upper process is marked by a rib reaching here to the margin of the socket. The glenoidal process was short (15 mm as measured outside at the margin of the ornamented paranuchal surface) and obliquely placed. Its outline does not protrude beyond the margin of the joint socket.

The infragnathal (pl. I, fig. 7 a-b) is fragmentary, but with the functional part preserved on the left side. Its anterior symphyseal end is provided with a rather large tooth-like process, 10 mm high. Dorsally, behind it stretches the crushing surface, which is moderately broad (8 mm frontally and narrowing posteriorly). It has a mesial impression to accommodate a tubercle present on the posterior supragathal. The entire functional portion of the infragnathal is an almost perfectly flat, uniformly thick plate. At its lower margin there is a groove for the mandibular line, running antero-medially. Its presence indicates that Meckel's cartilage was not in contact with the lower margin of the infragnathal, as has been figured in Stensiö's (1934) reconstruction of *Leiosteus*, but that it occupied more mesial position in relation to the infragnathal. The length of the functional portion of the infragnathal in *Malerosteus* is 62 mm, the height being 24 mm.

The posterior supragathal (fig. 5; pl. I, fig. 6 a-c) is an elongated plate narrowing posteriorly. Frontally it is provided with a lateral process, as in *Cocosteus*, but without the vertical row of denticles. The lower side has a fairly broad surface, convex throughout, which, corresponding to the form of this element, is rhomboidal and has a triangular excavation bounded by two diagonals. The exterior corner corresponding to the lateral process is provided with a minute tubercle. A larger one is situated more or less centrally, i.e. nearer to the mesial angle. The anterior mesial surface is concave, both vertically and horizontally agreeing with the shape of the contiguous surface of the anterior supragathal. The length of the posterior supragathal is 48 mm, the width 32 mm, when measured in the upper part of the element from the apex of the upper process, which is here almost horizontally placed, to the side margin of the lateral process. The frontal width of the crushing surface is 16 mm; maximum height, together with the tubercles, is 18 mm, of which 2 mm are involved by the mentioned tubercle.

The anterior supragathal (fig. 5; pl. I, fig. 4 a-b, 5) of both sides have been preserved, though damaged. They are in the shape of horizontally curving plates. Along the curving edge is a rounded crest elongating downwards into a strongly tooth-like process 10 mm in length.

Mesially, behind the mentioned process, there is an excavation to fit a similar process of the lower jaw. Farther to the rear stretches a small flat area which is the extension of the crushing surface in the posterior supragathal. The upper portion and the anterior margin are damaged in both specimens.

The height of the anterior supragathal cannot have been much in excess of 22 mm (not comprising the tooth-like process). The maximum attained thickness is 7 mm.

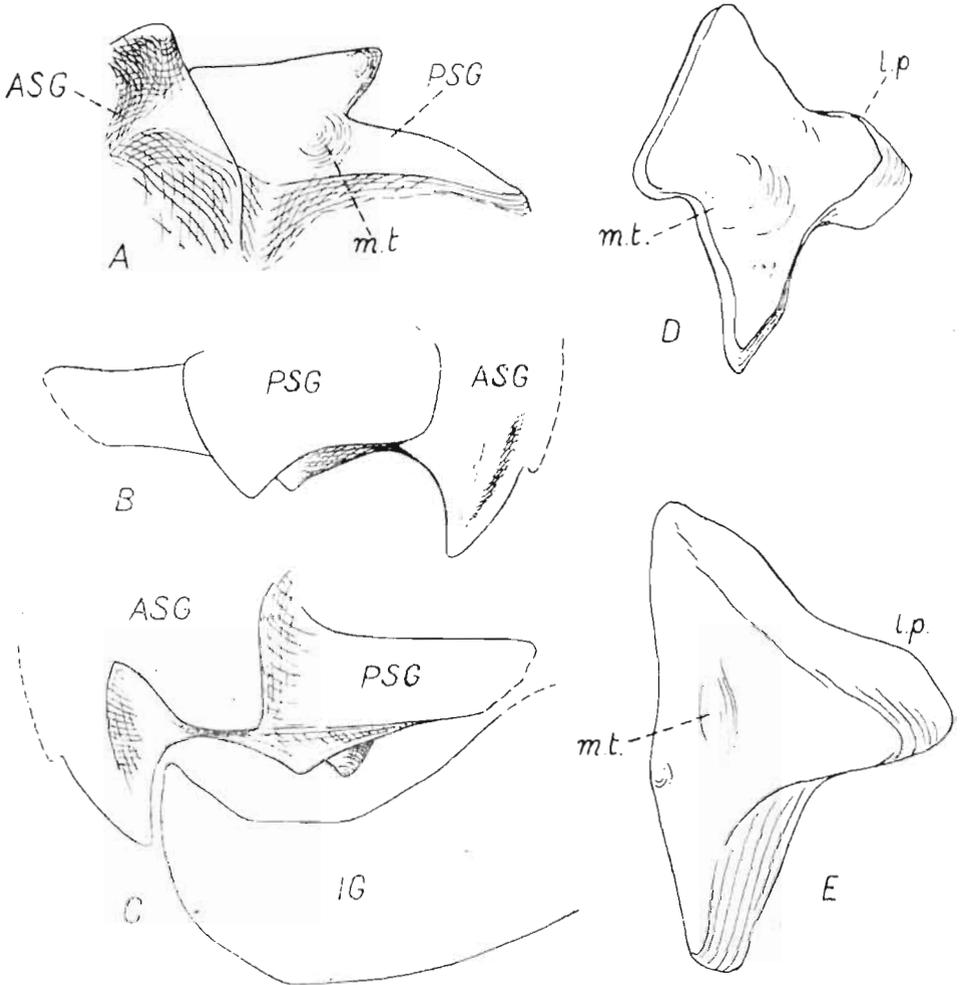


Fig. 5. — *Malerosteus gorizdroae* n. gen., n. sp.; jaw apparatus: A upper elements, ventral view, B same, side view, C jaw apparatus, medial view, D-E posterior supragathals, ventral view, D *Dinomylostoma becheri*, E *Mylostoma variabile*, ASG anterior supragathal, IG infragathal, PSG posterior supragathal, pl lateral process, posterior supragathal, mt middle tubercle.

The parasphenoid belonging to this specimen has already been individually described in a previous note of the writer (Kulczycki, 1956) as an element of *Brachythoraci* n. gen.

The anterior dorsolateral (pl. II, fig. 3) is here incomplete, as most of the bones of this specimen. The sensory line runs on the outside, reaching to the hind margin of the bone, perhaps even beyond it. The course of the lateral line also indicates the dorsolateral margin, along which the lower and the upper parts of the anterior dorsolateral lean against one another. The angle thus produced by them near the anterior margin has  $140^\circ$ , while posteriorly it approaches  $180^\circ$  and the dorsolateral edge disappears. On the median side, along the posterior margin, a flat area is indicated, overlapped by the posterior dorsolateral. On the anterior damaged edge there is an inconspicuous thickening suggesting that the condyle was not developed very strongly. The length of the preserved part is 85 mm. The thickness at the anterior margin is up to 18 mm.

As is shown by its description, the head shield of *Malerosteus* displays marked resemblance to that of *Pholidosteus*. It is to this genus that Gorizdro-Kulczycka (1950) has referred fragments of head shield from Czarnocki's collection. Nevertheless, the evidence acquired on a more complete specimen, particularly that from the characteristic jaw apparatus, calls for the assignment of this form to a new genus.

A specimen of the posterior median ventral bone (fig. 6; pl. III, fig. 3) in a satisfactory state of preservation, found in the Frasnian of the Wietrzna hill, can only tentatively be assigned to the same species. Its tuberculation pattern does not exclude the possibility that this element is referable to genus *Malerosteus* whose range should in this case be shifted to the Middle Frasnian. Specimens of *M. gorizdroae* from the Upper Frasnian, however, do not exhibit a concentric arrangement of tubercles, which is here quite conspicuous near the ossification centre.

The posterior median ventral here considered (fig. 6; pl. III, fig. 2) is in the form of a large plate, 107 mm long and about 85 mm broad. It is gently transversely curved indicating that the ventral shield of this species was slightly convex. Anteriorly there is a small area, 12 mm in length and 32 mm in width, to fit the anterior median ventral. Fairly large areas stretch along the side edges to be overlapped by the ventrolaterals. Further to the front are somewhat raised areas, about 60 mm in length on every side and about 88 mm in width, overlapped by the anterior ventrolateral. At the back a lowered and smaller area is observable to fit the posterior ventrolateral. Its maximum width is 20 mm while the length is 58 mm. The free area of the posterior median ventral, covered by tuberculation, has the outline of a cross with a blunt fore-

arm, while the others are pointed. Its tuberculation resembles that characteristic of *M. gorizdroae*.

The element described above is interesting since we can observe in the middle of its free surface an area distinctly limited posteriorly and exhibiting a finer tuberculation with a radial arrangement. This area most likely corresponds to the juvenile stage of the posterior median

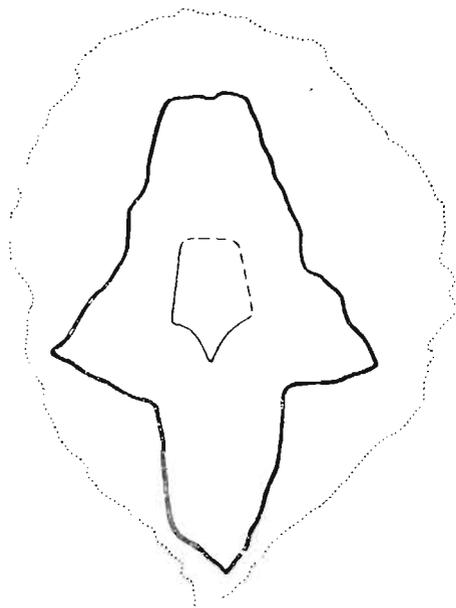


Fig. 6. *Malerosteus gorizdroae*?, posterior median ventral. Thick continuous line — outline of free area in adult individual; thin continuous and broken line — outline of free area in young individual; dotted line — outline of the whole element in adult individual.

ventral plate. Its outline indicates that considerable changes in the shape of this element must have occurred along with its growth. In a young individual it was short, its outline being an almost regular pentagon with gently concave margins. The differences occurring between a juvenile and an adult specimen are so great as to make possible the assignment of their detached skeletal elements to different taxonomic units.

A nuchal (pl. III, fig. 2 *a-b*) in a fairly satisfactory state of preservation has been found in the same beds as the specimen described above. It has a similar ornamentation, consisting of coarse tubercles whose arrangement is concentric around the ossification centre only where they are of smaller size. Ventrally, near to the hind margin a double socket distinctly divided centrally is discernible. The partition that divides it is broad anteriorly, narrowing down to

the back. In addition a relatively low transversal ridge occurs here, behind which on the hind edge there is a minute central process. The preserved fragment is 40 mm in length along the central line and 73 mm broad along the hind margin.

*Occurrence.* — The Frasnian, horizons II? and III in the Psie Górki and Wietrznia hills.

#### Genus *Tomaiosteus*<sup>3</sup> n. gen.

*Diagnosis.* — Brachythoraci, with the head broad and flattened, at least in the anterior part, and moderately large orbits placed near the

<sup>3</sup> The generic name from the Greek word *τομαίος* — „cutting” is an allusion to the cutting type of the jaw apparatus.

anterior end of the skull. The pineal touches the centrals and the rostral, thus completely separating both preorbitals. The jaw apparatus of the cutting type not too highly specialized. Posterior gnathal with preserved lateral process.

*Remarks.* — This genus is monotypic, erected to include *Tomaiosteus grossi* n. sp. From other forms with a cutting jaw apparatus this genus differs in the presence on the posterior supragnathal of the lateral process which is here, however, not so strong as in *Cocosteus* and similar forms. From the latter, *Tomaiosteus* also differs in a poorly developed upper process and in general outline of the hind upper jaw element.

*Tomaiosteus grossi* n. sp.<sup>4</sup>  
(text-fig. 7; pl. III, fig. 4, 5).

*Material.* — The preserved fragment represents an almost complete pineal, a major part of the preorbital, small fragments of the centrals and a satisfactorily preserved posterior supragnathal. An indeterminate endocranial fragment was also found together with these remains.

*Diagnosis.* — The same as for the genus, but also sculpture characteristics, consisting of irregularly disposed tubercles of varying size and with basal diameter of 1 mm or less.

*Holotype.* — Fragment of fore-part of skull with the posterior supragnathal (I. G.) (pl. III, fig. 4, 5).

*Description.* — Pineal (fig. 7; pl. III, fig. 4) is an elongated bone whose length measured medially, without the portion missing in the specimen but together with the posterior process, is 40 mm. Dorsal, tuberculated surface 15 mm in length and minimum 7 mm in width. The pineal plate overlaps the centrals wedging in between their dorsal surfaces. In this way, when seen from the ventral side of the head shield, this process appears as a triangular element, half its actual length. The remaining free margins preserved in the specimen, have grooves fitting the corresponding ridges of the mesial preorbital margins. At a distance of 25 mm from the apex of the medial posterior process is the minute

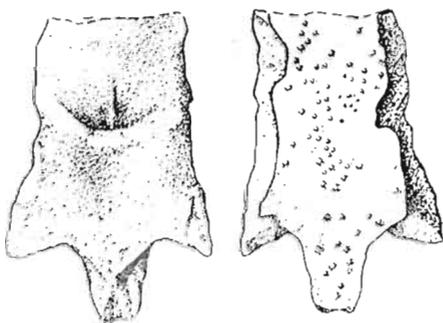


Fig. 7. — *Tomaiosteus grossi* n. gen., n. sp.; the pineal: A ventral view, B dorsal view.

<sup>4</sup> This species is dedicated to Prof. Dr. W. Gross from the Geol.-Paleontological Institute of the Humboldt University in Berlin.

pineal foramen opening on the ventral surface of the bone into the pineal depression. This hollow is sharply limited by a distinct ridge while to the front it gradually passes into the ventral surface of the pineal plate. It is noteworthy that the pineal foramen is placed somewhat laterally to the plane of symmetry indicated at the bottom of the pineal foramen by a slight elongated rib. This is also a sign that the pineal opening was originally paired.

The preorbital (pl. III, fig. 4) must have been very broad and almost flat. Its median margin is arcuate, at first adjacent to the rostral. The preorbital was connected with the latter by a narrow but rather long, transversally directed embayment in the anterior part of the median margin. The orbital margin of the preorbital is not preserved. The limit, however, of the orbital vault, visible from the ventral side, where we can also see a fragment of the postorbital, suggests that the orbits were relatively small, most likely much less than 45 mm in diameter. In the anterior median portion of the orbital vault is a funnel-like impression. Above it, in the crest centrally limiting the vaulting, a notch and a groove occur, probably serving as a duct for a nerve or vessel branching.

The preserved fragment of the central indicates that this element was more than 60 mm broad in the anterior part. The anterior margin of its lateral portion is nearly straight, transversal to the cranial axis. Mesially it develops a broad triangular process, about 20 mm high and as much basally broad. This process fits between the preorbital and the posterior pineal process.

The posterior supraghathal (pl. III, fig. 5 a-b) is of the cutting type with a fairly sharp lower edge. It is in the form of a plate, 43 mm long, mesially divided by a vertical ridge into the hind portion 27 mm in length and the front portion 10 mm in length. The basal width of this ridge-like thickening is 6 mm, being 4 mm at top. It extends above the upper border of the element and forms a rod-like upper process gently curved inward. The posterior supraghathal attains a maximum height of 25 mm within the ridge-like thickening. Laterally, the anterior thickened portion, 20 mm in length, forms a protrusion limited by the vertical posterior margin. This protrusion corresponds with the lateral posterior supraghathal process occurring in genus *Cocosteus* and others. Above this process, on the upper border on the element, is an impression to fit the ligaments or muscles. The lower margin, seen from the side, has the outline of a flattened letter „W“, showing two sharp bends. In agreement with this arrangement, the surface touching the infragathal and occurring on the mesial side of this element is narrow and

arched posteriorly, while anteriorly it widens out overlapping the vertical ridge-like thickening and then abruptly narrowing again.

*Occurrence.* — The Frasnian, horizon II in the Wietrzna Hill.

Genus *Dinichthys* Newberry, 1885

*Remarks.* — Genus *Dinichthys* was erected by Newberry to include species *D. herzeri* described by him. Later, a number of species was included into the genus, some of which subsequently were referred to other genera, while many of the remaining forms are known only on very inadequate fragments.

In 1946, Dunkle and Bungart differentiated two groups of forms in the dinichthyids. One of them, in those authors' opinion comprising *D. herzeri* Newberry and genus *Gorgonichthys*, is characterized by jaws with a blunt crushing edge, while the other group, typically represented by *D. terrelli* Newberry and *D. intermedius* Newberry, displays sharp, cutting edges. These suggestions led Lehman (1956) to separate *D. herzeri* from the remaining forms, retaining for it the generic name of *Dinichthys* and creating the new genus *Dunkleosteus* to include the forms of the "terrelli" group.

Even such forms whose referability to genus *Dinichthys* had not been questioned until a short time ago, represent various evolutionary stages and lines of this stock. To give a true picture of the relationship of these forms it will, doubtless, be necessary to separate a number of subgenera, or maybe, even genera. At the present moment, however, Lehman's otherwise reasonable standpoint creates many practical difficulties. It either leads to a mechanical assignment of all forms, *D. herzeri* excepted, to the new genus *Dunkleosteus*, engendering the possibility of their being subsequently shifted from one to another systematic unit, or left unclassified. Both these possibilities seem obviously uncommendable to the present author who is prompted tentatively to retain the old systematic arrangement of *Dinichthys* alterable in the future, after a detailed revision based on study of new material concerning the now inadequately known forms.

*Dinichthys pustulosus* Eastman, 1897

(text-fig. 8, 9; pl. IV, V; pl. VI, fig. 1-3)

1897. *Dinichthys pustulosus* Eastman; C. R. Eastman, On the relations..., p. 38.  
 1898. *Dinichthys pustulosus* Eastman; C. R. Eastman, Some new points..., p. 748—754, fig. 1, 2.  
 1907a. *Dinichthys pustulosus* Eastman; C. R. Eastman, Devonian fishes..., p. 130—132, pl. 12.  
 1918. *Dinichthys pustulosus* Eastman; L. Hussakoff & W. L. Bryant, Catalog of fossil fishes..., p. 50—53, pl. 12; pl. 13, fig. 1, 2, 4.  
 1956. *Dinichthys* cf. *pustulosus* Kulczycki; J. Kulczycki, On the parasphenoid..., p. 105—106, pl. 1, fig. G; pl. 2, fig. 3.

*Material.* — Material consisting of two large cranial fragments, one from the Lower, the other from the Middle Frasnian in the Wietrznia hill; fragments of the median dorsal, nuchal, paranuchal and anterior lateral plates from the Middle Frasnian of Wietrznia, while an anterior supragnathal has been recovered from the lower *Cheiloceras* beds, and two median dorsal fragments from the Frasnian horizon III (*Mantico-ceras* beds) in Kadzielnia.

*Description.* — Head shield fragment from the Lower Frasnian of the Wietrznia hill (fig. 8B; pl. IV) comprises a complete nuchal and right paranuchal, part of left paranuchal, both centrals without anterior processes, medial part of the marginal and a small portion of the postorbital. This specimen has not been distorted and exhibits the natural doming of this portion of the head shield.

On the posterior margin, limited by the nuchal, the head shield is with a roof-like bend of about  $130^\circ$ . Farther to the front the doming grows gentle, more arcuate and, beginning from the anterior suture of the nuchal bone, a shallow, extensive depression is indicated, stretching to the sides of the supraorbital lines on the centrals.

The nuchal is with a markedly regular outline which is almost perfectly symmetrical. Its free outer surface is of trapezoidal form, 110 mm in height and with the basal width equal to about 180 mm, when measured along the chord line between the most outlying lateral points. The posterior margin, limiting the nuchal gap, is slightly concave, arched, provided with a central process, 40 mm broad at the base. The anterior margin, 68 mm long, limiting both centrals, runs in a straight line across the head shield, interrupted by only three small, sharp processes. The middle one of these wedges in between the two centrals, while the two others are placed on the side ends of the anterior nuchal margin with their apexes directed to the middle of the respective centrals. The lateral nuchal margins frontally uniting with the posterior central processes and to the hind with the paranuchals, show a gently arcuate course, only slightly broken up in the area of contact with the suture between the central and the paranuchal. In the hindmost section only, the suture between the nuchal and paranuchal forms two larger indentations. Ventrally, the nuchal is considerably narrower. Its posterior margin is 120 mm long. To the front the nuchal contracts centrally to 45 mm broadening out again to 55 mm in the region of the anterior paranuchal margins. From this point the nuchal margins extend in converging rectilinear lines directed to the front, producing an angle of  $70^\circ$ , and wedging in between both centrals. In the centre of this area an elevation rises from which stretches a faintly indicated ridge laterally limited by likewise slight grooves. At a distance of approx. 80 mm

from the anterior end there occurs on the ventral surface of the nuchal plate a depression (the „double sockets“ of Heintz), sharply limited at the front as well as at the back, 40 mm broad and 15 mm long and high. The bi-partition of the depression is indicated by a slight notch on the front wall together with a small median crest, and two, similarly small crests on the back wall. The posterior limit of the depression consists of a transversal ridge („transversal commissure“ of Heintz), considerably more massive than in *Dinichthys intermedius* with a thickness of 20 mm. From its back wall, a small median crest probably ending in a larger process, as well as two lower lateral crests extend on the central process of the posterior nuchal margin. At the transversal commissure the nuchal thickness attains 30 mm. As may be seen in the section obtained by the breaking off of the area occupied by the left joint socket, the nuchal wedges in this area into the deep pocket produced by the mesial paranuchal margin and forms the major bulk of the ridge (the „hind thickening“ of Heintz) which mesially limits the posterior lateral cranial cavities.

The paranuchal has the outline of a triangle with truncated corners. The hind corner involves the joint socket. The shape of the latter element suggests that the condyle must have been thick and relatively short. The width of the joint surface measured parallel to the axis of the joint is 22 mm, while the diameter of the curvature is 16 mm on the lateral margin and 14 mm on the mesial. It should be stressed that the axis of the joint is not placed horizontally, as figured by Heintz in the reconstruction of the skull of *Dinichthys intermedius* (1932, fig. 35), but runs obliquely from outside of the top and front mesially downward and backward at an angle of approx.  $15^{\circ}$  to the horizontal line drawn across the head shield. The lower lip of the joint socket unites with the base of the joint process (lacking in the specimen under consideration). At the base it is 14 mm wide and 6 mm thick. Quite close to the boundary between the outer margin of the joint surface and the mesial margin of the joint process, the paranuchal margin produces a moderately conspicuous, sharp process traversed by the groove of the lateral line passing on to the anterior dorsolateral. At a small distance from this place, the posterior lateral margin of the paranuchal limiting the cleft between the head shield and body armor beneath the joint, forms a small list which, with head lowered, is overlapped by the front margin of the pectoral girdle. Mesially, the upper lip of the joint surface forms a sharp, beak-like process overhanging the joint cavity and at the same time closing up the pocket-like depression of the median paranuchal margin occupied by the lateral part of the nuchal plate. From this point, along the lateral part of the posterior nuchal margin, extends the fairly long shelf-like list, taking part in the limitation of the anterior head shield

margin. This process resembles a similar structure in *Plourdosteus trautscholdi*. The anterior paranuchal margin contacting with the central and marginal plates is irregularly arcuate. The outer paranuchal surface is traversed by the sensory line canal, by Gross referred to as temporal, while Heintz calls it marginal, and by an „occipital canal” (called so in the nomenclature of Gross, by Stensiö called the „posterior pit-line”) not

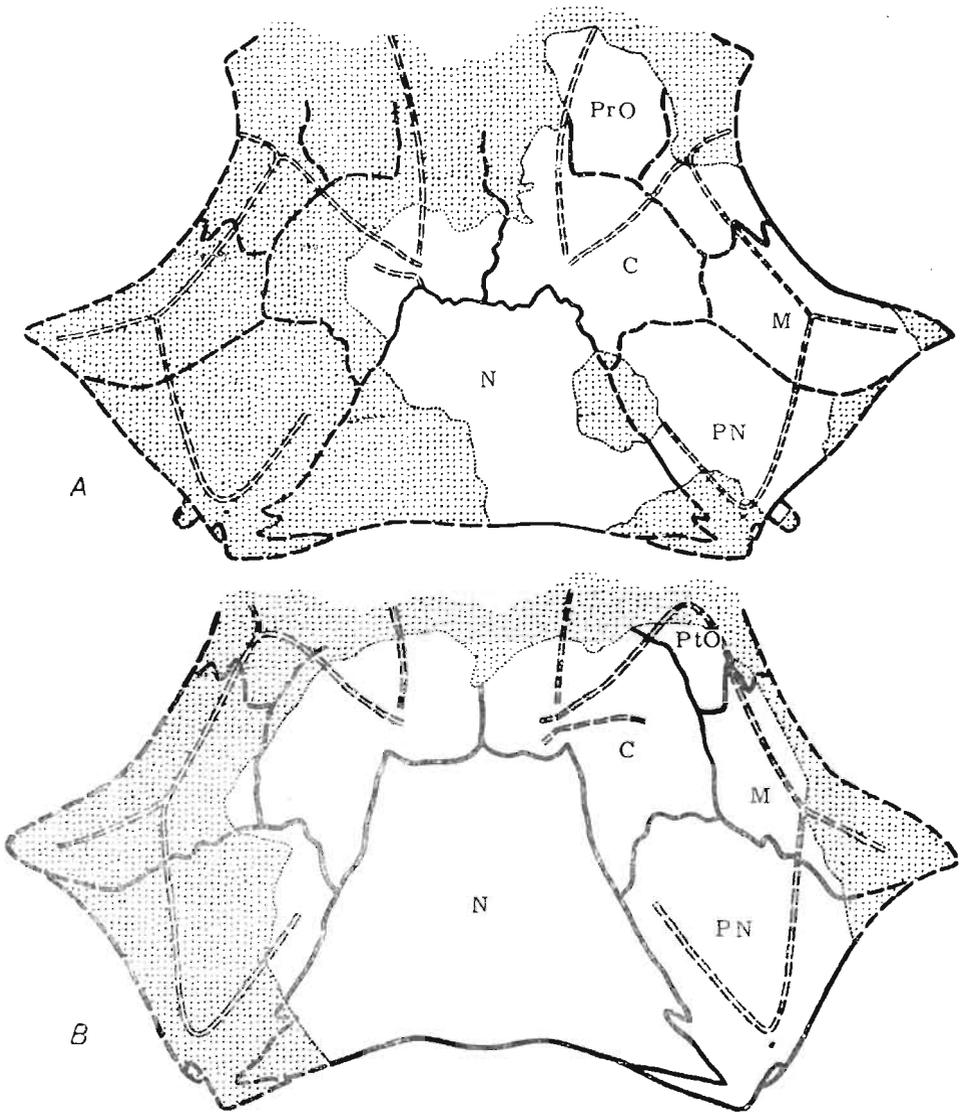


Fig. 8. — *Dinichthys pustulosus*, part reconstruction of head shield (dotted areas). A from the Middle Frasnian, B from the Lower Frasnian of Wietrzna; C central, N nuchal, M marginal, PN paranuchal, PrO preorbital, PiO postorbital.

reaching the suture with the central. In the angle produced at the contact of these canals is the opening of the endolymphatic canal. At a distance of 10 mm from the apex of this angle, the temporal canal branches off passing onto the anterior dorsolateral. The ventral surface of the nuchal in *Dinichthys pustulosus* is distinguished by the considerable width of the mesial step-like elevation forming a pocket for the lateral nuchal margin and, together with it, producing the hind thickening of Heintz. This thickening as compared to that in *D. intermedius*, is very massive and characterized by considerable width, increasing anteriorly (42 mm above the joint socket, 57 mm near the transversal thickening, limiting the nuchal depression). Within the central portion of the hind thickening, along its lateral side, a broad but shallow depression extends ventrally, which, to the hind passes into a similarly wide and low blind canal, rapidly growing narrower. Within the lateral wall of the hind head shield thickening, formed by the vertical paranuchal shelf, runs the endolymphatic canal. Its inner opening is placed at the anterior end of the above mentioned thickening opposite to the point of convergence of the nuchal, paranuchal and central sutures.

The centrals show an intricate outline. Medially they are united by somewhat flexuous suture. In the hind of the mesial part they are transversally truncated by the nuchal element stretching far to the front. The posterior tongue-shaped processes of the centrals adjoin the fore part of the lateral nuchal margin. Laterally to these processes wedged in between the nuchal and paranuchal, the margin of the central after a slight bend resumes its rectilinear course sideward to touch the genal plate where it curves and then mesially runs on arcuately forward. The width of the central is 92 mm as measured from the point where the two centrals and nuchal come together to the point of convergence between the central, genal and paranuchal. The length is 97 mm, as measured from the hindmost point of the posterior process laterally to the frontal margin of the anterior processes which are missing on the here considered specimen. On the external surface of the central plate, supraorbital and central, sensory line canals are visible, converging to the middle of the element. The latter of these lines projects somewhat farther across the plate inward in relation to the supraorbital line. Besides these two canals, an isolated section of the sensory line (the „Restkanal“ of Gross, the „central pit-line“ of Stensiö) is also found on the central. After running inwards in a transversal direction to the middle of the element, this line bends backwards without, however, attaining the margin adjacent to the nuchal. A considerable portion of the ventral surface of the central is overlapped by the plates encircling it so that its free surface is confined to the middle area. In the studied

specimen this is 71 mm in width and 74 mm in length. This area is occupied by a shallow, bowl-like depression, without sharp lateral limits, elsewhere surrounded by a semicircular thickening. At the boundary with the nuchal plate there is a groove. It forms an embayment near the end of the paranuchal at the opening of the endolymphatic canal. Farther this embayment opens into the posterior lateral cavity and extends over a short distance along the suture between the central and the paranuchal.

The only preserved part of the marginal is that occupying a mesial position in relation to the lateral line groove running across this element. Along the anterior part of this line, on the ventral surface of the plate, stretches a ridge-like thickening which posteriorly lowers down and becomes sharp-edged. It constitutes the hind part of the „lateral consolidated part“ of Heintz. At the boundary between the marginal and the postorbital it is 30 mm long.

A large area of the external surface is smoothed out, undamaged tuberculation is to be found on the centrals only. The tubercles are very minute, below 0.3 mm and densely disposed (100 to 200 over 1 cm<sup>2</sup>).

The parasphenoid, already described in details by the present author (Kulczycki, 1956) was found together with the above considered head shield fragment. From the same element in *Dinichthys terrelli* it differs primarily in the presence on the dorsal surface of a small tuberculated area. The other differences mainly concern proportions.

The other cranial fragment (fig. 8A; pl. VI, fig. 2) from the Middle Frasnian beds of the Wietrznia hill (horizon II), belongs to an individual with similar, perhaps somewhat lesser dimensions, and is characterized by less regular shape of bones. This is particularly so in the case of suture between the two centrals which displays a markedly flexuous course, also in that between the centrals and the nuchal which is equally zigzag and less symmetrical than in the above described specimen. The proportions of the respective bones are also somewhat different. For example, the nuchal is here relatively short and wide, being 90 mm long as measured dorsally along the median line, while the width of the anterior margin is 75 mm, the length of the posterior margin being probably about 180 mm. The rather bad state of preservation of the studied specimen makes impossible a closer comparison of proportions in the particular plates, it would seem, however, that the shortness of the nuchal is its chief characteristic. The ventral length of the nuchal is 100 mm as against 130 mm displayed by the lower Frasnian specimen. The distance from the base of the joint process to the anterior nuchal extremity is here 155 mm, being 175 mm in the Lower Frasnian specimen. Correspondingly, the distance from the point of divergence of the sensory line on

the marginal from the median head line, measured on the cranial curvature, is 140 and 130 mm respectively. The proportions of the centrals were markedly similar or even the same as observed in the individual from the Lower Frasnian. The width and length (without the anterior process) are, in both cases, 70 mm. The length of the anterior process is not less than 30 mm.

The considered specimen is with an almost perfectly preserved marginal. It is a relatively narrow bone, with width never exceeding 50 mm and length up to 110 mm, forming the lateral margin of the cranial dome with the posterior lateral corner. The latter projects far to the side (the distance from its apex to the median head line, measured on the curvature, being approx. 200 mm) and does not display the presence of an independent postmarginal element. The lateral border of the marginal is incurved to produce an angle at the middle bone level. Its shape indicates that, similarly as in *Coccosteus* and other species of *Dinichthys*, the union of the cranial dome with the bones in the cheek area was not intimate. The boundary with the postorbital is anteriorly indented where the sensory line groove passes from one bone to the next. This is similar to what has been observed in the before described specimen and in the fragment of a North American head shield (Eastman, 1898, fig. 2). On the lower surface, from the apex of the process forming the exterior angle of the skull to the middle of the element and then parallel to the sensory line, stretches a thickening. It is low at its beginning, but gains in height as it advances, sharp-edged in its hind part, and particularly so in the central region. This is the posterior part of the so called lateral consolidated part. It displays a frontal height of 25 mm. This thickening passes on to the postorbital where, about the middle of the element it tapers into a rather narrow crest, inwardly inclined. On the ventral side it exhibits a concavity (the double sockets) posteriorly steeply limited.

The middle part of the postorbital being damaged, it is impossible to ascertain whether the median cranial process existed at all and how it was shaped. Hereabout, along the course of the central groove on the external surface, the triangular, shelf-like process of the central plate is wedged into the inner border of the marginal. On the ventral surface, the suture between the marginal and the postorbital has a similar course as that in *Dinichthys intermedius*.

The course of the sensory line grooves displays some individual variations as compared with the Lower Frasnian head shield. To say the central groove does not on the inward side go beyond the line indicated by the course of the supraorbital groove. The so called vestigial groove or the median pit-line lies very close to the central groove, cur-

ving backward it reaches the margin of the central plate contacting with the nuchal. In these details the here described specimen closely resembles the head shield described from North America (fig. 9).

In addition to these major samples, two smaller cranial fragments have been found in the Middle Frasnian of the Wietrznia hill.

An incomplete nuchal represents an individual at least three and a half times larger than that from the Lower Frasnian. On the ventral side it exhibits a concavity (the double sockets) posteriorly steeply limited. On the posterior margin there is a surface for the process of the paranuchal reaching far inwards. A deep notch in the frontal part of the lateral margin indicates that the paranuchal overlapping the nuchal, particularly so on the dorsal side, was itself wedged into the margin of that element by means of a stout shelf.

A fragment of the joint socket area of the paranuchal is, on the contrary, to be referred to a considerably smaller individual. The width of the joint socket, measured parallel to the axis of the joint, is scarcely 13 mm, while the diameter of the curvature is 9 to 10 mm. In spite of the smaller dimensions of that specimen the size of the ornamenting tubercles and its density do not differ from those common in larger individuals, which indicates that the size of tubercles did not alter with the age of the individual.

Of the jaw apparatus belonging to the here studied form our material only contains the right anterior supragathal collected from the lower *Cheiloceras* beds of Kadzielnia (pl. VI, fig 1). Its shape is that typical of genus *Dinichthys*. We may distinguish here an anterior part which is narrower, being only about 15 mm wide, and a wider posterior (lateral) one, about 30 mm in width. Both these parts meet at an angle of nearly 90° forming a ridge, in the lower portion made conspicuous as a rounded crest. In the upper part it is replaced by a triangular nearly plane surface. Along this ridge the anterior supragathal is thickened and elongating downwards forms a tooth-like process, triangular in section. Another tooth-like process, though much smaller, occurs at the lower end of the posterior edge of the element. The upper end of the anterior part continues as a lobe-like process, curved inward. The presence of „denticles” on the vertical edge of the tooth-like process is an index character permitting the assignment of this jaw element to the remains of *Dinichthys pustulosus*. The height of the preserved part of the anterior supragathal is 42 mm. Another 10 mm must be added to this figure to make up the missing apical pick of the tooth-like process.

Of the body armour the Holy Cross Mts. material contains four fragments of the median dorsal and one of the anterior lateral.

The most complete specimen of the median dorsal (pl. V) has been

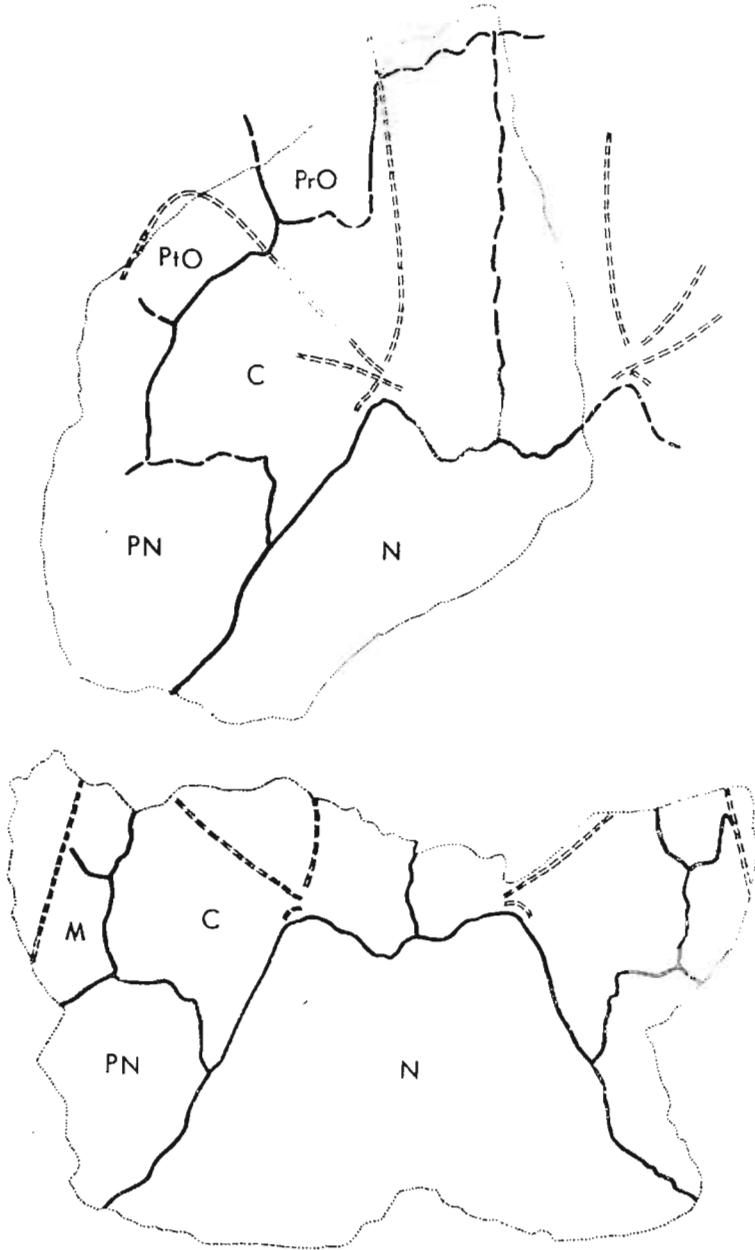


Fig. 9. — *Dinichthys pustulosus*; sketch drawings of fragmentary North American head shields, after Eastman, 1898, fig. 1; 1907, pl. 12. Legend — as in fig. 8.

recovered from the Lower Frasnian of the Wietrznia hill, together with the described above fragment of skull. It is strongly curved at an angle of  $110^\circ$ , without, however, forming an edge. Ventrally there is a strongly developed keel, attaining in the hind part a height of 60 mm and a length of over 180 mm at the base. The process of the keel, not preserved in the studied specimen, was placed in a more vertical position than that in *Dinichthys intermedius*, meeting with the external surface of the element at an angle of  $110^\circ$ . From its base, clearly indicated ridge-like thickenings extend to the side forming an angle of nearly  $90^\circ$ . They go on arching laterally and growing flatter and broadening out to disappear completely at a distance of about 80 mm from the keel. The dorsal surface is tuberculated finely but apparently not so densely as in the above described fragment of the head shield. Very faint traces are discernible of the sensory line grooves (pl. V, fig. 2), running obliquely on the dorsal surface of the median dorsal from the side and front, inwards, to the hind part of the surface, without, however, attaining it.

The other median dorsal fragment collected from the Middle Frasnian of the Wietrznia hill is in a still more fragmentary state of preservation, being broken up into minute fragments. It belonged to a far larger individual and may have been less strongly transversally curved. On the outer surface the tubercles show a most uniform and very dense arrangement.

The two remaining median dorsal fragments, recovered from the Upper Frasnian (*Manticoceras* beds) in Kadzielnia, are still more incomplete. They are referable to *Dinichthys pustulosus* on the character of ornamentation.

The anterior lateral fragment (pl. VI, fig. 3) corresponds to that part of the anterior margin which was bent at the level of the posterior lateral corner of the head shield. Similarly as in *D. intermedius*, above the bent on the front margin of the anterior lateral, there is an elongated excavation, more closely limited anteriorly, overlapping the hind margin of the head shield, when the head is lowered. Farther downward, the front margin of the anterior lateral widens out forming the base of the median process connected with the interolateral. Here a characteristic knob is to be noted. On the outer surface the tubercles are arranged with relative scarcity (less than 100 over  $1\text{ cm}^2$ ), similarly as they are on the median dorsal from the Lower Frasnian.

*Remarks.* — The shape of the anterior lateral, the median dorsal with its characteristic keel, the anterior supragnathal, as well as the general arrangement of bones in the head shield, and the free cheek area, all indicate that the above described fossils are doubtlessly referable to genus *Dinichthys* (as interpreted above). Similar ornamentation is

displayed besides *D. pustulosus* Eastman, also by other representatives of this genus such as *D. oviformis* Gross from the Eifelian of the Rhine province, and *D. magnificus* Hussakof & Bryant from Genesee in the state of New York.

*Dinichthys oviformis* is known on detached fragments of the paranasal, anterior dorsolateral and median dorsal described by Gross (1933b, 1937). The two first mentioned specimens differ from the remaining ones as well as from the Holy Cross Mts. specimens in larger size and less dense arrangement of tubercles on the periphery. One specimen of the median dorsal of *D. oviformis* is with rounded, very closely disposed tubercles, and is not provided with thickened ridges reaching to the base of the crest. This specimen is doubtlessly referable to a different form than that described above. The other median dorsal specimen of *D. oviformis* in character of ornamentation, preserved over a small area only, resembles more closely the Holy Cross Mts. specimens, but differs from them in the tapering hind end and less strong transversal curvature forming here an angle of  $120^\circ$ .

*Dinichthys magnificus* differs conspicuously from our form both in the shape of the whole head which narrows strongly anteriorly and widens out posteriorly, and in the outline of the various bones.

The resemblance of the Holy Cross Mts. specimens with *D. pustulosus* is, on the other hand, obviously striking.

Besides such characteristic features as the presence of a number of denticles on the anterior supragnathal, of vestigial sensory lines on the median dorsal, the outlines of the various bones of the head shields in both — the American and Holy Cross Mts. specimens — are identical so much so as to include such a detail as for example the bent of the suture between the central and the marginal, situated to the side of the hind tongue-shaped process in the central part. Some existing unimportant differences do not appear to the present author as exceeding the range of individual variation which, on evidence of specimens from Wietrzna and more particularly so of the North American head shields is rather strong within this form and is mainly associated with irregularities of growth and ossification. The only differences, possibly observable, between specimens from North America and those from the Holy Cross Mts. are as follows: a) somewhat coarser tuberculation in the American specimens; b) the presence of an additional branching of the sensory line groove on the central plate (the „Restkanal“ of Gross, or the „median pit-line“ of Stensiö); finally possibly also less clearly marked sensory line grooves on the median dorsals of the Polish specimens. This last difference, however, has not been quite doubtlessly ascertained by the writer since no adequate illustrations of the American median dorsal

specimens were available besides a schematic drawing. Inasmuch, however, as these dissimilarities are of no great importance and pertain to characters displaying strong variability, it is probable that we have here a geographical variety of *D. pustulosus* representing a somewhat more advanced evolutionary stage.

*D. pustulosus* was established by Eastman (1897) on evidence of a fragmentary ventral plate, probably the anterior ventrolateral, and of a somewhat more complete anterior dorsolateral, both distinguished by a „finely tuberculated style of ornament“. As figured in the original description, these tubercles, however, are large and scarce, rather approaching the ornamentation of *D. tuberculatus*. They do not fit into the description of other specimens of *D. pustulosus* published subsequently either by Eastman himself or by other authors. This is most likely a result of the lack of precision in figuring them, since Eastman writes that: „... the artist has represented these somewhat diagrammatically...“. Hence, during comparative studies of material the present writer relies on fuller descriptions of more complete material later published by Eastman (1898) and by Hussakof and Bryant (1918) rather than on Eastman's type.

The presence of a branch of the sensory line groove on the central plate, as mentioned here above, is thus not regarded by the present writer to be a constant feature of the American specimens; in any case its behaviour varies considerably.

On evidence of the above data, *D. pustulosus* corresponds to a primitive form of moderate dimensions, distinguished a) by markedly fine tuberculation which is absent from very narrow strips only along the margins of bones; b) by strongly domed head shield; c) by somewhat flexuous course of sutures; d) by a relatively long contact of the centrals along the median line; e) by an anteriorly bluntly truncated, fairly long trapezoidal nuchal; f) by the presence of the median pit-line (the „Restkanal“ of Gross) on the centrals, and of traces of the sensory line grooves on the median dorsal; g) finally by the presence of vestigial tooth denticles on the infragnathal and anterior supragathal.

In his paper on the Brachythoraci from Tafilalet in Marocco published in 1956, Lehman refers to the view held by Ørvig, according to which *D. pustulosus* is not believed to be a dinichthyid. Unfortunately, Lehman does not state any evidence for what he postulates besides mentioning the fossil remains described by Hussakof in 1942. In what these are concerned, the views advanced by the authors mentioned above seem reasonably admissible. Nevertheless, as suggested by character of ornamentation, neither do Hussakof's specimens described in 1942 belong to *D. pustulosus*. In what regards other American materials known to

the present writer from literature, and still more so in regard to specimens from the Holy Cross Mts., it is not excluded that a fuller knowledge of the here considered form in particular and that of *Dinichthyidae* in general will necessitate the subgeneric or even generic separation of *D. pustulosus*, but will also confirm beyond doubt its association with the *Dinichthyidae*.

*Occurrence.* — *D. pustulosus* has thus far been recorded from the Middle Devonian (Hamilton) of the states of Wisconsin, Iowa and Illinois, also from the Upper Devonian (Genesee) of Indiana, Kentucky and New York; now the range of this form must be extended throughout the Frasnian and the lower *Cheiloceras* Famennian horizons in the Holy Cross Mts.

*Dinichthys denisoni*<sup>5</sup> n. sp.  
(text-fig. 10; pl. VI, fig. 4; pl. VII)

*Material.* — Three specimens of the median dorsal, two of which come from the *Clymenia* beds of Gałęzice and the third one from the lower *Cheiloceras* beds of Kadzielnia in Kielce.

*Diagnosis.* — A rather small representative of genus *Dinichthys* with bones unornamented, with the median dorsal characterized by a straight course of the lower margin of the keel, like it is in *Dinichthys? jeffersonensis* Branson & Mehl, but differing from it in greater height of keel and in presence on apex of the carinal process of a typical spoon-like excavation.

*Holotype.* — A nearly perfect median dorsal (I. G.) (pl. VII, fig. 2 a-c).

*Description.* — All the specimens of the median dorsal plates are of pretty the same size, indicating that they represent the average dimensions of an adult individual of this form. The best preserved specimen (pl. VII, fig. 2 a-c) from the *Clymenia* beds, is 135 mm in width, when measured along the chord line, and about 150 mm, when measured along the curvature. It is gently domed and relatively strongly elongated, attaining in the median line a length of above 105 mm. The hind, gently rounded margin displays centrally, above the base of the carinal process, a rather small, semicircular process usually missing in representatives of genus *Dinichthys*. The keel, as mentioned in the above diagnosis, is characterized by a rectilinear margin stretching to the apex of the carinal process and attaining a length of 125 mm. The carinal process is slender and fairly long (60 mm in length and 15 mm in width). It starts with a slightly broadened out base without any branching

<sup>5</sup> This species is dedicated to Dr. R. H. Denison, Curator of the Fossil Fishes Department in the Natural History Museum of Chicago.

thickened ridges. Seen in profile its outline is gently arched. In the upper portion of the posterior surface a rather small rib runs along the median line extending to half the length of the process. A third, lower part of the process is occupied by a characteristic spoon-like excavation. The hind margin of the carinal process meets with the dorsal surface of the element at an angle of about  $120^\circ$ .

The other specimen (pl. VII, fig. 1 a-c), collected at the same site, differs from that described above in somewhat larger dimensions. The carinal process here attains nearly 80 mm of length. In relation to the

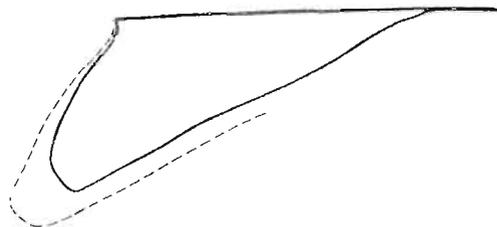


Fig. 10. — *Dinichthys denisoni* n. sp., longitudinal section of the median dorsal with discernible outline of crest. Outline of less complete specimen shown by broken line.

dorsal surface of the element it is placed at an angle of  $125^\circ$ .

The specimen (pl. VI, fig. 4) from lower *Cheiloceras* shales of Kadzielnia is strongly compressed. Its state of preservation, however, permits to ascertain that the shape of the crest and of the carinal process were the same as those in specimens from the *Clymenia* beds of Gałęzice. Similarly, the vaulting

of the bones is gentle. The carinal process is here 75 mm long.

*Remarks.* — In regard to the shape of the crest, the here considered form resembles *D. jeffersonensis*, but differs from it in greater height of crest and a more characteristic shape of the carinal process.

*Occurrence.* — The Famennian, lower *Cheiloceras* beds of the Kadzielnia hill in Kielce, and the *Clymenia* beds of Gałęzice.

*Dinichthys ceterus*<sup>6</sup> n. sp.

(pl. VIII, fig. 1 a-b)

*Material.* — One specimen of the median dorsal.

*Diagnosis.* — A small form characterized by lack of ornamentation and the nearly horizontal position of the carinal process.

*Holotype.* — A fragment of the median dorsal (M. Z.) (pl. VIII, fig. 1 a-b).

*Description.* — The preserved fragment of the median dorsal 120 mm in length, comprises the median part of the element including the crest. The crest has a maximum height of 30 mm, while its length is over 150 mm. The carinal process is slightly curved from the plane, so that it projected very conspicuously beyond the hind margin of the median dorsal. A transverse thickening at the base of the carinal process is not

<sup>6</sup> The specific name is derived from the Latin word *ceterus* — other.

indicated on the dorsal surface of the element, thus differing from the corresponding thickening in *D. pustulosus*. From the latter form, as well as from *D. denisoni* and other representatives of the same genus *D. ceterus* differs also in the presence of a sharp hind margin of the thickening at the base of the carinal process.

*Occurrence.* — The Famennian, *Cheiloceras* beds of the Kadzielnia hill in Kielce.

*Dinichthys* cf. *tuberculatus* Newberry  
(pl. VIII, fig. 2, 3)

*Material.* — Several, characteristically ornamented fragments from the *Clymenia* beds of the Famennian in Gałęzice.

From this material fragments of the preorbital, marginal and paranasal have been recognized. They are, however, so fragmentary that they give no clue to the more significant structural details. A more complete fragment constitutes the supposed hind portion of the right posterior ventrolateral. In addition to minute, typically ornamented head shield fragments, an impression has been found of the right infragnathal mesial surface comprising a small piece of bone corresponding to the anterior lower portion of that element.

*Description.* — The infragnathal (pl. VII, fig. 2) whose broken off, probably posterior end left no traces on the rock surface, was found to be over 200 mm long. Its hind portion constituting the „blade“ fused with the upper part of the arched jaw, is of a rather robust appearance. It is 65 mm wide at the posterior end and 38 mm forward where the „blade“ passes into the fore part. The latter, 109 mm long, occupies about one half of the entire length of the element. Along the lower margin there is a thickening posteriorly passing, without sharp limitation, into the back, blade-like part and projecting forward along the anterior margin and to the top passing into a large toothed process. As compared with *D. intermedius* and other representatives of this genus, the here described infragnathal is, among others, distinguished by the rather small height of the above mentioned thickening. It is here but 15 mm high against 45 mm of entire height shown by the anterior part of the element. The remaining portion of the fore part of the infragnathal, lying above the thickening, is gently arched and smooth. In half length only, on the functional edge, there is a thickened ridge forming the second, smaller toothed process. It is nearly 20 mm high and 5 mm broad, and its position is very characteristic being equidistant from the anterior and posterior ends of the functional part. In this point it differs from other species of *Dinichthys*. Its upper cutting edge, contrary to what we see in *D. intermedius*, *D. terrelli* and others, in

*D. newberryi* Clarke, particularly so, displays no incision between the two toothed processes but runs almost rectilinearly to the back, where it descends abruptly near the boundary with the posterior part of the infragnathal. The upper cutting edge rises slightly in the region corresponding to the smaller toothed process only. As a whole the infragnathal, when seen from above, is gently sigmoidal, somewhat more so at the posterior, inwardly directed end.

The supposed posterior ventrolateral is 101 mm broad. Its outer surface shows an ornamentation consisting of irregularly disposed, moderately large tubercles, with diameter occasionally up to 1.5 mm, mostly rounded, domed, frequently quite flat, more seldom of a conically pointed shape.

*Remarks.* — The shape of the infragnathal which is a skeletal part of such diagnostic significance assures us that we are dealing here with a representative of genus *Dinichthys*, as broadly recognized, or more strictly speaking with the „terrelli“ group, by Lehman separated into genus *Dunkleosteus*. The character of ornamentation supports the assignability of the Gałeczice specimens to *D. tuberculatus* Newberry. This species was established by Newberry in 1889 on fragments of the median dorsal and anterior lateral, with the shape typical for genus *Dinichthys*, and with a peculiar ornamentation about which Newberry writes: „The tuberculation of the surface is relatively coarse, and the tubercles vary much in size and are irregularly scattered. Most of them seem to be hemisphaenical and plain, but others are more or less pitted and few stellate“ (1889, p. 99).

Into this species Newberry also incorporated specimens from Psammite de Condroz in Belgium which Lohest, in 1889, also described as *Dinichthys pustulosus* (non *D. pustulosus* Eastman, 1897). It is to be noted that the drawing of the anterior dorsolateral, as figured by Newberry in his original description, does not adequately show off the character of ornamentation as stated in his text, and has been done in a somewhat idealized and schematic manner. On the base of a probably equally inadequate drawing by Eastman (here mentioned in the description of *D. pustulosus*), in 1932 Heintz referred Newberry's specimens to *D. pustulosus* Eastman. Leriche (1930), on the other hand, differentiated the Belgian specimens into a new species, *D. belgicus* Leriche, on evidence of a certain difference in the width of the anterior dorsolateral and the absence from it of the sensory line groove. The details stressed by Leriche, i. e. the expansion of the free area and absence of the sensory line groove, do not seem to the present writer sufficiently valid ground for the establishment of a new species, all the more so in view of the bad state of preservation of the specimen as figured in the published photo-

graph. In connection therewith, the present writer is inclined, tentatively at least, to regard *D. belgicus* Leriche as synonymous with *D. tuberculatus* Newberry. The wide range of distribution of *D. pustulosus* Eastman reinforces the probability of the identity of the coarse tuberculated representatives of genus *Dinichthys* from both continents. Additional evidence in support of this opinion, supplied by American material, is the longevity of these forms.

In spite of the fair abundance of the fossil remains of *D. tuberculatus*, they are generally most fragmentary so that our present knowledge on the structural details of this form is most inadequate. The characteristic ornamentation is so far the only observable diagnostic character. It is thus a representative of genus *Dinichthys*, of moderate size, with bone surface covered by irregularly scattered tubercles, fairly large though of varying dimensions, sometimes rounded and flat, elsewhere more sharply pointed.

The lack in the material from Gałęzice and from other parts of the same bones and the scantiness of the available information hinder more accurate comparative studies and the establishment of identity suggested with reasonable likelihood by the type of ornamentation. The ornamentation of the Gałęzice specimens is identical with that in *D. tuberculatus* from North America, as described by Newberry, and also with that of Belgian specimens. The writer was able to ascertain the identity not only on the photograph published in Leriche's paper, but also on a specimen from the Devonian of Belgium, in the collections of the Geol.-Paleontological Institute of the Humboldt University in Berlin.

*Occurrence.* — In accordance with the above conception of species *D. tuberculatus*, its distribution would include: the Middle Devonian (Hamilton) of Wisconsin, Iowa and Illinois; the Upper Devonian (Portage) of Kentucky, Pennsylvania and Ohio, and the Famennian of Belgium and Poland.

*Dinichthys?* sp.

(pl. VI, fig. 5)

An anterior dorsolateral, probably referable to *Dinichthys*, has been recovered from the lower *Cheiloceras* beds of Kadzielnia. It must have belonged to an individual of moderately large size. The unornamented outer surface is traversed by two grooves of the lateral line. One of them projects from the anterior margin of the bone where the sensory line passes onto the paranuchal above the joint, the other starts at a distance of about 40 mm from the anterior margin of the bone and is directed somewhat obliquely upward and backward. As stated by Heintz (1932) similar secondary grooves are also observable in *D. intermedius*, where

as many as three of them occur occasionally and are not in the least related to the line extending over the median dorsal in *Cocosteus* and other similar forms. According to data published by Eastman, there is also an additional groove on the anterior dorsolateral of *Dinichthys pustulosus*. Its course, however, is different, resembling that common in the Holonemidae. In consideration of this character the above mentioned anterior dorsolateral cannot be regarded as an element of *D. pustulosus* from the same beds, with the ornamentation worn off.

The free area in this specimen exceeded 10 mm in width. The length of the preserved fragment was 120 mm, indicating that the entire length must have been more than that. A portion of the anterior margin of the free area situated above the condyle meets that portion lying below the condyle at an angle of  $126^\circ$ . The whole bone is gently domed. Its anterior margin is bent at an angle of  $150^\circ$ . The condyle must have been large and very robust. It is 33 mm wide at the base and 17 mm thick at the mesial border. To the rear and downward it gently passes into a thickening projecting, as in *D. intermedius* and probably in others, on the inner surface of bone. The thickness of the here considered specimen attained 17 mm in the lower part of the anterior margin, being 7 mm at the back.

*Remarks.* — The specific position of this specimen cannot be now established. It has been already mentioned above that it is not an abraded element of *D. pustulosus*. The relative robustness of the anterior dorsolateral structure as compared with the slightly more delicate structure of the described median dorsals speaks against its relationship with either of the two other forms recorded from the same beds.

Brachythoraci gen. et sp. indet. (β)

(pl. XII, fig. 2)

An anterior dorsolateral, more closely indeterminate, was found in the *Clymenia* beds of the Famennian in Gałęzice, which have also yielded remains of *Titanichthys*, *Pachyosteus* and *Dinichthys*.

It is a fairly well preserved plate with an almost complete condyle. It is gently arched transversally and has a narrow free area. Most particularly narrow was that part lying beneath the sensory line groove horizontally intersecting the bone. The width of the free area is 45 mm when the length of the element is at least 85 mm without the condyle which strongly protrudes beyond the anterior margin of the bone. On the outer surface of the down side, there is a large plane overlapped by the anterior lateral. To the front of the latter element, along the anterior margin of the anterior dorsolateral a high crest projects (17 mm). On the upper margin of the specimen we can note a small portion

of the surface serving for attachment with the median dorsal. The condyle is robust, 30 mm in length (measured parallel to the axis of joint) and 15 mm in thickness at the outer margin. Mesially, the condyle grows narrower tapering into a point. From the condyle, on the inner surface of the bone, a crest extends with height first equal to the length of the condyle and abruptly lowering to the rear, though still discernible at the posterior border of the bone as a slight elevation. The outer surface of the anterior dorsolateral is perfectly smooth, without any ornamentation. The bent in the anterior margin near the condyle, as well as others characters speak against their assignment to any of the mentioned genera.

Genus *Titanichthys* Newberry, 1885

*Titanichthys kozłowskii*<sup>7</sup> n. sp.

(text-fig. 11; pl. IX, fig. 6)

*Material.* — Two head shield fragments, of which one comprises an incomplete nuchal and the left central, while the other probably constitutes a part of the paranuchal.

*Diagnosis.* — A relatively small form in which the centrals are large and extending far to the back and sides, thus resembling *T. clarki* Newberry and *T. agassizi* Newberry, and differing from *T. termieri* Lehman. The scheme of the sensory line grooves on the centrals probably that in the holotype of *T. termieri*. The nuchal broad at the front as in *T. agassizi* or in *T. termieri*. From *T. agassizi* it differs in another shape of the depression (double sockets) on the ventral surface of the nuchal, which is here characterized by larger posterior embayments, projecting far backward, while the anterior ones are smaller.

*Holotype.* — A fragment of the head shield comprising a portion of the left central and nuchal plates.

*Description.* — The nuchal had the outline of a low equilateral triangle with rather strongly concave base. Medially flat, its elongated posterior lateral portions are gently curved sideward and downward, so that as a whole this element was slightly arcuate. Very thin in the fore part, it attains a considerable thickness (26 mm) in the hind part, producing an arched thickened ridge beyond which is the broad shelf of the posterior margin. Behind this thickening, in the central part, is an extensive double depression (double sockets) with a four-lobed outline, medially separated by a high crest. At the back it is limited by a moderately high buckle-shaped crest. Each of the double sockets attains

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<sup>7</sup> This species is dedicated to Prof. R. Kozłowski, Head of the Institute of Paleozoology of the Polish Academy of Sciences.

its maximum depth (approx. 20 mm) in the anterior median part and is divided by a thickened elevation of the side wall into two embayments. Of these the anterior projects farther to the side than the posterior one directed to the rear. On the anterior border the excavation is up to 58 mm in width, its medial length is 40 mm and it overlaps the central process of the posterior nuchal margin. The process is over 15 mm long and 40 mm broad. Ventrally, beyond the posterior margin of the double

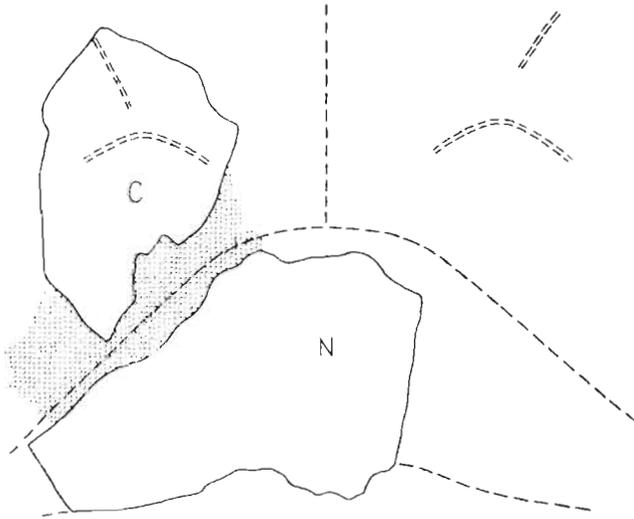


Fig. 11. — *Titanichthys kozłowskii* n. sp., diagrammatical drawing of posterior part of head shield. Continuous line — limits of preserved fragments; broken line — supposed course of suture between the nuchal (N) and the centrals (C); dotted area — part of specimen with damaged surface.

sockets, the process is striped by sagittal ribs, of which three — a central one and two laterals — are more conspicuously indicated as small crests. The length of the preserved part of the nuchal on the median line is 98 mm. The distance between its posterior lateral ends projected farthest to the side exceeds 220 mm.

No natural margin has been preserved on the central, but it must have been a very large bone reaching far to the rear. The preserved fragment is 115 mm in length and 70 mm in width. Actually the central must have been at least twice as broad and considerably longer.

Besides the much erased traces of the terminal parts of the supra-orbital and central lines we may note here a characteristic independent branch of the sensory canals (the „Restkanal” of Gross, the „central pit” of Stensiö), running from the middle of the bone mesially and

somewhat to the back. No occipital line is observable, such as present in *Titanichthys agassizi*, but its lack here may be due to the state of preservation.

The bad state of preservation does not permit a closer description of the supposed paranuchal. It is a thin bone, displaying a more important thickening (32 mm) in the mesial part only, on which two impressions are to be seen ventrally, serving perhaps as the means of attachment to the nuchal. This thickening probably corresponds to the „hind consolidated part“ of Heintz. On the posterior end of this thickening there is an excavation which may be the joint socket. It is rather large though shallow. Its length (measured parallel to the supposed axis of joint) is 50 mm, while the width is 30 mm.

*Remarks.* — The characteristic features of the above described specimens are the relative thinness and fineness of bones common in the genera *Titanichthys* and *Gorgonichthys*. Both genera are characterized by relatively large centrals. In *Gorgonichthys* the shape of the joint socket apparently resembles the excavation present on the supposed paranuchal. Unfortunately, we lack closer data concerning this details in *Titanichthys*. The assignment of specimens from the Holy Cross Mts. to the latter genus is suggested foremost by the shape of the ventral surface of the nuchal which has the characteristic form of a double excavation. The presence of a vestigial canal on the central, missing in a well known representative of the *Gorgonichthys* is a less diagnostic feature. As may be seen from the drawing published by Dunkle & Bungalow (1940), this region is differently shaped in *Gorgonichthys*. Different proportions and details, for example the stronger development of the posterior embayments as compared with those in *T. agassizi*, another behaviour of the centrals than those in *T. termieri*, also the absence of the occipital canal, finally a different outline of the nuchal, as compared with *T. clarki*, — all indicate that we are here dealing with a new species of *Titanichthys*.

*Occurrence.* — *Clymenia* beds of the Famennian in Gałężice near Chełm.

#### Genus *Stenosteus* Dean, 1901

*Stenosteus?* sp.

(pl. XI, fig. 4)

The *Cheiloceras* (Lower Famennian) beds of the Kadzielnia hill have yielded a rather small fragment of the infragnathal, referable to some representative of Selenosteidae. It comprises the hind portion of the functional part together with an impression on the rock of the fore portion of the posterior blade. The functional part of the infragnathal

in this form was narrow and elongated. Its height was 8 mm, while the length of the preserved fragment constituting no more than half of the entire functional part was 21 mm. The upper edge of the functional part is provided with a single row of minute knotty denticles rather scarcely arranged (4 cusps over 10 mm). A similar single row of denticles also occurs in genus *Rhinosteus*, but the denticles there are more densely arranged and the height of the entire functional part is considerably greater. In connection with the above features this poorly defined specimen is by the present writer tentatively referred to genus *Stenosteus*.

Genus *Pachyosteus* Jaekel, 1903

*Pachyosteus bulla* Jaekel, 1903

(fig. 12, 13; pl. IX, fig. 1—5)

1932b. *Pachyosteus bulla* Gross; W. Gross, Die Arthrodira Wildungens, p. 16—18, fig. 4 a-c, 5 a.

1933b. *Pachyosteus bulla* Gross; W. Gross, Die Wirbeltiere..., p. 35.

*Material.* — Five specimens, one of them, comprising a large fragment of the head shield and shoulder girdle, contains a number of elements thus far unknown in this genus, to say: the postsuborbital, postmarginal, anterior supragnathal, posterior supragnathal, probably the parasphenoid, the anterior lateral, anterior median ventral, interolateral, anterior ventrolateral. Other elements preserved almost complete in this specimen are the preorbital, suborbital, rostral, anterior part of the pineal and the infragnathal.

*Description.* — The head shield as a whole is broad, strongly domed, bluntly terminating at the fore end. The preorbitals, however, do not form such sharply indicated anterior lateral corners, as those reconstructed by Gross (1932, fig. 4A), in consequence of which the front of the head is more rounded.

The rostral is rather small, 14 mm long and 16 mm broad, its outline approaching that of an equilateral triangle with rounded corners and gently incurved sides which meet the preorbitals. The arcuate anterior border curves downward.

The pineal is approximately of the same width as the rostral. The distance from the pineal excavation to the contact with the rostrum is 14 mm.

The large orbital cavity, over 50 mm in diameter, is limited by four bones. The preorbital, about 50 mm long and 25 mm broad, does not differ in its outline from the corresponding element in Wildungen specimens. The postorbital is with damaged mesial and hind margins,

at the same time, however, its shape does not apparently differ from that common in German specimens. The margin of the orbital cavity produces a horizontal shelf in the fore part. The dorsal surface of the postorbital is striped by the groove line of the postorbital and a section of the infraorbital line, branching in a mode characteristic of the Pachyosteidae. The suborbital has a narrow and elongated fore part, basally limiting the orbital cavity which is provided with a mesial list only indicated by an inconspicuous rib. To the hind the suborbital broadens out into a „blade“. The posterior margin of the orbital cavity is provided with a list placed somewhat lower than the remaining outer surface of the bone. In the Wildungen specimens this list is not always discernible and has not been shown in the reconstruction of Gross (1932b, fig. 4A), owing to which the posterior part of the suborbital appears here narrower than it is actually. Its presence, however, in one of the Wildungen specimens, has been quite doubtlessly ascertained by the present writer, together with the essential resemblance of the shape of the suborbital in the Polish and German specimens. The specimens from Gałeczice suggest that the posterior blade of the suborbital was not so nearly horizontal as has been shown in the reconstruction by Gross, and that it did not give the impression of being so much elongated owing to its longer contact with the postsuborbital. The infraorbital line running over the outer surface of the anterior, narrow portion of the suborbital meets the forward part of the „supramaxillar line“ (so called by Stensiö) at a point somewhat to the front of the area where the latter element broadens out. This imparts a picture, so common in Pachyosteidae, of a bifurcating ramification.

The postsuborbital is a considerably larger bone than that shown in the reconstruction of *Pachyosteus bulla* executed by Gross in 1932b (fig. 5A). Its outline is that of an elongated rightangle triangle, whose shortest side forms the suture with the suborbital. The course of this suture is essentially the same as that in the above mentioned reconstruction, but it extends lower down, partly involving the hind part of the lower margin of the suborbital, which has been placed horizontally in that reconstruction. One side of the triangle constitutes the free margin of the postsuborbital, while its hypotenuse meets the marginal and the postmarginal by a suture running rectilinearly and horizontally. The length of the postsuborbital, as measured along its upper margin, is 46 mm in the described specimen, while the distance of the suture between the postsuborbital and the suborbital from the orbital cavity is 25 mm and corresponds to the width of the posterior suborbital blade, or to its height as reconstructed by Gross.

The postmarginal is a rather small bone, also triangular in outline.

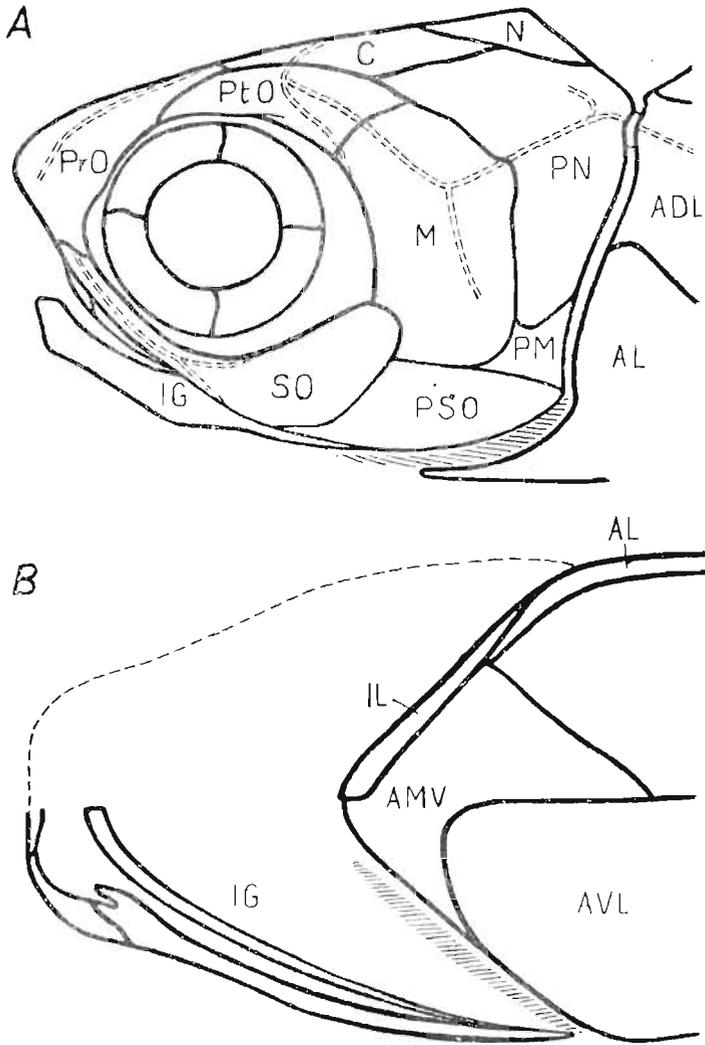


Fig. 12. — *Pachyosteus bulla*: A reconstruction of head skeleton, side view; B diagrammatical drawing in the fore part of the ventral armor and its position in relation to the head shield (above-dorsal surface, below-ventral surface). AL anterior lateral, AMV anterior median ventral, C central, IL interolateral, IG infragnathal, AVL anterior ventrolateral, M marginal, N nuchal, PM postmarginal, PN paranuchal, PrO preorbital, PSO postsuborbital, PtO postorbital, SO suborbital.

Stippled area — supposed position of the gill slit.

The margin in contact with the paranuchal and the marginal, unfortunately damaged, apparently seems to have formed several bents. The lower margin, in contact with the postsuborbital, about 23 mm long, had a rectilinear course, meeting the free posterior margin of the element at a sharp angle. Owing to this and to the relatively great length as well as to the position of the suborbital, the posterior margin of the head shield did not project obliquely downward beginning from the point of connection between the joint and the shoulder girdle. On the level of contact between the postmarginal and the postsuborbital, it formed a bent to the rear, to agree with the corresponding embayment of the forward margin of the anterior lateral. The hind margin of the postmarginal, about 30 mm long, is provided with a list fitting, with the head lowered, into the cleft of the forward margin of the anterior lateral.

The infragnathals, both right and left, are damaged in their hind portions. The preserved part of the more complete left plate is 106 mm long and 18 mm broad in the back. In the front, at a distance of 45 mm from the anterior end, the lower margin of the infragnathal displays a gentle curve limiting the functional part from the posterior „blade“. The upper margin displays a narrow surface (4 mm), characteristic of genus *Pachyosteus*, covered by minute denticles arranged at random. This surface, somewhat raised in relation to the upper margin of the posterior blade of the jaw, grows narrower to the front and back. At the back it occupies the upper edge and partially overlaps the mesial surface of the infragnathal. To the front it passes onto the outer surface of the element. On the mesial surface of the fore part of the infragnathal, starting at the bent on the lower margin mentioned above, a crest extends toward the front limiting the lower and upper parts of the mesial surface. Not far from the anterior end of the bone, this crest is arcuately directed to the upper margin of the infragnathal, at the same time becoming flattened out and from the top limiting the excavation in the symphyseal part. Ventrally this excavation is concealed by an extremely fine, probably perichondral, osseous lamella.

The anterior supragnathal is a very small bone, not exceeding 12 mm in length. It constitutes an arched blade, with a finely tuberculated surface on the lower margin, similarly as in the infragnathal. On the upper margin of the anterior supragnathal, at approximately its mid-length is placed the upper process. Hence the whole element has a triangular outline with the lower margin convex and the other two concave.

The posterior supragnathal, contrary to the above considered element, is very long but equally narrow. Its length attains 52 mm, which is approximately the length of the functional part of the infragnathal. The

thickness and the height of the element do not seem to exceed 3 mm. Backward and forward this jaw grows narrower and more pointed. Over a considerable central portion of the lower margin there is a narrow cuspidate surface. First it occupies the lower margin, and a part of the outer surface of the element, and forward overlaps the mesial surface, following the shape of the infragnathal surface.

The parasphenoid (fig. 13) shows a different structure than that in *Dinichthys*, *Heintzichthys*, *Malerosteus* and *Brachythoraci* gen. indet., described in 1956, and apparently represents here a more primitive

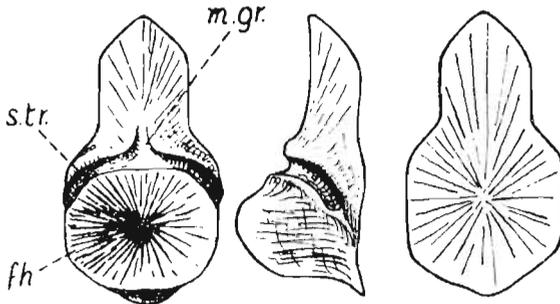


Fig. 13. — *Pachyosteus bulla*, the parasphenoid: A dorsal view, B side view, C ventral view; fh hypophyseal depression, m. gr. unpaired central groove, s. tr. transverse groove.

evolutionary stage. This is a bone, 25 mm in length and 14 mm in maximum width. Its smooth and plane ventral surface has the outline of a somewhat elongate and rounded hexagon. Anteriorly it is provided with a process whose lateral margins first run parallel and then converge at a nearly right angle. Dorsally, in the hind part of the parasphenoid is a raised area with an extensive bowl-like, pituitary depression (fig. 13, fh). On both lateral sides the margin of the depression is particularly raised. To the front of this depression, on its outer embankment extends a transverse groove (s.tr.) whose lateral ends are directed arcuately backward. Medially this groove branches off into an unpaired ramification (m. gr.) directed straight forward, along the central line, over the dorsal surface of the anterior process, which is here somewhat raised. These grooves probably contained internal carotids fusing here into one unpaired canal entering the cranial cavity.

The anterior lateral (pl. IX, fig. 2) is not completely preserved. The hind part and a considerable portion of the lower margin are missing. The hind part of the anterior lateral was an elevated blade (over 45 mm in height); forward it gradually elongated into a long and relatively narrow process. The fore margin of the blade, which, at the back, limited the cleft separating the shoulder girdle from the head shield, was

bifurcated into two lists bounding a slit-like depression. The mesial list is wider and continues farther forward. Downward it grows narrower while the slit becomes shallower. A rather small oval tubercle is placed at the lower end of the slit and inward of the external base of the list. The top of a triangular embayment extending from the front margin of the anterior lateral is directed toward this tubercle. In that point the margin of the considered element bends continuing in the upper margin of the anterior process. Immediately in front of the oval tubercle and beneath the mentioned embayment this margin forms a semicircular elevation and then is directed arcuately forward, widening out lanceolately. The anterior process of the anterior lateral is 67 mm long. First it is relatively high (over 15 mm on the level of the semicircular elevation) and blade-like with thickened upper margin only. Forward it grows narrower so that its terminal end, with a length of 16 mm, is a narrow rod. This part of the infragnathal was in contact with the interolateral.

The interolateral is an elongated rod-like bone. Unfortunately, it is not well preserved. It was about 40 mm long with thickness and width not exceeding 3 mm. It was in contact with the anterior margins of the anterior ventrolateral and the anterior median ventral. Following the shape of the ventral armor, the interlaterals of both sides met at the front at an angle of 75°.

The anterior median ventral is in an extremely fragmentary state of preservation, but on evidence of the preserved remains it seems to be of a broadly rhomboidal shape. The anterior ventrolaterals completely concealed its hind part from the ventral side. The width of the anterior median ventral was about 45 mm, with the length probably at nearly the same figure.

The anterior ventrolateral is also in an unsatisfactory state of preservation. It was 35 mm wide and approx. 60 mm long.

A detached median dorsal, referable to a considerably larger individual, was found within the same Gałęzice beds. The shape of this specimen suggests that it was a representative of Pachyosteidae. Since *Pachyosteus bulla* is thus far the only known representative of this family, recorded from the mentioned deposits, it is probably referable to that same species.

The width of the median dorsal is 144 mm, with the maximum length at nearly the same or slightly higher figure. Along the central line of the ventral surface extends a low crest, whose maximum height probably did not exceed 40 mm, measured from the outer surface of the median dorsal. In its lower part, i.e. 12 mm below the base, the carinal process has a spoon-like depression but slightly protrudes (about 15 mm)

beyond the hind margin of the element. As a whole the median dorsal is almost flat, very gently arched. The hind margin is somewhat rounded.

The same beds have also yielded a fragment of the head shield of a large individual, comprising a considerable part of the postorbital and the paranuchal, as well as small fragments of the preorbital and the central. The preorbital, 40 mm wide and over 70 mm long, is traversed by the central canal which bends angularly and continues as a canal running on the marginal. The upper portion of the postorbital part of the infraorbital canal branches off from that angular bend in a manner characteristic of the *Pachyosteidae*. The bad state of preservation renders impossible a more precise description of the remaining elements.

Suggestions as regards the dimensions of the studied specimen may be supplied by the size of the area, here measuring 94 mm, between the ramification of the sensory line grooves on the preorbital and a similar point on the joint part of the paranuchal.

The remaining specimens consist of the infragnathals of small individuals, also recorded from the *Clymenia* beds of Gałęzice.

*Remarks.* — The species *Pachyosteus bulla*, established by Jaekel in 1903, is thus far the only known representative of genus *Pachyosteus*. Gross (1932b, p. 16) characterizes it as follows: „A large and broad pineal wedges deeply between large centrals and at the front comes in contact with an equally broad and blunt rostral. The marginal does not unite with the central. The nuchal is broad and short... The occipital canal is indicated on the paranuchal only as a vestigial detail. The opercular canal is present. The ramification of the postorbital canal is characterized by the approach of the infraorbital to the postorbital canal. The infraorbital canal overlaps the marginal without uniting with the prolongation on the suborbital. Lack of tubercles on the head shield and the body armor“.

The specimens from the Holy Cross Mts. fully coincide with this description. Neither did a close comparative study of the here described material with the Wildungen specimens from the collections of the Geol.-Paleontological Institute of the Humboldt University in Berlin reveal any cardinal difference. More conspicuous lateral angles at the front of the head shield in some of the German specimens are associated with a *post-mortem* deformation, while certain differences in proportions of the rostral dimensions are within the limits of individual variations shown by the Wildungen specimens. To sum up, the only difference of any significance are the relatively large dimensions displayed by some of the Gałęzice specimens. Since, however, the majority of the Gałęzice specimens also in this respect agree with those from the Rhine province, it must be recognized that they are conspecific.

*Occurrence.* — The distribution of *Pachyosteus bulla*, thus far only recorded from *Manticoceras* beds of the Frasnian in the Rhine province, must now be extended throughout the Famennian of the Holy Cross Mts.

Genus *Oxyosteus* Jaekel (1911)

*Oxyosteus* sp.

(pl. VIII, fig. 4 a-b)

In the material recovered from horizon II (Middle Frasnian) of the Wietrznia hill a fragment of the median dorsal was found characteristically bent medially, so that the two sides meet at a rather sharp angle. Owing to the damaged condition of the surface it is hard to ascertain whether the bend in the bone produced here a sharp edge or a rounded ridge. The ventral surface shows the fore portion of the carinal process which was low and broad. The outer surface is fairly uniformly tuberculated (tubercles up to 1 mm in diameter). On areas from which the outer bone layers have been eroded the tubercles are very minute, suggesting that their size depended on the dimensions and the age of the individual. This median dorsal resembles the corresponding element in representatives of genus *Oxyosteus*. Two species of this genus differing in character of ornamentation are known from the Frasnian of the Rhine province. In respect to the size of tubercles the Wietrznia specimen comes close to *Oxyosteus magnus* Gross, from which it differs in the density and regularity of tuberculation resembling more that in *Oxyosteus rostratus* Gross.

The median dorsal from the Holy Cross Mts. is considerably larger than the German specimens, attaining a length of over 90 mm and a width of 40 mm, while these dimensions in specimens of *O. rostratus* and *O. magnus*, as described by Gross, are 35×30 mm and 54×35 mm respectively. Hence it is quite likely that we are dealing here with a very large individual of *O. rostratus*, though it is not quite inadmissible that it may be a new species. (*Pachyosteus bulla*, as shown above, may also attain considerably larger dimensions than those displayed by the material from the Rhine province).

Genus *Holonema* Newberry, 1889

*Holonema radiatum* (Rohon in coll.) Obručev, 1932

(pl. X, fig. 2 a-b)

1932. *Holonema radiatum* Obručev; D. W. Obručev, *Holonemidae...*, p. 100-107. pl. 5, fig. 2-5; pl. 6, fig. 5; pl. 7, fig. 3.

*Material.* — A fragment of the anterior dorsolateral, by Gorizdro-Kulczycka identified as *Holonema radiatum*, from the collections of the Geological Institute.

*Description.* — In shape and dimensions this specimen is almost identical with that element described by Obruchev (Obručev, 1932, fig. 7-8). The anterior margin is characterized by a similar indentation backward at the base of the joint process and by a doming beneath that process. The lower margin of the free area in the fore part shows an upward curving at a small distance from the anterior margin of the bone. The incomplete and damaged state of preservation of the studied specimen does not permit any precise measuring of the angle of inclination of the upper and lower parts of the plate, in relation to the horizontal plane, as indicated by the axis of condyle and by the course of the lateral lines. This angle seems likely to be somewhat greater than in the specimen described by Obruchev. It should be noted that these angles must have been slightly different in relation to the anterior and posterior margins of the bone. The condyle is large, conical, growing narrower toward the rather sharp mesial end. It is in the shape of a high pyramid with a triangular base, toward the top more rounded in section. One edge of the base corresponds to the anterior edge of the condyle which does not extend here beyond the anterior margin of the anterior dorsolateral. The wall of the condyle base opposite to this edge passes without sharp limitation onto the inner surface of the element, not producing a thickening directed backward, as may be seen for example in *Dinichthys*. The lower edge of the base continued downward as a thickened crest extending mesially along the broad anterior margin. On the outer side of this margin, under the condyle, is placed the characteristic subglenoidal process (Obručev, 1932). The anterior edge of condyle meets the lateral surface of the bone at an angle of about  $125^\circ$  (in the plane indicated by the axis of condyle and by the horizontal branch of the lateral line), suggesting that in this region the body broadened out backward.

The free outer area of the anterior dorsolateral has a characteristic ornamentation consisting of costae produced by the fusion of 1-2 rows of minute tubercles. In costae made up of two rows of tubercles, the tubercles are of smaller dimensions. Similarly as in the specimen described by Obruchev, above the horizontal lateral line, these costae are directed from the front and bottom upward and backward. Over a small distance under the mentioned line they are disposed parallel to its course, while farther downward they are placed normally to the lower margin of the free area.

Besides ornamentation the outer surface displays the already mentioned groove of the sensory line which projects backward from the base of the condyle. At a distance of about 35 mm from the anterior margin of the base, a ramification branches off from this canal at

a nearly right angle, first directed upward and then curving in an arch backward. The course of this canal in our specimen differs from that figured by Obruchev only in a less conspicuous backward and then forward curve in the fore part of the canal and in the longer backward extension. Nevertheless, in the reconstruction published by Obruchev (1932, fig. 26) the canal likewise projects far to the hind.

The preserved fragment is 80 mm in size, as measured along the anterior margin, and 75 mm as measured along the horizontal lateral line; the thickness of the bone at the base of the condyle attains 25 mm, and an average of 7 mm in other portions. The length of the condyle measured on the anterior edge is 55 mm. There are about 10 costae on a distance of 10 mm.

*Occurrence.* — According to Obruchev (1932) *Holonema radiatum* is recorded from the Frasnian deposits within the Leningrad and Donetz basins. At present its distribution must be extended into the Frasnian of the Holy Cross Mts.

Genus *Deveonema*<sup>8</sup> n. gen.

*Diagnosis.* — The same as for the species described below, the only one so far known.

*Deveonema obruchevi*<sup>9</sup> n. sp.

*Material.* — A fragment of the median dorsal.

*Diagnosis.* — A rather small representative of the Holonemidae, with the outer surface of dermal bones ornamented by small, detached tubercles (only occasionally 2-3 being fused together), on the whole dispersed at random, but in some parts, as for instance in the mesial portion of the median dorsal, arranged in longitudinal rows.

*Holotype.* — A fragment of the median dorsal (I. G.).

*Description.*—A small fragment of the median dorsal, representing not more than one third of the entire bone. Nevertheless it may be ascertained on the preserved part that this element displayed the elongation and roof-like doming common in Holonemidae. Both lateral parts descend from the edge projecting on the central line sideward and downward, and meeting at an angle of 135°. On the ventral side a smooth area is visible, narrow and elongate, limited by straight nearly parallel margins and on the central line provided with a slightly indicated, shallow and rather broad groove. Sideward from the smooth area a surface extends

<sup>8</sup> The generic name is composed of the initials of Prof. D. W. Obruchev.

<sup>9</sup> This species is dedicated to Prof. D. W. Obruchev of the Paleontological Institute of the Academy of Sciences of the USSR.

on each side, overlapping the posterior dorsolateral. They form bands, uniformly perforated by pores, with width constant throughout the entire length. The outer dorsal surface is covered by rather small tubercles, dispersed at random and only along the ridge in the central line arranged into longitudinal rows, slightly converging to the rear, without, however, fusing together. The rows of tubercles over a small area along the lateral margin of the bone are less distinctly marked. In the area of convergence of the longitudinal rows of tubercles, which corresponds to the ossification centre placed near the hind end of the median dorsal, the tubercles are somewhat smaller, arranged more densely and more at random. The fusion of two or three tubercles is observable at very few points of the bone surface only; the axes of the thus formed thickenings do not display any definite direction.

The width of the median dorsal is 60 mm; the width of the free ventral area is 25 mm, that of the central groove is 6 mm; the depth of the groove up to 2 mm. The tubercles are with an average diameter of 1 mm.

*Remarks.* — The particular genera of the Holonemidae family have been differentiated on character of ornamentation. Their typical representatives, *Holonema*, *Gyroplacosteus* and *Megaloplax*, are distinguished by the presence on the outer surface of the bone of variously shaped costae, produced by the fusion of tubercles. Ornamentation consisting of detached tubercles is common in genus *Aspidichthys* inclusive of „*Aspidichthys*” *ingens*, by Schmidt (1938) re-named *Anomalichthys ingens*, whose appurtenance to the Holonemidae was established by Gross (1937). The median dorsal of the last form, however, differs rather strongly in shape from that displayed by typical Holonemidae with which more closely allied is *Deveonema obručevi* n. sp. The systematic position of the inadequately known American forms, referred to genus *Aspidichthys*, is not thus far quite clear, moreover they differ from the here considered Holy Cross Mountains specimen in the character of ornamentation. Hence the latter form may not be associated either with the American forms of genus *Aspidichthys* or with *A. ingens* from the Rhine province.

On the whole, in brachythoracids, neither the character nor the very presence of ornamentation, is a generic feature, nevertheless, it seems most likely that this is not so in Holonemidae which constitute a rather peculiar stock line of these fishes. Therefore, the present writer accepts the suggestions of Prof. D. W. Obruchev, an authority on Holonemidae, kindly communicated by letter, to separate the above described form into a new genus.

*Occurrence.* — Horizon II of the Frasnian in the Wietrzna hill in Kielce.

Genus *Anomalichthys* (Koenen, 1883) Schmidt, 1938

*Anomalichthys ingens* (Koenen, 1883)

(pl. XI, fig. 1—3)

1883. *Aspidichthys ingens* Koenen; A. Koenen, Beitrag zur Kenntniss...  
 1895. *Aspidichthys ingens* Koenen; A. Koenen, Über einige Fischreste...  
 1932b. *Aspidichthys ingens* Gross; W. Gross, Die Arthrodira..., p. 47.  
 1933b. *Aspidichthys ingens* Gross; W. Gross, Die Wirbeltiere..., p. 48—49, fig. 14A;  
 pl. 6, fig. 5; pl. 7, fig. 2.  
 1937. *Aspidichthys ingens* Gross; W. Gross, Ibid., p. 40, fig. 20; pl. 5, fig. 4.  
 1938. *Anomalichthys ingens* Schmidt; H. Schmidt, Über *Aspidichthys*..., p. 313—317.

*Material.* — Fossil remains of this form occur in great abundance in the Holy Cross Mts. and more particularly so in the hills of Wietrznia, Psie Górki and Kadzielnia within the town of Kielce where they are confined to the upper part of the Frasnian deposits, i.e. to the *Manticoceras* beds. In the majority of cases they are recovered as fragments of markedly large and thick bones, with characteristic very large tubercles on the surface. From the collections of J. Czarnocki two specimens only permit closer classification. They are a large fragment of the hind part of the median dorsal (pl. XI, fig. 1, 2) and a part of the nuchal.

*Description.* — The preserved nuchal fragment comprises the depression by Heintz (1932) called „double sockets“, probably also the whole fore part of the element. The mentioned depression shows here no signs of bi-partition and is sharply limited by steep enbankment at the hind part only. To the front it forms the continuation of the nuchal depression produced by its roof-like doming. The median ridge is clearly indicated on the outer side, from this ridge the surface descends sideward forming planes inclined at an angle of  $110^\circ$ . The entire outer surface is covered with rounded, smooth, blunt tubercles of large dimensions, occasionally fused together, with diameter from 3 to 6 mm and height from 1.5 to 3 mm, sometimes finely radiating at the base. The thickness of bones, least at the front in the central line where it is 7 mm, gradually grows to 20 mm in the posterior lateral area and attains over 55 mm at the hind of the „double sockets“. The length of the fragment measured in the central line on the outer surface is 90 mm. The anterior border bears traces of weathering. It seems likely, however, that this element did not project much farther forward and that it was outlined like a low triangle, similarly as is the case with *Holonema radiatum* in Obruchev's reconstruction (1932).

The other fragment belonging to this form represents a large part, i.e. approximately one third, of the median dorsal. The margins of the element have not been preserved in any part of the specimen, yet it may

be supposed that this bone was gently rounded posteriorly, like that in the specimen described by Gross (1937). The roof-like doming of the median dorsal is well indicated by the ridge which is particularly strong in its median part, also by the lateral planes which descend to the side at an angle of  $120^{\circ}$ . The carinal process is preserved complete at the anterior end of the element. Like in other Holonemidae it is in the shape of an inconspicuous cone. From other representatives of this family, *Anomalichthys ingens* differs in the considerable robustness and relative shortness of this process, while the diameter of its base is quite large. It is also characterized by greater inclination. The hind surface of the process is striped by a longitudinal groove and placed very nearly normally in relation to the outer surface of the median dorsal.

The outer surface of the bone is ornamented with the same kind of tubercles as those on the above described nuchal plate. The only noteworthy feature is that, posteriorly, around the ossification centre, where the tubercles are markedly smaller, they are arranged in fairly distinct concentric rows.

The length of the preserved fragment, without the carinal process, is 284 mm at the central line, the maximum width 257 mm, the thickness up to 36 mm; the height of the median dorsal 115 mm (measured from the top of the carinal process normally to the plane of the median ridge on the dorsal side). The length of the carinal process is 70 mm; the depth and width of the groove on that process is equally 15 mm.

*Remarks.* — In 1883 Koenen described fragmentary fossil remains of huge brachythoracids from Upper Devonian deposits (*Manticoceras* beds) of the Rhine province. He referred one of them to genus *Aspidichthys* Newberry, recorded from North America, establishing the new species *A. ingens* to include it. The remaining specimens were by him differentiated under the new generic and specific name of *Anomalichthys scaber*. Specimens representing these two forms differed solely in size of tubercles ornamenting their bone surface. In the opinion of Gross (1932 b) this may have been due to the difference in age of the particular individuals.

As has been proved by Gross (1937), all the other specimens subsequently described under the name of *Anomalichthys* belong to genus *Brachydirus*, hence the name of *Anomalichthys* has become void of meaning. In this connection Schmidt (1938) suggests to retain the generic name of *Anomalichthys* for the large-tubercles forms from the Rhine province, since their appurtenance to the inadequately described American genus *Aspidichthys* is doubtful.

Schmidt's opinion as to the differentiation of the American and German large-tubercles forms seems reasonably correct, though the

suggestion of using for European forms the generic name of *Anomalichthys*, formerly applied to quite a different genus, does not seem a very happy one. Nevertheless, in order to avoid further misunderstandings the present writer here adopts Schmidt's proposition.

The following brief characteristics may be added to the information published by Koenen (1883, 1895) and Gross (1932 b) on this species: to *Anomalichthys ingens* belong huge brachythoracids with bones ornamented by large tubercles up to 10 mm in diameter. In the central portions of the bones the tubercles are smaller and arranged in more or less distinctly concentric rows. The median dorsal, as is usual in Holonemidae, is elongated and roof-domed, with the ridge in the central line. The carinal process is in the shape of a massive, stout cone and is more inclined downward than in other Holonemidae. The nuchal is relatively short and bears a ventrally depression, not limited anteriorly and without bi-partition.

*Occurrence.* — The Frasnian (beds with *Manticoceras intumescens*) from the Rhine province and the Holy Cross Mts.

Genus *Operchallosteus*<sup>10</sup> n. gen.

*Diagnosis.* — Brachythoracids with dermal bones ornamented by basally sharply limited meandering ribs and by less numerous, flattened tubercles in the median part of bones. From *Gyroplacosteus* the mentioned genus differs in a more delicate pattern of ornamentation, less regular arrangement of elevations and their flattened tops.

*Operchallosteus vialowi*<sup>11</sup> n. sp.

(pl. XII, fig. 3)

*Material.* — A fragment of a posterior ventrolateral.

*Diagnosis.* — The same as that for the genus given above.

*Holotype.* — A fragment of the right posterior ventrolateral (I. G.) (pl. XII, fig. 3).

*Description.* — The preserved fragment, 145 mm in length and 85 mm in maximum width, probably represents a major part of the posterior ventrolateral. It is distinguished by extremely characteristic ornamentation, at first sight resembling the relief on the bones of Bothriolepidae. It, however, does not exhibit microstructure characteristic of Antiarchi. Its ornamentation somewhat resembles that of genus

<sup>10</sup> The generic name is an allusion to the beautiful ornamentation from the Greek word *ὀπερχαλλύς*, meaning unusually beautiful.

<sup>11</sup> This species is dedicated to Prof. O. S. Vialow from Lvov.

*Gyroplacosteus*. In the latter form, however, contrary to *Operchallosteus*, the details of ornamentation are much more densely arranged, particularly so in the central parts of the bones. Moreover, in *Gyroplacosteus*, the tubercles are domed and placed near the ribs throughout the surface of bones, while in *Operchallosteus* they are bluntly truncated and concentrated in the middle portions, the peripheral part being occupied by meandric ribs here fused together into an intricate meshwork.

*Occurrence*. — The Frasnian, horizon II (median) in the Wietrznia hill of Kielce.

### Infraordo **Arctolepida**

Within Upper Devonian deposits of the Holy Cross Mts., particularly so in the Famennian (*Cheiloceras* beds) of the Kadzielnia hill, there is an abundance of placoderms remains ornamented by tubercles, sometimes arranged in concentric rows and displaying a structure common in Arctolepida. Unfortunately all the found specimens are very fragmentary and specifically indeterminate. On account, however, of their copiousness the writer feels justified in mentioning their occurrence.

### Ordo **Antiarchi**

Genus *Bothriolepis* Eichwald, 1840

*Bothriolepis* sp.

(pl. XII, fig. 1)

In her paper on dipnoan fishes (1950) from the Devonian of the Holy Cross Mts. Z. Gorizdro-Kulczycka mentioned the presence of *Bothriolepis* cf. *maxima* and *B. panderi* within Middle Frasnian deposits. The material at the present writer's disposal contains but one fragment of bone referable to a large representative of genus *Bothriolepis* (pl. XII, fig. 1) whose specific position it is now difficult to establish.

Placodermi incerti ordinis

(pl. XII, fig. 4)

Fragment of an armor plate recovered from the *Clymenia* beds of Gałęzice is a markedly interesting though puzzling specimen. Its outer surface is ornamented by peculiar wrinkles whose symmetric arrangement suggests that we are here dealing with an unpaired element of the median series. The bone structure indicates that this form did not belong either to Antiarchi or to Euarthrodira. Lack of exact information with respect

to bone structure of other placoderms hinders proper comparative studies. The outer surface of the bone consists of a paper-thin layer wrinkled as mentioned above and covered by tubercles hardly discernible with the naked eye. The tubercles display the absence of „unipolar“ cells so characteristic in Euarthrodira. Layers of bone and bone cells are here disposed parallel to the outer surface. The remaining mass of the element is made up of a spongy bone tissue with large intra-trabecular spaces. The bone is up to 4 mm in thickness. In spite of the meagreness of the available evidence this form undoubtedly represents a new placoderm.

#### REMARKS ON CERTAIN STRUCTURAL DETAILS OF SOME BRACHYTHORACIDS

The posterior supragnathals described in the preceding chapter, though distinguished by extremely divergent trend of specialization, producing in the former a crushing jaw apparatus and a cutting one in the latter, both display the same essential structural scheme. This may, moreover, be encountered in a number of other representatives of Brachythoraci, as for instance in *Coccosteidae* and *Mylostomidae*, indicating that the various types of jaw apparatus in these forms have all evolved from the same initial type, illustrated by the catching jaw apparatus in primitive *Coccosteidae*.

A specification of the posterior supragnathals belonging to various representatives of *Coccosteus* and *Plourdosteus* is given in Heintz's paper (1938). In these genera the posterior supragnathal is shaped like an elongated plate. On its upper margin, somewhat in front of the point corresponding to its midlength, we find the upper process which is the place of attachment for ligaments or muscles. From its top toward the lower border, a thickened ridge extends on the mesial surface. On the outer lateral side, the anterior slightly inflated portion forms a lateral process whose vertical edge is provided with a row of denticles. A similar row of denticles is also noted on the hind edge of the posterior supragnathal.

Observations made by Gross (1932b) and by the present writer indicate close resemblance in the structure of the jaw apparatus between *Coccosteus* and forms allied with it, on the one hand, and *Pholidosteus*, on the other hand. In the latter the posterior supragnathal was also provided with a lateral process. The chief difference consists in the far advanced atrophy of the rows of denticles in *Pholidosteus*, although the same tendency may also be observed in *Coccosteus* and *Plourdosteus* (Heintz, 1938). An additional point of difference in the jaw apparatus of these brachythoracids is the development of a conspicuous cuspidate process on the fore end of the infragnathal in *Pholidosteus*.

With further reference to the new representatives of brachythoracids described in this paper, it should be noted that in *Tomaiosteus* we again encounter all the structural elements of the posterior supragathal common in *Cocosteus* and similar forms. The cardinal difference here is again that of the absence of vertical rows of denticles. The remaining differences are merely those of proportions, particularly respecting the poorer development of the upper and lateral processes, and the higher but stouter vertical thickening on the mesial surface of *Tomaiosteus*.

In genus *Malerosteus* the posterior supragathal, besides the absence of vertical rows of denticles, is characterized by a conspicuous thickening of the element and stronger development of the crushing surface replacing the lower edge. On this surface two tubercles are visible, one of which is placed near the corner corresponding to the vertical thickening on the mesial surface, while the other one is near the top of the lateral process.

In genus *Mylostoma*, with an extremely specialized crushing type of jaw apparatus, we note an unusually strong development of the lateral process and relatively shortened anterior portion of the element. At the same time the whole posterior supragathal becomes flattened out dorso-ventrally. As in *Malerosteus*, there are here also two tubercles on the lower crushing surface. In *Mylostoma*, however, the outer tubercle, here centrally placed, is much more robust. Toward the top of the lateral process, an inconspicuous ridge or crest extends from the outer tubercle. It might be supposed that this tubercle corresponds to a similar product in *Malerosteus*. In *Dinomylostoma*, which is a less strongly specialized form regarded as ancestral of genus *Mylostoma*, there is only one tubercle on the crushing surface. For the present, these structures cannot be definitely homologized since it may reasonably enough be conjectured that we have here a case of convergence. In any case, the jaw apparatus in *Malerosteus* and Mylostomidae displays the same trend of specialization; in *Mylostoma*, however, this process has attained the highest evolutionary stage, while in *Malerosteus* it is less advanced, similarly as in *Dinomylostoma*. In both the latter genera the posterior supragathal shows the strongest adaptation for the crushing of food, the infragathal somewhat less so, while the anterior supragathal has retained its catching character. In *Mylostoma*, however, also this element is thoroughly adapted to the crushing of food.

This functional differentiation of the jaw elements in brachythoracids resembles the differentiation of teeth in higher vertebrates where the fore part of dentition retains the catching character, while the hind part is adapted to some manner of fragmentation of the food. A striking feature is that of the higher crushing specialization of the upper elements which generally develop a larger functional surface than is the

case in the lower ones. This applies to the posterior supragnathal in brachythoracids, and seemingly to the upper molars of perissodactyls and ruminants. Naturally, in all the quoted examples this specialization develops quite independently and is probably referable to greater fixedness of the upper jaw element and greater freedom for movement in the lower ones.

Thus, as on the one hand, *Malerosteus* and Mylostomidae display a similar trend of specialization, so on the other hand, *Tomaiosteus* and the dinichthyids adapt a similar mode of taking their food too. Of the latter forms it is the dinichthyids which attain a higher degree of specialization. Their adaptation to the cutting of food passes from an extreme narrowing of the posterior supragnathal to a complete disappearance of the lateral process.

The adaptive similarities do not indicate close genetic alliance of the considered forms. *Tomaiosteus* and the dinichthyids are probably related by distant coccosteidal ancestors and undoubtedly represent distinct evolutionary lines. Neither is it inadmissible, as mentioned above, that similarities in the jaw apparatus of Mylostomidae and *Malerosteus* are the result of convergence, but it is not quite out of the question that they are the representatives of the same stock.

In *Pachyosteus*, similarly as in the jaw apparatus of dinichthyids, the posterior supragnathal lack the lateral process. Here, however, this lack may be a primary phenomenon, as is also the lack of the differentiation of denticles and of arrangement into well marked rows in the catching jaw apparatus of this genus. In this respect, *Coccosteus* and *Plourdosteus*, provided with distinct rows of denticles, have probably attained a higher degree of specialization.

The structure of denticles in *Pachyosteus* is of particular interest. Even an outer inspection made under slight magnification reveals a different degree of the union of denticles with the jaw surface. Some of them have fused completely with the underlying bone, while others are separated from it by a slit on the peripheral portion of its base. The relative independence of the denticles is also clearly shown in cross sections of jaws longitudinally cutting through the denticle. In such a section (fig. 14) we distinctly see the upper edge of the jaw with a cap-like denticle seated on it (*d*). The peripheral portion here is entirely fused with the underlying bone, while in the centre it is separated by a slit. In the denticle itself we may differentiate the base, the lateral wall and the internal cavity. In the wall (fig. 14 C) there are three zones, indistinctly limited. The outermost and thinnest layer consists of an osseous tissue with typical bone cell-spaces connected by branching canaliculi and arranged more or less parallel to the plane

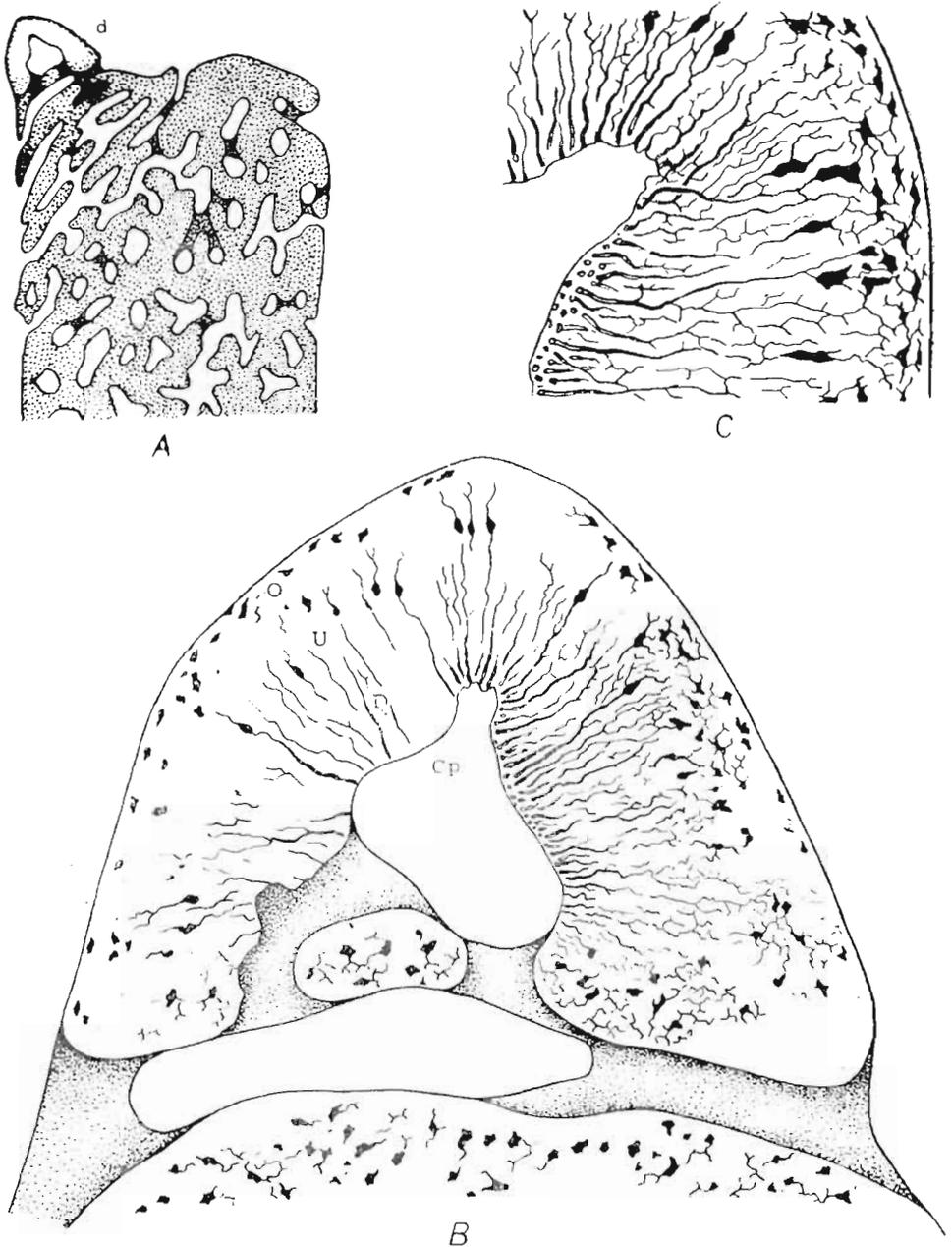


Fig. 14. — *Pachyosteus bulla*: A cross section of upper margin of the infragnathal with the denticle ( $\times 20$ ), B longitudinal section of denticle ( $\times 150$ ), C section of denticle wall ( $\times 300$ ), Cp pulp cavity, O osseous tissue, U intermediate layer, d denticle.

of the tooth. This layer, thin at the apex of the tooth, grows thicker downward passing into the osseous tissue of the base (fig. 14 B). More centrally, in the lateral tooth wall we note the intermediate layer (U) with elongated cell spaces and with the longer axis placed normally to the plane of tooth. Among the canaliculi for the cell processes one, branching from the central extremity of the cell-space, is slightly more conspicuous, particularly when seen under small magnification, owing to which these cell-spaces resemble the „unipolar“ cells of Heintz and Gross, so characteristic of the tubercles or denticles present in the jaw and dermal bones of *Coccosteus* and *Plourdosteus*.

The inner, thickest layer (D) consists of a tissue by the writer regarded as modified dentine. In this layer, from the inner cavity which may thus be considered as pulp cavity (Cp), canaliculi radiate, thicker mesially and narrowing peripherally. The peripheries of many of these canaliculi are connected with the mesial pole of the cell-spaces in the intermediary zone. This, together with the more clearly expressed canaliculus branching from the outward pole of the cell-space imparts the impression that the cell-spaces lie on the course of the radial canaliculi. The cell-spaces on the intermediary zone, as stressed above, differ from the remaining bone cell-spaces by their arrangement only. We might thus be dealing with dentine canaliculi connected to canaliculi of bone cell processes, which is quite a common occurrence. The only peculiar feature is that the network produced by the connection of minute ramifications branching off throughout the course of the radial canaliculi only slightly differs from that formed by canaliculi for the bone cell processes, with which it is also connected without delimitation. The connections between dentine canaliculi, however, are also observable within the dentine of other fishes, while their appearance is greatly diversified. Moreover, the dentine appears to be of a transitory nature leading to complete disappearance and replacement by an osseous tissue, whence may result its non-typical pattern. This problem will be discussed later.

Another peculiar feature of denticles in *Pachyosteus* is that their outer part consists of bone tissue. In this respect denticles in the studied form resemble tubercles in the dermal bones of *Plourdosteus livonicus* (Gross, 1933 a) and of *Holoptychius* (Bystrow, 1942).

When comparing the structure of denticles on the infragnathal and that of tubercles on bones in *Plourdosteus livonicus*, Gross (1933a) concluded that between them there is no essential difference. They differ only in the predominance of dentine in the jaw denticles and that of „unipolar“ cells in the tubercles of dermal bones. At that time the jaw denticles were by Gross considered to be differentiated tubercles. Evidence contained in Bystrow's paper (1942), however, shows a reversed

state of conditions in Crossopterygii, i.e. that the tubercles of the dermal bones are modified denticles. In coincidence with those studies and with observations of Gorizdro-Kulczycka (1953), during the evolution of Crossopterygii and the Dipnoi the originally uniform dentine coating was desintegrated into detached denticles. On the dermal bones the latter were subsequently transformed into osseous tubercles and finally disappeared. The desintegration of the dentine coating must have occurred at an earlier date, within the mouth cavity, where it ceased without producing the complete disappearance of dentine but was followed by the next development and differentiation of denticles.

The present writer concurs with the views of Ørvig (1957) and Gross (1957) that the disappearance of dentine may have taken place also in the Arthrodira. The difference consists in the earlier occurrence of the process in the placoderms, and, in its final stage, that of the transformation of denticles into osseous tubercles and their subsequent disappearance, having involved not the dermal bone denticles only, but the denticles within the mouth cavity as well.

Such an evolutionary trend of this process is suggested in the brachythoracids both by the gradual disappearance of ornamentation on the dermal bones during phylogenetic evolution and by the fact that the presence of mandibular denticles is, in the first place, common in primitive forms of the brachythoracids, while in forms occupying a higher phylogenetic stage they usually disappear. During the ontogeny of some forms (Heintz, 1938) young individuals may still be provided with denticles lacking in older individuals, but this fact can also be referable to the wearing off.

The dinichthyids may be mentioned among those stocks in which the disappearance of denticles is observable in the course of evolution. In the primitive *Dinichthys herzeri*, the jaws are provided with a row of denticles on the edge, whose histological structure is unfortunately unknown. Also in the primitive *D. pustulosus* there are vestigial denticles which disappear completely in more advanced representatives. Neither are traces of dentine ascertained in their jaws (Heintz, 1931b), as is also the case in the posterior supragnathal of *Tomaiosteus*. Here this element is made up entirely of an osseous tissue with densely arranged osteons separated by diminutive inter-osteonal trabecules and having relatively narrow vascular canals. The orientation of these canals is in most cases perpendicular to the cutting edge. In *Malerosteus* too, nearly the whole infragnathal is made up of the osseous tissue. Here, however, there is no such regular arrangement of the osteons and the inter-osteonal trabecules are strongly developed. It is only in the central part of the tooth-like cusp, placed at the anterior end of the infragnathal that it

was possible to ascertain the presence of a detached dentine system. In the drawing (fig. 15) we see the cross section of the pulp canal (Cp) encircled by concentric dentine layers with the characteristic thin dentine canaliculi. Peripherally (U) there are few, detached cell-spaces. The dentine system is on all sides surrounded by osseous tissue (O) whose

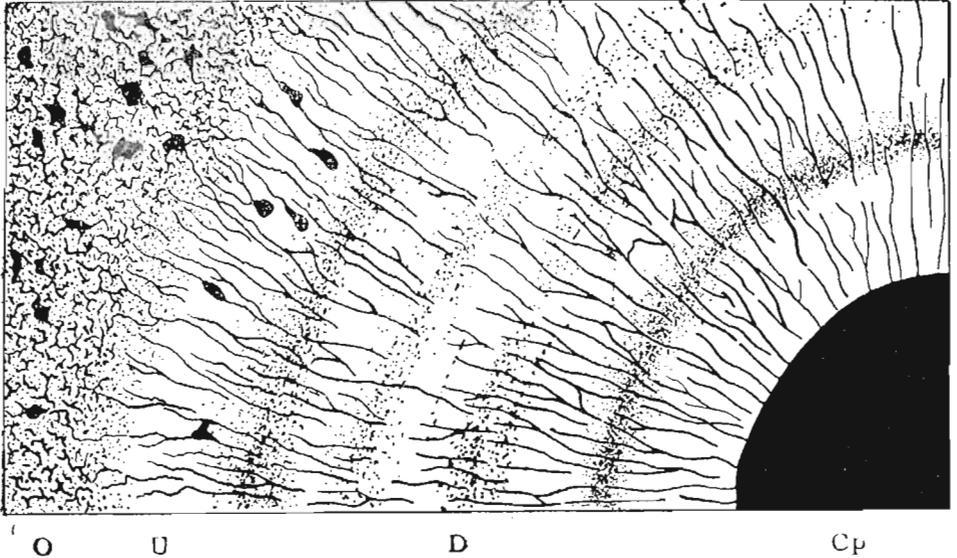


Fig. 15. — *Malerosteus gorizdroae* n. gen. n. sp., fragmentary cross section of tooth-like process of the infragnathal ( $\times 150$ ); CP pulp canal, O osseous tissue, U transitory layer, D dentine.

cells were united with the processes of the odontoblasts. The absence of any traces of resorption and the character of the union of the dentine system with the surrounding osseous tissue suggest that we are not dealing here with a tooth of the older generation, functional at some earlier date, and now enclosed in the bone. Most likely it is the vestigial remains of teeth once existing in ancestral forms of *Malerosteus*.

The presence of cell-spaces and their connection with dentinal canaliculi in the dentine system of *Malerosteus* resemble the picture of the tissue differentiated by Ørvig (1951) under the name of „semidentine”. The difference between the dentine as figured in Ørvig’s drawing (1951, fig. 2a) and that seen in *Malerosteus* consists in that the latter form displays cell-spaces grouped in some peripheral parts of the dentine system only. This system attains here considerably larger dimensions than those in *Plourdosteus canadensis* investigated by Ørvig (1951). In the latter species the dentine seems to correspond with the tissue only of the peripheral part of the dentine system in *Malerosteus*. It may be

reasonably inferred that semidentine is not a distinct type of dentine, but a transition in respect to both its position, intermediary between bone tissue and typical dentine, and to the process of the disappearance of dentine and its substitution by the bone tissue. In other words, at the moment of deposition of the first dentine layer in the spaces between the already existing bone foundation (it is known that in teeth the dentine is laid down inward) the odontoblasts here are not fully differentiated since they display certain osteoblastic features and, in some cases, are enclosed within the dentine mass. It is not before the next stage — which is not attained by *Plourdosteus* owing to the small dimensions of its dentine elements, but observable in genus *Malero-steus* — that the differentiation of odontoblasts is completed. Hence they persist under their typical form. These disturbances in the differentiation of odontoblasts are most likely associated with the general process of the disappearance of dentine and its substitution by bone

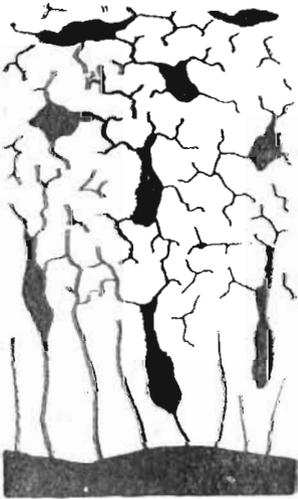


Fig. 16. — Fragmentary section of tubercle on the bone of *Arctolepida* gen. et sp. indet. from the Famennian of Kadziunia, showing changes in the shape and arrangement of cell spaces from the vascular canal towards the outer surface of bone.

tissue, experienced by brachythoracids and probably by other Arthrodira too. These irregularities may sometimes have been very intensified, leading gradually to less and less typical form of cells with the appearance and behaviour intermediate between odontoblasts and osteoblasts. And thus, on a bone fragment, found in the Famennian shales of the Kadziunia hill, more closely indeterminate but probably belonging to *Arctolepida*, the present writer was able to ascertain all the transitions from typical odontoblasts to osteocytes (fig. 16.). These transitory cells resembled to the so-called unipolar cells. They are bottle-shaped and placed normally to the plane of tubercles. The thick cell process, starting from the outward pole, narrowed into a neck-like shape, is next divided into smaller cell processes connected with the network formed by the cell processes of normal osteocytes. Some of the here described bottle-shaped cells were connected by the outward pole with the canaliculi radiating from the outward part of vascular canals. Others, retaining the characteristic bottle-shaped out-

line and the disposition of bones normal to the surface, produce processes throughout their surface, as is usually the case in ordinary osteocytes. As was kindly communicated to the writer in a letter, Prof. W. Gross

has also encountered most diverse passage forms ranging from unipolar cells to osteocytes.

The disappearance of dentine from the jaws of brachythoracids is not reasonably clear insomuch that it involves not only forms taking their food without fragmentation, but those with the cutting (as in *Dinichthys* and *Tomaiosteus*) or crushing (*Malerosteus*) type of jaw apparatus too. This phenomenon may perhaps be interpreted by the inability to cease of the process of dentine disappearance, in spite of modified food requirements, hence the transformation process of dentine or its substitution by bone cannot be here reversible. Another interpretation is that of the development of structures taking over the function of dentine, such as the progressing keratinization of the epithelium covering the jaws. A possibility of this kind was already suggested by Newberry (1889) in connection with the lower jaw structure in *Titanichthys*.

At the present moment it is scarcely possible to support this hypothesis. Most authors assert the presence of distinct traces of the wearing off in jaws of brachythoracids. The material available to the present writer provides no decisive evidence in favour of either of the two alternatives. The character of the cutting edge in the posterior supra-gnathal of *Tomaiosteus* speaks rather against the wearing off of jaws. In *Malerosteus* the wearing off is quite admissible. Somewhat confusing is the lack of structural differences in the surficial part of the tooth-like infragnathal cusp between the side contacting the anterior supra-gnathal, where the abrasion should take place, and the mesial, free part where it could not take place. It should also be noted that in its normal position the tooth-like infragnathal cusp does not extend to the top of the corresponding notch on the anterior supra-gnathal and that in order to make a notch it must have turned round its axis, this being quite improbable.

Another supplementary remark is that keratinization of the epithelium, which may explain the disappearance of dentine from the jaws of brachythoracids and at the same time also contribute to the clarification of the problem of the growth of these elements in brachy-thoracids provided with a crushing or cutting jaw apparatus, is not a strange though indeed not a very common occurrence among fishes. A compensation in the growth of jaws on the basal side does not seem very likely, since, e.g. this would alter the position of the functional part of the infragnathal in relation to its hind blade, making it subject to continuous structural modifications parallel to resorption of its upper edge. In a contrary case, the upper edge of the functional part, as it wears off, would have gradually to lower its position in relation to the upper edge of the hind portion of the mandible. This phenomenon

actually occurs in Ptyctodontidae. They are provided, however, with strongly developed dentine and the reasonable supposition is that the wearing off was not so very rapid here. It must have been much more intense in brachythoracids which lacked dentine structures, unless we take into consideration the possibility that their food consisted of soft substances only. In this case, however, the powerful adaptations to crushing and cutting would be strikingly out of proportion with the softness of food.

These difficulties in the interpretation of the function and growth of jaws in brachythoracids, adapted for crushing and cutting food, do not concern forms with a catching jaw apparatus, as for instance *Cocosteus*. In this genus the wearing off of denticles (and in older individuals — even that of functional edges of jaws) may have occurred. Still less do these difficulties concern with such forms as *Pachyosteus*, in which the wearing off of jaws did not certainly take place and where the growth of jaws did not necessarily differ from that in the remaining dermal bones. With growth, the denticles, which in *Pachyosteus* were probably inserted entirely in the soft tissue of the mucuous lining, most likely experienced resorption and were substituted by the next generations of denticles formed by independent dental papillae subsequently fusing with the jaw.

Besides the peculiar structure of its denticles, *Pachyosteus* is an interesting form by the shape of its parasphenoid too. A description of this element is given in the former chapter of this paper; here it is only noted that the shape of this element in *Pachyosteus* seems more primitive than that in dinichthyids and even in *Buchanosteus*. In *Pachyosteus*, similarly as in most Arctolepida, the internal carotids pierced the cranial base sideward from the parasphenoid and run on the dorsal surface of the latter. In opposition to *Dinichthys* they would not produce here a transverse anastomosis, but would fuse together into one unpaired vessel entering the cranial cavity. Their behaviour must probably have been similar in *Malerosteus* whose parasphenoid was described by the present writer in a short paper of 1956 as an element of a new genus of Brachythoraci.

The diversity in the structure of the parasphenoid in various brachythoracids as well as the behaviour of the above mentioned vessels will, in the future, probably serve as additional evidence for the differentiation of separate evolutionary lines within this stock.

During the investigation of brachythoracid material from the Holy Cross Mts. the writer's attention was drawn to the shape of the hind margin of the head which, beginning from the joint socket to as far as the boundary between the postmarginal and the postsuborbital, is

usually provided with a list somewhat lowered down in relation to the remaining surface of the bone. This detail, together with the shape of margin on the anterior lateral, indicates that with the head lowered the above part of the hind margin of the head armor extended beneath the front margin of the body armor. At the same time, there are lists and tubercles on the edge of the anterior lateral (one of them placed at the bend of the free anterior lateral edge seems to be rather constant), which must have served as attachment points for the ligaments and muscles. All this indicates that the gill slit could not have projected above the boundary between the postmarginal and the postsuborbital. It must have, therefore, been placed ventrally, as supposed by Heintz (1932). Such a position of the gill slit is also suggested by the structure of *Synauchenia*, one of the Wildungen forms, in which the dermal head armor bones were ankylosed with those of the thoracic armor, thus filling up the cleft between these regions. Since *Synauchenia* belongs to brachythoracids extremely flattened laterally and was certainly a nectonic form, it is hardly admissible that a secondary displacement removed its gill slits onto the ventral side, this being common rather in benthonic forms. Therefore, we ought to accept that the ventral position of the gill slits in *Synauchenia* corresponds to an ancestral character with structure more typically brachythoracid.

Reverting to the problem of growth, those of the jaw elements excepted, the writer wishes to draw attention to a specimen of posterior median ventral of *Malerosteus gorizdroae*?, described in the present paper (pl. III, fig. 3). As stated above, this specimen shows two growth lines, of which one consists of the margin of the free area. The lack of apposition of new bone layers on the outer surface, has here made possible the preservation of the original outline of a young stage of this element on the bone of an older individual. Being not of frequent occurrence in the brachythoracids, it probably resulted from a disturbance of the normal growth process. The disturbing factor, to judge from the normal peripheral growth, acted uniformly throughout and did not penetrate to any great depth of the bone. In the writer's opinion it may have been the pressure exercised by the bottom, on the ventral surface of that rather benthonic animal.

The considered specimen also displays traumatic damages. They consist of two damaged areas on the right and left sides of the element. The tubercles present on the bottom of these areas, which might be damaged by the jaws of some aggressor, indicate that the individual to which the studied element belonged, escaped death and that the regenerating process had already started.

Disturbances in the apposition of new bone layers on the outer

surface are also observable on the nuchal of *Malerosteus gorizdroae?*, where near the ossification centre we find an area without the last bone layer. It is only encroached by detached tubercles differing in size from tubercles of the preceding generation. This produces something like Westoll's line. Whether we are dealing here with a physiological phenomenon or with the consequence of a disease of periosteum of the bone itself, is difficult to conjecture. Since the lack of continuity does not affect the last layer only, the writer is inclined to the latter conjecture.

It should be stressed that the picture presented by the ossification centre in the nuchal of *Malerosteus gorizdroae?*, i.e. the presence of detached tubercles of the new generation on the surface of the preceding layer, in some brachythoracids results from physiological growth. To say in *Dinichthys* cf. *tuberculatus* (pl. VIII, fig. 4), among tubercles of the older generation, intimately connected with the corresponding continuous layer, are isolated and seemingly apposed tubercles of a new generation, or rather generations. At first they are flat and lens-like, but with growth they become high, cupola-like or conical. It would appear that the polymorphic tuberculation, so characteristic of this form, is due to that type of the growth process.

As is observable on specimens of *M. gorizdroae?*, the tubercles become larger with growth, hence also with age of the individual. This also holds good in the specimen of *M. gorizdroae* where, in parts with removed last bone layer (e.g. in the course of preparation), the disclosed earlier layer displays finer tuberculation. In the mentioned case the tubercles increase with the growth of the individual. In *Dinichthys pustulosus* the behaviour of tuberculation is different. Although it has not been here possible to ascertain the ornamentation on deeper bone layers, probably owing to their resorption upon the deposition of the next layer, still, observation of specimens of different size (age) permits to establish that the size of tubercles was not controlled by the dimensions of the individual. Throughout its life-time the tubercles retained their initial character, not being subject to further development with the growth of the animal.

#### REMARKS ON THE SYSTEMATICS OF BRACHYTHORACI

The structure of the parasphenoid, together with the structure and character of the mandibular denticles in genus *Pachyosteus* exclude the descent of Pachyosteidae from the Coccosteidae. These are certainly two distinct stocks. Their independence has already been stressed by Stensiö (1944) in the course of studies on the pectoral girdle. As a result of these studies Stensiö separated two groups of the Brachythoraci, i.e.

Coccosteomorpha and Pachyosteomorpha. The former were made to include *Coccosteus*, *Plourdosteus* and *Pholidosteus*, the latter the majority of the remaining forms. Whereas the opposition of Pachyosteidae to the Coccosteidae seems reasonable enough, it is difficult to accept the natural character of the Pachyosteomorpha group. It seems more likely that they comprise a number of different evolutionary lines, while some of them (dynichthyids) may perhaps be related with the coccosteids, according to the former belief. Unfortunately, the parasphenoid of the last mentioned forms is unknown.

Should its structure prove to resemble that of the Dinichthyidae, it will then be possible to speak of a line going from forms represented by *Buchanosteus* (by White, 1952, shown to belong to the brachythoracids) through the Coccosteidae to the Dinichthyidae. In any case, the dinichthyids and the coccosteids appear to be equally distant from the pachyosteids. The latter display a number of primitive characters, such as the dental structure, the parasphenoid and possibly also the scapulo-coracoid. But this last point does not seem quite doubtless inasmuch as the structural peculiarities in the fore part of this element, as indicated by Stensiö (1944), may as well be the result of reduction associated with the reduction of the dermal bones in this area. Besides these primitive characters, the Pachyosteidae display certain features of specialization which, in the writer's belief, comprise the disappearance of the spinals. In these respects, however, the dinichthyids are more primitive. Unfortunately, the writer does not know whether the scapulo-coracoids of other Pachyosteomorpha than *Ensoosteus*, mentioned by Stensiö in his paper on the Arthrodiran pectoral girdle, have been studied. The mentioned genus belongs to the Pachyosteidae.

Owing to the meagreness of information available on the structure of the brachythoracids, it is difficult to establish a satisfactory classification which would depict the actual genetical connections between the various families, uniformly treating all the representatives. In this state of conditions it seems preferable to admit a division of this stock into distinct families without any hints as to their relationships, such as has been done by Romer in his handbook „Vertebrate Paleontology” (1947). We must note, however, that in this handbook not all of these units are of the same rank. To say, the Coccosteidae, into which Romer among others also includes the dinichthyids and several forms without a clear position, if not an artificial assemblage, would have to be considered of a higher rank as compared with the other differentiated families. It rather seems that the majority of the latter have been ranked too high and that in the future they will have to be re-layed to the

rank of sub-families. For the time being, however, the retention of the present classification seems more to the purpose.

Having here touched the problem of the systematics the writer also wishes to mention the occasional tendency to separate the Mylostomidae into a unit of equal rank with the group embracing virtually all of the remaining Brachythoraci (Berg, 1955). *Mylostoma* is an example of highest specialization as regards the mode of the nourishment. This specialization probably involves only the jaw apparatus, which in Brachythoraci displays great variability. It is *Synauchenia* markedly more than Mylostomidae that deviates from the general structural scheme of the Brachythoraci. *Synauchenia* is thus far the only known form which, by the fusion of the head armor with the thoracic armor, loses one of the most diagnostic features characterizing the group to which it belongs. But even this specialization, so exceptional among the Brachythoraci, does not justify a special treatment of the Synauchiidae. This applies all the more so to the Mylostomidae.

#### STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION OF DESCRIBED FORMS

The material described in the present paper has been collected from but four sites, three of which are adjacent. In this connection it is difficult to conceive a general idea of the fish-fauna involving the entire Holy Cross Mts. area. The Upper Frasnian excepted, the character of the particular Upper Devonian horizons is here depicted by finds from various sites which makes difficult the investigation of the evolution of the ichthyo-faunal assemblage in the progress of time. Another important deficiency is that the majority of forms is represented by single specimens only.

The above mentioned deficiencies in the available material greatly limit, if not altogether exclude, the possibility of reasonably valid biostratigraphic, paleogeographic and paleoecological conclusions, and imply the necessity of exercising the utmost care in considering these problems.

In spite of the inadequacy of the available material, the picture it gives us is, surely, not completely accidental. Hence, in this chapter, the writer will risk an attempt at picking out some regularities in the vertical and horizontal distribution of the brachythoracids, at least within this very limited part of the Holy Cross Mts. region.

The attached table contains a specification of brachythoracid forms recorded from the Upper Devonian of the Holy Cross Mts. Each vertical column limited by continuous lines contains forms occurring within one horizon, marked with a cross.

As is shown in this table, *Dinichthys pustulosus* seems to have the greatest vertical distribution, as it ranges from the lowermost Frasnian upwards inclusive of the Lower Famennian. Second to it in this respect is *D. denisoni* which embraces the whole of the Famennian period. The next to be mentioned is *Malerosteus gorizdroae* which probably lasted through the Middle and Upper Frasnian.

*Anomalichthys ingens*, recorded from three sites, is among the forms represented by a greater number of specimens. It is confined here to the Upper Frasnian, i.e. to horizon III, or the *Manticoceras* beds of Czarnocki.

The Middle Frasnian is characterized by greatest diversity of brachy-thoracid forms. The majority of forms, however, recorded from this horizon are represented by single specimens only.

Differences of faunal composition in the particular horizons are stressed by the sequence of forms followed in the specification table. Thus it is seen that of nine forms recorded from the Middle Frasnian, two only were found in other horizons. Out of the three Upper Frasnian forms, one, characterized by widest range of distribution, has not been recorded from other horizons. Two out of the four Lower Famennian forms and three out of the four Upper Famennian ones, are apparently characteristic of these horizons only.

Thus the depicted picture, if at all reflecting the actual faunal changes, would naturally characterize the considered area, since some forms encountered outside of the Holy Cross Mts. display there a somewhat different vertical distribution. To say, *Dinichthys tuberculatus* and *D. pustulosus* are known from the Givetian to the Lower Famennian, *Pachyosteus bulla* and genus *Oxyosteus* — from the Frasnian, while *Anomalichthys ingens* is apparently confined to the Upper Frasnian only.

The asynchronous occurrence of the mentioned forms within different areas is very probable, but does not exclude the necessity for the introduction of a number of corrections on the consideration of facial difference.

It should again be stressed here that the discussion of either the vertical or horizontal distribution of forms known on detached specimens only, is altogether impossible.

Local assemblages of forms recorded from the particular sites have been shown in the same table, grouped in vertical columns limited by broken lines. It can be seen that this does not much alter the arrangement of columns as compared with the preceding one. The possibility of representing in this way two different interrelations in one specification table is dependent on the circumstance that the faunas from the

## Distribution of the described brachythoracids

Species	Horizon		Frasnian			Famennian	
	I Lower	II Middle	III Upper with <i>Manticoceras</i>		<i>Cheiloce-</i> <i>ras beds</i>	<i>Clymenia</i> <i>beds</i>	
<i>Pachyosteus bulla</i>							+
<i>Titanichthys kozłowskii</i>							+
<i>Dinichthys cf. tuberculatus</i>							+
<i>Dinichthys denisoni</i>						+	+
<i>Dinichthys ceterus</i>						+	
<i>Stenosteus?</i> sp.						+	
<i>Dinichthys pustulosus</i>	+	+	+	?	+	+	
<i>Anomalichthys ingens</i>			+	+	+		
<i>Malerosteus gorizdroae</i>		?	+	+			
<i>Tomaiosteus grossi</i>		+					
<i>Deveonema obručevi</i>		+					
<i>Holonema radiatum</i>		+					
<i>Operchallosteus vialowi</i>		+					
<i>Oxyosteus</i> sp.		+					
<i>Plourdosteus</i> sp.		+					
Locality	Wietrznia		Psie Górkę		Kadzielnia		Gałęzice

particular horizons have been recorded — that from the Upper Frasnian excepted — from different sites. This is not, however, an accidental outcome only, being to a large measure dependent on facial differentiation, since, with the exception of Gałęzice, there are several horizons in every exposure and the search for material was made at every locality throughout the whole section.

Three sites: Wietrznia, Psie Górkki and Kadzielnia, with Frasnian outcrops, lie within the range of the Kielce facies which is a more shallow-water one as compared with the deeper Łysa Góra facies, starting at a small distance to the north and outcropping in the north-western periphery of Kielce at Czarnów, and at Zagórze and Radlin to the east. The mentioned sites are situated on the elevation of the Frasnian sea floor connected (Czarnocki, 1947) with the periphery of the Dyminy anticline. In spite of the small distances separating these localities, rather important facial differences are displayed in deposits of Lower and Middle Frasnian age occurring there. To say, at Kadzielnia, Lower and Middle Frasnian deposits are made up of poorly layered reef limestones, first of the gastropod-brachiopod fauna, with *Loxonema polonicum*, *Pleurotomaria kadzielniae*, and higher up of the brachiopod-coral fauna. At the same time, more bituminous and clayey, layered limestones, with thin shale intercalations were deposited at Wietrznia. To the east of Wietrznia (Zagórze, Radlin) and to the north-east of Kielce (Śluchowice, Czarnów), the reef facies disappears completely and Frasnian deposits are represented by thin-layered limestones, marls and shales passing into similar Famennian deposits (Czarnocki, 1947).

Differences between the Lower and Middle Frasnian fish faunas in Wietrznia and Kadzielnia are apparently associated with facial differentiation. While in Kadzielnia these deposits have not, thus far, yielded any fish remains, relatively many forms have been recovered from Wietrznia. Some of them (*Plourdosteus*, *Holonema*, *Bothriolepis*) are characteristic rather of continental deposits, or deposits formed at a small distance from the land. The diversity of sediments and their faunal assemblage (e.g. presence of *Lingula* banks) indicates that they are marine shallow-water deposits.

Although, it is not impossible that the above mentioned placoderms might have lived in an open sea, nevertheless their remains might have been transported by currents. The latter alternative may be suggested by their sporadical occurrence, since they are represented by single specimens. From the eventual transport we must, however, exclude that of being dragged over the sea floor, since there are no traces of abrasion. Ptyctodontidae and *Dinichthys pustulosus*, found in fair abundance, are certainly forms who had lived here at that time.

During the Upper Frasnian, within the Wietrznia-Kadzielnia area, the facies grows more uniform. We have here thick-layered limestones with *Manticoceras intumescentes* and *Hypothyridina cuboides*. At the same time the ichthyo-fauna also becomes more uniform, with *Anomalichthys ingens* as the most common representative occurring in all the three localities. In the Karczówka hill only, to the west of Kadzielnia, does the rocky reef limestone facies still persist. The last mentioned form is absent there.

Further facial changes and more extensive uniformity occur at the beginning of the Famennian when the entire Kielce region is covered by thin-layered slate limestones and marls of deep sea origin. These circumstances are responsible for the greater dispersion of fish remains. They are somewhat more abundant within the lowermost *Cheiloceras* beds only. *Dinichthys pustulosus* continues to occur along with other forms which, most likely, did not occur during the Frasnian, at least in the considered area. Within upper *Cheiloceras* and *Clymenia* beds of this region, fish remains are very sporadic and no brachythoracids have thus far been recorded there. At that time (corresponding to the *Clymenia* beds) these fishes occur in greater abundance south-west of Kielce, i.e. in Gałęzice (at a distance of 15 km).

The *Clymenia* beds rest here directly on Givetian limestones and differ markedly from those occurring within the remaining area. While there they are made up of alternating thin beds of slates, marls and limestones, with a total thickness of up to some hundred meters, in Gałęzice they are reduced to a limestone layer, 3 to 4 m in thickness containing an abundant and diversified fauna (gastropods, goniatites, clymeniids, solitary corals, crinoids, trilobites, as well as plant remains). Of the brachythoracids, in addition to *Dinichthys denisoni* known from the *Cheiloceras* beds of Kadzielnia, *Titanichthys kozłowskii*, *Dinichthys* cf. *tuberculatus* and *Pachyosteus bulia* have also been encountered. Though facial features may also be of significance here, it is hardly probable that *Pachyosteus* — should it have existed within this area already in the Frasnian, as it did in the Rhine province — could have remained and been discovered among the abundant brachythoracid remains in Wietrznia. This form may not, therefore, have penetrated into the Holy Cross Mts. basin before the Upper Famennian time. It would, however, be puzzling why it did not appear at an earlier time, together with *Anomalichthys ingens* whose occurrence is noted within *Manticoceras* beds both in the Rhine province and in the Holy Cross Mts. It is possible that the absence of *Pachyosteus* in the Upper Frasnian beds of the Kielce region resulted from different environmental requirements of this form.

As before mentioned, *Dinichthys* cf. *tuberculatus* is if not identical with *D. belgicus* and *D. tuberculatus* from North America, in any case closely related to them. The identity of the two last forms is also suggested by the facial resemblance of the so-called *Psammites* from Condroz in Belgium and the Catskill facies in North America where these fishes occur together with other forms common to Upper Devonian beds of both Belgium and America, such as *Dipterus nelsoni* and *Holoptychius purchisoni*. They belong to the few paleozoic species occurring simultaneously within areas so far distant. *Dinichthys pustulosus* has proved to be one of these exceptional forms.

Though it is not quite inadmissible that future, more adequate finds and more thorough studies will reveal some differences between the American *D. pustulosus* and the form from the Holy Cross Mts. the evidence now available to the writer, supplied by his fairly copious material and by literature, do not reveal any such differences that would reasonably justify their separation.

Contrary to the rather widespread opinion in respect to the impossibility of the occurrence of the same species in far distant areas, the Recent ichthyo-fauna contains a number of very widely distributed forms. Examples of such forms are most numerous among the Pleuronectiformes i.e. benthonic, in many cases littoral fishes. As stated by Nikolskiy (1950) the same species of *Reinhardtius hippoglossoides* and *Hippoglossoides hippoglossus* live both in the Atlantic and Pacific Oceans. In the Pacific they are represented by the distinct varieties of *R. hippoglossoides matsuurae* and *R. hippoglossus stenolepis*. The latter, alike to *R. elassodon*, *Platyichthys stellatus* and *Atherestes evermani*, inhabit both the Asiatic and American shores of the Pacific Ocean. Similarly, *Hippoglossoides platessoides* inhabits both the European and the American shores of the Atlantic Ocean. It is true, however, that these fishes are characterized by pelagic spawn. Independently of this, however, though they are poor swimmers, they often undertake markedly distant migrations. Other fishes too, though not to such an extent, supply illustrations of the wide range of distribution. Among others, the common fresh water pike *Esox lucius* is recorded from northern Eurasia and America. These examples diminish the improbability of such a wide range of distribution as that of *Dinichthys pustulosus*, all the more so that it was a long-lived form, known from the Middle to Upper Devonian, i.e. from a lapse of time sufficiently long for penetration into the vast expanses near the shores of the Northern Devonian Continent. The presence of such invertebrates, common to both Europe and America, as e.g. *Manticoceras intumescens*, also suggests migration at that time.

The wide range of distribution of *D. pustulosus* gives rise to the problem respecting the centre of its evolution and migration routes.

In North America this form is known from the higher part of Middle Devonian beds (Hamilton). Its range of distribution is limited to areas lying west of Kentucky. It is not before the Upper Devonian time (Genesee) that *D. pustulosus* makes its way, together with *Manticoceras intumescens*, eastward, into the state of New York. According to Eastman (1907 a), the migration route of this form leads from Europe, through Manitoba in Canada. In western Europe, however, this form has not thus far been discovered. Within the Holy Cross Mts., i.e. in central Europe, its presence is not recorded before the Upper Devonian time. From the Frasnian of Russia, Obručeva (1956) has described, under the name of *Dinichthys licharevi*, a form which is closely related. Though the present knowledge on *D. pustulosus* is extremely inadequate and may give rise to grave errors with respect to its distribution, nevertheless, on the information now available it seems more likely that the centre of evolution of this form was in the western part of North America, or maybe, in Siberia whence it was shifted equatorially on one side from the west to the eastern part of America and on the other side from the east into Europe.

Counterwise, *D. tuberculatus* having developed in the eastern part of North America has migrated at the close of the Famennian through western Europe (Belgium) to central Europe (Poland).

#### APPENDIX

##### ON SOME ICHTHYODORULITES AND ELASMOBRANCHIAN REMAINS FROM THE UPPER DEVONIAN OF THE HOLY CROSS MTS.

###### Genus *Sentacanthus*<sup>12</sup> n. gen.

*Diagnosis.* — Paired spines of moderate size, built of osseous tissue, provided with large dentine teeth, sparsely aligned in a asymmetrical row on the hind edge of the spine.

###### *Sentacanthus zelichowskæ*<sup>13</sup> n. sp.

(pl. XIII, fig. 3 a-b)

*Diagnosis.* — The same as that for the genus, since it is at present the only known species.

<sup>12</sup> The generic name has been formed from the Latin word *sentus*, meaning spiny.

<sup>13</sup> This species is dedicated to Dr. M. Zelichowska, Head of the Documentation Dept. of the Geological Institute in Warsaw.

*Material.* — Detached specimens of spines.

*Holotype.* — An incomplete paired spine (M. Z.).

*Description.* — The preserved fragment (base and apical part missing) is over 120 mm in length, 15 mm in width and 7 to 8 mm in thickness. It appears, therefore, to have been a fairly large and slender spine. At first it gently curves forward, then, nearer the top, backward. Its cross section nearer to the base is elliptic with the larger diameter equal to 15 mm and the smaller one to 7 mm. To the top it first widens out up to 18 mm, then gets narrower again and somewhat thickened (width 13 mm, thickness 8 mm). Owing to the enlargement of the hind margin the section here is more regularly oval. At the same time the front margin tapers out. The spine retains this shape until it reaches the apical part, the transverse dimensions only being reduced to 10 and 8 mm on the highest level of the preserved fragment. The outer surface of the spine is perfectly smooth. On one side of the broad hind margin (in the studied specimen it is the left one) along its whole length, there is a row of large — over 4 mm in height and 3 mm in diameter — straight „thorns” or denticles, 10 mm distant from one another. In the cross section we can see one longitudinal canal running nearer to the front margin. Its diameter does not exceed 1 mm. The denticles excepted, the whole spine is built of osseous tissue with Havers canals disposed parallel to the axis, and with well developed osteones and interosteone trabecules.

*Occurrence.* — The Famennian lower *Cheiloceras* beds of Kadzielnia.

#### Genus *Alienacanthus*<sup>14</sup> n. gen.

*Diagnosis.* — Extremely large, paired and unpaired spines, built exclusively of osseous tissue.

#### *Alienacanthus małkowskii*<sup>15</sup> n. sp.

(pl. XIII, fig. 1 a-c)

*Diagnosis.* — The same as for the genus.

*Holotype.* — A fragmentary paired spine.

*Material.* — Fragments of large osseous spines are frequently yielded by *Clymenia* limestones from Gałęzice near Chęciny. Some are perfectly straight (circular in cross section) and are symmetric, unpaired

<sup>14</sup> The generic name is derived from the Latin word *alienus*, meaning alien, being an allusion to the dissimilarity of this spine to other ichthyodorulites.

<sup>15</sup> This species is dedicated to Prof. St. Małkowski, former Director of the Muzeum Ziemi (Museum of the Earth) in Warsaw.

structures, others are gently bent and flattened, thus being paired. One specimen of this paired spine represents a fragment sufficiently large for its description.

*Description.* — The preserved fragment is 320 mm in size, with the upper and lower ends missing. It is gently curved both antero-posteriorly and laterally. In the lower part it is flattened, with one surface nearly plane, while the other is somewhat convex. Here both the fore and hind edges are sharp. The spine is 30 mm in width and 10 mm in thickness. In the central part the thickness of the spine increases to 14 mm, while the convex (front?) edge grows blunter and broader. On this edge there are fairly large, widely spaced denticles. Toward the top the front edge tapers out again. On the upper end of the specimen the width of the spine is 19 mm, the thickness 10 mm. The spine is built entirely of osseous tissue. The canals run parallel to the axis of the element, forming occasional anastomoses. One of the canals is slightly broader (1 mm in diameter), it extends throughout the spine, somewhat nearer to the convex (denticled) edge. The osseous tissue has the character of intervascular trabecules.

The fin spines, described above, similarly as in *Sentacanthus*, differ from all other ichthyodorulites known to the present writer in that they are made of osseous tissue only. It is probable that they were covered by a dermal coating. They may not be referred either to Selachii or to Acanthodii. It seems more likely that they formed the armor of some placoderms.

*Occurrence.* — The Famennian *Clymenia* beds of Gałęzice near Chęciny.

Genus *Ctenacanthus* Agassiz, 1837

*Ctenacanthus* sp.

(pl. XIII, fig. 2)

This form is represented by two specimens. One of them corresponds to the median part of the spine and the other (I. G.) — to a part nearer to the base.

On the preserved fragments it may be inferred that the spine was moderately slender, very gently curved and equally gently narrowing toward the top. In these features it differs from Devonian species of America which, moreover, are characterized by more densely arranged costae. To a certain extent it resembles *Asteroptychius*. The spine is strongly flattened with the interior occupied by a large pulp cavity. On both sides of the flat hind margin there are rows of minute denticles

with the apexes directed toward the base. The sharper front margin is gently rounded. The outer surface is ornamented by longitudinal costae rather closely spaced and separated by narrow grooves which do not widen out toward the base, contrary to the arrangement we find e.g. in *Ct.? erectus*. Three fine costae run along the front margin. On the lateral surface, in the central part of the specimen, there are 10 anterior thicker costae and 7 finer posterior ones. The costae bear tubercle-like, moderately spaced swellings. In this, the ornamentation of the Kadzielnia specimen resembles that of *Ct. gracillissimus* N. & W. common in the Carboniferous (comp. Eastman, 1902, p. 86, fig. 12), but differs from it by the non-stellate character of tubercles. The tubercles here are arranged rather sparsely and on different levels of the particular costae. The costae multiply by intercalation, being from the first thicker in the anterior part of the lateral surface. Besides *Ct.? erectus* Kocnen two more forms have been recorded from the Devonian beds of Europe and tentatively assigned to genus *Ctenacanthus*. They are the *Ct. gemündensis* Gross from the Middle Devonian, and *Ct.? jaekeli* Gross from the Upper Devonian. The former differs from the Holy Cross Mts. specimen in its general shape and ornamentation characterized by greater uniformity of costae and stronger development of crests. The latter German species of *Ctenacanthus* is differentiated by being more conspicuously curved and by fewer and smooth costae.

The specimen from the Holy Cross Mts. probably belongs to a new species. Since the writer has not been able to make closer comparative studies owing to lack of proper literature, he can only mention its presence.

*Occurrence.* — The Famennian lower *Cheiloceras* beds in the Kadzielnia hill of Kielce.

#### Genus *Cladodus* Agassiz, 1843

##### *Cladodus* sp. 1

(pl. XIII, fig. 4)

It is a very small tooth with the basal width equal to 4 mm and the same height of the main cusp. The main cusp, fairly robust, narrowing swiftly from mid-height and tapering off into a sharp apex. The anterior surface, somewhat flattened, is in its lower part ornamented by fine vertical striae, at the sides more densely spaced. The main cusp is gently sigmoidal. On each side of the main cusp are two lateral ones, of which the outer are large, attaining half the size of the central cusp. The intermediate denticles are quite tiny. The outer cusps are relatively

slender, conical and slightly diverging. The lower margin of the crown is gently flexuous.

The tooth has been recovered from the Famennian *Cheiloceras* beds of the Kadzielnia hill.

*Cladodus* sp. 2

(pl. XIII, fig. 5)

This tooth, found in the same beds as the above, is differentiated by the presence of but one main cusp, thus resembling *Cl. conicus* and *Cl. urbs-ludovici* Eastman (comp. Hussakof & Bryant, 1913, pl. 44, fig. 1, 1a). From the two last named it differs, however, by lack of ornamentation. The base of the tooth is not very broad, measuring scarcely 3.5 in width. The cusp is nearly erect, with the section circular at the base. Toward the apex it becomes flattened out. Lateral edges gently pointed.

*Cladodus?* sp. 3

(pl. XIII, fig. 6)

This tooth, rather strongly damaged, is by the writer only tentatively included in genus *Cladodus*, from which it differs in that it does not develop a uniform crown, the cusps being independently placed on a massive base. The base, measured antero-posteriorly, is 5 mm long, measured bi-laterally probably about 14 mm, with height about 4 mm. At the bottom it is concave. Two cusps only have been preserved, but it rather seems that the tooth was symmetrical and that it had three cusps. The central, twice as high as the lateral ones, is strongly bent backward, fairly robust, with the anterior surface flattened out and the posterior convex, with moderately sharp side edges. It is 8 mm high. The lateral cusp, only half that height, is also inclined to the back, but it does not display any curves and is in the shape of an erect cone. It is fairly distant from the main cusp, and like it without ornamentation. The intermediate denticles are missing.

The studied specimen has been found in the *Clymenia* beds of Gałęzice.

Genus *Dittodus* Owen, 1867

*Dittodus* sp.

(XIII, fig. 7, 8)

The tooth referred to this provisional genus is of a type to which the equally tentative name of „*Phoebodus*“ has been assigned. As shown

by Hussakof and Bryant (1918), this type of teeth is encountered along with those called „*Dittodus*“ and a number of forms intermediary between these types. Most likely therefore, they all belong to the dentition of the same fishes from the family Pleuracanthidae.

The first of the studied specimens (pl. XIII, fig. 7) is 8 mm in width as measured between the apexes of the outer cusps, and 5 mm in height. All the three cusps are approximately of the same thickness, i.e. 1.5 mm at the base. The median is perhaps slightly more slender. The outer cusps are divergent. The lateral edges are moderately sharp. Under magnification, a scarcely discernible striation may be observed on the surface of cusps. No intermediary denticles present.

Out of this type of teeth so far known, those in *Dittodus priscus* Eastman (comp. Eastman, 1907a, pl. 1, fig. 7—8, also Hussakof & Bryant, 1918, pl. 44, fig. 3 a-b), with striation relatively delicate but more conspicuous than that in the Kadzielnia specimen, come nearest to the considered specimen. „*Phoebodus*“ *knightianus* Eastman (comp. Eastman, 1903, pl. 4, fig. 40, 40a) resembles our specimen in the robustness of its main cusps and in the lack of intermediary cusps. Its outer cusps, however, in addition to a more circular section, are quite erect, and do not diverge, as is the case in our specimen. „*Phoebodus*“ *politus* Newberry (comp. Eastman, 1907 a, pl. 1, fig. 12, also Newberry, 1889, pl. 27, fig. 27—28) is sometimes without ornamentation. It also resembles our specimen in the flattened anterior surface of the cusps and the presence there of sharp lateral edges. On the figures of Newberry and Eastman, however, the cusps in „*Phoebodus*“ *politus* are apparently more slender than those in our specimen, which, moreover, lacks intermediary cusps. „*Phoebodus*“ *dens-neptuni* Eastman (comp. Eastman, 1903, pl. 4, fig. 39) is entirely different since it is with markedly slender and distinctly ribbed cusps.

The second specimen of *Dittodus* tooth (pl. XIII, fig. 8) differs from the former by the more slender and diverging cusps. It is 5 mm in width at the base and 3 mm in height.

Both specimens have been yielded by the *Cheiloceras* beds of Kadzielnia.

Paleozoological Laboratory  
of the Polish Academy of Sciences  
Warszawa, September 1957

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RYBY GÓRNO-DEWOŃSKIE Z GÓR ŚWIĘTOKRZYSKICH  
(PLACODERMI, ELASMOBRANCHII)

*Streszczenie*

Przedmiotem pracy są szczątki plakoderm i spoduustych z utworów górnego dewonu Gór Świętokrzyskich. Okazy z osadów frańskich pochodzą z odkrywek Wietrzni, Psich Górak i Kadzielni w Kielcach, fameńskie zaś z Kadzielni i Gałęzic. Materiał wypreparowano metodą chemiczną za pomocą kwasu octowego.

W wyniku badań stwierdzono obecność następujących nowych form.

Rząd **Arthrodira**

Podrząd **Brachythoraci**

Rodzaj *Malerosteus* n. gen.

Ryby o szerokiej czaszce z zaznaczonymi kantami bocznymi, o dużym oczodole ograniczonym trzema elementami kostnymi. Układ elementów okolicy policzkowej podobny jak u rodzaju *Pholidosteus* lub *Brachyosteus*. Aparat szczękowy typu miazdżącego przypomina szczęki rodzaju *Dinomylostoma*. Od tego ostatniego różni się jednak słabym rozwojem powierzchni miazdżącej na infra-gnathale i obecnością dodatkowego guzka na postero-supra-gnathale.

*Malerosteus gorizdroae* n. sp.

(tekst: fig. 3—6; pl. I, fig. 4—7; pl. II; pl. III, fig. 1—3)

Jest to jedyny dotychczas znany gatunek rodzaju *Malerosteus*, wobec czego charakterystyka gatunku pokrywa się obecnie z rodzajową. Gatunek ten cechuje urzeźbienie, złożone z gęsto i bezładnie rozmieszczonych guzków o kopulastym kształcie i zmiennej wielkości.

Materiał stanowi fragment czaszki, obejmujący prae-orbitale, sub-orbitale, marginale, paranuchale, parasphenoidium i elementy szczękowe oraz luźno znalezione sub-orbitale, post-sub-orbitale i antero-dorso-laterale. Wszystkie te okazy pochodzą z górnego franu sąsiadujących ze sobą wzgórz Wietrznia i Psie Górki. Do powyższego gatunku zaliczono też warunkowo nuchale i postero-mediano-ventrale ze środkowego franu wzgórza Wietrznia.

Rodzaj *Tomaiosteus* n. gen.

Ryby o szerokiej, płaskiej głowie z niewielkimi oczodołami, położonymi blisko przedniego końca czaszki. Pineale łączy się z centraliami i rostrale, oddzielając w ten sposób całkowicie oba prae-orbitalia. Aparat szczękowy typu krającego, o niezbyt wysokim stopniu specjalizacji. Postero-supra-gnathale posiada wyrostek boczny, czym różni się od odpowiednich elementów innych form o tym samym typie aparatu szczękowego.

*Tomaiosteus grossi* n. sp.

(tekst: fig. 7; pl. III, fig. 4, 5)

Jedyny znany gatunek tego rodzaju, poza cechami wymienionymi w diagnozie rodzaju, odznacza się urzeźbieniem złożonym z rzadko rozsianych, niezbyt dużych guzków.

Materiał stanowi fragment czaszki obejmujący pineale, prae-orbitale, centrale i post-supra-gnathale, a pochodzący ze środkowego franu wzgórza Wietrznia.

Rodzaj *Dinichthys* Newberry, 1885

*Dinichthys denisoni* n. sp.

(tekst: fig. 10; pl. VI, fig. 4; pl. VII)

Niewielki przedstawiciel rodzaju *Dinichthys*, o kościach pozbawionych urzeźbienia. Mediano-dorsale charakteryzuje się prostym brzegiem grzebienia, podobnym do właściwego *D. jeffersonensis*. Od tej ostatniej formy różni się większą wysokością grzebienia i obecnością łyżkowatego zagłębienia na wyrostku grzebieniowym.

Materiał stanowią trzy okazy mediano-dorsale, z których jeden pochodzi z warstw dolno-cheilocerowych wzgórza Kadzielnia, pozostałe zaś — z warstw klimeniowych miejscowości Gałęzice.

*Dinichthys ceterus* n. sp.

(pl. VIII, fig. 1 a-b)

Niewielka forma o mediano-dorsale pozbawionym urzeźbienia, zaopatrzonym w niski grzebień i niemal poziomo ustawiony wyrostek grzebieniowy.

Materiał stanowi okaz mediano-dorsale z warstw dolno-cheilocerowych wzgórza Kadzielnia.

Rodzaj *Titanichthys* Newberry, 1885

*Titanichthys kozłowskii* n. sp.

(tekst: fig. 11; pl. IX, fig. 6)

Stosunkowo niewielka forma, posiadająca duże centralia, podobnie jak *T. clarkei* i *T. agassizi*. Układ kanałów linii czuciowych zapewne taki, jak u *T. termieri*. Od *T. agassizi* różni się ukształtowaniem podwójnego zagłębienia na brzusznej stronie nuchale.

Materiał stanowią fragmenty nuchale i centrale oraz przypuszczalnego paranuchale, pochodzące z warstw klimeniowych miejscowości Gałęzice.

Rodzaj *Deveonema* n. gen.

Nieduży przedstawiciel rodziny Holonemidae, o zewnętrznej powierzchni kości skórnych pokrytej małymi, oddzielnymi guzkami, rozsianymi na ogół bezładnie i jedynie w niektórych miejscach układającymi się w podłużne szeregi.

*Deveonema obručevi* n. sp.

(pl. X, fig. 1 a-b)

Jedyny gatunek rodzaju. Definicja gatunkowa pokrywa się na razie z rodzajową.

Materiał stanowi fragment mediano-dorsale ze środkowego dewonu wzgórza Wietrznia.

Rodzaj *Operchallosteus* n. gen.

Przedstawiciel Brachythoraci, o kościach skórnych pokrytych urzeźbieniem, złożonym z wyraźnie odgraniczonych, u podstawy meandrycznych, płaskich żeberk i guzków. Od *Gyroplacosteus* rodzaj ten różni się delikatniejszą ornamentacją, luźniejszym ułożeniem wyniosłości i spłaszczeniem ich szczytu.

*Operchallosteus vialowi* n. sp.

(pl. XII, fig. 3)

Definicja tego jedyne go przedstawiciela pokrywa się z rodzajową.

Materiał stanowi fragment postero-ventro-laterale ze środkowego franu wzgórza Wietrznia.

Ponadto wśród szczątków plakoderm stwierdzono obecność następujących form: znanego z Ameryki Półn. *Dinichthys pustulosus* Eastman, gatunków nadreńskich *Anomalichthys ingens* (Koenen) i *Pachyosteus bulla* Jaekel oraz notowanego we franie Rosji *Holonema radiatum* (Obručev). Bardzo prawdopodobną wydaje się tożsamość formy z warstw klimeniowych Gałęzic, opisanej tu jako *Dinichthys* cf.

*tuberculatus*, z północno-amerykańskim *D. tuberculatus* Newberry i włączanym do tego ostatniego przez autora niniejszej pracy *D. belgicus* Leriche z najwyższego fałunu Belgii.

Na podstawie materiału świętokrzyskiego udało się uzupełnić wiadomości o szczegółach budowy niektórych z powyższych form.

Przy szczątkach *D. pustulosus* znaleziono nie znane dotychczas u tego gatunku parasphenoideum, które umożliwiło wyjaśnienie przebiegu arteriae carotidae internaе.

Dla *Pachyosteus bulla* opisano po raz pierwszy górne elementy szczękowe, parasphenoideum oraz budowę pancerza brzuszno-go.

Wśród szczątków *D. cf. tuberculatus* stwierdzono obecność infra-gnathale o typowej budowie dla rodzaju *Dinichthys*. Element ten u bliskich naszej formie ryb amerykańskich i belgijskich nie był dotychczas opisany.

Poza omówionymi wyżej spotkano szereg bardziej fragmentarycznych okazów, których przynależność nie mogła być ściśle ustalona. Należą tu szczątki *Oxyosteus* sp., *Plourdosteus* sp. i *Bothriolepis* sp. ze środkowego frantu Wietrzni oraz *Stenosteus?* sp. z fałunu Kadzielni. W części dodatkowej opisano kilka okazów zębów *Cladodus* i *Dittodus* oraz kołec płetwowy w rodzaju *Ctenacanthus*, jak również dwa nowe kołce płetwowe: *Alienacanthus małkowskii* n. gen., n. sp. i *Sentacanthus żelichowskiae* n. gen., n. sp. charakteryzujące się niemal całkowitym (u pierwszego) lub zupełnym (u drugiego) brakiem dentyń.

#### NIKTÓRE SZCZEGÓŁY BUDOWY BRACHYTHORACI

Postero-supra-gnathalia rodzajów *Malerosteus* i *Tomaiosteus* uwiadcniają różny kierunek specjalizacji. U pierwszego, podobnie jak u *Dinichthyidae*, aparat szczękowy przystosowuje się do cięcia, u drugiego zaś, podobnie jak u *Mylostomidae*, do miażdżenia pożywienia. Mimo przeciwstawnego kierunku rozwoju postero-supra-gnathalia tych form zachowują ten sam zasadniczy schemat budowy. Świadczy to, że ich aparat szczękowy rozwinął się z jednakowego typu wyjściowego, którego przykładem jest chwytny aparat szczękowy *Coccosteidae*. Zarówno u *Malerosteus* i *Mylostomidae*, jak u *Tomaiosteus* i *Coccosteidae* obecny jest na postero-supra-gnathale wyrostek boczny. W związku z przystosowaniem do cięcia, postero-supra-gnathale u *Tomaiosteus* ulega zwężeniu do cienkiej płytki z mało wydatnym wyrostkiem bocznym. Ten ostatni zanika całkowicie u *Dinichthyidae*, które posunęły się dalej w tej specjalizacji. U *Malerosteus*, przeciwnie, w związku z przystosowaniem do miażdżenia pokarmu, postero-supra-gnathale ulega rozszerzeniu. Jednocześnie silnie rozwija się wyrostek boczny. To samo stwierdzamy u *Dinomylostoma* i *Mylostoma*. U tego ostatniego rodzaju, który osiąga krańcową specjalizację, postero-supra-gnathale jest płaskie i niezwykle szerokie, przy czym wyrostek boczny stanowi główną masę elementu. Na miażdżącej powierzchni znaj-

dują się tu, podobnie jak u *Malerosteus*, dwie wyniosłości. Czy są one u obu form homologiczne, trudno jest określić. Możliwe, że mamy tu zjawisko konwergencji. Zestawienie aparatów szczękowych *Malerosteus*, *Dinomylostoma* i *Mylostoma* uwidocznia, że w procesie przystosowywania się do miażdżenia pokarmu poszczególne elementy szczękowe ulegają zmianom w różnym stopniu i nie jednocześnie. Powierzchnia miażdżąca rozwija się najpierw na postero-supra-gnathale, następnie na infra-gnathale i w końcu na antero-supra-gnathale. Stosunek między powierzchniami miażdżącymi poszczególnych elementów przypomina stosunek właściwy innym kręgowcom miażdżącym pokarm i wywołany jest zapewne tymi samymi czynnikami mechaniki aparatu szczękowego.

W przeciwieństwie do Dinichthyidae brak wyrostka bocznego na postero-supra-gnathale u Pachyosteidae wydaje się być pierwotny. Przemawia za tym ogólnie pierwotny typ aparatu szczękowego u *Pachyosteus*. Cechami, które świadczą, że jest on bardziej pierwotny niż u Coccosteidae, są: brak zróżnicowania ząbków pod względem postaci i wielkości oraz bezładne ich rozszanie, bez wytworzenia zróżnicowanych szeregów.

Bardzo swoista jest budowa ząbków na szczękach rodzaju *Pachyosteus*. Mają one jamę mięksizową i ściankę złożoną z trzech warstw: 1) dentynowej, 2) przejściowej, z komórkami ułożonymi prostopadle do powierzchni, i 3) zewnętrznej, typowej kostnej, z komórkami ułożonymi równolegle do powierzchni. Obraz ten przypomina budowę guzków na kościach skórnych u *Holoptychius* i pozwala przypuszczać, że:

a) guzki na kościach powłokowych i ząbki gębowe są takimi samymi i powstałymi w jednakowy sposób tworami;

b) u Brachythoraci nastąpił proces rozpadu jednolitej powłoki dentynowej na oddzielne ząbki i przekształcania ich w kostne guzki, podobnie jak u Crossopterygii i Dipnoi;

c) proces ten u Brachythoraci nastąpił wcześniej i ostatnia jego faza, w przeciwieństwie do tego, co widzimy u Crossopterygii i Dipnoi, dotknęła również ząbków gębowych.

Za występowaniem wymienionego wyżej procesu u Brachythoraci przemawia też obecność urzeźbienia na kościach skórnych u form bardziej prymitywnych i zanikanie jego u form posuniętych dalej w rozwoju oraz jednoczesne znikanie dentyny i wreszcie sam jej charakter.

Obecność dentyny notowana była u *Coccosteus* i *Plourdosteus*, a obecnie stwierdzona została przez autora również u *Pachyosteus*. U bardziej wyspecjalizowanych *Tomaosteus* i *Dinichthys* dentyny brak. U *Malerosteus* w infra-gnathale zachował się jeden niewielki układ dentynowy w przednim zębowatym wyrostku. Charakter tego wyrostka świadczy, że nigdy nie funkcjonował jako ząb i należy go rozpatrywać jako twór rudymenarny. Cechy dentyny u *Malerosteus* świadczą, że tzw. semidentyna (Ørvig, 1951) nie stanowi samodzielnego typu dentyny, ale jest mody-

fikacją występującą na pograniczu między tkanką kostną i typową dentyną; charakterystyczna dla niej obecność jamek komórkowych związana jest z niedoskonałym różnicowaniem się odontoblastów, zależnym od zachodzącego u *Brachythoraci* procesu zastępowania dentyny przez tkankę kostną.

Zanik dentyny na szczękach *Brachythoraci* jest o tyle niezrozumiały, że dotyczy zarówno form pobierających pokarm bez rozdrabniania, jak też form o tnącym i młazdzącym typie aparatu szczękowego. Zjawisko to można by tłumaczyć tym, że raz rozpoczęty proces zanikania dentyny nie mógł się zatrzymać i był nieodwracalny, albo że dentyna zastępowana była przez inne twory, spowodowane np. rogowaceniem. Na razie trudno jest się wypowiedzieć za jedną lub drugą możliwością. Wielu autorów podaje obecność śladów ścierania szczęk. Materiał, jakim dysponuję, nie daje zdecydowanych dowodów na korzyść jednej czy drugiej alternatywy.

Poza swoistą budową ząbków rodzaj *Pachyosteus* ciekawy jest również ze względu na budowę parasphenoideum, która jest tu, jak się wydaje, bardziej prymitywna niż u *Dinichthys*, a nawet niż u *Buchanosteus*. U *Pachyosteus*, podobnie jak u większości *Arctolepida*, arteriae carotidae internae wnikają do podstawy czaszki do bocznie od parasphenoideum i biegną następnie po jego grzbietowej powierzchni. W przeciwieństwie do tego, co znajdujemy u *Dinichthys* i szeregu innych rodzajów, naczynia te nie tworzyły poprzecznej anastomozy, lecz zlewały się w jedno nieparzyste naczynie, wnikające do jamy czaszkowej. Różnice w budowie parasphenoideum dostarczają z pewnością jeszcze jednej wskazówki dla wyodrębnienia poszczególnych linii rozwojowych tego szczepu.

Ukształtowanie tylnego brzęgu czaszki *Brachythoraci* świadczy, że przy opuszczonej głowie odcinek między panewką stawową i granicą między marginale (lub post-marginale, o ile występuje) a post-sub-orbitale zachodził pod pancierz tułowia. Okoliczność ta, wraz z obecnością na wspomnianym odcinku różnych tworów dla przyczepu mięśni i więzadeł, dowodzi, że szczelina skrzelowa sięgała w górę co najwyżej do górnej granicy post-sub-orbitale. Za takim położeniem szczeliny skrzelowej przemawia też fakt, że u rodzaju *Synauchenia* nastąpiło całkowite zrośnięcie pancerza głowowego z tułowiem. Ponieważ jest to forma nektoniczna, trudno przypuszczać, by nastąpiło u niej wtórne przemieszczenie szczelin skrzelowych na stronę brzuszną i położenie takie musiało być właściwe wszystkim *Brachythoraci*.

Okaz postero-mediano-ventrale *Malerosteus gorizdroae?* uwidocznia obecność linii przyrostowej, czego na ogół nie spotyka się u *Brachythoraci*. Obecność jej związana jest z brakiem appozycji warstw kości na wolnej powierzchni płytki, co może być wynikiem ucisku wywieranego np. przez podłoże na ciało tej bentonicznej formy. Przebieg linii przyrostowej świadczy o tym, że zarys poszczególnych elementów szkieletowych ulegał znacznym zmianom w ciągu rozwoju osobniczego. Na tym samym okazie widoczne jest uszkodzenie urazowe w postaci dwóch ubytków ze śladami regeneracji. Odnowa wyraża się tu w obecności pojedynczych

guzków na dnie uszkodzenia. Podobne nieciągłe nawarstwianie kości widzimy na okazy nuchale tejże formy, gdzie powstaje coś w rodzaju „linii Westolla”. Wydaje się, że zjawisko to ma tu charakter patologiczny, chociaż taki sposób rośnięcia kości staje się niekiedy regułą. U *Dinichthys* cf. *tuberculatus* powoduje to zapewne różnorodność guzków urzeźbienia. Jeśli chodzi o urzeźbienie, to tworzące je guzki mogą zwiększać swe rozmiary wraz ze wzrostem osobnika, jak to jest u *Malerosteus*, lub też mieć stałą wielkość, jak u *Dinichthys pustulosus*.

### O SYSTEMATYCE BRACHYTHORACI

Budowa parasphenoideum i charakter ząbków szczękowych rodzaju *Pachyosteus* świadczą, że, zgodnie z poglądami E. Stensiö, forma ta nie może być wyprawiana z Coccosteidae. Jednocześnie jednak trudno się zgodzić, by wyodrębniona przez Stensiö grupa Pachyosteoromorpha była jednostką naturalną. Zaliczone do niej Pachyosteidae i Dinichthyidae reprezentują odległe od siebie szczepy.

Ze względu na zbyt szczupłe dane o budowie Brachythoraci, autor stoi na stanowisku, że bardziej celowe jest na razie wyodrębnianie poszczególnych rodzin, bez wiązania ich w wyższe jednostki taksonomiczne, tak jak to znajdujemy w klasyfikacji Romera (1945). Należy jednak zwrócić uwagę, że nie wszystkie wyodrębnione tam rodziny są równej wartości. Tak np. Coccosteidae, w ujęciu Romera, o ile w ogóle stanowią naturalną jednostkę, to jest ona wyższego rzędu, niż pozostałe rodziny. Autor nie uważa też za usprawiedliwione przeciwstawianie Mylostomidae wszystkim pozostałym Brachythoraci, jak to czyni np. L. S. Berg (1955). Osobliwość ich dotyczy jedynie aparatu szczękowego, którego ukształtowanie u Brachythoraci jest niezwykle różnorodne.

### ROZPRZESTRZENIENIE NIEKTÓRYCH BRACHYTHORACI

Niewielka ilość odstonień, z których pochodzi opracowany materiał, skupienie ich na niedużym odcinku oraz fakt, że większość form występuje tylko jako pojedyncze szczątki — utrudniają wyciąganie wniosków natury biostratygraficznej, paleoekologicznej i paleogeograficznej. Z pewnością jednak nie cały obraz, jaki dają opisane tu materiały, jest wynikiem przypadku.

Na tabeli w tekście angielskim (p. 352) zestawione są dane o występowaniu poszczególnych form w dewonie świętokrzyskim. Widzimy tam, że szereg form ogranicza się do pojedynczych poziomów. Są to jednak przeważnie gatunki, reprezentowane w kolekcji przez pojedyncze okazy. Wyjątek stanowi *Pachyosteus bulla* i *Anomalichthys ingens*. Ten ostatni występuje tutaj, podobnie jak w Nadrenii, we franie; natomiast *Pachyosteus bulla*, znany w Nadrenii również we franie, u nas występuje w górnym famenie. Różnoczasowe występowanie jednej formy na różnych obszarach nie jest zjawiskiem niezwykłym. Musimy się jednak liczyć z tym, że w danym przypadku może ono być wynikiem różnic facyjnych. Mimo to, że

punkty, z których pochodzą okazy, leżą blisko siebie, osady ich wykazują dość znaczne różnice facjalne. Odsłonięcia Wietrzni, Psich Górak i Kadzielni, które dostarczyły okazów fauny frańskiej, znajdują się w obrębie tzw. facji kieleckiej, bardziej płytkowodnej w porównaniu z facją łysogóorską, odsłaniającą się niedaleko w Śluchowicach-Czarnowie. W dolnym i środkowym franie zaznaczają się duże różnice facjalne między Kadzielnią i Wietrzną. Podczas gdy na Kadzielni mamy skaliste wapienie rafowe, które nie dostarczyły dotychczas szczątków ryb. W Wietrzni utwory tego wieku złożone są z bardziej ilastych i bitumicznych wapieni płytowych z licznymi szczątkami ryb. Wśród nich znajdujemy szereg form (*Plourdosteus*, *Holonema*, *Bothriolepis*), charakterystycznych raczej dla utworów przybrzeżnych lub lądowych. Chociaż nie można wykluczyć, że formy te zamieszkiwały otwarte morze, istnieje też jednak możliwość, że szczątki ich zostały tu wtórnie przyniesione przez prądy; przemawiałaby za tym sporadyczność ich występowania.

W górnym franie następuje wyrównanie facji na danym terenie; zarówno na Kadzielni, jak na Psich Górkach i Wietrzni osadzają się płytowe wapienie z *Manticoceras intumescens* i *Hypothyridina cuboides*. Jednocześnie następuje ujednostajnienie fauny ryb i wszędzie tu spotyka się *Anomalichthys ingens*. Dalsza zmiana facji następuje z początkiem famenu, kiedy na obszarze kieleckim osadzały się cienkopłytowe wapienie, margle i łupki głębszego morza. Poza przejściowymi dolnymi warstwami famenu na Kadzielni, w osadach fameńskich okolic Kielc szczątki ryb są bardziej rozproszone. Liczniejsze szczątki w najwyższym famenie spotyka się w Gałęzicach (15 km od Kielc), gdzie osadzały się wapienie o małej miąższości, z bogatą fauną bezkręgowców. Z ryb, poza znanym z dolnego famenu Kadzielni *Dinichthys denisoni*, występują tu *D. cf. tuberculatus*, *Titanichthys kozłowskii* i *Pachyosteus bulla*. Forma opisana jako *D. cf. tuberculatus* jest prawdopodobnie identyczna z amerykańskim *D. tuberculatus* i belgijskim *D. belgicus*, które autor traktuje jako jeden gatunek. Za tożsamością tych dwóch ostatnich form przemawia m. in. podobieństwo facji psammitów z Condroz w Belgii i facji Catskill w Ameryce Płn., gdzie występują wspomniane formy obok wspólnych dla obu obszarów *Dipterus nelsoni* i *Holoptychius purchisoni*. *Dinichthys tuberculatus* znany jest w centralnych stanach Ameryki Płn. w utworach środkowego dewonu. W czasie odpowiadającym franowi forma ta ukazuje się również we wschodniej części Stanów Zjednoczonych A. P. Oba znaleziska europejskie pochodzą z górnego famenu. W ten sposób zarysowuje się kierunek ekspansji tej formy z zachodu Ameryki Płn. przez Belgię do Europy<sup>środkowej</sup>.

Równie szeroko rozprzestrzenioną formą okazał się *D. pustulosus*. Początkowo forma ta w środkowym dewonie zajmuje obszary na zachód od stanu Kentucky w Ameryce Płn. We franie przenika wraz z *Manticoceras intumescens* do stanów wschodnich. Jednocześnie ukazuje się w Europie środkowej. Trudno przypuścić, by tak szybko zdołała pokonać tę wielką przestrzeń; ponadto nie jest znana dotychczas w Europie zachodniej. Wydaje się więc bardziej prawdopodobne, że osro-

dek jej rozwoju znajdował się w zachodniej części Ameryki Płn. lub nawet w północnej Azji, i że stamtąd forma ta rozprzestrzeniła się w obu kierunkach, docierając jednocześnie do Ameryki wschodniej i Europy środkowej.

OBJAŚNIENIA DO ILUSTRACJI

Fig. 1 (p. 286)

Rozmieszczenie punktów, gdzie znaleziono szczątki ryb. Sytuacja geologiczna zaznaczona w uproszczeniu, na podstawie mapy J. Czarnockiego. Skala 1:100.000.

Fig. 2 (p. 290)

Brachythoraci gen. et sp. indet. (a); podłużny przekrój przez mediano-dorsale, zarys grzebienia.

Fig. 3 (p. 294)

*Maleroosteus gorizdroae* n. gen., n. sp.; schematyczna rekonstrukcja szkieletu z boku; brakujące części kropkowane. ADL antero-dorso-laterale, IG infra-gnathale, M marginale, PN para-nuchale, PrO prae-orbitale, PSO post-sub-orbitale.

Fig. 4 (p. 294)

*Maleroosteus gorizdroae* n. gen., n. sp.: tylny brzeg para-nuchale; fg panewka stawowa, pg wyrostek stawowy, x kant boczny.

Fig. 5 (p. 296)

*Maleroosteus gorizdroae* n. gen., n. sp.; aparat szczękowy: A elementy górne od strony brzusznej, B to samo, od strony bocznej, C aparat szczękowy od strony przyśrodkowej, D-E postero-supragnathalia od strony brzusznej, D *Dinomylostoma beecher*, E *Mylostoma variable*, ASG antero-supra-gnathale, IG infra-gnathale, PSG postero-supra-gnathale, pl wyrostek boczny postero-supra-gnathale, mt guzek środkowy.

Fig. 6 (p. 298)

*Maleroosteus gorizdroae?*, postero-mediano-ventrale. Gruba linia ciągła — zarys powierzchni wolnej u osobnika dorosłego; cienka linia ciągła i przerywana — zarys powierzchni wolnej u osobnika młodego; linia kropkowana — zarys całego elementu u osobnika dorosłego.

Fig. 7 (p. 299)

*Tomaiosteus grossi* n. gen., n. sp.; pineale: A od strony brzusznej, B od strony grzbietowej.

Fig. 8 (p. 304)

*Dinichthys pustulosus*; częściowo zrekonstruowane (pola kropkowane) czaszki: A ze środkowego franu, B z dolnego franu Wietrzni; C centrale, N nuchale, M marginale, PN para-nuchale, PrO prae-orbitale, PtO post-orbitale.

Fig. 9 (p. 309)

*Dinichthys pustulosus*; szkice fragmentów czaszek z Ameryki Płn., wykonane na podstawie fotografii. Oznaczenia — jak fig. 8.

Fig. 10 (p. 314)

*Dinichthys denisoni* n. sp.; przekrój podłużny przez mediano-dorsale, uwidoczniający zarys grzebienia. Linia przerywana zaznaczono zarys mniej kompletnego okazu.

Fig. 11 (p. 320)

*Titanichthys kozłowski* n. sp.; schemat tylnej okolicy czaszki. Linia ciągła — granice zachowanych fragmentów; linia przerywana — przypuszczalny przebieg szwu między nuchalą (N) i centraliami (C); pole zakropkowane — część okazu o zniszczonej powierzchni.

Fig. 12 (p. 324)

*Pachyosteus bulla*: A rekonstrukcja szkieletu z boku; B schemat przedniej części pancerza brzuszego i jego położenia względem czaszki (u góry strona grzbietowa, u dołu — strona brzuszna). Al antero-laterale, AMV antero-mediano-ventrale, C centrale, IL intero-laterale, IG infra-gnathale, AVL antero-ventro-laterale, M marginale, N nuchale, PM post-marginale, PN para-nuchale, PrO prae-orbitale, PSO post-sub-orbitale, PtO post-orbitale, SO sub-orbitale. Pole zakreślowane — przypuszczalne położenie szczeliny skrzelowej.

Fig. 13 (p. 326)

*Pachyosteus bulla*, parasphenoideum: A od strony grzbietowej, B od strony bocznej, C od strony brzusznej; fh zagłębienie przysadkowe, m. gr nieparzysty rowek środkowy, s. tr rowek poprzeczny.

Fig. 14 (p. 340)

*Pachyosteus bulla*: A przekrój poprzeczny przez górny brzeg infra-gnathale i ząbek ( $\times 20$ ), B podłużny przekrój ząbka ( $\times 150$ ), C przekrój przez ściankę ząbka ( $\times 300$ ), Cp jama miękiszowa, D dentyna, O tkanka kostna, U warstwa pośrednia, d ząbek.

Fig. 15 (p. 343)

*Maleroosteus gorizdroae* n. gen., n. sp., fragment przekroju poprzecznego przez zębowały wyrostek infra-gnathale ( $\times 150$ ); Cp kanał miękiszowy, O tkanka kostna, U warstwa przejściowa, D dentyna.

Fig. 16 (p. 344)

Fragment przekroju guzka kości Arctolepida gen. et sp. indet. z famenu Kaddielni, uwidoczniający zmianę kształtu i układu jamek komórkowych w kierunku od kanału naczyniowego ku powierzchni zewnętrznej kości.

## Pl. I

Fig. 1. *Plourdosteus* sp., marginale (I. G.);  $\times 3$ .

Fig. 2. *Plourdosteus* sp., infra-gnathale (I. G.);  $\times 1,5$ .

Fig. 3. *Brachythoraci* gen. et sp. indet. ( $\alpha$ ), mediano-ventrale (I. G.): a powierzchnia grzbietowa, b powierzchnia brzuszna; wielk. nat.

*Maleroosteus gorizdroae* n. gen., n. sp.; wielk. nat.

Fig. 4. a Lewe antero-supra-gnathale (M. Z.) od strony przyśrodkowej, b to samo, z boku.

Fig. 5. Prawe antero-supra-gnathale (M. Z.) od strony przyśrodkowej.

Fig. 6. a Lewe postero-supra-gnathale (M. Z.) od strony bocznej, b to samo, od strony przyśrodkowej, c to samo, od strony brzusznej.

Fig. 7. a Lewe infra-gnathale (M. Z.) od strony grzbietowej, b to samo, z boku.



## Pl. IX

*Pachyosteus bulla* Jaekel

- Fig. 1. Mediano-dorsale (M. Z.),  $\times 0,5$ .  
 Fig. 2. Antero-laterale (I. G.),  $\times 0,75$ .  
 Fig. 3. Infra-gnathale (I. G.), wielk. nat.  
 Fig. 4. Fragment czaszki (I. G.),  $\times 0,75$ .  
 Fig. 5. Fragment infra-gnathale (I. G.); wielk. nat.  
 Fig. 6. *Titanichthys kozłowskii* n. sp., nuchale (M. Z.) od strony brzusznej;  
 $\times 0,75$ .

## Pl. X

Fig. 1. *Deveonema obrucevi* n. gen., n. sp., mediano-dorsale (I. G.); a od strony grzbietowej, b od strony brzusznej, wielk. nat.

Fig. 2. *Holonema radiatum* (Rohon in coll.) Obrucev, antero-dorso-laterale (I. G.),  $\times 0,75$ ; a od strony brzusznej, b od strony grzbietowej.

## Pl. XI

*Anomalichthys ingens* (Koenen)

- Fig. 1. Mediano-dorsale (I. G.), od tyłu;  $\times 0,5$ .  
 Fig. 2. To samo, powierzchnia grzbietowa;  $\times 0,33$ .  
 Fig. 3. Fragment płytki z charakterystyczną ornamentacją; wielk. nat.  
 Fig. 4. *Stenosteus?* sp., fragment infra-gnathale (M. Z.);  $\times 3$ .

## Pl. XII

- Fig. 1. *Bothriolepis* sp. (I. G.);  $\times 0,75$ .  
 Fig. 2. *Brachythoraci* gen. et sp. indet. ( $\beta$ ), antero-dorso-laterale (I. G.)  $\times 0,75$ .  
 Fig. 3. *Operchallosteus vialowi* n. gen., n. sp.; postero-ventro-laterale (I. G.);  
 $\times 0,75$ .  
 Fig. 4. *Placodermi* sp., nieparzysta płytka (I. G.);  $\times 0,75$ .

## Pl. XIII

- Fig. 1. *Alienacanthus małkowski* n. gen., n. sp. (M. Z.): a z boku, ca.  $\times 0,33$ ; b od przodu, ca.  $\times 0,33$ ; c fragment kolca z zachowanymi ząbkami,  $\times 0,75$ .  
 Fig. 2. *Ctenacanthus* sp. (M. Z.); wielk. nat.  
 Fig. 3. *Sentacanthus żelichowskae* n. gen., n. sp.; dwie części kolca (M. Z.); z boku; wielk. nat.  
 Fig. 4. *Cladodus* sp. 1 (M. Z.);  $\times 8$ .  
 Fig. 5. *Cladodus* sp. 2 (M. Z.);  $\times 4$ .  
 Fig. 6. *Cladodus* sp. 3 (M. Z.); ca.  $\times 2,5$ .  
 Fig. 7. *Dittodus* sp. (M. Z.);  $\times 5$ .  
 Fig. 8. *Dittodus* sp. (M. Z.);  $\times 3$ .

## ЮЛИАН КУЛЬЧИЦКИ

## РЫБЫ ИЗ ВЕРХНЕГО ДЕВОНА СВЕНТОКРЖИСКИХ ГОР

## Резюме

Материалом настоящей работы являются остатки панцирных и пластиножаберных рыб из франского (обнажения Ветржия, Псе Гуржи, Кадзелья) и фаменского (обнажения Кадзелья и в местности Галэнзице) ярусов.

Среди исследованной фауны найдено несколько новых форм: *Malerosteus gorizdroae* n. gen., n. sp.; *Tomaiosteus grossi* n. gen., n. sp.; *Dinichthys denisoni* n. sp.; *Dinichthys ceterus* n. sp.; *Titanichthys kozlowskii* n. sp.; *Devgonema obrucevi* n. gen., n. sp.; *Operchallosteus vialowi* n. gen., n. sp.; *Alienacanthus maikowskii* n. gen., n. sp.; *Sentacanthus zelichowskiae* n. gen., n. sp.

Кроме того установлено присутствие *Dinichthys pustulosus* Eastman, *Dinichthys* cf. *tuberculatus*, *Pachyosteus bulla* Jaekel, *Holonema radiatum* Obrucev, *Anomalichthys ingens* (Koenen) и нескольких менее точно определенных форм, как: *Plourdosteus* sp., *Oxyosteus* sp., *Stenosteus?* sp., *Ctenacanthus* sp., *Cladodus* sp., *Dittodus* sp.

На основании изученного материала автор приходит к следующим заключениям:

1. Челюстные аппараты — раздвигивающий рода *Malerosteus*, *Dinomylostoma* и *Mylostoma*, и режущий рода *Tomaiosteus* — происходят от типа схватывающего свойственного *Coccosteus* и *Plourdosteus*.
2. Челюстной аппарат рода *Pachyosteus* более примитивный чем у *Coccosteus* и *Plourdosteus*.
3. В зубах рода *Pachyosteus* имеется дентин и пульпарная полость.
4. У *Brachythoraci*, подобно кистеперым и двоякодышащим, происходил процесс исчезновения дентина и замещения его костной тканью.
5. Этот процесс распространяется у *Brachythoraci* на зубики ротовой полости.
6. Парасфеноид рода *Pachyosteus* имеет другое и повидимому более примитивное строение, чем у *Dinichthyidae*.
7. У *Pachyosteus* сонные артерии соединялись в одну непарную, вместо соединения анастомозом и сохранения самостоятельности обеих артерий, как это имеет место у *Dinichthyidae*.
8. Согласно мнению Гейнца (A. Heintz, 1932) и Уайта (E. White, 1952), жаберные щели занимали вентральное положение.
9. Во время онтогенеза происходило довольно значительное изменение очертаний костей.
10. Родственная связь между *Pachyosteidae* и *Dinichthyidae* также далека, как и между *Pachyosteidae* и *Coccosteidae*; *Pachyosteomorpha* не являются по всей вероятности естественной группой.
11. *Dinichthys tuberculatus* и *D. belgicus* являются повидимому представителями одного вида.
12. *Dinichthys pustulosus*, а также повидимому *D. tuberculatus* являются широко распространенными видами, которые совершили миграцию из северной Америки в Европу.

## EXPLANATIONS OF PLATES

### Pl. I

- Fig. 1. *Plourdosteus* sp., marginal (I. G.);  $\times 3$ .  
Fig. 2. *Plourdosteus* sp., infragnathal (I. G.);  $\times 1.5$ .  
Fig. 3. Brachythoraci gen. et sp. indet. (a), median dorsal (I. G.) a dorsal view, b ventral view; nat. size.

#### *Malerosteus gorizdroae* n. gen., n. sp.; nat. size

- Fig. 4. a Left anterior supragathal (M. Z.), medial view, b same, side view.  
Fig. 5. Right anterior supragathal (M. Z.), medial view;  
Fig. 6. a Left posterior supragathal (M. Z.), side view; b same, medial view; c same, ventral view.  
Fig. 7. a Left infragnathal (M. Z.), dorsal view; b same, side view.

### Pl. II

#### *Malerosteus gorizdroae* n. gen., n. sp.; $\times 0.75$

- Fig. 1. *PrO* preorbital, *SO* suborbital (M. Z.).  
Fig. 2. Suborbital (I. G.).  
Fig. 3. Anterior dorsolateral (M. Z.).  
Fig. 4. *PN* paranuchal, *M* marginal, *PtO* postorbital (M. Z.).

### Pl. III

- Fig. 1. *Malerosteus gorizdroae* n. gen., n. sp.; postsuborbital (M. Z.);  $\times 0.75$ .

#### *Malerosteus gorizdroae?* $\times 0.75$

- Fig. 2. a Nuchal (I. G.), ventral view; b same, dorsal view.  
Fig. 3. Posterior median ventral (I. G.).

#### *Tomaiosteus grossi* n. gen., n. sp.

- Fig. 4. Fragment of the head shield (I. G.) with *C* central, *P* pineal, *PrO* preorbital;  $\times 0.75$ .  
Fig. 5. a Posterior supragathal (I. G.), medial view, nat. size; b same, side view.

### Pl. IV

#### *Dinichthys pustulosus* Eastman

- Fig. 1, 2. Fragment of the head shield (M. Z.) from the Lower Frasnian of Wietrzna, approx.  $\times 0.33$ : 1 dorsal view, 2 ventral view; *C* central, *M* marginal, *N* nuchal, *PN* paranuchal, *PtO* postorbital.

### Pl. V

#### *Dinichthys pustulosus* Eastman

- Fig. 1-4. Median dorsal (M. Z.).  $\times 0.5$ ; 1 ventral view, 2 dorsal view, 3 side view, 4 posterior view.

### Pl. VI

#### *Dinichthys pustulosus* Eastman

- Fig. 1. Anterior supragathal (M. Z.), nat. size.  
Fig. 2. Fragment of the head shield from the Middle Frasnian (M. Z.); approx.  $\times 0.33$ .  
Fig. 3. Fragment of the anterior lateral (M. Z.),  $\times 0.75$ .  
Fig. 4. *Dinichthys denisoni* n. sp., median dorsal (M. Z.) from *Cheiloceras* bed in Kadzielnia;  $\times 0.5$ .  
Fig. 5. *Dinichthys* sp., anterior dorsolateral (M. Z.);  $\times 0.5$ .

Pl. VII

*Dinichthys denisoni* n. sp.

- Fig. 1, 2. Two median dorsals (I. G.): 1 a posterior view, b side view, c ventral view;  $\times 0.5$ .

Pl. VIII

- Fig. 1. *Dinichthys ceterus* n. sp., median dorsal (M. Z.),  $\times 0.5$ ; a side view, b ventral view.

*Dinichthys cf. tuberculatus*

- Fig. 2. Infragnathal (M. Z.),  $\times 0.33$ .  
 Fig. 3. Fragment of the posterior ventrolateral (M. Z.),  $\times 0.75$ .  
 Fig. 4. *Oxyosteus* sp., median dorsal (I. G.),  $\times 0.75$ ; a dorsal view, b front view.

Pl. IX

*Pachyosteus bulla* Jaekel

- Fig. 1. Median dorsal (M. Z.),  $\times 0.5$ .  
 Fig. 2. Anterior lateral (I. G.),  $\times 0.75$ .  
 Fig. 3. Infragnathal (I. G.), nat. size.  
 Fig. 4. Fragment of the head shield (I. G.),  $\times 0.75$ .  
 Fig. 5. Fragment of the infragnathal (I. G.), nat. size.  
 Fig. 6. *Titanichthys kozłowski* n. sp., nuchal (M. Z.), ventral view;  $\times 0.75$ .

Pl. X

- Fig. 1. *Deveonema obručevi* n. gen., n. sp., median dorsal (I. G.); a dorsal view, b ventral view; nat. size.  
 Fig. 2. *Holonema radiatum* (Rohon in coll.) Obručev, anterior dorsolateral (I. G.),  $\times 0.75$ ; a ventral view, b dorsal view.

Pl. XI

*Anomalichthys ingens* (Koenen)

- Fig. 1. Median dorsal (I. G.), posterior view;  $\times 0.5$ .  
 Fig. 2. Same, dorsal view;  $\times 0.33$ .  
 Fig. 3. Fragment of the shield plate showing ornamentation; nat. size.  
 Fig. 4. *Stenosteus?* sp., fragment of the infragnathal (M. Z.);  $\times 3$ .

Pl. XII

- Fig. 1. *Bothriolepis* sp. (I. G.),  $\times 0.75$ .  
 Fig. 2. *Brachythoraci* gen. et sp. indet. ( $\beta$ ), anterior dorsolateral (I. G.)  $\times 0.75$ .  
 Fig. 3. *Operchallosteus vialowi* n. gen., n. sp.; posterior ventrolateral (I. G.),  $\times 0.75$ .  
 Fig. 4. *Placodermi* sp., unpaired plate (I. G.);  $\times 0.75$ .

Pl. XIII

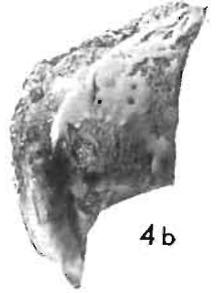
- Fig. 1. *Alienacanthus malkowskii* n. gen., n. sp. (M. Z.): a side view, approx.  $\times 0.33$ ; b front view, approx.  $\times 0.33$ ; c fragment of the spine showing the shape of denticles,  $\times 0.75$ .  
 Fig. 2. *Ctenacanthus* sp. (M. Z.); nat. size.  
 Fig. 3. *Sentacanthus žel chowskæ* n. gen., n. sp.; two parts of the spine (M. Z.), side view; nat. size.  
 Fig. 4. *Cladodus* sp. 1 (M. Z.);  $\times 8$ .  
 Fig. 5. *Cladodus* sp. 2 (M. Z.);  $\times 4$ .  
 Fig. 6. *Cladodus* sp. 3 (M. Z.); approx.  $\times 2.5$ .  
 Fig. 7. *Dittodus* sp. (M. Z.);  $\times 5$ .  
 Fig. 8. *Dittodus* sp. (M. Z.);  $\times 3$ .



4a



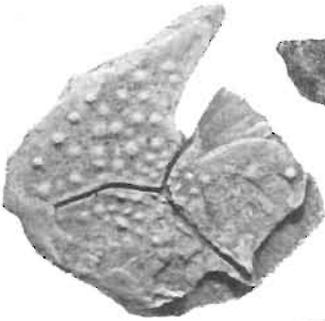
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6a



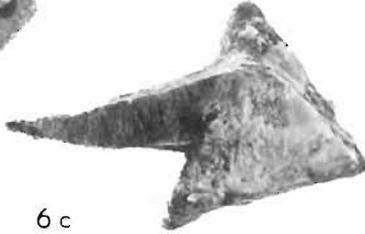
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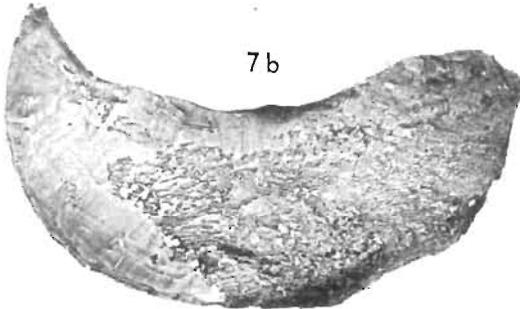
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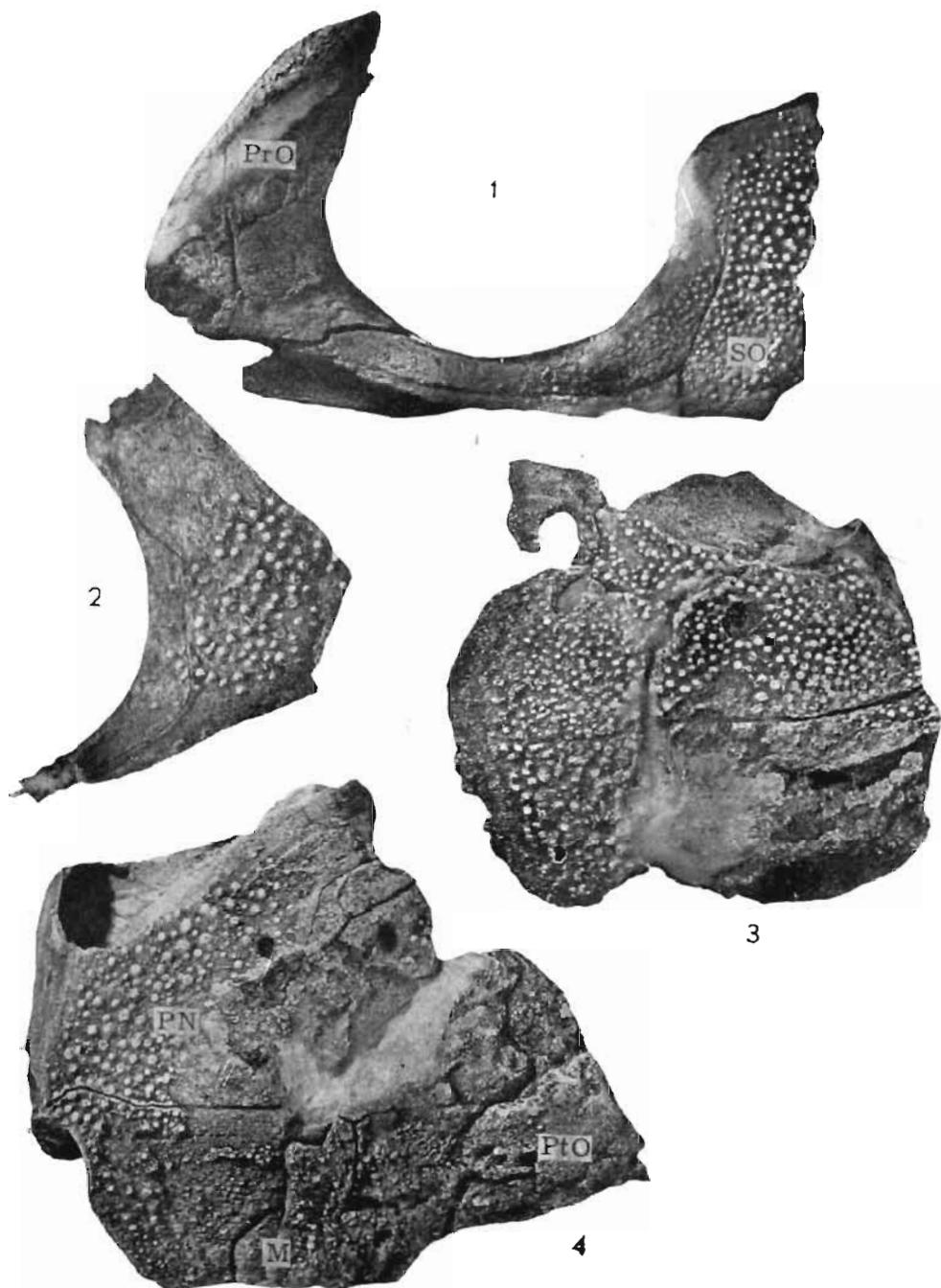
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7b



3b

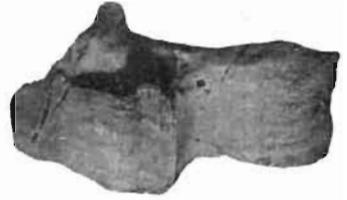




5a



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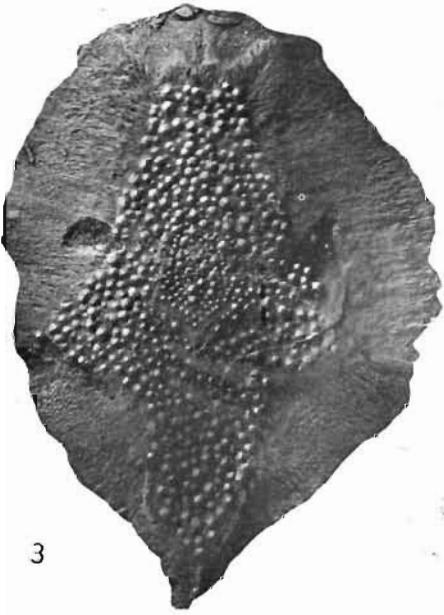


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2a



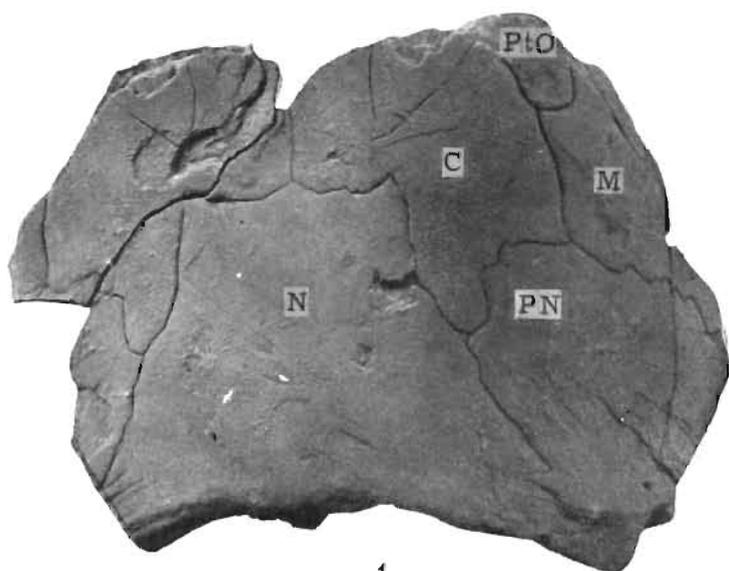
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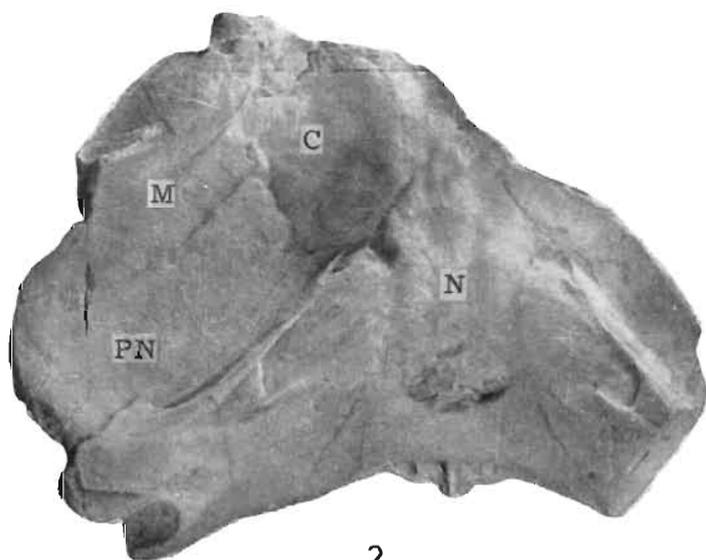
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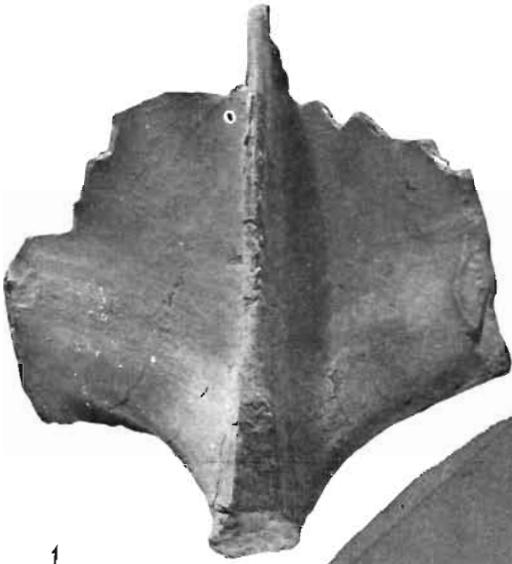
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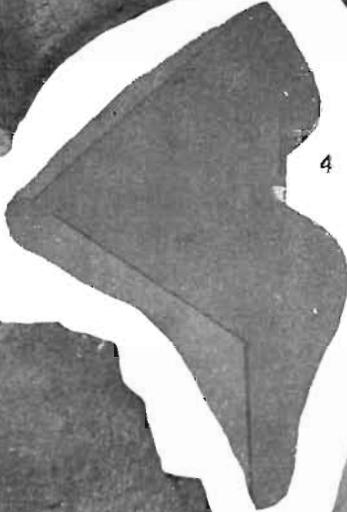
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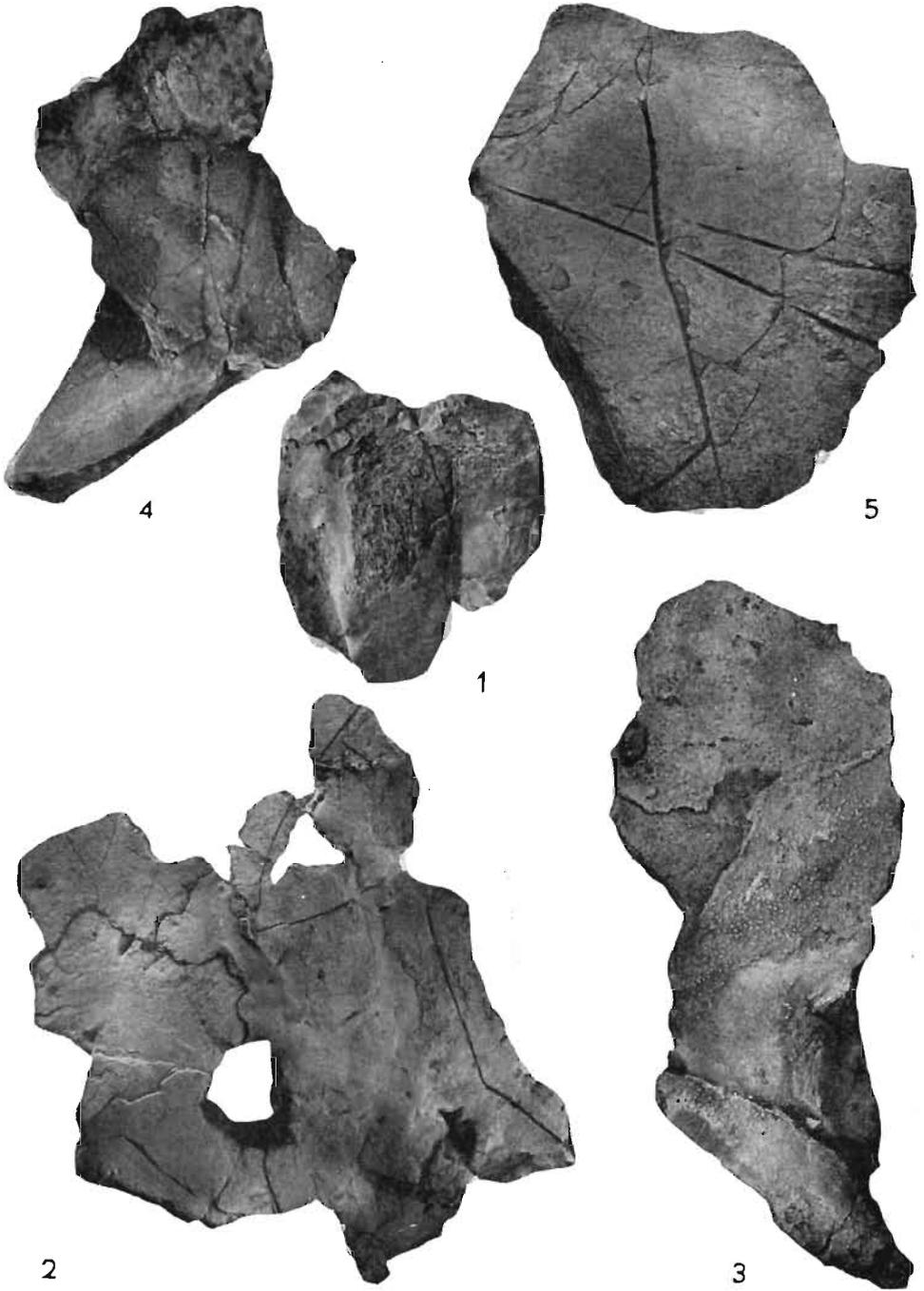
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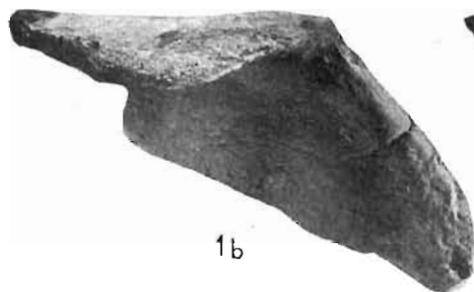




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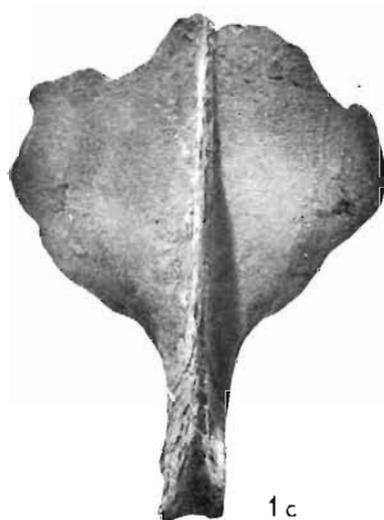
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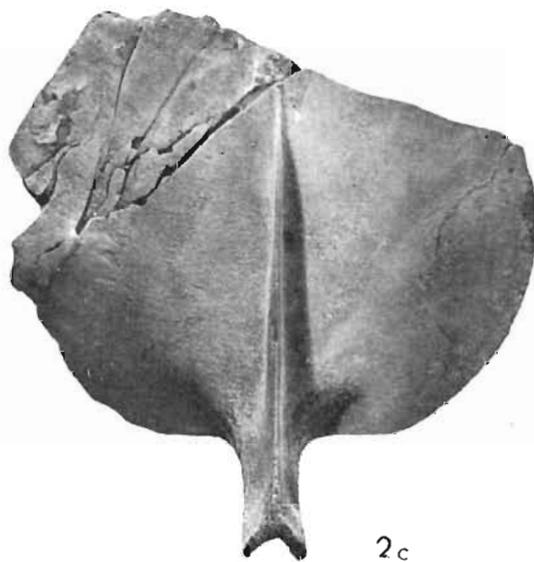
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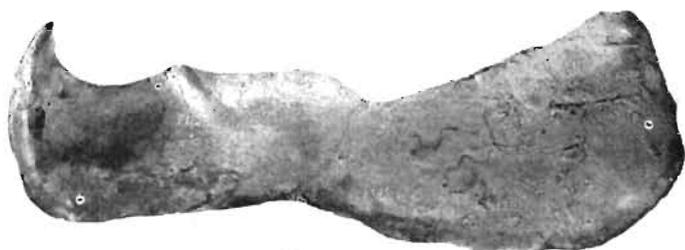
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2c



1a



2



3



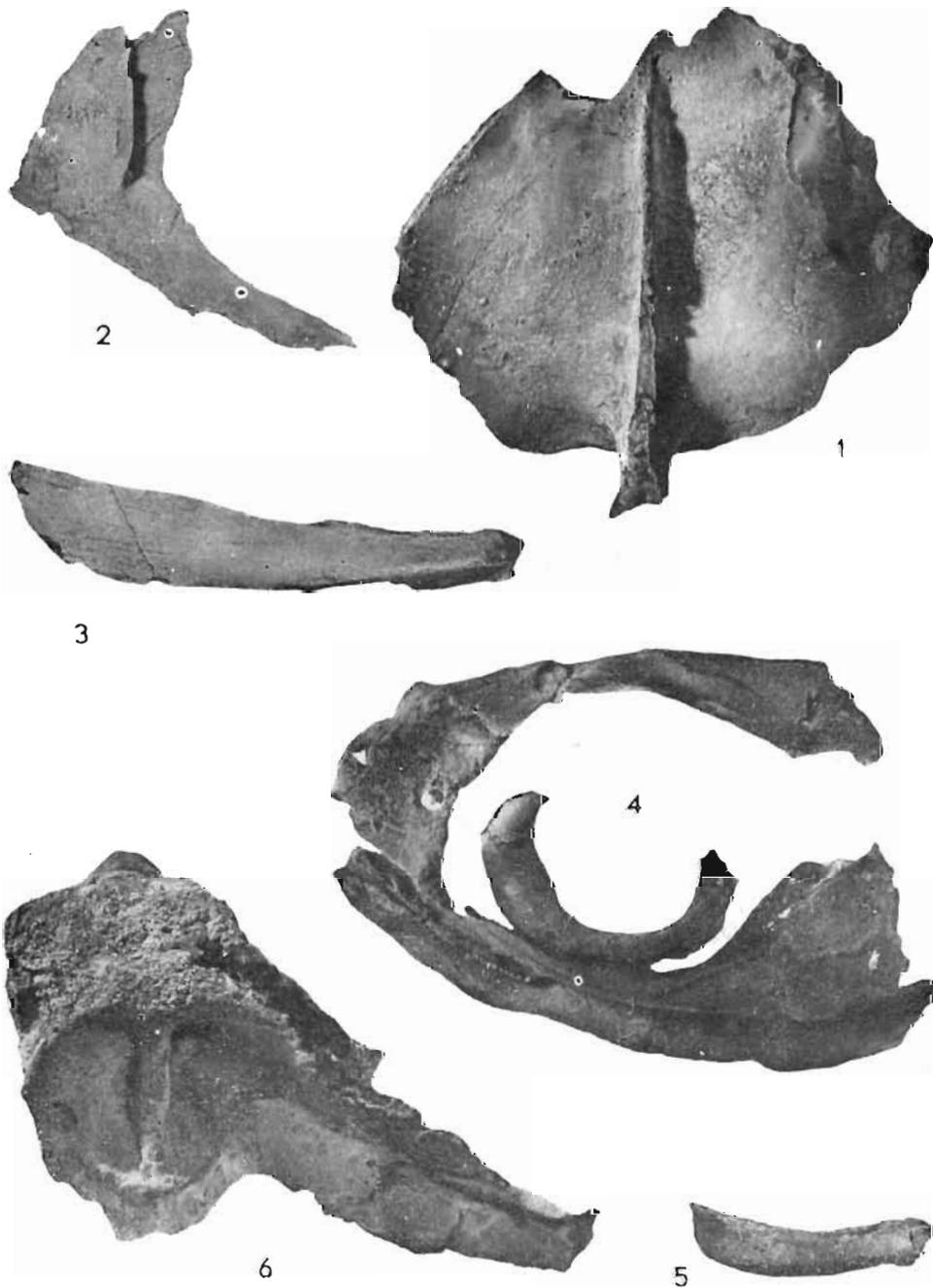
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4b



4a





2a



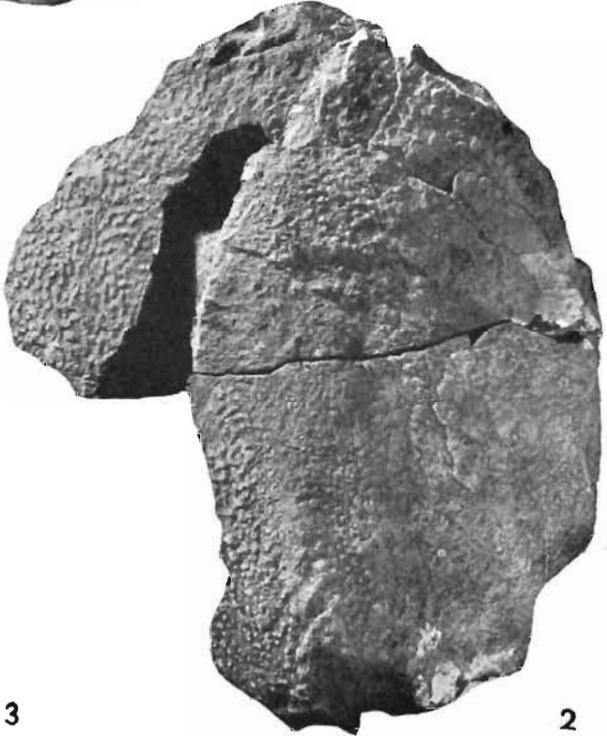
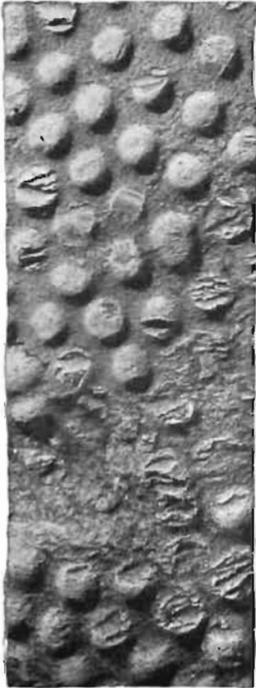
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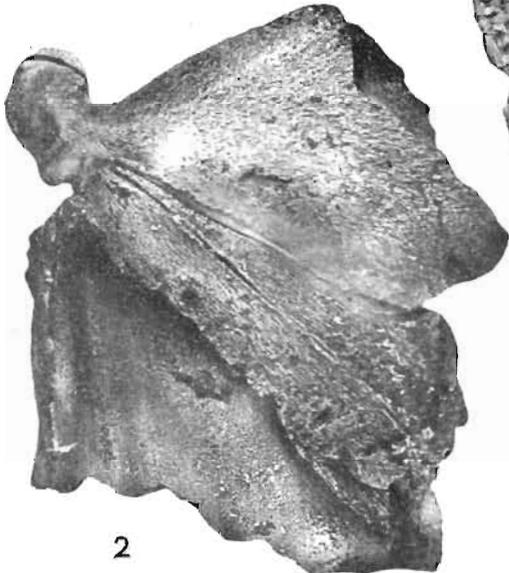
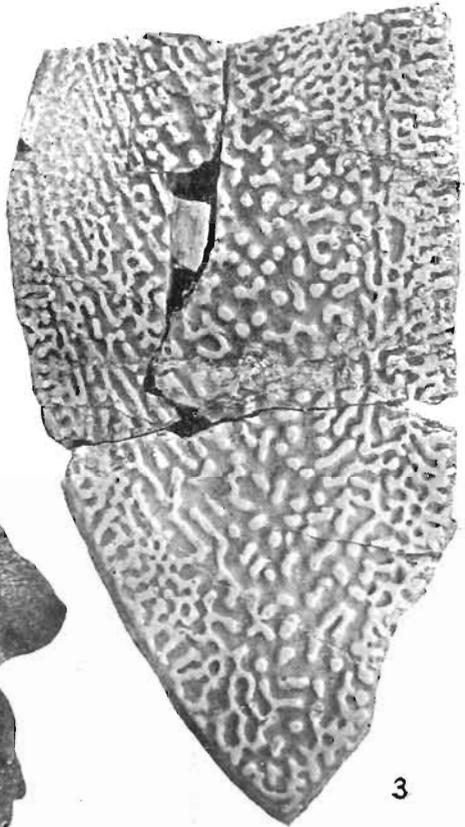
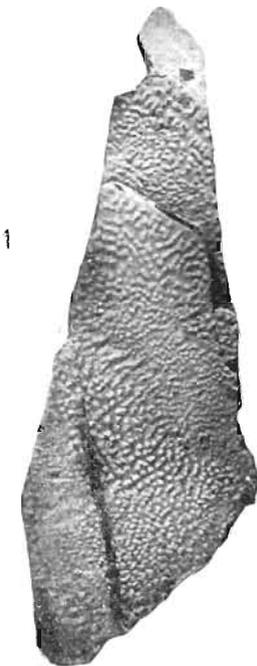


1b



2b







1a



1b



4



8



7



3b



2



5



6



1c



3a