A C T A P A L A E O N T O L O G I C A P O L O N I C A
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ON THE UPPER CAMBRIAN *LINGULELLA* SALTER (BRACHIOPODA) FROM THE HOLY CROSS MOUNTAINS, POLAND

Abstract. — Abundant but not very well preserved uppermost Cambrian Obolidae King, genus *Lingulella* Salter dominating, was recovered from recent boring in the Holy Cross Mountains (Góry Świętokrzyskie). One of the aims of this study was to define and discuss some of the available diagnostic characters for species within lingulellids. *Obolus* sp. and two species of *Lingulella* Salter were recognized, *Lingulella lepis* Salter represented by numerous valves, and *L.* cf. *davisi* (M'Coy) occurring spcradically.

INTRODUCTION

In the northern region of the Holy Cross Mountains (Góry Świętokrzyskie), Łysogóry belt, in deep borings made recently by the Geological Institute, Warsaw, uppermost Cambrian and lowermost Ordovician beds in continuous transition have been recovered. These deposits contain a rich and greatly differentiated assemblage of trilobites, on which their stratigraphy was based (Tomczykowa, 1968), as well as numerous inarticulate brachiopods of the familly Obolidae King, representing the genus *Lingulella* Salter (*L. lepis* Salter, *L.* cf. *davisi* (M'Coy)) and specimens of *Obolus* sp.

The uppermost Cambrian fauna in the Holy Cross Mountains was first recognized by Czarnocki (1927) and mentioned by Samsonowicz (1956) in the districts of Mąchocice and Bączkowa. They stated the presence there of trilobites characteristic for the zone of *Peltura scarabeoides scarabeoides,* as well as numerous brachiopods of the genera *Lingulella* Salter, *Acrotreta* Kutorga, *Orusia* Walcott and *Eoorthis* Walcott. According to Czarnocki (1927) and Samsonowicz (1956), uppermost Cambrian and lowermost Ordovician are absent in the Holy Cross Mountains.

The Cambrian obolids from Poland are not, up to now, well known. Only some species have been described or mentioned from the Holy Cross Mountains (Gürich, 1892, 1896; Siemiradzki, 1886; Walcott, 1912; Czarnocki, 1927; Samsonowicz, 1956; Orłowski, 1964), but these were not of uppermost Cambrian age.

The stratigraphical part of this paper has been prepared by the second author (E. Tomczykowa, Geological Institute, Warsaw), the remainder by the first author (G. Biernat, Palaeozoological Institute, Polish Academy of Sciences, Warsaw).

All the core material of inarticulate brachiopods made available to the first author for detailed studies comes from the Geological Institute, Warsaw, where the collection is deposited, for which the abbreviation *I. G. 1108/II.* is used.

An acknowledgement is made to Dr. A. J. Rowell, University of Kansas, U.S.A., for sending photocopies of selected pages of M'Coy's (1851) and Salter's (1866) papers. The photographs were taken by Miss M. Czarnocka, the ink-drawings by Mrs. K. Budzyńska, both from the Palaeozoological Institute, Polish Academy of Sciences, Warsaw.

STRATIGRAPHY

The uppermost Cambrian deposits in a continuous transition to the Lower Ordovician in the northern part of the Holy Cross Mountains, named Łysogóry beds (Tomczykowa, 1968), were found in ten bore holes between the localities Kajetanów in the West, and Opatów, some sixty kilometres distant to the East (Fig. 1). These borings, taken as a whole, furnish a full profile of the deposits of the uppermost Cambrian and lowermost Ordovician (Tremadocian) of total thickness 200 m, not previously known in Poland.

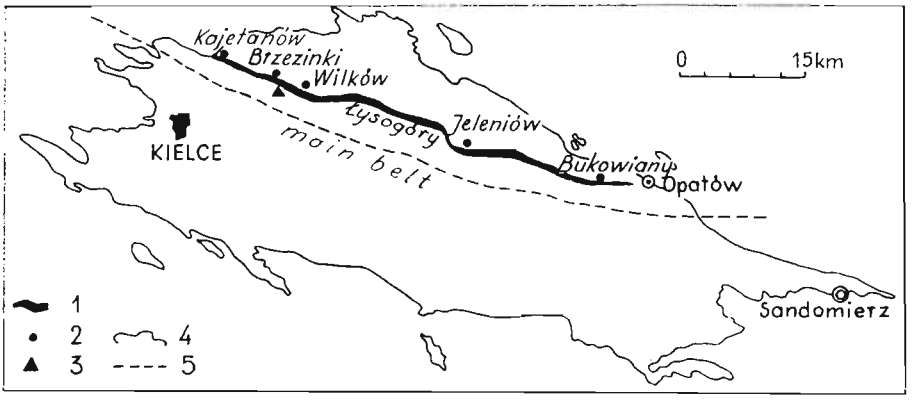

Fig. 1. — Upper Cambrian of the Łysogóry beds in the Holy Cross Mountains (Góry Świętokrzyskie), according to Tomczykowa, 1968; *1* Łysogóry beds on the northern slope of the main belt, *2* location of bore hole, *3* Upper Cambrian of Mąchocice beds, *4* extent of Palaeozoic deposits in the Holy Cross Mountains, *5* boundary between the Łysogóry (northern) and Kielce (southern) regions, according to Czarnocki, 1957.

The Łysogóry beds comprise, according to the Scandinavian division, the upper part of zone 5c and zone 6 (Westergard, 1922; Henningsmoen, 1957) and the lowermost Tremadocian — 2eα (Strand & Henningsmoen, 1961) (Table 1).

Table 1

Stratigraphy of the uppermost Cambrian and the boundary with Ordovician in the Holy Cross Mountains

Norway (Henningsmoen, 1957)				Poland (Tomczykowa, 1968)		
UPPER CAMBRIAN	Tremadocian	*Dictyonema*		*Dictyonema*		ŁYSOGORY BEDS
	6	*Acerocare ecorne*	*Parabolina acanthura*	*Parabolina acanthura*	6d	
		Westergardia	*Parabolina heres lata*	*Paraboliana bukowiana*	6c	
		Peltura costata	*Parabolina heres heres*	*Beltella rotundata*	6b	
		Peltura transiens	*Acerocarina micropyga*	*Parabolina latilimbata*	6a	
	5c	*Peltura paradoxa*		*Beltella convexa*	5c	
		Parabolina lobata lobata *Peltura scarabeoides westergardi*		*Parabolina lobata lobata* *Peltura scarabeoides* cf. *westergardi*		

The lithology of deposits is, in general, very monotonous, developed as gray and dark-gray siltstones with intercalations of micaceous mudstones. The mudstones are, sometimes, very sandy or replaced by gray and compact quartzitic sandstones. The fauna is, in general, rich and in the case of trilobites well preserved. In the Łysogóry beds, brachiopods represented mainly by *Lingulella* Salter are abundant throughout, while trilobites, though numerous and very differentiated, occur only in some levels (Fig. 2). Fragments of gastropods, *Hyolithes* and spicules of sponges sporadically occur. Near the top of the Łysogóry beds, fragments of rhabdosome of *Dictyonema* sp. are recorded.

The deposits corresponding to zone 5c, about 35 m in thickness, were stated in the bore holes of Wilków, Jeleniów 3 and in all probability in the top of the section of borings: Brzezinki 1, 2, 3, and Bukowiany 1, 1a. This zone has been recognized on the base of trilobites representing new species, such as: *Parabolina parva* Tomczykowa, *Beltella convexa* Tomczykowa, *B. lata* Tomczykowa, *B. czarnockii* Tomczykowa and numerous brachiopods of the species *Lingulella lepis* Salter and *L.* cf. *davisi* (M'Coy).

The Łysogóry beds corresponding to zone 6 attain a thickness of about 150 m (Fig. 2) and were found in all sections of the above mentioned bore holes. They have been divided into four subzones.

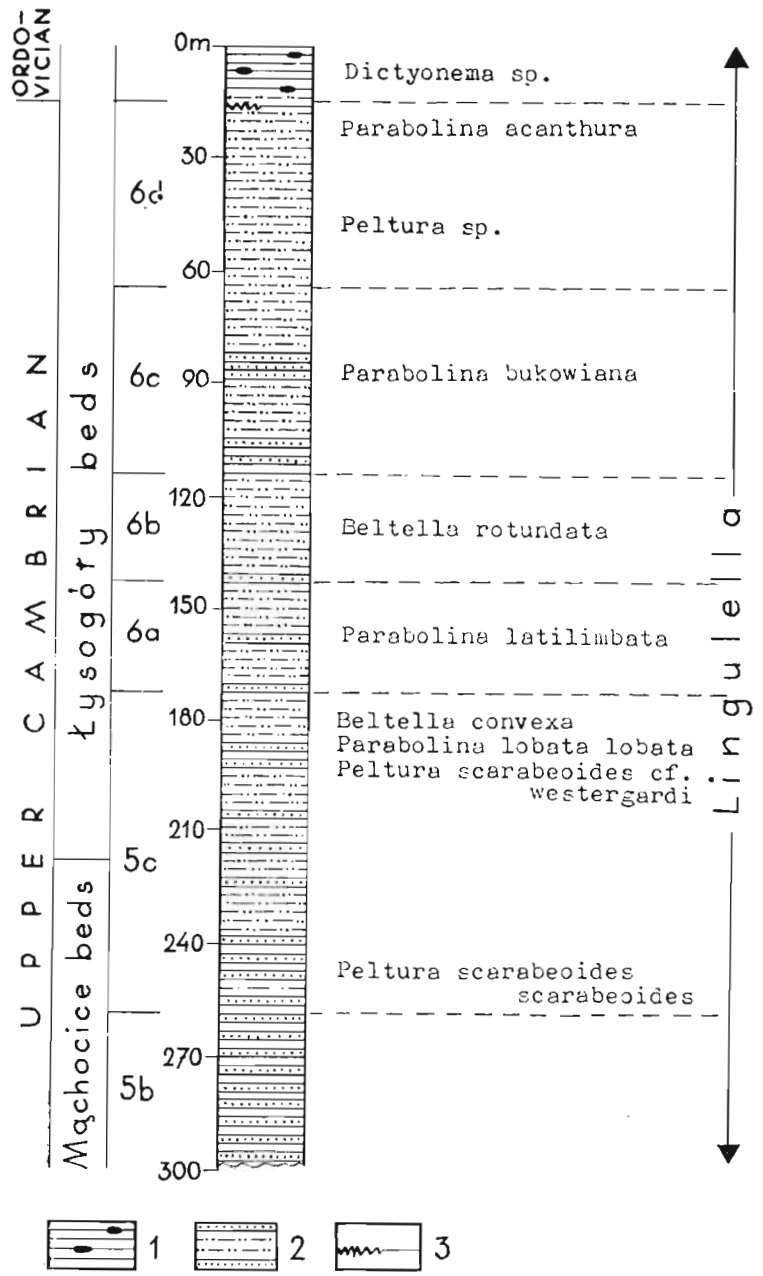

Fig. 2. — Lithology and stratigraphy of the Upper Cambrian in Łysogóry belt; *1* siltstones with limestone concretions, *2* siltstones with intercalations of mudstones and sandstones.

Subzone 6a contains abundant trilobite fauna occurring mainly in the bore hole Jeleniów 3 at a depth of 150—125 m. This fauna contains among others: *Parabolina latilimbata* Tomczykowa, *Beltella lata* Tomczykowa, *B. czarnockii* Tomczykowa, accompanied by numerous brachiopods *Lingulella lepis* Salter and rare *Obolus* sp. In the other bore holes, in the parts of profiles corresponding to subzone 6a, only fragments of trilobites were recorded, brachiopods of *Lingulella lepis* Salter being numerous.

Subzone 6b, about 25 m thick, is characterized by an abundant and differentiated fauna of trilobites as well as by numerous brachiopods. The cores yielding the richest fauna come from the bore holes Jeleniów 3, Bukowiany and, to a much lesser extent, Brzezinki.

In the boring Jeleniów 3, in subzone 6b, occur trilobites, among others: *Beltella lata* Tomczykowa, *B. czarnockii* Tomczykowa with *Acerocarina* sp. in the lower part of the profile, and *Acerocare* sp. at the top. The inarticulate brachiopods are represented by *Lingulella lepis* Salter. In the bore holes Bukowiany and Brzezinki occur specimens of *Peltura* sp., *Parabolina* sp., and very rare *Lingulella* cf. *davisi* (M'Coy). The subzone 6c comprising sediments about 50 m thick is, in general, very weakly documented by faunal assemblage. Recorded here were single specimens of *Peltura* sp., *Parabolina* sp., *Beltella* sp. and numerous fragments of *Lingulella* Salter and *Obolus* Eichwald. Complete valves of these latter are extremely rare.

Uppermost Cambrian, subzone 6d, has been recorded in the profiles of boring Jeleniów 2 and at the top of bore hole Jeleniów 3, this subzone attaining a thickness of about 50 m. The index trilobite fauna, found only in Jeleniów 2, at a depth of about 194—192 m, contains specimens of about 189 m, some 3 m above *Parabolina acanthura* (Angelin). Also remnants of brachiopods.

In Jeleniów 3, remnants of *Dictyonema* sp. have been found at a depth of about 189 m, some 3 m above *Parabolina acanthura* (Angelin). Also occurring here is an accumulation of small valves (=young) of in all probability *Lingulella lepis* Salter. On the basis of the small lithological differences (the rock slightly more micaceous) and the rare concretions of limestone, a boundary of about 7 m thick, between the uppermost Cambrian and Tremadocian has been suggested in the section of Jeleniów 2 at a depth of about 190 m. In boring Brzezinki 1, a fault is present at the uppermost Cambrian-Tremadocian boundary. The Tremadocian occurs at a depth of 91.7—73.0 m, remnants of *Dictyonema* sp. being found at a depth of about 79 m.

REMARKS ON CORE LINGULELLIDS

All lingulellids come from selected portions of cores from the following bore holes: Brzezinki, Bukowiany, Jeleniów (2,3) Wilków (Fig. 1). They occur at different depths: Brzezinki 79—181 m, Bukowiany 238—241 m, Jeleniów 2 195—241 m, Jeleniów 3 27—180 m, Wilków 796—952 m. The Cambrian deposits of the core Jeleniów 3 are of the greatest thickness, the most complete and yield abundant inarticulates.

All the assemblage of brachiopods is dominated by lingulellids such as *Lingulella lepis* Salter and *L.* cf. *davisi*; *Obolus* sp. is much less numerous.

In each mentioned core, the composition of species as well as the number of valves only slightly differs. In Bukowiany, Brzezinki and especially in Wilków occur mainly *Lingulella* cf. *davisi* (M'Coy) and *Obolus* sp., and in Jeleniów 2,3 — *L. lepis* Salter and very rarely *Obolus* sp.

The quantitative distribution of brachiopod valves is judged to be rather uniform throughout all cores, contrary to trilobites which are abundant in some levels (see p 163). In general, the valves of lingulellids occur regularly, approximately 20 valves to each 30 cm of core, approximately 10 cm in diameter. In only some cases is their number much reduced, occasionally even to a single valve or its fragment (comp. Jeleniów 3 at a depth of 30 m, 144 m, etc.).

At some depths, however, occur great accumulations of small (=young) valves, as well as inarticulate debris which is almost impossible to identify. The largest accumulation of small valves (of *Lingulella lepis* Salter about 2.0—3.8 mm long) has been recorded in bore hole Jeleniów 2, at a depth of 184—192 m, in deposits probably belonging to Tremadocian (see p. 163). Inarticulate debris have been found several times in all cores at different depths, e. g. Jeleniów 3 at a depth of 168 m, Brzezinki — 142 m. In general, however, specimens in different state of preservation and of different size are intermingled together. This suggests some destructive activity of gentle sea currents and some but unimportant deplacement of valves or their remnants in the Cambrian sea basin.

The state of preservation of the studied lingulellids is not so good as at first seemed. They are all embedded in soft siltstones, not very favourable for good preservation of these thin-shelled and phosphatic brachiopods. All specimens are preserved as simple, more complete or less complete, external or internal moulds of single valves only, the brachial ones being much more numerous. The valves range in length from approximately 2 to 20 mm. The smallest valves (2—4 mm) and the largest (16—20 mm) are in the minority.

This abundant fossil material, comprising over 300 single valves,

contains only 2 complete shells of *Lingulella lepis* Salter of small size, with both valves almost opposite each other, found in the Jeleniów 3 bore hole (Pl. I, Fig. 6). In general, valves show their natural outline, often their original convexity which, as a rule, is low, especially in the pedicle valves. Valves distorted tectonically, sometimes strongly occur mostly in Wilków (Pl. I, Fig. 11; Pl. IV, Fig. 15). Specimens free of matrix are completely lacking. They cannot be obtained by mechanical preparation (because of the nature of matrix and their state of preservation). Also the acid etching method cannot be applied for fossils preserved as moulds or imprints.

On many valves, larger or smaller fragments of phosphatic shell, composed of two thin and very fragile layers are preserved. Reconstruction of the surface ornamentation from the fragments shows that the surface of each layer has a slightly different surface ornament (a feature supposed, among others, to be of diagnostic value for e.g. lingulellids (Rowell, 1965, p. H266)). The preserved external layer bears concentric microlines and much thicker macrolines, the former, very delicate in appearance, are regularly disposed, the latter being arranged in longer or shorter intervals. In some cases, there are traces suggesting radial striation which is characteristic for *Lingulella lepis*. The second, inner layer, being highly polished, is in general very thin, closely adhering to the upper surface of matrix. It is covered by traces of radiating striae, sometimes expressed more distinctly, sometimes less. This layer is mostly preserved in our fossils. The visceral area often preserves its pustulous character.

The elements of internal structure are, as a rule, not preserved because of the thinness of shell (an additional feature characterizing the majority of inarticulates, i.e. lingulellids). Weakly marked on internal moulds are: median dorsal ridge of slightly varying length and some muscle scars of four brachial valves of *Obolus* sp. and a fragment of a pedicle valve of *Lingulella lepis* Salter (Pl. II, Fig. 9; Pl. III, Figs. 1—3). Their uncovering with a thin needle, is extremely difficult and yielded very poor results, the matrix becoming scratched by the dissecting needle. Of the other structural details, the ventral pedicle groove, the ventral and often dorsal pseudointerareas, which usually very closely adhere to the inner surface of the valves, can be observed, but are weakly marked. This applies mainly to pseudointerareas, often very inconspicuous because of the varying degree of exfoliation of the umbonal portions of valves. The lack of internal structure much reduces the palaeontological value of this material. Detailed information regarding the muscular area and pallial sinuses, so far not well known in Obolidae, could not be obtained.

The biometric method could only in part be used for the studied fossils (Fig. 3). Some measurements, e.g. valve length to valve width,

apical width to the anterior width (see p. 173), showed two main morphological types (but with intermediate individuals): 1) longitudinally ovate, and 2) roundly outlined. Such measurements, as length of pedicle groove, its width posteriorly and anteriorly, height and width of ventral and

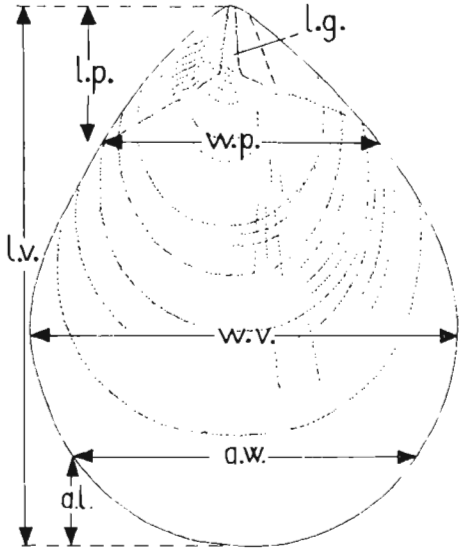

Fig. 3. — Measurements; *l.g.* length of pedicle groove, *l.p.* length posteriorly, *w.p.* width posteriorly, *l.v.* valve length, *w.v.* valve width, *a.w.* anterior width, *a.l.* anterior length; approx, × 10.

dorsal propareas, height and width of median dorsal segment, were however not sufficiently accurate due to the poor material, hence not very suitable for comparison.

REMARKS ON THE DIAGNOSTIC CRITERIA FOR SPECIES OF *LINGULELLA* SALTER ON THE BASIS OF THE STUDIED MATERIAL

Recognition of the fossil species of *Lingulella* is not easy. The known species are not well defined, the few morphological characters that may differ, e.g. shell outline and shape, appearance of umbonal portions, appearance of anterior margin and surface ornamentation, show minor quantitative changes only.

It is difficult, on the present material, to estimate the taxonomic value of the surface ornamentation of lingulellids. Its pattern in the studied specimens is, generally speaking, very similar, composed of (so far as can be judged from moulds and fragments of shell, comp. p. 165) concentric microlines and macrolines, and in some cases very faintly marked radial ornamentation. The fine concentric microlines are almost

identical being similarly expressed and regularly disposed over all the shell surface. The concentric macrolines, distinct to different degrees, are more or less irregularly arranged with intervals usually better accentuated on the anterior half of the shell. Besides, there occur specimens with surface undulations of varying intensity, disposed on the anterior half or two-thirds of the valve length, fairly distinct on the moulds (Pl. I, Figs. 2, 4). The wavy character of the shell surface, together with usually thicker macrolines, was considered by Salter as a feature sufficiently distinct to characterize *Lingulella ferruginea* Salter (Salter, 1867, p. 340). The presence of concentric waves may have some value as an additional diagnostic character for species, but not, probably, the pattern of their arrangement on the shell surface. These waves appearing at marked intervals can be connected with the rate of growth (which may be slightly different for specimens within a population), being an expression of periods of intensive activity followed by temporary arrest of growth process. This latter may be judged perhaps as evidence of seasonal growth.

About 200 specimens (separate valves) of all cores were closely examined for size and morphology. An additional 100 separate brachial and 80 pedicle valves coming from Jeleniów 2,3 and Bukowiany were measured (see p. 172, Remarks). By using standard measurements (see Fig. 3) and a simple graphical method it is not possible to split the measured collection into distinct specific categories according to some morphological characteristics such as: shell outline, appearance of antero-lateral margins etc., although the specimens on visual inspection are not quite uniform morphologically. In consequence, one can conclude that the measured collection represents one species only — *Lingulella lepis* Salter.

Although all lingulellids are generally longitudinal-ovate, there occur some differences in the shell outline. These were observed by Walcott (1912, p. 470) who distinguished 5 groups within lingulellids: acuminate, subacuminate, ovate-elongate, ovate-subtriangular, subtriangular, and considered the outline of the pedicle valve in particular, as one of the diagnostic characteristics for the species of *Lingulella* Salter.

The studied collection includes almost all shell outlines mentioned by Walcott, but it is difficult to divide the specimens into distinct groups in Walcott's meaning, as there occur intermediate specimens which obliterate the boundaries between these „types" of shell outline. In addition, within one species only, *Lingulella lepis* Salter, there occur specimens ranging from subacuminate, more roundly ovate to subtriangular (Pls. I, II, IV). Hence, the above feature has not, in the case of the studied collection, diagnostic value for the species.

In general, the valve outline depends much upon the degree of elongation of the ventral umbo, its width posteriorly and the appearance of the antero-lateral margins. As a rule, with greater the valve width, the

more obtuse and wider the umbo, and reversely, the more acute and elongate the umbo, the smaller the valve width.

The appearance of the anterolateral margins, i.e. the degree of exterior arching was, in general, considered as having taxonomic value for the species. The lateral margins may be parallel or almost parallel to each other (*Lingulella ferruginea* Salter, *L. ovalis* Salter), or arched and divergent to different degrees (narrowed anteriorly *L. davisi* M'Coy, broadened anteriorly *L. lepis* Salter). In addition, the anterior margin may be straight or almost straight (*L. davisi* M'Coy, *L. lingulaeformis* (Mickwitz)), or in varying degrees rounded (*L. lepis* Salter, *L. vistulae* Gürich).

In the case of our specimens, the above mentioned differing characters are judged to be not significant for the species. They occur, in different degree, in *Lingulella lepis* Salter the dominant species in the uppermost Cambrian of the Łysogóry belt (see p. 172).

It is assumed here that these variations being gradual are of quantitative, and not of qualitative value (see p. 173). It seems that the time of sedimentation during the uppermost Cambrian and lowermost Ordovician of the Łysogóry belt was not sufficiently long for the establishment of more distinct and better delimited differences in the external morphology of our lingulellids. This all is apparently correlated with the degree of environmental stability. The environmental conditions in which these animals lived, were stable, and can, to some degree, be considered as „stagnant", the monotonous lithology of the uppermost Cambrian — lowermost Ordovician deposits being evidence of this latter (see p. 161) therefore the lack of more „abrupt" and consequent morphological changes in lingulellids.

In addition, in the case of the very simple external morphology of the lingulellid shell, the possibility of changes are very limited, and the rate of change was extremely slow.

REMARKS ON GROWTH

The large lingulellid faunule does not furnished a complete growth series. It comprises, in general, valves from about 2 to 20 mm long, but these dimensions, e.g. 3 mm to about 5 mm in length, are extremely rare or occur in single valves. They, in all probability, existed in a much larger number on the sea bottom, but were easily broken during or after the deposition of sediments. Valves, 7 to 12 mm long, are the most abundant, the smallest ones being in a minority.

Growth series, although incomplete, is suggested by the fact that in all considered bore holes, valves usually of different size occur intermingled together. This latter may also indicate that they were found, in

all probability, in their life environment, being the normal occupant of this part of the sea bottom on which they had accumulated.

Unfortunately, the small valves interpreted here as counterparts of young individuals are, similarly as adults, preserved as internal or external moulds, very rarely showing traces of *post mortem* deformation, except breakage. The mentioned growth series are ascribed to *Lingulella lepis* Salter, the most numerous species in the collection. The young age of specimens about 2 mm long is suggested especially by their oval shell outline, delicate concentric lines of uniform appearance, not yet differentiated into microlines and macrolines, regularly disposed over the valve surface, and their moderate valve convexity. All these features, together with macrolines, characterize the adult lingulellids, and in this case *L. lepis* Salter (no other features, except the mentioned, are preserved).

Specimens ranging from about 2 mm to about 15 mm in length show great regularity in the growth process. This regularity is evidenced, above all, by the uniformly arranged concentric microlines, in general faintly expressed and by slightly thicker macrolines in larger specimens, from about 4 mm long.

As to the macrolines, they are at first disposed at short regular intervals which become longer and more or less irregular with progressing growth, e.g. in specimens about 5 mm long.

Also valves of different size are similarly outlined (Fig. 4). The changes during growth are minimal, shell remains almost uniform in outline, outline variation being restricted mainly to a progressive increase of the longitudinal and transverse elongation of both valves, the convexity of valves remaining very low.

DESCRIPTION

Family **Obolidae** King, 1846
Subfamily **Lingulellinae** Schuchert, 1893
Genus *Lingulella* Salter, 1866

Type species: Lingula davisi M'Coy, 1851, p. 405; Upper Cambrian, Wales.

Remarks. — The morphological characters of the here recognized species together with the ventral and dorsal pseudointerareas are virtually the same as those of *Lingulella davisi* (M'Coy), type species of the genus *Lingulella* Salter. Also, thin-shelled specimens, elongate shell outline, low convexity especially of the pedicle valve, differentiated ornamentation of each shell layer being marked in *L. davisi* (M'Coy) are typical of representatives of lingulellids, all mentioned features being recorded in our species.

Occurrence. — Throughout the world, in the deposits of Cambrian-Ordovician (?Middle Ordovician).

Lingulella cf. *davisi* (M'Coy, 1851)
(Pl. III, Figs. 4—10)

Material. — Twenty five moulds of the pedicle and brachial valves. Locality: Brzezinki, Bukowiany and Wilków.

Approximate dimensions (in mm):

Cat. No. I. G. 1108	Valve length	Maximum width	Locality
II.8, brachial valve	11.0	6.7	Brzezinki
II.9, brachial valve	10.0	6.2	Brzezinki

Description. — Elongate-ovate in outline, moderately biconvex, all shell margins moderately rounded, anterior margin slightly narrower than the greatest shell width, which occurs at mid-length of shell. Pedicle valve minimally longer with pointed umbo, pedicle groove widening anteriorly, propareas badly conspicuous. Shell surface ornamentation with concentric microlines to about 6 in 1 mm, concentric macrolines sometimes of wavy character.

Remarks. — Identification with the British species has been made on the similarities in the thin shell structure, almost „symmetrical" oval shell outline, nature of both umbones and to some extent of the surface ornamentation.

Our specimens much resemble in general morphology specimens of *Lingulella davisi* (M'Coy) figured by Salter (1866, Pl. 2, Figs. 7—12; Pl. 4, Fig. 14) and Rowell (1965, Fig. 161, 3). In the description of *L. davisi* given by M'Coy (1851, p. 405) and Salter (1866, p. 333), the mentioned authors define some external characters: shell outline ovate to pentagonal or broadly subtrigonal („satchel-shaped", according to M'Coy), the surface ornamentation as composed of numerous and faint concentric undulations of growth accompanied with irregular concentric and imbricating laminae, and the pedicle groove being linear and well pronounced.

This so characteristic „satchel-shaped" shell is not well shown in specimens illustrated by Rowell (1965, Fig. 161, 3 a-b); specimens on Fig. 161, 3c-d are more quadrate in outline and very short, as a result of being flattened, and it is difficult to judge to what degree this flattening has influenced the general shell outline.

In Salter's paper (1866, Pl. 2, Figs. 7-12; Pl. 4, Fig. 14) and in that of Davidson (1866—1871, Pl. 4, Figs. 1-9, 11, 13-16) the illustrated specimens of *Lingulella davisi* (M'Coy) show a widely pentagonal or even subquad-

rate outline. It is quite possible that the above species also varies in its external shell outline, similarly as *L. lepis* Salter (comp. p. 167). Some characters appear to be almost constant in *L. davisi* (M'Coy), i. e. appearance of the anterior margin, which is straight to very gently rounded, moderately elongate and conspicuous ventral umbo and lack of radial striation.

Our specimens possess all of the mentioned morphological features of *L. davisi* (M'Coy), differing only slightly in having more rounded anterior margin.

Occurrence. — Europe, Upper Cambrian.

Lingulella lepis Salter, 1866

(Pls. I; Pl. II, Figs. 1—9; Pl. IV, Figs. 1—13; Text-fig. 4)

1866. *Lingulella lepis* Salter; J. W. Salter, The geology..., p. 334, Fig. 11.

Material. — About 200 moulds of separate valves, many fragments. Locality: Bukowiany, Jeleniów and Wilków.

Approximate dimensions (in mm):

Cat. No. I. G. 1108	Valve length	Maximum width	Locality
II.8a, brachial valve	8.9	7.0	Jeleniów 3
II.8b, brachial valve	8.9	7.8	„
II.8c, pedicle valve	8.3	6.2	„
II.8d, pedicle valve	9.3	7.9	„

Description (emend.). — Moderately biconvex, inequivalve, ornamentation of fine concentric growth lines, more distinct on the anterior shell half, concentric waves of different degree of distinctness, as a rule marked on the anterior half of shell; delicate radial striation only sometimes observed on the shell surface.

Pedicle valve varying in outline with maximum width about mid-length of valve or anteriorly to it; valve posteriorly moderately and uniformly narrowed; anterolateral margins gently rounded. Brachial valve usually less elongate ovale, maximum width near mid-length of valve, posterolateral and anterolateral margins slightly more rounded than those of the opposite valve, umbonal regions, in all probability, slightly convex. Pseudointerarea of the pedicle valve only weakly and rarely marked and, judging from the material, strongly adhered to the inner valve surface; pedicle groove narrow, its maximum width at the anterior end about 0.1 mm, its length about 1.5 mm, this groove occupying about one-seventh of all valve length; flexure lines on propareas present. Muscle scars and pallial sinuses not preserved. Pseudointerarea of the brachial

valve similarly closely adhered to inner surface of the valve, not distinctly defined; median segment narrow, dorsal propareas half the size of those of the opposite valve. Muscle area and pallial sinuses not preserved.

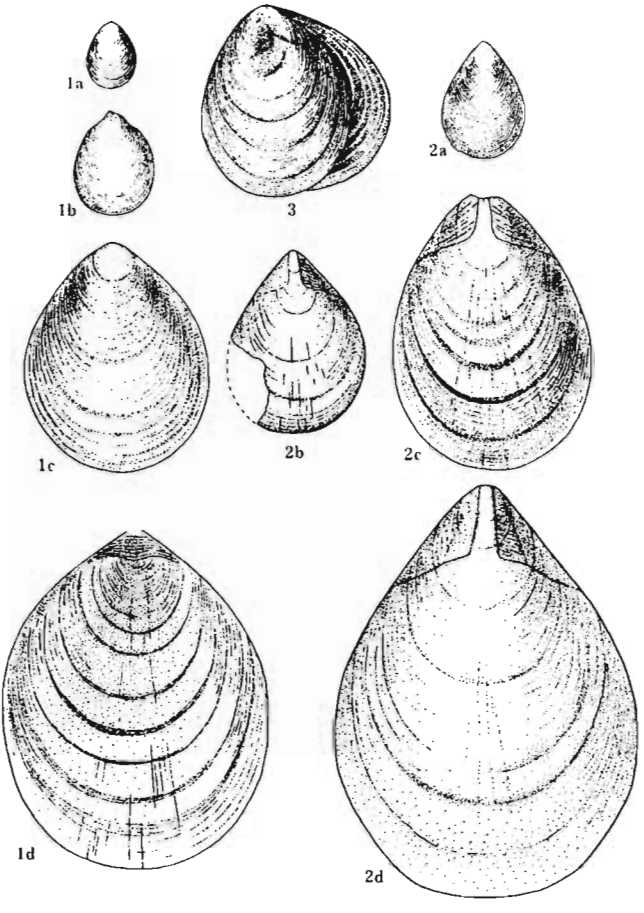

Fig. 4. — Separate valves of *Lingulella lepis* Salter in different size, Jeleniów-3; *1 a-c* brachial valve view, *1d* internal mould with slightly marked pseudointerarea; *2 a-d* pedicle valve view, pedicle groove bordered by propareas present, flexuosity of lines not very distinct; *3* specimens with both valves slightly displaced; approx. × 7.5.

Remarks. — This species originally described by Salter (1866) from the Upper Cambrian of Wales includes specimens of slightly varying shell outline, ranging from widely ovate to almost subquadrate (Salter, *l.c.*, Text-fig. 11). Similar variability in the shell outline occurs also within this species from the Łysogóry belt of the Holy Cross Mountains. Measurements (100 brachial valves and 80 pedicle valves measured) of the valve length and maximum width show the index ratio of width to length changing in the limits of 0.6—1.0, with maximum at 0.7 (54.5%)

for brachial valves and 0.8 (46.4%) for the pedicle valves. Valve outline is, as a rule, ovate to roundly subtriangular for the brachial and pedicle valves, the latter being more subacuminate.

Index ratio of the apical width to maximum valve width only slightly changes in both valves, in the limits of 0.2—0.5 with maximum at 0.3 (64.5%) for the brachial valves and 0.4 (55.4%) for the pedicle ones. The ventral apex is distinctly subacuminate, apical width one-fourth to one-fifth of maximum valve width.

Index ratio of the anterior valve width to maximum valve width changes in the narrow limits of 0.6—0.9 with maximum for both valves at 0.8 (58.2% for brachial valves and 61.8% for pedicle ones). The maximum width of valves occurs at mid-length or anteriorly to it.

All these small variations are expressed (in graph) in terms of an unimodal distribution curve.

One of more changing characters, which may have some diagnostic value for species, appears to be the apical width in relation to the anterior width. Index ratio for both valves changes in the limits of 0.2—0.6, but there occur two maxima, one at 0.3 (43% for brachial valves and 47% for pedicle ones). The second maximum occurs at 0.4 (38% for the brachial valves and 40% for the pedicle ones). While the difference between the two maxima is not very great, it can, in all probability, give rise to a bimodal curve. The anterior margin width of specimens with an index ratio 0.3 is almost three times greater than the apical width and the maximum shell width is, on an average, 2 mm greater than the anterior shell width.

All characters occurring in our specimens are in agreement with those mentioned by Salter (*l.c.*, p. 334) in the short diagnosis of his species which was supplemented by Walcott (1912, p. 514). The only feature, not very comparable, is the radial ornamentation which is in our specimens very poorly preserved or absent. Only in some cases are the fragments of radial striae shown, suggesting presence of the same kind of ornament as in British specimens of *Lingulella lepis* Salter.

The considered species is very close to *L. vistulae* Gürich (= *L. siemiradzkii* Walcott, 1912), described by Gürich (1892) from the Middle Cambrian sandstones of the Pepper Mountains (Góry Pieprzowe), in vicinity of Sandomierz, Poland. The general shell outline of specimens of both mentioned species is almost the same. The differences are small, *L. vistulae* Gürich being more triangular in outline is not radially striated, also shell probably is less biconvex.

In addition to *L. lepis* Salter from the Holy Cross Mountains also included are specimens slightly deviating from widely ovate to subquadrate specimens which dominate in our collection. These differing specimens are characterized by a more acutely-elongate posterior part of pedicle valve and a slightly more trigonal shell outline. These specimens are few,

coming from Jeleniów 3, at a depth of about 100—112 m (see e.g. Pl. IV, Fig. 6). However, the differences are too small, and specimens too few to consider them as an eventual new taxon.

Occurrence. — Europe, Upper Cambrian.

Obolus sp.

(Pl. II, Figs. 10—12; Pl. III, Figs. 1—3; Pl. IV, Figs. 14—15)

Material. — About 20 internal and external moulds of brachial valve, several fragments, more complete or less.

Locality: Brzezinki, Jeleniów and Wilków.

Approximate dimensions (in mm):

Cat. No. I. G. 1108	Valve length	Maximum width	Locality
II.9g	9.1	9.0	Wilków
II.9h	9.9	9.8	„
II.9k	14.4	1?.8	Brzezinki

Remarks. — The very rounded outline suggests the genus *Obolus* Eichwald for specimens which are not numerous in our core material. The preserved anterior and central adductor scars and very weak median ridge are judged to be characteristic for *Obolus*, although similarly developed characters are seen also in specimens of the genus *Lingulella* (e.g. Walcott, 1912, Pl. 29, Fig. 1-t).

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RODZAJ *LINGULELLA* SALTER Z GÓRNEGO KAMBRU GÓR ŚWIĘTOKRZYSKICH

Streszczenie

Brachiopody Inarticulata, będące przedmiotem niniejszego opracowania, pochodzą z wierceń wykonanych przez Instytut Geologiczny (Warszawa) w północnej części Gór Świętokrzyskich, w miejscowościach: Brzezinki, Bukowiany, Jeleniów i Wilków (Fig. 1). W tych otworach wiertniczych po raz pierwszy zostały stwierdzone osady najwyższego kambru w Górach Świętokrzyskich (Tomczykowa, 1968), odpowiadające najwyższej części poziomu 5c i poziomowi 6 w Skandynawii (Westergard & Henningsmoen, 1957), z przejściem ciągłym do najniższego tremadoku — poziom 2eα (Henningsmoen, 1961). Stratygrafia osadów tych wierceń została oparta

na faunie trylobitowej oraz *Dictyonema* sp. (Tbl. 1 i Fig. 2), (Tomczykowa, *l.c.*). Poza trylobitami stwierdzono obecność licznych brachiopodów, reprezentujących rodzinę Obolidae King, ponadto igły gąbek, hyolitesy, fragmenty gastropodów i *Dictyonema* sp.

Brachiopody są liczne, lecz taksonomicznie bardzo słabo zróżnicowane. Występują one we wszystkich rdzeniach i są rozmieszczone mniej lub bardziej równomiernie w całej ich miąższości. Ich stan zachowania nie jest najlepszy. Okazy zachowały się jako całe lub fragmentaryczne wewnętrzne lub zewnętrzne odlewy poszczególnych skorupek, bez zachowanej struktury wewnętrznej; ornamentacja powierzchni skorupek zachowana jest tylko fragmentarycznie. Fauna brachiopodowa jest bardzo monotonna, reprezentowana przez *Lingulella lepis* Salter, *Lingulella* cf. *davisi* (M'Coy) i *Obolus* sp.

Zmierzono 100 skorupek brachialnych i 80 nóżkowych *Lingulella lepis* Salter. Pomiary te wykazały pewną zmienność, istniejącą w obrębie tego gatunku, przejawiającą się szczególnie w różnym zarysie: od wydłużonego owalnie do szeroko trójkątnego lub półkwadratowo zaokrąglonego, o dość umiarkowanie wydłużonym dziobie brzusznym i największej szerokości muszli przypadającej na połowę jej długości, lub nieco przesuniętej ku przodowi. Ponadto analiza pomiarów wykazała że w przypadku *Lingulella lepis* Salter z Gór Świętokrzyskich, takie cechy morfologiczne, jak ogólny zarys muszli, wygląd apikalnej części muszli i brzegów przednio-bocznych itp., nie mają znaczenia taksonomicznego.

ГЕРТРУДА БЕРНАТ & ЭВА ТОМЧИКОВА

РОД *LINGULELLA* SALTER ИЗ ВЕРХНЕГО КЕМБРИЯ СВЕНТОКРЖИСКИХ ГОР (ПОЛЬША)

Резюме

Описанные в настоящей работе брахиоподы Inarticulata происходят из буровых скважин, проведенных Геологическим Институтом (Варшава) в северной части Свентокржиских Гор, в местностях: Бржезинки, Буковяны, Еленюв и Вилькув (фиг. 1). В этих скважинах впервые констатировано осадки самого верхнего кембрия в Свентокржиских Горах (Томчикова, 1968); соответствуют они самым верхам горизонта 5c и горизонту 6 в Скандинавии (Westergard & Henningsmoen, 1957), с постепенным переходом к самому нижнему тремадоку — горизонт 2eα (Henningsmoen, 1961). Стратиграфия отложений из этих скважин основана на трилобитах и *Dictyonema* sp. (Таб. 1 и фиг. 2), (Томчикова, 1968). Кроме трилоби-

тов, констатировано присутствие обильных брахиопод из семейства Obelidae King, а также спикулы губок, *Hyolithes*, фрагменты гастропод и *Dictyonema* sp.

Брахиоподы обильные, но в таксономическом отношении слабо дифференцированы. Находятся оне во всех кернах и расположены менее или более в целой их мощности. Сохранность их не очень хорошая. Образцы сохранены в виде целых или частичных внутренних либо наружных оттисков створок, без внутреннего их строения. Скульптура створок сохранена только частично. Очень монотонная фауна брахиопод представлена *Lingulella lepis* Salter, *L.* cf. *davisi* (M'Coy) и *Obolus* sp.

Измерено 100 спинных и брюшных створок *Lingulella lepis* Salter. Измерения эти указали некоторую изменчивость существующую в пределах этого вида; проявляется она особенно в разном очертании: от овально-удлиненного к широко-треугольному, или же полуквадратно-округленного, с умеренно удлиненной брюшной макушкой и наибольшей шириной раковины в половине ее длины, или же чуть передвинутой к переди. Кроме этого, анализ измерений указал, что в случае *Lingulella lepis* Salter из Свентокржиских Гор, такие морфологические признаки, как общее очертание раковины, строение ее апикальной части и передне-боковых краев и т.п., не имеют таксономического значения.

PLATES

Plate I

Lingulella lepis Salter
(bore hole Jeleniów 3)

Fig. 1. Internal mould of the pedicle valve with marked surface undulations (I. G. 1108/II.41); × 4.

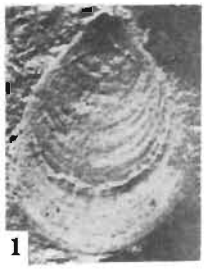
Fig. 2. Internal mould of the brachial valve, the undulations marked (I. G. 1108/II. 16); × 4.

Figs. 3—5. Three external moulds of the brachial valve (I. G. 1108/II. 14, 8, 5); × 4.

Fig. 6. Almost complete specimen with both valves slightly displaced (I. G. 1108/II. 17); × 6.

Figs. 7—10. Four external moulds of pedicle valve, showing pedicle groove and pseudointerareas (I. G. 1108/II. 7, 7a, 39, 10); *Figs.* 7—9 ×4, *Fig.* 10 ×6.

Fig. 11. Fragment of core showing accumulation of brachiopod debris (I. G. 1108/II. 11); approx. × 4.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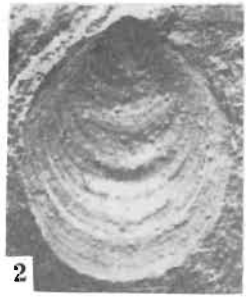
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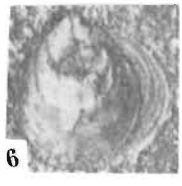
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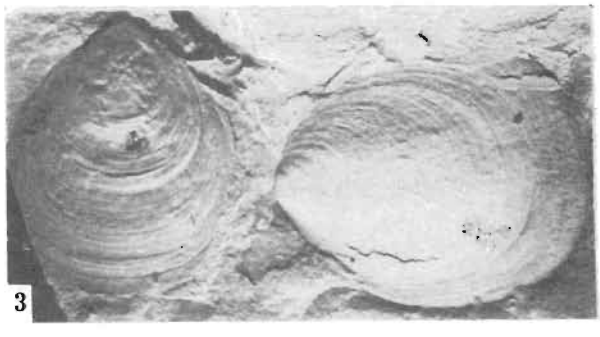
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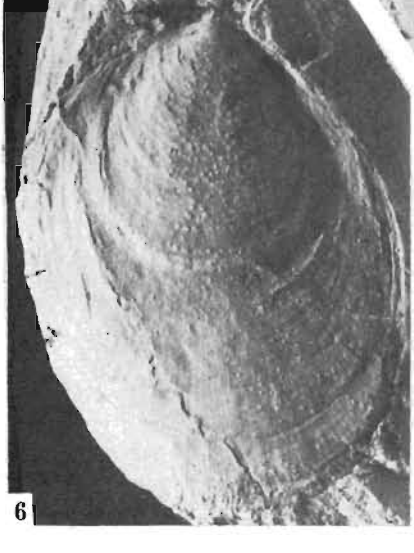
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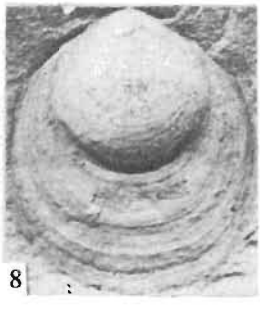
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Plate II

Lingulella lepis Salter

Figs. 1—8. Brachial valve view of specimens in different state of preservation: *1—6, 8* Jeleniów 3 (I.G.1108/II. 12a, 12b, 12c, 43, 11, 36, 35); 7 Jeleniów 2 (I.G.1108/II. 34); *Figs. 1, 3—8* × 4.5, *Fig. 2* × 3.

Fig. 9. Posterior half of the pedicle valve; Jeleniów 3 (I.G.1108/II. 12); approx. × 4.5.

Obolus sp.

Figs. 10—12. Brachial valve view of different specimens; *10, 12* Jeleniów 3 (I.G. 1108/II. 42, 33); *11* Bukowiany (I.G.1108/II. 42a); × 4.

Plate III

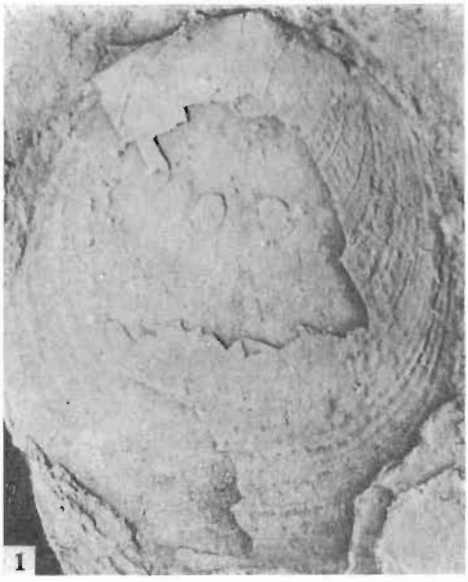
Obolus sp.

Figs. 1—3. Brachial valve view of specimens with partly preserved central and anterior adductor scars and weak median ridge; Jeleniów 3 (I.G.1108/II. 38, 10, 32); × 6.

Lingulella cf. *davisi* (M'Coy)

Figs. 4—8. Brachial valve view of specimens of different dimensions, Fig. 7 — brachial valve greatly deformed; Wilków (I.G.1108/II. 27, 28, 25, 26, 18); *Figs. 4—7* × 2, *Fig. 8* approx. × 3.5.

Figs. 9, 10. Brachial valve view of different specimens; Fig. 9 — Jeleniów 3 (I.G. 1108/II. 22), Fig. 10 — Bukowiany (I.G.1108/II. 31; × 2.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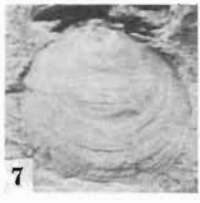
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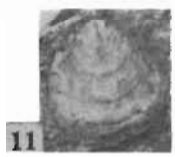
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Plate IV

Lingulella lepis Salter

Figs. 1-8. Pedicle valve view of different specimens (I.G.1108/II. 39, 39a, 39b, 29, 30, 7, 7a, 9). Figs. 1, 2, 4, 6-8 — Jeleniów 3; Fig. 3 — Jeleniów 2; Fig. 5 — Brzezinki; *Figs. 1-7* × 4, *Fig. 8* × 2.

Figs. 9-12. Brachial valve view of different specimens (I.G.1108/II. 24a, 19, 24b, 24); Fig. 9 — Jeleniów 2; Fig. 10 — Wilków; Figs. 11, 12 — Jeleniów 3; *Figs. 9, 10* × 4, *Figs. 11, 12* × 2.

Fig. 13. Specimen with both valves partly preserved; Jeleniów 2 (I.G.1108/II. 50); approx. × 4.

Obolus sp.

Figs. 14, 15. Brachial valve view of two specimens. Fig. 14 — Jeleniów 3 (I.G.1108/II. 45), × 4; Fig. 15 — Bukowiany (I.G.1108/II. 21), × 2.

Fig. 16. Fragment of core showing accumulation of valves; Jeleniów 2 (I.G.1108/II. 51), × 2.