A new late Givetian rhynchonellid species from the Holy Cross Mountains, Poland, and its relevance to stratigraphical and ecological problems near the Givetian/Frasnian boundary

by Paul SARTENAER and Grzegorz RACKI

Abstract

A new rhynchonellid species, *Hadrotatorhynchus laskowaensis*, is described from the *Klapperina disparilis* Zone of the Holy Cross Mountains in Poland, and its stratigraphical and ecological meanings are stressed. The species is another example of the importance of the genus *Hadrotatorhynchus* SARTENAER, 1986 both as a tool for correlating late Givetian beds and as an element of the succession of the rhynchonellid genera *Hadrotatorhynchus* - *Phlogoiderhynchus* SARTENAER, 1970 across the Givetian/Frasnian boundary. In the Łysogóry facies region this boundary can consequently be placed near the top of the middle member of the Szydłówek Beds composed of marly shales containing large-sized *P.polonicus* (ROEMER, 1866), and succeeded by the upper member, which is characterized by a small-size variety of the same species, and is mostly composed of platy marly limestones passing laterally into detrital beds. *Hadrotatorhynchus laskowaensis* n.sp. thrived in shallower water than the succeeding *Phlogoiderhynchus polonicus*, and forms chiefly monospecific shell banks on the storm-disturbed, prograding carbonate slope bordering the Łysogóry intrashelf basin.

Key-words: *Hadrotatorhynchus laskowaensis* - rhynchonellids - late Givetian - early Frasnian - Holy Cross Mountains.

Résumé

Une nouvelle espèce, *Hadrotatorhynchus laskowaensis*, de la Zone à *Klapperina disparilis* des Monts Sainte-Croix de Pologne est décrite et sa signification stratigraphique et écologique est mise en évidence. L'espèce constitue un nouvel exemple de l'importance du genre *Hadrotatorhynchus* SARTENAER, 1986 pour la corrélation des couches d'âge givetien terminal et en tant qu'élément de la succession des genres Rhynchonellides *Hadrotatorhynchus* - *Phlogoiderhynchus* SARTENAER, 1970 de part et d'autre de la limite Givetien/Frasnien. Dans la région du facies de Łysogóry, cette limite peut être placée en conséquence dans la partie supérieure du membre moyen des Couches de Szydłówek, composé de schistes marneux contenant des spécimens de *P. polonicus* (ROEMER, 1866) de grande taille, auquel succède le membre supérieur, caractérisé par une variété de petite taille de la même espèce et composé principalement de calcaires marneux en plaquettes passant latéralement à des bancs détritiques. *Hadrotatorhynchus laskowaensis* n.sp. vivait dans des eaux moins profondes que *Phlogoiderhynchus polonicus* qui lui succède et qui forme à elle seule des bancs coquilliers sur la pente calcaire en voie de progradation et soumise à l'action des tempêtes en bordure du bassin de Łysogóry creusé dans la plate-forme continentale.

Mots-clefs: *Hadrotatorhynchus laskowaensis* - Rhynchonellides - Givetien terminal - Frasnien inférieur - Monts Sainte-Croix.

Streszczenie

Nowy gatunek rynchonellida *Hadrotatorhynchus laskowaensis* został opisany z poziomu *Klapperina disparilis* Gór Świętokrzyskich w Polsce i jego znaczenie stratygrafczne oraz ekologiczne jest uwypuklone. Gatunek ten stanowi kolejny przykład znaczenia rodzaju *Hadrotatorhynchus* SARTENAER, 1986, zarówno jako narzędzia do korelacji utworów późnożyweckich jak i elementu w sekwencji rodzajów rynchonellidów *Hadrotatorhynchus* - *Phlogoiderhynchus* SARTENAER, 1970 po obu stronach granicy żywet/fran. W łysogórskim regionie facjalnym granica ta może być konsekwentnie umiejscowiona w wyższej części warstw szydłóweckich: środkowe ogniwo składa się z łupków marglistych zawierających dużą odmianę *P. polonicus* (ROEMER, 1866) i zastąpione jest w sekwencji przez górne ogniwo (głównie płytowe wapienie margliste) przechodzące obocznie w warstwy detrytyczne i charakteryzujące się występowaniem małej odmiany tego gatunku. *Hadrotatorhynchus laskowaensis* n.sp. rozwijał się w mniej głębokich wódach niż stratygraficznie młodszy, ekspansywny *Phlogoiderhynchus polonicus* i tworzył na ogół jednogatunkowe ławice muszlowe na podlegającym oddziaływaniom sztormów, progradującym skłonie węglanowym ograniczającym łysogórski basen śródszelfowy.

Key - words: *Hadrotatorhynchus laskowaensis* - rynchonellidy - późny żywet-wczesny fran - Góry Świętokrzyskie

Introduction

Brachiopods are among the most frequently reported fossils in the Devonian of the Holy Cross Mountains, but little work has been undertaken on their taxonomy and biostratigraphy. This is true particularly for the western part of the Łysogóry (northern) palaeogeographical region (Fig. 1A), where abundant Givetian and Frasnian faunas are known to occur (see RACKI, GŁUCHOWSKI & MALEC, 1985, pp.165-167, 169).

This paper is a refinement of the one presented by RACKI (1986) on the distribution of the common species *Phlogoiderhynchus polonicus* (ROEMER, 1866), which BIERNAT & SZULCZEWSKI (1975, p.212) considered of great significance for regional correlation of early Frasnian strata. Current study of the brachiopod succession across the Givetian/Frasnian boundary in the Łysogóry region indicates abundant occurrence of a new Givetian species of the genus *Hadrotatorhynchus* SARTENAER, 1986. Some problems related to the rhynchonellid suc-

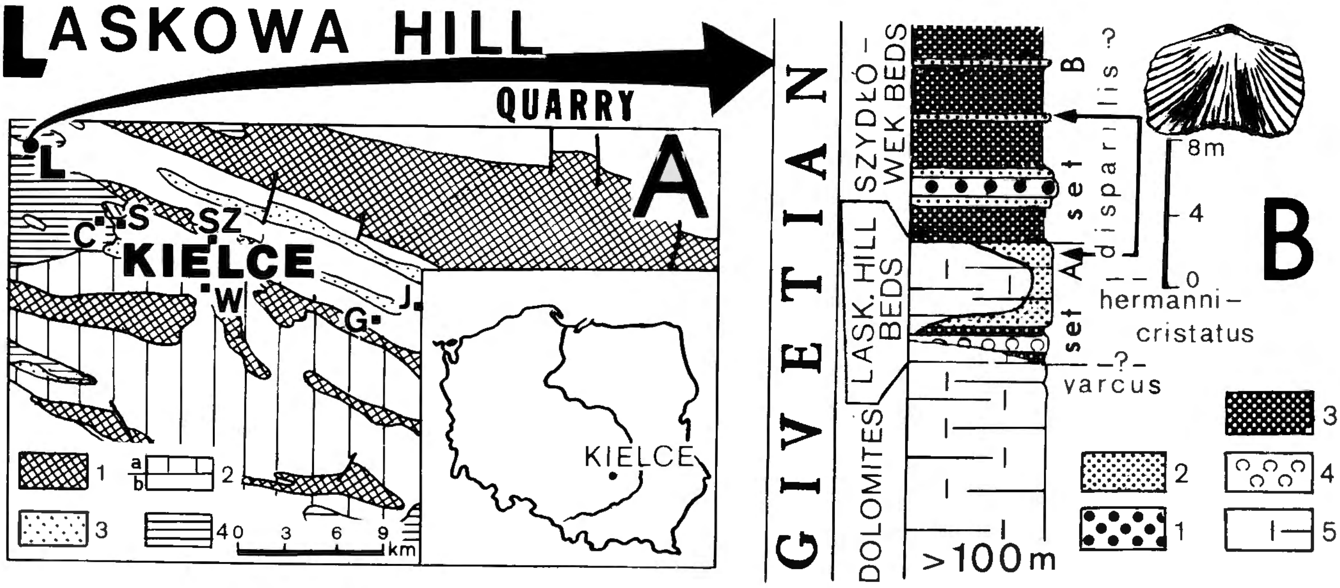


Fig. 1 — *A* - Location of discussed exposures in the western part of the Holy Cross Mountains after RACKI, GŁUCHOWSKI & MALEC (1985, Fig.1, *modified*). 1 - Lower Palaeozoic, 2 - Devonian (a - late Givetian Kielce carbonate platform, b - late Givetian Łysogóry intrashelf basin), 3 - Carboniferous, 4 - post-Variscan cover. L - Laskowa Hill and adjacent Kostomłoty quarries, C - Czarnów (Grabinowa Hill), S - Śluchowice Quarry, SZ - Szydłówek (outcrops at Bocianek quarter), W - Wietrznia-I Quarry, G - Górno (Józefka Hill Quarry), J - Wola Jachowa (western hill).

B - Generalized section of the Laskowa Hill Quarry, taken from RACKI, GŁUCHOWSKI & MALEC (1985, Fig.3), showing the stratigraphical range of *Hadrotatorhynchus laskowaensis* n. sp. 1 - calcirudites, 2 - calcarenites, 3 - marls and marly shales, 4 - coral biolithites, 5 - dolomitized deposits.

cession in this region are examined as well as their bearing on the recognition of the Givetian/Frasnian boundary in the Holy Cross Mountains. The succession follows the pattern established by SARTENAER (1985, p.314; 1986, pp.137-138) for other areas, and is, thus, particularly helpful when rocks displaying an ambiguous conodont record are concerned, e.g. the Szydłówek Beds in the Łysogóry region.

The reader is reminded that the International Subcommission on Devonian Stratigraphy has decided, in Frankfurt/Main (1982), the base of the Frasnian (and the Middle/Upper Devonian Series Boundary) to be the lower boundary of the Lower *Polygnathus asymmetricus* Zone. This decision has been approved by the International Commission on Stratigraphy, and ratified by the International Geological Congress held in Moscow in 1984.

Geological and stratigraphical setting (G.R.)

The main collection examined comes from the basal part of the Szydłówek Beds exposed in the northeastern part of Laskowa Hill Quarry at Kostomłoty, northwest of Kielce (set B, RACKI, GŁUCHOWSKI & MALEC, 1985, pl.I, fig. 3, p. 163, fig.4, p. 164; and RACKI, 1985, fig.2, p.268, figs.3,4 between p.268 and p.269, pl. 1, fig.1). This marly lithostratigraphical unit, at least 50m thick, contains in its lower part some intercalations of detrital limestone (mostly calcarenites); one of them occurring at 6.2m above the base, is an up to 0.2m thick brachiopod coquina of *Hadrotatorhynchus laskowaensis* n.sp.(Fig.1B). These beds are assigned to the late Givetian *Klapperina disparilis* Zone, and their higher part possibly to its middle and upper parts (viz.with *Polygnathus dengleri* BISCHOFF et ZIEGLER, 1957), on account of the recognition of the index *Klapperina disparilis* (ZIEGLER & KLAPPER, 1976) by RACKI (1985, table 1, samples L-VI/40, L-VI/45) above the upper range of *K. disparata* (ZIEGLER & KLAPPER, 1982). However, this eventual subdivision into two parts of the *Klapperina disparilis* Zone, as well as the extension of its upper part, remain undetectable in the Kostomłoty profile, and in the other localities where the Szydłówek Beds crop out, because conodonts are very rare in the thick, strongly marly middle member of the formation.

Poorly preserved specimens and isolated valves occur about one metre below the top of the underlying Laskowa Hill Beds (=Fossiliferous Limestones and Marls = set A of RACKI, GŁUCHOWSKI & MALEC, 1985, pl.I, fig.3, p.163, fig.4, p.164, and RACKI, 1985, fig.2, p.268, figs.3,4 between p.268 and p.269, pl.1, fig.1; Laskowa Hill Beds of NARKIEWICZ, RACKI & WRZOŁEK, 1990, fig.2, p.439, p.452)(Fig.2); the uppermost (8m) part of these beds is composed of ca. 1m thick variably-bedded (usually 2-3 layers) and irregu-

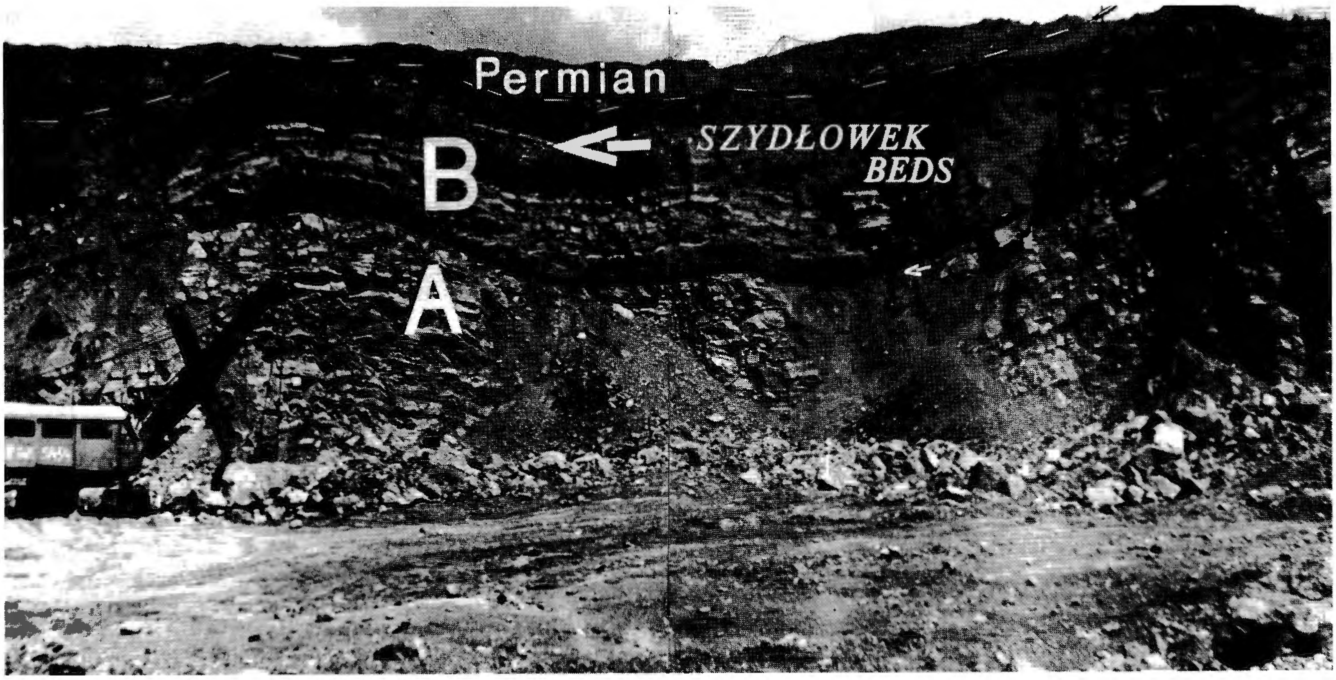


Fig. 2 — Northeastern part of Laskowa Hill Quarry in May 1986 showing the position (arrows) of *Hadrotatorhynchus laskowaensis* n. sp.; A-B - lithologic sets (see Fig.1B).

larly dolomitised crinoid-brachiopod calcarenites. These beds are also in the *Klapperina disparilis* Zone, but apparently in its lower part (viz. with *K. disparata*).

Thus, *Hadrotatorhynchus laskowaensis* n. sp. is found at the base and at the top of a thickness of beds of about 7.4m.

Systematic Description (P.S.)
***Hadrotatorhynchus laskowaensis* n.sp.**

(Plate 1, Figures 1a-e, 2a-e, 3a-e, 4a-e, 5a-e, 6a-e,7a-e, 8a-e; Text-fig.3)

SYNONYMY

1985 *Platyterorhynchus* (?) sp.n. - SARTENAER (personal communication) *in* RACKI, GŁUCHOWSKI & MALEC, p.166, pl.X, figs.1a-c;

1985 *Phlogoiderhynchus* sp.n. (? new genus) - SARTENAER *in* RACKI, GŁUCHOWSKI & MALEC, p.167;

1986 species from the Holy Cross Mountains (Poland) - SARTENAER, p.137, p.138, p.141.

DERIVATIO NOMINIS
From Laskowa Hill, Holy Cross Mountains, Poland.

TYPES
GIUS: *G*eological *I*nstitute *U*niversity of *S*osnowiec; 4: Devonian; La: Laskowa Hill Quarry; 296 and 297: specimens from set A and set B respectively.

Holotype, GIUS4 - 297La/1 (Pl.1, Figs.2a-e); Paratypes A, GIUS4 - 297La/2 (Pl.1, Figs.1a-e), B, GIUS4 - 297La/3 (Pl.1, Figs.4a-e), C, GIUS4 - 297La/4 (Pl.1, Figs.5a-e), D, GIUS4 - 297La/5 (Pl.1, Figs.3a-e), E, GIUS4 - 297La/6 (Pl.1, Figs.7a-e), F, GIUS4 - 297La/7 (Pl.1, Figs.8a-e), G, GIUS4 - 297La/8 (Pl.1, Figs.6a-e), J, GIUS4 - 297La/9 (Fig.3). A 0.2m thick calcarenite located in the lower part (set B) of the Szydłówek Beds, at 6.2m above the base, Laskowa Hill Quarry, at Kostomłoty, north-west of Kielce, 297La. Collector: RACKI, 1984.

Paratypes H, GIUS4 - 296La/1, I, GIUS4 - 296La/2. Bed one metre below the top of the thick calcarenite beds located in the upper part of the Laskowa Hill Beds (=Fossiliferous Limestones and Marls = set A of RACKI, GŁUCHOWSKI & MALEC, 1985, pl.I, fig.3, p.163, fig.4, p.164, and RACKI, 1985, fig.2, p.268, figs.3,4 between p.268 and p.269, pl.1, fig.1; Laskowa Hill Beds of NARKIEWICZ, RACKI & WRZOŁEK, 1990, fig.2, p.439, p.452) about one metre below the top. Same locality as Holotype. Locality 296La. Collector: RACKI, 1984.

Plaster casts of these primary types have been made and are deposited in the Royal Institute of Natural Sciences of Belgium in Brussels under the number 27770. A plaster cast of paratype J was made before grinding and is joined to the remainder of the specimen.

Locus Typicus

Northeastern part of Laskowa Hill Quarry at Kostomłoty, north-west of Kielce, Holy Cross Mountains, Poland.

Stratum Typicum

A 0.2m thick brachiopod calcarenite located in the lower part (set B of Racki, Głuchowski & Malec, 1985, pl.I, fig.3, p.163, fig.4, p.164, and Racki, 1985, fig.2, p.268, figs.3,4 between p.268 and p.269, pl.1, fig.1) of the Szydłówek Beds of late Givetian - early Frasnian age, at 6.2m above the base. In terms of conodont chronology, this calcarenite is located in the higher part of the *Klapperina disparilis* Zone.

Material. State of preservation

Seventy four specimens from locality 297La: thirty two specimens are in a good state, and thirteen in a satisfactory state of preservation; twenty five specimens are fragmental; five specimens are isolated valves.

Twenty five specimens from locality 296La: three specimens are in good state, and five in satisfactory state of preservation; five specimens are fragmental; twelve specimens are poorly preserved isolated valves.

Description

General external characters

Medium to large sized. Front margin uniplicate. Thick-set and bulging. Inequivalve, the thickness of the pedicle valve varying from 35 to 43 per cent of the thickness of the shell. Transversely subelliptical, sometimes tending to become subcircular, in ventral and dorsal views, subelliptical to suboval in frontal view. Commissure sharp, slightly or hardly (exceptionally not) undulated by the low costae. Cardinal line is more or less long, and slightly undulating. Postero-lateral margins concave near the commissure. Commissures are located high as seen in lateral profile.

Pedicle valve

Contour of pedicle valve is a low half-ellipse or half-oval in longitudinal median sections, and a flattened half-ellipse in transverse median sections. Flanks regularly convex sloping sometimes gently, sometimes steeply toward the lateral commissures, but becoming always steeper near the postero-lateral commissures. Well marked sulcus, wide at front, beginning well in front of the beak: 45-67 per cent of the length of the shell (most values between 55 and 62 per cent) or 34-50 per cent of the unrolled length of the valve (most values between 45 and 50 per cent). Sulcus is shallow to moderately deep; bottom of sulcus is flat to slightly convex; width of sulcus at point of origin varies from 27 to 48 per cent of its greatest width (60-70 per cent of the width of the shell at the junction of the frontal and lateral commissures). Tongue trapezoidal or slightly arched, moderately high to high with sharp borders, standing out clearly, vertical or almost vertical at its crest. The top of the tongue is the top of the shell for 45.85 per cent of the specimens, and in almost half of them the fold becomes slightly concave before reaching the front. Beak thick-set, erect to slightly incurved, overhanging the cardinal line, and often almost in contact with the dorsal umbonal region. Interarea ill-defined. No deltidial plates have been observed in transverse serial sections.

Brachial valve

Curve of the brachial valve is one quarter of an ellipse in longitudinal median sections. Flanks uniformly convex. Umbonal region tangential to a vertical plane. Well marked fold, moderately high to high, wide at front, beginning well in front of the beak. Top of the fold is flat or slightly convex. A slight, more or less median depression is rarely observed in the anterior third of the fold; it affects the frontal commissure.

Ornament

The general costal formula is: $\frac{5\text{ to }7}{4\text{ to }6}$; 0; $\frac{7\text{ to }11}{8\text{ to }12}$. The general costal formula gives a grouping of at least 75 per cent of the specimens in the categories: median, parietal, and lateral.

The median and lateral costae are distributed as follows:

Median			Lateral		
Number of costae	Number of specimens	%	Number of costae	Number of specimens	%
4/3	1	2.7	5/6	1	3.6
5/4	12	32.45	6/7	1	3.6
6/5	14	37.85	7/8	5	17.85
7/6	7	18.9	8/9	6	21.4
8/7	3	8.1	9/10	7	25
	37	100	10/11	3	10.7
			11/12	4	14.25
			12/13	1	3.6
				28	100

Costae low, rounded. Median costae starting at a great distance from the beaks, almost where sulcus and fold start. Median costae are sometimes divided or intercalated, but even without these divisions and intercalations they are often irregular because they differ in width. Lateral costae begin on the border of the umbonal regions, but the most external ones are restricted to the margins of the flanks and are often evident only as mere undulation(s) of the commissure. Sometimes one (exceptionally two) internal lateral costa does not reach the commissure. Parietal costae are rarely present; when present, there is generally one parietal costa, exceptionally (in three specimens) two.

Dimensions
Measurements of ten specimens, of which eight are photographed:

in mm	Paratype H	Paratype A	Holotype	Paratype I	Paratype B	Paratype C	Paratype D	Paratype E	Paratype F	Paratype G
l	25.9	(23.2)	22.8	22.5	(22.1)	21.8	21.2	20.8	19.7	19.6
w	31.5	(31.4)	30.6	(28.3)	28.5	28.7	30	25.7	25.2	27.5
lpv unrolled	44.5	42	39	39.5	(40)	39	35.5	36	35	32.5
t	20.7	20	19.2	(18.6)	21.5	18.9	17.5	17.4	16.3	16.1
tpv	8.1	7.8	7.5	7.7	8.2	7.3	6.5	7.4	6.8	6.8
tbv	12.6	12.2	11.7	(10.9)	13.3	11.6	11	10	9.5	9.3
l/w	0.82	(0.74)	0.75	(0.80)	(0.78)	0.76	0.71	0.81	0.78	0.71
t/w	0.66	(0.64)	0.63	(0.66)	0.75	0.66	0.58	0.68	0.65	0.59
t/l	0.80	(0.86)	0.84	(0.83)	(0.97)	0.87	0.83	0.84	0.83	0.82
apical angle	131°	134°	135°	(135°)	133°	133°	133°	129°	135°	137°
angle of the cardinal commissure	138°	140°	143°	?	?	?	(140°)	137°	139°	141°

The abbreviations used are: l = length; w = width; t = thickness; pv = pedicle valve; bv = brachial valve. Measurements shown in parentheses indicate a reasonable estimate on a damaged specimen.

Highest part of pedicle valve is located between 31 and 42 per cent of the length of the shell or between 24 and 36 per cent of the unrolled length of the valve. Greatest thickness of the shell is located, in 54.15 per cent of the specimens, at a variable point posterior to the frontal commissure; from this point the brachial valve either curves gently toward this commissure (37.5 per cent) or stays at this level (16.65 per cent). In the remaining 45.85 per cent of the specimens, the greatest thickness of the shell is reached at the frontal commissure, either directly (18.75 per cent) or as the result of the fold becoming concave before reaching this commissure (27.1 per cent). Width is always the largest dimension. Maximum width of shell occurs, with very few exceptions, at a point between 45 and 61 per cent (most values are between 50 and 61 per cent) of the length of the shell anterior to the ventral beak. Apical angle varies from 127° to 140° (most values are between 133° and 137°). Angle of the cardinal commissure varies from 135° to 145°.

Internal characters
The characteristic features of the genus can easily be recognized on figure 3, among others: no clear but only residual dental plates, stout and widely separated teeth, long and lamellar septum, no true outer hinge plates, crural trough, delicate crural bases, short crura curved at their distal ends.

COMPARISONS

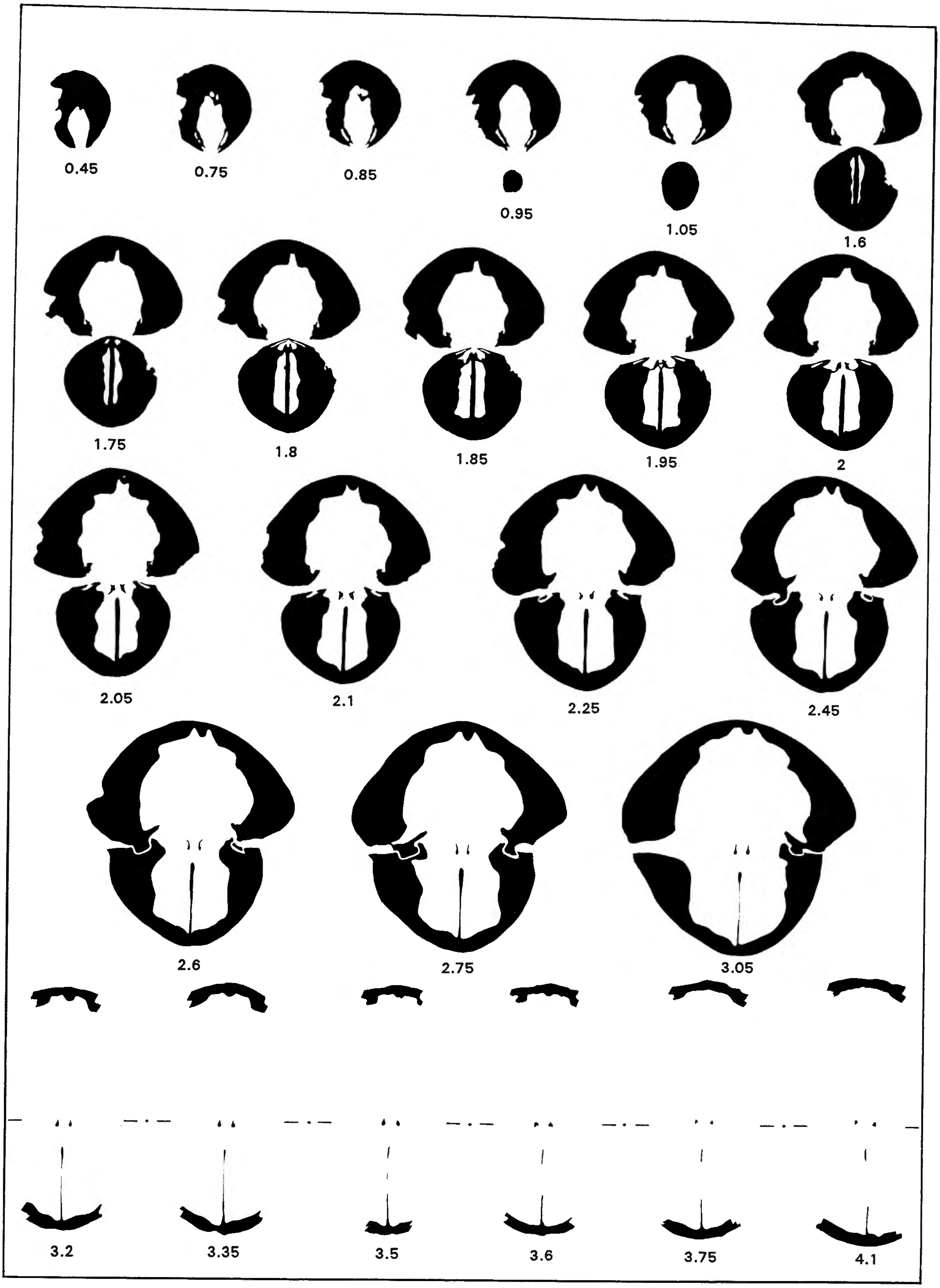
Hadrotatorhynchus laskowaensis n. sp. may be distinguished from *H.halli* FLAMAND, 1911, the type species of the genus, by: sulcus, fold, and median costae starting generally farther away from the beaks; top of tongue never strongly arched; fold becoming slightly concave before reaching the front (this happens seldom in *H.halli*); the possibility of reaching higher numbers of costae, although the general costal formulae are similar; the greatest thickness of the shell reached at the frontal commissure in almost half the specimens (this is exceptional in *H.halli*).

Biostratigraphical and ecological aspects (G.R.)

The discovery of a species of the genus *Hadrotatorhynchus* in the Holy Cross Mountains supplies, in spite of its isolated nature, new data for stratigraphical and ecological refinement of the *Phlogoiderhynchus* group, believed to be of more than regional significance.

BIOSTRATIGRAPHY

As already emphasized by SARTENAER (1986, p.138, p.141), the range of the Polish species of *Hadrotatorhynchus* is restricted to the *Klapperina disparilis* Zone, which corresponds to the age of the North African (Algeria and Morocco) representatives of the genus, and thus is useful for intercontinental correlation. Furthermore he underlined that the succession in time of the genera *Hadrotatorhynchus* and *Phlogoiderhynchus* is of basic importance for biostratigraphical evaluation of the Middle/Upper Devonian boundary. The age of the genus *Phlogoiderhynchus*, as presently known, is that of


0.45
0.75
0.85
0.95
1.05
1.6
1.75
1.8
1.85
1.95
2
2.05
2.1
2.25
2.45
2.6
2.75
3.05
3.2
3.35
3.5
3.6
3.75
4.1

the *Mesotaxis falsiovalis* to *Palmatolepis punctata* Zones (see SARTENAER, 1985, p.314) and stradles this boundary. The same succession is found in the Holy Cross Mountains, where the thickest sequence with rhynchonellids has been described by RACKI, GŁUCHOWSKI & MALEC (1985, p.162, pp.166-167) in the Kostomłoty section. *Hadrotatorhynchus laskowaensis* n. sp. is found in rocks overlying older Givetian [Middle *Polygnathus varcus* Subzone to *Schmidtognathus hermanni-Polygnathus cristatus* Zone (= *S. hermanni* Zone of KLAPPER & JOHNSON, 1990, p.934)] assemblages of the Laskowa Hill Beds (= Fossiliferous Limestones and Marls = set A) at Laskowa Hill Quarry, with locally abundant representatives of the genus *Uncinulus* BAYLE, 1878 and rare representatives of the genus *Septalaria* LEIDHOLD, 1928. The beds with *Hadrotatorhynchus laskowaensis* n. sp. are in turn overlain by the middle Szydłówek Beds (viz. a thick monotonous marl-shaly complex) exposed in the northern Kostomłoty quarries, which are a well-known locality (called Laskowa Quarry by BIERNAT & SZULCZEWSKI, 1975, p.202, p.210) of large size (above 40mm in width) *Phlogoiderhynchus polonicus*, accompanied by infrequent atrypids and lingulids. A morphotype of *P.polonicus*, associated with a much more diversified fauna, is a prominent fossil in correlative beds at Szydłówek, the *locus typicus* of the species; this brachiopod-rich marly sequence represents the interval in which lies the Givetian/Frasnian boundary (*Mesotaxis falsiovalis* to *Palmatolepis transitans* Zones, according to dating of the directly older strata by BULTYNCK & RACKI, 1991, in press).

The abundance of this characteristic rhynchonellid species is strongly reduced in the upper part (Frasnian) of the Szydłówek Beds, composed chiefly of platy marly limestones at Kostomłoty-II Quarry; small-sized (up to 25mm in width), mostly disarticulated, specimens were collected exclusively in a coquina tempestite bed. A parallel can be drawn between this find and data from the Sluchowice Quarry and the Czarnów trench (excavated in 1984 in the northern slope of Grabinowa Hill) in Kielce, where small morphologically advanced individuals of *P.polonicus* of the "*arefactus*"-type, according to BIERNAT & SZULCZEWSKI (1975, pp.206-207), occur in abundance (although almost restricted to micritic-shaly interbeds within the fine-grained complex) in beds of corresponding age (*Palmatolepis transitans* Zone) (see BULTYNCK & RACKI, 1991, in press).

It is assumed that this sequential regressive shift in morphological development is typical for *Phlogoiderhynchus polonicus* in the western part of the Łysogóry region; in the eastern part, in localities such as Górno and Wola Jachowa, this assumption requires a re-evaluation.

It is important to note that a similar sequence could possibly be recognized in Wietrznia-I Quarry at Kielce (northern periphery of the shallow-water Kielce region; Fig. 1A). A small- sized variety of this species is frequent in the basal part of the marly-detrital set C *sensu* SZULCZEWSKI (1971, p.70) belonging to the *Palmatolepis transitans* Zone (see BULTYNCK & RACKI, 1991, in press) and containing diversified, rhynchonellid-dominated assemblages, according to MAKOWSKI (1988, pp.30-31; *in* RACKI & *al.*, 1991, in press). This morphologic difference is probably not only related to environmental factors as pointed out by BIERNAT & SZULCZEWSKI (1975, p.214), because the small variety occurs in contrasting lithological settings and habitats comprising pelagic *Styliolina* shales as well as detrital beds with redeposited stromatoporoids and corals.

This conclusion is a first attempt to elucidate the wide intraspecific variability of *P.polonicus* advocated by BIERNAT & SZULCZEWSKI (1975, pp.206-208). The biostratigraphical significance of rhynchonellid data available can be summarized in the following tentative sequence (Fig.4):

1. *Hadrotatorhynchus laskowaensis* n. sp. is restricted to the upper part of the Laskowa Hill Beds and to the lower part of the Szydłówek Beds, i.e. to the *Klapperina disparilis* Zone;
2. The entry of *Phlogoiderhynchus polonicus* corresponds approximately to the boundary between the *Klapperina disparilis* and *Mesotaxis falsiovalis* Zones, according to the range of the genus given by SARTENAER (1980, p.19, p.32; 1985, p.314; 1986, p.137);
3. A small-sized morphotype of *Phlogoiderhynchus polonicus* is a conspicuous fossil of the upper member (early Frasnian) of the Szydłówek Beds and their detrital equivalents.

Data on the *Ancyrodella* succession in the Czarnów section (BULTYNCK & RACKI, 1991, in press) suggest that the Givetian/Frasnian boundary falls somewhere in the uppermost part, or even near the top, of the range of the large-sized *Phlogoiderhynchus polonicus*.

The following questions need further accurate palaeontological analysis: the reappearance of fairly large and evenly biconvex *P.polonicus* in the southern Kielce region (especially the Kowala site; BIERNAT & SZULCZEWSKI, 1975, p.207, p.214), and its southward expansion during early Frasnian transgressive pulses suggested by RACKI (1986, p.209). It could be a relict occurrence of the genus on account of its exceptionally high stratigraphical position (*Palmatolepis punctata* Zone).

Fig. 3 — *Hadrotatorhynchus laskowaensis* n. sp. Camera lucida drawings of serial transverse sections (x 3.5); distances are in mm forward from the crest of the ventral umbo. Paratype J, GIUS4 - 297La/9. l: 23.2mm; w: 30.0mm; t: 19.4mm.

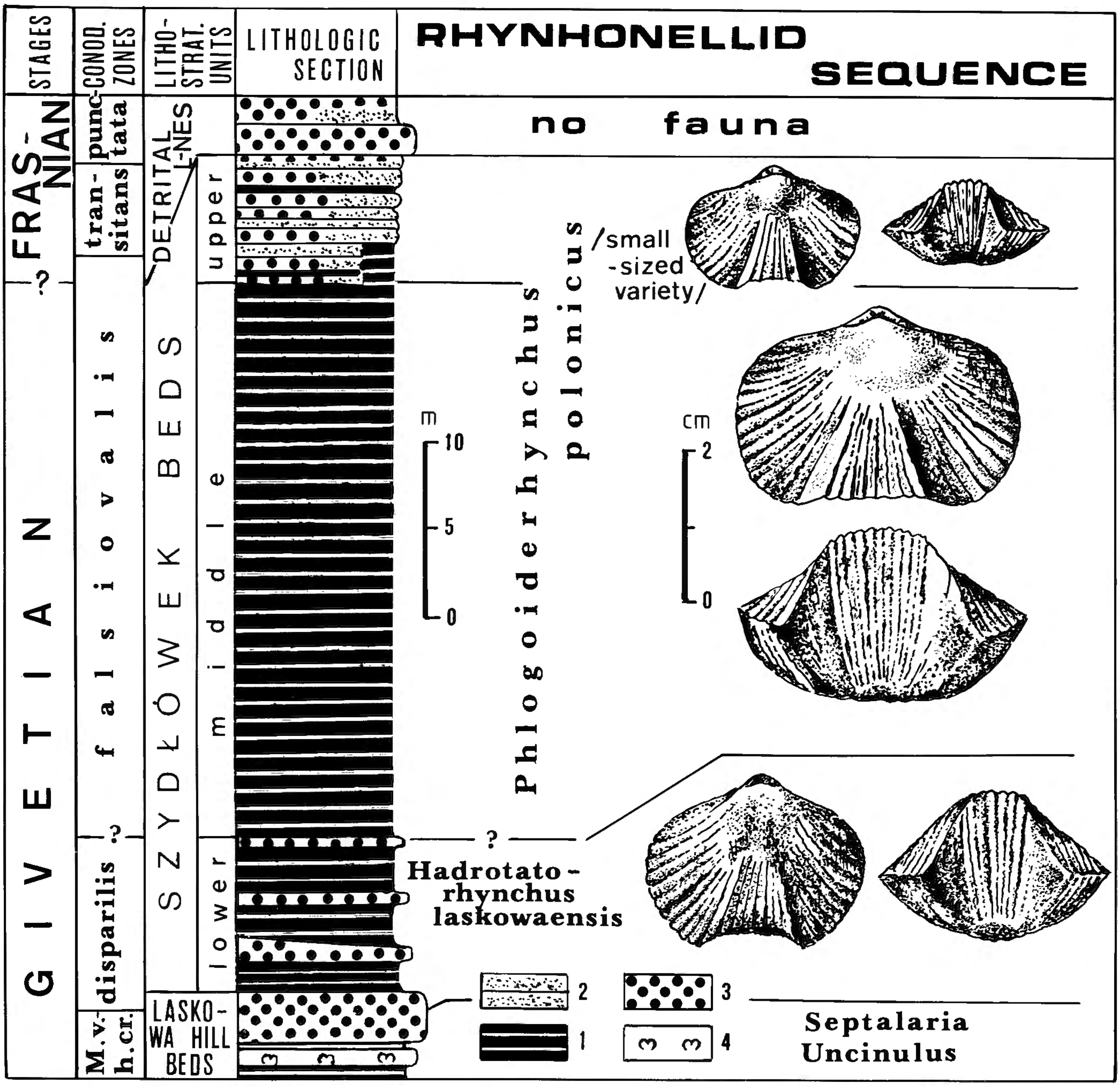


Fig. 4 — Stratigraphical scheme of the Middle/Upper Devonian boundary beds of the western Łysogóry region based on conodont datings and a preliminary rhynchonellid succession; note distinct differences in size and shape (especially convexity) of the brachiopod shells. M.v. - Middle *Polygnathus varcus* Zone, h.cr. - *Schmidtognathus hermanni-Polygnathus cristatus* Zone (*S. hermanni* Zone of Klapper & Johnson, 1990, p.934); 1 -marls and marly shales, 2 - micritic limestones, 3 - detrital limestones, 4 - coral biolithites.

Ecology

Biernat & Szulczewski (1975, pp.213-215) stated that the widespread *Phlogoiderhynchus polonicus* thrived in a relatively deep water, calm and muddy habitat, below storm base. This species, of which adult specimens were propably free-lying, has been found in various marly (typically bituminous) and micritic deposits, and only sporadically(see above) in detrital limestones, which are considered to have formed in shallower water and in turbulent conditions.

Hadrotatorhynchus laskowaensis n. sp., which occurs only in the Laskowa Hill Quarry, behaves ecologically very differently. At its main occurrence it forms a typical monospecific high- density (up to 20 specimens per dcm square) coquina that varies laterally in thickness (Fig.5) and probably pinches out completely. Shells are mostly disarticulated, sometimes fragmented, and val-

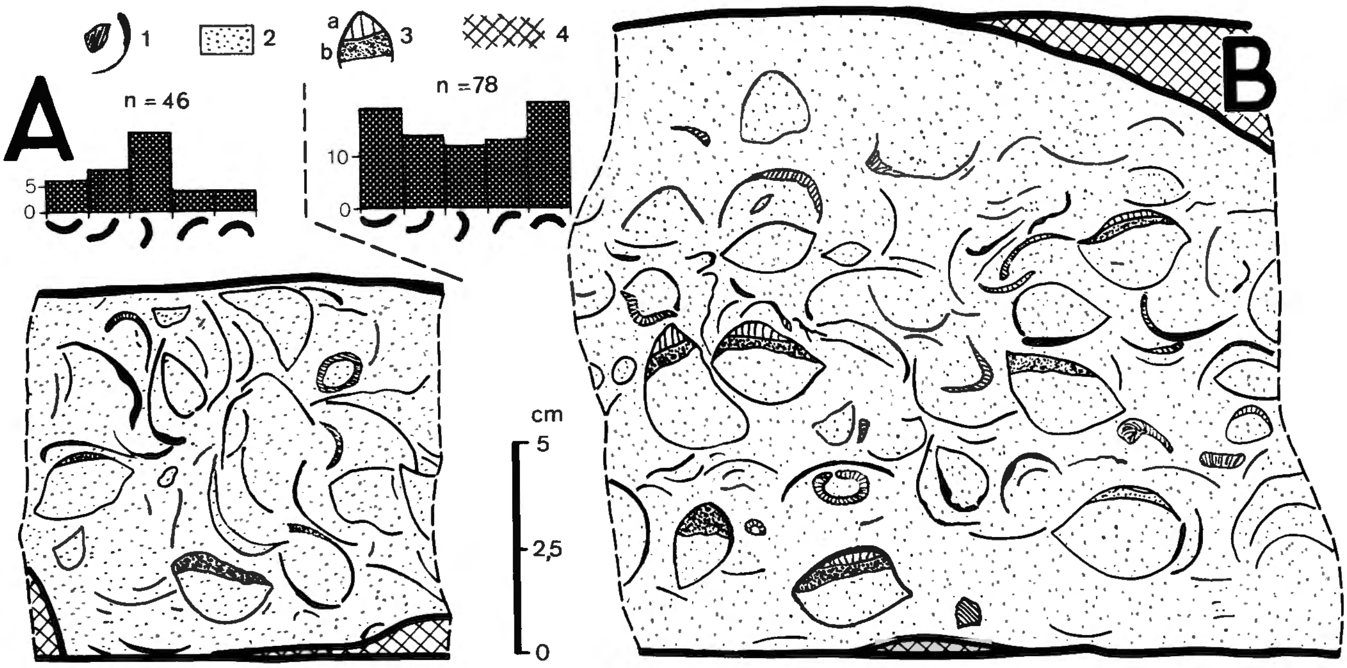


Fig. 5 — Variable distribution of fossils, and isolated valve orientation in two polished slabs taken from the rhynchonellid shell bed at Laskowa Hill sections: L-VI (*A*); see RACKI, GŁUCHOWSKI & MALEC, 1985, Fig.4) and L-II (*B*); n - number of valves measured, 1 - brachiopod remains, 2 - arenite matrix, 3 - geopetal filling with pelitic sediment (a) and calcite cement (b), 4 - fragment covered with hematite.

ves have, in some places, perpendicular and stacking positions. Size sorting is obviously due to strong dominance of large shell remains, rarely with adhering or contained brownish pelitic sediment, distinctly different from black fine-grained interstitial deposits. The matrix consists chiefly of intrabiomicrosparite, suggesting a primary packstone texture affected by progressive neomorphism. The most common skeletal constituents include fine echinoderm detritus (crinoid remains, echinoid spines), ostracods and gastropods. Moreover, high amounts of bioclasts (calcispheres and other parathuramminoid "foraminifera") as well as clotted (cryptalgal) micrite or micritized grains derived from shallow water, partly restricted-marine environments (see RACKI & BALIŃSKI, 1981, pp.188-189) indicate a peri-platform debris supply from the adjacent Kielce region. The shell bed considered is interpretable (see e.g. *whole fossil packstone* of KREISA, 1981, pp.829-830) as a severely winnowed skeletal lag accumulation. However, it is important to note that this layer is embedded in fossil-poor (background) marly deposits (with *Styliolina* in places), and similar rhynchonellid low-density occurrences are limited to underlying detrital beds. For such cases BRETT, SPEYER & BAIRD (1986, pp.137-139) and KIDWELL, FÜRSICH & AIGNER (1986, p.235) prefer a model of episodic low depositional rates, due either to regional sediment starvation or to locally altered current patterns. These shell beds probably represent both longer interval(s) of the skeletal concentration under sediment-starved conditions, and final storm reworking and rapid burial in resuspended fine-grained sediments. Indeed, skeletal cavities filled mostly with interstitial sediment (Fig.5) suggest, according to BRETT & BAIRD (1986, p.221), slow net deposition. On the other hand, significance of down-slope transport, and consequently, strictly parautochtonous status of the shelly material remain an open question for the Laskowa Hill coquina. Evidently, the reworking was more significant in the case of the lowest occurrence of *Hadrotatorhynchus laskowaensis* n. sp.in the uppermost Laskowa Hill Beds. The calcarenites locally contain rich crinoid debris and intraclastic partings (see RACKI, GŁUCHOWSKI & MALEC, 1985, pl.4, fig.4), and diversified, but more fragmented, brachiopods, such as *Hypothyridina, Warrenella* and atrypids. In conclusion, the storm-disturbed banks of *Hadrotatorhynchus laskowaensis* n.sp. flourished locally on a prograding carbonate slope forming the southern border of the Łysogóry intrashelf basin. The succeeding species, *Phlogoiderhynchus polonicus*, expanded geographically as a result of progressive development of this basin, but its expansion was connected also with successful colonization of deeper, semi-stagnant and oxygen-deficient biotopes (RACKI, 1989, p. 148) as, for example, is the case for the "*Leiorhynchus*" fauna of the Middle and Upper Devonian of southwestern New York (see e.g. THOMPSON & NEWTON, 1987, pp.274-280), and generally speaking, for the widespread Rhynchonellid Biofacies typical of basinal (off- reef) settings, as discussed by RACKI & *al.* (1991, in press). According to RACKI (1986, pp.209-210;

RACKI & *al.*, 1991, in press), the expansion of similarly shaped large rhynchonellids is a remarkable brachiopod event in many basins developing as a result of late Givetian through early Frasnian progressive onlaps. In this context differences in shell convexity within the *Phlogoiderhynchus* group, which are important from a taxonomic point of view, may be partly a functional reflection of evolutionary habitat shift linked to disparate bottom preferences: firmer and sandy for the genus *Hadrotatorhynchus*, unstable and muddy for the flatter genus *Phlogoiderhynchus*. This hypothesis could be checked by examination of other occurrences of these genera, e.g. in Morocco.

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Plate 1

Hadrotatorhynchus laskowaensis n. sp.
All figures are natural size

a = ventral view; b = dorsal view; c = frontal view; d = apical view; e = lateral view

Figs.1a-e. Paratype A, GIUS4 - 297La/2. Costal formula: $\frac{7}{6}$; $\frac{1\text{-}0}{1\text{-}0}$; $\frac{12}{13}$.

Figs.2a-e. Holotype, GIUS4 - 297La/1. Costal formula: $\frac{6?}{6}$; 0 ; $\frac{9}{10}$.

Figs.3a-e. Paratype D, GIUS4 - 297La/5. Costal formula: $\frac{5}{4}$; 0 ; $\frac{9}{10}$.

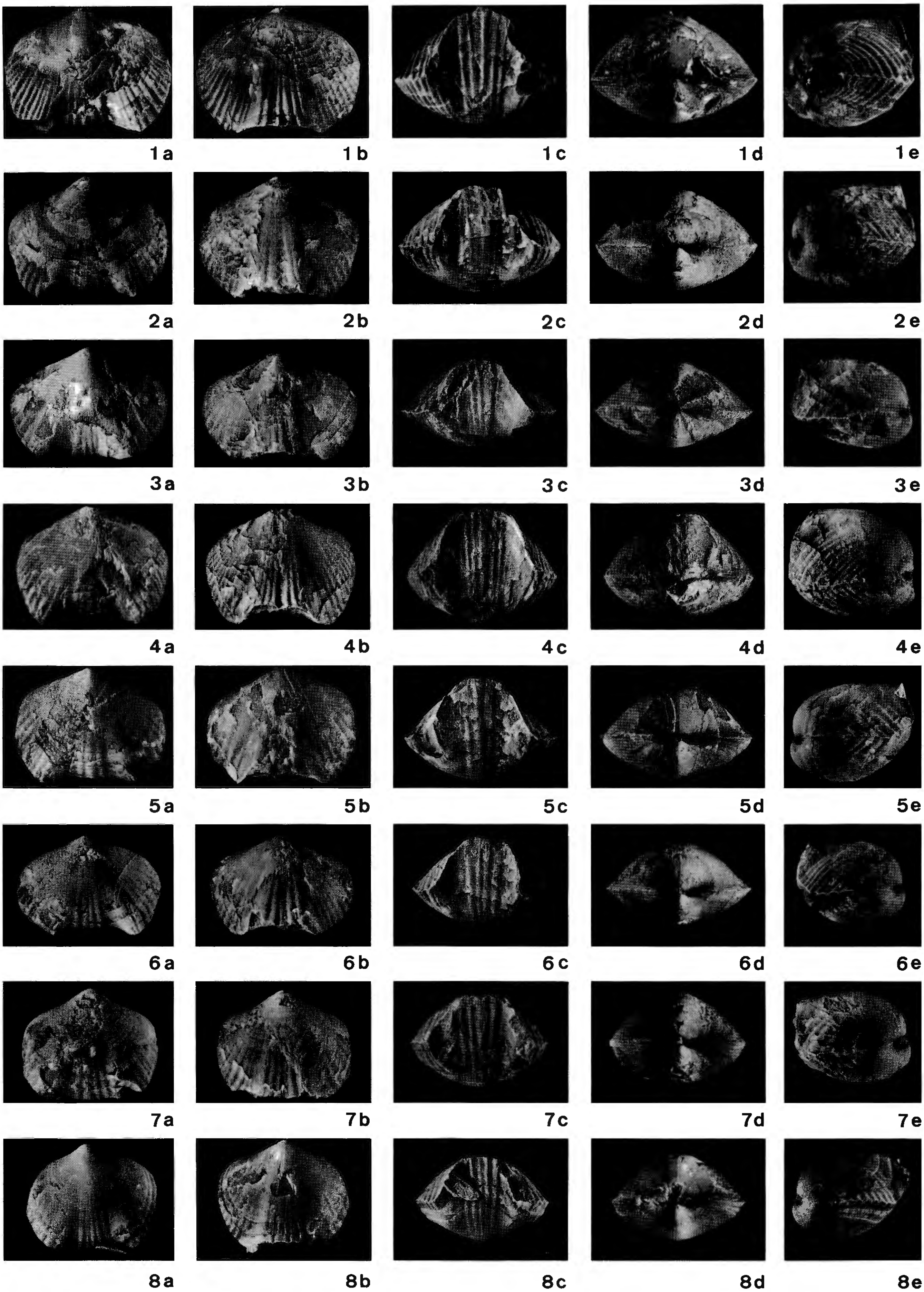
Figs.4a-e. Paratype B, GIUS4 - 297La/3. Costal formula: $\frac{7}{6}$; 0 ; $\frac{11}{12}$.

Figs.5a-e. Paratype C, GIUS4 - 297La/4. Costal formula: $\frac{4}{4}$; 0 ; $\frac{6}{7}$.

Figs.6a-e. Paratype G, GIUS4 - 297La/8. Costal formula: $\frac{5}{4}$; 0 ; $\frac{8}{9}$.

Figs.7a-e. Paratype E, GIUS4 - 297La/6. Costal formula: $\frac{6}{5}$; 0 ; $\frac{7}{8}$.

Figs.8a-e. Paratype F, GIUS4 - 297La/7. Costal formula: $\frac{6}{5}$; 0 ; $\frac{7}{8}$.



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