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Upper Ludlow trilobites from the southern part of the Holy Cross Mts.

Five trilobite species, in that one new, have been described from five genera: *Helokybe*, *Harpidella*, *Ballozoma*, *Dalmanites* and *Richterarges*. They occur in the Upper Ludlow Niewachlów grauwackes from the Niewachlów Anticline in the northern part of Kielce. The species described represent the characteristic not known till present assemblage and they document the Upper Ludlow deposits.

INTRODUCTION

Abundant and generally well preserved fauna has been discovered by J. Malec (1988–1991) in the northern part of Kielce (the Gruchawka quarter) in the ditch for the heat and power generating plant. The Silurian cross-section of the thickness of 650 m belonging to the Niewachlów Anticline has been discovered there. There occur grauwackes, mostly fine-grained and interlayered with claystones and mudstones. In the weathered zone those deposits are mainly olive-green, at the top even cherry-red to brown. The fauna is represented by limonite-covered moulds. In the non-weathered zone the deposits display grey colour. Their fauna corresponds to moulds with remnants of the weathered shells or carapaces.

The deposits of the Niewachlów grauwackes formation with the trilobites unknown in Poland which occur in the Kielce region correspond to the lower part of the Wydryszów Formation in the Łysogóry region and to the Lower Siedlce deposits on the East-European Platform (H. Tomczyk, 1970).

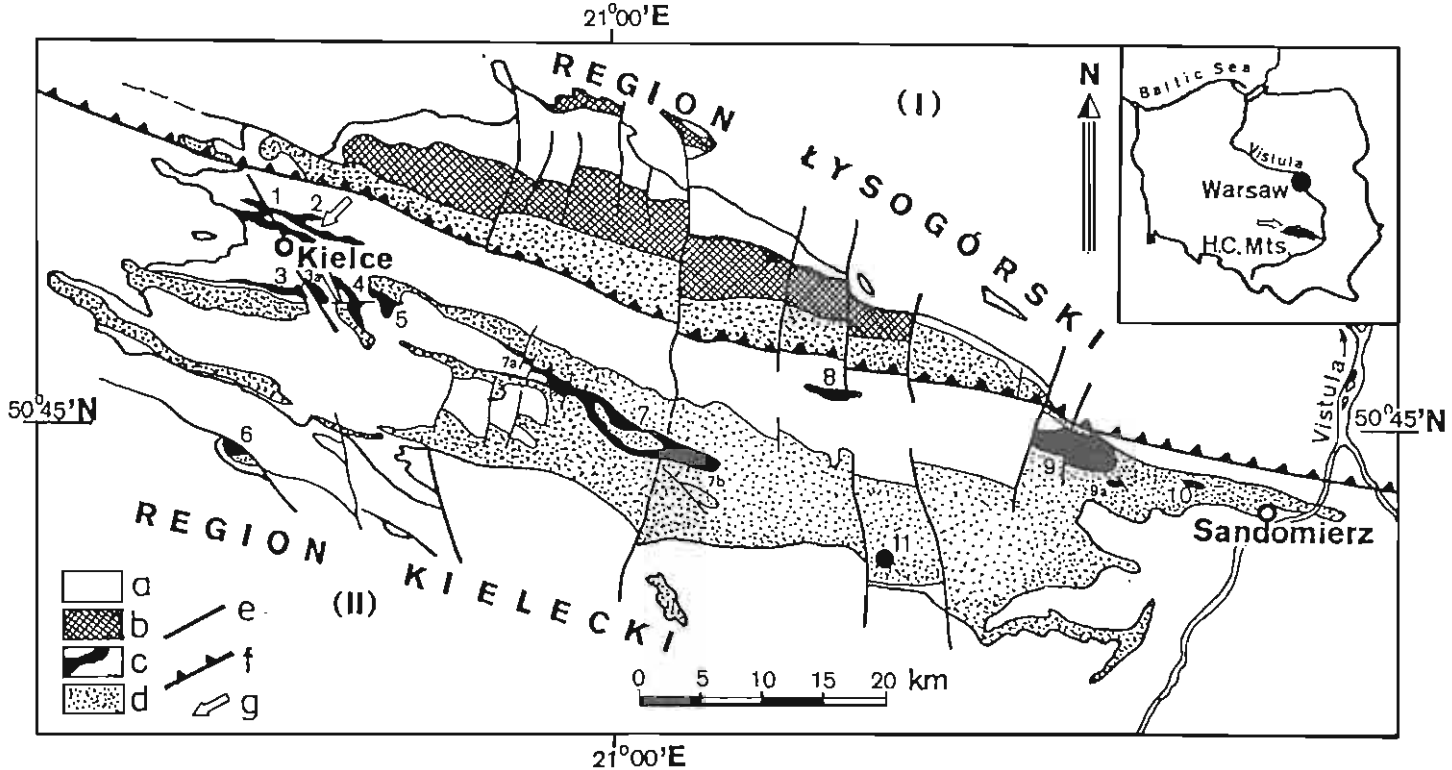

Fig. 1. Map of occurrence of the Silurian deposits on the background of the Paleozoic massif in the Holy Cross Mts.
(I) — Łysogóry region; (II) — Kielce region; a — Younger Paleozoic (Devonian, Carboniferous, Permian); b — Silurian deposits in Łysogóry region; c — Silurian deposits in Kielce region together with structural units: 1–2 — Niewachlów and Szydłówek Anticlines (small arrow shows the outcrop in Gruchawka), 3 — northern wing of the Dyminy Anticline (outcrop near the Telegraf Mt.), 3a — Bukówka Anticline, 4 — Mójcza Anticline, 5 — outcrop in Niestachów, 6 — Zbrza Anticline, 7 — Bardo Syncline (7a — outcrop in Widełki, 7b — outcrops in Zalesie — Kędziorka), 8 — outcrop in Piskrzyń, 9 — Międzygórz Syncline (9a — Święcica thrust), 10 — Lenarczyce thrust, 11 — Jurkowice outcrop; d — deposits of Holy Cross Mts. Cambrian; e — main dislocations and faults; f — border of regions; g — main outcrop with trilobites in Gruchawka; H.C.Mts. — Holy Cross Mts.

Samples of the fauna described are housed in the Muzeum Geologiczne Państwowego Instytutu Geologicznego (Geological Museum of the Polish Geological Institute) under the numbers of MUZ PIG 1605.II.1–44.

STRATIGRAPHIC OCCURRENCE OF TRILOBITES

The Silurian deposits in the area of the southern Holy Cross Mts. have been relatively well recognized, especially in their lower part comprising Llandovery, Wenlock and Lower Ludlow up to the graptolite *Saetograptus leintwardinensis* Zone inclusive (H. Tomczyk, 1954, 1956; E. Tomczykowa, 1957, 1958). Due to the graptolite abundance together with locally accompanying benthic fauna those deposits display the detailed biostratigraphic division and determined correlation both with the platform area and with the other European sections (H. Tomczyk, 1970).

Above the *Saetograptus leintwardinensis* Zone there occurred in the southern part of the Holy Cross Mts. analogically to Great Britain a distinct change in sedimentation character from the clay facies with graptolites to the mudstone-claystone and grauwackes deposits, known in general as the grauwackes series. Those deposits are know from numerous outcrops (J. Czarnocki, 1919; H. Tomczyk, 1956; P. Filonowicz, 1977) and boreholes (Z. Deczkowski, 1963) spread from the Niewachlów and Szydłówek Anticlines in the west through the Bardo Syncline to the Międzygórz Syncline and the Klimontów Anticline in the east (Fig. 1).

The grauwackes traditionally known as the Niewachlów grauwackes were best recognized and documented in Niewachlów (J. Czarnocki, 1919, 1922, 1936). This fact was confirmed by J. Malec (1988, 1989, 1990, 1991) who skillfully documented the section and sampled the abundant fauna in the Gruchawka outcrop. The thickness of the Silurian deposits exposed there was originally estimated by J. Malec (1989) for 650 m, whereas later — for about 1300–1500 m (J. Malec, 1991).

In contrary to those facts the thickness of the grauwackes series in the individual sections of the whole southern part of the Holy Cross Mts. has not been recognized in detail. It has also not been evidenced in detail aiming at the search for fauna. The occurrence of the grauwackes series with fragmentary fauna assemblages in the whole southern part of the Holy Cross Mts. from Kielce to Jurkowice, is, however, totally

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Mapa występowania utworów syluru na tle masywu paleozoiku Gór Świętokrzyskich

(I) — region łysogórski; (II) — region kielecki; a — młodszy paleozoik (dewon, karbon, perm); b — osady syluru regionu łysogórskiego; c — osady syluru regionu kieleckiego z jednostkami strukturalnymi: 1–2 — antyklina Niewachlowa i Szydłówka (strzałka oznacza wychodnie — przekop w Gruchawce), 3 — północne skrzydło antykliny dymińskiej (odsłonięcie przy górze Telegraf), 3a — antyklina Bukówki, 4 — antyklina Mójczy, 5 — odsłonięcie w Niestacbowie, 6 — antyklina Zbrzy, 7 — synklina Barda (7a — odsłonięcie w Widełkach, 7b — odsłonięcia Zalesie — Kędziorka), 8 — odsłonięcia w Piskrzyniu, 9 — synklina Międzygórza (9a — łuska Święcicy), 10 — łuska Lenarczyc, 11 — odsłonięcie Jurkowice; d — utwory kambru świętokrzyskiego; e — ważniejsze dysłokacje i uskoki; f — granica regionów; g — główne odsłonięcie z trylobitami w Gruchawce; H. C. Mts. — Góry Świętokrzyskie

out of discussion. Nowhere as complete and well faunistically documented sequence as that described by J. Malec has been found.

The base of the grauwackes series is in the section of northern Kielce unknown, analogically to Niewachlów and Szydłówek. It may correspond to the Mójcza, Posłowice and Dyminy regions where the *Lobograptus scanicus* Zone is concerned the youngest graptolite zone (J. Czarnocki, 1919, 1936; H. Tomczyk, 1956; P. Filonowicz, 1977). Further to the east of Kielce, i.e., in the Niestachów, Widełki, Bardo — Prągowiec, Zalesie, Kędziorka and Kleczanów areas H. Tomczyk (1956, 1962) distinguished *Saetograptus leintwardinensis* Zone

Disappearence of the graptolites occurred in the higher horizons due to the change in the sedimentation character. Only individual species as *Monograptus* sp., *Bohemograptus bohemicus* (Barrande), *B. bohemicus tenuis* (Bouček), *Pristiograptus* sp. were found above the *Saetograptus leintwardinensis* Zone. Fragments of straight rhabdosomes determined by L. Teller (*fide* J. Malec, 1989) and earlier by H. Tomczyk (*fide* E. Tomczykowa, 1959) as *Pristiograptus transgrediens* give the evidence for simple, not characteristic forms of the graptolites, really abundant within the extent of the key genus for the Lower Siedlce (H. Tomczyk, 1962, 1970). It should be stressed here that *Bohemograptus bohemicus* (Barrande) and *B. bohemicus tenuis* (Bouček) were stated by H. Tomczyk in the sections from Widełki and Kleczanów.

Together with graptolites there occurred also the benthic fauna either in irregular interlayers or in form of abundant accumulations (J. Czarnocki, 1936; E. Tomczykowa, 1959). There were moulds, generally yellow in colour and covered with limonite. Those moulds belong to: brachiopods, bivalves (mostly *Cardiola* genus), ostracods (Beyrichiidae and rarely — *Leperditia*), crinoid stems, rare tentaculitids and gastropods. Still more rare are bryozoans and tabulata as well as floral detritus.

The fauna mentioned above has not been described in detail. In majority — the assemblages are strictly related to the facies and do not have any biostratigraphic significance, but only for the period of their existance. Determinations of the brachiopods species listed by J. Czarnocki (1919, 1936) as well as by the present author can contain uncertainities. No palaeontologist wanted to identify brachiopods basing on the moulds. The present paper's author aimed mainly at distinguishing of the abundance and differentiation of the assemblages in which she suggested the similarity to the identified species or genera. This point of view, however, resulted in a kind of a trap both for the author and (earlier) for J. Czarnocki as well as recently — J. Malec. Since the Niewachlów grauwackes contain for the first glance the similar faunal assemblages as the Wydryszów and even Rzepin Formations, they were incorrectly concerned contemporary.

The trilobites represent the best biostratigraphic index within the whole benthic fauna. They are in general not facially but time-dependant. Due to their fragmental character they have never been described in the grauwackes series in the southern part of the Holy Cross Mts. In the old notes the author has found, however, the following informations: in Niestachów — *Calymene* sp., in Widełki — *Calymene* sp., *"Proetus"* sp., *"Otarion"* sp., *"Hemiarges"* sp., while in Zalesie and Kędziorka — the unidentified trilobite pleura. In addition to that — in the easternmost grauwackes outcrop in Jurkowice — A. Romanek found, when mapping, the trilobites determined prelimi-

narily by the present author as *Encrinurus* sp. and *Dalmanites* sp., assigned in the present paper to *Baliozoma erraticum* (Schrank) and *Dalmanites nexilis* (Salter), respectively. Only the sensational discovery of J. Malec (1988–1991) in the northern part of Kielce allows to understand the hitherto incomplete data and to assign the following genera into one zone: *Helokybe, Harpidella, Dalmanites, Richterarges* and possibly *Calymene* (that last, however, not being found in the Gruchawka section).

The earlier described trilobite assemblages (E. Tomczykowa, 1957, 1958) from the Lower Ludlow in the southern part of the Holy Cross Mts. comprises the following genera: *Decoroproetus, Scharyia, Raphiophorus, Ananaspis, Struveria* and the most abundant — *Odontopleura*. The trilobites from the Rzepin Formation in the northern part of the Holy Cross Mts. also described by the author (E. Tomczykowa, 1962, 1975, 1991) represent the assemblage consisting of the genera as: *Proetus, Calymene, Homalonotus, Acastella, Scotiella, Richterarges*. On the East-European Platform in the equivalent formation of the Upper Siedlce deposits those genera are also accompanied by *Trimerus, Dipleura, Harpidella, Conoparia* and *Ananaspis*.

As it results from the above — even the spectrum of the trilobites from the younger stratigraphic Silurian units is different from the assemblage present in the Niewachlów grauwackes or the Kielce grauwackes in the nomenclature of J. Malec.

The trilobite species described in the present paper point to the age of the sediments in the period from the upper part of Lower Ludlow until the Upper Ludlow (J. W. Salter, 1864; D. G. Mikulič, R. Watkins, 1981; L. Ramsköld, 1985, 1986; A. T. Thomas, G. M. Narbonne, 1979). *Dalmanites nexilis* (Salter) occurs in the fine-grained mudstones in the Vinnall Hill section near Ludlow in England. *Baliozoma erraticum* (Schrank) was described from the erratic boulders displaying the age determined as the Upper Ludlow. It occurs there together with the other Encrinuridae and Proetidae remnants as well as with *Trochurus*(?) sp. and *Dalmanites* cf. *imbricatulus* (Angelin), i.e., in the assemblage similar to that in Gruchawka.

The fact that A. T. Thomas and G. M. Narbonne (1979) described the following trilobites in the A Member of the Read Bay Formation on the Cornwallis Island in the arctic Canada: *Helokybe spio* Thomas, *Baliozoma hyperboreum* (Thomas), *Richterarges echinatum* (Thomas), *R.* aff. *aquilonius* (Whittington), *Kailia*? *capra* Thomas and *Cyphaspis* sp. (probably *Harpidella* sp.) seems to be very interesting. In the opinion of the present paper's author the specimens assigned to *Richterarges* aff. *aquilonius* belong to *R. kielcensis* sp. n. It should be stressed here that the trilobites from the Cornwallis Island nearly co-occur with the *Bohemograptus bohemicus tenuis* (Bouček). They are, therefore, of the similar age as those described from the Niewachlów grauwackes (H. Tomczyk, 1956, 1970; A. T. Thomas, G. M. Narbonne, 1979).

In the stratigraphic unit in Łysogóry equivalent to the Niewachlów grauwackes — in the lower part of the Wydryszów Formation over the *Saetograptus leintwardinensis* Zone (Wilków, Jeleniów, Kichary) — there occur the fine-grained mudstones with *Bohemograptus* but without the benthic fauna, analogically to the East-European Platform (H. Tomczyk, 1970; A. Urbanek, 1970). The younger — upper part of the Wydryszów Formation contains interlayers of dolomite-limestone and mudstone deposits, occasionally with the assemblages of the benthic fauna. Trilobites have not been found there.

The Lower Rzepin Formation equivalent to the Upper Siedlce Stage is in general carbonate both the Łysogóry and partly on the East- European Platform. The Rzepin Formation comprises characteristic trilobites occasionally in co-occurrence with the graptolites from *Formosograptus* genus (H. Tomczyk, 1970; E. Tomczykowa, 1982, 1988, 1991). The deposits of the Rzepin Formation do not occur in the southern part of the Holy Cross Mts., where the marine sedimentation was finished earlier, possibly at the end of the Ludlow (per analogiam to Great Britain).

The author agrees with J. Malec (1989) that "... the drastic change in the colour in the top interval of the Silurian in the Niewachlów Anticline (from dark-grey to cherry-red) possibly reflects the uplift movements in the adjacent (southern) areas ...". They probably took place at the end of Ludlow being connected with the Cracow Phase of the Caledonian Orogeny (H. Tomczyk, 1964). This suggestion is supported by the characteristic conglomerates from Łapczyca correlated with the gravelstones from Kleczanów (K. Łydka et al., 1963).

J. Malec maybe is right in his opinion on the regressive character of the Miedziana Góra conglomerates and their concordant sedimentation position on the top of the Silurian deposits, not on the Rzepin Formation but on the Niewachlów one. Those conglomerates, however, are of local significance being limited only to the Niewachlów Anticline, as it was presented by J. Czarnocki (1936).

SYSTEMATIC DESCRIPTION OF SPECIES

Family **Proetidae** Salter, 1864
Subfamily **Warburgellinae** Owens, 1973
Genus *Helokybe* Thomas, 1979
Helokybe cf. *spio* Thomas, 1979
(Pl. I, Figs. 1–7)

1979 *Helokybe spio* gen. et sp. nov.; A. T. Thomas (*fide* A. T. Thomas, G. M. Narbonne): p. 5, Pl. 2, Figs. a–j, m–o.

M a t e r i a l : 1 cranidium with a part of thorax, 2 small cranidia (in that — 1 negative), 6 free cheeks, 6 pygidia; all specimens are the moulds, but two with the remnants of the weathered carapaces. MUZ PIG 1605.II.1–14.

Dimensions in mm:

	Cranidium		Glabella		Pygidium			
	MUZ PIG 1605.II.							
	1	3	1	3	2	7	5	6
Lenght (sag.)	4.0	3.8	2.8 (without occipital ring)	2.4	3.3	3.9	2.8	2.7
Width (tr.)	5.3	–	3.0	2.2	5.0	5.5	4.5	4.1
Lenght of axis					2.4	3.1	2.2	2.2
Width of axis					1.4	1.7	1.4	1.2
Number of axial rings					7+1	7+1	6+1	6+1
Number of pleural ribs					4	5	5	4

Comparison. The Polish specimens display dimensions similar to those of the Canadian ones, being, however, worse preserved and representing only moulds. The most significant feature of the species discussed is the slightly inflated middle part of the preglabellar field passing towards anterior into the anterior border (comp. Pl. I, Figs. 2, 7, and A. T. Thomas, G. M. Narbonne, 1979, Pl. 2, Figs. a, d, f). Other characteristic features of both the Canadian and Polish specimens: anterior border furrow — entirely wide and shallow, especially in its middle part. Preglabellar furrow deep in the middle part above the glabella is adaxially shallower. Trapezoidal glabella dull-rounded in the anterior part. Glabellar furrows 1p deep and wide, especially in the middle part, shallow both near the occipital furrow and the axial furrows. Furrows 2p and 3p weakly marked, short. The 1p furrows run close to the anterior margins of the palpebral lobes and gently curving reach the occipital furrow close to the abaxial limits of the occipital lobes. Those last ones are distinct, while the occipital ring as a whole is convex with a small median node. The glabellar furrows 2p and 3p are indistinctly marked, short and shallow. Glabellar lobes 1p are separated, gently convex, their width being equal to one half of the length (sag.) of the glabella, while their width (tr.) corresponding to about 1/4 of the width (tr.) of the glabella. Palpebral lobes — long; a little longer than the half of the length (sag.) of the glabella. Field of free cheek slightly convex. Lateral border — almost flat, terrace lines — not distinct. Genal spine is equal to almost 2/3 of the length (exag.) of the remaining cheek. Convex thoracic axis (number of segments unknown — in the Canadian specimens equal to 9) covers nearly 1/3 of the thorax width (tr.). Preannulus distinct.

Pygidium wider (tr.) than its length (sag.) in ratio of 3:2. Axis distinctly convex, gently narrowing towards the posterior part; first ring more convex than the other ones and separated, the other — faintly isolated. Pleural ribs, gently curved, almost reach the pygidial border. Absence of distinct border, on the flat border — distinct terrace lines.

The comparative description from the above confirms co-specifics of the Polish and Canadian specimens. The present author agrees with the opinion of A. T. Thomas (A. T. Thomas, G. M. Narbonne, 1979, p. 4–5) that *Helokybe spio* Thomas reminds from one side *Cyphoproetus insterianus* Schrank, while from the other — *Warburgella Tetinia ludlowensis* (Alberti). The author agrees further with M. Šnajdr (1980) that

the last species mentioned does not belong to the *Tetinia* Chlupač genus and should be assigned to *Helokybe* Thomas. This is evidenced by the similarity of some Polish and Canadian specimens (comp. Pl. I, Figs. 1, 2, 4, 5 and A. T. Thomas, G. M. Narbonne, 1979, Pl. 2, Figs. c, d, j, a, m) to *H.*(?) *ludlowensis* in the illustrations of R. M. Owens (1973, Pl. 14, Fig. 15; Pl. 15, Fig. 1). Moreover *Helokybe*(?) *ludlowensis* (Alberti) has distinctly inflated medium part of the preglabellar field (R. M. Owens, 1973, Pl. 14, Figs. 13, ?14, 16, 17; Pl. 15, Fig. 2) which represents the diagnostic feature of the genus *Helokybe* Thomas.

The present author has only some objections to classify *Helokybe* Thomas (A. T. Thomas, G. M. Narbonne, 1979) to the subfamily Dechenellinae. Such a classification is not suggested by the structure of cephalon and pygidium. Distinctly isolated glabellar lobes 1p and very faint glabellar furrows 2p and 3p as well as subparabolic form of pygidium with less numerous segments and with no distinct border in *Helokybe spio* points to the relationship of this species with genus *Tetinia* Chlupač or even with *Cyphoproetus* Kegel. Representatives of Dechenellinae Přibyl have been recently assigned to another family Dechenellidae Přibyl separated from Proetidae Salter (E. A. Yolkin, 1968; E. A. Yolkin, V. A. Zheltonogova, 1974). It seems to be correct since Dechenellidae characterize the Devonian deposits, starting mostly from the Eifelian (A. R. Ormiston, 1967).

Family **Aulacopleuridae** Angelin, 1854
Subfamily **Otarioninae** Richter and Richter, 1926
Genus *Harpidella* M'Coy, 1849
Harpidella sp.
(Pl. I, Figs. 8–10)

M a t e r i a l : 1 incomplete cranidium, 1 almost complete pygidium negative, 1 free cheek. MUZ PIG 1605.II.15–17.

R e m a r k s . Only three specimens preserved in a very poor state do not encourage their classification to be more detailed than the genus rank. Detailed analysis of the hitherto described *Harpidella* species from the Silurian deposits — where they are predominant (J. W. Salter, 1849; F. Prantl, A. Přibyl, 1950; H. B. Whittington, K. S. W. Campbell, 1967; A. T. Thomas, 1978; A. T. Thomas, R. M. Owens, 1978; A. T. Thomas, G. M. Narbonne, 1979; A. Přibyl, J. Vaněk, 1981; M. Šnajdr, 1984) — suggests that the specimens under discussion are most similar to *Harpidella instita* (Whittington et Campbell) from Maine. Specimens like small cranidia (H. B. Whittington, K. S. W. Campbell, 1967, Pl. 6, Figs. 16–20) are close in size to the Polish specimen (Pl. I, Fig. 8). The following common features confirm the relationship between the Polish and American species: gently convex anterior border displaying the length (sag.) almost equal to the preglabellar field, entirely big palpebral lobes, convex and rather significant occipital ring with median tubercle. The Polish specimen displays indistinct abaxial bow at the margin of the free cheek. This feature, however, cannot be seen in some specimens from *Harpidella instita* species even better preserved in the Upper

Silurian deposits from the Hardwood Mts. Formation in Maine (H. B. Whittington, K. S. W. Campbell, 1967, Pl. 6, Figs. 7, 10).

Cyphaspis sp. described by A. T. Thomas (A. T. Thomas, G. M. Narbonne, 1979), occurring together with *Helokybe spio* Thomas, belongs in the opinion of the present author to the *Harpidella* genus. The Canadian samples presumably represent a different species due to the distinctly smaller glabellar lobes 1p (see Pl. I, Fig. 8 and A. T. Thomas, G. M. Narbonne, 1979, Pl. 2, Figs. r, s). Real representatives of *Cyphaspis* Burmeister are much bigger than *Harpidella* specimens, the most convex of all Otarioninae and have the eyes on the high columns. Moreover, *Cyphaspis* occur in the Devonian, not before the Eifelian (A. Přibyl, J. Vaněk, 1981).

Family **Encrinuridae** Angelin, 1854
Subfamily **Encrinurinae** Angelin, 1854
Genus *Baliozoma*[1] Holloway, 1980
Baliozoma erraticum (Schrank, 1972)
(Pl. II, Figs. 1–3)

1972 *Encrinurus (Frammia) obtusus erraticus* n. subsp; E. Schrank: p. 45, Pl. 13, Figs. 4–7; Pl. 14, Figs. 1–5 (with synonymy list).
1977 *Encrinurus erraticus* Schrank; R. P. Tripp et al.: p. 855, Fig. 3D.
1980 *Encrinurus erraticus* Schrank; D. L. Strusz: p. 17, 44, 51, 55, 57.
1986 *Balizoma obtusus* (Angelin, 1851); L. Ramsköld: p. 560, 561, 566.

M a t e r i a l : 1 incomplete cranidium, 2 free cheeks, 1 incomplete pygidium. MUZ PIG 1605.II.33–34, 43–44.

D i s c u s s i o n . The present author is of opinion analogically to R. P. Tripp et al. (1977) and D. L. Strusz (1980) that *Baliozoma erraticum* (Schrank) is suffficiently different from *B. obtusum* (Angelin) to be concerned as the separate species. The differences described by E. Schrank (1972, p. 47) as: less numerous but bigger tubercles on the cephalon and absence of the central tubercles on the 5th, 6th, 8th, 10th and 12th rings of the pygidial axis are well seen even on the specimens without the carapaces. Big, almost equal in size tubercles on the posterior part of the glabella mould (Pl. II, Fig. 3) lie so exactly that they form three first rows. Free cheek of *Baliozoma erraticum* displays distinctly narrower and flatter field with only seven tubercles (Pl. II, Fig. 2), while the same field in *B. obtusum* (Angelin) is more convex and has more tubercles (even to 13). The field of free cheek in *B. obtusum* (Angelin) being as narrow as in *B. erraticum* (E. Schrank, 1972, Pl. 13, Fig. 6) is much higher (L. Ramsköld, 1986, Pl. 49, Figs. 2, 3, 7). Pygidium in *B. erraticum* is much narrower (tr.) than that in *B. obtusum*. In that aspect *B. erraticum* (Pl. II, Fig. 1) is most similar to *B. dakon* (M. Šnajdr, 1983, Pl. 1, Fig. 2). That last species has been enclosed by L. Ramsköld (*op. cit.*) to the synonymy of *B. obtusum* (Angelin) with some doubts,

[1] Due to the error in the first part of the word displying Greek origin *balios*, the genus *Balizoma* should be changed into *Baliozoma* with species ended by *um* due to the neutral form of the second part of the word *zoma*.

however, since only one pygidium specimen is illustrated by M. Šnajdr (1983). *B. hyperboreum* (Thomas) has been concerned as the most similar to *B. erraticum* (Schrank) by A. T. Thomas (A. T. Thomas, G. M. Narbonne, 1979). The author quoted presented all the differences between both the species. Those differences should be still supplemented by the L. Ramsköld's (1986) remark on tuberculation of glabella which concerns both *B. erraticum* and *B. obtusum* in respect to *B. hyperboreum*.

Family **Dalmanitidae** Vogdes, 1890
Genus *Dalmanites* Barrande, 1852
Dalmanites nexilis (Salter, 1864)
(Pl. II, Figs. 4–6; Pl. III, Figs. 1–7)

1849 *Phacops caudatus* Salter; J. W. Salter: p. 1, Pl. 1, Figs. 10, 11.
1864 *Phacops (Odontochile) caudatus* Brünnich, var. *nexilis* Salter; J. W. Salter: p. 54, Pl. IV, Figs. 3–5.
1981 *Dalmanites myops* (König); D. G. Mikulič, R. Watkins: Figs. 4–6, 4–9 A, D.

M a t e r i a l : 4 almost complete and 4 incomplete cephalons, 3 almost complete pygidia, 5 incomplete free cheeks. MUZ PIG 1605.II.18–32, 42

D i m e n s i o n s in mm:

	Cephalon				Glabella				Pygidium		
	MUZ PIG 1605.II.										
	18	20	21	22	18	20	21	22	19	23	24
Lenght (sag.)	17.0	10.5	10.4	8.1	12.5 (without occipital ring)	7.6	7.5	6.3	9.2	12.8 (without caudal spine)	21.0
Width (tr.)	26.7	18.5	–	13.1	5.3	4.6 (at the base)	4.0	3.5	17.0	21.9	–
Axis lenght									8.6	10.9	8.9
Axis width									4.0	5.7	8.3
Number of axial ring									12+1	12+1	12+1
Number of pleural ribs									7	8	8

C o m p a r i s o n . Since its determination, *Dalmanites nexilis* (Salter 1864) has not been quoted or described. Only L. Ramsköld (1985) showed that the specimens from the Welsh Borderland presented by D. G. Mikulič and R. Watkins (1981, Figs. 4–6, 4–9 A, D) and classified as *Dalmanites myops* belong to *D. nexilis* (Salter). From the other side L. Ramsköld (*op. cit.*, p. 50) not knowing the species *D. bituberculatus* Reed as well as *D. nexilis* (Salter), recognized them both as conspecific. The present author (E. Tomczykowa, 1991) has found *D. bituberculatus* in the Lower Ludlow of the East-European Platform and is of opinion on the individual character of both the species. *D. nexilis* differs from *D. bituberculatus* due to the smaller size of cephalon and its flatter nearly smooth surface. *D. nexilis* has a short triangular frontal process (in contrary to the rectangular, straightly cut one in *D. bituberculatus*), shallower glabellar furrows, less convex glabella, absence of occipital tubercle and smooth antero-lateral border (in contrary to the wavy one in *D. bituberculatus* Reed; E. Tomczykowa, 1991,

p. 34, Pl. VII, Figs. 26, 27). *D. obtusus* (Lindström) seems to be most similar to *D. nexilis*. L. Ramsköld (1985), however, separates both those species in his detailed revision of the Gotland Dalmanitidae being of opinion that *D. nexilis* "...is similar to myops in general features, but differs in much narrower rachis and wider field of cheek beneath the eye...". The present author still adds the difference in shape of the anterior cephalic border, which is in *D. nexilis* more elongated into the triangular frontal process (similar to *D. obtusus*) but without the depression in the middle (which is characteristic for that last species). Pygidium of *D. nexilis* quite similar to *D. obtusus* has presumably a larger number of the non-separated axial rings (12 in contrary to 10–11 in *D. obtusus*). The final part of the pygidial axis, presented here as 1, can comprise small separated rings not seen on the mould, i.e., not comparable with the carapaces of *D. obtusus*. Caudal spine of *D. nexilis* is short and delicately rounded in contrary to the longer and tapering one in *D. obtusus*.

D. nexilis (Salter, 1864) seems to be one of the last representatives of the *Dalmanites* genus. It is evidenced by the smooth (analogically to *D. obtusus* (Lindström) antero-lateral border of the cephalon. The stratigraphically older species, as *D. bituberculatus* Reed and *D. myops* (Lindström), have this border more or less wavy. In the younger Silurian deposits *Dalmanites* genus is not being found, while in the Lower Devonian there appear *Huntonia* Campbell and *Odontochile* Hawle et Corda closely related to *Dalmanites*.

Family **Lichidae** Hawle et Corda, 1847
Subfamily **Trochurinae** Phleger, 1936
Genus *Richterarges* Phleger, 1936
Richterarges kielcensis sp. n.
(Pl. IV, Figs. 1–6)

?1965 *Hemiarges aquilonius* Whittington; T. E. Bolton: Pl. 2, Fig. 7, Pl. 3, Fig. 10.
1979 *Hemiarges* aff. *aquilonius* Whittington; A. T. Thomas (*fide* A. T. Thomas, G. M. Narbonne): p. 14, Pl. 15, Figs. j, m, n, p.

Material: 3 almost complete cranidia, 1 fragment (negative) of middle part of cranidium, 3 pygidia (in that — 1 incomplete); MUZ PIG 1605.II.35–41.
Holotype: cranidium, MUZ PIG 1605.II.36; Pl. IV, Fig. 4.
Paratype: pygidium, MUZ PIG 1605.II.38; Pl. IV, Fig. 2.
Type locality: Kielce, Holy Cross Mts.
Type horizon: Upper Silurian — Upper Ludlow (Lower Siedlce), the Niewachlów grauwackes.
Derivation of the name: *kielcensis* — after the town of Kielce.

Diagnosis: Gently convex glabella. Longitudinal furrows being relatively deep, also in the anterior part as well as in the basal lobes, reach the occipital furrow. Convex basal lobes, slightly elongated. No occipital lobes. Distinct anterior border, flat, slightly bent upwards in the anterior part.

Description. Cranidium gently convex of length (sag.) of 5.5 mm (3.5 and 7.6 mm) and of width (tr.) at the base of basal lobes of 5.8 mm (5.3 and 7.8 mm). Anterior border flat, almost equal to the length (sag.) of the occipital ring, in form of a rim slightly bent upwards. Basal lobes convex and elongated, wider (tr.) than bullar

lobes, more than twice as long (exag.) as the occipital ring (sag.). Longitudinal furrows relatively deep, distinct also in the anterior part, gently adaxially bent at the level of the half of bullar lobes, reaching adaxially the occipital furrow in form of a gentle arch. Bullar lobes moderately convex, isolated from the basal lobes by deep and wide furrows, across the median lobe distinctly shallowed and widened. Occipital furrow wide and deep. Posterior furrows of the same depth but much narrower. Occipital ring equals to almost 1/8 of cranidium length (sag.). Median lobe almost equal in its width (tr.) widens in the anterior part. At the level of a gentle median widening — median lobe equals to 1/3 of the cranidium width (tr.). Occipital lobes absent. Palpebral lobes occur as the elongation of basal lobes. Triangular fixed cheek with roll-like and narrow posterior border. Free cheeks, hypostome and thorax unknown.

Pygidium not convex, of length (sag.) of 5.2 mm (4.3) and of width (tr.) — 7.4 mm (7.0). Slightly convex axis occupies 2/3 of the total pygidium length (sag.) and less than 1/3 of its width (tr.). 9 + 1 axial rings. The axis changes into postaxial ridge reaching pygidium border; 2 first rings distinct, the other ones separated by distinct furrows; the posterior end with small tubercles. 2 pleural ribs passing into relatively long spines. At the half distance between the second pair of spines and the axis (possibly on the continuation of narrow roll-like ribs extending from the 7th axial ring), there is another pair of spines — the longest and the thickets ones. The posterior border displays one pair of short, thin spines and axial spine relatively thicker but not longer. Surface of cranidium and pygidium covered with fine granulation.

C o m p a r i s o n . *Richterarges kielcensis* sp. n. is relatively similar to *R. convexus* Tomczykowa earlier described by the author. It differs from it, however, due to distinctly smaller dimensions, narrower basal lobes elongated sidewards (exag.) being deeper in the anterior part and not truncated by longitudinal furrow at the base of basal furrows. Longitudinal furrows distinctly reach occipital furrow. Widening of the median lobe in the middle of cranidium is indistinct for *R. kielcensis* sp. n. and not connected with lobe convexity in contrary to *R. convexus* Tomczykowa. The pygidium of that last one is, moreover, more convex displaying the axis occupying 3/4 of length (sag.) and exceeding 1/3 of pygidium width (tr.), whereas the pygidial axis of *R. kielcensis* sp.n. occupies about 2/3 of pygidium length and less than 1/3 of pygidium width. Pygidial rings are in *R. kielcensis* sp. n. countable — apart from the first two rings — until the 7th one, whereas in *R. convexus* — apart from the first two rings — other eight are only marked either with small and narrow ridges or with fine tubercles (comp. E. Tomczykowa, 1991, Pl. XVI, Fig. 1 and here: Pl. IV, Fig. 2). The present author has earlier mentioned (*op. cit.*) that *R. convexus* is similar to *R.* aff. *aquilonius* (Whittington) described by A. T. Thomas (A. T. Thomas, G. M. Narbonne, 1979). The Canadian specimens are conspecific with *R. kielcensis* sp. n. This opinion concerns also the specimens assigned by T. E. Bolton (1965, Pl. 2, Fig. 7; Pl. 3, Fig. 10) to *R. aquilonius* (Whittington, 1961). That last species is in its cranidium structure rather similar to *R. convexus* Tomczykowa due to the anteriorally very shallow, longitudinal furrows and nearly circular basal lobes.

Elongated (sag.) pygidium of *R. aquilonius* (H. B. Whittington, 1961, Pl. 35, Figs. 14, 17, 22, 25, 29, 34) without roll-like border but with a notched pygidial border is completely different from those in case of *R. convexus* Tomczykowa, 1991 and *R.*

kielcensis sp. n. Both the species mentioned display half-circular pygidia with roll-like borders and roll-like spines. *R. convexus* has very short posterior spine and the first pair of adaxial spines — in form of swellings. *R. kielcensis* sp. n. has those spines not long but thin and pointed. Type genus *R. ptyonurus* (Hall et Clarke) has anterior border more convex than that of *R. kielcensis*. Its basal lobes are subsquare in contrary to the elongated (tr.) roll-like ones in *R. kielcensis*. Pygidium of *R. ptyonurus* is sub-triangular and has border with denticulate spines while *R. ormistoni* (Whittington) has entire, spine-free border.

CONCLUSIONS

The trilobite fauna described documents the Upper Ludlow deposits. In the area of the East-European Platform and in the northern part of the Holy Cross Mts. in the Łysogóry region, deposits of the same age have only graptolite evidence, as the Lower Siedlce or the lower part of the Wydryszów Formation. The benthic fauna has not been noticed in those deposits.

The Niewachlów Formation — being equivalent to the Lower Siedlce mentioned above — occurs in the southern part of the Holy Cross Mts. in the Kielce region spreading from Niewachlów and Kielce in the west to Jurkowice in the south-east (Fig. 1). In some outcrops there, there have been observed rare trilobites, as:

— in Niestachów: *Calymene* sp.;

— in Widełki: *Calymene* sp. "*Proetus*" sp., "*Otarion*" sp. and "*Hemiarges*" sp.;

— in Zalesie and Kędziorka: unidentified trilobite pleura;

— in Jurkowice: *Dalmanites* sp., *Encrinurus* sp., i.e., the assemblage identic with that described above from Kielce, but *Calymene* sp., which was not found in the Gruchawka section.

In the Niewachlów grauwackes the following graptolites were found in the sections quoted: *Bohemograptus* sp., *B. bohemicus tenuis* (Bouček), *Pristiograptus* sp. and incorrectly defined in the earlier and recent papers (E. Tomczykowa, 1959; J. Malec, 1989) *P. transgrediens* (Perner). The graptolites from the group *Bohemograptus* are evident for the Upper Ludlow age of the deposits discussed which in their turn are equivalent to the Lower Siedlce (H. Tomczyk, 1970; A. Urbanek, 1970).

Some trilobite species — especially *Dalmanites nexilis* (Salter) — point to the closer relation of the Niewachlów grauwackes with the Lower Ludlow than with the younger deposits. This species occurs, namely, in the Lower Ludlow rocks in the Vinnal Hill section near Ludlow in England (J. W. Salter, 1864; D. G. Mikulič, R. Watkins, 1981) in the association with trilobites from the genera: *Calymene, Proetus, Encrinurus, Otarion, Hemiarges*, i.e., almost identical as in the Gruchawka section. This assemblage characterizes deposits much older than the Whitcliffian. The Gruchawka section is also older than the Rzepin Formation (E. Tomczykowa, 1991).

The trilobite assemblage nearly identical to the above described one occurs in the Read Bay Formation in the arctic Canada and in the Upper Silurian in the New York State (H. B. Whittington, 1961; T. E. Bolton, 1965; A. T. Thomas, G. M. Narbonne, 1979). It is also similar to the Hardwood Mts. Formation in Maine (H. B. Whittington,

K. S. W. Campbell, 1967). The Read Bay Formation represents the Upper Silurian deposits, in that in the Member A there has been described the extent of *Bohemograptus bohemicus tenuis* (Bouček). The trilobites as: *Helokybe spio* Thomas, *Harpidella* sp., *Baliozoma hyperboreum* (Thomas), *Richterarges echinatus* (Thomas), *R.* aff. *aquilonius* (Whittington) which occur there, have been cited and compared with those described in the present paper. *R.* aff. *aquilonius* has been even enclosed in the synonymy list of *R. kielcensis* sp. n.

The erratic boulders from the Peri-Baltic area biostratigraphically undetermined occasionally contain fauna assemblages which can be correlated with the adequate sections. For example — the Upper Ludlow erratic boulder with *Baliozoma erraticum* (Schrank) contains also the other trilobites from the genera: *Dalmanites, Proetus*, and *Trochurus* which correspond to the Kielce assemblage.

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TRYLOBITY GÓRNEGO LUDLOWU POŁUDNIOWEJ CZĘŚCI GÓR ŚWIĘTOKRZYSKICH

Streszczenie

Opisane gatunki trylobitów pochodzą z przekopu pod elektrociepłownię w Kielcach (Gruchawka), skąd zostały zebrane przez J. Malca. Występują one w szarogłazach niewachlowskich i wyznaczają wiek tych osadów na górny ludlow. Trylobity te stanowią charakterystyczny zespół, nieznany dotychczas w Polsce, i obejmują następujące gatunki: *Helokybe* cf. *spio* Thomas, *Harpidella* sp., *Baliozoma erraticum* (Schrank), *Dalmanites nexilis* (Salter) i *Richterarges kielcensis* sp.n.

Szarogłazy niewachlowskie, odpowiadające dolnej części formacji wydryszowskiej w Łysogórach i dolnym siedlcom na platformie wschodnioeuropejskiej, występują w południowej części Gór Świętokrzyskich (region kielecki) od Niewachlowa i Kielc na zachodzie do Jurkowic na południowym wschodzie. Nieliczne trylobity były wcześniej notowane w niektórych odsłonięciach na tym odcinku: w Niestachowie — *Calymene* sp., w Widełkach — *Calymene* sp., *Proetus* sp., "*Otarion*" sp. i "*Hemiarges*" sp., w Zalesiu i Kędziorce — nie oznaczone pleury trylobitów oraz w Jurkowicach — *Dalmanites* sp. i *Encrinurus* sp. (znalezione tam przez A. Romanka). W cytowanych profilach znajdowane były także graptolity: *Bohemograptus* sp., *B. bohemicus*

tenuis (Bouček) i *Pristiograptus* sp. świadczące o górnoludlowskim wieku omawianych osadów, odpowiedników dolnych siedlec (H. Tomczyk, 1970; A. Urbanek, 1970).

Z opisanych gatunków trylobitów *Dalmanites nexilis* (Salter) występuje w dolnym ludlowie Wielkiej Brytanii. *Baliozoma erraticum* (Schrank) opisany został z nadbałtyckich głazów narzutowych, których wiek oceniono na górny ludlow. Gatunek ten występuje razem ze szczątkami innych Encrinuridae i Proetidae oraz z *Trochurus* sp. i *Dalmanites* sp., a więc w zespole o podobnym spektrum rodzajowym jak w Gruchawce. Niezwykle interesujący wydaje się fakt, że w części A formacji Read Bay na wyspie Cornwallis w arktycznej Kanadzie A. T. Thomas i G. M. Narbonne (1979) opisali trylobity: *Helokybe spio* Thomas, *Baliozoma hyperboreum* (Thomas), *Richterarges echinatum* (Thomas), *R.* aff. *aquilonius* (Whittington), *Kailia? capra* Thomas i *Cyphaspis* sp. (prawdopodobnie *Harpidella* sp.). Okazy zaliczane tu do *Richterarges* aff. *aquilonius* należą według autorki do *R. kielcensis* sp. n. Należy podkreślić, że trylobity te niemal współwystępują z *Bohemograptus bohemicus tenuis* (Bouček), a więc zarówno zespół trylobitów, jak i jego położenie stratygraficzne są bardzo podobne jak w szarogłazach niewachlowskich.

W Łysogórach — w odpowiednikach stratygraficznych szarogłazów niewachlowskich — w dolnej części formacji wydryszowskiej występują drobnoziarniste mułowce z *Bohemograptus*, ale bez fauny bentonicznej. Górna część formacji wydryszowskiej zawiera wkładki dolomityczno-wapienne niekiedy ze skupieniami fauny bentonicznej, jednak trylobity nie były tam znajdowane. Natomiast formacja dolnego rzepina, odpowiadająca górnym siedlcom, jest przeważnie węglanowa zarówno w Łysogórach, jak i na platformie wschodnioeuropejskiej, i zawiera bardzo charakterystyczny zespół trylobitów niekiedy współwystępujących z graptolitami rodzaju *Formosograptus* (H. Tomczyk, 1970; E. Tomczykowa, 1983, 1988, 1991). Osady te nie występują już w regionie kieleckim, południowej części Gór Świętokrzyskich, gdzie sedymentacja morska osadów syluru zakończyła się wcześniej, prawdopodobnie z końcem ludlowu, podobnie jak w Wielkiej Brytanii.

PLATE I

Helokybe cf. *spio* Thomas, 1979

Figs. 1, 4. Pygidium, x 7; 1 — MUZ PIG 1605.II.6, 4 — MUZ PIG 1605.II.5

Fig. 2. Another pygidium, x 7; MUZ PIG 1605.II.2
Inne pygidium

Fig. 3. Almost complete eranidium, x 8; MUZ PIG 1605.II.3
Prawie kompletne kranidium

Fig. 5. Pygidium, x 7: a — negative, b — latex cast; MUZ PIG 1605.II.7
Pygidium: a — negatyw, b — odlew lateksowy

Fig. 6. Free cheek, x 8: a — exterior view, b — ventral view; MUZ PIG 1605.II.4
Policzek wolny: a — widok zewnętrzny, b — widok wewnętrzny

Fig. 7. Cranidium with part of thorax, dorsal view, x 6; MUZ PIG 1605.II.1
Kranidium z częścią toraksu, od strony grzbietowej

Harpidella sp.

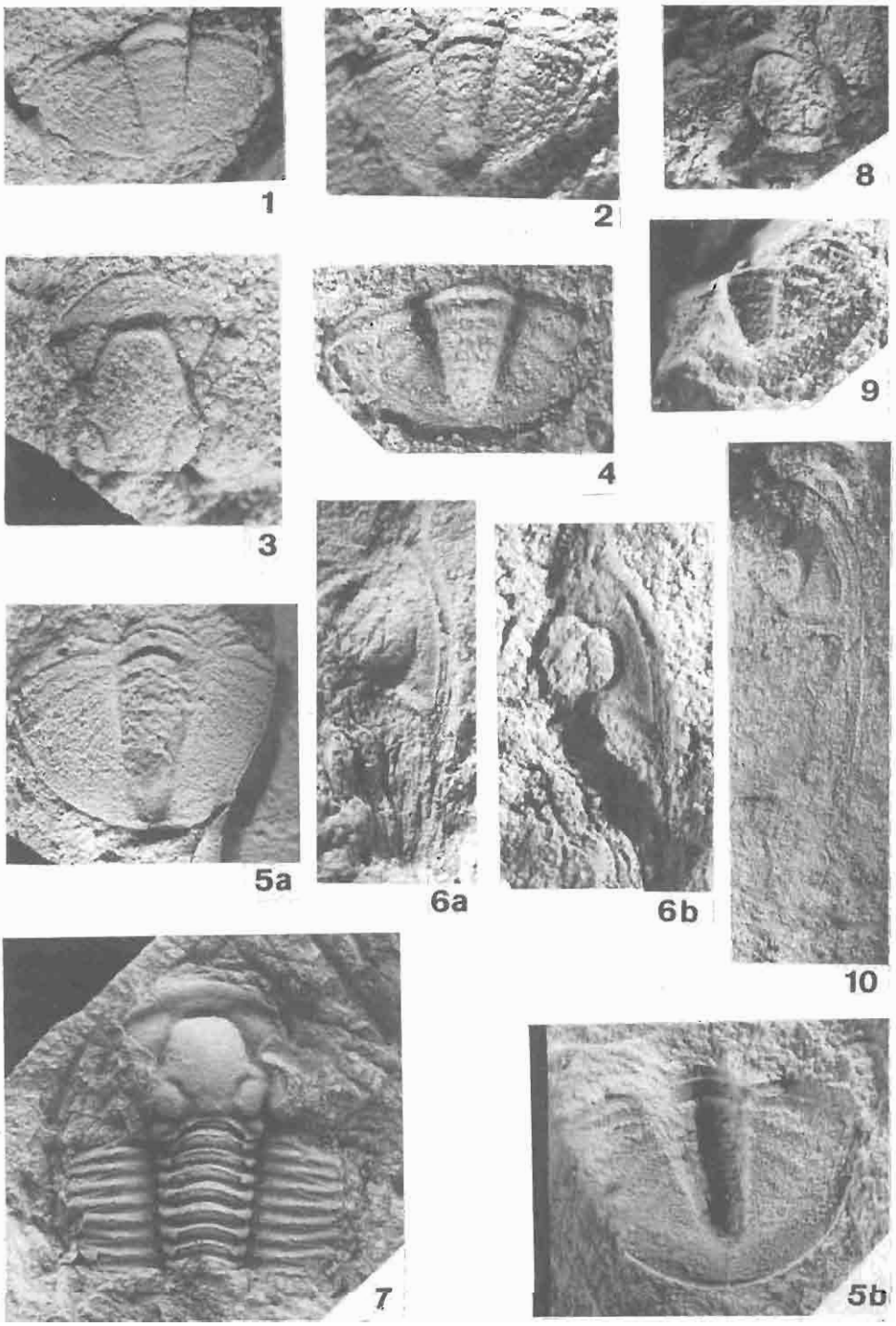
Fig. 8. Incomplete cranidium, x 7; MUZ PIG 1605.II.15
Niekompletne kranidium

Fig. 9. Incomplete pygidium, exterior view, x 8; MUZ PIG 1605.II.17
Niekompletne pygidium, widok zewnętrzny

Fig. 10. Free cheek, x 8; MUZ PIG 1605.II.16
Policzek wolny

Upper Ludlow, Niewachlów grauwackes. Kielce — Gruchawka (Holy Cross Mts.). All samples are moulds, to photography coated with amonium chloride. Photo J. Modrzejewska

Górny ludlow, szarogłazy niewachlowskie. Kielce — Gruchawka (Góry Świętokrzyskie). Wszystkie okazy są ośródkami, do fotografowania pokryte chlorkiem amonu. Fot. J. Modrzejewska



Ewa TOMCZYKOWA — Upper Ludlow trilobites from the southern part of Holy Cross Mts.

PLATE II

Baliozoma erraticum (Schrank, 1972)

Fig. 1. Incomplete pygidium, x 6: a — internal mould, b — negative; MUZ PIG 1605.II.43
Niekompletne pygidium: a — ośródka wewnętrzna, b — negatyw

Fig. 2. Fairly complete free cheek, x 6; MUZ PIG 1605.II.44
Prawie kompletny policzek wolny

Fig. 3. Incomplete cranidium, x 5; MUZ PIG 1605.II.33
Niekompletne kranidium

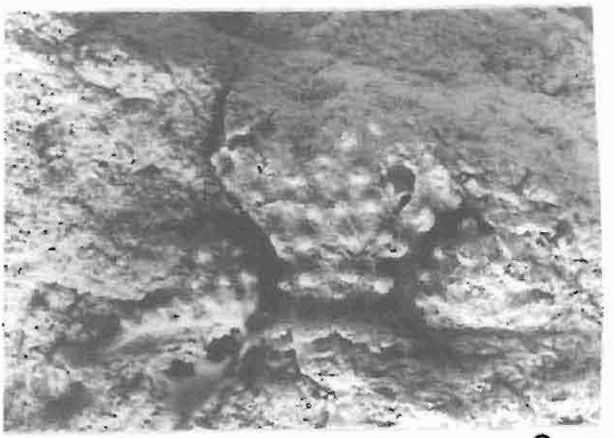
Dalmanites nexilis (Salter, 1864)

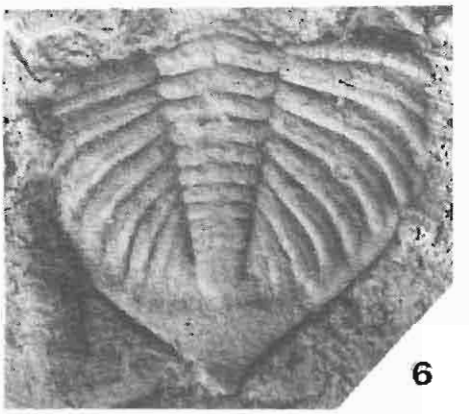
Fig. 4. Exfoliated cephalon with broken one cheek spine, x 2; MUZ PIG 1605.II.18
Cefalon z ułamanym kolcem policzkowym, pozbawiony pancerza

Fig. 5. Cheek spine internal mould, x 6; MUZ PIG 1605.II.42
Kolec policzkowy, ośródka węwnętrzna

Fig. 6. Latex cast of pygidium, x 3 (see also Pl. III, Fig. 7); MUZ PIG 1605.II.25
Odlew lateksowy pygidium (patrz także Tabl. III, fig. 7)

Figs. 3, 4, 6 — Kielce — Gruchawka, Figs. 1, 2, 5 — Jurkowice. Photo J. Modrzejewska





Ewa TOMCZYKOWA — Upper Ludlow trilobites from the southern part of Holy Cross Mts.

PLATE III

Dalmanites nexilis (Salter, 1864)

Fig. 1. Cephalon dorsal view, x 2; MUZ PIG 1605.II.22
Cefalon od strony grzbietowej

Fig. 2. Pygidium with broken caudal spine, natural size; MUZ PIG 1605.II.23
Pygidium ze złamanym kolcem kaudalnym, wielkość naturalna

Fig. 3. Fairly complete pygidium, natural size: a — dorsal view, b — ventral view, c — latex cast; MUZ PIG 1605.II.24
Prawie kompletne pygidium, wielkość naturalna: a — strona zewnętrzna, b — strona wewnętrzna, c — odlew lateksowy

Fig. 4. Almost complete cephalon, x 2; MUZ PIG 1605.II.21
Prawie kompletny cefalon

Fig. 5. Fairly complete cephalon: a — x 2, b — x 4; MUZ PIG 1605.II.20
Prawie kompletny cefalon

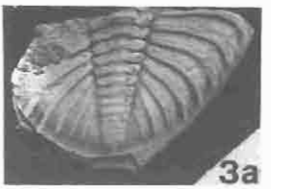
Fig. 6. Pygidium with partly broken caudal spine, x 2; MUZ PIG 1605.II.19
Pygidium z częściowo ułamanym kolcem kaudalnym

Fig. 7. Almost complete pygidium, x 2: a — latex cast, b — negative (see also Pl. II, Fig. 6); MUZ PIG 1605.II.25
Prawie kompletne pygidium: a — odlew lateksowy, b — negatyw (patrz także Tabl. II, fig. 6)

Kielce — Gruchawka. Photo J. Modrzejewska


1


2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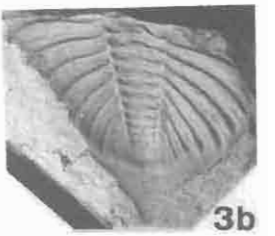
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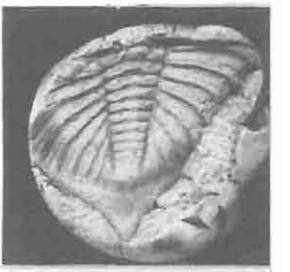
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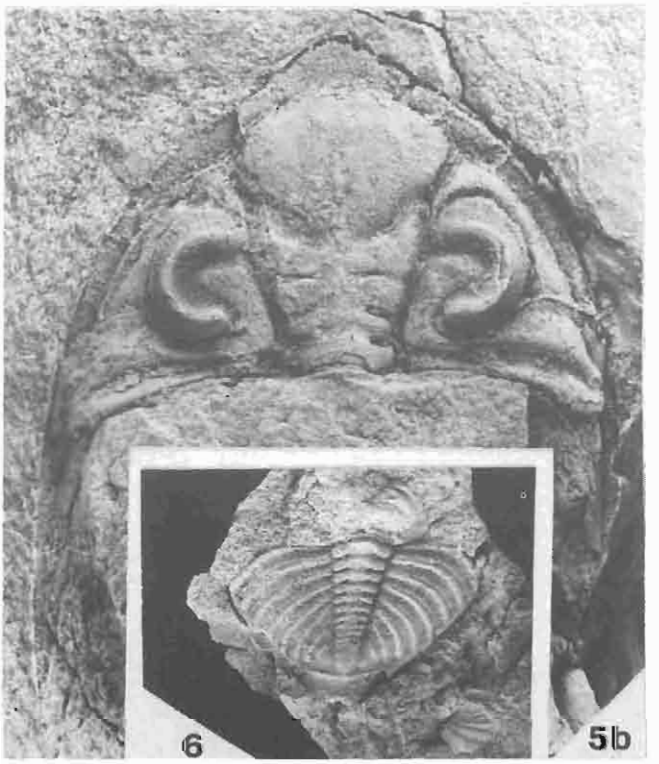
4


5a


5b

6


7a


7b

Ewa TOMCZYKOWA — Upper Ludlow trilobites from the southern part of Holy Cross Mts.

PLATE IV

Richterarges kielcensis sp. n.

Fig. 1. Almost complete pygidium: a — x 3, b — x 5; MUZ PIG 1605.II.37
Prawie kompletne pygidium

Fig. 2. Dorsal view of another pygidium: a —negative, x 3, b — x 5, c — latex cast, x 3, d — x 5; MUZ PIG 1605.II.38
Inne pygidium od strony grzbietowej: a — negatyw, 3 x, b — 5 x, c — odlew lateksowy, 3 x, d — 5 x

Fig. 3. Paratype cranidium: a — x 3, b — x 5; MUZ PIG 1605.II.35
Kranidium, paratyp

Fig. 4. Fairly complete cranidium, holotype: a — x 5, b — x 12; MUZ PIG 1605.II.36
Prawie kompletne kranidium, holotyp

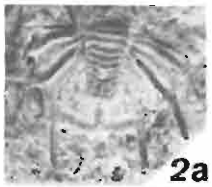
Fig. 5. Median cranidial part, ornamentation, internal mould, x 5; MUZ PIG 1605.II.40
Środkowa część kranidium, ornamentacja wewnętrzna widoczna na ośródce

Fig. 6. Almost complete cranidium, x 5; MUZ PIG 1605.II.39
Prawie kompletne kranidium

Kielce — Gruchawka. All samples are moulds. Photo. J. Modrzejewska

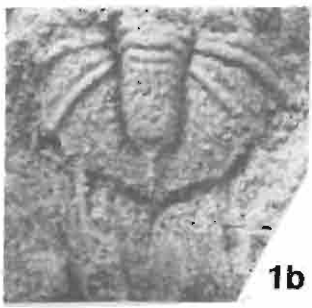
Kielce — Gruchawka. Wszystkie okazy są ośródkami. Fot. J. Modrzejewska


1a


2a


2c


3a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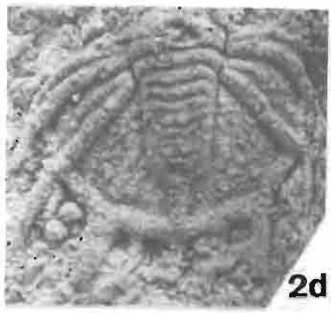
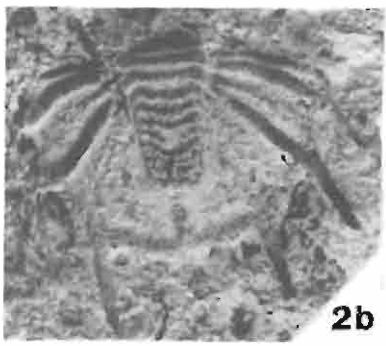

2d


4a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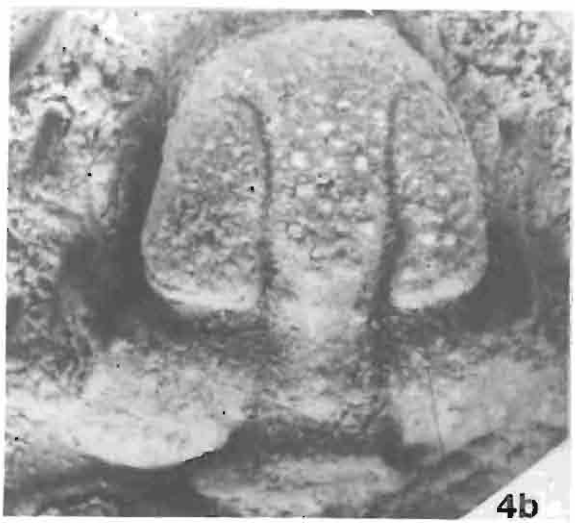
3b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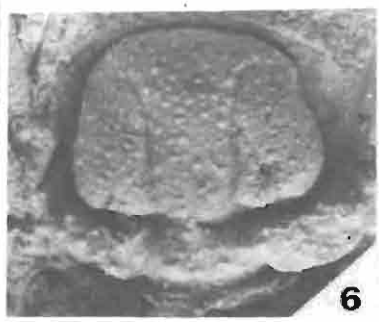
5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Ewa TOMCZYKOWA — Upper Ludlow trilobites from the southern part of Holy Cross Mts.