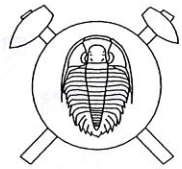
Representatives of genera *Mucronaspis* and *Songxites* (Trilobita) from the Bohemian Upper Ordovician



Zástupci rodů *Mucronaspis* a *Songxites* (Trilobita) z českého svrchního ordoviku (Czech summary)

(12 text-figs., 3 plates)

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The study presents a critical revision of Bohemian representatives of genera *Mucronaspis* Destombes, 1963, and *Songxites* Lin, 1981. The descriptions of these species are completed particularly with respect to a relatively high intraspecific variability. Validity of the individual species and their assignment to different genera are discussed. The subspecies *M. mucronata juna* Šnajdr 1987 is included in the synonymy of *Mucronaspis mucronata* (Brongniart, 1827).

Key words: Barrandian, Ordovician, dalmanitid trilobites, variability

Introduction

Representatives of the family *Dalmanitidae* Vodges, 1890, belong to the most important faunal elements of the Bohemian Ordovician. Here, the genus *Mucronaspis* Destombes, 1963, is represented by two species in the Králův Dvůr Formation (stage Kralodvorian) and one species in the Kosov Formation (stage Kosovian). The related genus *Songxites* Lin, 1981, is represented by a single species in the Králův Dvůr Formation. These species show very close affinities to the representatives from Scandinavia, Great Britain, Poland, Kazakhstan, but also, to a certain extent, from Morocco. This implies their importance for phylogenic, stratigraphic and paleogeographic studies.

The material studied comes from the collections of the Czech Geological Survey (ČGÚ): MŠ (Milan Šnajdr), JV (Jiří Vaněk), PB (Petr Budil) and XA (paleontological collections of ČGÚ), of the Faculty of Sciences of the Charles University (PřfUK), National Museum (NM), and from the collections of Ladislav Marek (LM) and Pavel Šlehoffer (Š) presently deposited in the Geological Institute of the Czech Academy of Sciences.

I would like to acknowledge all staff of the National Museum in Prague, Department of Paleontology, for their patience during my studies in the museum collections, particularly to Dr. R. Prokop and Mr. P. Kácha. Dr. V. Petr enabled me to study the material from the collections of the Faculty of Sciences of the Charles University. Prof. Dr. I. Chlupáč of the same institution is acknowledged for his valuable advice and comments to this paper. My access to the collections of LM and Š was mediated by Dr. A. Galle of the Geological Institute of the Czech Academy of Sciences. Dr. P. Štorch of the same institution is thanked for providing the material from his collection for my studies and for valuable comments to this paper. I also wish to thank Prof. Dr. W. Hammann, Würzburg University, and Prof. Dr. F. C. Shaw, Lehmann College, City University of New York, for their beneficial suggestions and commentary.

This paper was funded by the Grant No 205/94/0759 „The Ordovician of the Prague Basin".

Morphology and biometrics

In the exoskeleton description I follow the morphological terminology of dalmanitid trilobites published by Šnajdr (1990), supplemented by only few other terms. Therefore, only some basic morphological terms often cited in the text are given here (Fig. 1).

Systematics

Family: *Dalmanitidae* Vodges 1890
Subfamily: *Mucronaspidinae* Holloway, 1981

Genus: *Mucronaspis* Destombes, 1963

Type species: *Dalmanitina (Mucronaspis) termieri* Destombes, 1963

Diagnosis: Cephalon broadly arched. Glabella with three distinct glabellar furrows, the most impressed being S3. S2 adaxially directed slightly backwards, not extending to dorsal furrows. Dorsal furrows narrow but distinct. Eyes large to medium in size; their anterior part situated near S3, their posterior part may extend from S2 to almost posterior border furrow. Facial suture fairly to sharply sigmoidal in outline depending on size of eyes. Anterior border narrow but mostly well developed, frontal lobe of glabella only exceptionally extending to but never beyond cephalic margin. Lateral border narrow, mostly only weakly arched to flat. Lateral border furrows mostly broad and shallow, less frequently narrow. Cephalon in lateral outline mo-

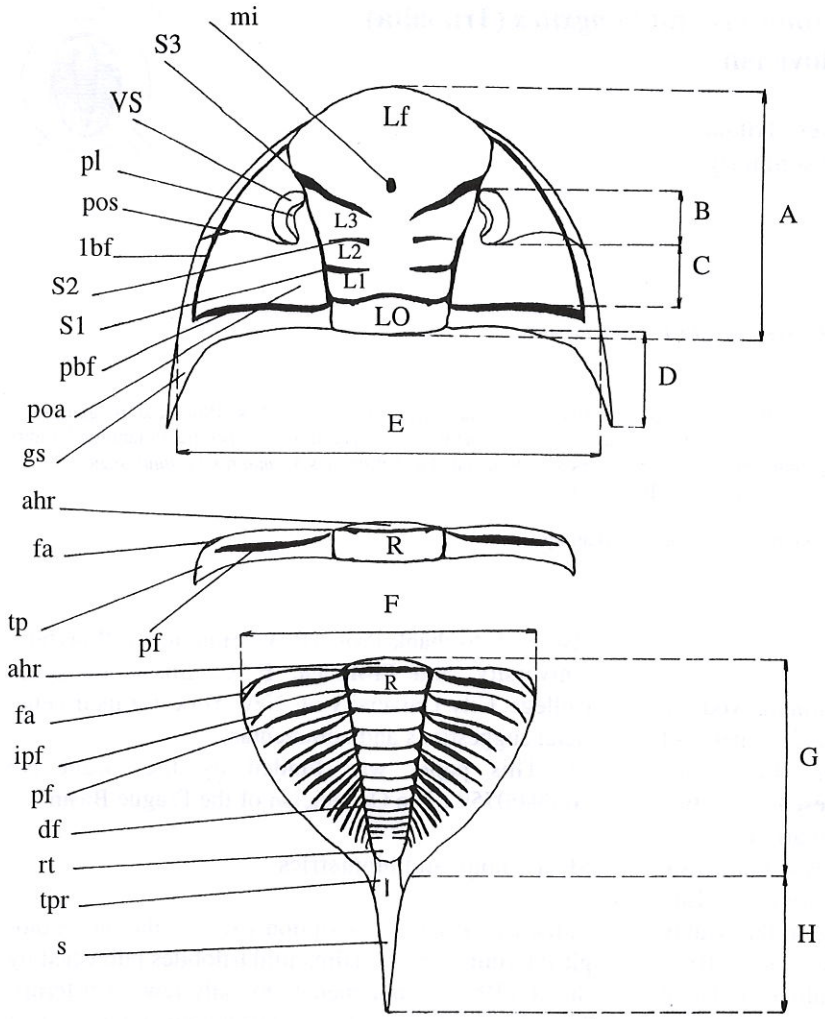


Fig. 1. Exoskeletal morphology and biometrics of the dalmanitid trilobites (after Rabano 1989 and Šnajdr 1990)
mi - median impression, S3 - anterior glabellar furrows, S2, S1 - lateral glabellar furrows, LO - occipital ring, Lf- frontal glabellar lobe, L3, L2, L1 - lateral glabellar lobes, vs - visual surface of eye, pl - palpebral lobe, pos - postocular part of facial suture, lbf - lateral border furrow, pbf - posterior border furrow, poa - postocular area, gs - genal spine ahr - articulating halfring, fa - articulating facet, tp - terminal part of pleura, pf - pleural furrow, ipf - interpleural furrow, R - rhachis, df - dorsal furrows, rt - rhachial terminal piece, tpr - terminal pygidial ridge, s - pygidial spine
An adapted biometrical classification of dalmanitid exoskeleton as given by Rabano (1989) was followed in biometrical measurements. A - cephalon length not including genal spine length (sag.), B - eye length (sag.), C - postocular region length (sag.), D - genal spine length (sag.), E - maximum cephalon width not including genal spines (trans.), F - maximum pygidium width (trans.), G - pygidium length not including pygidial spine length (sag.), H - pygidial spine length (sag.)

re or less concavely incised at the genal spines base. Genal spines of various lengths. Hypostome with maculae situated on posterior furrow. Posterior margin bearing 2 to 6 short spines of different lengths (rudimentary but visible in some representatives). Thorax consisting of eleven segments. Terminal ends of pleurae simple, flat, their contour elongate, triangular. Pleurae terminally extended into short spines towards pygidium. Articulating facets minute on all pleurae except first, triangular. Contour of pygidium subtriangular. Number of rings on rhachis varying between 7 and 13, number of pleurae between 4 and 11. Pygidial border present or absent. Pygidial spine of various length.

Remarks: Representatives of the genus *Dalmanitina* Reed, 1905, are distinguished primarily by these features: Anterior border on cephalon mostly absent, only rarely a slightly indicated anterior border present. Posterior hypostomal margin with two rudimentary granules only (Struve 1958), spines not developed. Pleural tips arched, with well developed shallow notches in the anterior part of the thorax (used as auxilliary organs for thorax rolling); posteriorly these notches get shallower, pleurae margins ovally truncated or extended into very short spines (shorter and more gracile than in *Mucronaspis* Destombes, 1963). Articulating facets better developed. Thus, the representatives of the genus *Dalmanitina* Reed, 1905, developed a rather different mode of rolling, with notched pleural tips fitting into lateral part of the doublure and posterior processes of thoracic pleurae overlapped cephalic margin (Holloway 1981). This type of enrollment was probably physically stronger than that of genus *Mucronaspis* Destombes, 1963, in which, this structures were not developed.

Representatives: *Mucronaspis termieri* Destombes, *M. greti* Destombes, *M. alnifensis* Destombes, *M. zagoraensis* Destombes, *M. mucronata* (Brongniart), *M. grandis* (Barrande), *M. olini* (Temple), *M. brevispina* (Temple), *M. ? matutina* (Dean), *M. ganabina* Šnajdr, *M. ? nanchengensis* (Lu), *M. ? yichangensis* (Lin), *M. ? malayensis* (Kobayashi et Hamada), *M. danae* (Meek et Worthen).

Stratigraphic and geographical distribution: Caradocian to Ashgillian of Morocco, Scandinavia, Great Britain, Poland, Czech Republic (Barrandian area), Kazakhstan, U.S.A. (Illinois), ?China and ?Malaysia.

Mucronaspis mucronata (Brongniart 1822)

Pl. I., figs. 1, 2, 3

Synonymy of this species before 1952 is given by Temple (1952).

1952 *Dalmanitina mucronata mucronata* (Brongniart): Temple, Pl.I, figs. 1-8; Pl. II, figs. 1; 3-4, 6; Pl. III, figs. 1-4; Pl. IV, figs. 1, 3, 7.
1958 *Dalmanitina (subgen ?) mucronatata mucronata* (Brongniart): Struve, p. 198, 206-207.
1960 *Dalmanitina mucronata* (Brongniart): Kielan, Pl. XIX, fig. 4; Pl. XX, figs. 5-11, p. 118, 119.
1963 *Dalmanitina mucronata* (Brongniart): Kobayashi et Hamada, p. 104
1963 *Dalmanitina (Mucronaspis) mucronata* (Brongniart): Destombes, p. 51
1966 *Dalmanitina mucronata* Brongniart: Havlíček et Vaněk, p. 43, 61
1969 *Dalmanitina mucronata mucronata* (Temple): Temple, p. 228.
1972 *Mucronaspis mucronata* (Brongniart): Destombes, p. 51
1973 *Dalmanitina mucronata* (Brongniart): Campbell, p. 71
1975 *Mucronaspis mucronata* (Brongniart): Cocks et Price, Pl. 83, figs. 1-4, p. 272.
1980 *Dalmanitina mucronata* (Brongniart): Henry, p. 147
1981 *Mucronaspis mucronata* (Brongniart): Holloway, p. 709.
1982 *Mucronaspis mucronata:* Štorch, Pl. II., fig. 8, 10.
1983 *Mucronaspis mucronata*: Lu-Wu, p. 129
1987 *Mucronaspis mucronata juna* sp. n.: Šnajdr, p. 272, Pl. II, fig. 2, 3.
1990 *Mucronaspis mucronata mucronata* (Brongniart): Pillet, p. 3.

Barrandian area material: a part of cephalon with a part of thorax, 3 complete and 15 incomplete cephala, 7 complete and about 20 incomplete pygidia and 8 hypostomes from the collections of the Czech Geological Survey: MŠ, LM and PB, and also from the collections of JV, Š and NM. The material is mostly deformed and it comes from grey siltstones, less frequently from quartzites of the uppermost part of the Kosov Formation (stage Kosovian).

Remarks: Šnajdr (1987) described a separate subspecies *Mucronaspis mucronata juna* from the Kosov Formation of the Barrandian area (stage Kosovian). He defined this subspecies on the basis of these characters: almost straight dorsal furrows on pygidium (weakly curved in the type subspecies), rhachis composed of 10 (11) rings (11 to 13 in *mucronata* subspecies) and a rather wider pygidial doublure. The study of specimens from the collections of MŠ, PB and LM revealed that the course of dorsal furrows on pygidium is either straight or weakly curved, possibly depending on the mode of preservation. Rhachis is usually composed of 11 rings, although the last one is often very indistinct. Doublure width varies considerably in the specimens studied, therefore, neither this character can be considered sufficient for the erection of a separate subspecies.

Distribution: The uppermost Kosov Formation (stage Kosovian).

Localities: Zadní Třebaň, Kosov, Prague-Malá Ohrada, Prague-Řepy housing estate, Prague-Nová Ves, Prague-Pankrác, Běchovice.

Mucronaspis grandis (Barrande, 1852)

Pl. I, figs. 4-6; Pl. II, figs. 2-4; Pl. III, figs. 3, 4; Text-figs. 4, 9, 10a, 11a.

1852 *Dalmanites socialis* var. *grandis*: Barrande, p. 555, Pl. 27, figs. 15-17
1951 *Dalmanitina socialis grandis* (Barrande) Chlupáč, p. 198, 199, 202-208.
1958 *Dalmanitina (D?) grandis* (Barrande): Struve, p. 195
1960 *Dalmanitina mucronata* (Brongniart): Kielan, p. 119.
1963 *Dalmanitina mucronata* (Brongniart): Kobayashi et Hamada, p. 104
1963 *Dalmanitina (Mucronaspis) mucronata* (Brongniart): Destombes, p. 51
1966 *Dalmanitina mucronata* (Brongniart): Havlíček et Vaněk, p. 40, 41, 60; Pl. 16, fig. 2.
1970 *Dalmanitina (Dalmanitina) mucronata* (Brongniart): Marek in Horný et Bastl, p. 287
1972 *Mucronaspis mucronata* (Brongniart): Destombes, p. 51
1974 *Dalmanitina mucronata* (Brongniart): Apollonov, p. 66
1980 *Dalmanitina mucronata* (Brongniart): Henry, p. 147
1987 *Mucronaspis grandis* (Barrande): Šnajdr, p. 272
1989 *Mucronaspis grandis* (Barrande): Mergl - Štorch, Pl. 8, fig. 1.
non 1989 *Mucronaspis grandis* (Barrande): Mergl - Štorch, Pl. 8, fig. 2 (= *M. ganabina* Šnajdr)
1989 *Mucronaspis ganabina* Šnajdr: Mergl - Štorch, Pl. 8, fig. 3 (= *M. grandis* (Barrande)
1989 *Mucronaspis mucronata* (Brongniart): Pek et Vaněk, p. 14
1989 *Mucronaspis grandis* (Barrande): Pek et Vaněk, p. 14
1990 *Mucronaspis mucronata mucronata* (Brongniart): Pillet, p. 3.
1992 *Mucronaspis ganabina* Šnajdr: Havlíček in Chlupáč et al., Pl. 27, fig. 1.
1994 *Mucronaspis grandis* (Barrande): Havlíček - Fatka - Vaněk, p. 43.

Lectotype: Incomplete specimen: L 15116 figured by Barrande (1852) in Pl. 27, figs. 15-17.

Type locality: Kosov near Beroun.

Type stratum: The uppermost Králův Dvůr Formation (stage Kralodvorian).

Other material: 6 almost complete specimens, one of them protaspid and two meraspid (meraspis 0-1), 5 incomplete specimens, about 50 complete and about 120 incomplete cephala, about 60 complete and about 100 incomplete pygidia and about 20 hypostomes. The material comes from the collections of the Czech Geological Survey: MŠ, JV, PB, MM, XA and also from the collections of LM, Š, PfUK and NM (collections IT, ČD, L and accessite No. 19/77).

Description: Cephalon broadly arched, semiparabolic in outline. Glabella club-shaped, anteriorly extending to (but not beyond) cephalon contour. Anterior border only weakly indicated or absent. Dorsal furrows narrow but distinct and deeply impressed. Prominent glabellar furrows (more distinct than in *M. olini* (Temple) but slightly less distinct than in *M. mucronata* (Brongniart)). S1 and S2 almost parallel, S2 directed fairly backwards in some individuals, S3 being the broadest, arched or only very slightly sigmoidal. S2 gets shallower adaxially, not reaching dorsal furrow, thus making L2 and L3 somewhat fused. Occipital ring smooth or with only a very slight indication of nucleus. Lateral border broadly arched, lateral border furrow relatively narrow and deep. Posterior border broadly arched. Posterior border furrow broad and well-defined, joining lateral border furrow at genal angle.

Genal spines robust, their length variable (Fig. 5). Eyes small, visual surface kidney-shaped. Anterior part always located near junction of Sf with dorsal furrow. Eye length variable, posterior part of eye reaching S2 or possibly up to one half of L2 Increase in eye size approx. linear during ontogeny.

Note: In contrast, Temple (1952) described the following phenomenon in species *Mucronaspis mucronata* (Brongniart): In a subadult stage of ontogeny (cephalon length 5-11 mm) eye length increases and posterior part of eye extends to S1. Eye size rapidly decreases in the following period of ontogeny and approximates that of *M. grandis* (Barrande). On the other hand, in *M. olini* (Temple, 1952) the posterior part of eye extentds laterally between S2 and S1 in ephebic individuals and S2 in adult individuals (Temple, 1952).]

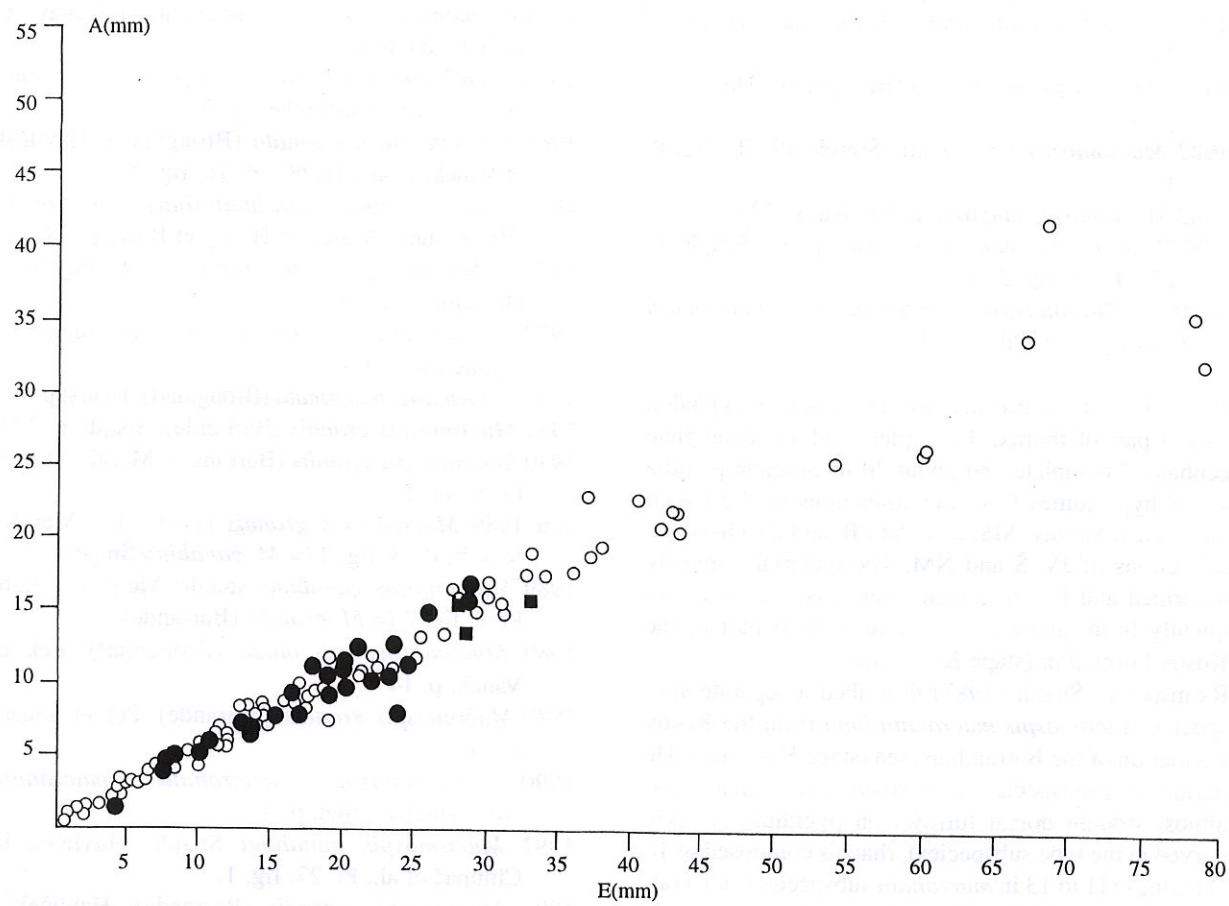


Fig. 2. Cephalon length vs. width ratios of *M. grandis* (circles), *M. ganabina* (dots) and *M. mucronata* (squares)

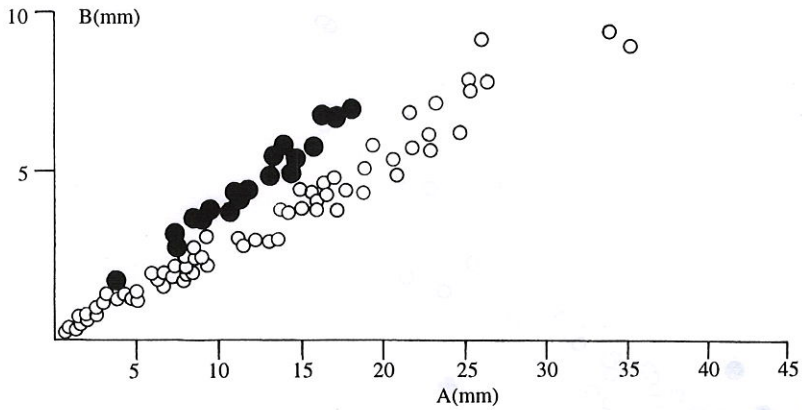


Fig. 3. Eye length vs. cephalon length in species *M. grandis* (circles) and *M. ganabina* (dots)

The number of lenses varies considerably among the individual specimens (120 to 215) the number of dorso-ventral rows also varies between 28 and 42. Neither the number of mostly very densely packed minute lenses, semicircular to semihexagonal in outline, on the order of tenths of mm in diameter, nor the number of dorso-ventral rows largely depend on cephalon length or the size of visual surface of eye in adult individuals. Instead, they rather depend on the diameter and density of eyes themselves, which vary to a large extent individually.

The highest numbers of lenses were recorded in cephala of rather average sizes. Maximum number of lenses in a dorso-ventral row varies between 8 and 9. Irregularities in the courses of dorso-ventral rows were detected in many specimens after a detailed inspection. Similar irregularities in the structure of visual surface of eye were recorded by Clarkson (1971) and by Henry - Vizcaino - Destombes (1992) in the oldest dalmanitid trilobites of genera *Toletanaspis* Rabano and *Ormathops* Delo (Fig. 4).

Posterior section of facial suture weakly sigmoidal, in specimens with higher eye length sometimes rather sharply sigmoidal, intersecting lateral cephalic margin approx. (trans.) between S2 and a half of L2. Doublure relatively broad, broadly arched. Hypostome very similar to that of genus *Dalmanitina* Reed representatives, posterior margin bearing 2 to 4 very slightly indicated, though well-defined, short spines. Cephalon surface covered by a dense, very fine granulation (granule size hudredths to first tenths of mm). Besides fine granules, larger, sparse granules tenths of mm in size were recorded on frontal glabellar lobe in only several samples. These granules are visible on outer surface of exoskeleton only. The surface of genae is finely pitted, with pits hundredths to first tenths of mm in diameter. Doublure very densely finely granulated.

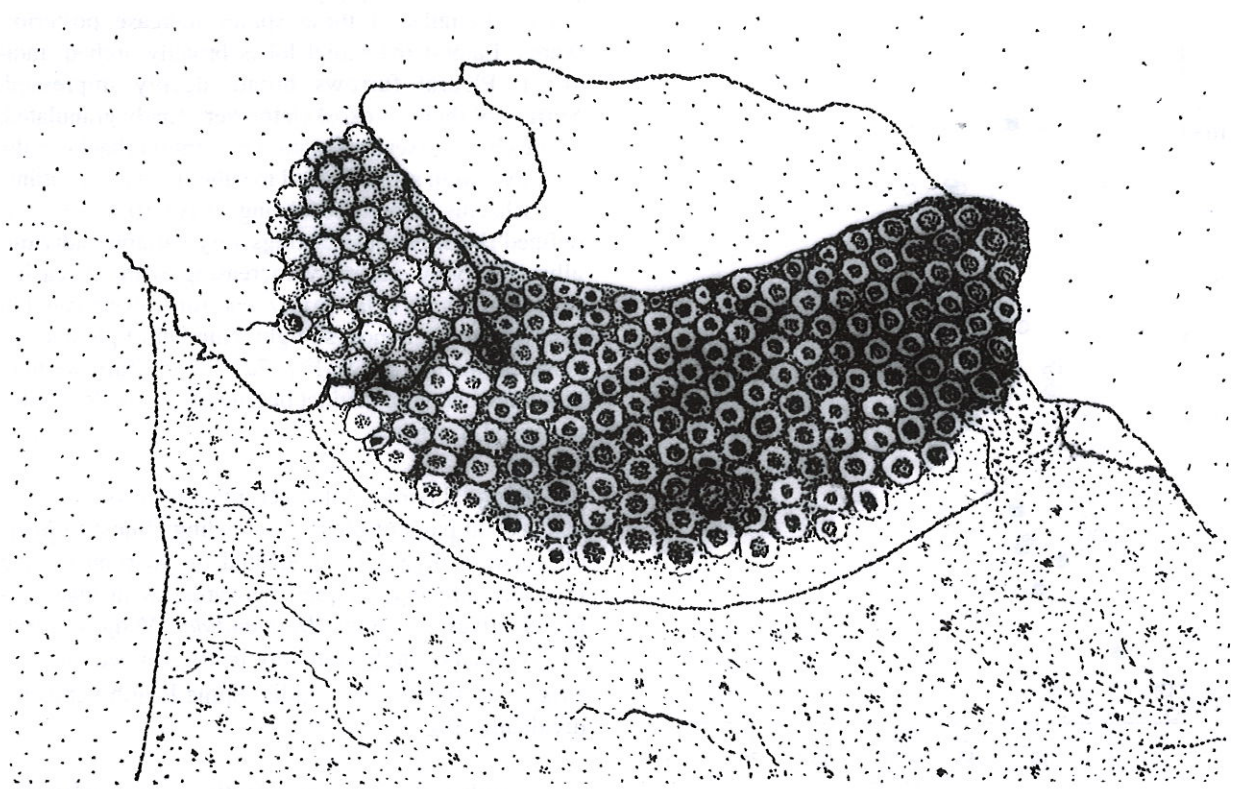


Fig. 4. A view of the visual surface of eye of *M. grandis* with locally irregular structure of dorso-ventral rows. After MŠ 14909, x11,5

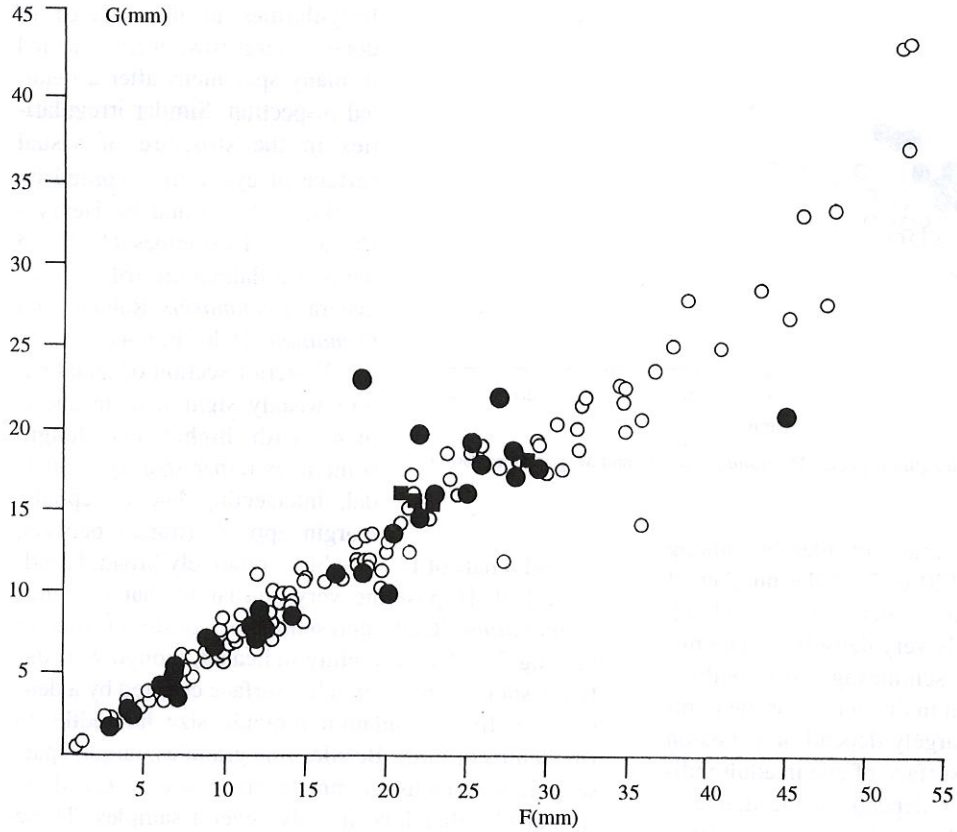


Fig. 6. Pygidium length vs. width in *M. grandis* (circles), *M. ganabina* (dots) and *M. mucronata* (squares)

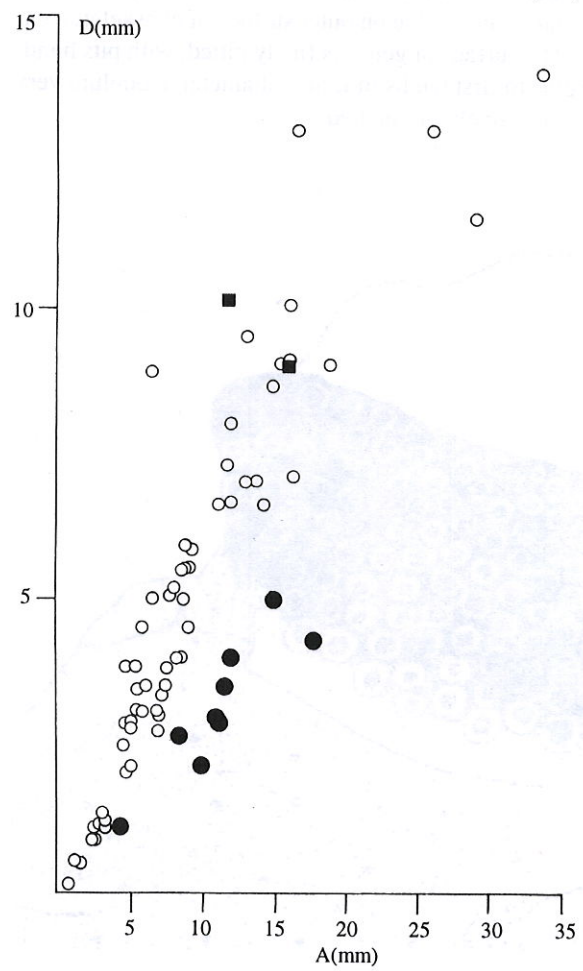


Fig. 5. Genal spine length vs. cephalon length in *M. grandis* (circles), *M. ganabina* (dots), *M. mucronata* (squares)

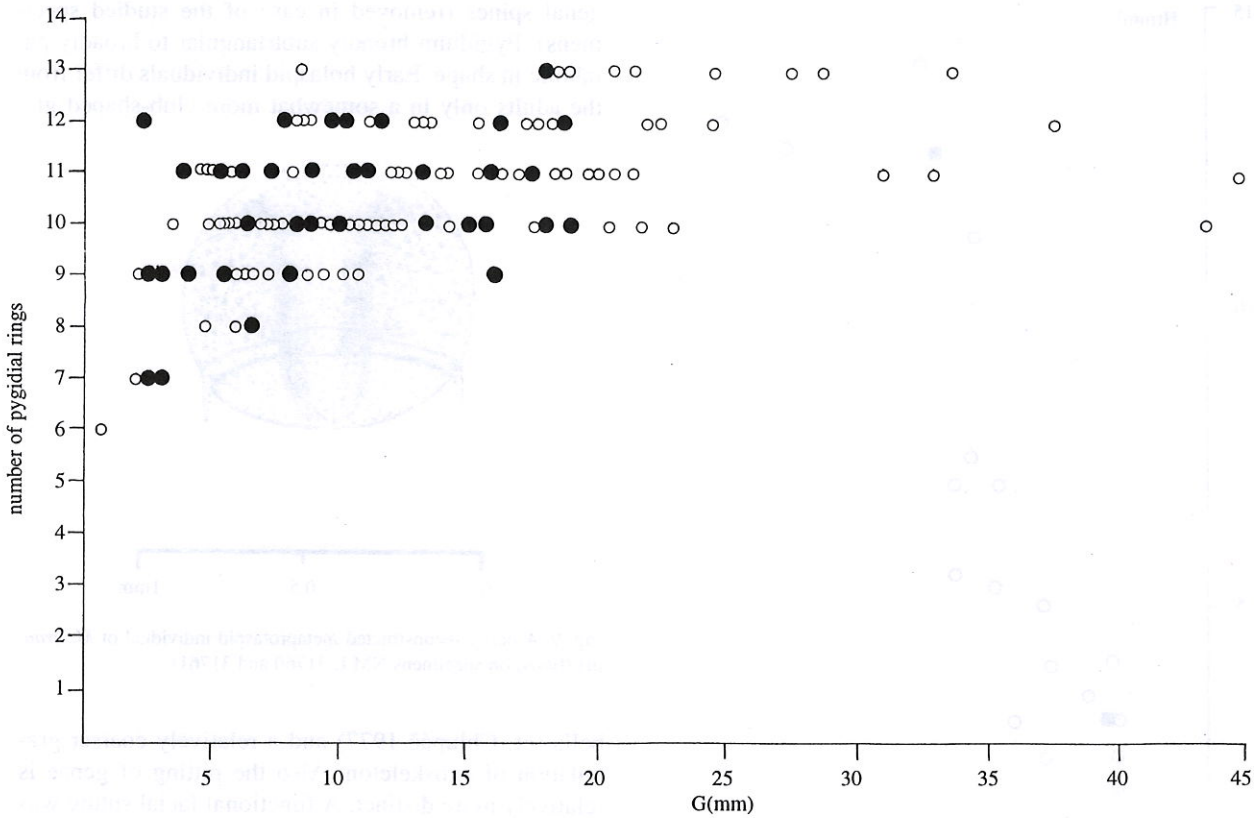
Thorax consisting of 11 segments. Terminal ends of pleurae flat, with no visible notches, elongate triangular in shape, sharply pointed or extended into short spines. Lengths of these spines increase posteriorwards. Lateral rhachidial lobes broadly arched, indistinct. Pleural furrows broad, deeply impressed. Surface of thoracic exoskeleton very finely granulated. Somewhat coarser granulation present on rhachis only.

Pygidium semielliptical to subtriangular in outline.

Rhachis arched, consisting of (9) 10 to 13 well-defined rings. Number of rings very variable individually, only very generally increasing with increasing pygidium length (Fig. 7a). Dorsal furrows narrow but distinct, mostly almost straight. Number of pleurae varying between 6 and 9 (Fig. 7c). Pleural furrows may be somewhat more distinct but mostly equivalent to interpleural furrows.

Pygidial border indistinct, pleural furrows of first and second pairs of pleurae extending almost to pygidial margin. Pygidium elongated into a robust spine probably directed obliquely upwards, as in many representatives of family *Dalmanitidae* Vodges, 1890. The respective angle could not be determined due to a strong deformation of pygidia. Spine length varies individually (Fig. 8).

Pygidial doublure imperfectly known, relatively broad (its width about 30-50 % of first rhachial ring width), probably slightly broadening posteriorly (to-

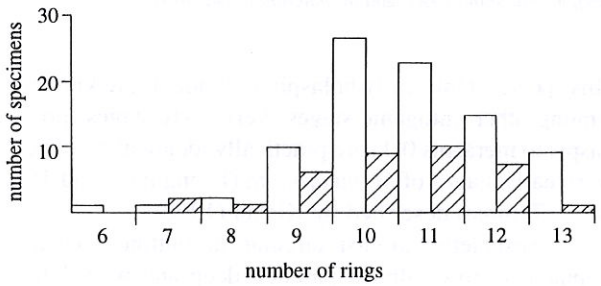


wards pygidial spine) and also broadly arched. Pygidial granulation very similar to thoracic granulation in character, coarser granules also present above pleural furrow frontal margin.

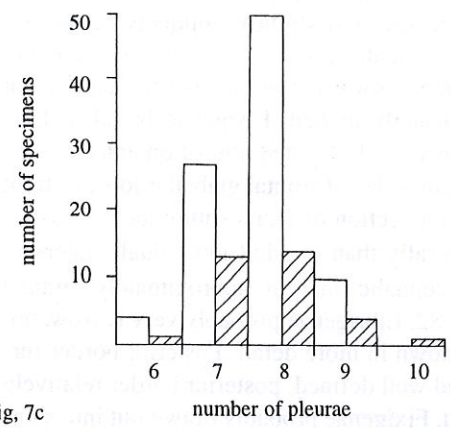
Variability: Representatives of *Mucronaspis grandis* (Barrande) show a surprising variability in some characters. A highly variable character is the number of lenses and dorso-ventral rows on visual surface of eye. Also eye length varies individually relative to cephalon length. The high variability in the number of pygidial rhachial rings (9-13, most frequently 10 rings) and in the number of pygidial pleurae (6-9, most frequently 8 pleurae) is surprising. In controversy, these numbers are the primary characters used for the discrimination between *M. mucronata* (Brongniart), having 11-13 rings and 8-9 ribs, and *M. olini* (Temple), having only 8-9 rings and 6-7 ribs. Systematic position of these species will have to be reevaluated in the light of the new observations.

Ontogeny: Approximately 50 young cephala and pygidia were studied including a protaspid individual (NM L 31760) and a meraspid individual [stage meraspis 0-1 (two almost complete individuals) - NM L 31761]. This material comes almost exclusively from the uppermost Králův Dvůr Formation documented in an excavation for a well in Nesvačily (leg. Horný, 1977, NM - accessite No. 19/77). The assemblage from this locality is represented almost solely (99.5 %) by the species *M. grandis* (Barrande); hence, the above mentioned juveniles can be probably assigned to

Fig. 7. a) Number of rings on pygidial rhachis vs. pygidium length in *M. grandis* (circles) and *M. ganabina* (dots). b) A histogram showing proportions of specimens with different numbers of distinct rings on pygidial rhachis. Hadched columns = *M. ganabina*, white columns = *M. grandis*. c) A histogram showing proportions of specimens with different numbers of distinct pleurae on pygidium. For explanations see Fig. 7b



Fig, 7b



Fig, 7c

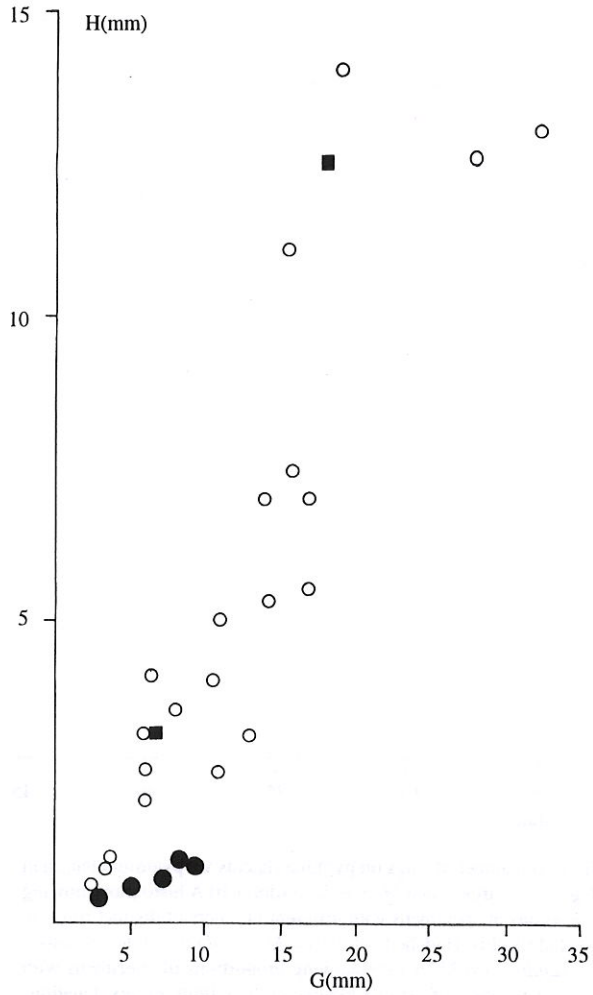


Fig. 8. Pygidial spine length vs. pygidium length in *M. grandis* (circles), *M. ganabina* (dots) and *M. mucronata* (squares)

this species. Only early holaspid individuals are known among other ontogenic stages. Very early stages (protaspis to meraspis 0-1) are practically identical with the very early stages of *M. mucronata* (Brongniart) and *M. olini* (Temple) described by Kielan (1960):

Exoskeleton almost circular in outline. Dorsal cephalic furrows almost parallel, deep and well defined. Frontal glabellar lobe sharply expanding anteriorly, making dorsal furrows concave in their course. S1, S2 subparallel, directed slightly obliquely backward, approximately equally distinct and long. S3 probably directed slightly forward. Anterior border narrow but prominent, strongly arched. Fixigenae broad and arched. Eyes very small, located almost on anterior cephalic margin, on sides of frontal glabellar lobe, in front of S3. Posterior section of facial suture located distinctly more laterally than in adult individuals, intersecting lateral cephalic margin approximately (trans.) against S3 to S2. Librigenae probably very narrow, however, not known in more detail. Posterior border furrows deep and well defined, posterior border relatively broad, arched. Fixigenae probably drawn out into short genal spines (removed in case of the studied specimens). Pygidium broadly subtriangular to broadly parabolic in shape. Early holaspid individuals differ from the adults only in a somewhat more club-shaped gla-

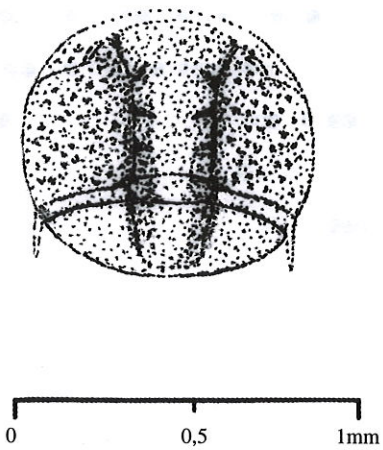


Fig. 9. A partly reconstructed metaprotaspid individual of *M. grandis* (based on specimens NM L 31760 and 31761)

bella (cf. Chlupáč 1977) and a relatively coarser granulation of exoskeleton. Also the pitting of genae is relatively more distinct. A functional facial suture was found yet in a cephalon 8.5 mm long. There is not much difference in the course of facial suture and eye size and position between holaspid-stage and adult individuals. Pygidia of holaspid individuals differ from those of the adults only in the (generally) lower number of pygidial segments and relatively coarser granulation.

Remarks: Representatives of the species *M. grandis* (Barrande) differ from *M. mucronata* (Brongniart) in the relatively stable eye size during ontogeny, almost absent anterior border, frontal glabellar lobe free of coarser dispersed granules and in the occipital node absent from the occipital ring. In these characters, *M. grandis* (Barrande) rather parallels the species *Mucronaspis olini* (Temple), from which it differs in deeper glabellar furrows. The high variability in the number of pygidial segments distinguishes *M. grandis* (Barrande) from both *M. mucronata* (Brongniart) and *M. olini* (Temple). This high variability involves the number of segments, on the basis of which the two above mentioned species are distinguished (*M. mucronata* (Brongniart) having 11-13 rhachial rings and 8-9 pleurae in contrast to *M. olini* (Temple) possessing (8)-9 rhachial rings and 6-7 pleurae). Statistical maximum of the number of pygidial segments in *M. grandis* (Barrande) lies intermediate between the two species (10 rhachial rings and 8 pleurae, see Fig. 7). Particularly in larger specimens of *M. grandis* (Barrande) is the number of pygidial segments always identical with that of *M. mucronata* (Brongniart). At the same time, however, these specimens resemble rat-

her *M. olini* (Temple) in some characters of the cephalon (smaller eye size, smooth glabella free of granulation etc.). I suggest that the species *M. grandis* (Barrande) may be lying systematically intermediate between both species, or may represent their phylogenic ancestor (cf. Temple 1952).

Distribution: Uppermost beds of the Králův Dvůr Formation (stage Kralodvorian).

Localities: Kosov, Lejškov near Libomyšl, Malá Ohrada, Zličín, Vráž, Zadní Třebaň, Levín, Liteň, Karlík, Zličín, Velká Chuchle, Jezerka, Nesvačily, Horní Počernice, Běchovice and others.

Mucronaspis ganabina Šnajdr 1987

Pl. II, figs. 1, 5-8; Pl. III, figs. 1, 5; Text-figs. 10b, 11b

1987 *Mucronaspis* ? *ganabina* n. sp.: Šnajdr, Pl. 2, fig. 4-7.

1989 *Mucronaspis grandis* (Barrande): Štorch - Mergl, Pl. 8, fig. 2.

non 1989 *Mucronaspis genabina* Šnajdr: Štorch - Mergl, Pl. 8, fig. 3.

1989 *Mucronaspis ganabina* Šnajdr: Pek et Vaněk, p. 14

non 1992 *Mucronaspis ganabina* Šnajdr: Havlíček in Chlupáč et al., Pl. 27, fig. 1 [= *M. grandis* (Barrande)].

Holotype: Incomplete deformed cephalon (internal mould) figured by Šnajdr (1987) in Pl. 2, fig. 5, MŠ 14160, refigured here in Pl. 2., fig. 1.

Type locality: Beroun, Kosov.

Type stratum: Uppermost beds of the Králův Dvůr Formation (stage Kralodvorian).

Other material: 22 complete and 15 incomplete cephala, 20 almost complete and about 40 incomplete pygidia, ? 2 hypostomes.

Description: Cephalon broadly semiparabolic in outline, broadly arched. Glabella roughly club-shaped, flatly arched, not reaching anterior cephalon margin. Lateral glabellar furrows well defined. S3 being the deepest, only very weakly sigmoidal in its course. Dorsal furrows broad, deeply impressed, somewhat wider than in *M. grandis* (Barrande). Anterior border narrow but well defined, alike in *M. mucronata* (Brongniart). Lateral border broader and less arched than in *M. grandis* (Barrande), lateral border furrow wider and shallower. At contact with deep and wide posterior border furrow, it formes a shallow, rounded depression, rather than a single-point junction of both sutures as in *M. grandis* (Barrande). Posterior border broad, broadely arched. Occipital ring bearing a minute but distinct node. Genal spines more gracile in appearance and somewhat shorter than in *M. grandis* (Barrande). The angle between the genal spines and the sagittal axis is also somewhat higher in *M. ganabina* Šnajdr (35 : 25 degrees). Eyes large, relatively high, dorsally located. Anterior part of eye lying close to S3, posteriorly reaching L1. Eye length is approximately a linear function of cephalon length (see Fig. 3), but more progressive than in *M. grandis* (Barrande). Only individuals of these two species with cephala longer than 4 mm are distinguishable. Number of lenses (estimated for only two specimens due to poor preservation of visual surfaces) ca. 220 and 270, number of dorso-ventral rows fluctuating between 36 and 43. Maximum lense number in dorso-ventral rows 10 or 11. Posterior section of facial suture sharply sigmoidal. Ventral side of cephalon not known in more detail. Cephalon covered by very fine, dense granulation (granule diameter hundredths to first tenths of mm), frontal glabellar lobe bearing coarse (tenths of mm), irregularly dispersed granulation of similar type as in *M. mucronata* (Brongniart) representatives. Genae ornamented with fine pits hundredths to tenths of mm in diameter, more distinct than in *M. grandis* (Barrande). Hypostome imperfectly known.

Note: Two isolated hypostomes found together with exoskeletal fragments of *M. ganabina* Šnajdr (prevailing) and *M. grandis* (Barrande) differ from hypostomes of *M. grandis* (Barrande) in the presence of four weakly indicated, although much more distinct posterior spines.

Thorax not known. Pygidium semielliptical in outline. Rhachis arched, composed of 9 to 12 (13) rings. Dorsal furrows straight; 6 to 9 (10) defined pleurae present (Fig. 7). Pleural furrows usually somewhat more distinct than interpleural furrows. Pygidial border well defined, broad, broadly arched. Pygidial spine very short, often removed. Broad doublure only imperfectly known. Internal margin located approximately below internal side of arched pygidial border. Pygidium very finely granulated, somewhat coarser granulation present on rhachis only.

Variability: Eye length fluctuations relative to cephalon length are only very limited. In contrast, the number of rhachial rings and the number of ribs are variable alike in *M. grandis* (Barrande) - Fig. 7.

Ontogeny: Ontogenic development of this species is only very imperfectly known. Cephala longer than 4 mm (probably early holaspid) can be discriminated from the species *M. grandis* (Barrande), cephala of younger stages are most likely very similar to each other and are probably often mutually substituted in species identification. Young individuals have somewhat shorter eyes relative to cephalon length. Neither the position of eyes on cephalon, nor the course of the facial suture are subject to substantial change during ontogeny from the holaspid stage to the adult. The facial suture of holaspid individuals is probably functional as librigenae are often disconnected. Glabella of younger individuals is usually somewhat more club-shaped and bears a coarser granulation. Also the pitting of genae is clearly more distinct than in larger individuals. The smallest known pygidia are 3 mm long, almost identi-

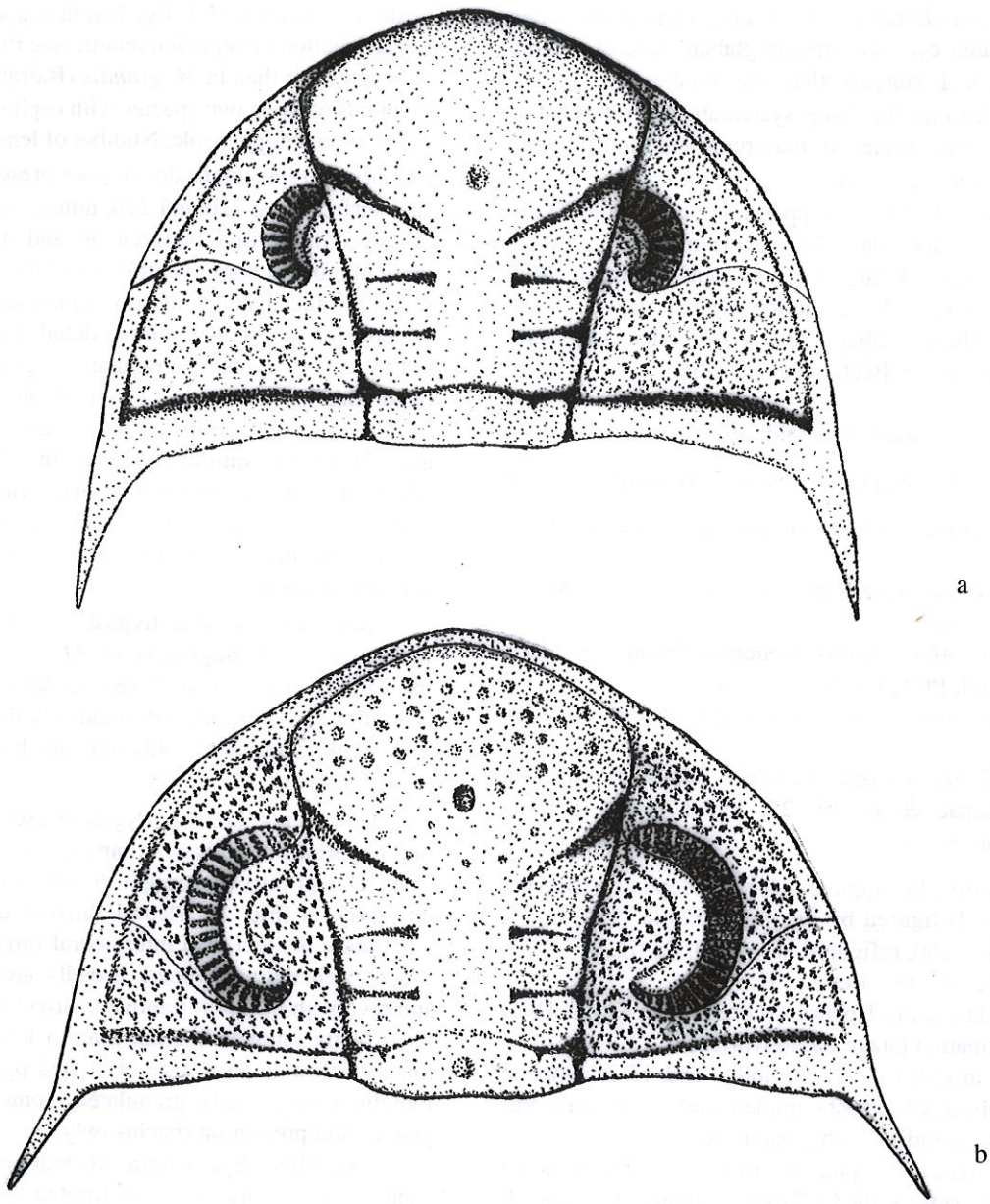


Fig. 10. Reconstructions of cephala of *M. grandis* (a) and *M. ganabina* (b), x4

cal with those of large individuals, except for the relatively coarser granulation and a (only generally) smaller number of segments.

Remarks: Representatives of the species *M. ganabina* Šnajdr show the closest morphological similarity to the individuals attributed to the English species *M. brevispina* (Temple). Besides its larger size, *M. ganabina* Šnajdr also differs from this species in a somewhat larger eye size and a shorter postocular field, more gracile genal spines and a coarse granulation on glabella. *M. ganabina* Šnajdr further differs in a higher variability in the number of pygidial segments, and also a lower variability of pygidial spine length. Pygidial spine of *M. brevispina* (Temple) may be short, similar to that of *M. ganabina* Šnajdr, but also long, similar to the spine of *M. mucronata* (Brongniart) - see Temple (1969). Also, the pygidial rhachis is probably somewhat broader in the English species. In addition, the two species have a different stratigraphic range (uppermost Kralodvorian for *M. ganabina*, Ordovician/Silurian boundary beds for *M. brevispina*).

Distribution: The uppermost beds of the Králův Dvůr Formation (stage Kralodvorian).

Localities: Kosov, Zadní Třebaň, Prague-Malá Ohrada, Zličín, Králův Dvůr, Levín, Nesvačily, Jezerka and others. At most localities, this species is more rare than *M. grandis* (Barrande), with which it occurs together.

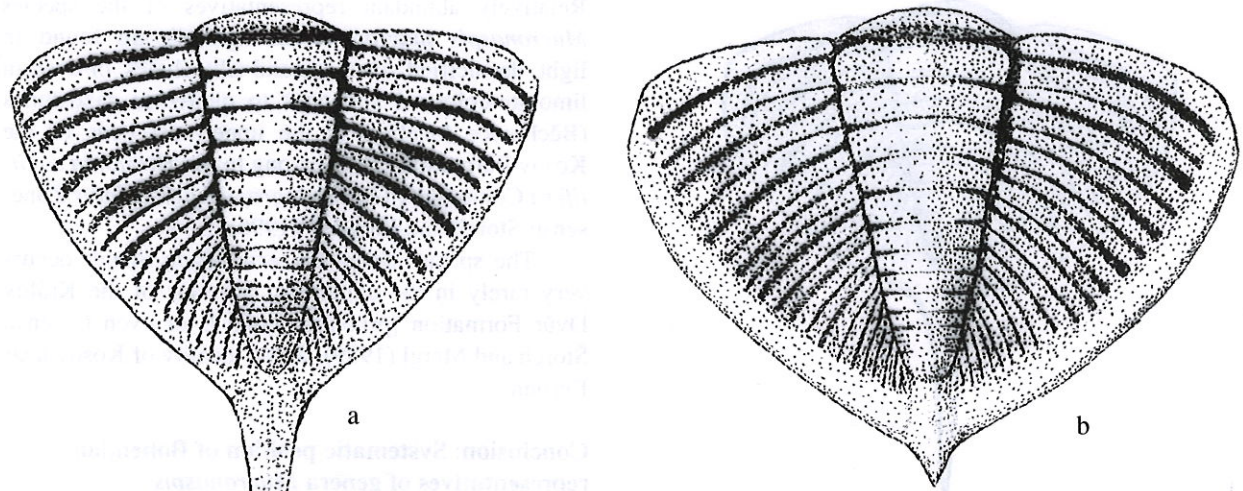


Fig. 11. Reconstructions of pygidia of *M. grandis* (a) and *M. ganabina* (b), x2.5

Genus: *Songxites* Lin, 1981

Type species: *Dalmanitina* (*Dalmanitina*) *wunignensis* Lin, Upper Ordovician of Wuning, NW Jangxi, China.

Other species: *Songxites darraweitensis* (Campbell 1973), *S. cellullanus* (Siveter et Ingham 1979), *S. gemmagog* Šnajdr, 1987. Upper Ordovician, China, Australia, Great Britain, Barrandian area.

Diagnosis: P. Lin (1981).

Remarks: Representatives of the genus *Songxites* Lin differ from the representatives of the genus *Mucronaspis* Destombes in these characters: Smaller eyes with visual surfaces orientated more anteriorly, located between S3 and S2, smaller number of lenses (56 in a typical specimen), course of posterior section of facial suture being only very gently sigmoidally curved, narrow and strongly arched lateral and posterior borders and deep, wide lateral and posterior border furrows. Hypostome probably lacks posterior spines. Pygidium differs in the somewhat narrower rhachis, pleural and interpleural furrows directed more sharply backwards, and in the very narrow or even absent pygidial border. Terminal ends of pygidial pleurae are often somewhat broadened and more strongly arched than in the representatives of the genus *Mucronaspis* Destombes. In spite of this, I suppose - primarily on the basis of the similarities in thorax morphology - that *Songxites* Lin has closer affinities to *Mucronaspis* Destombes than to *Dalmanitina* Reed. Characters (particularly on cephalon) resembling this genus can be considered a result of convergence.

Songxites gemmagog Šnajdr, 1989

Pl. III, fig. 2; Text-fig. 12

1987 *Songxites gemmagog* sp. nov.: Šnajdr, p. 274, Pl. 2, fig. 9.

1989 *Songxites gemmagog* Šnajdr, 1987: Pek et Vaněk, p. 14

Holotype: An incomplete pygidium (internal mould) figured by Šnajdr (1989) in Pl. 2, fig. 9. MŠ 14303, refigured here in Pl. 3, fig. 2.

Type locality: Beroun, Kosov hill.

Type stratum: Upper beds of the Králův Dvůr Formation (stage Kralodvorian).

Other material: An almost complete pygidium, external mould, NM L 31763 (ex coll. Barrande) from the same locality as the holotype.

Description: Cephalon and thorax unknown. Pygidium broadly subtriangular in outline. Rhachis relatively narrow, consisting of 10 well-defined rings. Lateral pygidial lobes with 7 to 8 well-defined segments. Pleural furrows wider and more distinct than interpleural furrows. Terminal ends of pleurae prominently arched, partly fused.

Note: In the holotype (length 3.2 mm), these ends extend beyond the pygidium contour. In the second, larger specimen (length 6.5 mm), a very thin (ca. 1/20 of trans. pygidium width), weakly arched pygidial border is developed from the third pleura.

Pygidial spine (removed in case of the holotype) narrow and long (3/4 of relative pygidium length). Pygidium surface probably smooth, only pygidial border very densely and very finely granulated (granule size hundredths of mm).

Remarks: It cannot be excluded that the extending of terminal parts of pleurae beyond the lateral pygidial border in the holotype (Pl. III, fig. 2) is-with respect to

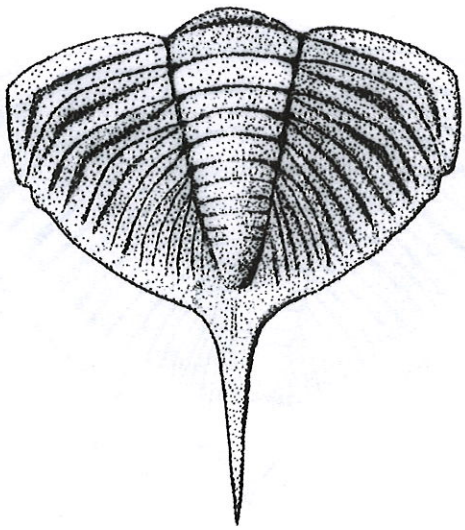


Fig. 12. A reconstruction of the pygidium of *Songxites gemmagog*, *x10*

its size-represents a larval character. Pygidia of larger specimens may be similar rather to the Australian species *S. darraweitensis* (Campbell) than to the British *S. cellullanus* (Siveter et Ingham).

Distribution: Very rare in the uppermost portion of the Králův Dvůr Formation (stage Kralodvorian).

Localities: Only the type locality.

Stratigraphical distribution of representatives of genera *Mucronaspis* Destombes and *Songxites* Lin in the Barrandian area

The species *M. grandis* (Barrande) and *M. ganabina* Šnajdr occur together in the uppermost portions of the Králův Dvůr Formation (stage Kralodvorian), i.e. at level B1 sensu Štorch and Mergl (1989) [olive grey calcareous shales with silt admixture and beds and nodules of biomicrititic limestones = the *Proboscisambon* Community] and especially in brownish-grey silty shales at level B2 [lower part of the *Mucronaspis* Community sensu Štorch and Mergl (1989)]. Level B1 corresponds to the *Marekolithus kosoviensis* Zone sensu Havlíček and Vaněk (1966). *M. grandis* (Barrande) can be rarely found also in grey silty shales at level C (middle part of the *Mucronaspis* Community) developed in the uppermost portions of the Králův Dvůr Formation. Rare fragments reported from level E (brownish-grey to greenish-grey silty shales corresponding to the upper part of the *Mucronaspis* Community) at the base of the Kosov Formation by Štorch and Mergl (1989) probably belong to the same species, however, do not allow a precise determination.

Relatively abundant representatives of the species *Mucronaspis mucronata* (Brongniart) are found in light, decalcified siltstones and silty shales, or even in limonite-coloured siltstones to quartzose sandstones (Běchovice locality) in the uppermost beds of the Kosov Formation. They belong to the *Hirnantia sagittifera* Community (*Normalograptus persculptus* Zone) sensu Štorch and Lloydell (1996).

The species *Songxites gemmagog* Šnajdr occurs very rarely in the uppermost portions of the Králův Dvůr Formation [probably Zone B or even C sensu Štorch and Mergl (1989)] at the locality of Kosov near Beroun.

Conclusion: Systematic position of Bohemian representatives of genera *Mucronaspis* Destombes and *Songxites* Lin

Bohemian representatives of the genus *Mucronaspis* Destombes show closer phylogenic affinities to the Scandinavian, British, Polish and also Kazakh species than to Moroccan species. From the point of systematics, species closest to, and often considered synonymous with the Bohemian species by foreign authors are *M. mucronata* (Brongniart), *M. olini* (Temple) and *M. brevispina* (Temple). These species, along with the Bohemian species, constitute a certain homogeneous group („mucronata group") somewhat different from the Moroccan representatives (see Campbell 1973). The species within the „mucronata group" have many characters similar to representatives of the genus *Dalmanitina* Reed (smaller eyes, lateral and posterior furrows narrow and deep, meeting at a genal angle, less distinct hypostomal spines etc.). However, I refer them to the genus *Mucronaspis* Destombes on the basis of similar shape of pygidium and, most importantly, the identical thorax morphology with flat pleural tips enabling a different type of enrolling than the one developed in *Dalmanitina* Reed. I consider this character so important in the evolution that I have to understand the characters similar to *Dalmanitina* Reed as a result of convergence. Nevertheless, I do not see erection of the „mucronata group" as a separate subgenus within *Mucronaspis* Destombes meaningful as there may exist some doubt about the monophyletic origin of this subgenus. *Songxites gemmagog* Šnajdr shares characters of *S. cellullanus* (Siveter et Ingham) and *S. darraweitensis* (Campbell) which probably represent its closest phylogenic relatives.

Submitted April 17, 1996 *Translated by the J. Adamovič*

References

Apollonov, M. K. (1974): Ashgilskie trilobity Kazachstana. - Nauka, Alma-Ata.

Barrande, J. (1852): Systême Silurien du centre de la Bohême. l'ere partie. Recherches paléontologiques, I.: Trilobites. 30 + 935 pp., Atlas 51 pls., Praha, Paris.

Campbell, K. S. W. (1973): A species of the trilobite Dalmanitina (Dalmanitina) from Australia. - Geol. Fören. Förh., 95, 1, 69-77. Stockholm.

Chlupáč, I. (1951): Stratigrafické poměry královdvorských břidlic u Karlíka a Zadní Třebaně. - Věst. Ústř. Úst. geol., 26, 194-212. Praha

- (1977): The phacopid trilobites of the Silurian and Devonian of Czechoslovakia. - Rozpr. Ústř. Úst. geol., 43. Praha.

Clarkson, E. N. K. (1971): On the early schizochroal eyes of Ormathops (Trilobita, Zelliszkellinae). - Mém. Bur. Rech. géol. min., 73, 51-63. Paris.

Destombes, J. (1963): Quelques noveaux Phacopina (Trilobites) de l'Ordovicien supérieur de l'Anti-Atlas (Maroc). - Not. Serv. géol. Maroc, 172, 47-65. Rabat.

- (1972): Les Trilobites du sous-ordre des Phacopina de l'Ordovicien de l'Anti-Atlas (Maroc). - Not. Serv. géol. Maroc, 240. Rabat.

Havlíček, V. (1992): Ordovik. - *In: I. Chlupáč* et al.: Paleozoikum Barrandienu. - Ústř. úst. geol., 59-116. Praha.

Havlíček, V. - Fatka, O. - Vaněk, J. (1994): Perunica microcontinent in the Ordovician (its position within the Mediterranean Province, series division, benthic and pelagic assotiations). - Sbor. geol. Věd, Geol., 46, 23-56. Praha.

Havlíček, V. - Vaněk, J. (1966): The biostratigraphy of the Ordovician of Bohemia. - Sbor. geol. Věd, Paleont., 8, 7-69. Praha.

Henry, J. L. (1980): Trilobites ordoviciens du Massiv Armoricain. - Mém. Soc. géol. et miner. de Bretagne, 22. Rennes.

Henry, J. L - Vizcaino, D. - Destombes, J. (1992): Evolution de l'oeil et héterochronie chez les Trilobites ordoviciens Ormathops Delo 1935 et Toletanaspis Rabano 1989 (Dalmanitidae, Zelliszkellinae). - Paläont. Z., 66, 3/4, 277-290. Stuttgart.

Holloway, D. J. (1981): Silurian Dalmanitacean trilobites from North America and the origin of the Dalmanitidae and Synphorinae - Palaeontology, 24, 4, 695-731. London.

Horný, R. - Bastl, J. (1970): Type specimens of fossils in the National Museum Prague. P. I. Trilobita. - Nár. Mus., Praha.

Kielan, Z. (1960): Upper Ordovician trilobites from Poland and some related forms from Bohemia and Scandinavia. - Paleont. pol., 11, Pol. Akad. nauk, II:IV. Warszava.

Kobayashi, T. - Hamada, T. (1963): On a new species of Dalmanitina. - Jap. J. Geol. Geogr., 35, 2-4, 101-113. Tokyo.

Lin, T. (1981): Songxites, a new subgenus of Dalmanitina (Trilobita) from the Late Upper Ordovician of Jiangxi. - Acta paleont. sin., 20, 91-92. Nanking.

Lu, Y. - Wu, H. (1983): Onthogeny of the trilobite Dalmanitina (Dalmanitina) nanchengensis Lu. - Pal. Cathayana 1, 123-153.

Marek, L. (1951): Nové nálezy ve vrstvách kosovských. - Sbor. Ústř. Úst. geol., 18, 233-244. Praha.

Pek, I. - Vaněk, J. (1989): Index of Bohemian trilobites. - Olomouc.

Pillet, J. (1990): Les faunes trilobitiques de l'Ordovicien Superieur en Anjou. - Mém. Soc. d'étud. sci., 8. Anjou.

Rabano, I. (1989): Trilobites del Ordovício Medio del sector meridional de la zona Centroibérica espanola. Parte 4. Phacopina, Scutelluina, Odontopleurida y Lichida. - Boll. geol. min. 100, 971-1032. Madrid.

Siveter, D. J. et al. (1979): Highest Ordovician trilobites and graptolites from County Cavan, Ireland. - J. Earth Sci. Roy. Dublin Soc., 2, 193-207. Dublin

Šnajdr, M. (1987): New Bohemian Ordovician Dalmanitidae and Calmonidae (Trilobita). - Věst. Ústř. Úst. geol., 65, 5, 271-277. Praha.

- (1990): Bohemian Trilobites. - Geol. Surv. Praha.

Štorch, P. (1982): Ordovician-Silurian boundary in the northernmost part of the Prague Basin (Barrandian, Bohemia). - Věst. Ústř. Úst. geol., 57, 4, 231-236. Praha.

- (1986): Ordovician-Silurian Boundary in the Prague Basin (Barrandian area, Bohemia). - Sbor. geol. Věd, Geol., 41, 69-103. Praha.

Štorch, P. - Lloydell, D. K. (in press): The Hirnantian graptolites Normalograptus persculptus and „Glyptograptus" bohemicus: Stratigraphical consequences of their synonymy. - Palaeontology, 39, 3. London.

Štorch, P. - Mergl, M. (1989): Královdvor/Kosov boundary and the late Ordovician environmental changes in the Prague Basin (Barrandian area, Bohemia). - Sbor. geol. Věd, Geol., 44, 117-153. Praha.

Struve, W. (1958): Beiträge zur Kenntnis der Phacopacea (Trilobita), 1: Die Zeliszkellinae. - Senckenberg. lethaea, 39, 3/4, 165-219. Frankfurt a. M.

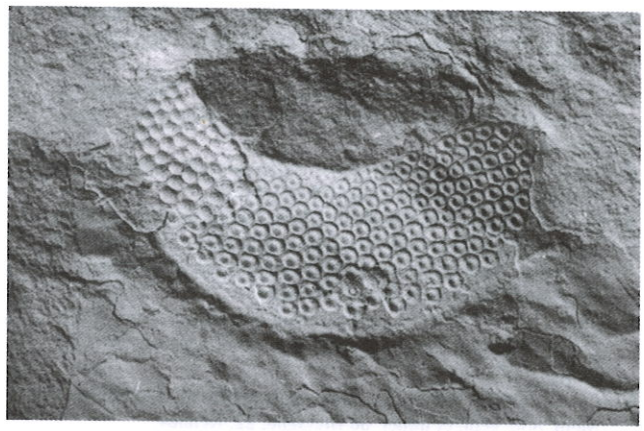
Temple, J. T. (1952): A Revision of the Trilobite Dalmanitina mucronata (Brongniart) and related Species. Skrft. fran. Min. och Pal. - Geol. Inst., 11, 1-33. Lund.

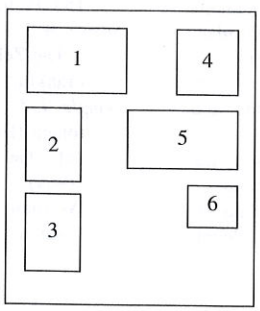
- (1969): Lower Llandovery (Silurian) trilobites from Keisley, Westmorland. - Bull. Brit. Mus. natur. Hist., Geol., 18, 6. London.

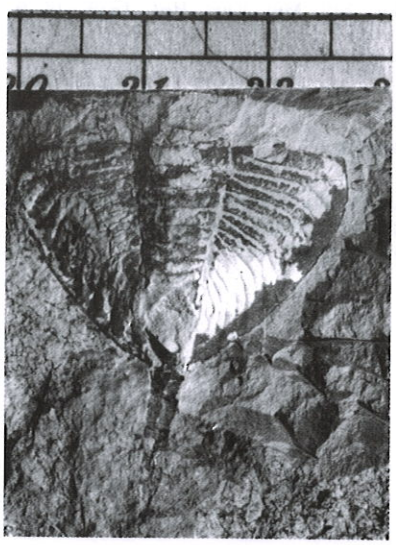
Zástupci rodů *Mucronaspis* a *Songxites* (Trilobita) z českého svrchního ordoviku

V práci je předložena kritická revize českých zástupců rodů *Mucronaspis* Destombes, 1963 a *Songxites*, 1981. U těchto druhů je doplněn popis, a to zejména s ohledem na relativně značnou vnitrodruhovou variabilitu. Je diskutováno rodové zařazení i platnost jednotlivých druhů. Do synonymiky druhu *Mucronaspis mucronata* (Brongniart, 1827) je stažen poddruh *M. mucronata juna* Šnajdr 1987.

P. Budil: Representatives of genera *Mucronaspis* and *Songxites* (Trilobita) from the Bohemian Upper Ordovician (Pl. I)

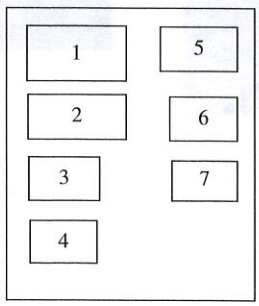




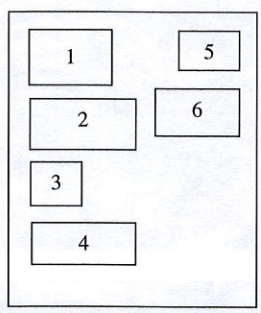


1-3. *Mucronaspis mucronata* (Brong.), uppermost beds of the Kosov Formation: 1 - cephalon of MŠ 14186, holotype of the invalid subspecies *M. mucronata juna* Šnajdr, figured by Šnajdr (1987) in Pl. II, fig. 2, Prague-Nová Ves, x3; 2 - pygidium of MŠ 14187, figured by Šnajdr (1987) in Pl. III, fig. 3, x3; 3 - pygidium of PB 50, Prague-Řepy, x1.5;

4-6. *Mucronaspis grandis* (Barr.), uppermost beds of the Králův Dvůr Formation: 4 - pygidium of MŠ 14256, Kosov, x3; 5 - a detail of visual surface of eye, MŠ 14909, Králův Dvůr, x6; 6 - cephalon of MŠ 14253, Kosov, x2



1, 5-7. *Mucronaspis ganabina* Šnajdr, uppermost beds of the Králův Dvůr Formation: 1 - Cephalon of MŠ 14160, holotype figured by Šnajdr (1987) in Pl. II, fig. 5, Kosov, x3; 5 - pygidium of MŠ 14218, Králův Dvůr, x3; 6 - pygidium of MŠ 14211, paratype figured by Šnajdr (1987) in Pl. II, fig. 6, Kosov, x3; 7 - pygidium of MŠ 14229, paratype figured by Šnajdr (1987) in Pl. II, fig. 7, x3;
2-4. *Mucronaspis grandis* (Barr.): 2 - cephalon of MŠ 14261, Kosov, x3; 3 - pygidium of MŠ 14250, Kosov, x5; 4 - pygidium of MŠ 14252, Kosov, x3



1, 5, 6. *Mucronaspis ganabina* Šnajdr, uppermost beds of the Králův Dvůr Formation: 1 - pygidium of MŠ 14212, Králův Dvůr, x5; 5 - cephalon of MŠ 14221, Králův Dvůr, x3; 6 - pygidium of MŠ 14226, paratype figured by Šnajdr (1987) in Pl. II, fig. 4, x3;
2 - *Songxites gemmagog* Šnajdr, uppermost beds of the Králův Dvůr Formation, pygidium of MŠ 14212, holotype figured by Šnajdr (1987) in Pl. II, fig. 9, Kosov, x10;
3, 4. *Mucronaspis grandis* (Barr.), uppermost beds of the Králův Dvůr Formation: 3 - pygidium of MŠ 14228, Kosov, x6; 4 - a detail of pygidium of MŠ 14252, Kosov, x6