First record of the Carboniferous trilobite Bollandia from the Moravian Karst (Czech Republic) and its significance

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The presence of bollandiine trilobites is reported for the first time in the early Carboniferous of Moravia, the Czech Republic. Bollandia persephone (Hahn & Hahn, 1970) and B. cf. megaira (Hahn & Hahn, 1970) were recovered from pelitic shales of late Tournaisian age within the Březina Formation exposed in Mokrá quarry, near Brno. Along with other taxa, these two species constitute a trilobite assemblage with few affinities to other Carboniferous associations known from the Czech Republic, but resemble an assemblage from the late Tournaisian of the Harz Mountains. Morphological characters of Bollandia species are interpreted as being indicative of an epibenthic mode of life, with possible adaptations for digging and for predatory/scavenging feeding habits. • Key words: Trilobita, Phillipsiidae, Bollandia, Carboniferous, palaeoecology, Moravian Karst.


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The first report of late Devonian and early Carboniferous trilobites from the Moravian Karst was by Rzehak (1910) who recorded an indeterminate proetid specimen from the probable Famennian of Lišč, near Brno. Additional specimens subsequently found by Oppenheimer at this locality were described by Richter (1912, 1913).

During the 1950s, Chlupáč undertook extensive investigations in the Moravian Karst and reported the presence of Carboniferous trilobites from Hranice na Moravě (Chlupáč 1956) and Zbrašov na Moravě (Chlupáč 1958). In a comprehensive monograph on the Upper Devonian and Lower Carboniferous trilobites from Moravia (Chlupáč 1966), additional specimens found in a number of pits in the Hády-Říčka limestone sequence at Mokrá near Brno, as well as from previously known localities were described. To date, about 12 species representing 10 genera and 5 subfamilies have been recorded in the Carboniferous of Moravia, but hitherto, no representatives of the Bollandiinae have been found, although they are a common component of some Lower Carboniferous trilobite faunas from other parts of Europe.

Here we report the recent discovery of the genus Bollandia in the Early Carboniferous section of the Mokrá quarry within the Moravian Karst (Fig. 1). This area has yielded a particularly diversified fossil assemblage dominated by trilobites which are dated to the latest Tournaisian–earliest Viséan, Gnathodus interzone according to conodonts and upper part of zone 8 to lower part of zone 9 according to foraminifera (Devuyst & Hance in Poty et al. 2006; Kalvoda et al. 2009). Twelve species of trilobites have been identified, of which the majority were previously unknown from the Moravian Karst (Rak 2004). Among these there are eight fragmentary specimens which belong to two species of Bollandia: B. persephone (Hahn & Hahn, 1970) and B. cf. megaira (Hahn & Hahn, 1970). The specimens were recovered from pelitic shales and show clear evidence of dorsoventral and lateral deformation. However, preservation is sufficient to enable comparison with the type material of these species from coeval carbonate sequences (Erdbach Limestone) in the Harz Mountains.

Systematic palaeontology

The specimens described herein form part of Š. Rak’s collections deposited in the Czech Geological Survey, Praha (SR 2–9). Abbreviations used are: exs. – exsagittal; sag. – sagittal; tr. – transverse.

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Family Proetidae Hawle & Corda, 1847
Subfamily Bollandiinae Hahn & Brauckmann, 1988

Genus Bollandia Reed, 1943

Type species. – Asaphus globiceps Phillips, 1836, County Kildare, Ireland; Carboniferous, Tournaisian (Courceyan) (for a review, see Owens 2000).

Diagnosis. – See Hahn & Hahn (1971).

Assigned species. – B. albae (Gandl, 1977); B. alekto (Hahn & Hahn, 1970); B. claviceps (Burmeister, 1846); B. columba Tilsley, 1988; B. eudora Hahn & Hahn, 1992; B. frechi (Scupin, 1900); B. gerehahnorum Müller, 2007; B. kirgisiana Osmólska, 1970; B. globiceps (Phillips, 1836); B. granulifera (Phillips, 1836); B. megaira (Hahn & Hahn, 1970); B. obsoleta (Phillips, 1836); B. persephone (Hahn & Hahn, 1970); B. persephonoïdes Hahn, Hahn & Müller, 2003; B. proserpina Hahn, Hahn & Müller, 1998; B. rugiceps Tilsley, 1988; B. sonkalensis Osmólska, 1970; B. tissiphone (Hahn & Hahn, 1970); B. torionis (Gandl, 1977). Tentatively assigned: B. ?karatauensis (Weber, 1937).

Occurrence. – Late Tournaisian to Viséan, Asia (Kyrgyzstan, ?Turkey), Europe (Belgium, Czech Republic, France, Germany, Great Britain, Ireland, Poland, Russia, Spain), and North America (Alaska).

Bollandia persephone (Hahn & Hahn, 1970)

Figures 2A–K, 3

1970 Griffithides (Bollandia) persephone; Hahn & Hahn, pp. 211, 212.
1971 Griffithides (Bollandia) persephone; Hahn & Hahn, pp. 136–141, figs 16–19, pl. 26, figs 19–24.
1975 Griffithides (Bollandia) persephone; Hahn & Hahn, p. 60, pl. 9, fig. 10a, b.
1977 Griffithides (Bollandia) persephone; Gandl, p. 190.
2003 Bollandia persephone; Hahn, Hahn & Müller, p. 60.

Material. – Two incomplete cranidia, five incomplete pygidia, Moravia, SR 3–9.

Locality. – Mokrá quarry, Moravian Karst, near Brno, the Czech Republic (Fig. 1).

Horizon. – Pelitic shales, Březina Formation. Late Tournaisian, Carboniferous.

Description. – S1 deep, straight, rather shallow and broad, and running inwardly and obliquely towards SO but without reaching it; SO straight, narrow, rather deep sagittally, but shallowing laterally; LO wide (tr.), of almost equal length (sag. and exs.) throughout, and bearing a tiny occipital node; palpebral lobe apparently narrow (tr.), widest opposite mid-length of L1. In lateral profile, glabella strongly inflated anteriorly. Sculpture: posterior three-quarters of glabella are covered with granules that progressively merge into terrace ridges on the anteriormost quarter.

Pygidium of semicircular outline; axis moderately wide, transversely convex, posterior end apparently reaching border furrow; 8 particularly broad, shallow inter-ring furrows delimiting 8 + 1 raised axial rings; pleural field bearing up to five pleural ribs with narrow pleural furrows that divide them into flat anterior bands and more convex posterior bands; pleural and interpleural furrows terminate at the border which is moderately convex, rather wide posteriorly but narrowing anteriorly. Sculpture: small tubercules on pygidial border.

Remarks. – These specimens are assigned to Bollandia persephone (Hahn & Hahn, 1970) because they are similar to the type specimens in the following features: the sculpture of the glabella, the straight, broad, shallow S1, the proportions, convexity and general outline of the pygidium, the number of axial rings, depth of the axial and inter-ring furrows, number and organization of pleural ribs, and the relative width of pygidial border. Minor differences are the slightly wider (tr.) glabella and pygidium and a less inflated pygidial axis. These can be accounted for by intraspecific variation, and possibly also taphonomic deformation.
Czech Republic (Fig. 1).

the anterior width (tr) of the pygidium), moderately taper-
tal length of the pygidium) and rather wide (about a third of
Locality
Material
Figure 2L
Scale bar represents 5 mm.

Bollandia cf. megaira (Hahn & Hahn, 1970)

Figure 2L

Material. – A single weathered pygidium (Fig. 2L), SR2.

Locality. – Mokrá quarry, Moravian Karst, near Brno, the
Czech Republic (Fig. 1).

Horizon. – Pelitic shales, Březina Formation. Late Tourna-
ian, Carboniferous.

Description. – Axis long (about three-quarters of the sagi-
tal length of the pygidium) and rather wide (about a third of
the anterior width (tr) of the pygidium), moderately taper-
ing and rounded posteriorly, subdivided into 8 + 1 axial
rings by deep and broad inter-ring furrows; axial furrows
deep; pleural field moderately convex and bearing 5 deep
pleural furrows and 4 shallow interpleural furrows which
die out before reaching the border furrow; pygidial border
wide, convex, without terrace ridges. Sculpture: as far as
can be determined, pygidium entirely smooth.

Remarks. – This pygidium is similar to that of B. megaira
(Hahn & Hahn 1971, pl. 27, fig. 38) in its proportions and
vaulting, the number of axial rings, the depth of axial and
inter-ring furrows, its rather wide border, and in the absence
of sculpture. Because we have only one incompletely pres-
served specimen, we have placed it in open nomenclature;
additional material is required for confident specific deter-
mination.

Remarks on the autecology of Bollandia

The exoskeleton of Bollandia exhibits some morphologi-
cal traits which are potentially informative with regard to
the autecology of this trilobite. The frontal lobe of the gla-
 bella is inflated, and overhangs the anterior border. This
morphology suggests that the hypostome was probably ‘secondarily attached’ in this taxon in the impendent mode
(Fortey 1990, pp. 538, 543), a character which has been as-
associated to scavenging/predatory habits in trilobites
(Fortey & Owens 1999, p. 434). To our knowledge, the
morphology of the Bollandia hypostome is known only
from a single specimen figured by Woodward (1884, pl. 6,
fig. 5) and is now believed to be lost (see Owens 2000,
p. 21). If Woodward’s attribution is correct, the wide ante-
rior margin of this hypostome suggests that it was firmly
attached to the cephalic doublure ['buttressed hypostome'
sensu Fortey & Owens (1999), p. 433]. Along with the ap-
parently pointed posterolateral angles, this supports the
view that Bollandia had scavenging/predatory feeding ha-
bits (Fortey & Owens 1999, pp. 436, 437). Lastly, the strong
S1 and inflated L1 might be regarded as indicative of signifi-
cent musculature enabling rather complex movements of the
underlying appendages. As far as we know, these appenda-
dges were most likely located adjacent to the mouth (Bruton
& Haas 1997, text-figs 23a, 25), and thus it seems reason-
able to speculate that the characteristics of the posterior part
of the glabella in this trilobite were also related to specific
feeding habits, possibly scavenging/predatory.

The size of eyes in Bollandia varies from one species to
another, but the visual surface is always vertical and dis-
plays strong convexity antero-posteriorly, and to a lesser
extent dorso-ventrally (e.g., Osmólska 1970, pl. 1, fig. 10;
Owens 2000, fig. 5). This indicates the visual field of this
trilobite was relatively wide, but mainly in a horizontal
plane (e.g., at least 180° in B. globiceps, see fig. 5D in
Owens 2000), dorsal vision being more limited. Conse-
quently, it seems reasonable to assume that Bollandia lived
on the sea-floor instead of being endobenthic. However,
the development of structures resembling terrace ridges
on the anterior part of the glabella in B. persephone
(Figs 2B, C, E, F, 3A–C) might indicate adaptation for dig-
ing in this species (Schmalfuss 1981). In this regard, B.
persephone resembles some scutelluids with vaulted exo-
skeleton, such as the Early Devonian Paralejurus (e.g., P.
rehanmanus, Schraut & Feist 2004, fig. 7) or the Frasnian
Telopeltis (especially T. woodwardi, McNamara & Feist
2006, fig. 3.1–6), which have been regarded as semi-
endobenthic forms (Schraut & Feist 2004, Feist &
Lerosey-Aubril in press). Bollandia generally exhibits a
wide axis and rather vaulted exoskeleton which might con-
firm some digging adaptations. However, whether it dug to
conceal part of its body within the substrate, or to feed from
endobenthic organisms cannot be determined.
Conclusion

The discovery of new trilobites within the Březina Formation in Mokrá quarry will substantially enhance our current knowledge of Moravian Carboniferous trilobites. In this paper, the occurrence of Bollandiinae in Moravia is documented for the first time which demonstrates the obvious palaeogeographical affinities of Czech trilobite assemblages with other European Carboniferous faunas, especially those of the Harz Mountains (Hahn et al., 1998, 2003). However, further investigation is required to determine precisely to which facies-constrained associations the new Moravian fauna corresponds, for example those from Belgium and Germany (Hahn 1990).

As recently demonstrated quantitatively (Lerose-Aubril & Feist in press), Tournaisian times represented a major period of diversification for trilobites following the late Famennian Hangenberg extinction event. The associated adaptive radiation is clearly illustrated by the emergence of morphological characteristics, such as associated adaptive radiation is clearly illustrated by the emergence of morphological characteristics, such as those of *Bollandia*, which have no known equivalents in Famennian trilobites. We interpret the morphological characteristics of *Bollandia* as indicative of an epibenthic mode of life, with possible adaptations for digging, and for predatory/scavenging feeding habits. This is just one example of the great ecological diversity exhibited by trilobites in the early Carboniferous, but a full assessment of this must await detailed quantitative analysis of trilobite disparity at that time. A typical trilobite association – comparable to the association described from Erdbacher Kalken in Steeden, Hessen (Germany) – was found during the excavations in Mokrá quarry. It consists of the following taxa:

- *Cyrtoproetus (Cyrtoproetus) cracoensis cracoensis* (Reed 1899),
- *Semiproetus (Macrobole) dreverensis latipalpebratus* (Osmlóka, 1973),
- *Liobole (Panibole)* sp., and
- *Linguaphillipsia* sp.

Among the associated faunal components collected, there were also isolated valves of brachiopods, ossicles and columns of crinoids as well as limited remains of other groups of fossils.

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References

BURMEISTER, H. 1846. The organisation of trilobites, deduced from their living affinities, with a review of the species hitherto described. 136 pp. The Ray Society, London.


HAIN, G., HAIN, R. & MÜLLER, P. 2003. Trilobiten aus den


