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FIRST EURYPTERID FROM ITALY: A NEW SPECIES OF *ADELOPHTHALMUS* (CHELICERATA: EURYPTERIDA) FROM THE UPPER CARBONIFEROUS OF THE CARNIC ALPS (FRIULI, NE ITALY)

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Abstract. The first eurypterid known from Italy is described, as *Adelophthalmus piussii* n. sp. It comes from the Upper Carboniferous of the Carnic Alps (Friuli, NE Italy). Relationships with related species are discussed. Adelophthalmids are the commonest eurypterids of the late Palaeozoic, at which time the disparity of the order was waning. The new record enhances our knowledge of adelophthalmid distribution and diversity.

Riassunto. Viene descritto *Adelophthalmus piussii* n. sp., il primo eurypteride rinvenuto in Italia; l'esemplare proviene dal Carbonifero Superiore delle Alpi Carniche (Friuli, Italia nord-orientale). Vengono discusse le relazioni con specie simili. Gli adelophthalmidi sono i più comuni eurypteridi del Paleozoico superiore quando la diversità all'interno dell'ordine andava diminuendo. Il nuovo esemplare contribuisce a migliorare le conoscenze sulla distribuzione e sulla diversità degli adelophthalmidi.

Introduction

Eurypterids form a group of extinct Palaeozoic aquatic chelicerates found in marginal marine, brackish and freshwater environments. Although globally widespread, eurypterids tend to be restricted to Konservat-Lagerstätten due to their unmineralized cuticle (Gupta et al. 2007). Despite having a fossil record from every continent with the exception of Antarctica, it is only with the amalgamation of the palaeocontinents in late Devonian and early Carboniferous times that these animals gained a truly cosmopolitan distribution (Tetlie 2007, but see Lamsdell et al. 2013), with the radiation of hibbertopterid and adelophthalmid eurypterids following the extinction of every other major eurypterid group (Lamsdell & Braddy 2010).

Of the two eurypterid groups found in the Carboniferous, adelophthalmids are by far the commonest, with over 40 species currently recognized (Tetlie & Poschmann 2008), the majority of which are assigned to the genus *Adelophthalmus* Jordan in Jordan & von Meyer, 1854. *Adelophthalmus* reached its peak diversity in the late Carboniferous, although the earliest known species occurred in the early Devonian (Siegenian and Emsian in terms of Rhenish stratigraphy) of Germany (Poschmann 2006, 2012). Three other Devonian occurrences have been reported: a single specimen from the Frasnian of Australia (Tetlie et al. 2004), material from North America that is most likely Famennian in age (Hall & Clarke 1888), and a series of poorly preserved specimens from the Middle Devonian of Russia (Shpinev 2012) which exhibit a number of bizarre characteristics that warrant further investigation and may suggest that their assignment to *Adelophthalmus* is erroneous. There is a dearth of specimens from the early Carboniferous, with a single species described from the Tournaisian of Russia (Shpinev 2006). Any occurrence of the genus is important for reconstructing the biogeography of post-Devonian eurypterids. Here, we report the first eurypterid known from Italy, describe the new species as *Adelophthalmus piussii* n. sp. from the Upper Carbo-

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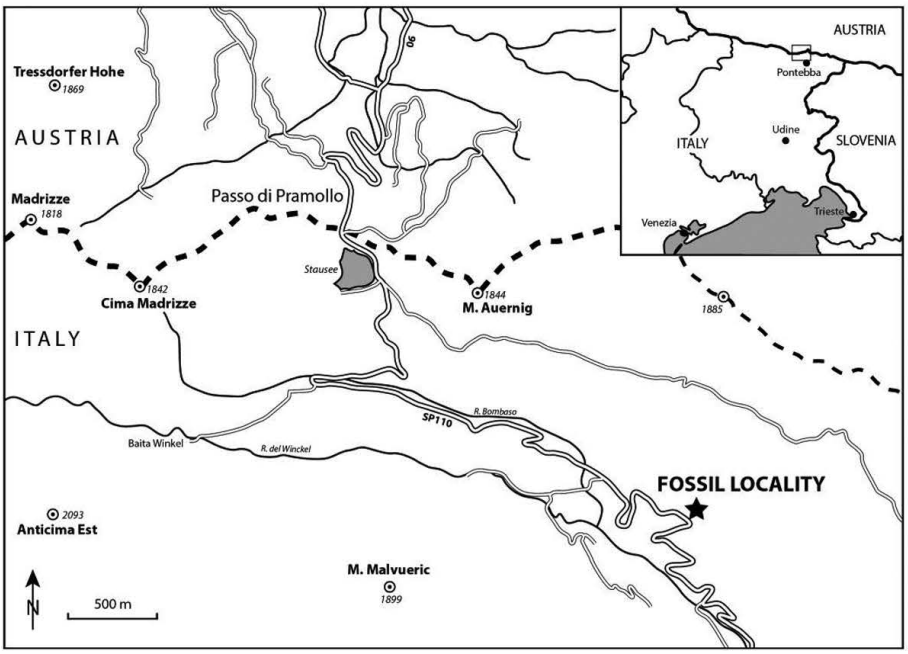

Fig. 1 - Position of the fossil locality (star) near the road SP110 from Pontebba to Passo Pramollo, which is situated on the Italy-Austria border; spot heights in metres. Inset: location map of the Passo Pramollo area near Pontebba in the north of Friuli.

niferous of the Carnic Alps, and discuss its position within the genus.

Geological Setting

The specimen comes from the debris of a large loose block found in the gravel bank of a small creek, a tributary of Bombaso creek, near to Malga Tratte (Fig. 1). The site is located north of the village of Pontebba, on the main road (SP110) that leads to the mountain border post of Passo Pramollo-Naßfeld between Italy and Austria. It is preserved as a cast in a small slab of thin sandstone. In the block from which the slab originated is a thin level with several fragments of fossil plants, mostly fern-like foliage. A small piece of the slab was sent to Prof. Paola Pittau, Dipartimento di Scienze Chimiche e Geologiche, Cagliari University, for palynological analysis, but it was not possible to obtain accurate dating because of the poor preservation of the microfossils; only long-ranging microspores were found. Based on lithological features, and according to the geological setting of the area, it is most likely that the specimen comes from the upper part of the Meledis Formation (upper Moscovian-lower Kasimovian) (Venturini pers. com.), the oldest among the five formations of the Pramollo Group (upper Moscovian-Gzhelian, Upper Carboniferous) (Venturini 1990, 2002). The whole group is characterized by alternation of transgressive-regressive cycles related to glacio-eustatic control and tectonic activity (Vai & Venturini 1997). The result is a thick sequence of conglomerates and arkoses with high quartz content, from a fluvio-deltaic environment, intercalated with marine shallow-water carbonates and pelites. In the lower part of the Meledis Formation, the carbonate levels are intercalated with bioturbated siltstones with abundant ichnofossils and marine fossils, arranged in a transgressive sequence mostly driven by transtensive tectonics which produced several slumping episodes. Alternatively, the deposits of the upper part of the Meledis Formation reflect local transpressive tectonics which were responsible for a fluvio-deltaic environment, testified by channelized quartz-rich conglomerates and shoreface arenites. The specimen seems to be from this upper sequence.

Material and Methods

The single specimen (part only; Fig. 2) is preserved as a three-dimensional representation of the dorsal surface in a fine sandstone. It was studied under a Leica MZ605 stereomicroscope, drawn using a camera lucida attachment on the microscope, and photographed dry, in low-angle light, with a Canon 5D MkII digital camera and 50 mm macro lens. Note that, unconventionally, the lighting in Fig. 2 is directed from the SW in order to illuminate the specimen which would otherwise be in the shadow of higher rock matrix. The final drawing and photographs were prepared for publication using the Adobe CS6 software suite. All measurements are in mm; the > symbol indicates an incomplete article and hence a minimum measurement.

Systematic Palaeontology

Subphylum **Chelicerata** Heymons, 1901

Order **Eurypterida** Burmeister, 1843

Suborder **Eurypterina** Burmeister, 1843

Infraorder **Diploperculata** Lamsdell, Hoşgör & Selden, 2013

Superfamily Adelophthalmoidea Tollerton, 1989

Family Adelophthalmidae Tollerton, 1989

Genus *Adelophthalmus* Jordan in Jordan & von Meyer, 1854

Adelophthalmus piussii n. sp.

Fig. 2

Material. Holotype and only known specimen, number MFSNgp 31681, Museo Friulano di Storia Naturale, Udine.

Horizon and locality. Upper Moscovian-lower Kasimovian (Upper Carboniferous); from near Malga Tratte, Bombaso valley, Pontebba, Udine.

Etymology. The species is named in honour of the collector, Stefano Piussi of Udine.

Diagnosis. *Adelophthalmus* with median furrow on carapace; carapace lacking expanded posterolateral corners; lateral margins of first opisthosomal tergite angled anteriorly; first opisthosomal tergite maintains constant width at lateral margins.

Description. Body length >37.89 mm. Carapace parabolic (sensu Tollerton 1989), 16.98 long, >18.53 wide, bordered by narrow marginal rim. Lateral eyes reniform, 2.88 long, 1.69 wide, located centrimesially 7.96 from carapace posterior border on outer margin of vaulted central portion of carapace. Ocellar mound located between lateral eyes at rear of median furrow 5.82 from carapace posterior border. Four partial prosomal appendages (IV–VI) preserved on left side, but no details discernible. Anterior seven opisthosomal tergites preserved; first reduced, with lateral margins converging slightly forwards. Opisthosomal tergite lengths/widths: 1 = 0.92/>17.36; 2 = 2.06/>19.66; 3 = 3.21/>20.08; 4 = 4.29/>21.24; 5 = 4.61/21.52; 6 = 3.47/>15.76; 7 = >2.35/>8.74. Slight epimera on all opisthosomal tergites. Cuticular ornamentation of lunate scales (preserved as impressions).

Remarks. The specimen is considered to belong to a new, undescribed species on account of its possession of a carapace median furrow combined with its lack of expanded posterolateral corners of the carapace.

Discussion

The genus *Adelophthalmus* is speciose, widespread, long-ranging, taxonomically old (being named in 1854), and the nominate form of a higher taxon (in this case the family Adelophthalmidae); it therefore meets every criterion for the identification of wastebas-

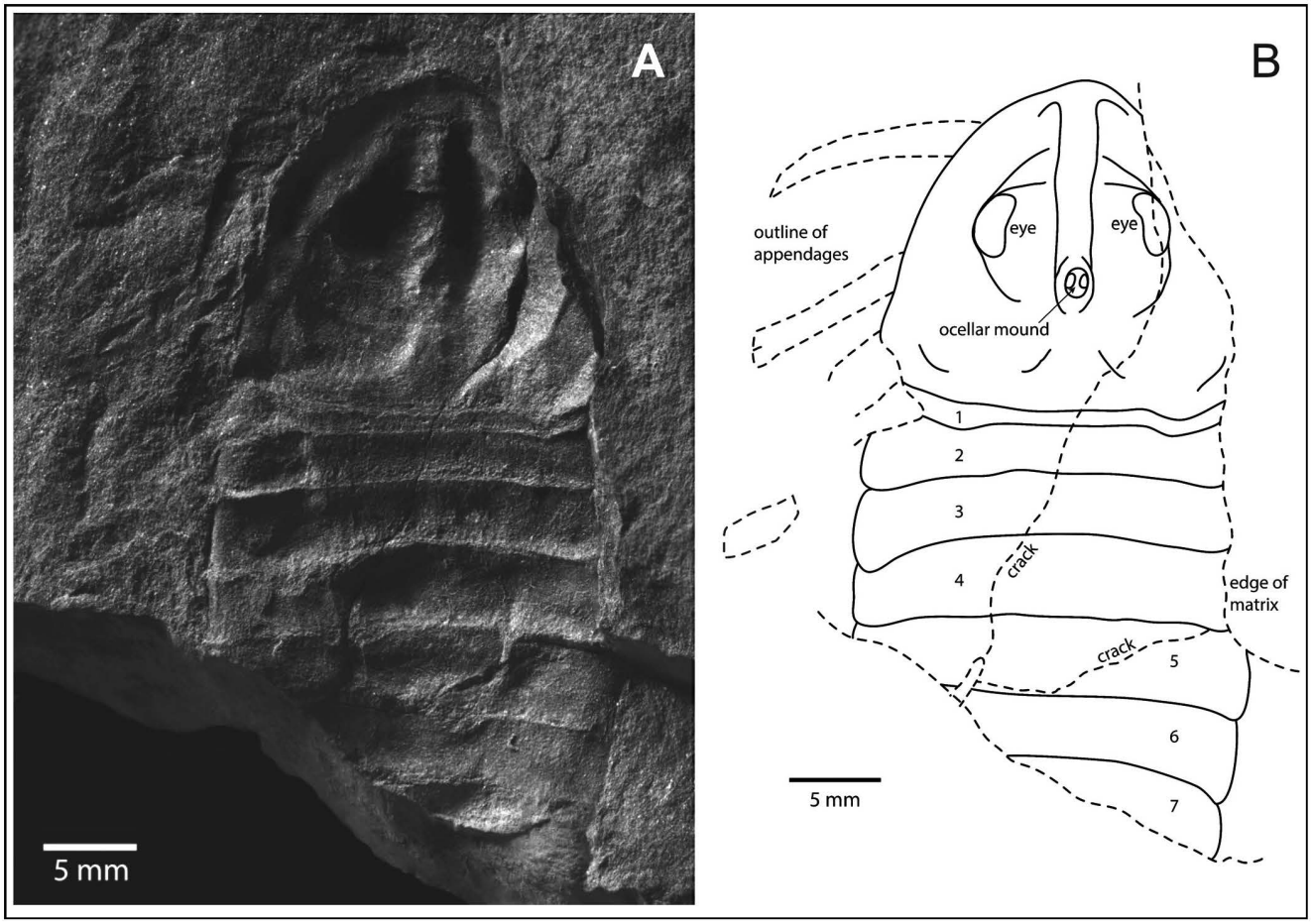

Fig. 2 - *Adelophthalmus piussii* n. sp. from the Upper Carboniferous (upper Moscovian-lower Kasimovian) Meledis Formation, Friuli, specimen MFSNgp 31681. A) Photograph under low-angle light (illumination from the SW). B) Interpretative drawing for A. Scale bar: 5 mm.

ket taxa as set out by Plotnick & Wagner (2006). The phylogeny of the genus is poorly known; Tetlie & Poschmann (2008) performed an analysis of the Adelophthalmoidea and retrieved *Adelophthalmus* as monophyletic; however, there was a general lack of resolution within the genus, and 18 of the 25 then-known species were excluded from the study. It seems unlikely that the genus is polyphyletic or paraphyletic, though it may suffer simultaneously from under-splitting at the generic level and, paradoxically, over-splitting at the species level. The species now assigned to *Adelophthalmus* have previously been divided into five genera: *Adelophthalmus*, *Lepidoderma* Reuss, 1855, *Anthraconectes* Meek & Worthen, 1868, *Polyzosterites* Goldenberg, 1873, and *Glyptoscorpius* Peach, 1882. These taxa have all subsequently been synonymized into *Adelophthalmus*, which has priority, for reasons that appear valid for the type species in question (see Tetlie & Dunlop 2005 for a full review). It is possible, however, that *Adelophthalmus* may consist of two or more large clades that could be considered to be distinct genera; it is also uncertain how the Carboniferous genus *Unionopterus* Chernyshev, 1948 resolves in relation to the various *Adelophthalmus* species (Tetlie & Van Roy 2006).

A number of species of *Adelophthalmus* have also been suggested to be synonyms, with Van Oyen (1956) suggesting that as many as 11 species may be junior synonyms of *Adelophthalmus imhofi* (Reuss, 1855). Many of these species are in need of restudy, however, and Van Oyen's proposed synonymies have not been widely accepted, with three of the supposedly synonymous species resolving disparately in the phylogeny of Tetlie & Poschmann (2008). A number of characteristics used to define species are also suspect; the type species, *Adelophthalmus granosus* Jordan in Jordan & von Meyer, 1854, was originally described as lacking lateral eyes, something that is almost certainly a preservational artifact (Tetlie & Dunlop 2005), while *Adelophthalmus luceroensis* Kues & Kietzke, 1981, was described as possessing no median ocelli, however they can be clearly seen on two figures (Kues & Kietzke 1981 pl. 1, figs. 5 & 8). Ultimately only a redescription of museum specimens will resolve these issues, however until this is done the true number of true *Adelophthalmus* species currently known will remain uncertain.

The current specimen can clearly be distinguished as a novel species by the autapomorphy of a median carapace furrow and the unique character combination of the carapace lacking expanded posterolateral corners along with the lateral margins of first opisthosomal tergite being angled anteriorly and maintaining a constant width at its lateral margins. The morphology of the first opisthosomal segment also reveals close affinities to some other species of *Adelophthalmus*, with *Adelophthalmus wilsoni* (Woodward, 1888) possessing a first tergite with almost identical morphology (see Owens & Bassett 1976, pl. 29, fig. 5). *Adelophthalmus luceroensis* and *Adelophthalmus dumonti* (Stainier, 1917) also exhibit an anterior curvature of the lateral regions of the first tergite; however, *Adelophthalmus dumonti* also has extended posterolateral regions of the carapace that dorsally overlap the tergite. This configuration is also seen in *Adelophthalmus moyseyi* (Woodward, 1907) and *Adelophthalmus granosus* which, together with *Adelophthalmus dumonti*, resolved as a clade in the analysis of Tetlie & Poschmann (2008). *Adelophthalmus piussii* n. sp. exhibits slight posterolateral extension of the carapace margin but not to the degree seen in *Adelophthalmus dumonti*, with the lateral portions of the first tergite not being completely covered. *Adelophthalmus piussii* n. sp. thus appears to be an intermediate form between taxa with an anteriorly deflected first tergite such as *Adelophthalmus luceroensis* and the *Adelophthalmus dumonti* clade. It is also possible to polarize these characters, as the earliest known species, *Adelophthalmus sievertsi* (Størmer, 1969), lacks both posterolateral extensions of the carapace and any lateral differentiation of the first tergite. The trend in *Adelophthalmus* thus appears to be one of increasing anterior deflection of the lateral regions of the first opisthosomal tergite followed by an expansion of the posterolateral regions of the carapace eventually resulting in the total dorsal overlap of the lateral regions of the first tergite. *Adelophthalmus piussii* n. sp., with its first tergite exhibiting marked lateral deflection, appears to show the onset of posterolateral carapace extension.

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