The Cambrian genus *Onaraspis* Öpik, 1968 (Trilobita), in Spain

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The genus *Onaraspis* was originally described by Öpik (1968) from the Ordian Stage of Australia. Sdzuy (1971) noted the presence of a genus similar to *Onaraspis* in the Bilbilian Stage (late Early Cambrian) of Spain. Jell (1974) reported *Onaraspis* from the early Middle Cambrian of Israel.

Several species, assigned to different genera but similar to *Onaraspis*, were defined in the same period: *?Jakutus kielcensis* Bednarcyzk, 1970 from Poland, *Myopsolenus palmeri* Parnes, 1971 from Israel, and *Perrector altus* Liñán & Gozalo, 1986 from Spain. They have very similar morphological features to *Onaraspis*, both in the cranidium and the pygidium.

Jell (in Bentgson et al. 1990) described *Onaraspis rubra* from the Lower Cambrian of South Australia; this species is older than those described by Öpik (see Bentgson et al. 1990, p. 15).

Gozalo & Liñán (1997a, b) revised the Spanish material of *Perrector? altus*, and reassigned the species to *Onaraspis*; they also proposed to include *Myopsolenus palmeri* within *Onaraspis*. Subsequently, Rushton & Powell (1998), in their description of a trilobite fauna from the Lower Cambrian of Jordan, figured Jordanian material of *Myopsolenus palmeri* and concluded that the species belonged to *Onaraspis*.

Recently, Geyer & Landing (2004) postulated a clade composed of the genera *Onaraspis* and *Myopsolenites*. They assigned only species from Australia to *Onaraspis*, and transferred the morphologically comparable species from Israel, Jordan, Spain, Morocco and Poland to *Myopsolenites*. They therefore disagreed with the use of *Onaraspis* to accommodate *Perrector? altus*, as suggested by Gozalo & Liñán (1997a, b), and also *Myopsolenus palmeri*, following Gozalo & Liñán (1997a, b) and Rushton & Powell (1998). We believe the differences between species assigned to *Onaraspis* and *Myopsolenites* are insufficient to permit the recognition of two genera; we thus consider *Myopsolenites* to be a junior subjective synonym of *Onaraspis*.

**GEOLOGICAL AND STRATIGRAPHIC SETTING**

The material studied herein has been found in Murero (Zaragoza province; Iberian Chains) and Valdoré (León province; Cantabrian Mountains) in northern Spain (Fig. 1).

In the Iberian Chains, *Onaraspis altus* (Liñán & Gozalo, 1986) occurs in the Rambla de Valdemedies 1 and 2 sections (see Liñán & Gozalo 1986; Liñán et al. 1993a; Dies et al. 2004). The material is recorded in the upper part of the Valdemedies Formation (Liñán et al. 1993a).
1992), and the trilobite assemblage in these levels is composed of Protolenus jilocanus (Liñán & Gozalo, 1986), P. pisidianus Dean in Dean & Özgul, 1994, Hamatolenus (H.) ibericus Sdzuy, 1958, Sdzuyia sanmamesi Liñán & Gozalo, 1999, and Tonkinella sequei Liñán & Gozalo, 1999; this assemblage belongs to the Protolenus jilocanus Zone, formerly the Hamatolenus (H.) ibericus Zone (upper Bilbilian age).

In the Cantabrian Mountains, Onaraspis aff. kielcensis (Bednarczyk, 1970) is preserved in reworked rounded clasts of limestone within the base of the upper member of the Láncara Formation. The Valdoré section has been studied by Zamarreño (1972) and Álvaro et al. (2000). The base of the upper member of the Láncara Formation is erosive (Álvaro et al. 2000) and the lowest strata (50 cm) are composed of pink packstones with rounded clasts of limestone at the base. Liñán et al. (2003) found the trilobite species Kingaspis campbelli (King, 1923) in the rounded clasts; Geyer & Landing (2004) questioned their identification, but Gozalo et al. (2007, pp. 364-365) rebutted that query. In the latter paper they recorded a cranidium of Onaraspis sp. in the same rounded clasts, and here it is identified as O. aff. kielcensis. The trilobites in these rounded clasts are indicative of an upper Bilbilian age, but specimens of Acadoparadoxides mureroensis (Sdzuy, 1958) have been found at this level, marking the first zone of the Leonian stage (early Middle Cambrian).

Onaraspis altus and O. aff. kielcensis have been found in the upper Bilbilian stage, which is considered the last stage in the lower Cambrian of Spain (see Liñán et al. 1993a, b, 2002; Sdzuy et al. 1993; Gozalo et al. 2007).

SYSTEMATIC PALAEONTOLOGY
The material studied herein is housed in the Museo Paleontológico de la Universidad de Zaragoza-Gobierno de Aragón at Zaragoza (Spain) under references MPZ 838-839, MPZ 841-848, MPZ 99/510-562, MPZ 99/582-597, MPZ 99/599 and MPZ 2005/297.

The abbreviations employed in the measurements (in mm) (Appendix 1 and Fig. 4) are: Cw = Cranidial width, Cl = Cranidial length (sag.), Gw = Glabellar width (at occipital furrow), Gl = Glabellar length (sag.), Pw = Pygidial width (at anterior margin), Pl = Pygidial length (sag.), Rw = Pygidial axial width (at anterior margin), and Rl = Pygidial axial length (sag.).

Order REDLICHIIDA Richter, 1932
Suborder REDLICHIINA Richter, 1932
Family SAUKIANDIDAE Hupé, 1953
Subfamily RESSEROPINAE Chang, 1966

Remarks. Öpik (1968) included Onaraspis in the family Metadoxidae based on the cranidial morphology. This proposal was followed by Jell (in Bentgson et al. 1990), by Chang et al. (1997) with some uncertainty, and by Rushton & Powell (1998). Geyer & Landing (2004) considered the Onaraspis clade as being of uncertain familial assignment, but in discussing the morphology of the group, considered the pygidial morphology to be closer to the Resserops clade.

The thoracic morphology, the position of the macropleural segment and the pygidial morphology are similar to the genera Perrector Richter & Richter, 1940 and Richterops Hupé, 1953, which are representative of the subfamily Resseropinae. We consider that the morphology of the cranidium, the position of the genal spines near the middle of the lateral cephalic margin, the thorax of 12 to 14 segments with a posteriorly located macropleural segment, and a relatively large subcircular pygidium permits placement...
of Onaraspis in the subfamily Resseropinae in accordance with the diagnosis of this subfamily by Chang et al. (1997).

Onaraspis Öpik, 1968

Type species. Onaraspis somniurna Öpik, 1968.

Original diagnosis. “Onaraspis gen. nov. refers to species of Metadoxididae distinguished by a relatively small number of segments in the thorax (twelve in the type species), well developed pygidium with concave flange, and only slightly tapering glabella; in the type species the tenth segment is macropleural” (Öpik 1968, p. 151).

Emended diagnosis. A genus of the Resseropinae characterised by trapezoidal cranidium with anterior dorsal outline slightly concave to slightly convex; slightly tapering glabella with transglabellar S1 and no transglabellar S2 and S3; anterior border narrow and preglabellar field lacking; narrow precocular field. Thorax with twelve to fourteen segments, the antepenultimate is macropleural. Pygidium well developed with a long axis with three to eight ring furrows developed.

Remarks. The original diagnosis by Öpik (1968) made reference to thorax, pygidium and glabella. In the emended diagnosis above, cranidial characters are given more weight.

Geyer & Landing (2004) considered the genus Myopsolenites based on Myopsolenus palmeri Parnes, 1971, to be a valid genus. While they gave a diagnosis of Myopsolenites, they did not discuss the differences between it and Onaraspis. For a discussion on the availability of the name Myopsolenites see Żylińska (in Żylińska & Masiak 2007, p. 676-677).

Rushton & Powell (1998) asserted that the morphological differences between the Australian species of Onaraspis and Myopsolenus palmeri from Jordan were more likely of specific significance. We agree with this assertion and believe that the relatively slight morphological differences in the cranidium, thorax and pygidium between these species are insufficient to separate them generically. As a consequence, all of the species assigned to Myopsolenites by Geyer & Landing (2004) should be included in Onaraspis. Therefore, in addition to the type species, the following species should be included in Onaraspis: O. adusta Öpik, 1968; ?Jaktus kielcensis Bednaryk, 1970; Myopsolenus palmeri Parnes, 1971; Parrector? altus Liñán & Gozalo, 1986; O. rubra Jell, 1990; and Myopsolenites boutiouiti Geyer & Landing, 2004.

Onaraspis altus (Liñán & Gozalo, 1986) (Figs 2C-G, 3A-B, D, F-K)

v 1986 Perrector? altus n. sp.; Liñán & Gozalo, p. 44-45, pl. 3, figs 1-6, pl. 4, figs 1-2.

v 1986 Neoredlichiidae? sp. indet.; Liñán & Gozalo, p. 45, pl. 4, figs 3, 5-6.

v 2004 Onaraspis altus (Liñán & Gozalo, 1986); Dies Álvarez, p. 32-35, pl. 2, figs 3-7, pl. 3, pl. 4, figs 1-4.

v 2007 Onaraspis altus (Liñán & Gozalo, 1986); Gozalo et al., fig. 5c.

Material. Thirty complete specimens, eleven cranidia, ten cephalothoraces, eight pygidia, six thoracopyga, four incomplete thoraces, three hypostomes, several librigenae and two axial rings. All specimens have suffered tectonic deformation to some degree. They are preserved as internal and external moulds in green, yellow and pink lutites and yellow, fine-grained sandstones.

Emended diagnosis. Species of Onaraspis with long palpebral lobes (more than two thirds of the glabellar length) and genal spines beginning in an advanced position and extending to the eighth thoracic segment. Border of the pygidium marked.

Description. Cranidium subrectangular; with straight or slightly curved anterior margin; narrow, rounded (sag.) anterior border, slightly narrower axially. Fine terrace ridges parallel or almost parallel to the anterior margin in larger specimens. Deep anterior border furrow. Preglabellar field absent. Glabella subcylindrical

The posterior border of the hypostome is narrower and less convex than the lateral borders. The maculae are crescent shaped and are located in the posterior part of the hypostome.

Thorax composed of thirteen segments. Axis narrows posteriorly, while the pleurae are of equal width up to the tenth thoracic segment. Axial rings are convex (sag., tr.) and each possesses a median node. Pleurae possess a deep pleural furrow dividing each pleura into two triangular bands. Most pleurae terminate in wide, short, pleural spines. Tenth thoracic segment is macropleural with a thin, long spine extending to the pygidium.

Pygidium semicircular. Axis well defined, strongly tapering posteriorly, reaching the pygidial border; with at least five axial rings. Border flat or slightly convex. Pleural field elevated above border. Smaller specimens show a narrower border that is difficult to distinguish from the pleural field.

**Fig. 4.** Bivariate scatterplots showing relationships between cranidial length and glabellar length (A), cranidial width and glabellar width (B), pygidial length and pygidial axis length (C), pygidial width and pygidial axis width (D), in *Onaraspis altus*.

Measurements. Appendix 1 shows the measurements of the best preserved specimens collected. The bivariate method has been applied in the morphometric analysis of this data. Following the methods of Hughes & Jell (1992),
Labandeira & Hughes (1994), Hughes (1994) and Chirivella et al. (2003), we have used the measurements obtained in the same direction (i.e., width versus width and length versus length) in order to avoid low correlation coefficients due to tectonic distortion (Fig. 4A-D); the Pearson coefficients ($R^2$) are high (>0.85) in all bivariate plots, and the regression lines show clearly that all specimens belong to a single species.

Remarks. Liñán & Gozalo (1986) defined *Perrector? altus* in the lower Cambrian of Murero. They noted that this species shows clear differences from the type species of the genus in having a straight anterior margin and a very thin anterior border at a lower level than the glabella and the fixigenae. Gozalo & Liñán (1997a, b) considered *Perrector? altus* (Liñán & Gozalo, 1986) to belong to the genus *Onaraspis*. In addition, the specimens referred to *Neoredlichiidae?* sp. indet. by Liñán & Gozalo (1986) are here considered to belong to *Onaraspis altus*.

*Onaraspis altus* has a longer palpebral lobe than other congeners. Its postocular field is very narrow or absent, its genal spine considerably longer and more advanced than in other species.

Stratigraphic distribution. Levels 4, 5 and 6 from the Rambla de Valdemiedes-1 section and levels 4, 5 and 6 from the Rambla de Valdemiedes-2 section. *Protolenus jilocanus* Zone (Upper Bilbilian).

*Onaraspis aff. kielcensis* (Bednarczyk, 1970)  
(Fig. 3C, E)

v 2007 *Onaraspis* sp.; Gozalo et al., fig. 4E, I.

Material. One incomplete, partially exfoliated cranidium.


Remarks. This specimen is similar to *Onaraspis kielcensis* (Bednarczyk, 1970), but differs in that the “S” parameter, which is secant and strongly convergent in the Polish species, is outer and moderately convergent in the Spanish cranidium. They also differ in that the anterior margin in *Onaraspis aff. kielcensis* is slightly concave, while in *Onaraspis kielcensis* (see Żylińska in Żylińska & Masiak 2007, fig. 10a-d, f) it is convex.

Both this specimen and *Onaraspis kielcensis* have the same pattern of ornamentation (dense tuberculation on the surface of the cranidium and terrace ridges on the anterior border), similar to that illustrated in one specimen of *Onaraspis somniurna* (Opik 1968, pl. 19, fig. 1).

BIOSTRATIGRAPHY AND BIOGEOGRAPHY OF *ONARASPIS*

The genus *Onaraspis* has been recorded from five localities in Australia, all of them assigned to the *Xystridura templetonensis–Redlichia chinensis* Zone (Ordian/Early Templetonian). *Onaraspis somniurna* and *O*. sp. indet. from the Northern Territory, and *O. adusta* from Western Australia were described by Opik (1968); *Onaraspis* sp. was reported by Shergold (1986) from the Amadeus Basin; and *O. rubra* Jell, 1990 was recorded from the Moodlatana Formation near Wirrealpa (South Australia) and is considered to be of early Cambrian age (pre-Redlichia chinensis Zone) (see Bengtson et al. 1990, p. 15). Jago (in Brock et al. 2000) and Jago et al. (2006) considered the level with *Onaraspis rubra* as equivalent to the latest Toyonian (lower Cambrian).

*Onaraspis kielcensis* (Bednarczyk, 1970) was found near Brzechów village, in the western part of the Svietskryskie Mountains, Poland, in the lower *Paradoxides oelandicus* layers (Middle Cambrian). Orłowski (1985, fig. 1) located this species in the lower part of the *Paradoxides insularis* Zone in the Holy Cross Mountains.

*Onaraspis palmeri* (Parnes, 1971) occurs in the Timna and Burj Formations in Israel and Jordan (Parnes 1971; Rushton & Powell 1998). Rushton & Powell (1998) suggested a correlation with the Bilbilian stage for this material; Liñán et al. (2003) and Gozalo et al. (2007) subsequently refined this assignment to the upper Bilbilian.

The two species found in Spain and described above also belong to the upper Bilbilian.

*Onaraspis boutioui* (Geyer & Landing, 2004) is recorded from the base of the Jbel Wawrmast Formation, Brèche à Micmacca Member, in the *Cephalopyge notabilis* Zone (Middle Cambrian).
Figure 5 shows a correlation chart of the levels with *Onaraspis* based on Gozalo et al. (2007), and uses the zonation proposed for the Holy Cross Mountains by Orłowski (1985, 1992) and Żylińska & Masiak (2007). Abbreviations: *O. i. FAD*, first appearance datum of *Oryctocephalus indicus*; *O. g. FAD*, first appearance datum of *Ovatoryctocara granulata*.

Finally, we agree with Rushton & Powell (1998), Liñán et al. (2003) and Gozalo et al. (2007) in considering the levels with *Onaraspis* spp. and/or *Kingaspis campbelli* in the Middle East and Spain as late Early Cambrian in the traditional sense. Those levels may be correlated with the *Onaraspis* spp. from Australia. On the other hand, *Onaraspis* spp. from Poland and Morocco belong to the base of the traditional Middle Cambrian in that they are associated with paradoxids. Thus, *Onaraspis* is a useful biostratigraphic tool for correlation between Australia, peri-Gondwana areas and Baltica during the lower–middle Cambrian interval.

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APPENDIX
Measurements of specimens housed in the Museo Paleontológico de la Universidad de Zaragoza-Gobierno de Aragón at Zaragoza (MPZ). The abbreviations employed in the measurements (in mm) are: Cw = Cranidial width, Cl = Cranidial length (sag.), Gw = Glabellar width (at occipital furrow), Gl = Glabellar length (sag.), Pw = Pygidial width (at anterior margin), Pl = Pygidial length (sag.), Rw = Pygidial axial width (at anterior margin), and RL = Pygidial axial length (sag.).

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APPENDIX