The first record of *Dinesus* (Trilobita, Dinesidae) in the Cambrian of the Mediterranean region

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The first record of *Dinesus* (Trilobita, Dinesidae) in the Cambrian of the Mediterranean region

RODOLFO GOZALO, ELADIO LIÑÁN AND JUAN B. CHIRIVELLA MARTORELL


An important problem facing inter-regional correlation in the Cambrian is the scarcity of shared taxa between different palaeogeographic domains. Currently, species of the Corynexochida are proposed as tools to define the base of Cambrian Series 3. However, few Mediterranean Corynexochida species are known. A specimen of *Dinesus truyolsi* comb. nov. from the middle Cambrian of Spain represents the first record of this genus in the Acadobaltic province. *Erbia* and *Tinguyania* are accepted as junior subjective synonyms of *Dinesus*, and we now recognize 22 species within this genus. *Dinesus* has been found previously in lower to middle Cambrian strata of Australia, Russia, Kazakhstan, North America and China providing the potential for improved global correlation for this interval.

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ONE of the most important problems facing inter-regional correlation in the Cambrian is the lack of shared genera and species between different palaeogeographic provinces; i.e. many of the zonal trilobite species for Cambrian Series 3 (Stage 5 and Drumian Stage) are representatives of the Ptychagnostidae, but this family has not yet been found in the Mediterranean region. Many of the trilobite species in this region are endemic. Correlation between the Mediterranean and other regions must depend on the few and rare taxa that have wide geographic distribution.

Two species currently being considered as potential guides for the base of Cambrian Series 3 are *Oryctocephalus indicus* (Reed, 1910) and *Ovatoryctocara granulata* Tchernysheva, 1962 (see Fletcher 2003, Geyer 2005, Zhao *et al.* 2008); both are within the Corynexochida, and neither is known from the Mediterranean region. Few Corynexochida specimens are known from the Mediterranean, and their diversity is very low. However, some (e.g. *Tonkinella* sp. aff. *T. breviceps*) are useful for correlation (see Gozalo *et al.* 2003). Here we report the first occurrence of the widespread genus *Dinesus* in the Mediterranean area, within the Acadobaltic province *sensu* Sdzuy (1972). Previously, *Dinesus* has been found in Australia, the Siberia Platform, Altai-Sayan Fold Belt (Russia), Alaska, Canada, Kazakhstan and China.

Regional setting and stratigraphy

The species described here was collected in the Ateca-2 section of the Mansilla Formation (Leonian regional Stage, middle
Cambrian; Stage 5 of Cambrian Series 3) of the Badules unit in the Ateca area of the western Cadena Ibérica (asterisk, Fig. 1A, B). The Mansilla Formation (sensu Liñán et al. 1992, 2002) is 10–90 m thick and composed of alternating brown dolostones and limestones, and purple and violet shales containing trilobites, brachiopods, sponges, algae, hyoliths, monoplacophorans and ichnofossils. Trilobites have been found only in the upper part, and their assemblages belong to the Eccaparadoxides asturianus Zone (late Leonian Stage) and the Badulesia tenera Zone (early Caesaraugustan Stage; see Sdzuy et al. 1999).

The Ateca-2 section (Fig. 1C) is located 6 km north of Ateca village (Zaragoza province), at a site named ‘La Veguilla’. The section, which includes parts of the Mansilla and Murero formations, has been studied by Álvaro Blasco (1994).

**Trilobite assemblage**

Based on the data presented by Chirivella Martorell (2008), the trilobite assemblage of the Eccaparadoxides asturianus Zone in the Mansilla Formation in the Ateca area is composed of Eccaparadoxides asturianus (Sdzuy, 1968), Eccaparadoxides sdzuyi Liñán Guijarro, 1978, Cainatops schirmi (Sdzuy & Liñán, 1996), Parabailiella sp., Holocephalina? leve Gozalo & Liñán, 1996, Parasolenopleura ouangondiana (Hartt in Dawson, 1868), Asturiaspis inopinatus Sdzuy, 1968, Peronopsis acadica (Hartt in Dawson, 1868), Peronopsella pokrovskajae Sdzuy, 1968 and Dinesus truyolsi (Liñán & Gozalo, 2001). This assemblage is recorded just below the FAD of Badulesia tenera (Hartt in Dawson, 1868), which marks the beginning of the Caesaraugustan Stage. Sdzuy et al. (1999) and Gozalo et al. (2003, 2007) have provided correlation charts for this interval.

**Systematic palaeontology**

Order CORYNEXOCHIDA Kobayashi, 1935
Suborder CORYNEXOCHINA Kobayashi, 1935
Family DINESIDAE Lermontova, 1940

**Dinesus** Etheridge, 1896

*Type species.* Dinesus ida Etheridge, 1896, p. 56, pl. 1, figs 1–4 only.

**Comments.** For many years, *Dinesus* had been considered a monotypic genus containing only *D. ida* (see Palmer 1968, p. B60). However, Palmer (1968) proposed to include *Erbia granulosa* Lermontova, 1940 and the new species *D. arcticus* in *Dinesus*; he commented that the relationships between *Dinesus* and *Erbia* are very close. Subsequently, Repina & Romanenko (1978, p. 226) considered *Erbia* Lermontova, 1940 and *Paratollaspis* Kobayashi, 1943 as junior synonyms of *Dinesus*. Recently, Zhu et al. (2005, p. 560) also considered the Chinese genus *Tingyuania* Sun & Chang in Chang, 1937 as a junior synonym of *Dinesus*. Finally, Lin (2008, p. 58) reassessed all Chinese species previously classified as *Erbia* and *Tingyuania* and included all of them in *Dinesus*. We also agree that *Erbia*, *Paratollaspis* and *Tingyuania* are junior subjective synonyms of *Dinesus*.

However, we consider that *Tingyuania granulosa* Sun & Chang in Chang, 1937 does not belong in *Dinesus*. The diagnosis proposed by Sun & Chang in Chang (1937, p. 38) for this species states: ‘*Tingyuania* with very broad convex frontal limb, . . .’, a character that is clearly identifiable in the figures of this species by Lu et al. (1965, pl. 19, figs 12–13). This character makes the species quite different from others included in *Dinesus* where the preglabellar field is absent or is very short (sag.); see the emended diagnosis of *Dinesus* by Palmer (1968, p. B60).
Fig. 1. Geological setting of the Ateca-2 section in the Cadenas Ibéricas. A, Pre-Hercynian outcrops and tectono-stratigraphic zones of the Iberian Peninsula; the Cadenas Ibéricas are framed. B, Pre-Hercynian outcrops and tectono-stratigraphic zones and units of the Cadenas Ibéricas; *A2 section (modified from Gozalo & Liñán 1988). C, Composite stratigraphic section of the Mansilla Formation in the Ateca region, modified from Álvaro Blasco (1994).

Stratigraphic and geographic distribution. *Dinesus* has been recorded widely (Fig. 2): *Pararaia janae* Zone (lower Cambrian) and Ordian–early Templetonian Stage (middle
Cambrian) of Australia (Brock et al. 2000, Paterson 2005); Lermontovia grandis Zone to Kounamkites Zone (upper lower Cambrian and lower middle Cambrian) of the Siberian Platform and Altay-Sayan Fold Belt (Russia), generally as Eribia (see Tchernysheva 1971, Savitsky et al. 1972, Repina & Romanenko 1978, Egorova et al. 1976, Astashkin et al. 1991, 1995, Repina et al. 1999, Pegel 2000, Varlamov et al. 2008, Shabanov et al. 2008); Lungwangmioan Stage (upper lower Cambrian) of China (see Lin 2008) and, probably, Taijiangian Stage (middle Cambrian) of China (see Peng 2008); Montezuman and Dyeran stages (lower Cambrian) of Alaska and Canada (Palmer 1968, Fritz 1973); and lower Cambrian of Kazakhstan (Ivshin 1978, Repina et al. 1999). The specimen described herein is the first record of the genus from Spain (Mediterranean subprovince) in the Acadian province (sensu Sdzuy 1972). It occurs within the Eccaparadoxides asturianus Zone (lower middle Cambrian).

**Dinesus truyolsi** (Liñán & Gozalo, 2001) comb. nov. (Fig. 3)

2001 *Aragotus truyolsi*; Liñán & Gozalo, pp. 273–274, fig. 2f.

**Material.** Internal mould of cranidium preserved in light beige dolomitic marl. The specimen is housed in the Museo Paleontológico de la Universidad de Zaragoza-Gobierno de Aragón, Spain, number MPZ 97/418.

**Description.** Cranidium subquadrate. Glabella well defined at sides by deep subparallel axial furrows, moderately convex transversely and longitudinally; front evenly and strongly rounded, reaching nearly to border (Fig. 3). Occipital furrow is badly preserved. Occipital ring moderately wide on axial line, distinctly narrower at distal ends. Axial furrows branched forward adjacent to anterior end of glabella; inner branches outline anterior end of glabella, and are tangential to border furrow on axial line; outer branches moderately divergent forward across inner part of brim to border furrow outlining lateral parts of medium triangular lobes. Frontal area very short, sagittal length less than 10% of sagittal length of glabella, exclusive of occipital ring. Anterior margin slightly concave. Border of nearly constant width and slightly convex. Area between border and anterior end of glabella on axial line concave. Fixed cheek gently convex, horizontal; width about one-half basal glabellar width. Ocular ridge short and narrow. Palpebral lobe of medium size and moderately convex, situated opposite middle third of glabella; length slightly less than sagittal length of glabella exclusive of occipital ring; palpebral furrow well marked. Posterior border furrow deep. Posterior border has distinct angulation on line directly behind palpebral lobe, directed slightly forward lateral to this angulation. External parts of all convex surfaces including palpebral lobes covered with closely spaced coarse granules.

**Comments.** Liñán & Gozalo (2001) included this species in *Aragotus* Liñán & Gozalo, 2001. After publication, A. Palmer suggested to the authors that the cranidium
morphology was characteristic of Dinesus. In accordance with Palmer’s (1968) diagnosis of Dinesus, the presence of a hemicylindrical glabella and a preglabellar area that disappears in the axial region and is delimited from the preocular fields by two wide, deep, oblique furrows allows us to include the Spanish material in this genus, and we propose the new combination Dinesus truylsii.

The Ateca specimen resembles the type species Dinesus ida Etheridge, Jr, 1896, figured by Whitehouse (1939), although the Australian species has narrow palpebral lobes and fine tubercular ornamentation. Also, the stratigraphic distribution of both species is similar; Dinesus ida has been found in the Xystridura templetonensis Zone, which has been correlated with the Leonian Stage (Sdzuy et al. 1999, Gozalo et al. 2007).

Most Dinesus species have coarse tubercular ornamentation (Palmer 1968, Repina & Romanenko 1978) as does Dinesus truylsii, but the latter has a slightly concave anterior margin whereas the other species have straight or convex margins. Some specimens of Dinesus sibirica figured by Egorova et al. (1976, pl. 22, figs 21, 25) have straight or slightly concave anterior margins, but this species always has a preglabellar area that is wider than the anterior border.

Stratigraphic distribution. The specimen was collected in the lower part of the Ateca 2 section, Eccaparadoxides asturianus Zone (upper Leonian Stage).

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