A REVIEW OF THE GENUS Kingaspis (TRILOBITA, LOWER CAMBRIAN) FROM SPAIN AND ITS BIOSTRATIGRAPHICAL CONSEQUENCES FOR CORRELATION IN THE MEDITERRANEAN SUBPROVINCE

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ABSTRACT

Several specimens of the genus Kingaspis from the Lower Cambrian of Valdoré (León Province), Los Cordúes de Malagón (Ciudad Real Province), Murero, Ateca, Jarque and Tierga (Zaragoza Province) have been revised from a systematic point of view in order to decide their biostratigraphical value and their correlations within the Mediterranean subprovince. After the systematic study, the chronological order was found to be: Kingaspis (Kingaspidoidea) velata, Kingaspis (Kingaspidoidea) cf. velata and Kingaspis (Kingaspis) campbelli. Kingaspis (Kingaspidoidea) velata is typical of the Marrianian Stage while K. (Kingaspidoidea) cf. velata belongs to the upper Marrianian?-lower Bibiliian Stage. Kingaspis. (K.) campbelli was found in the upper Bibiliian levels of several Spanish localities. This fact facilitates the comparison between Spanish, Moroccan and Jordanian upper Lower Cambrian because this species is present in all these countries.

Keywords: Kingaspis, Trilobita, Lower Cambrian, biostratigraphy, Spain, Mediterranean subprovince.

RESUMEN

En este trabajo se revisa el material del género Kingaspis del Cámbrico Inferior que se ha encontrado en diversas localidades españolas (Valdoré, provincia de León; Los Cordúes de Malagón, provincia de Ciudad Real; Murero, Ateca, Jarque y Tierga, provincia de Zaragoza). La revisión de este material desde el punto de vista sistemático ha permitido calibrar su valor bioestratigráfico y de correlación dentro de la subprovincia Mediterránea. Las especies encontradas son Kingaspis (Kingaspidoidea) velata, Kingaspis (Kingaspidoidea) cf. velata y Kingaspis (Kingaspis) campbelli. Kingaspis (Kingaspidoidea) velata es característica del piso Marianiense, mientras que Kingaspis (Kingaspidoidea) cf. velata tiene una distribución Marianiense?-Bibliiense inferior. Por último Kingaspis (Kingaspis) campbelli ha sido hallada en el Bibliiense superior en varias localidades de las Cadenas Ibéricas y de la Cordillera Cantábrica; esta presencia permite la comparación entre el Cámbrico Inferior de España, Jordania y Marruecos donde también se ha encontrado la misma especie.

Palabras clave: Kingaspis, Trilobita, Cámbrico Inferior, bioestratigrafía, España, subprovincia Mediterránea.
INTRODUCTION

The genus *Kingaspis* is a common trilobite taxon from upper Lower Cambrian sequences of the Mediterranean region. This is present in Spain (Sdzuy, 1961; Gil Cid and Jago, 1989; Liñán et al., 1993a; Gozalo et al., 1996), Jordan (King, 1923; Rushton and Powell, 1998), Morocco (Termier and Termier, 1950; Gigout, 1951; Hupé, 1953; Geyer, 1990) and Poland (Orlowski, 1964; Lendzion, 1972). Recently *Kingaspis* has been found in New Brunswick (Canada; Westrop and Landing, 2000).

In Spain, Lotze and Sdzuy (1961) gave the name *Kingaspis velatus* Sdzuy, 1961 to specimens collected by Richter and Richter (1948) from Huérmeda, in the Iberian Chains. Subsequently, specimens of *Kingaspis* sp. have been found in Murero (Liñán et al., 1993a; Gozalo et al., 1996), Ateca (Álvaro et al., 1993a), Jarque (Liñán et al., 1996) and other localities of the Iberian Chains. Lotze and Sdzuy (1961) referred some poorly preserved material from Los Cortijos de Malagón (a trilobite locality discovered by Prado [1855]) in the Toledo Mountains, Ciudad Real Province to *Kingaspis cf. velatus*; and Gil Cid and Jago (1989) also recognised *Kingaspis* sp. in this area.

*Kingaspis* may therefore be useful for correlating different upper Lower Cambrian strata in the Mediterranean subprovince that were affected by the Daroca Regression (Liñán and Gámez-Vintaned, 1993; Álvaro and Vennin, 1998) when large areas emerged during the Bilbilian in some continents (Rushton and Powell, 1998).

The object of this work is the taxonomic revision of new and old material of kingaspidids from several sections (Fig. 1) in northern (Iberian Chains and Cantabrian Mountains) and central Spain (Toledo Mountains) in order to interpret any morphological changes from a stratigraphical point of view and to compare the new data in a Mediterranean context.

SYSTEMATIC DESCRIPTIONS

The studied material is deposited in the Museo Paleontológico de la Universidad de Zaragoza (Spain) as MPZ 7867, MPZ 7868, MPZ 99/22 to MPZ 99/52, MPZ 99/171 and MPZ 2000/4 to MPZ 2000/140. And in the Münster University (Germany) as L.3230. The abbreviations used in the measurements are: Gw = glabellar width, GI = glabellar length, Cw = cranial width, and Cl = cranial length. The “S” parameter (Liñán Guijarro, 1978, p.158 and fig. 35) makes reference to the imaginary straight line joining the initial and final points of the facial suture.

Superfamily Ellipsoccephaloidea Matthew, 1887
Family Ellipsoccephalidae Matthew, 1887
Subfamily Ellipsoccephalinae Matthew, 1887
Genus *Kingaspis* Kobayashi, 1935

Type species: *Anomocare campbelli* King, 1923; by original designation.

Discussion

Kobayashi (1935) assigned *Kingaspis* to the subfamily Ellipsoccephalinae. Later, Richter and Richter (1941) placed it close to the genus *Palaeoleolenus* Mansuy, 1912, but Hupé (1953) noted different differences between them. According to Hupé, *Kingaspis* has a shorter and less well-defined glabella and its eye ridge is barely defined. Hupé established the subfamily Kingaspidiinae and two subgenera: *Kingaspis* (Kingaspidoidea) with, and *K. (Kingaspis)* without, an occipital spine. Geyer (1990, p. 333) proposed to turn these subgenera into genera in base of several characters which, in our opinion, do not make easy the distinction of both genera in his emended diagnosis. Geyer’s emended diagnosis is difficult to apply in distorted material which is very common in Cambrian rocks. According to Rushton and Powell (1998) the main character of *Kingaspidoidea* to be distinguished from *Kingaspis* is the relatively uneven convexity of the cranidium in the transverse section.

Among the Spanish specimens, there are two different morphologies which coincide with the *Kingaspis* and *Kingaspidoidea* species differentiated in the material figured from Morocco by Geyer (1990) and from Jordan by Rushton and Powell (1998). The morphology A shows a peculiar-preglabellar furrow that defines a distinct frontal area which is not present in the type species of *Kingaspis campbelli* (King, 1923). We interpret this morphology as typical of *Kingaspidoidea*. Morphology B (or *Kingaspis* type) has not a peculiar-preglabellar furrow. In the present state of knowledge, we prefer to consider *Kingaspis* and *Kingaspidoidea* as subgenera.

Subgenus *Kingaspis* (Kingaspidoidea) Hupé, 1953

Type species: *Kingaspis* (Kingaspidoidea) armatus Hupé, 1953 [= *Kingaspis* (Kingaspis) brevisfrons Hupé, 1953].

Figure 1. Iberian Peninsula showing the Pre-Hercynian outcrops and the location of the studied sections. At: Ateca; Co: Cortijos de Malagón; Hu: Huérmeda; Ja: Jarque; MT: Tierga; Mu: Murero; Va: Valderé.
Figure 2: Stratigraphic distribution of trilobite taxa in section Jiark. (modified from Lithin et al., 1996). * = Studied taxa.
Kingaspis (Kingaspidoides) velata Sdzuy, 1961
Figs. 3 a, b, e

1929 Agraulos sp.; Lotze, p. 27.

v 1948 Ellipsocéphalidae, gen. et sp. indet.; Richter and Richter, 34, pl. 1 figs. 9-11.

v 1958 Palaæolemus velatus n. sp. (Sdzuy, manuscr.); Lotze, 730.

v* 1961 Kingaspis velatus n. sp.; Sdzuy, 308-310, pl. 15, figs. 1-8.

Emended name: The suffix -aspis (as in Kingaspis) is feminine, so the correct binomen is Kingaspis velata (Dr. Dean, p. com.) referring to the concealed relief.

Material and localities: Two cranidia preserved as tectonically distorted internal moulds in green lutites from the Jarque 1 section (Zaragoza province; Fig. 2). Sdzuy’s holotype (Fig. 3a, e) comes from the Huérmédex section and is housed in the Geologisches-Paläontologisches Museum of Münster (Germany), number L3230.

Measurements: The best preserved cranidium (Fig. 3 b) exhibits the following proportions: Gw/Cw = 1/2, Gl/Cl = 4/5.

Description

Cranidium subrectangular, slightly transversely convex, characterised by an arch-like anterior margin. The preglabellar field and the smooth preocular area lie below the levels of the glabella and eye. Subquadrates to subconical glabella with anterior and lateral furrows; anterolateral corners not expanded. Some of the specimens have three pairs of non-transglabellar furrows bent slightly backwards. Occipital furrow wide and well marked, occipital ring rounded and extended posteriorly. Eye ridges constant in width, but not always well defined. Palpebral lobe approximately as long as the anterior and posterior branches of the facial suture. Wide (sag.) posterior border furrow in the fixigena bent slightly forward. Thorax and pygidium unknown.

Remarks

For discussion see Sdzuy (1961), who founded his new species K. velatus (now K. velata) based on a high number of cranidia from Huérmédex locality (Iberian Chains) with a glabella approximately half the cranidial width, the lateral margins of the glabella convergent forward, and an occipital ring wider (sag.) medially than laterally.

Kingaspis (Kingaspidoides) velata shows the diagnostic character of Kingaspidoides. This species differs from those from Morocco described by Geyer (1990) as Kingaspoides because the Spanish species has not an anterior border marked. It differs also from Kingaspidoides cf. obliquocellatus from New Brunswick (Westrop and Landig, 2000) because the Avalonian North American specimens have an intercolar fixigena that slopes down less steeply to the palpebral lobes.

Stratigraphical distribution: Levels 110 and 111 of the Jarque 1 section in the middle part of the Ribota Formation (Fig. 2), and in the Huérmédex section at the top of the Ribota Formation (Lotze, 1961, fig. 6).

Kingaspis (Kingaspidoides) cf. velata Sdzuy, 1961
Fig. 3c, d, f, g, i, j

v 1961 Kingaspis cf. velatus n. sp.; Sdzuy, 592, pl. 15, figs. 9-14.


Material and localities: Eight poorly preserved tectonically distorted cranidia in yellow sandstones (Los Cortijos de Malagón) and red lutites (Tierga). The samples were collected from the Los Cortijos de Malagón site (Ciudad Real province) and from an unpublished section at Tierga (Zaragoza province).

Measurements: Measurements for the largest cranidium (MPZ 99/28) are: Cl = 14 mm. Gl = 10 mm. Gw = 6 mm. The best preserved cranidium (Fig. 3j) exhibits the following proportions: Gw/Cw = 2/5, Gl/Cl = 5/7.

Description

Cranidium smooth, very similar to Kingaspis (Kingaspidoides) velata, but with an anterior margin more convex (trans.) and a moderately marked anterior border furrow; this border is approximately 1/3 of the preglabellar field’s width (sag.). Preglabellar field convex with one preglabellar-preocular furrow. Palpebral lobes curved.

Remarks: Sdzuy (1961) assigned the material from Los Cortijos de Malagón to Kingaspis cf. velatus. The new specimen from Tierga is included in open nomenclature together with the specimens from Los Cortijos de Malagón because of the scarce number of samples.

Stratigraphical distribution: Lower part of the Huéremada Formation at the Tierga section, and upper part of Los Cortijos Formation from Los Cortijos de Malagón site.

Kingaspis (Kingaspidoides) sp.
Fig. 3h, k

Material and locality: one cranidium preserved in green lutites as internal mould from Murero (Rambla de Valdemiedes 2 section). MPZ 99/52.

Description
Cranidium arch-like anterior margin in frontal view and slightly convex in dorsal view. Smooth preglabellar field (directly connected to the anterior margin) and of 1/3 of the cranidium length (sag.). Glabella with marked lateral and anterior furrow, parallel sides, and expanded anterolateral corners. Four pairs of slightly marked non-transglabellar furrows directed backward. Deep and rectangular occipital furrow. The only sample is broken so that we cannot see completely the occipital ring. Smooth preocular field as wide as the preglabellar field (sag.). Marked preocular-preglabellar furrow. Long palpebral lobe joint to the anterior corner of the glabella by a slightly curved eye ridge and directly joint to the posterior border so that it has not postocular field. Subtrapezoidal and smooth palpebral field. “S” parameter (Liñán Guijarro, 1978) secant and slightly convergent. Thorax and pygidium unknown.

Remarks
Kingaspis (Kingaspidoides) sp. differs from the Moroccan species in the lack of anterior border.

Stratigraphical distribution: This specimen was found removed in the upper part of the Valdemiedes Formation (upper Bibilbian-early Leonian), and it is the youngest Kingaspidoides found in Spain.

Subgenus Kingaspis (Kingaspis) Kobayashi, 1955

Type species: Anomocare campbelli King, 1923

Kingaspis (Kingaspis) campbelli (King, 1923)
Figs. 3i-r, 4.

1990 Kingaspis campbelli (King, 1923); Geyer, 104, pl. 15 fig. 11, pl. 17 fig. 8-10 (with previous full synonymy).

1993a Kingaspis sp.: Liñán et al., fig. 3.

1993a Kingaspis sp.: Alvaro et al., 44-46, pl. 1 figs. 5-6.

1996 Kingaspis sp.; Gozalo et al., fig. 34.

1998 Kingaspis campbelli (King, 1923); Rushton and Powell, 141, fig. 21-26.

1999 Kingaspis campbelli (King, 1923); Díes et al., 223-225, fig. 1.

Material and localities: The material from the Iberian Chians includes three almost complete specimens, one hundred and thirty-eight cranidia and three librigenae preserved in green lutites as internal moulds, and some external moulds from the Jarque 1 section (Zaragoza province); eleven cranidia, two cranidia attached to incomplete thoraces and one cephalon preserved in green and yellow lutites as internal moulds showing traces of the organic carapace and some of their external moulds, from the Rambla de Valdemiedes 1 and 2 sections (near Murero, Zaragoza province); one cranidium preserved in grey limestone from the Ateca section (Zaragoza province); all tectonically distorted. In the Cantabrian Mountains, five cranidia preserved within limestone pebbles from the Valdoré section (León province).

All the collected material belongs to the Hamatoleon ibericus zone (Liñán et al., 1993a), Upper Bibilbian, according to the trilobite assemblages. Therefore the high number of Spanish specimens studied (more than 150) permits a better knowledge of the intraspecific variation of K. (K.) campbelli.

Measurements: The largest cranidium (Fig. 4e, f) has the following proportions: Gw/Cw = 1/2, GI/CI = 3/4; and for the smallest one (Fig. 4g, h): Gw/Cw = 1/2, GI/CI = 3/4. These parameters, calculated in 119 Spanish specimens, are represented in the figure 5 together with those from the lectotype (King, 1923), Morocco (Geyer, 1990) and Jordan (Rushton and Powell, 1998). The lectotype coincides with the regression line that results from the Spanish material measurements.

Description
Cranidium - See Geyer (1990: 104). The librigena shows pointed genal spines (as in Kingaspis cf. sarhraeensis Geyer, 1990) reaching at least as far as the third axial ring. Thorax with up to fourteen thoracic segments. In the first five segments the rachis is distinctly wider than the pleura and, in the following segments, the axis is approximately as wide as the pleura. The pleura are bent by the fulcrum line and have wide and leaf-shaped pleural furrows. An eroded pygidium attached to an almost complete specimen (Fig. 4a, d) exhibits semicircular shape with only one noticeable axial and pleural furrow. The ratio between the width of the pleural field in the pygidium and the axis (trans.) is 1/2.

The grade of effacement is different between the interior and exterior of the exoskeleton. In the internal mould, the furrows are more marked than in the external mould as it is also evident in the material from Jordan (Rushton and Powell, 1998).
Ontogeny and variability

The best preserved immature cranidia (Fig. 4g-h) have a well-defined glabella and are not so convex transversally as the adult cranidia. Furthermore, they show a preglabellar-preocular furrow as well as marked glabellar furrows that are not always present in adults.

In the internal mould, the adult specimens show an intraspecific variability from a smooth cranidium with only a partially defined glabella (Fig. 3p) to a well-defined anterior border, glabella and glabellar furrows (Fig. 3n, q and Fig. 4e, f). This variability includes transitional specimens (Fig. 4b, c) without an anterior border but with well-defined glabellar furrows as in the Jordan material (Rushton and Powell, 1998: Figs. 21a, 25a and 23a).

There are also some differences in the relative length of the palpebral lobe. A morphotype can be distinguished because it has a palpebral lobe slightly longer than the posterior branch of the facial suture; the other is characterised by a palpebral lobe approximately as long as the posterior branch of the facial suture. This feature is also present in the material figured by Rushton and
The Jarque 1 section is one of the most complete Cambrian sequences in the Iberian Chains (Liñán et al., 1996). Upper Lower Cambrian strata are represented by the dolomite and marble alternations of the Ribotta Formation, the shale and fine sandstone of the Huérmeda Formation, alternations of shale and sandstone (Daroca Formation) and alternations of shale and carbonate nodules of the Valdemiedes Formation (Fig. 2). The specimens assigned here to *Kingaspis* (*Kingaspidoidea*) *velata* were found in the middle part of the Ribotta Formation. This agrees with previous data on the species which was originally reported by Lotze and Sdzuy (1961) from the top of the Ribotta Formation at Huérmeda, a locality near the Jalón valley. The youngest species, *Kingaspis* (*Kingaspis*) *campbelli*, is recorded from the middle part of the Valdemiedes Formation.

Near Tierga, specimens of *Kingaspis* (*Kingaspidoidea*) cf. *velata* in the lower part of the Huérmeda Formation represent the earliest stratigraphical position of this taxon in the Iberian Chains.

At Murero, the material now assigned to *K. (Kingaspis) campbelli* derives from the middle part of the Valdemiedes Formation at the base of the sections Rambla de Valdemiedes 1 and Rambla de Valdemiedes 2 (Liñán and Gozalo, 1986; Liñán et al., 1993a; Gozalo et al., 1996), the same stratigraphical position as in the Atea section (Álvaro et al., 1993a).

In the Valdoré section, *K. (Kingaspis) campbelli* was found within pebbles in the conglomeratic base of the upper member of the Lánaca Formation.

Los Cortijos de Malagón section was studied by Weggen (1955) who distinguished five stratigraphic units within the Los Cortijos Sandstone. These were recognised by Zamarréno et al. (1976) as follows: Unit 1, bright green argillite (base); Unit 2, green sandstone with abundant shale; Unit 3 consisting of a sandstone-shale alternation; Unit 4, quartzite; and Unit 5, trilobite sandstone (top). The trilobites described herein as *Kingaspis* (*Kingaspidoidea*) cf. *velata* were collected from the lower part of the Unit 5. Given that the Los Cortijos Formation was tentatively correlated with the Daroca Formation of the Iberian Chains by Sdzuy (1971) and Liñán et al. (1993b), the specimens from Los Cortijos de Malagón are probably stratigraphically higher than those now reported from Tierga (Iberian Chains).

**BIOCHRONOLOGY**

The position of the Lower-Middle Cambrian boundary is still a controversial subject studied by the International Subcommission on Cambrian Stratigraphy (Sdzuy, 1971; Geyer and Palmer, 1995; Rushen and Powell, 1998; Geyer and Shergold, 2000). We adopt herein the classic boundary used in the Mediterranean subprovince that is placed at the first appearance datum (FAD) of *Acadoparadoxes (=Eoparadoxes)* *mureroensis* (Sdzuy, 1958). This formal aspect will allow us to employ the regional Stages of Spain (Sdzuy, 1971; Liñán et al., 1993b) which are considered, at present, by

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**STRATIGRAPHY**

The material studied here was collected in the Iberian Chains (Jarque, Atea, Tierga and Murero sections), the Cantabrian Mountains (Valdoré) and the Toledo Mountains (Los Cortijos de Malagón site).
Sdzuy et al. (1999) as the most useful units for the Mediterranean subprovince correlation.

*Kingspis* (Kingaspidoideae) velata Sdzuy, 1961 was cited by Lotze (1961) associated with *Lasatiops ribotanus* Richter and Richter, 1948 and the FAD of *Stremaeva incinata* Sdzuy, 1961 in the Huémeda section. This assemblage characterises the Marrianian Stage (Sdzuy, 1971; Liñán et al., 1993b). In the Ribota Formation at the Jarque 1 section, *K. (Kingaspidoideae) velata* occurs with *S. incinata* and immediately below *L. ribotanus* and the presence at the base of the overlying Huémeda Formation of a Middle–Upper Marrianian trilobite assemblage, including *Andalusiana, L. ribotanus, Trianglescopus* and *Macmecca aff. coloi* (see Sdzuy, 1971; Liñán et al., 1993b) at several localities in the Iberian Chains confirms this biochronological interpretation.

In Los Cortijos de Malagón, *Kingspis* (Kingaspidoideae) cf. *velata* is associated with *Realaspis sternoides* Sdzuy, 1961, *Pseudolenus wegeneri* Sdzuy, 1961, *Pseudolenus glaber* Sdzuy, 1961 (Lotze and Sdzuy, 1961) and cf. *Laioucheia* sp. (Gil Cid and Jago, 1989) of lower Bibilbian age (Sdzuy, 1971; Liñán et al. 1993b). As *Kingspis* (Kingaspidoideae) cf. *velata* is also recorded in the lower part of the Huémeda Formation, the specimens from Tierga may still be of Marrianian age. Thus, an Upper Marrianian–Lower Bibilbian range for this taxon is indicated.

*Kingspis* (Kingaspis) campbelli (King, 1923) is found together with *Protolenus* (*Hupeolenus*) cf. *termierelloides* Geyer, 1990, *Protolenus* (*Hupeolenus*) *jilocanus* (Liñán and Gozalo, 1986) and *Protolenus* (*Hupeolenus*) *dimarginatus* Geyer, 1990 at the Jarque 1 section (Liñán et al., 1996; Dies et al., 2001); it is now reported together with *P. (H.) jilocanus* from Ateca (Alvare et al., 1993a) and with *Hamatolenus* (*Hamatolenus*) *ibericus* Sdzuy, 1958, *P. (H.) jilocanus*, *Onaraspis altus* (Liñán and Gozalo, 1986), Tonkinella *sequel* Liñán and Gozalo, 1999, *Sdzuyia sanamemii* Liñán and Gozalo, 1999 and *Hamatolenus* (*Myopsolenus*?) sp. at the Rambla de Valdemiedes 1 and 2 sections (Liñán and Gozalo, 1986, 1999; Gozalo et al. 1996). These records suggest an Upper Bibilbian age for the species *Kingspis* (Kingaspis) campbelli (King, 1923) in Spain. A Bibilbian age has also been inferred for the trilobite levels with *Kingspis* (Kingaspis) campbelli from the Wadi Zarqa Ma’in section in Jordan and with doubt from Morocco by Rushton and Powell (1998).

**KINGASPIS (KINGASPIS) CAMPBELLII CORRELATION**

*Kingspis* (Kingaspis) campbelli occurs in Jordan (Burj Formation, Wadi Zarqa Ma’in; see Rushton and Powell, 1998), Morocco (Jbel Wawrmat Formation, Boukaïs; see Geyer, 1990) and Spain (Valdemiedes Formation, Jarque, Murero and Ateca; and Lâncara Formation, Valdoré; herein).

The Jordanian specimens of *Kingspis* (Kingaspis) campbelli belong to the uppermost part of the Numayri
Dolomite Member and/or the Hanneh Silestone Member within the Burj Formation (Rushhton and Powell, 1998: 134). This species is associated with *Palaeolecanus antiquus* (Chernysheva, 1956) which characterises the basal Zone of the Amgan Stage in Siberia. Rushhton and Powell (1998: table 1) correlated it with the Bilbilian Stage. Nevertheless, their correlation with the Siberian Stages is slightly different from that of Sdzuy (1995) and Sdzuy et al. (1999) emphasising the lack of biochronological knowledge in the upper Lower Cambrian.

The upper part of the Numayri Dolomite Member also contains *Redlichops blanckenhorni* Richter and Richter, 1941 and *Realaspis* sp. nov. sensu Rushhton and Powell, 1998 in Wadi Un'ai at the southern edge of Dead Sea (see op. cit.: Fig. 2). These authors suggest a Bilbilian age for this fauna.

A comparison of Jordan faunas (Fig. 6) with classic and new kingaspidid taxa from Spain permit us to tentatively propose a Lower Bilbilian-lower Upper Bilbilian age for the *Redlichops blanckenhorni* and *Realaspis* sp. nov. faunus and an Upper Bilbilian age for the *Kingaspis* (*Kingaspis*) campbelli and *Palaeolecanus antiquus* faunal assemblages.

The Moroccan specimens of *Kingaspis* (*Kingaspis*) campbelli are from the Jebel Warwmas Formation (probably Breche à Mimaacca Member), but their exact stratigraphical level is unknown (see Geyer, 1990: 44, and Rushhton and Powell, 1998: 137). The assemblages at these levels include *Kingaspis* (*Kingaspis*) campbelli, *Ornamentaspis desombei* Geyer, 1990 and *Ornamentaspis ?* sp. A sensu Geyer, 1990 and regarded as part of the *Ornamentaspis frequens* Zone (Geyer, 1990; Rushhton and Powell, 1998), correlated with the middle Leonian Stage by Geyer (1990) and Sdzuy et al. (1999). The new biostratigraphic data from Spain indicate that *Kingaspis* (*Kingaspis*) campbelli is not limited to the Moroccan equivalents of the Leonian Stage, but ranges up from the Bilbilian levels in Spain and Jordan.

**SUMMARY AND CONCLUSIONS**

Our review of the available material of the genus *Kingaspis* from the Iberian Chains and Toledo Mountains places both subgenera *Kingaspis* (*Kingaspidoides*) and *Kingaspis* in equivalent Lower Cambrian sequences in Spain. Four kingaspidid taxa are included in this study. The former *Kingaspis velatus* and *Kingaspis* cf. *velatus*, originally described by Sdzuy (1961), are now placed in the subgenus *Kingaspidoides* sensu Geyer (1990); *Kingaspis* (*Kingaspis*) campbelli is recognised as the species known in Jordan and Morocco and permits a better correlation of the upper Lower Cambrian of the Mediterranean subprovince.

*Kingaspis* (*Kingaspidoides*) velata is reported from the Rubota Formation characterising a Middle-Upper Maranian Stage in the Iberian Chains. *Kingaspis* (*Kingaspidoides*) cf. *velata*, in the Los Cortijos Formation (Toledo Mountains) is now known from the Huérmada Formation (Iberian Chains) and its trilobite association suggests an uppermost Maranian? and Lower Bilbilian age. *Kingaspis* (*Kingaspis*) campbelli is cited herein from several Spanish localities in the Iberian Chains and Cantabrian Mountains, where it occurs in the middle part of Valdemiedes Formation and in the basal beds of the upper member of the Lánzara Formation respectively; an upper Bilbilian age for this species is indicated by its trilobite association.

At present, *Kingaspis* (*Kingaspis*) campbelli is the first Cambrian species common to Jordan and Spain allowing a more accurate correlation in upper Bilbilian times (Fig. 6). Rushhton and Powell (1998) correlated the Burj Formation with the Bilbilian Stage by means of the recorded trilobites, suggesting that the Daroca Regression probably re-established fluvial deposition over Jordan and on the Arabian Craton, an opinion with which we agree. If our biostratigraphic conclusions are correct, a more exact correlation is now possible with the Wadi Zarqa Ma'in area in the Northern Dead Sea, where we consider that the fluvial Hanneh Silestone Member has a similar biostratigraphical position in the upper part of the Valdemiedes Formation. Furthermore we cannot discard the possibility that the fluvial Hanneh Silestone Member includes the Valdemiedes Event (Liñán et al., 1993a), which was the last regressive pulse of the generalized Daroca Regression in upper Lower Cambrian.

**ACKNOWLEDGEMENTS**

This work is a contribution to projects PB96-0744 of the Dirección General de Estudios Superiores, BTE 2000-1145-C02-01 of the Dirección General de Investigación, 121/99 and 166/99 of the Departamento de Educación y Cultura del Gobierno de Aragón. M. E. Dies holds a pre-doctoral
research grant from the Departamento de Educación y Cultura del Gobierno de Aragón. Dr. Markus Bertling allowed us to study the *Kingaspis* (*Kingaspiloidea*) velata holotype and Dr. Karsten Weddige allowed us the revision of the Senckenberg Museum collection of *Kingaspis*. Photography by Servicio de Fotografía de la Universidad de Zaragoza. Comentarios to original manuscript were made by Dr. Álvaro, Dr. Arbizu, Mr. Gámez Vintaned, Dr. Geyer, Dr. Fletcher, Dr. Martínez Chacón and Dr. Villas. The authors wish to thank the following persons for helping them in the sample preparations: Mr. Eduardo Martín, Mr. Enrique Oliver, Mrs. Silvia Gracia and Mrs. Teresa Rodríguez.

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Manuscrito recibido: 31 de agosto, 2001