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Polygnathids (Conodonta) around the lower/upper Emsian boundary from the La Guardia d'Àres section (Lower Devonian, Spanish Central Pyrenees)

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ABSTRACT - Study of the La Guardia d'Àres section from the Spanish Central Pyrenees has yielded significant conodont faunas relevant for the subdivision of the Emsian stage. Four Polygnathus *species are described and discussed:* P. laticostatus*,* P. gilberti*,* P. linguiformis bultyncki *and* P. vigierei*. The latter three are cited for the first time from the Spanish Central Pyrenees. The new conodont record includes two of the three conodont index taxa proposed for the identification of the lower Emsian/upper Emsian boundary* (P. laticostatus *and* P. gilberti)*. Consequently, they may prove useful for the future decision on the position of this boundary by the Subcommission on Devonian Stratigraphy. These data allow a precise placement of the boundary in the Spanish Central Pyrenees.*

RIASSUNTO - [Polignatidi (Conodonta) al limite Emsiano inferiore/superiore nella sezione di La Guardia d'Àres (Devoniano Inferiore, Pirenei Centrali, Spagna)] - *Lo studio della sezione di La Guardia d'Ares (Pirenei Centrali, Spagna) ha rivelato una fauna a conodonti di significativa importanza per la suddivisione dell'Emsiano (Devoniano Inferiore). In questo lavoro sono descritte e discusse quattro specie del genere* Polygnathus: P. laticostatus*,* P. gilberti*,* P. linguiformis bultyncki *e* P. vigierei*, di cui le ultime tre sono segnalate per la prima volta nei Pirenei Centrali Spagnoli. Questo record a conodonti ha permesso l'identificazione di due dei tre possibili conodonti proposti come specie indice per la definizione del limite Emsiano inferiore/Emsiano superiore:* P. gilberti *e* P. laticostatus*. Di conseguenza, questi dati potranno essere molto utili per le future decisioni che la Subcommission on Devonian Stratigraphy dovrà adottare sulla suddivisione dell'Emsiano e sulla posizione del limite Emsiano inferiore/superiore. I nostri dati ci permetteranno quindi di posizionare questo limite in modo accurato proprio nei Pirenei Centrali Spagnoli.*

INTRODUCTION

Some of the major efforts of the Subcommission on Devonian Stratigraphy (SDS) during the last years have focused on the Emsian Stage (Lower Devonian). Amongst the different problems of this stage, two aspects stand out: the redefinition of its lower boundary and the subdivision into two substages. The former is the subject of intensive current research (see update in Carls et al., 2008), and the intra-Emsian subdivision is one of the main ongoing objectives of the SDS (e.g., Becker, 2011).

The convenience of an Emsian subdivision has historically been based on two main aspects: 1) the extensive duration of the Emsian, which is markedly longer than all other adjacent stages (approximately 16 Ma according to Ziegler & Sandberg, 1994, or about 17.2 Ma in Kaufmann, 2006); and 2) the significant differences between the faunas of the lower and upper Emsian intervals, highlighting innovations in conodonts, ammonoids, tentaculites, brachiopods, and trilobites in the upper Emsian. These faunal differences are associated with a major event of sea level change, the Daleje Event (House, 1985; García-Alcalde & Truyols-Massoni, 1994; Chlupáč, 1997; Becker, 2007), reinforcing the proposal of the stage subdivision. However, further data are necessary before a formal decision can be made.

In recent years we conducted intensive conodont research in the Emsian of the Spanish Central Pyrenees. This comprehensive study yielded an abundant record of *Polygnathus* taxa relevant for the Emsian conodont-based biozonation (Valenzuela-Ríos, 1994, 2001; Martínez-Pérez & Valenzuela-Ríos, 2005; Martínez-Pérez et al., 2010, 2011), including important species around the lower/upper Emsian boundary interval. Continuing this work, the main purpose of this paper is to describe the *Polygnathus* succession around this interval in the Spanish Central Pyrenees.

GEOGRAPHICAL AND GEOLOGICAL SETTINGS

The material here presented has been recovered from the La Guardia d'Àres section (LGA), located between the localities of Gerri de la Sal and Seu d'Urgell in the Lérida Province (Fig. 1a). The access to the section is through the local road LV-5134 between the small villages of Noves de Segre and La Guardia d'Àres, roughly 1.5 km northeast to La Guardia d'Ares (see Martínez-Pérez, 2010 for a more detailed geographical description). The LGA section has been assigned to the extensive Southern Facies Area of the Spanish Central Pyrenees defined by Mey (1967a) (Fig. 1b). This facies area can be subdivided into four smaller "subfacies areas": Sierra Negra, Baliera, Renanué and Compte (Mey, 1967a,b, 1968; Hartevelt, 1970; Valenzuela-Ríos & Liao, 2006); the section belongs to the Compte Subfacies Area (Mey, 1967a; Hartevelt, 1970) (Fig. 1b). The LGA section (Fig. 2) consists of approximately 60 m of red and green limestones with intercalated red calcareous shales that belong to the Villech Formation. The base of the section also exposes

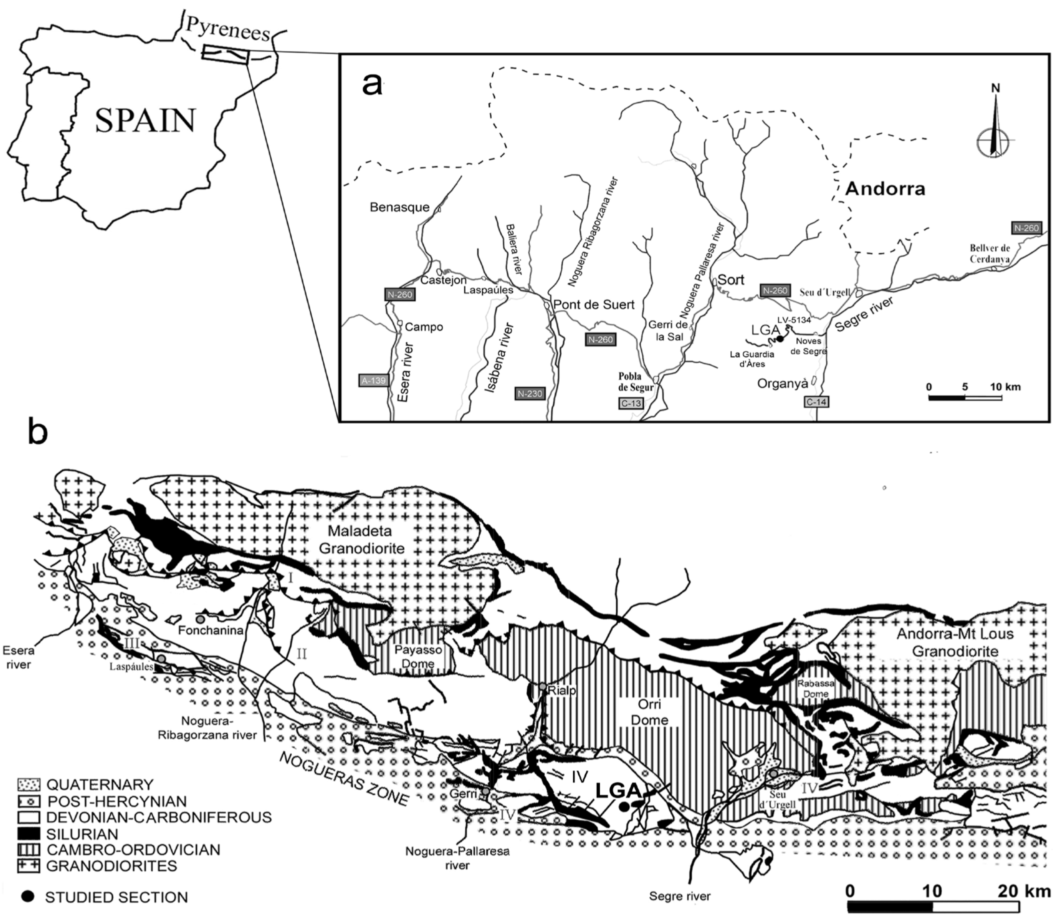


Fig. 1 - a) Geographical location of the La Guardia d'Àres section (LGA); b) geological scheme of the study area in the Spanish Central Pyrenees, indicating the four subfacies areas contained in the Paleozoic outcrops in the Southern Facies-area of Mey (1967a): I) Sierra Negra Subfacies, II) Baliera Subfacies, III) Renanué Subfacies and IV) Compte Subfacies; together with the location of the studied section (LGA). Based on Valenzuela-Ríos (1994).

the local Castells Beds Member, which is characterized by brownish, platy limestones with numerous millimetric to centimetric intercalations of brown shales. The section was sampled thoroughly for conodonts and other microfossils. The positions of samples in the section is shown in Fig. 2 (black dots), together with the stratigraphical ranges of the selected conodont taxa. A complete stratigraphical and geological description of the section can be found in Martínez-Pérez (2010).

SYSTEMATIC PALEONTOLOGY

All specimens discussed herein appear as isolated elements after the dissolution of carbonate rocks with formic acid (5-10%), and they are deposited at the Museo de Geología de la Universitat de Valencia (MGUV).

Class Conodonta Eichenberg, 1930
Order Ozarkodinida Dzik, 1976
Family Polygnathidae Bassler, 1925

Genus *Polygnathus* Hinde, 1879

Polygnathus gilberti Bardashev, 1986
(Pl. 1, fig. 5)

Type species - Polygnathus dubius Hinde, 1879

1975 *Polygnathus gronbergi* transitional to *laticostatus* Klapper & Johnson, Pl. 1, figs 25-26.
* 1986 *Polygnathus gilberti* n. sp. Bardashev, p. 63-64, Pl. V, figs 17-18 (with synonymy list).
2002 *Polygnathus* aff. *gilberti* García-López et al., Pl. 5, figs 27-28.
2002 *Linguipolygnathus gilberti* Bardashev - Bardashev et al., Text-figs 10, 15.29 (with synonymy list).

Material - 3 specimens from the levels LGA 33 (MGUV-20.916) and LGA 37 (MGUV-20.917 and MGUV-20.918).

Description - Free blade relatively high and short, representing about 1/4 of the total length of the element. The carina is situated centrally and flanked by narrow and poorly developed adcarinal troughs, the outer being slightly wider and both of equal length, disappearing at the posterior half of the element, coinciding with the development of the tongue. The main body has a wide suboval platform outline with a moderate constriction

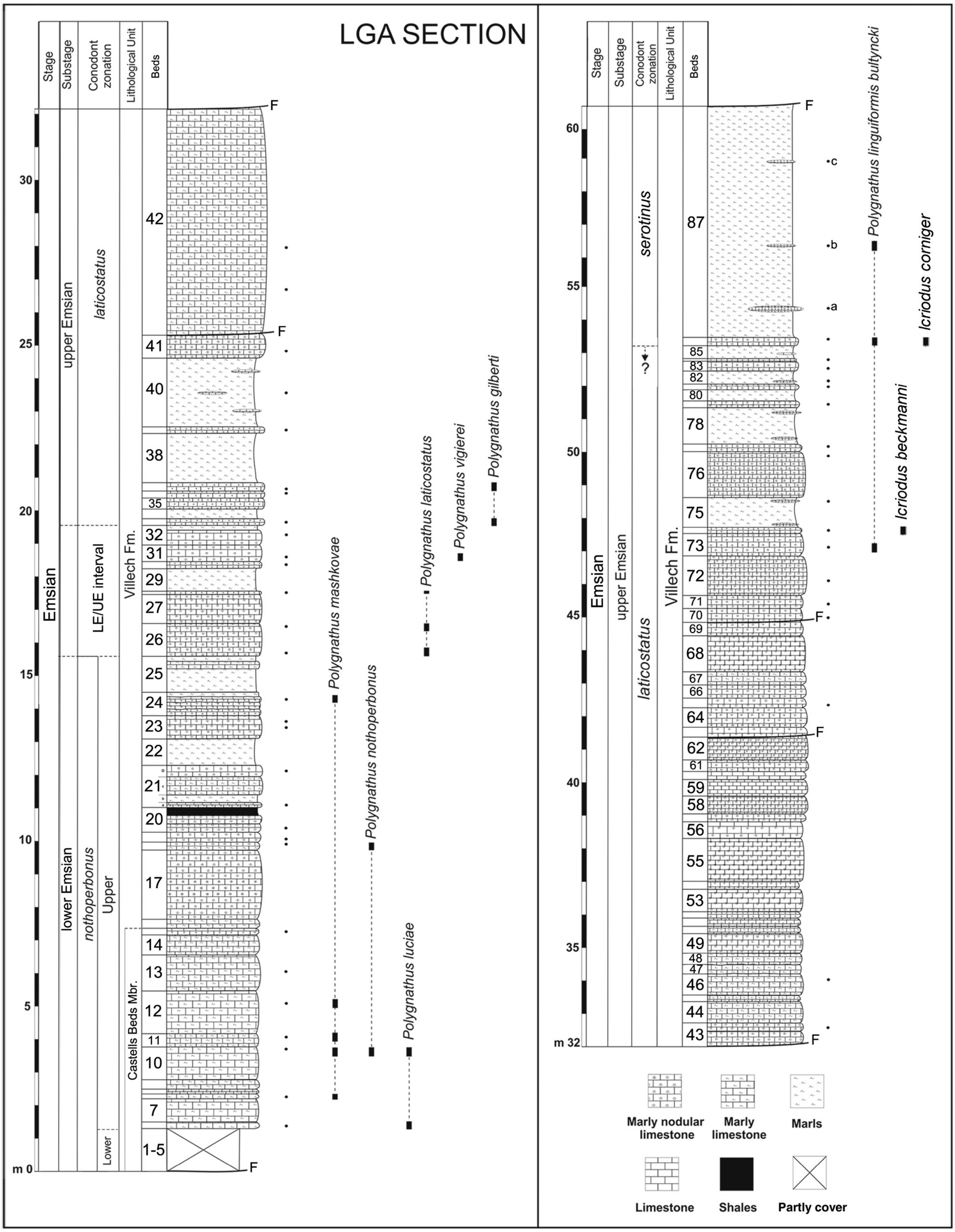


Fig. 2 - Stratigraphical log of the La Guardia d'Àres section (LGA) showing the location of the levels sampled for conodonts (black dots). Together with the stratigraphical range of the *Polygnathus* here described, other non-relevant species for the Emsian subdivision are also shown for a better understanding of the conodont sequences. For a detailed description of these taxa see Martínez-Pérez et al. (2011). F= Fault.

in the anterior region. Outer platform greater than inner especially in the posterior half (Pl. 1, fig. 5a). The posterior half of the platform develops a broad semicircular tongue, which is slightly curved interiorly and ornamented by up to eleven straight, transverse ridges. Some of them show an open V-shape, with the apex directed posteriorly, the last two are short and do not reach the middle part (Pl. 1, fig. 5a). The anterior edges of the platform join the free blade at angles slightly greater than 90°. The oral surface of the platform is ornamented by well developed ridges arranged perpendicular to the edges, or slightly convergent towards the center of element.

An inverted, symmetrical and small basal cavity is situated in the anterior half of the element just anterior to the keel's inward deflection (Pl. 1, fig. 5b). The basal cavity shows an anterior narrow groove and a posterior keel that reaches the posterior end of the element.

Discussion - Several features allow assignation of our specimens to *P. gilberti*: 1) the platform suboval shape and ornamentation, with well developed ridges arranged perpendicular to the edges, and transverse ridges on the tongue; 2) the development of short, shallow and narrow adcarinal troughs; and 3) a basal cavity that is completely inverted and located in the anterior half of the element. Our specimens are very similar to the holotype figured by Bardashev (1986: pl. 5, fig. 18) and those specimens of *P. gilberti* determined originally by Klapper & Johnson (1975: pl. 1, figs 29-32) as *P. laticostatus*. Although both taxa show some similarities, they clearly differ because, in contrast with the symmetrical basal cavity of *P. gilberti*, *P. laticostatus* presents an asymmetrical basal cavity. Besides, some of the type specimens of *P. laticostatus* show a wider developed outer margin (e.g., Klapper & Johnson, 1975: pl. 1, fig. 31; pl. 2, fig. 22), a feature absent in *P. gilberti.* The oral morphology of both taxa is also different; the platform edges of *P. laticostatus* are straight, while the ones of *P. gilberti* are curved giving to the platform a characteristic suboval outline. Bardashev et al. (2002) installed the taxon *P. talenti* for some specimens previously attributed to *P. gilberti* exhibiting a narrow platform and short ribs. Our specimens clearly fall within *P. gilberti* due to the wide platform and long ribs.

Stratigraphical and geographical distribution - The stratigraphical distribution of this taxon is not well known, but according to different authors it ranges from the base of the *P. laticostatus* zone (Bultynck, 1989; Bardashev & Ziegler, 1992), to the lower part of the *P. serotinus* zone (Bardashev et al., 2002). This taxon has been proposed as one of the possible index for the lower boundary of the upper Emsian substage (Becker, 2007).

It has been recorded from Spain, Central Pyrenees (herein) and Cantabrian Mountains (García-López et al., 2002), France (Armorican Massif; Bultynck, 1989), Central Asia (Bardashev, 1986; Bardashev & Ziegler, 1992), South China (Wang & Ziegler, 1983) and North America, Nevada (Clark & Ethington, 1966; Klapper & Johnson, 1975) and Alaska (Lane & Ormiston, 1979).

Polygnathus laticostatus Klapper & Johnson, 1975
(Pl. 1, figs 1-2)

* 1975 *Polygnathus laticostatus* Klapper & Johnson, p. 74, Pl. 2, figs 20-33.
2011 *Polygnathus laticostatus* Klapper & Johnson - Martínez-Pérez et al., Fig. 6c (with synonymy list).

Material - 3 elements from the levels LGA 26 (MGUV-20.928 to MGUV-20.930) and one specimen from the level LGA 28 (MGUV-20.931).

Description - Free blade relatively high and short, representing less than 1/5 of the total length of the element. The main body is straight and asymmetrical, with the platform edges running approximately parallel and showing a greater development of the outer platform in the posterior half (Pl. 1, figs 1b, 2b). The edges of the platform join the free blade approximately at the same point, with angles slightly greater than 90°. The platform is curved inwards in the posterior third, developing a large triangular tongue. The oral surface is ornamented by numerous short to medium size transverse ridges. The carina is situated centrally and flanked in the anterior two thirds by narrow and equally developed adcarinal troughs. The tongue is ornamented by 5-7 transverse or semi-crossed ridges (Pl. 1, figs 1b, 2b). In side view the main body is straight, bending aborally in the posterior region.

The specimens studied have a completely inverted basal cavity with a relatively large, asymmetrical basal pit (with a more developed outer lip) located just anterior to the inward deflection of the keel (Pl. 1, figs 1a, 2a).

EXPLANATION OF PLATE 1

Emsian conodonts from the La Guardia d'Àres section (LGA) (Spanish Central Pyrenees) around the lower/upper Emsian boundary. All scale bars are 200 µm.

Fig. 1 - *Polygnathus laticostatus* Klapper & Johnson, 1975. a) Lower view of MGUV-20.929, LGA section Bed 26; b) upper view of MGUV-20.929, LGA section Bed 26.

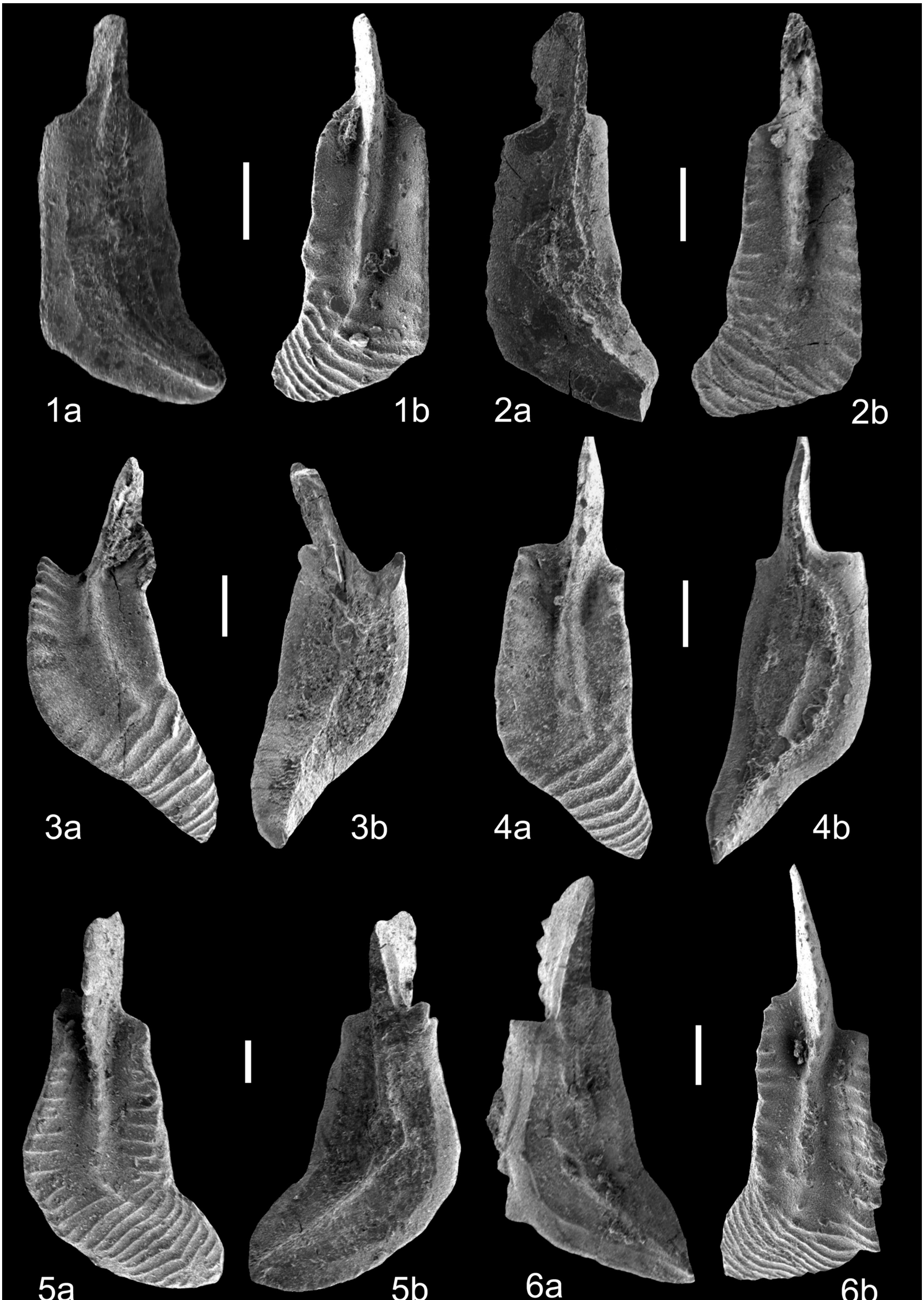
Fig. 2 - *Polygnathus laticostatus* Klapper & Johnson, 1975. a) Lower view of MGUV-20.931, LGA section Bed 28; b) upper view of MGUV-20.931, LGA section Bed 28.

Fig. 3 - *Polygnathus linguiformis bultyncki* Weddige, 1977. a) Upper view of MGUV-20.933, LGA section Bed 86; b) lower view of MGUV-20.933, LGA section Bed 86.

Fig. 4 - *Polygnathus linguiformis bultyncki* Weddige, 1977. a) Upper view of MGUV-20.934, LGA section Bed 87b; b) lower view of MGUV-20.934; LGA section Bed 87b.

Fig. 5 - *Polygnathus gilberti* Bardashev, 1986. a) Upper view of MGUV-20.917, LGA section Bed 37; b) lower view of MGUV-20.917, LGA section Bed 37.

Fig. 6 - *Polygnathus vigierei* Bultynck, 1989. a) Lower view of MGUV-21.087, LGA section Bed 31; b) upper view of MGUV-21.087, LGA section Bed 31.


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b

Discussion - Our specimens are similar to the type material of the species figured by Klapper & Johnson (1975: pl. 2, figs 20-33), as well as to other specimens figured in the literature (Glenister et al., 1976: figs 1, H, I; Klapper et al., 1978: pl. 1, figs 4-7; Bultynck & Morzadec, 1979: pl. 1, figs 21-24; Mashkova & Sobolev, 1980: pl. 1, figs 17-20). They are characterized by: 1) a straight and wide platform, developing a triangular tongue, 2) a platform ornamented by numerous transverse ridges, and 3) a complete inverted and asymmetrical basal cavity, located in the middle of the platform in aboral view.

P. laticostatus presents clear differences with the other contemporaneous species recorded in the Spanish Central Pyrenees, such as *P. gilberti* and *P. vigierei*. *P. gilberti* shows a symmetrical basal cavity and a semicircular platform (see discussion above); *P. vigierei* has an asymmetrical platform, different tongue shape and the characteristic serrated outer edge (see discussion below).

Stratigraphical and geographical distribution - *P. laticostatus* is an important biostratigraphical marker that has been proposed, together with *P. inversus*, as a putative index for the lower/upper Emsian boundary; it is also the index of the *P. laticostatus* zone (see, for example, Bultynck, 1976; Bultynck & Hollard, 1980; Weddige & Requadt, 1985; Becker, 2007). Its stratigraphical distribution seems to be restricted to the *P. laticostatus* zone. It has been found in the Pyrenees and Celtiberia in Spain (Carls & Valenzuela-Ríos, 2002), in southern Morocco (Bultynck & Walliser, 2000; Becker & Aboussalam, 2011), in the Armorican Massif in France (Bultynck & Morzadec, 1979), in the Barrandian area in the Czech Republic (Weddige & Ziegler, 1977; Klapper et al., 1978), in Novaya Zemlya, Arctics (Mashkova & Sobolev, 1980), in central Asia (Bardashev & Ziegler, 1992), in Nevada (Klapper & Johnson, 1975; Johnson et al., 1980; Klapper & Johnson, 1980) and British Columbia (Pyle et al., 2003) in North America.

Polygnathus linguiformis bultyncki Weddige, 1977
(Pl. 1, figs 3-4)

1970 *Polygnathus linguiformis* morphotype α Bultynck, Pl. 9, figs 1-11 (with synonymy list).
1975 *Polygnathus linguiformis* Hinde - Snigireva, Pl. 4, fig. 5.
1977 *Polygnathus linguiformis linguiformis* morphotype α Bultynck - Klapper in Ziegler (ed.), Pl. 9, figs 6, 8.
* 1977 *Polygnathus linguiformis bultyncki* n. subsp. Weddige, p. 313-314, Pl. 5, figs 90-92.
1978 *Polygnathus linguiformis bultyncki* Weddige - Klapper et al., Pl. 1, figs 21-22, 26-27, 28-29.
1978 *Polygnathus linguiformis* morphotype α Bultynck - Apekina & Mashkova, Pl. 77, figs 4-5, 8, 10.
1978 *Polygnathus linguiformis bultyncki* Weddige - Apekina & Mashkova, Pl. 78, figs 5-6.
1980 *Polygnathus linguiformis linguiformis* Hinde - Schönlaub, Pl. 9, fig. 23.
1980 *Polygnathus linguiformis* morphotype α Bultynck - Bultynck & Hollard, Pl. 2, figs 14-16.
1985 *Polygnathus linguiformis linguiformis* Hinde - Schönlaub, Pl. 5, figs 27-28.
1985 *Polygnathus linguiformis linguiformis* Hinde - Ziegler & Wang, Pl. 1, fig. 32.
1990 *Polygnathus linguiformis linguiformis* Hinde - Lazreq, Pl. 1, figs 14-16 (non 17-18).
1992 *Polygnathus linguiformis bultyncki* Weddige- Bardashev & Ziegler, Pl. 6, figs 27-28.
1992 *Polygnathus linguiformis bultyncki* Weddige - Bardashev, Pl. 3, figs 1-3, 9.
1995 *Polygnathus linguiformis linguiformis* Hinde - Furey-Greig, Pl. 1, fig. 5.
1995 *Polygnathus linguiformis linguiformis* Hinde - Mawson et al., Pl. 3, fig. 16.
1995 *Polygnathus linguiformis linguiformis* Hinde - Sloan et al., Pl. 7, figs 1-2.
2002 *Linguipolygnathus bultyncki* Weddige - Bardashev et al., Text-fig. 15.34 (with synonymy list).
2003 *Polygnathus linguiformis bultyncki* Weddige - Pyle et al., Pl. 2, figs 9-10.
2003 *Polygnathus linguiformis linguiformis* Hinde - Pyle et al., Pl. 2, fig. 11.
2009 *Polygnathus linguiformis linguiformis* Hinde - Berkyová, figs 8H-I.

Material - 4 specimens from the following levels: LGA 73 (MGUV-20.936), LGA 86 (MGUV-20.933) and LGA 87b (MGUV-20,934 and MGUV-20.935).

Description - Free blade short and high, representing approximately 1/4 of the total length of the element. The main body is elongated and asymmetrical, the outer platform being wider. The platform edges are nearly parallel, with a marked inner bend at its posterior half, developing an elongated and triangular tongue, ornamented by 8-9 well developed transverse ridges (Pl. 1, figs 3a, 4a), which represents about 1/3 of the total length of the element, and it is turned downwards. The torsion of the platform at the posterior half gives the outer edge a subrounded appearance, but does not develop a projection.

The platform anterior edges join the free blade at the same height at an angle of about 90°; they are slightly elevated with respect to the central part, developing in some specimens a small parapet (Pl. 1, fig. 3a). The oral surface of the element is ornamented by transverse ridges perpendicularly arranged to the platform edges, being larger and more numerous in the outer platform. Adcarinal troughs are well developed, the outer broader and deeper than the inner, both ending just before the start of the tongue.

The inverted basal cavity, with the small basal pit, is located in the anterior part of the element. The basal cavity is continued anteriorly as a narrow groove, while posteriorly it does as a slightly bent keel, following the shape of the platform.

Discussion - Our specimens are similar to others described and figured in the literature (e.g., Bultynck, 1970: pl. 9, figs 1-11; Weddige, 1977: pl. 5, figs 90-92; Klapper et al., 1978: pl. 1, figs 21-22, 26-27; Lane & Ormiston, 1979: pl. 7, figs 1-2, 34, 38-39, pl. 8, figs 11-12, 23-24; Bultynck & Hollard, 1980: pl. 2, figs 14-16; Pyle et al., 2003: pl. 2, figs 9-10). *Polygnathus linguiformis bultyncki* Weddige, 1977 was initially described by Bultynck (1970) as *P. linguiformis* morphotype α. According to the original description, this subspecies is characterized, like the rest of the *linguiformis* group by: 1) an ornamentation formed by transverse ridges that cross completely the tongue; 2) the carina and the adcarinal troughs end just before the development of the tongue; 3) the outer adcarinal trough is deeper than the inner one;

4) a long triangular tongue that bends towards the lower and inner side; and 5) small basal cavity situated anteriorly (feature that allow the differentiation from *P. laticostatus*).

The most important feature that allows us to distinguish this subspecies is the morphology of the outer edge, with the absence of a "protuberance" at the height of the platform turning (see, for example, Bultynck, 1970). Our specimens somewhat resemble the two morphotypes of *P. linguiformis* recognized by Wang & Ziegler (1983), based on the angularity and the height of the anterior outer margin. However, our material is clearly separated from their alpha morphotype by the lack of a sharp angular contact between the outer platform margin and tongue. Besides, the longer and wider tongue of our specimens separate them from their beta morphotype. In addition, Bardashev et al. (2002) erected the taxon *Linguipolygnathus anastasiae* with two morphotypes (alpha and beta). According to the synonymy list given by these authors, this new species includes specimens previously assigned to *P. linguiformis bultyncki* (see Bardashev et al., 2002: pp. 419-420). However, the beta morphotype of *P. anastasiae* is clearly related to the *serotinus* stock because of the well developed shelf-like protuberance on the outer side of the pit; this feature distinguished this morphotype from our specimens. The alpha morphotype of *P. anastasiae* has a wider and sharper tongue than our specimens.

Stratigraphical and geographical distribution - The stratigraphical range of *P. linguiformis* goes from the upper Emsian to the Givetian, reaching its highest diversity during the Middle Devonian. In the Pyrenean LGA section, the lowest record of *P. linguiformis bultyncki* below the last record of *Icriodus beckmanni* (see Fig. 2) suggests that either *P. linguiformis bultyncki* starts in the upper part of the *P. laticostatus* zone (upper Emsian) or that the range of *I. beckmanni* reaches the lower part of the *P. serotinus* zone, which has previously been noted in Bohemia (Berkyová, 2009). The upper range of *P. linguiformis bultyncki* elsewhere reaches the *P. costatus* zone (lower Eifelian).

It is a cosmopolitan taxon and it has been recorded from Spain (Pyrenees), France (Armorican Massif: Bultynck & Morzadec, 1979), Belgium (Couvin: Bultynck, 1970), Germany (Rhenish Mountains: Weddige, 1977; Werner & Ziegler, 1982), the Czech Republic (Barrandian: Klapper et al., 1978; Berkyová, 2009), Austria (Alps: Schönlaub, 1980 and 1985), several regions of central Asia: North Urals (Snigireva, 1975), Uzbekistan (Apekina & Mashkova, 1978), Turkestan (Bardashev, 1992), Tadjikistan (Bardashev & Ziegler, 1992) and South East Asia (China) (Ziegler & Wang, 1985), Morocco (Bultynck & Hollard, 1980; Bultynck, 1985; Lazreq, 1990), several regions of North America: Alaska (Lane & Ormiston, 1979) and British Columbia (Pyle et al., 2003), and Australia: New South Wales (Furey-Greig, 1995; Mawson et al., 1995) and Queensland (Fordham, 1976; Sloan et al., 1995).

Polygnathus vigierei Bultynck, 1989
(Pl. 1, fig. 6)

1985 *Polygnathus laticostatus* Klapper & Johnson - Bultynck, Pl. 5, fig. 19.
*1989 *Polygnathus vigierei* Bultynck, p. 184-185, Pl. 5, figs 1-13.
1992 *Polygnathus inversus* Klapper & Johnson - Bardashev & Ziegler, Pl. 5, figs 22-24 (only).
2000 *Polygnathus vigierei* Bultynck - Bultynck & Walliser, p. 15.
2002 *Linguipolygnathus vigierei* Bultynck - Bardashev et al., Text-fig. 14.26 (with synonymy list).
2011 *Polygnathus* cf. *vigierei* Bultynck - Becker & Aboussalam, Pl. 6, figs 9-10.

Material - One specimen from the level LGA 31 (MGUV-21.087).

Description - Free blade short and high, representing 1/4 of the total length of the element. The carina is situated near the center of the platform, slightly closer to the inner edge. The individual denticles of the free blade are strongly compressed laterally. In contrast, the denticles of the carina of the main body are partially fused, forming a thin ridge that shows a slightly sigmoidal morphology (Pl. 1, fig. 6b). Wide, straight and asymmetrical main body; outer platform higher and wider developed than the inner, with maximum height in the posterior part just before the deflection. This outer edge has a clearly irregular outline, where some of the ridges protrude slightly from the edge (Pl. 1, fig. 6b). The platform is narrower anteriorly, becoming wider towards the middle part of the element, and bending abruptly in its posterior third with an angle of about 120º, developing a broad and triangular tongue. The platform is ornamented by thick and short ridges perpendicular to the platform edges. The tongue is ornamented by numerous transverse ridges, most of them cross the entire surface of the platform; however, it is also common that ridges either do not reach the middle part or that they are fused with others or bifurcate, especially in the marginal part. The adcarinal troughs are well developed, being deeper in the anterior region. The outer trough is wider, deeper and extends further than the inner one, and both end just before the start of the tongue.

The small and slightly asymmetric basal cavity shows a slightly swollen outer lip (Pl. 1, fig. 6a). The basal cavity is completely inverted, with the basal pit located in the anterior half of the element. It extends towards the anterior end of the element as a narrow groove, and posteriorly as a keel that is curved following the shape of the platform.

Discussion - We have included the specimen MGUV-21087 (Pl. 1, fig. 6) in *P. vigierei* by the combination of the following features: 1) the presence of a wide platform with a narrow anterior region; 2) the development in its posterior third of a triangular tongue that bents interiorly; 3) an ornamentation based on thick ridges that overpass the outer edge of the platform, giving the appearance of a "serrated" edge (characteristic but not discussed in the original description; it is very clear in the material figured by Bultynck, 1989: pl. 5, figs. 1-13); and 4) the small and slightly asymmetric (with a slight thickening, forming an outer lip expansion) basal cavity located anteriorly.

P. vigierei shares with *P. serotinus*, *P. laticostatus* and *P. inversus*, an asymmetric basal cavity with the development of an external lip in the form of a small bump (Pl. 1, fig. 6a). However, our specimen clearly differs from all of them basically by the features mentioned above (asymmetrical platform, tongue shape and mainly by the characteristic serrated outer edge).

P. vigierei shows some similarities with *P. apekinae* and *P.* sp. A of Klapper & Johnson (1975), but as Bultynck (1989) indicates, *P. vigierei* differs from them because it has an elongate platform, being clearly narrower in the anterior region, and by the shape and position of the basal cavity, that is located in the anterior half of the element.

Stratigraphical and geographical distribution - The distribution of *P. vigierei* is restricted, according to Bultynck (1989), to the *P. inversus* zone or *P. laticostatus* zone (upper Emsian). It has been recorded from Spain (Pyrenees), France (Armorican Massif) (Bultynck, 1989), Morocco (Bultynck, 1985; cf. Becker & Aboussalam, 2011), and central Asia (Bardashev & Ziegler, 1992).

CONCLUDING REMARKS

The study of the La Guardia d'Àres section (LGA) from the Spanish Central Pyrenees has yielded a scarce but significant conodont fauna relevant for the Emsian stage subdivision. Four *Polygnathus* species are described and discussed: *P. gilberti, P. laticostatus, P. linguiformis bultyncki*, and *P. vigierei*. The last three are cited for the first time from the Spanish Central Pyrenees. All taxa show short stratigraphical ranges (see Fig. 2): *P. laticostatus* ranges from Bed 26 to Bed 28; *P. vigierei* occurs only in Bed 31; *P. gilberti* ranges from Beds 33 to 37; and *P. linguiformis bultyncki* ranges from Beds 73 to 87b. This sequence takes over the last local occurrences of *P. mashkovae* and *P. nothoperbonus*, which in the Pyrenean sections do not extend higher than the lower Emsian upper *P. nothoperbonus* zone (Martínez-Pérez et al., 2011).

According to these occurrences, we have identified the base of the *P. laticostatus* zone in Bed 26 coinciding with the first record of *P. laticostatus*. This important biostratigraphical marker has been proposed, together with *P. inversus*, as a putative index for the lower/upper Emsian boundary (Bultynck, 1976; Bultynck & Hollard, 1980; Weddige & Requadt, 1985; Becker, 2007). However, the first records of *P. laticostatus* and *P. inversus* seem to be registered within the upper part of the lower Emsian, at the top of the Zlichovian stage of Bohemia (Klapper et al., 1978) and within the *N. barrandei* zone, overlapping its range with the *Anetoceras* faunas (Bultynck et al., 1999), classically considered as of early Emsian age.

Another species found in the LGA section, *P. gilberti*, has also been proposed as candidate to indicate this boundary (Becker, 2007). However this also carries some problems. The first record of *P. gilberti* seems to be slightly older than *P. inversus* and *P. laticostatus* in Central Asia (Bardashev, 1986), the Armorican Massif (France) (Bultynck, 1989) and Nevada (USA) (Klapper & Johnson, 1975); a situation that seems to occur as well in the Pyrenees (Fig. 2). In addition, the use of *P. gilberti* as an upper Emsian index is also questionable, since for example, in La Grange (Armorican Massif, France), its range overlaps with the *Anetoceras* faunas that, as commented previously, are traditionally considered as belonging to the Zlichovian or early Emsian age (Becker, 2007).

Therefore, further data on conodonts (chiefly *Polygnathus* and *Icriodus*) and other groups (mainly tentaculitids and ammonoids) are necessary before a decision about the formal subdivision of the Emsian stage will become possible. But independent of this future development, the LGA section has recorded the entry of two of the three putative conodont indexes, *P. laticostatus* (Bed 26) and *P. gilberti* (Bed 33). Consequently the new data will be very useful for the future SDS discussions, and will permit the boundary identification in the Spanish Central Pyrenees.

Finally, this study increases the paleontological and biostratigraphical characterization of the Emsian in the Spanish Central Pyrenees, providing information for future correlations between this region and other areas, such as Celtiberia in Spain (Carls & Valenzuela-Ríos, 2002), the Armorican Massif in France (Bultynck & Morzadec, 1979; Bultynck, 1989), the Czech Republic (Weddige & Ziegler, 1977; Klapper et al., 1978), North Africa (Bultynck & Walliser, 2000; Becker & Aboussalam, 2011), Novaya Zemlya, Arctics (Mashkova & Sobolev, 1980), central Asia (Bardashev, 1986; Bardashev & Ziegler, 1992), and North America (Klapper & Johnson, 1975; Johnson et al., 1980; Klapper & Johnson, 1980; Pyle et al*.,* 2003).

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