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Original article

# Ontogeny of *Ancyrodelloides carlsi* (Boersma) and comments on its generic attribution (Conodonta, Lower Devonian)<sup>☆</sup>



Maria G. Corrigan<sup>a</sup>, Carlo Corradini<sup>a,b,\*</sup>

<sup>a</sup> Dipartimento di Scienze Chimiche e Geologiche, Università di Cagliari, Cittadella Universitaria (Blocco A), SS.554 bivio per Sestu 09042 Monserrato (CA), Italy

<sup>b</sup> Dipartimento di Matematica e Geoscienze, Università di Trieste, via Weiss 2 34128 Trieste, Italy

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## ABSTRACT

The ontogeny of the Lochkovian conodont species *Ancyrodelloides carlsi* (Boersma) is demonstrated thanks to a rich population from Morocco. The studied sample includes elements at various growth stages from juvenile to gerontic. The data are confirmed by several elements in collections from several localities in the Carnic Alps (Italy and Austria). The absence of terraces at every stage of growth and the presence of a strong denticulated lateral process confirms the generic attribution of the species to genus *Ancyrodelloides*. Comments on the apparatus are provided. The geographical distribution of the species, limited to Europe and the Mediterranean region, challenges its stratigraphic value for long distance correlations.

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## 1. Introduction

*Ancyrodelloides carlsi* (Boersma, 1973) is a characteristic Lochkovian conodont species. It is the link between genera *Lanea* Murphy et Valenzuela-Ríos and *Ancyrodelloides* Bischoff et Sannemann (Corrigan et al., 2014b), and is an important biostratigraphic marker within the Lochkovian. Several authors consider it as the first representative of *Ancyrodelloides* (e.g., Murphy and Valenzuela-Ríos, 1999; Corrigan et al., 2014b), whereas others (Slavík, 2011, Slavík and Hladil, in press) attributed the species to *Lanea*. In this paper, based on a rich fauna from Morocco and data from the Carnic Alps that allow to demonstrate the ontogeny of the species, we support the attribution of the species *carlsi* to genus *Ancyrodelloides*, and we largely confirm the apparatus reconstruction by Slavík (2011).

## 2. Material

This work is mainly based on a sample from Morocco collected by Prof. O.H. Walliser in the 1990s and stored in the “Walliser conodont collection” at the Geoscience Centre, Georg-August University, Göttingen, Germany, under reference collection number GZG 1612. The sample is labelled “Wa3715” and was collected from a loose block near the Atrous 3 section, ca. 12 km southwest of Merzouga,

southeastern Tafilalt (Fig. 1). For more information on the locality and stratigraphic data, refer to Corrigan et al. (2014a, 2014b).

The sample yielded a rich population of *Ancyrodelloides carlsi*, *Zieglerodina eladioi* Valenzuela-Ríos and *Pseudooneotodus beckmanni* (Bischoff et Sannemann), beside rare elements of *Belodella resima* (Philip) and *Icriodus angustoides* cf. *alcolae* Carls. The ramiform elements can be easily subdivided into two groups: one is represented by small and thin elements with a characteristic denticulation attributed to *Z. eladioi* (Corrigan and Corradini, 2019), and the other by large and strong elements belonging to *Ancyrodelloides carlsi*.

In this study we integrate the material from Morocco with collections from the Carnic Alps, where *A. carlsi* is relatively common in rocks collected in the upper part of the Rauchkofel and Nöbling formations and in the lower part of the La Valute Fm. In fact, the lower boundary of the La Valute Fm. lies within the *A. carlsi* Zone (Corradini et al., 2016, 2019; Schönlaub et al., 2017b). In our collections the species occurs in the Rio Malinfier (Corrigan et al., 2012, 2017) and Val di Puartis East (unpubl.) sections. Also, we observed the presence of elements of *A. carlsi* in collections from various sections from the area stored at the Austrian Geological Survey in Vienna: Oberbuchach Ib (Schönlaub and Corradini, 2017), Oberbuchach II (Schönlaub, 1985; Schönlaub et al., 2017a), Oberbuchach IV (unpubl.), Rauchkofel Boden (Schönlaub et al., 2017b), Rauchkofel South (unpubl.), and Seekopf Sockel (Schönlaub, 1980).

The studied material is stored at the Geoscience Centre of Georg-August University Göttingen (GZG), Museo Friulano di Storia Naturale (MFSN<sub>gp</sub>), Museo di Paleontologia “Domenico

<sup>☆</sup> Corresponding editor: Catherine Girard.

\* Corresponding author.

E-mail address: [ccorradini@units.it](mailto:ccorradini@units.it) (C. Corradini).

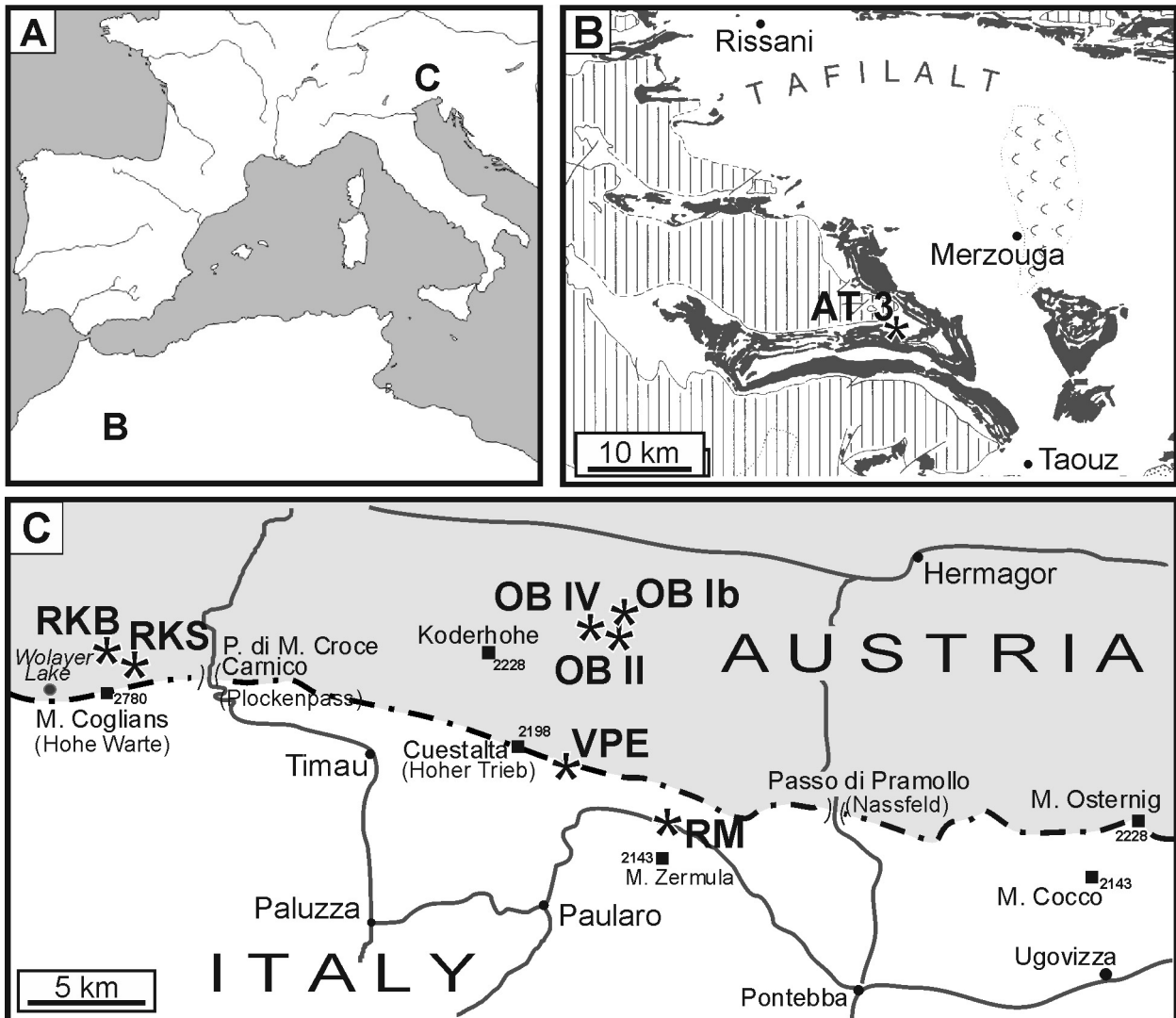


Fig. 1. Map of Northern Africa and Southwestern Europe (A) showing the location of the Moroccan (B), Austrian and Italian (C) sections cited in this work.

Lovisato” of Cagliari University (MDLCA), and the Austrian Geological Survey. Precise information and repository numbers of illustrated elements are reported in the caption of the figures.

### 3. Systematic palaeontology

Class Conodonta Pander, 1856

Order Ozarodinida Dzik, 1976

Family Spathognathodontidae Hass, 1959

Genus *Ancyrodelloides* Bischoff et Sannemann, 1958

**Type species:** *Ancyrodelloides trigonica* Bischoff et Sannemann, 1958.

**Original diagnosis** (Bischoff and Sannemann, 1958; in German): Compound conodonts consisting of a denticulated free blade and an arrow-shaped platform with two anterior lobes, on which occasionally one further lobe can be developed, and a pointed posterior lobe. The oral surface of the platform is smooth, except for the fixed blade and the median carinae on the lobes. A small basal cavity is on the aboral surface in mature specimens.

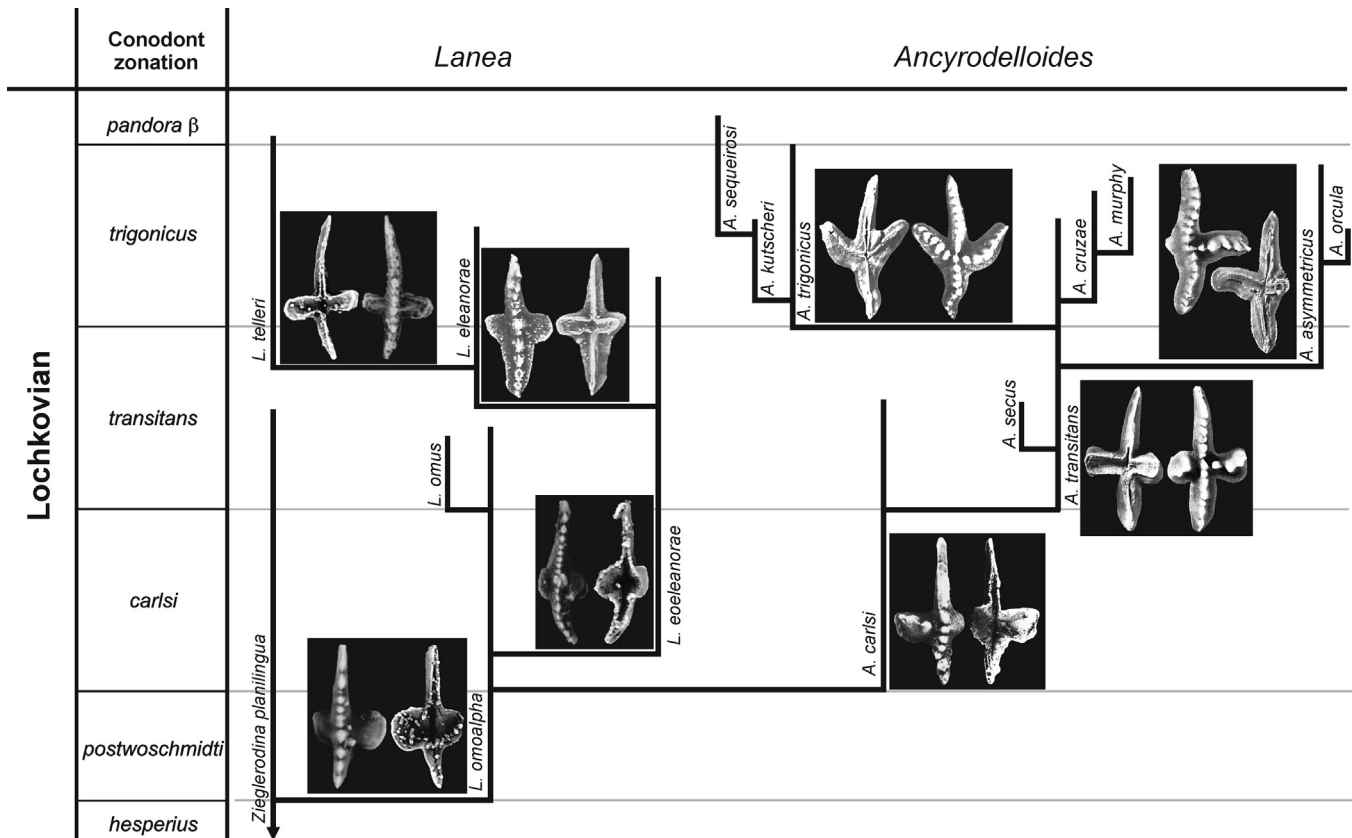
**Emended diagnosis** (Murphy and Matti, 1983): A polygnathid genus with a well-developed, shelf-like platform, with or without

lateral processes and with a basal cavity that is more restricted than the platform except in the most primitive forms.

**Emended diagnosis** (this work): An ozarkodinid genus in which the  $P_1$  element is characterized by well-developed denticulated and expanded lateral processes and a basal cavity that is more restricted than the platform except in the most primitive forms. The apparatus includes six elements ( $P_1$ ,  $P_2$ , M,  $S_0$ ,  $S_1$  and  $S_2$ ).

**Remarks:** Murphy and Valenzuela-Ríos (1999) erected the genus *Lanea* separating from *Ancyrodelloides* those species characterized by the presence of “terraced, normally unornamented basal platform lobes”. In the diagnosis of *Lanea* (Murphy and Valenzuela-Ríos, 1999: p. 326) is also reported that early members of the genus have “open basal grooves, unrestricted basal cavities”, and later members show “constricted basal cavities”. The species attributed to *Ancyrodelloides* differ from those of *Lanea* by having strong, denticulated lateral lobes, without a terrace; the basal cavity is open in early forms (*A. carlsi*), restricted in species in the middle part of the lineage (*A. transitans* and *A. asymmetricus*), and reduced to narrow grooves in late forms (*A. trigonicus*, *A. kutscheri*, etc.) (Fig. 2).

The phylogeny of *Ancyrodelloides* and *Lanea* was discussed by Corrigan et al. (2014b). In that paper we left open the origin of



**Fig. 2.** Phylogenetic relationships of the genera *Lanea* and *Ancyrodelloides* (modified after Corrigan et al., 2014b) with reproduction of the lower and upper views of the holotypes or significant elements (*L. telleri*) of selected species to show the analogous evolution from wide open to restricted basal cavities in both genera. Conodont zonation after Corrigan et al. (2016) and Schönlaub et al. (2017). Figured specimens: *A. asymmetricus* (Bischoff et Sannemann, 1958), holotype; *A. carlsi* (Boersma, 1973), holotype; *A. transitans* (Bischoff et Sannemann, 1958), holotype; *A. trigonicus* Bischoff et Sannemann, 1958, holotype; *L. omoalpha* (Murphy et Valenzuela-Ríos, 1999), holotype; *L. eleanorae* (Lane and Ormiston, 1979), holotype; *L. eoeleanorae* (Murphy et Valenzuela-Ríos, 1999), holotype; *L. telleri* (Schulze, 1968), element figured by Murphy and Valenzuela-Ríos (1999: pl. 2, fig. 38), because the holotype is a juvenile element and its aboral view is not available.

*A. asymmetricus* as evolving from *A. carlsi* or from *A. transitans*. Now we believe that the second hypothesis is correct, as already suggested by Murphy and Cebecioglu (1987), because the shape of the basal cavity in *A. asymmetricus* and *A. transitans* is similar (Fig. 2). Furthermore, these two species partly overlap stratigraphically in the upper part of the distribution of *A. transitans*, whereas a short interval occurs between the last occurrence of *A. carlsi* and the first appearance of *A. asymmetricus* (Fig. 2). Likely *A. asymmetricus* derived from *A. transitans* by the loss of one lateral process.

*Ancyrodelloides carlsi* (Boersma, 1973)

Figs. 3–5

1958. *Spathognathodus steinhornensis* Ziegler – Bischoff and Sannemann, p. 106, pl. 13, figs. 3, 7, 9.

1973. *Spathognathodus carlsi* sp. nov. – Boersma, p. 289–290, pl. 3, fig. 1–6; pl. 4, fig. 1–9.

1980. *Ozarkodina masara* Schönlaub – Schönlaub (in Chlupac et al.), p. 159, pl. 20, figs. 15–20.

1991. *Ancyrodelloides carlsi* (Boersma) – Klapper (in Ziegler), p. 9–10, pl. *Ancyrodelloides*-1, fig.

1994. *Ozarkodina carlsi* (Boersma) – Valenzuela-Ríos, p. 64–66, pl. 1, fig. 19; pl. 3, figs. 3?, 9–10, 14.

2011. *Ancyrodelloides carlsi* (Boersma) – Corrigan, p. 94–95, pl. 6, figs. 7–9.

2011. *Lanea carlsi* (Boersma) – Slavík, p. 321–325, figs. 3–8.

2012. *Ancyrodelloides carlsi* (Boersma) – Corradini and Corrigan, fig. 6P.

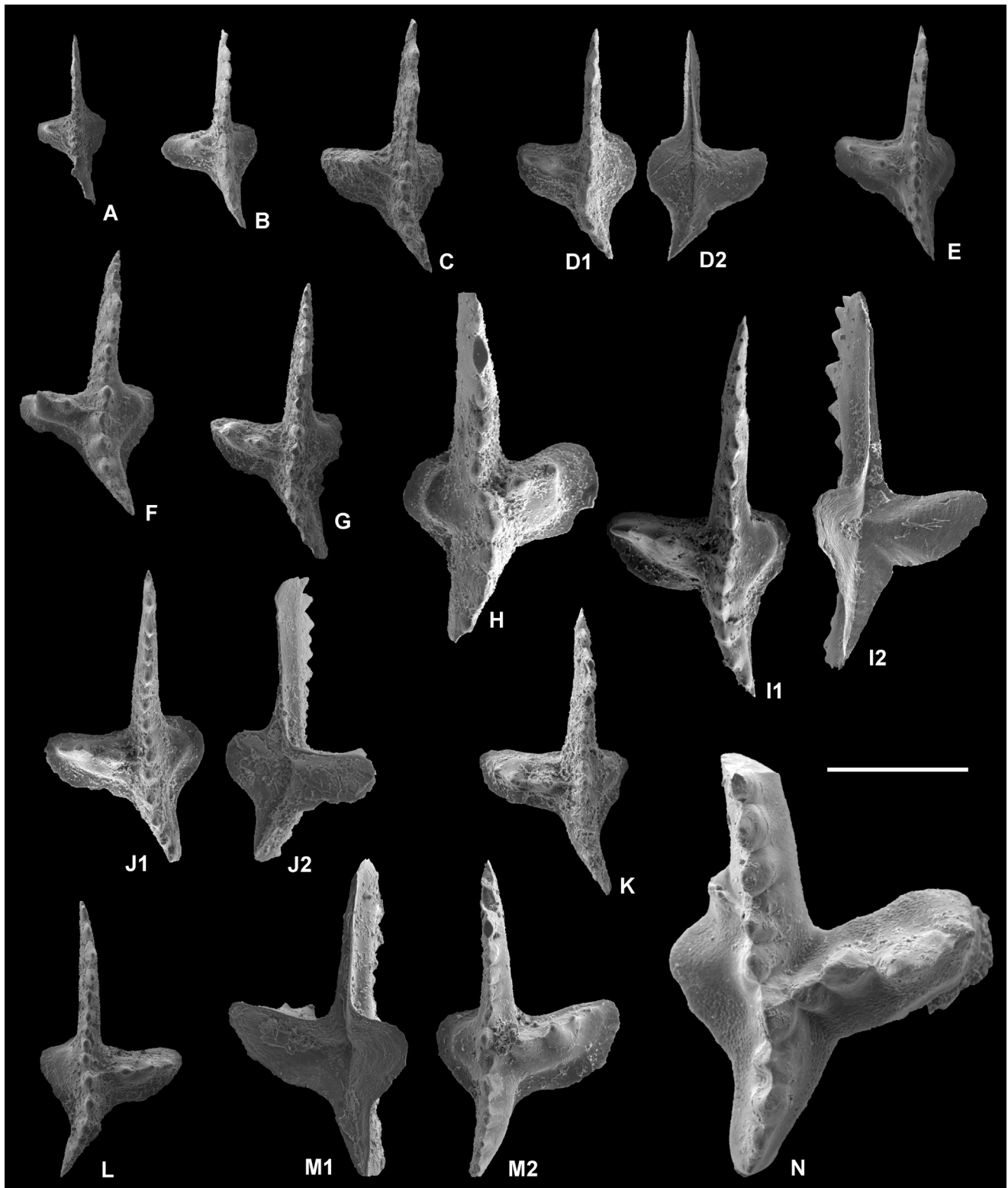
(See Appendix A for a complete list of synonymy.)

**Material:** in the sample from Morocco: 46 P<sub>1</sub>, 5 P<sub>2</sub>, 2 M, 2 S<sub>0</sub> and 3 S<sub>1</sub>. In collections from the Carnic Alps we observed a few dozens of elements, both P<sub>1</sub>, P<sub>2</sub> and ramiforms.

**Stratigraphic distribution:** Middle Lochkovian, from the base of the eponymous *Ad. carlsi* Zone into the *Ad. trigonicus* Zone (Corrigan et al., 2014b). The first appearance of the species was proposed for defining the base of the middle Lochkovian (Slavík, 2011; Corrigan et al., 2014a,b).

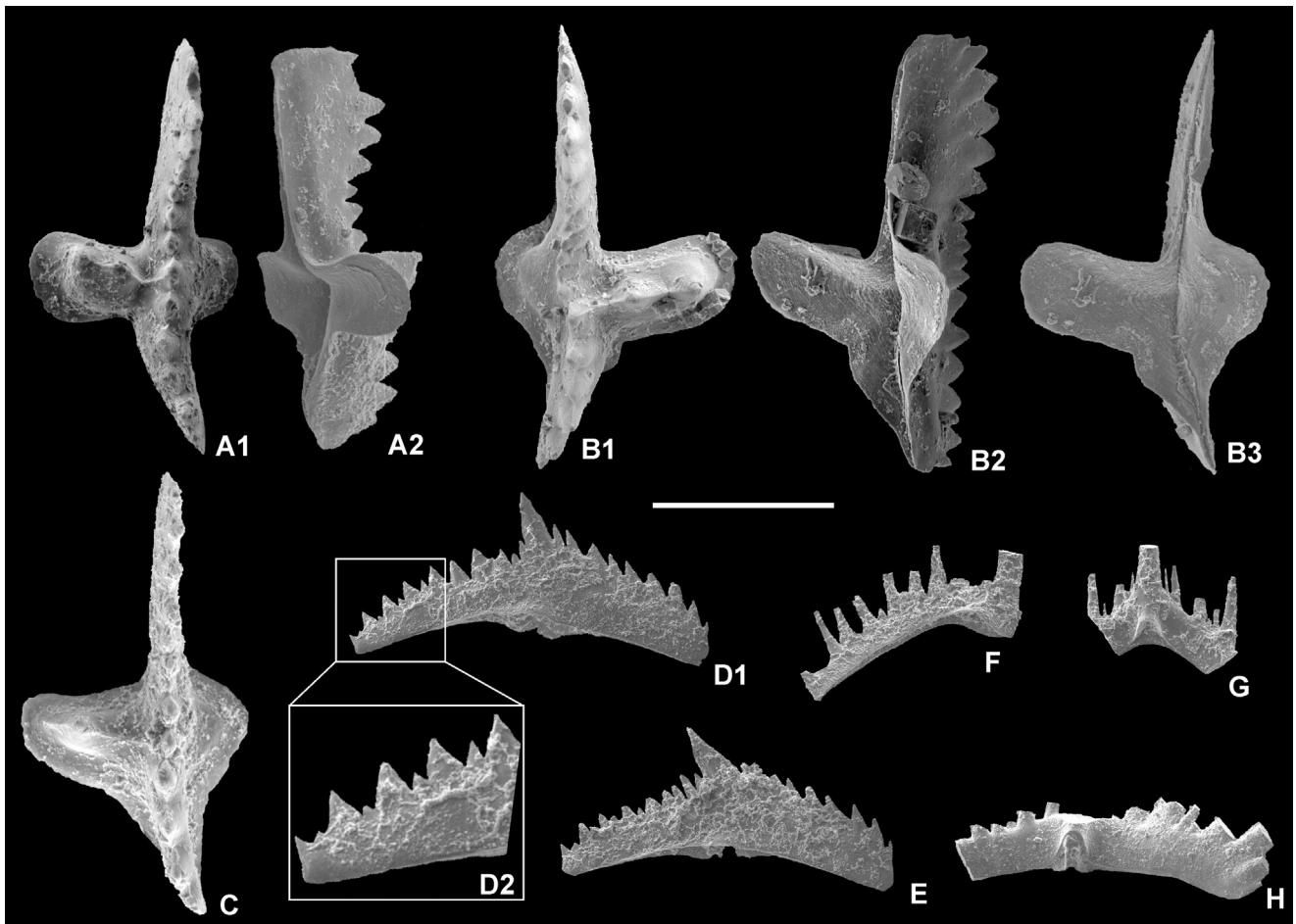
**Geographic distribution:** *Ancyrodelloides carlsi* is widely distributed in central and southern Europe and north Africa, being documented in Germany (Bischoff and Sannemann, 1958), Spain (Valenzuela-Ríos, 1994; Valenzuela-Ríos et al., 2005, 2017; Valenzuela-Ríos and Liao, 2017), the Carnic Alps (Jaeger and Schönlaub, 1980; Schönlaub, 1980, 1985; Corrigan, 2011; Corrigan et al., 2012, 2017; Corradini and Corrigan, 2012; Schönlaub et al., 2017a, b), Bohemia (Spasov, 1971; Chlupac et al., 1980; Slavík, 2011, 2017; Slavík et al., 2012), Morocco (Lazreq and Ouanaimi, 1998; Jansen et al., 2007; Rytina et al., 2013; this paper), Hungary (Kovacs, 1981; Kovacs and Vetö-Akos, 1983; Kozur, 1984), and Albania (Schönlaub and Meco, 1986). In North America, the only element somehow recalling *A. carlsi* were figured by Murphy and Matti, 1983 (1983: pl. 2, figs. 13, 15, 17) from Nevada, but its attribution to *A. carlsi* is doubtful. The claimed occurrence in Australia (Farrell, 2003) is here disregarded. The species is not documented in China up to date.

**Original diagnosis** (Boersma, 1973): A species of *Spathognathodus* with broadly flaring lips of the basal cavity. The inner lip is rounded and unornamented in upper view. The outer lip is slender,



**Fig. 3.** P1 elements of *Ancyrodelloides carlsi* (Boersma). All specimens from sample Wa3715, Atrous 3 locality, Morocco. The elements show different ontogenetic stages from younger (A) to older (N) specimens. **A.** Upper view of P1 element GZG 1612-477-3715-7. **B.** Upper view of P1 element GZG 1612-477-3715-8. **C.** Upper view of P1 element GZG 1612-477-3715-9. **D.** Upper (D1) and lower (D2) views of P1 element GZG 1612-477-3715-9. **E.** Upper view of P1 element GZG 1612-477-3715-10. **F.** Upper view of P1 element GZG 1612-477-3715-11. **G.** Upper view of P1 element GZG 1612-477-3715-12. **H.** Upper view of P1 element GZG 1612-477-3715-13. **I.** Upper (I1) and lower (I2) views of P1 element GZG 1612-477-3715-14. **J.** upper (J1) and lower (J2) views of P1 element GZG 1612-477-3715-15. **K.** Upper view of P1 element GZG 1612-477-3715-16. **L.** Upper view of P1 element GZG 1612-477-3715-17. **M.** Lower (M1) and upper (M2) views of P1 element GZG 1612-477-3715-18. **N.** Upper view of P1 element GZG 1612-477-3715-19. Scale bar: 500  $\mu$ m.





**Fig. 4.** *Ancyrodelloides carlsi* (Boersma). All specimens from sample Wa3715, Atrous 3 locality, Morocco. **A.** Upper (A1) and lower-lateral (A2) views of P1 element GZG 1612-477-3715-20. **B.** Upper (B1), lower-lateral (B2) and lower (B3) views of P1 element GZG 1612-477-3715-21. **C.** Upper view of P1 element GZG 1612-477-3715-22. **D.** Lateral view of P2 element GZG 1612-477-3715-23 (D1), and enlargement of the distal part of the anterior process to show the alternate denticulation (D2). **E.** Lateral view of P2 element GZG 1612-477-3715-24. **F.** Lateral view of M element GZG 1612-477-3715-25. **G.** Lateral view of S0 element GZG 1612-477-3715-26. **H.** Lateral view of S1 element GZG 1612-477-3715-27. Scale bar: 500  $\mu\text{m}$ .

ornamented at the upper side with 1–3 thick denticles, and roughly perpendicular to the blade.

**Emended diagnosis** (Slavík, 2011): A species of *Lanea* with weakly developed terraces on basal platform lobes. The basal cavity is shallow, strongly asymmetrical and unrestricted. The outer platform lobe is considerably larger than the inner one and its upper side is ornamented with 1 to 3 nodes interconnected with the cusp by a faint ridge.

**Emended diagnosis** (this work): A species of *Ancyrodelloides* whose P1 element is characterized by a strongly asymmetrical platform. The outer platform is represented by a strong lobe, bearing 1 to 4 nodes, sometimes interconnected with the cusp by a faint ridge. The inner platform is strongly reduced or absent. The basal cavity widely open (scaphate) below the platform.

**Description:** The apparatus is composed by six elements (P<sub>1</sub>, P<sub>2</sub>, M, S<sub>0</sub>, S<sub>1</sub> and S<sub>2</sub>).

P<sub>1</sub> element (Figs. 3, 4(A–C), 5) pastiniscaphate characterized by a strong blade bearing several discrete triangular denticles. The distal denticles of the posterior (dorsal) process are larger than the others, forming a cockscomb structure. The anterior (ventral) process, shorter than the posterior one and slightly laterally curved, bears up to five discrete denticles. The cusp is small and similar to adjacent denticles. A strong, expanded lateral process bears 1 to 4 subtriangular denticles. A small ridge may connect the denticles of the lateral process to the cusp. A small lobe, not ornamented, is present in the inner (?caudal) side; in a few

specimens it is slightly inflated and may recall a weakly developed terrace, whereas in others it is a small bulge decreasing in height from the blade to the external part of the lobe. A brim is present in the lower outer part of the lateral outer (?rostral) process and of the inner lobe. The basal cavity is wide open, occupies the aboral part of the platform and extends as a groove below the processes.

P<sub>2</sub> element (Fig. 4(D, E)) pectiniform angulate with two processes laterally compressed forming an angle of ca. 160°. The strong, high, subtriangular cusp is posteriorly reclined. The anterior (ventral) process is thicker and stronger than the posterior (dorsal), and bears about nine triangular discrete denticles. The posterior process tapers towards the distal extremity and bears about eleven subtriangular denticles; in the distal third of the process denticles are of different size, alternating larger and smaller ones (Fig. 4(D2)). The basal cavity is relatively wide below the cusp and becomes thinner below the processes.

M element (Fig. 4(F)) dolabrate characterized by the posterior (adaxial) process curved downward bearing about nine discrete denticles, circular in cross section. The cusp is high and slightly laterally compressed, having an ovoidal cross section. A single small denticle may be present anterior (abaxial) of the cusp. The basal cavity is wider beneath the cusp and continues as a groove towards the posterior end.

S<sub>0</sub> element (Fig. 4(G)) alate with two lateral processes forming an angle of ca. 120°. The cusp is high and strong. The processes bear discrete alternate denticles. The narrow basal cavity enlarges a

little on the anterior (rostral) side of the cusp and extends as grooves below the processes.

$S_1$  element (Fig. 4(H)) digirate with anterior (rostral) and posterior (caudal) process laterally compressed, bearing robust denticles circular in cross section. Denticles on the distal part of the anterior process are bigger and stronger than the others. The cusp is strong and circular in cross section. The basal cavity enlarges a little on the inner (dorsal) side of the cusp and extends as grooves below the processes.

$S_2$  element bipennate. In our material all  $S_2$  elements are largely incomplete, so we cannot provide a detailed description. In general, the element has two laterally compressed processes with an alternate denticulation.

**Remarks:** In our material from sample Wa3715 there are several  $P_1$  elements of various sizes, from small to very large, allowing us to demonstrate the ontogeny of the species (Fig. 5). Smaller elements are nearly straight with a subtriangular basal cavity, slightly larger in the external side, where one single small denticle is present (Fig. 5(A)), sometimes connected to the main blade by a small narrow ridge (Fig. 5(B)). During the growth the external side of the platform enlarges ((Fig. 5(C)), forming a true lateral process above which a second denticle appears (Fig. 5(D)). The outer part of the platform remains small and slightly inflated. Then, the distal part of lateral process continues to extend (Fig. 5(E, F)), first in the lower part (Fig. 5(G)), then in its upper part to host a third denticle (Fig. 5(H)). The growth continues analogously (Fig. 5(I)) until the development of a fourth denticle in larger specimens (Fig. 5(J)).

The apparatus of *A. carlsi* was reconstructed by Slavík (2011) based on material from the Czech Republic. In our sample from Morocco most elements are the same or very similar to that proposal, even if some differences should be remarked. Our  $P_2$  elements have a general morphology close to that figured by Slavík (2011: fig. 4b–c, only), but the denticulation pattern is different: material from Morocco has discrete subtriangular denticles, whereas elements from Bohemia show closely spaced, rounded, smaller denticles. Elements  $M$ ,  $S_0$  and  $S_1$  are similar. In our material we have only broken  $S_2$  elements, but several fragments recall the  $S_2$  element figured by Slavík (2011: fig. 7). The differences in the denticulation of the  $P_2$  element are difficult to explain, because in both our and in Slavík (2011) samples there are no other spathognathodid to which may be attributed those  $P_2$  elements, and all the other elements are the same.

#### 4. Discussion

The generic attribution of the species *carlsi* (Boersma) is debated: the  $P_1$  element was described by Boersma (1973) as the morphospecies *Spathognathodus carlsi*, and then moved to *Ancyrodelloides* by Klapper (in Ziegler, 1991). Many authors

supported this generic attribution, whereas Slavík (2011) claimed that the species belongs to genus *Lanea* Murphy and Valenzuela-Ríos. According to the diagnosis of *Lanea* (Murphy and Valenzuela-Ríos, 1999: p. 326), “early Pa members of the genus robust with medium- to large-sized, terraced, normally unornamented basal platform lobes and open basal grooves, unrestricted basal cavity”. A terrace is a flat area, more or less horizontal, occupying most of the platform lobes. According to Murphy and Valenzuela-Ríos (1999), representatives of *Lanea* differ from *Ancyrodelloides* in the general lack of ridges or tubercles on the basal platform terrace: the only species of *Lanea* with a single denticle on one platform lobe is *L. omus* (Murphy et Matti). *Ancyrodelloides* has strong lateral processes, without terraces, which bear strong denticles. The basal cavity in *Lanea* is widely open in early forms and constricted in late forms. In *Ancyrodelloides* the basal cavity is larger in *A. transitans*, and very restricted in all the younger representatives of the genus. Slavík (2011) based his attribution of the species *carlsi* to *Lanea* on the shape of the basal cavity that is wide open and claimed the presence of weakly developed terraces. In our opinion *A. carlsi* does not have terraces, which presence is diagnostic for *Lanea*. The apparent weak terraces actually are the elongation of the outer lobe before the appearance of a new denticle. In fact, as discussed above, during the grow the distal part of lateral process (lobe) expand first in the lower part, then in its upper part, where the denticle will be hosted. The elongated upper part, before the appearance of the new denticle, may recall a small terrace. In a few specimens the inner lobe has a more or less slightly inclined upper surface, recalling a small terrace, whereas in the majority of the elements this feature is not present, as the lobe gently decrease in height towards the base of the platform. Also, the holotype of *A. carlsi* (Boersma, 1973: pl. 6, figs. 1–3) clearly does not have any terrace.

*Ancyrodelloides carlsi* is the link between *Lanea* and *Ancyrodelloides* (Corrigan et al., 2014b), and has a few characteristics intermediate between the two genera. The basal cavity is widely open, but we believe that this is not the most important diagnostic feature for the generic attribution. As shown in Fig. 2, both genera have a similar evolution of the basal cavity, that is larger in older species and more restricted in younger. According to the diagnoses of *Ancyrodelloides* and *Lanea*, the absence of terraces and the presence of the strong denticulated lateral process are the key to attribute the species to genus *Ancyrodelloides*.

*Ancyrodelloides carlsi* is widely diffused in Central Europe and in the Mediterranean region, where it is a very useful and widely used index species. Based on this, a few authors (Slavík, 2011; Corradini and Corrigan, 2012; Corrigan et al., 2014b) proposed that the first appearance of this species may indicate the base of the middle Lochkovian. However, *A. carlsi* is very rare, if not absent, in the rest of the world: therefore, its value for global chronostratigraphic correlations should be reconsidered, and a different marker for the base of the middle Lochkovian may be indicated. The suggestion to

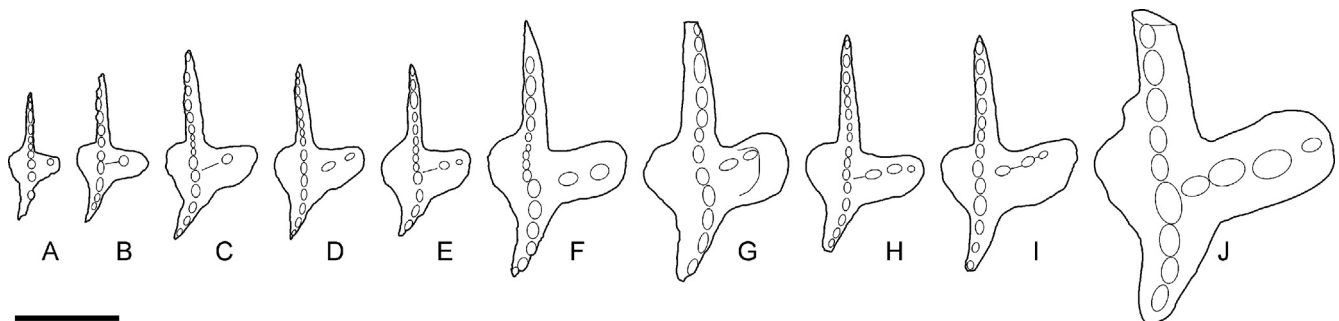


Fig. 5. Ontogenetic series of *Ancyrodelloides carlsi* from younger (left) to older (right) specimens. Drawings based on elements figured in Fig. 3. Some elements have been mirrored to always have the lateral process on the right side. Scale bar: 500  $\mu\text{m}$ .

use the first appearance of *A. transitans* for this purpose (Murphy and Valenzuela-Ríos, 2017) looks a good proposal because this species is relatively abundant and widely documented everywhere in the world.

## 5. Conclusion

The main results of this study on *Ancyrodelloides carlsi* can be summarized as follows:

- the generic attribution to *Ancyrodelloides* is confirmed based on the ontogenetic reconstruction of the P<sub>1</sub> element;
- the reconstruction of the apparatus by Slavík (2011) is largely confirmed, with some differences only in the denticulation pattern of the P<sub>2</sub> element;
- the possible use of *A. carlsi* as marker for global correlations in the middle Lochkovian is questioned, due to its limited geographic distribution.

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## Appendix A. Complete list of synonymy of *Ancyrodelloides carlsi*

1958. *Spathognathodus steinhornensis* Ziegler - Bischoff and Sannemann, p. 106, pl. 13, figs. 3, 7?, 9.
1969. *Spathognathodus* cf. *asymmetricus* Bischoff et Sannemann - Carls and Gandl, p. 197, pl. 19, fig. 1.
1971. *Spathognathodus steinhornensis steinhornensis* Ziegler - Spassov, pl. 1, figs. 11–12.
1973. *Spathognathodus carlsi* sp. nov. - Boersma, p. 289–290, pl. 3, fig. 1–6; pl. 4, figs. 1–9.
1980. *Ozarkodina masara* Schönlaub - Schönlaub, pl. 2, figs. 10, 16–17; pl. 3, figs. 24–30; pl. 7, fig. 3.
1980. *Ozarkodina masara* Schönlaub - Schönlaub (in Chlupac et al.), p. 159, pl. 20, figs. 15–20.
1980. *Ozarkodina masara* Murphy et al. - Jaeger and Schönlaub, pl. 5, figs. 10, 16–17.
1981. *Ozarkodina asymmetrica* Bischoff et Sannemann - Kovacs, pl. 1, fig. 4 (only).
- ? 1983. *Ancyrodelloides omus* sp. nov. - A. transitans - Murphy and Matti, pl. 2: 13, 15, 17 (only).
1983. *Ozarkodina masara* Schönlaub - Kovacs and Vetö-Akos, pl. 5, fig. 1.
1984. *Ancyrodelloides asymmetricus* (Bischoff et Sannemann) - Kozur, pl. 6, fig. 3 (only).
1985. *Ozarkodina masara* Schönlaub - Schönlaub, pl. 2, figs. 10, 16–17.
1986. *Ozarkodina masara* Schönlaub - Schönlaub and Meco, pl. 2, fig. 21.
1991. *Ancyrodelloides carlsi* (Boersma) - Klapper (in Ziegler), p. 9–10, pl. *Ancyrodelloides*-1.

1994. *Ozarkodina carlsi* (Boersma) - Valenzuela-Ríos, p. 64–66, pl. 1, fig. 19; pl. 3, figs. 3?, 9–10, 14.
1998. *Ancyrodelloides carlsi* (Boersma) - Lazreq and Ouanaimi, pl. 1, fig. 14–15.
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