

## Lower and Middle Cambrian trace fossils from the Láncara and Oville formations in the area of Presa del Porma (Cantabrian Zone, northern Spain)

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The Lower Cambrian succession of the Cantabrian Zone (northern part of the Iberian Massif, Spain) consists of two lithostratigraphic units: the basal Herrería Formation (a thick unit of mainly coarse siliciclastics unconformably overlying the uppermost Precambrian shales of the Narcea Group) and the Láncara Formation (composed of a Lower dolomitic member and a calcareous upper member). The Lower/Middle Cambrian boundary lies within the upper member of the Láncara Formation and is marked by the FAD of the trilobite *Eoparadoxides mureroensis* (cf. Gozalo *et al.*, 1993). The overlying Middle Cambrian Oville Formation consists of greenish mudstones and scarce fine-grained sandstones.

The Láncara and Oville formations crop out downstream the dam wall of Presa del Porma (northern León province, northern Spain). During our work, research was focused on two sections running from the upper part of the basal dolomitic member of the Láncara Formation to the Lower part of the Oville Formation. Sections separate by some 2 km. Sdzuy (1969) established the trilobite biostratigraphy for most of rocks included in the two sections but reported them into a composite one, classically known as Presa del Porma section. Following indications by Klaus Sdzuy, the bigger part of the classical Presa del Porma section is named here section "Pu" ("u" stands for the German *untere*, Lower). Zamarreño (1972) described the stratigraphy and sedimentology of the Láncara Formation at this section, and Sdzuy (1995) summarised the trilobite biostratigraphy of the upper Láncara and Lower Oville formations and assessed the value of the eodiscid trilobite genus *Macannaia* (present at the base of the upper member of the Láncara Formation) for intercontinental correlation. The second section in the area of Presa del Porma is reported here as "Po" ("o" standing for the German *ober*, upper). This paper brings out the first ichnological data from both sections, which will contribute to the reconstruction of the palaeoecology of the Presa del Porma area during late Lower and early Middle Cambrian times, together with studies based on body fossils.

### **Section "Pu" .**

The bottom of section "Pu" records the upper part of the Lower, mainly dolomitic member of the Láncara Formation. It is built up by 34 m, the Lower part of which are beige, parallel-laminated platy dolomicrites with dark grey and yellowish claystones interbedded; beige dolomicrites with interbedded bluish grey siltstones and claystones appear at the upper part; both intervals are separated by some 3 m covered. Sparse, simple trace fossils occur in yellowish claystones near the bottom of the section (level Pu/0.2), consisting of small sized burrows (2 to 4 mm in diameter) attributable to *Helminthopsis* ichnosp. and aff. *Neonerites*, as well as dispersal faecal pellets. Mud-tracks do also occur in adjacent beds. Minuscule cf. *Bergaueria* appear in bluish grey siltstones near the top of the member (level Pu/0.12). Scarcity of ichnological data prevents from establishing any ichnoassociation for this interval.

The boundary between the Lower and upper members of the Láncara Formation is marked by a sharp contact on a decimetric bed of red claystone. The basal part of the upper member is Middle Cambrian in age (Sdzuy, 1995), and consists of 11 m of glauconitic, light grey limestones. The brachiopod *Trematobolus* do occur. Ichnocoenoses occur in glauconitic, light grey limestones with dispersal thin lenses of reddish claystone (level Pu/5). Four types of traces have been identified, concentrating at the contact between the two lithologies. Firstly, crescent-shaped *cf. Planolites* 1.5 to 2.0 cm wide and 5 to 15 cm in length are preserved as partial full reliefs overprinting the top of limestone beds. In most cases, the overlying claystone was eroded and we only know of its existence from the partial preservation of the burrow's muddy infill. Secondly, apparently paired vertical burrows identified as *Cylindrichnus?* are also common. They are somewhat elliptical in cross section, 1 to 2 cm deep and 2 to 3 cm in the bigger dimension across. Centres of paired burrows separate up to 6.5 cm. Additionally, *Rhizocorallium?* 15 cm long and over 4 cm wide occur as limestone hyporeliefs, meniscate burrows 2.6 cm wide as full reliefs, and *Monocraterion* 2 cm in diameter on top of limestone beds (penetrating a thin layer of overlying reddish mud). The middle part of the upper member of the Láncara Formation is made up by 8 metres of mainly pink and reddish glauconitic limestones. Crinoid remains are abundant at level Pu/7. Trace fossils are *cf. Monocraterion* (up to 2 cm wide), *cf. Planolites* (1.5 cm wide) and *Rhizocorallium?* (all preserved as limestone hyporeliefs surrounded by reddish claystone). The top of the Láncara Formation is 4.5 m of *griotte* limestones. In summary, an ichnoassociation of *cf. Planolites* accounts for most of the upper member of the Láncara Formation.

A thickness of 10 m at the boundary between the Láncara Formation and the overlying Oville Formation is covered by soil, the covered interval possibly including the very basal part of the latter unit. Ten metres of the basal Oville Formation were measured along the section (top covered), consisting mainly of greyish green siltstones bearing carbonate nodules, and subordinate reddish siltstones, very fine green sandstones and centimetre-scale layers of limestone. Trace fossils are very abundant and show a higher diversity than in previous ichnoocoenoses: *Cochlichnus* ichnosp. (1.3 mm across), *Cylindrichnus concentricus* Toots in Howard, 1966 (2 to 11 mm; appearing in both siltstone and limestone), *Planolites annularis* Walcott, 1890 (4 to 13 mm), *P. beverleyensis* (Billings, 1862) (3.5 to 5 mm), *P. montanus* Richter, 1937 (2.5 to 3.5 mm), *P. terraenovae* Fillion and Pickerill, 1990 (11 mm), *Planolites* ichnosp., *Psammichnites* ichnosp. (7 mm), *Sericichnus mureroensis* Gámez Vintaned and Mayoral, 1995 (3 to 15 mm), *Teichichnus* ichnosp. (9 to 34 mm across, and 4 to 20 mm in height), and meniscate burrows (4 mm across). An ichnoassociation of *Cylindrichnus*+*Teichichnus* is representative for the Oville Formation. Ichnocoenoses reflect soft substrata very rich in nutrients, exploited by a diversity of soft-bodied organisms together with trilobites in an open sublittoral setting.

According to Sdzuy (1969) and Gozalo *et al.* (in this volume), the trilobites *Acadolenus decorus* Sdzuy, 1968, *Eccaparadoxides asturianus* (Sdzuy, 1968) and *Tonkinella* aff. *breviceps* have been found at the bottom of the Oville Formation, level Pu/21. The age of this assemblage is *E. asturianus* zone (i.e., Upper Leonian, in the Mediterranean biochronology). *Badulesia tenera* (HARTT in Dawson, 1865) appears at the top of the section (level Pu/24), indicating a lowermost Caesaraugustan age.

## **Section "Po" .**

It starts with 17 m of beige dolomicrites, with dark grey and yellowish claystones interbedded at the lower part, and bluish grey siltstones at the upper part. The boundary with the overlying upper member of the Láncara Formation is covered. The basal 11 m of the upper member are glauconitic, secondary dolostones. Then follow 5 m of light grey and greenish grey limestones, *griotte* limestones, and bioclastic, glauconite-bearing reddish limestones. The top of the upper member of the Láncara Formation is 2.3 m of *griotte* limestones. According to Sdzuy (1969), the topmost strata of the griotte contain the trilobites *Asturiarps* cf. *inopinatus*, *Corynexochus* aff. *delagei* and *Peronopsella pokrovskajae pokrovskajae* Sdzuy, 1968. This assemblage correlates probably with early *Acadolenus*-bearing strata, and may indicate a Middle to lowermost Upper Leonian age. No ichnofossils were recovered throughout the formation.

A sharp contact separates the bottom of the Oville Formation, which is made up by 4.4 m of greyish green siltstones with carbonate nodules and two centimetre-scale beds of nodular limestone, constituting the top of the section (levels Po/14 to Po/16). Trace fossils are very abundant throughout the siltstones: *Cylindrichnus concentricus* (from vertical to almost horizontal), *Sericichnus mureroensis*, *Planolites terraenovae*, and wandering *Planolites*? 1.5 cm across. The trilobite *Eccaparadoxides asturianus* occurring at level Po/16 indicates an Upper Leonian age.

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