

Reconstructing the foraging environment of the latest titanosaurs (Fumanya dinosaur tracksite, Catalonia)



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ABSTRACT

The analysis of depositional environments associated with sauropod dinosaurs has been revealed as a key element for assessing their palaeoecology. A detailed study of the sedimentology, plant taphofacies and titanosaur ichnology at the Fumanya localities (early Maastrichtian, Catalonia) reveals that two distinct palaeoenvironments existed within the coastal wetlands. These settings are correlated with the occurrence of two distinct track and plant remains distributions, which correspond to a) a marginal brackish lagoon environment where no vegetation grew and titanosaurs roamed, during a short time span, without apparently any preferential purpose, and b) a freshwater swamp area around charophyte lakes with evidence of vegetation growth (charophytes, palms, and probably ferns and cheirolepidiacean conifers) where titanosaurs congregated and fed actively during a long time span. These data indicate that titanosaurs trampled the muddy substrates of freshwater wetlands in order to forage according to the availability of plants.

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1. Introduction

Over the last decades, greater understanding of sauropod palaeoecology has been achieved by the discovery of new fossils and the study of depositional environments associated with both bone and tracksites. Classical palaeoenvironmental analyses stated that sauropods inhabited a wide variety of environments, ranging from terrestrial (floodplain and fluvio-lacustrine settings) to coastal/nearshore settings (Sloan, 1969; Dodson et al., 1980; Russell et al., 1980; Lucas, 1981; Lehman, 1981; Lucas and Hunt, 1989). Studies on tracks and trackways suggested that sauropods frequently walked on submerged substrates in coastal and deltaic environments (Lockley et al., 1994) but later works rejected this possibility (Wright, 2005). Recent analysis of extensive datasets supported the first idea (i.e., Sloan, 1969; Lucas, 1981, among others) that sauropods were strongly linked to inland environments (Butler and Barrett, 2008). However, global quantitative analyses revealed a more complex scenario, with some clades (the non-titanosaur sauropods) linked to coastal environments (e.g. carbonate platforms), and others (the titanosaurs) linked to inland environments (e.g. fluvio-lacustrine systems) (Mannion and Upchurch, 2010). The titanosaurs appeared between the Middle and Late Jurassic, and underwent an extensive and apparently rapid radiation, to become the predominant sauropods of many terrestrial ecosystems throughout

every landmass, before their extinction at the end of the Cretaceous (Barrett and Upchurch, 2005; Wilson, 2005).

The Fumanya titanosaur localities (early Maastrichtian, Tremp Formation, southeastern Pyrenees) display nearly 3000 footprints, arranged in more than 50 trackways (Viladrich, 1986; Le Loeuff and Martínez-Rius, 1997; Schulp and Brox, 1999; Vila et al., 2005, 2008), and record a progression from marginal brackish lagoon to more protected freshwater palustrine settings. The Fumanya wetlands are thus an exceptional place to elucidate the titanosaurs' foraging behaviour and habitat preferences with respect to plant cover. Plant communities featured include diverse charophyte meadows in freshwater alkaline lakes and poorly-diversified charophyte assemblages in brackish lagoons (Villalba-Breva and Martín-Closas, 2011; Villalba-Breva et al., 2012). The freshwater swamps were vegetated by dense cheirolepidiacean conifer-arecacean wetlands, whilst the marginal lagoon was devoid of vegetation and only transported plant debris accumulated there (Villalba-Breva et al., 2012). Despite the fact that titanosaurs were documented in previous studies to inhabit fluvial settings, evidence from Fumanya show that their behaviour was more complex and specific to each sedimentary setting.

2. Geological and palaeontological setting

In the southern Pyrenees foreland basins, the Maastrichtian to Thanetian materials of the Tremp Formation (Mey et al., 1968) crop out in numerous localities within the Vallcebre, Coll de Nargó, Tremp

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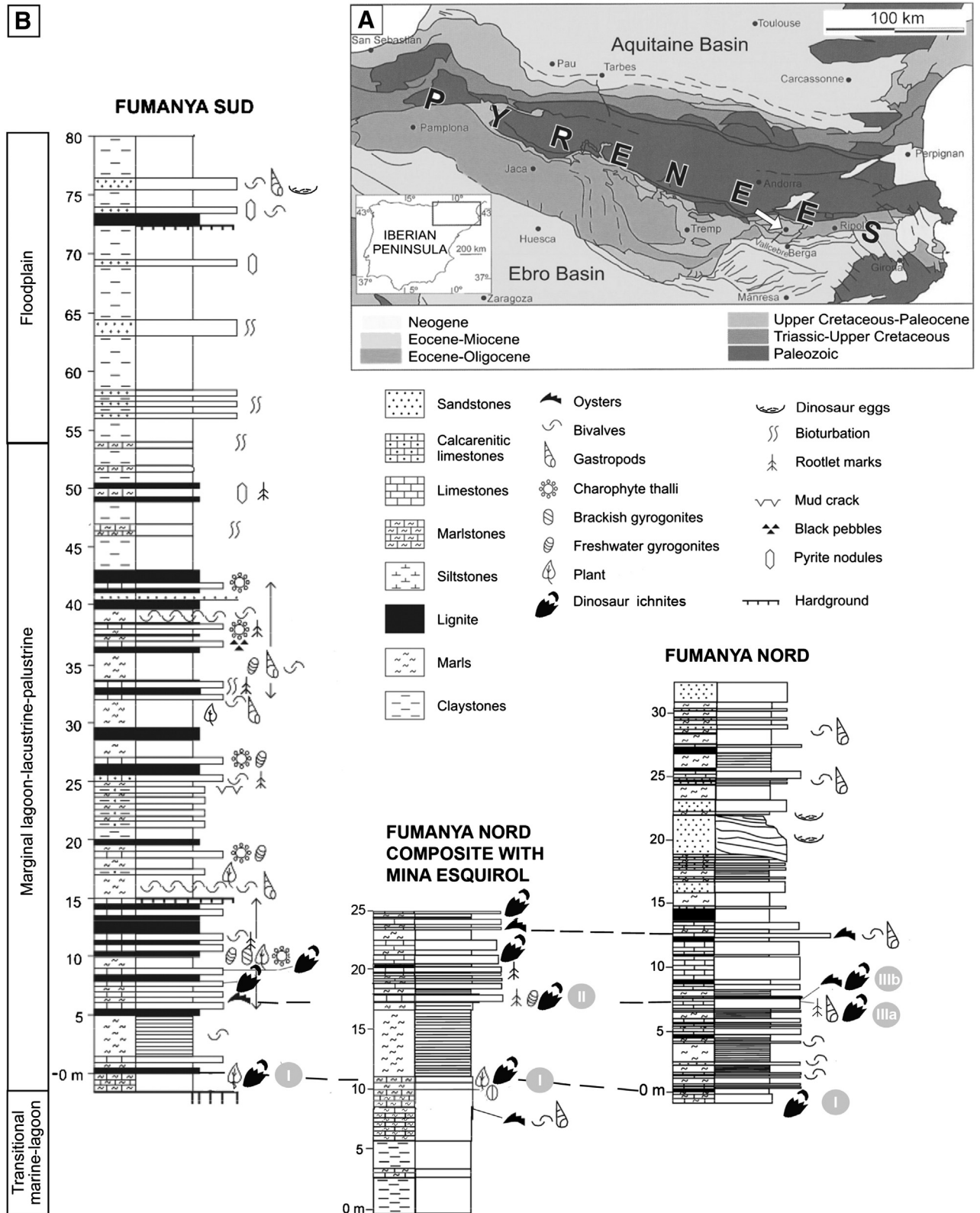


Fig. 1. Geographical and stratigraphic setting of the localities studied in the Vallcebre syncline. A, geological map of the Pyrenees with location of studied area (arrow). B, stratigraphic section of the 'Grey Garumnian' in the Vallcebre syncline with detailed sections of Fumanya Sud, Fumanya Nord and Mina Esquirol quarries, with the location of titanosaur track levels studied herein (I, II, and III).

and Àger synclines (north-eastern Iberian Peninsula). Most continuous series are exposed in the Vallcebre syncline, where they measure up to 760 m thick (Oms et al., 2007). Here, the lower boundary of the Tremp

Formation corresponds to its contact with the near-shore calcarenitic limestones of the Terradets Formation (Pons, 1977), which contain a diverse fossil assemblage, including foraminifera, corals, bryozoans,

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