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Fossiliferous amber deposits from the Cretaceous (Albian) of Spain

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Abstract

Amber-bearing deposits are a specific kind of fossil bioaccumulation that preserves exceptionally well palaeobiological information from the past. The present article discusses the 'state of the art' of the knowledge of certain Spanish amber-bearing deposits from the Cretaceous (Albian-Cenomanian). A bibliographic compilation of previous studies, together with new discoveries, shows the existence of over 100 amber localities; nevertheless, only in seven of these have arthropod inclusions been found. The sites are Albian in age, associated with coal deposited on deltaic environments. These outcrops are distributed in a strip curve through the North to the East of the Iberian Peninsula and which corresponds to the coastal line during the Early Cretaceous. It includes (from the northwest to the east): the Central Asturian Depression, the Basque-Cantabrian Basin, and the Maestrat Basin, respectively. Infrared spectroscopy (IRTF) analyses show close similarities between all these amber localities. Gas chromatography–mass spectrometry (GC–MS) of the Álava amber suggests that *Agathis* (Coniferales: Araucariaceae) or another closely related group of conifers was one of the resin producer trees of Spanish ambers. Numerous new records and taxa occur in the botanical source for Spanish Cretaceous amber; additional material has been newly excavated in the Moraza-Peñacerrada, Arroyo de la Pascueta, La Hoya, and San Just outcrops. More than two thousand inclusions are found in the Moraza-Peñacerrada sites (Burgos and Álava Provinces). In all the amber outcrops, the dominant group is composed by arthropods, and among them hexapods, with 17 orders being recognized to date. The most abundant and diverse insect groups are dipterans, hymenopterans and coleopterans, mainly parasitoid, saproxylic or herbivorous forms. ***To cite this article: X. Delclòs et al., C. R. Palevol 6 (2007).***

Résumé

Dépôts d'ambre fossilifère du Crétacé (Albien) d'Espagne. Les dépôts d'ambre sont des bioaccummulations à fossiles particulières, préservant de manière exceptionnelle l'information paléobiologique du passé. Dans ce travail, nous exposons les dernières

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connaissances sur les dépôts à ambre du Crétacé d'Espagne (Albien–Cénomanien). Une compilation bibliographique et de nouvelles découvertes montrent l'existence d'une centaine de localités contenant de l'ambre. Jusqu'à présent, seules sept d'entre elles, d'âge Albien, ont livré des inclusions d'arthropodes. Dans ces gisements, correspondant à des paléoenvironnements deltaïques, l'ambre est associé à d'importants dépôts de lignite. Les gisements sont distribués le long d'une courbe allant du Nord jusqu'à l'Est de la péninsule Ibérique, qui correspond à la ligne de côte pendant le Crétacé inférieur et inclut, du nord-ouest jusqu'à l'est, la dépression centrale Asturienne, le bassin Basque-Cantabrique et le bassin du Maestrat. L'analyse des ambres en spectroscopie infrarouge (IRTF) montre de grandes similitudes entre toutes les localités. L'analyse en spectroscopie de masse par chromatographie gazeuse (GC–MS) de l'ambre Álava suggère que *Agathis* (Coniférales : Araucariaceae), ou un autre groupe de conifères étroitement apparenté, ait pu être l'arbre producteur des ambres crétacés en Espagne. Le nouveau matériel excavé dans les gisements de Moraza–Peñacerrada, Arroyo de la Pascueta, La Hoya et San Just a livré de nombreuses inclusions ; plus de 2 miliers d'inclusions ont été trouvées dans les gisements de Moraza–Peñacerrada (provinces de Burgos et d'Álava). Dans tous les gisements d'ambre, les arthropodes constituent le groupe dominant, avec 17 ordres reconnus, les insectes les plus abondants et diversifiés étant les diptères, les hyménoptères et les coléoptères, principalement des formes parasites, saproxyliques ou herbivores. ***Pour citer cet article : X. Delclòs et al., C. R. Palevol 6 (2007).***

Keywords: Amber; Lower Cretaceous; Sedimentary environments; Geochemistry; Palaeobiology; Spain

Mots clés : Ambre ; Crétacé inférieur ; Environnements sédimentaires ; Géochimie ; Paléobiologie ; Espagne

1. Introduction

The fossilization processes imply, in almost all cases, an important loss of palaeobiological information; nevertheless, it is possible to gain sedimentological and palaeoenvironmental information with respect to other deposits [57]. In amber, the fossilization processes imply an excellent preservation of the palaeobiological content. Inclusions in amber show the best palaeobiological and palaeoenvironmental information of organism remains in the fossil record, and in the deposits where amber is placed, their sedimentological, palaeoenvironmental and diagenetic history is recorded as well. The amber deposits should be interpreted as Konservatt-Lagerstätten, not as Koncentrat-Lagerstätten [48], and should be considered as a particular type of fossil concentration with excellent preserved organism remains.

A concentration of organism remains, fossil or not, may be defined as a relatively dense accumulation of biological remains or fossils, independent of the composition in organism remains (one or several different species), their state of preservation, size, or taphonomic degree of modification [24]. The concentration processes may have a very different time range of formation depending on the cases. Amber inclusions can be geologically instantaneous.

Concentrations may be defined descriptively or genetically. Descriptive classification of concentrations includes the taxonomic composition, the internal structure of the deposit, the spatial distribution and disposition of remains, etc. Genetically, the palaeobiological concentrations are usually defined as biogenical, sedimentological or diagenetical, depending on the formation process. Amber inclusions may be classified into biogenical concentrations (a unique piece of amber may contain hundred of insect remains), as well as sedimentological concentrations (many pieces of amber, originally resin, can be found in the same stratigraphic level) [39]. Genetically, concentrations may also be divided into (1) episodic: where concentrations took place in a single layer, and in registered moments of usually unique and brief concentrations, as is the case of insect swarm inclusions, and termite or ant mass mortality due to a copious resin production [3,34]; (2) multiepisodic or composed: where concentration is characterized by an outflow or stalactite resin formation with several episodic sets of resin microlayers; and (3) condensed: with fine multilayers distributed over several centimetres, such as the litter fauna preserved in the Early Cretaceous amber of southwestern France [40].

Amber usually includes remains of organisms that lived close to the resinous trees, inside the forests, and this allows the interpretation of palaeoecological relationships between organisms better than any other fossil deposits. Nevertheless, amber is not usually found at its place of production, but transported by water flows to the final sedimentological deposits [34]. During transport the mixing of resins produced by different trees at different altitudes can occur. For this reason, palaeoecological reconstructions of forests ecosystems based on amber inclusions need to be especially accurate [42].

2. Geological settings of the Early Cretaceous amber-bearing deposits of Spain

The first reference to Spanish Early Cretaceous amber dates from 1762 [18], when the presence of amber