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Paléontologie générale (Taphonomie et fossilisation)

La bioaccumulation de microorganismes dans l'ambre : analyse comparée d'un ambre cénomanien et d'un ambre sparnacien, et de leurs tapis algaires et bactériens

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Résumé

Ce travail compare la bioaccumulation par piégeage des microorganismes dans l'ambre cénomanien d'Écommoy (Sarthe, France) et l'ambre sparnacien des Corbières (Aude, France). Dans les deux cas, un feutrage (cyanobactéries ou actinomycètes) est piégé à la périphérie du morceau d'ambre. De nombreux autres microorganismes (bactéries, filaments mycéliens, protistes, spores. . .) sont piégés. L'enrobage dans la résine a eu lieu, pour la majorité des inclusions, sous une faible tranche d'eau en milieu dulcicole (Corbières) ou paralique (Écommoy). ***Pour citer cet article : G. Breton, C. R. Palevol 6 (2007).***

Abstract

Bio-accumulation of micro-organisms in amber: compared analysis of a Cenomanian and a Sparnacian amber, and their algal and bacterial mats. The bio-accumulation of micro-organisms trapped in Cenomanian amber from Écommoy (Sarthe, France) and Sparnacian amber from the Corbières (Aude, France) is compared. In both cases, a felting of cyanobacteria or actinomycetes is trapped in the periphery of the piece of amber. Many other more or less isolated micro-organisms, including bacteria, mycelian filaments, protists, spores. . .) can be trapped. Most of the inclusions were embedded in resin under aquatic conditions, at least in very shallow water, in a freshwater (Corbières) or parallic environment (Écommoy). ***To cite this article: G. Breton, C. R. Palevol 6 (2007).***

Mots clés : Ambre ; Microorganismes ; Bioaccumulation ; Piégeage ; Taphonomie ; France

Keywords: Amber; Micro-organisms; Bio-accumulation; Trap; Taphonomy; France

Abridged English version

Palaeontologists used to pay more attention to macrofauna preserved in amber, especially insects, than to micro-organisms. Henwood [7,8] and Penney [16] showed that arthropods are quite concentrated with respect to the original biocenosis (resin acts as a

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concentration trap: Seilacher et al. [22]), but the trapping is selective. Several works deal with animal, vegetal or bacterian micro-organisms in amber: Waggoner [26–28], Waggoner and Poinar [29], Breton et al. [1], Breton and Tostain [2], de Franceschi et al. [5], Dejax et al. [4], Schmidt et al. [24]. Cenomanian amber from Écommoy (Sarthe, France) [2] and Sparnacian amber from the Corbières (Aude, France) [1] are compared herein in order to decide on the mode of trapping of micro-organisms in amber.

Geological context and modes of preparation are detailed by Breton et al. [1] and Breton and Tostain [2]. Methodological traps include: (1) pseudofossils [1], (2) superficial cracks of the amber pieces, often exactly superposed to the course of filaments (Fig. 6) – we observed that the most superficial and the widest filaments induce the cracks –; (3) contamination by recent micro-organisms, more tricky. Both careful preparation and critical examination of individual micro-inclusions are necessary.

The Cenomanian amber from Écommoy yields following micro-organisms. Cyanobacteria *Palaeocolteronema cenomanensis* Breton & Tostain, 2005 (= ? *Leptotrichites resinatus* Schmidt, 2005) is preserved as a thin peripheral felting (Figs. 1 and 2). Other microbiotas are much less frequent and include: a group of 26 euglenas, four diatoms, one naked amoeba, filamentous algae and *incertae sedis* microbiotas. The resin presumably trapped free-living (euglenas, diatoms, amoeba) or fixed (*Palaeocolteronema*) organisms: embedding took place under water, at least under very shallow water. The taphocenosis comprises likely autochthonous organisms, developing in small puddles of freshwater (to slightly briny?) or in a very humid environments. The palaeobiotope was a swamp, maybe a mangrove, behind but close to the coastline, according to the geological data [10], and as suggested by Perrichot [17] for the Lower Cretaceous amber from Charente-Maritime (France).

The Sparnacian amber from the Corbières yields the following organisms. The bacteria include several cocci and rod-shaped bacteria, but are widely dominated by actinomycetes, developed as a felting at the surface of the sediment (Figs. 3–5 and 12). At least three morphospecies are quoted, all have been embedded sporulating in the resin. Frequent mycelian filaments often belong to Imperfecti (Fig. 6). The taxonomic assignation to the Chlorophyceae *Trentepohlia* sp. (Breton et al. [1]) has been confirmed by the subsequent observation of characteristic gametocysts. One Siphonale species is frequent in the amber pieces embedding also mats of actinomycetes. The lack of septae and the mode of ramification evoke the living genus *Dichotomosiphon* (Figs. 10 and 11). Filaments of a Zygnematale alga have been trapped while forming their zygospores *Ovoidites* Potonié, 1951 (Fig. 7). One of these spores is fossilized germinating (Fig. 8). Protists include: unicellular Chlorococcales algae, flagellate cells (protists or zoospores), *incertae sedis* protists, and ciliates, a pair of which being either in conjugation or dividing. Spores are frequent; few exhibit a characteristic morphology. Lastly, groups of spermatozoids (spermatodesms, spermatozeugmata) have been observed. The heads of spermatozoids are close together, the acrosoms are turned laterally. In one observation out of three, the bundle of spermatozoids is capped by what is thought to be the rest of a spermatophore.

In every piece of amber where both a felting of actinomycetes and algae cf. *Dichotomosiphon* are preserved, they are stratified: from the surface towards the centre of the piece of amber: (1) a mineral layer (the sediment on which the resin flowed or the sediment in which the resin piece was transported or both);(2) the felting of actinomycetes, with sporanges or clusters of spores directed towards the centre of the amber; (3) the filamentous algae as *Dichotomosiphon* sp. (Fig. 12). The trapping was thus peripheral and respected the superposition sediment/bacterial mat/filamentaous algae and free-living organisms.

The two cases are very similar: cyanobacterial felting (Écommoy) and actinomycetal felting (Corbières); peripheral trapping; taphocenosis of likely autochthonous micro-organisms, often embedded alive (sometimes in reproduction); very humid aerial to shallow freshwater environment (with possible briny episodes in the case of Écommoy).

The hypothesis of a settlement of cyanobacteria growing from the surface into already hardened pieces of resin (Néraudeau, Girard, in litt.) is discussed.

The striking similarity between the two ambers comes from the peripheral trapping of two aquatic mats of micro-organisms, cyanobacteria in the first case, actinomycetes in the second one. In such a ‘concentration trap’, bio-accumulation is obvious, understood either as an accumulation of microbiotas or as an accumulation thanks to a living organism, the resin-producing tree, which allowed the exceptional quantitative and qualitative preservation of this remarkable microtaphocenosis.

1. Introduction

Seilacher et al. [22] ont rappelé la classification génétique des «*fossil Lagerstätten*» comprenant les dépôts de concentration (*concentration deposits*) et les dépôts de conservation (*conservation deposits*). L’ambre