

LAND AND FRESHWATER MICROFLORA IN A SPARNACIAN AMBER FROM THE CORBIÈRE (SOUTH FRANCE) : FIRST OBSERVATIONS

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Abstract

Red amber was collected at the base of a transgressive deposition sequence of Sparnacian age, in the vicinity of Douzens (Aude, France). The peripheric layer of the amber fragments yields at least three morphological types of bacteria, filaments of fungi, several types of algae, spores (some of them seem to bear elaters), and *Pinus*-like pollen grains. Amongst the algae, some specimens are morphologically very close to living *Trentepohlia* sp. filaments, or to filaments evoking the Chaetophorales *Chaetonemopsis* sp. One unicellular alga or spore type is very puzzling : it bears two flagellas with pseudofossils which look like unipennate mastigonomas.

All these microfossils can be closely compared with whether terrestrial or freshwater living taxa : this is coherent with the taphonomy, the organisms living in freshwater or on the ground being embedded in the peripheric layer of amber. The amber has then been reworked in a marine or brakisch environment where it was definitely deposited. The transport was short because : 1) some « tears » are entire though this amber is very brittle, 2) the thin peripheric layer (less than 0.5 mm) was not eroded.

We have not yet found insects. The absence of diatoms is an other striking feature, still unexplained.

Key-words: Amber, taphonomy, Eocene, Corbières, France, pseudofossil, fossil bacteria, fossil fungi, fossil algae, land microflora, freshwater microflora.

GEOGRAPHICAL AND GEOLOGICAL SETTING (FIG. 1)

The outcrop of Douzens (Aude, France), located in the northern part of the Montagne d'Alaric displays: 8 m of lacustrine massive grey limestones, with a perforated and slightly encrusted surface; 4 m of beige-grey marls, the first decimeters of which provided amber. At the beginning of the transgressive series, one finds phosphatized nodules, charcoal, bones of chelonians and crocodiles and small oysters that Plaziat (1970) thought to be mangrove oysters. At the base of the series, a conspicuous *Thalassinoides* isp. network develops 3 cm-diameter burrows.

Amongst the examined charcoals fragments, D. Pons (pers. comm.) recognized two species: an *Abietina* conifere, and one unidentified Dicotyledone.

Upwards, the marine character of the series increases, with an increasing content of carbonate, and the diversification of a turritelles, cerithes, natices, volu-

tes... gastropod fauna. The resin is therefore rare and horizontally concentrated. All the series dips 40° N, and belongs to the Sparnacian stage.

Plaziat (1970, p. 82) quotes « fragments de résine » in the Upper Sparnacian Calcaire bioclastique à Huitres at Lagrasse-la-Caglière. The amber studied here was therefore found for the first time by one of us (D.V.) at Douzens: the amber is to be found on the rain-washed outcrop in the first meter of the transgressive series.

MATERIAL AND METHODES

The amber fragments have been picked on the outcrop: washing bulk samples of a total of 100 kg of marl was disappointing and provided very few more fragments. The fragments were washed in a detergent solution (without using ultrasonic systems because this amber is very brittle) then rinsed and dried.

Very small flakes of peripheral amber are removed with very minute instruments. They are mounted in glycerol on a microscopical slide and observed with a Leica DMLB microscope, with bright field, and transmitted light interference contrast, camera lucida drawing tube and 24 x 36 photographic camera.

The mounting in glycerol does not permit to use an immersion objective, but the different techniques of transfer towards a solid mounting medium (as Canada balsam or synthetic resin Eukitt) all failed, and many specimens of our first observations are now destroyed or heavily worn. Now, we use direct mounting in Canada balsam. All the preserved material is housed in the Muséum d'Histoire Naturelle, Le Havre (France).

TAPHONOMY AND PRESERVATION

All the inclusions are located in a very thin peripheral layer of amber. The trapped organisms were distorted or bent by the flowing resin: shrinkage, misleading reorientation of organites or ramifications are frequent (fig. 2. a: displaced flagellas of a cell; b: bent ramification of an alga). The intracellular material is not conserved, or very much opacified. The cellulosic cell wall itself is often more or less thinned or altered. If it completely disappears, the wall can be just underlined by an accumulation of gas bubbles, trapped at the time of the inclusion in the resin on a surface, for instance, of a sporange, the wall of which completely disappeared during amberization. Often, only the external shape of the cells, organisms or fragments, is preserved. « Tears » or stalactite-like fragments of amber, with an uneroded peripheral layer have been found. That means that the transport was short or very short.

Superficial cracking of the surface is very common: it is due to physical constraints during diagenesis and transport. The network of cracks often follows the main underlying inclusions, especially algal filaments.

The opacification is rare: it can be due to releasing water or other substances by decaying organisms, or by trapping opaque products, as humus or clay; more frequently, the amber is transparent.

PSEUDOFOSSELS

Pseudomicrofossils are very common in the Eocene amber from Douzens. They often have the shape of spores, cells or filaments, and sometimes display pseudonucleus (fig. 3a), pseudoorganites as flagellas (fig. 3b), or mime division phenomena. Some grouped pseudofossils (fig. 3c) look very much like the « unidentified spores clusters » in the Upper Cretaceous amber of Mississippi (Waggoner, 1994b; pl. 1, fig. 6-8) but are plane and not 3-dimensionnal structures.

SYSTEMATICS

Bacteria

The bacteria or bacteria-like organisms fall into three morphological types: isolated, aggregated or in short chains cocci (1 mm), bacillas (0,5-1 x 2-5 mm), and myceloid, i.e. branched filamentous bacteria

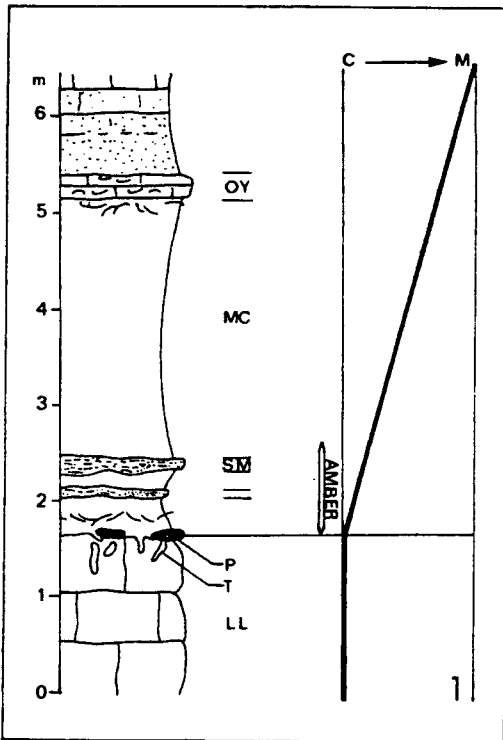


Figure 1. Lithostratigraphy of the Sparnacian outcrop of Douzens (Aude, France).

LL: lacustrine limestone. T: *Thalassinoides* isp. P: phosphate nodules. SM: sandy marl.

MC: marly clay. OY: limestone with oysters. The double arrow indicates the vertical range of the amber. C: continental. M: marine. Vertical scale in meters (m).

(0.5-1 mm diameter). We do not want to try any taxonomical assignation, because such a « bacterial taxonomy based on morphology alone is usually tentative at best » (Waggoner, 1993). Bacteria have been known in amber for a long time (Galippe, 1920).

Fungi

Fungi, which are common in amber (Poinar, 1994a) are here represented by branched filaments (4-6 mm diameter), moniliform or not, with sometimes a transition between the two types in the same filament.

Algae

Some unicellular algae have been found. The first one, with a 60 mm long cell with tapering ends and apical spines is assigned to the Zygomycete genus *Closterium*, and is morphologically close to the living species *C. cuspidatum* Bailey (fig. 4a). An other species, represented by three specimens in the same amber fragment, is a Dinoflagellate. In the three specimens, there is an apical « beak » which is whether a structure identical to the apical « beak » of the living marine *Herdmania littoralis* Dodge, or the result of a break in the theca on a brittleness zone during the hardening of the resin (fig. 4b). Three specimens of biflagellate cells in the same amber fragment (fig. 4c) may be unicellular green algae or zoospores: they display very puzzling « pseudomastigonemas » on the flagella.

Filamentous algae are represented at least by three taxa. The first one is very close to the erected filaments of the living Chlorophyceae *Trentepohlia aurea* (Linnaeus) Martius. Though the cell wall is very thin and worn by the fossilization and cytological characters can not be studied, and though the cells are twice smaller than in living forms, the shape of the cells and the mode of ramification are closely similar to those of erected filaments of *T. aurea*.

One specimen certainly belongs to order Chaetophorales and we compare it to the living species *Chaetonemopsis pseudobulbochaete* Gauthier-Lièvre (fam. Aphanochaetaceae), with a very similar organization of the thallus.

Last alga remains *incerta sedis*. Only three parallel lateral ramification are preserved. They certainly originated from an unpreserved axis. The ramifications are pluriseriate, and bear club shaped structures.

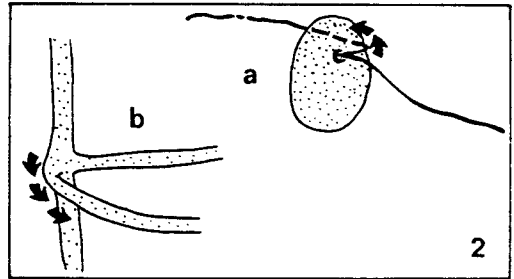


Figure 2. Distortion or bending of some organisms trapped in the Sparnacian amber from Douzens (Aude, France). a : displaced flagella of a cell. b : bent ramification of an alga.

Bryophyte ?

A pluricellular fossil seems to have an axial structure; a bit further there is the end of a similar axis. This fossil is perhaps the apex of the leaf of a moss.

Pollen and spores

One pollen grain (50 mm) bears two airbags and is very similar to *Pinus* spp. pollen grains (M. Clet, Caen, pers. comm.).

Spores are abundant in the Douzens amber. Most of them are dark spherical or ovoid inclusions and do not display any other morphological or ornamental feature. Thus, they can not be identified.

In one amber fragment, three microfossils are tentatively interpreted as spores bearing four unequal elateres (two long ones and two short ones). As far as we know, such spores with unequal elateres are not known in living taxa. The spore itself is spherical (approximate diameter 50 µm), and the three ones are crushed and/or germinated.

CONCLUSION

All the microfossils of the Sparnacian amber from Douzens (Aude, France) can be compared with terrestrial (*Trentepohlia* sp., *Pinus* sp., spores...) or freshwater (*Chaetonemopsis* sp., *Closterium* sp.) living taxa. This is coherent with taphonomy, the small organisms living in freshwater or on the ground being embedded in the peripheral layer of amber. The amber has then been shortly reworked and definitely deposited in a brackish or marine environment.

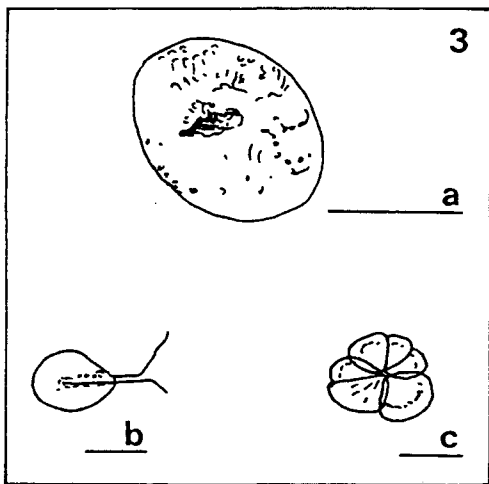


Figure 3. Pseudofossils. Sparnacian amber from Douzens (Aude, France), drawn from photographs.

a: pseudo-cell with pseudonucleus, scale bar 50 μm ; b: pseudo-flagellus, scale bar 20 μm ; c: cluster of pseudo-cells, scale bar 10 μm .

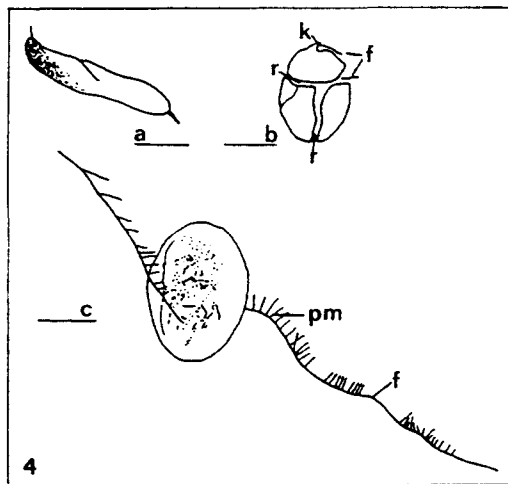
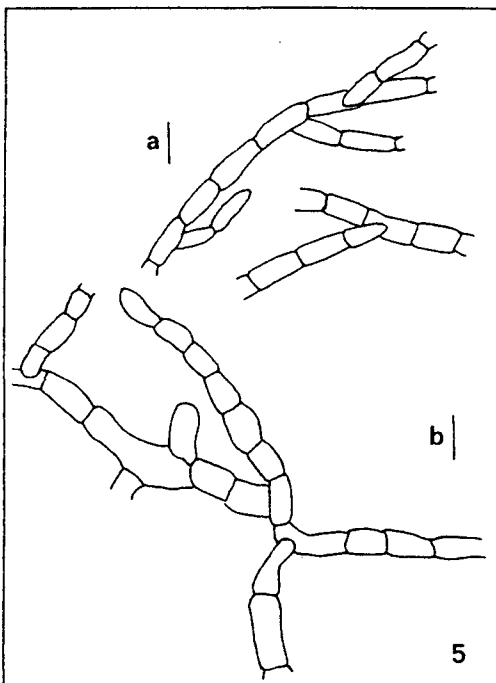


Figure 4. Unicellular algae. Sparnacian amber from Douzens (Aude, France), camera lucida drawings.

a: cf. *Closterium cuspidatum* Bailey with apical spines, scale bar 20 μm . b: unidentified Dinoflagellate; k: Apical « beak »; r: furrows; f: flagella. Scale bar 20 μm . c: unicellular biflagellate cell (green alga ? zoospore ?), pm: pseudomastigonemas; f: flagella. Scale bar: 10 μm .



We have not yet found insects or other animal fossils in the Douzens amber.

The absence of diatoms is another striking feature, still unexplained.

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Figure 5. a: Erected filaments of the living *Trentepohlia aurea* (Linnaeus) Martius, (St-Paterne-Racan, Sarthe, France). Scale bar 20 μm .

b: Filamentous alga cf. *Trentepohlia aurea*. Sparnacian amber from Douzens (Aude, France). Scale bar: 10 μm . Camera lucida drawings.

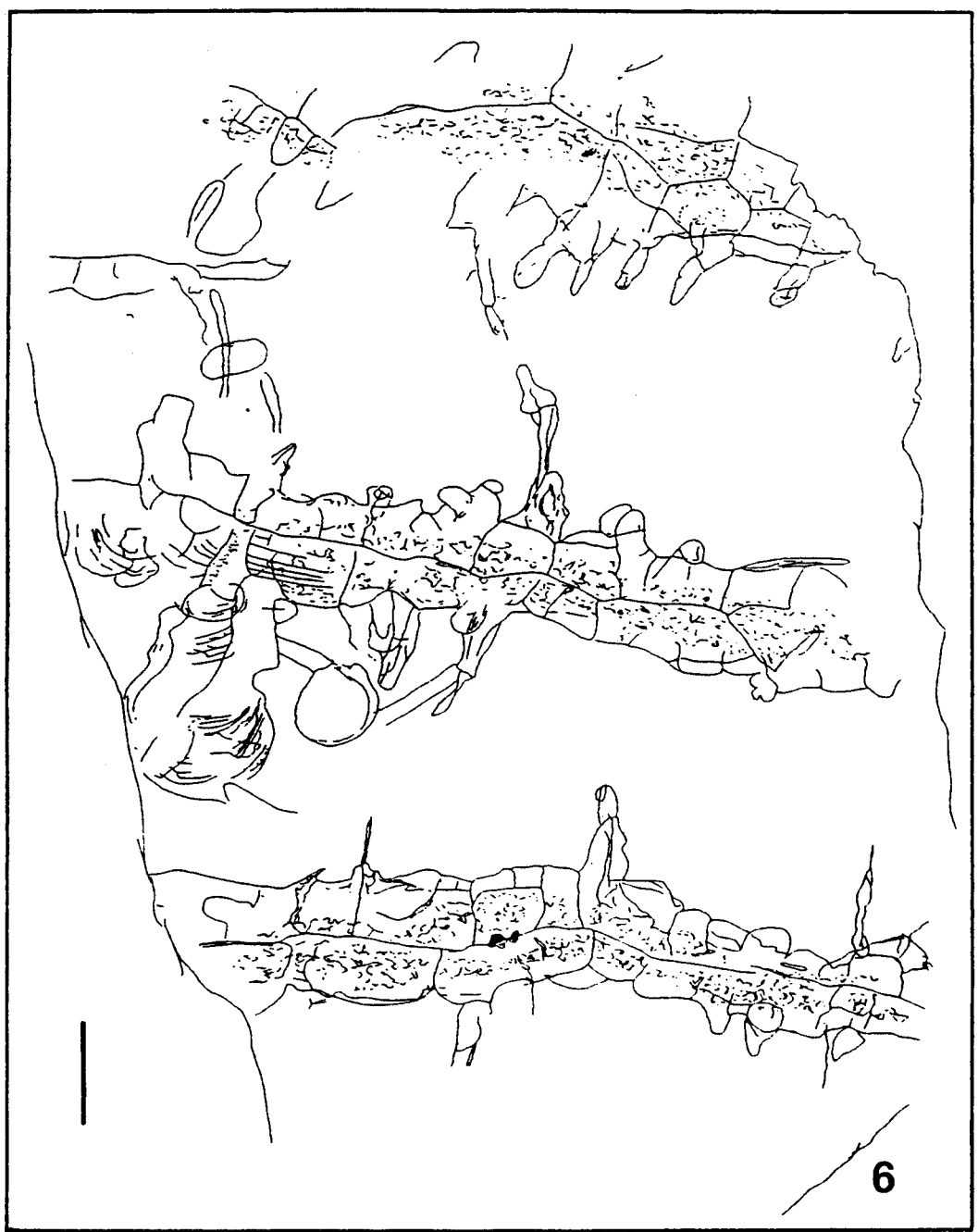


Figure 6. Filamentous alga (?) *incerta sedis*. Sparnacian amber from Douzens (Aude, France). Scale bar: 100 μ m. Camera lucida drawing.

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