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Palaeobotanical investigation of a Cenomanian clay lens in Hucheloup Quarry, Maine-et-Loire, NW France: Taxonomic, stratigraphic and palaeoenvironmental implications

Étude paléobotanique d'une lentille argileuse cénomanienne de la carrière de Hucheloup, Maine-et-Loire, NO France : implications taxonomiques, stratigraphiques et paléoenvironnementales

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ABSTRACT

A Cenomanian clay lens in Hucheloup Quarry (Maine-et-Loire, north-western France) has yielded 82 foliar compressions and impressions, of which 62 were identified at several taxonomic levels. The plants are ascribed to diverse Pinales (27%), ferns (27%), Ginkgoales (26%), angiosperms (19%) and Cycadales (1%). The most abundant species in the assemblage are *Frenelopsis alata* (K. Feistmantel) E. Knobloch emend. J. Kvaček (Pinales) and *Eretmophyllum obtusum* (Velenovský) J. Kvaček (syn. *E. andegavense* Pons, Bourreau et Broutin) (Ginkgoales). Wood fragments, along with very well-preserved cuticles, have also been recovered and identified. The specimens are usually very fragmentary, indicating that they had been transported over a significant distance before deposition. The Hucheloup clay was probably deposited in a brackish lagoon or in the lower part of an estuary, possibly in an abandoned channel or on a sandbar. The allochthonous flora represents at least two plant communities that developed in a subtropical–tropical climate, and along a salinity gradient in the vicinity of a fluvial network. Use of the fossil-genus *Eretmophyllum* Thomas emend. Harris in Harris *et al.* is considered to be the correct choice for ginkgoalean leaves within European Cenomanian deposits; the genus *Nehvizdya* Hluštík is regarded as a junior synonym. The clay lens has also yielded a palynological assemblage. Although lacking unequivocal indicators of this age and including some taxa that are more typical of older rocks, the composition of the associated, very small megaspore assemblage recovered is consistent with a Cenomanian determination.

Mots clés :
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Lagune

RÉSUMÉ

Quatre-vingt-deux compressions et impressions foliaires ont été collectées au sein d'une lentille argileuse cénomanienne située dans la carrière de Hucheloup (Maine-et-Loire, France), 62 d'entre elles ayant pu être identifiées. Les macro-restes observés correspondent à des Pinales (27%), des fougères (27%), des Ginkgoales (26%), des angiospermes (19%) et des Cycadales (1%). *Frenelopsis alata* (K. Feistmantel) E. Knobloch emend. J. Kvaček (Pinales) et *Eretmophyllum obtusum* (Velenovský) J. Kvaček (syn. *E. andegavense* Pons, Bourreau et Broutin) (Ginkgoales) sont les deux espèces les plus abondantes de l'assemblage. Des fragments de bois et des cuticules ont également été récoltés et identifiés.

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Anjou
Cénomanien

Les macro-restes végétaux sont souvent très fragmentés, conséquence d'un transport sur une distance considérable avant dépôt. La lentille argileuse de Hucheloup s'est vraisemblablement déposée au sein d'une lagune saumâtre ou de la partie inférieure d'un estuaire, possiblement au niveau d'un bras-mort ou d'une barre sableuse. La flore, allochtone, comporte des éléments issus de deux communautés végétales distinctes qui se sont développées sous l'influence d'un gradient de salinité aux alentours d'un réseau fluviatile, sous un climat subtropical à tropical. L'attribution des feuilles de Ginkgoales au morpho-genre *Eretmophyllum* Thomas emend. Harris in Harris et al. au sein des dépôts cénomaniens européens est ici discutée et défendue ; le genre *Nehvizdya* Hluštík est considéré comme synonyme junior. La lentille argileuse présente également un assemblage palynologique, dont 22 taxons ont été identifiés. Ce dernier est dépourvu d'indicateurs temporels indiscutables et présente des formes typiques de sédiments plus anciens, mais la composition du modeste assemblage associé de mégaspores est cohérent avec un âge cénomanien.

1. Introduction

Cenomanian plant-bearing deposits are fairly common in western France, and their fossil content has been studied since the mid-19th century (Bongniart, 1849; Crié, 1879). Even though most of the plant remains discussed in recent publications come from Charente-Maritime (Néraudeau et al., 2002, 2005, 2009; Gomez et al., 2004; Peyrot et al., 2005; Moreau et al., 2014), several Cretaceous sand quarries in the historical region of Anjou (consisting of Maine-et-Loire and part of neighbouring departments) have been subjected to numerous palaeobotanical investigations from the 1910s onward (Couffon, 1914; Juignet and Médus, 1971; Azéma et al., 1972; Pons et al., 1980; Berthelin and Pons, 1999; Néraudeau et al., 2013; Valentin et al., 2014).

Hucheloup Quarry (Fig. 1) is one of these. It exposes one of the few remaining Cenomanian outcrops in the vicinity of Angers. It is located 1 km west of the well-known deposits of Le Brouillard Quarry, from which a reasonably rich Cenomanian macroflora (Pons et al., 1976, 1980; Pons, 1979; Nguyen Tu et al., 1999), palynoflora (Pons and Boureau, 1977; Azéma, 1979), mesoflora (Batten et al., 2010) and microfauna preserved within amber (Néraudeau et al., 2013) have been recovered. Le Brouillard Quarry has been inaccessible since 2005, rendering further investigations difficult. Luckily, the Hucheloup fossiliferous bed was discovered in 2006, and has been regarded as a suitable alternative to the loss of Le Brouillard. Néraudeau et al. (2013) compared the palaeontological contents of the two quarries, which, although very similar, differ in that amber is scarce at Hucheloup whereas marine and brackish bivalves are abundant: these occur only rarely at Le Brouillard.

The work presented herein is the result of a full palaeobotanical investigation and focuses on observations on plant compressions/impressions, wood fragments, cuticles, and plant microfossils. Taxonomic, stratigraphic and palaeoenvironmental observations are presented.

2. Geological setting

Hucheloup Quarry is located between the villages of Briollay and Ecouflant, 8 km north of Angers (Fig. 1). The quarry deposits consist of an alternation of sand and grey, lignitic, clay beds, and are part of the "Argiles feuilletées du Baugeois" Member (Laminated clays of Baugeois), described by Louail (1984) as the top unit of the "Argiles, sables et graviers de Jumelles et Brissac" Formation (Clays, sands and gravels of Jumelles and Brissac). The latter is considered to be Cenomanian in age and directly overlies Jurassic or altered Palaeozoic strata (Juignet, 1974, 1980; Lasseur, 2008).

During the spring of 2016 a trench was dug to clarify the local succession (Fig. 2). The 5-m section (Fig. 2C) can be divided into three major sedimentary units. From base to top these are:

- unit A: 1.5 m of yellow, slightly clayey sand with intercalations of grey to black lignitic sand (A1, A3, A4) alternating with coarse sand with lignitic accumulations (A2), and green and black, gravelly coarse sand on top (A5);
- unit B: 1 m of alternating slightly gravelly, clayey sand (B2, B4) and brown coarse sand (B1, B5) with an intercalation of black lignitic clay (B3). An oxidation surface, appearing as a ferruginous crust, overlies the unit;
- unit C: 2.5 m of fine clayey sand alternating with sandy clay:
  - C1–C4: grey to black fine sand, sometimes slightly clayey with unidirectional cross bedding (slope less than 10°) and an intercalation of lignitic, clayey fine sand (C2),
  - C5: clay and very fine sand, slightly gravelly,
  - C6: lignitic clay and yellow sand, containing pieces of amber and brackish or marine bivalves,
  - C7–C11: grey to black clay, containing bivalves (C7, C8), with intercalations of yellow fine sand lenses (C8), altered at the top of the unit.

Plant macro- and micro-remains have been recovered from a clay lens less than 10 m^2 located about 30 m north-east of the trench (Fig. 3). The grey clays contain several angular gravel intercalations, and overlie a succession of more or less clayey sands (Fig. 2B), often lignitic, and sometimes containing glauconite (Durand, 2014). Néraudeau et al. (2013) suggested that the clay lens could have been deposited between Units A and B of the Le Brouillard succession. However, there is no clear lateral continuity of the beds within the Hucheloup quarry, rendering challenging the development of a general stratigraphic log and correlations with the succession from Le Brouillard and within other parts of the quarry itself. Two hypotheses can be proposed regarding the local correspondence of the clay lens:

- from a topographic point of view (Fig. 2A), the lens correlates with the A2 lignitic sub-unit, possibly indicating a synchronous deposit in an organic-rich environment;
- from a palaeontological viewpoint, the faunal content of the clay lens is very similar to that of the C7–C8 sub-units.

The second hypothesis seems more plausible: deposition could have occurred at the same time, differences in their elevation being explained by the establishment of sandbars in an estuarine environment.

3. Material and methods

The plant-rich clay lens was found by one of us (MD: Durand, 2014) in 2013. An additional investigation was carried out in 2016 by MD, RF, JDM, DN and FR. During these periods of

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