



New data on the age of the Lower Cretaceous amber outcrops of Lebanon

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Abstract

The “Grès du Liban” [Sandstone of Lebanon] is the basal lithostratigraphic unit for the Cretaceous series in Lebanon. In the upper part of these siliciclastic-dominated strata we identified three discrete intervals characterized by their richness in amber with biological inclusions, mostly insects. The middle and upper intervals previously attributed to an Early Aptian (= Bedoulian) age are nowadays ascribed to the Early and Late Barremian respectively; the lower interval is Early Barremian or possibly older. Besides that it is suggested that pieces of amber with inclusions from the middle and upper intervals could be reworked from the lower interval. In conclusion, the new dating of arthropod-bearing localities allows us to push back in time (at least to the Early Barremian) the first occurrences of all biological inclusions found therein.

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1. Introduction

Amber is a fossil plant resin that has the property to preserve pristine details of any zoological, botanical, or phycological inclusions. Lebanon is renowned for its numerous amber localities (with more than 450 outcrops) spanning a large time window from the Kimmeridgian up to the Albian times. Most of the outcrops are Early Cretaceous in age and among them twenty-three (Fig. 1) enter the category of the oldest “intensively fossiliferous” sites (Azar, 2012). Early Cretaceous is a crucial period for the understanding of the coevolution between flowering plants and insects because it witnessed the radiation of angiosperms and the coeval rapid diversification of insects accompanied by the massive extinction of older groups (Jarzembowski and Ross, 1993). Azar et al. (2003) were the first to use fossil insects in

amber to correlate discrete outcrops. However, they were not able to determine the exact geological age of these strata. Palynological dating was performed but it does not prove to be very successful with long-ranging taxa that are spanning the Late Jurassic and the Early Cretaceous (Azar et al., 2011). Fortunately, new paleontological and stratigraphic data (Maksoud et al., 2014; Granier et al., 2015) allowed us to give a more precise age to the Lebanese amber.

2. Geological context

The Lebanese Cretaceous strata begin with the “Grès du Liban” [Sandstone of Lebanon] (Granier et al., 2015), also called “Sandsteinformation des Libanon” [Sandstone Formation of Lebanon] (Fraas, 1878), “Grès lignitifère” [Sandstone with lignite] (Zumoffen, 1926) and “Grès de base” [basal Sandstone] (Dubertret, 1963, *inter alia*). The lower part of the “Grès du Liban”, which is supposedly azoic but includes locally pisolitic layers, was ascribed to the Neocomian (i.e., Valanginian–Barremian) by Dubertret (1963). Its fossiliferous upper part was ascribed to the Lower Aptian by Dubertret (1963) and other workers. This upper part includes a thick

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Fig. 1. Simplified map of Lebanon with locations of the Lower Cretaceous amber outcrops. Dark green areas indicate the distribution of the amber localities. Yellow circles indicate the outcrops with fossil inclusions. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

marker bed consisting of oolitic limestones known as “Banc de Mrejatt” [Mrejatt Bed]. Considering our modern approach (Maksoud et al., 2014; Granier et al., 2015; Maksoud, 2015), Dubertret’s lithostratigraphy can be regarded as facies-driven and his biostratigraphy as poorly constrained. Most authors were ascribing the amber outcrops we studied a Neocomian–Aptian (Zumoffen, 1926) or Neocomian–Early Aptian (Dubertret and Vautrin, 1937), or a Valanginian–Hauterivian age (Schlee and Dietrich, 2009), i.e., various ranges within the whole Early Cretaceous interval, except for the Albian and eventually the Late Aptian. The age of the overlying limestone unit, i.e., the “Falaise de Blanche” [Blanche Cliff] (Fig. 2), was also poorly constrained: Albian for Zumoffen (1926) or Late Aptian for Dubertret (Dubertret, 1934, 1955, 1963; Dubertret and Vautrin, 1937). A recent detailed holostratigraphic study led us to merge the whitish micritic limestones of the “Falaise de Blanche” with the immediate underlying yellowish grainy limestones in a single lithostratigraphic Unconformity Bounded Unit (Maksoud et al., 2014). Because this unit can be biostratigraphically constrained by its micropaleontological contents (Fig. 3), it also equates with a regional stage, the “Jezzinian” (Maksoud et al., 2014), which

is dated late Barremian–earliest Aptian (= early Bedoulian) age.

In Lebanon, the Lower Cretaceous fossiliferous amber outcrops are found in three intervals at the upper part of the “Grès du Liban” (Fig. 4):

- The **upper interval** is located between the Jezzinian above and the “Banc de Mrejatt” below. Outcrops belonging to this interval are those of the waterfall at Jezzine (South Lebanon), Hammana and Bouarij (Central Lebanon);
- The **middle interval** is located between the “Banc de Mrejatt” above and a pisolitic interval below. Outcrops belonging to this interval are those of Wadi Jezzine (South Lebanon), Ain Dara and Kfar Selouan (Central Lebanon);
- The **lower interval** falls below the pisolitic interval. Outcrops belonging to this interval are those of Rihane, Maknouiyyeh, Roum-Aazour-Homsiyeh and Jouar Es-Souss in Bkassine (South Lebanon), and Ain Zhalta (Central Lebanon).

The “Banc de Mrejatt” and the pisolitic interval are not present all over Lebanon but only in a tectonic compartment

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