CoForChange

The fragmentation of the African rain forests during the third millenium BP : palaeoenvironmental data and palaeoclimatic framework. Comparison with another previous event during the LGM.

Poster 2 - Holocene

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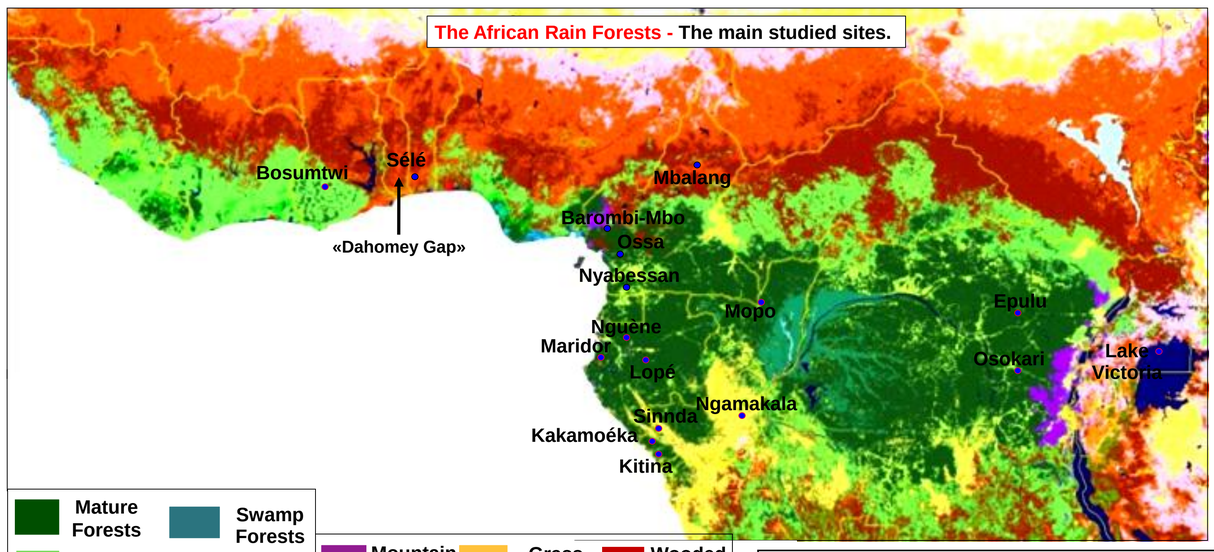

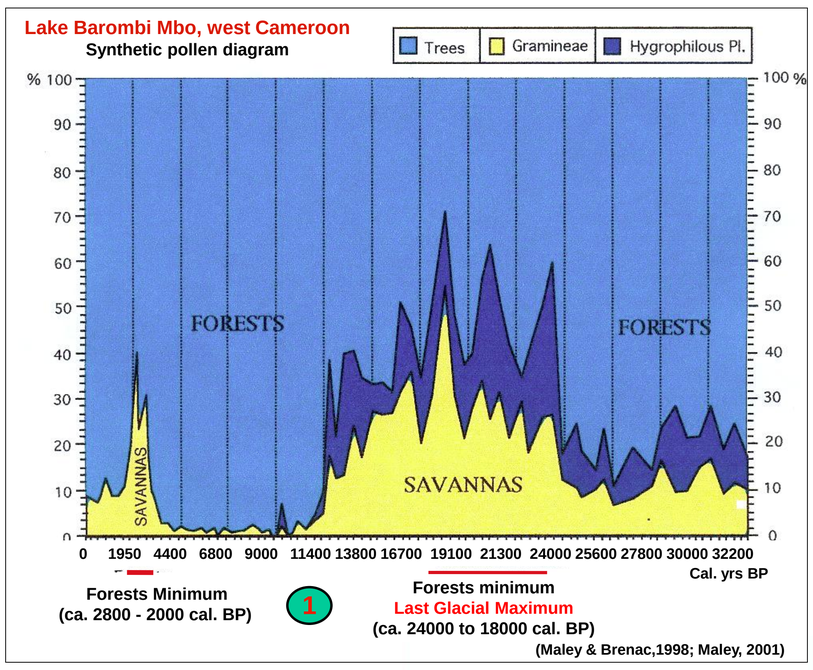

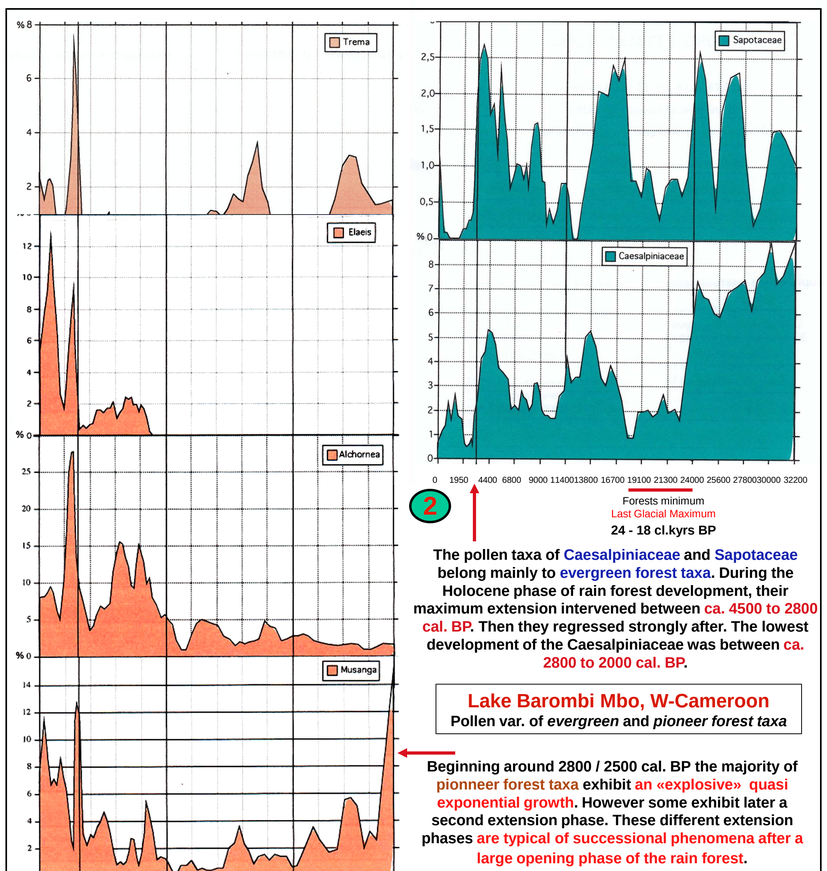

The pollen taxa of Caesalpiniaceae and Sapotaceae belong mainly to evergreen forest taxa. During the Holocene phase of rain forest development, their maximum extension intervened between ca. 4500 to 2800 cal. BP. Then they regressed strongly after. The lowest development of the Caesalpiniaceae was between ca. 2800 to 2000 cal. BP.

Lake Barombi Mbo, W-Cameroon
Pollen var. of *evergreen* and *pioneer forest taxa*

Beginning around 2800 / 2500 cal. BP the majority of pionneer forest taxa exhibit an «explosive» quasi exponential growth. However some exhibit later a second extension phase. These different extension phases are typical of successional phenomena after a large opening phase of the rain forest.

cal. yrs BP

(Maley & Brenac,1998; Maley, 2002)

During the early Holocene, a major period of increased humidity occurred, as evidenced by maximum Congo River discharge **(Poster 1, n° 5)** the high stands at lakes Bosumtwi (Shanahan,2006) and Victoria (Stager,1997) 10 ,but the level of the Barombi Mbo was stabilized by an overflow **(Poster 1, n° 2)**. Linked to this Humid Phase, probably until ca. 6000 cal. BP, **the African rain forest reached its maximum extent.** 1

Indeed, pollen data from Cameroon show that the rain forest extended up to the Adamaoua Plateau before 6000 cal yr BP (Vincens, 2010). After this maximum extension, **two major phases of perturbation impacted the African rain forests during late Holocene**. First a large contraction of the Forest Domain occurred abruply around 4000 cal yr BP **- so-called Fragmentation 1 -** and was linked to a strong extension of the northern and southern adjacent savannas. To the north, the main event was **the opening of the « Dahomey Gap »** in Togo and Benin 11 and to the south, the extension of the Niari savannas (W. Congo)(Vincens,1994) 4 and those in coastal Gabon (Giresse,2009). However, paradoxically, during this phase and until the middle of the 3nd millenium BP, inside the Forest Domain, **the evergreen type of rain forests** were apparently not reduced, because the pollen spectra show that the taxa belonging to **Caesalpiniceae, Sapotaceae,** etc, exhibited a marked increase (Maley,1998; Reynaud,1998; Ngomanda, 2009) 1,2,3.**Fragmentation 2** occurred during the second part of the 3nd millenium BP. The main characteristic was an abrupt extension of the pionneer forest vegetation 2,3,5,7 and, in some places, of savannas 1,5,6 .**The Fragmentation 2 was also linked to a strong erosion** resulting in the deposit of coarse sediments : sands, pebbles and the **« Stone-line 2 »** 8,9 .Two profiles, one in Mayombe close to the Guinea Gulf 8 ,and another in the eastern part of Congo Basin 9 ,contain similar and contemporary units showing that these two main erosive phases are linked to large-scale climatic changes. Data obtained for the Holocene in the lake Victoria (Stager,1997) 10 enlarge this conclusion and link the phenomena **to major variations in the African Monsoon**. To better understand monsoon dynamics during these diverse phases, one can observe **that Fragmentation 1, without erosion, was linked to a lowering of SSTs in the Guinea Gulf and the Fragmentation 2 occurred during a period of abrupt increasing SSTs** 7.

These SST variations could have induced **changes in the structure of the monsoon**.

- **Firstly**, **more stratiform types of cloud could have been more common during Fragmentation 1,** and also during the following phase of evergreen rain forest taxa development,

-**and second, more cumuliform types of cloud could have developed during Fragmentation 2, linked probably to a seasonality increase of the precipitation.**

These hypothetical changes in the monsoon **may also be applied to the late Pleistocene phases** described above **(Poster 1)**, which were also linked to SST variations, particularly with **an important decrease of SSTs during the LGM, for the period of the main Forest Refugia (Poster 1, n° 3), and increase of SSTs for the period of the « Stone-Line 1 »** (Maley, 2001, 2002).

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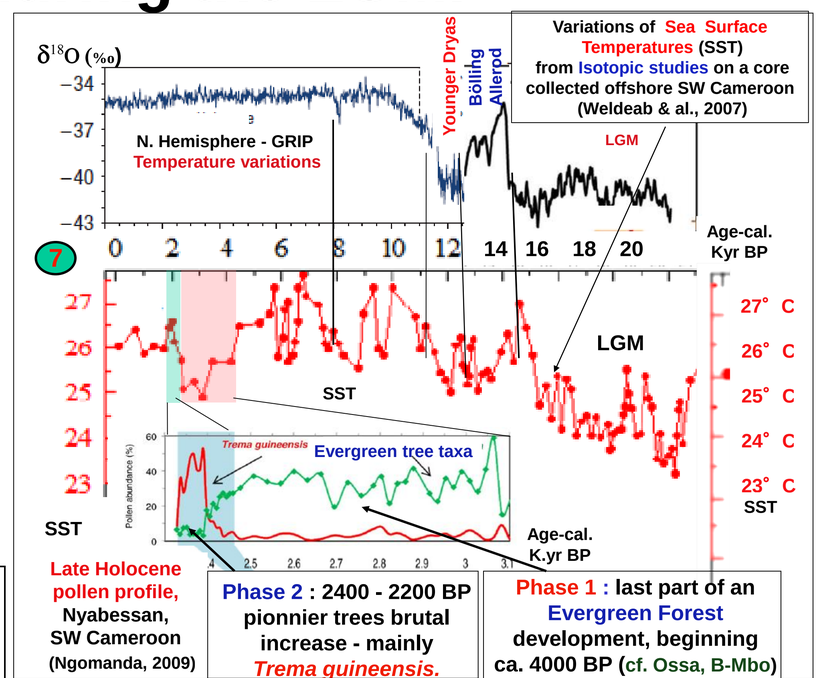
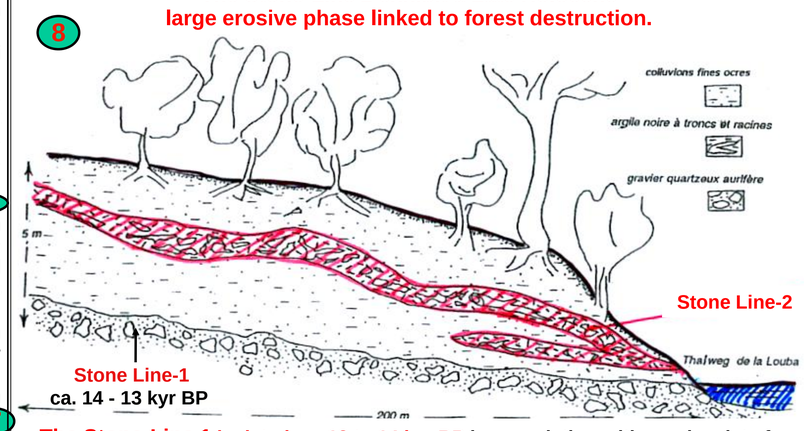


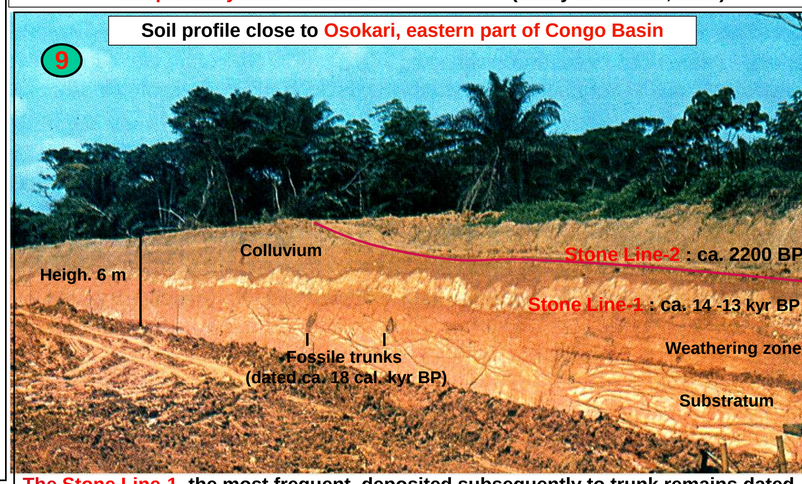
Kakamoéka - Forest of Mayombe (West Congo).
Soil profile in the Kouilou river catchment.
The Stone-Line 2 exhibit a Late Holocene large erosive phase linked to forest destruction.



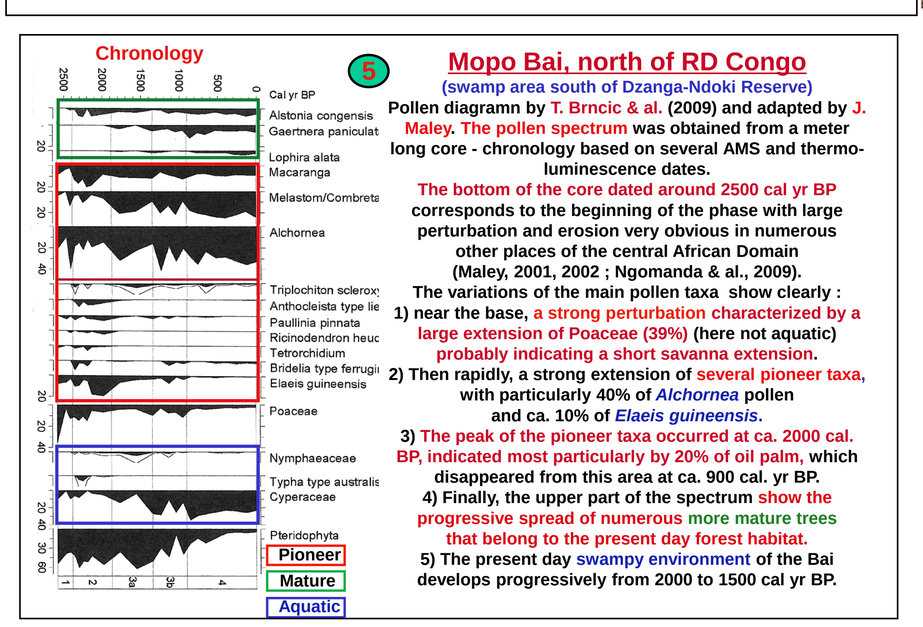
The Stone-Line 1 is dated ca. 13 to 14 kyr BP by correlation with erosive data from the core KZAI-1 collected in the Congo deep-sea fan sediments.

The Stone-Line-2, made of pieces of broken tree (boles, branches) in a silty-clay sediment, resulted from a catastrophic gullying phase which pulled down a pre-existing forest - following intense and stormy rains.
A piece of wood was dated to ca. 2700 years BP, thus corresponding to a tree growing there before this erosive phase, which so occurred later, and probably after ca. 2500 BP. (Maley & Giresse, 1998)

Soil profile close to Osokari, eastern part of Congo Basin



The Stone Line-1, the most frequent, deposited subsequently to trunk remains dated of ca. 18.000 cal. BP - the main dry phase of Late Pleistocene - must be dated to ca. 13.000 - 14000 BP by refering to a strong increase of detritic sediments in the Congo deep-sea fan. The upper part of the soil was eroded by the Stone Line-2 dated ca. 2200 BP on included charcoals. *(adapted from J. Rünge, 1997)*



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Mopo Bai, north of RD Congo
(swamp area south of Dzanga-Ndoki Reserve)

Pollen diagramn by T. Brncic & al. (2009) and adapted by J. Maley. The pollen spectrum was obtained from a meter long core - chronology based on several AMS and thermo-luminescence dates.

The bottom of the core dated around 2500 cal yr BP corresponds to the beginning of the phase with large perturbation and erosion very obvious in numerous other places of the central African Domain (Maley, 2001, 2002 ; Ngomanda & al., 2009).

The variations of the main pollen taxa show clearly :

1) near the base, a strong perturbation characterized by a large extension of Poaceae (39%) (here not aquatic) probably indicating a short savanna extension.

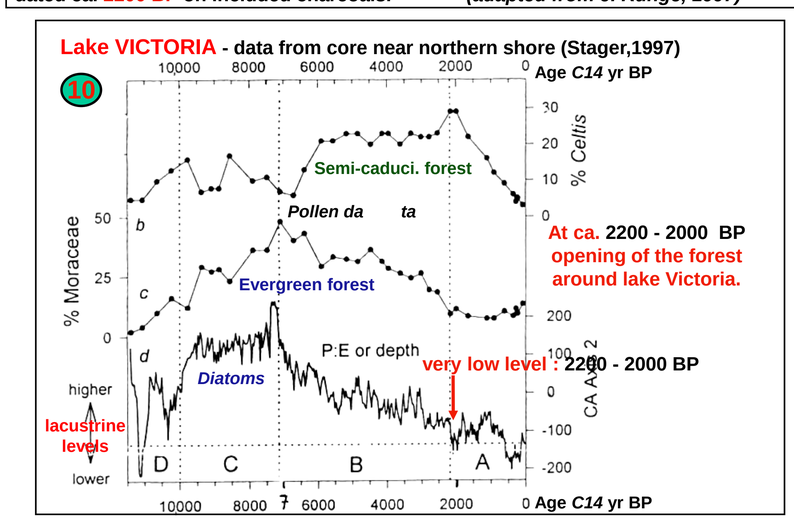
2) Then rapidly, a strong extension of several pioneer taxa, with particularly 40% of *Alchornea* pollen and ca. 10% of *Elaeis guineensis*.

3) The peak of the pioneer taxa occurred at ca. 2000 cal. BP, indicated most particularly by 20% of oil palm, which disappeared from this area at ca. 900 cal. yr BP.

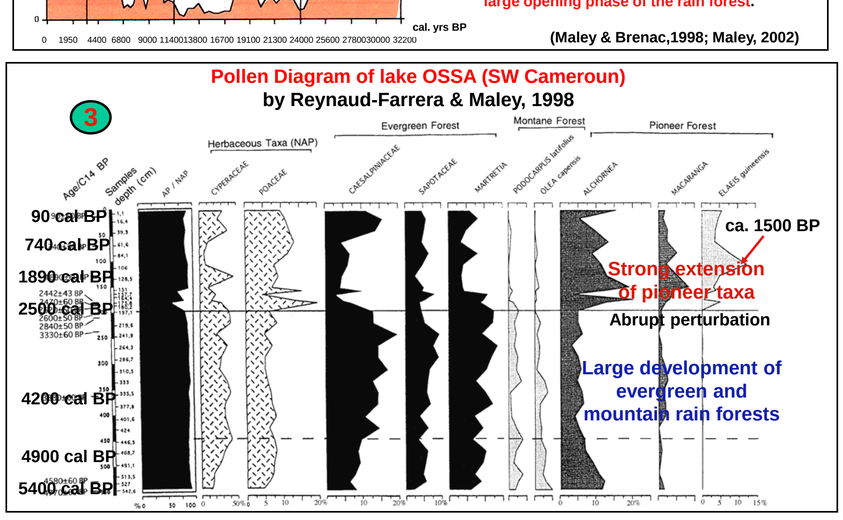
4) Finally, the upper part of the spectrum show the progressive spread of numerous more mature trees that belong to the present day forest habitat.

5) The present day swampy environment of the Bai develops progressively from 2000 to 1500 cal yr BP.

Lake VICTORIA - data from core near northern shore (Stager,1997)



Pollen Diagram of lake OSSA (SW Cameroun)
by Reynaud-Farrera & Maley, 1998



Hypothetical approximate areas of residual forests (green shaded areas) during the phase of large destruction which occurred between ca. 2500 and 2000 years BP, from diverse data obtained on many sites in the western part of the Forest Domain of central Africa. The residual forests were mainly pachtworks of pioneer and mature forests.
The blank areas were mainly savannas.

The pollen spectrum of Lake Sellé in Bénin, established by Salzmann & al., 2005 shows clearly that in early and middle Holocene, the rain forest dominated all the region. Then, following an abrupt climatic change at ca. 4000 cal. BP, savannas expanded creating what Biogeographers called the « Dahomey Gap ».

Pollen diagram of Lake SINNDA in west Congo (Vincens & al., 1994)

The abrupt drying of the lake at ca. 4000 BP, induced the disappearance of the rain forest and the spread of the Niari savannas - an history similar to that of the Dahomey Gap area, in the northern Guinea Region.

Poster in collaboration with the European program CoForChange :
Predicting the effects of global change on forest biodiversity in the Congo Basin.
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