Pollen analysis of the coprolite of Mammoth from Chukotka

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1- Introduction

It is well known that animals, either herbivores or carnivores, swallow pollen with their food. The analysis of the gut of herbivores shows that it contains many pollen grains which are getting more and more numerous along the intestine and, after, in the feces. This content varies with the season but it is not always easy to precise this one because remanent pollen accumulated on the ground, or in dry flowers, can be absorbed together with flowering plants and produce a mix of pollen from different periods in the year (Argant, 1990). But it reflects well the vegetation (trees as well as herbaceous plants) in the area where the animal was feeding. Many studies of fossilized feces of mammoth were still carried on and provided interesting data about the diet of these animals as well as about their environment and climate (Mol *et al*., 2006 ; Van Geel *et al.,* 2008). The discovery, in 2010, of coprolites of Mammoth in a collapse of the bank of the river Small Anjuj in the far East of Russia was particularly interesting as no other remains of the animal were found. The coprolites were consequently the only way to get information on this Mammoth and its environment. Irina Kirillova took a fragment in the heart of one coprolite, therefore protected against pollution by modern pollen rain, to perform its pollen analysis.

2- Preparation of the coprolite

The preparation of the coprolite comprises the following principal stages:
- Decarbonatation with hydrochloric acid, desilicification with hydrofluoric acid (concentration 40 %, cold test).
- Removal of the organic matter by heating in potassium hydroxide solution for 10 minutes.
- Concentration in a dense solution (d = 2)
- Washing out with dimineralised water after each operation.
- Mounting in glycerin.

3- Pollen content of the coprolite

This coprolite is made of a dark grey, very compact powder, enclosing a lot of plant fibres. As could be expected, the coprolite showed many microscopic remains of plant tissues. Well preserved pollen grains were dispersed among them. Twenty-one taxa could be observed. The table 1 provides the number of pollen grains of each taxon and its percentages calculated in relation to the total pollen sum: arboreal pollen (AP) + non arboreal pollen (NAP) + spores. The figure 1 is a simplified representation of the pollen spectra.

Pollen grains found in the coprolite are mainly from herbs, defining an open landscape. Among these, pollen grains of grass largely dominate with several species of Poaceae, which can be distinguished essentially by their various sizes. Unfortunately, based on this only characteristic, it is impossible to identify them precisely to species. The second more abundant taxon is *Artemisia* (15,81 %), represented by at least two species.
We find also Caryophyllaceae (4,99 %), Rosaceae (*Potentilla* type and the genus *Dryas,* respectively 2,83 and 0,33 %), Fabaceae (2,33 %), Cyperaceae (1%). The other herbaceous plants are all in low percentages, less than 1%. Only one spore of fern was observed.
Some taxa provide the indication of wet habitats, but they are few: *Polygonum amphibium* type, *Ranunculus aquatilis* type, *Thalictrum*, and two Rosaceae, *Sanguisorba officinalis* and *Filipendula*, the first growing well on grassy banks, the second in damp meadows. Cyperaceae is probably, as most often, also associated with wetlands.

As for the trees, they seems almost inexistant : a single pollen grain of *Alnus,* one of a Rosaceae *Sorbus* type, and one ballonnet of *Pinus*. It was likely that these trees were not present in the close vicinity of the site of Chukotka, as their pollen can fly a long distance, especially in the case of Pine.
Some spores of coprophilous fungi have also been observed.

Mammoth Coprolite from Chukotka		
	n	%
Alnus	1	0,17
Pinus	1	0,17
Roasaceae type *Sorbus*	1	0,17
AP	**3**	**0,50**
NAP	**597**	**99,33**
Spores	**1**	**0,17**
Poaceae	409	68,05
Artemisia	95	15,81
Caryophyllaceae	30	4,99
Rosaceae type *Potentilla*	17	2,83
Dryas	2	0,33
Plantago	4	0,67
Fabaceae	14	2,33
Apiaceae	3	0,50
Brassicaceae	3	0,50
Ericaceae	1	0,17
Polygonum amphibium	4	0,67
Ranuculaceae type *aquatilis*	3	0,50
Ranuculaceae type *R. pulsatilla*	1	0,17
Sanguisorba officinalis	2	0,33
Cyperaceae	6	1,00
Thalictrum	1	0,17
Filipendula	2	0,33
		0,00
Trilete spore	1	0,17
Undeterminate	9	1,50
Total	601	
Coprophilous fungi	9	1,50

Table 1 : Pollen analysis of a coprolite of mammoth from Chukotka

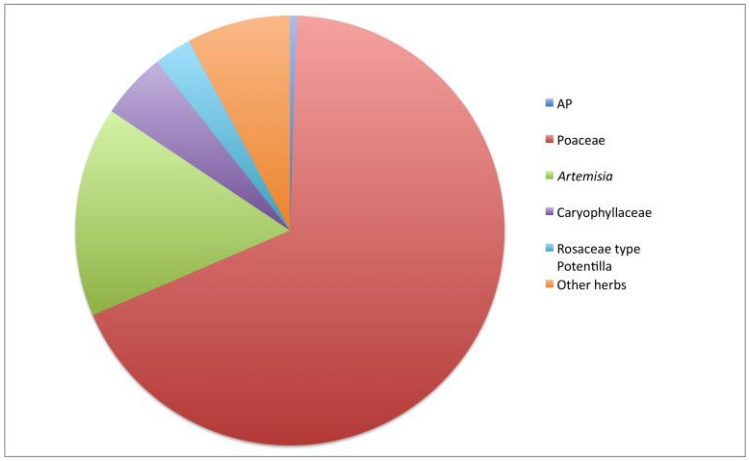

Fig. 1 : Simplified pollen spectra of the coprolite of Mammoth from Chukotka

4- Interpretation and conclusion.

The pollen spectra of the coprolite of Chukotka Mammoth is dominated by Poaceae, *Artemisia* and some other light-demanding taxa, without any tree pollen. The pollen assemblage is close for instance to those recorded from the Taimyr peninsula, especially the Jarkov Mammoth (Mol et al., 2006). It reflects a steppic, treeless environment, corresponding to the so-called "Mammoth Steppe", under cold and dry climatic conditions.
After Van Geel et al. (2008) "coprophagy which has been repeatedly reported from herbivores [...] is suggested as a purposeful behavior [...] for mammoths", as spores of coprophilous fungi were sometimes found inside the gut of these animals. The presence of similar spores inside the heart of the Chukotka coprolite may verify this assertion.

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