Spatial and temporal evolution of peat initiation (paludification) in the black spruce (*Picea mariana*) boreal forest of the James Bay Lowlands

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OBJECTIVES

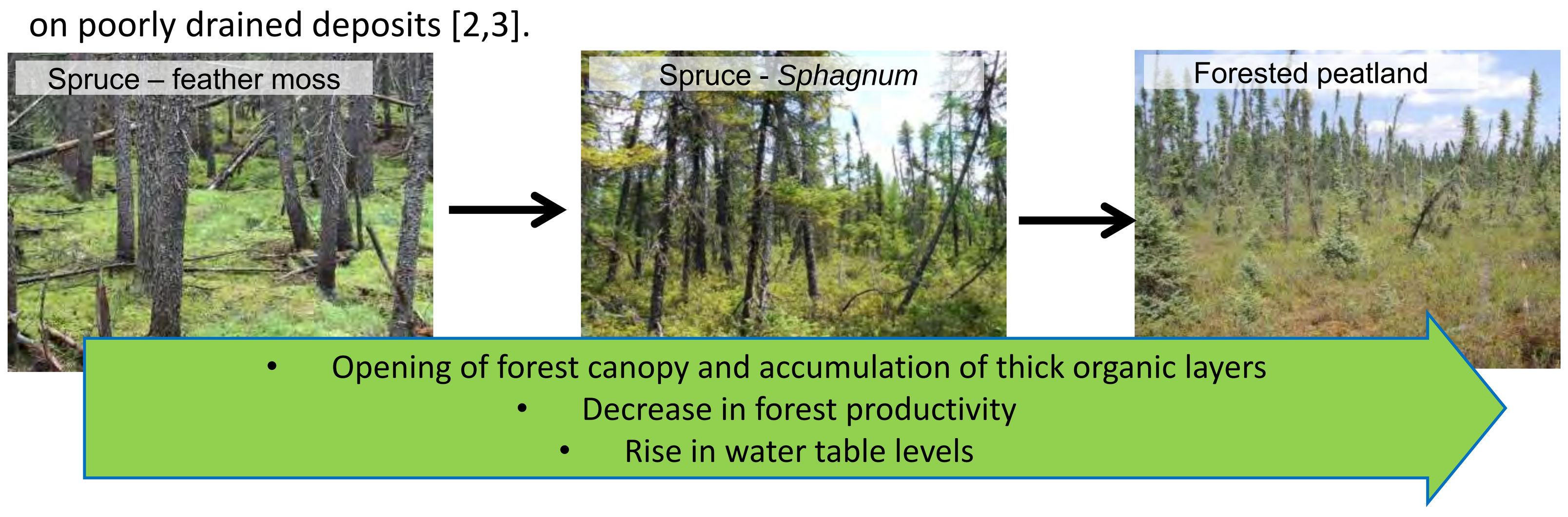
1- Evaluate the role of abiotic factors that trigger the paludification process (topography, superficial deposit and fire)

2- Determine how these factors influence the temporal evolution of plant communities

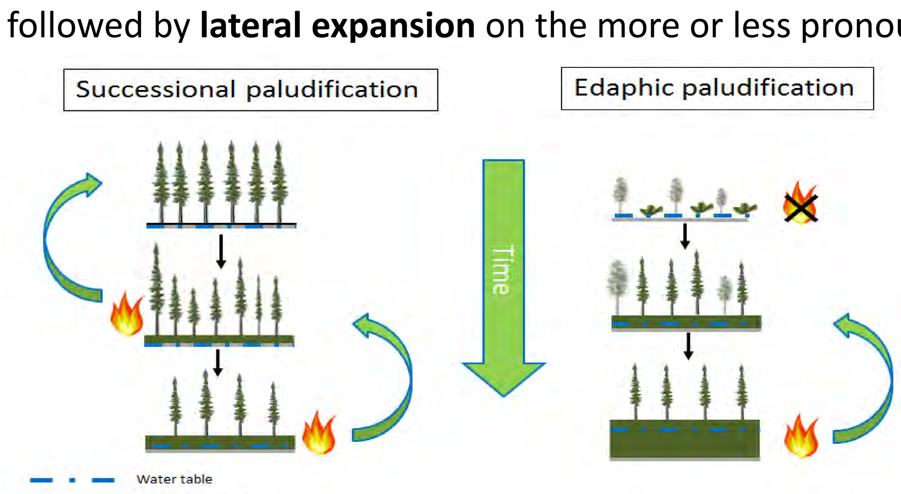
CONTEXT

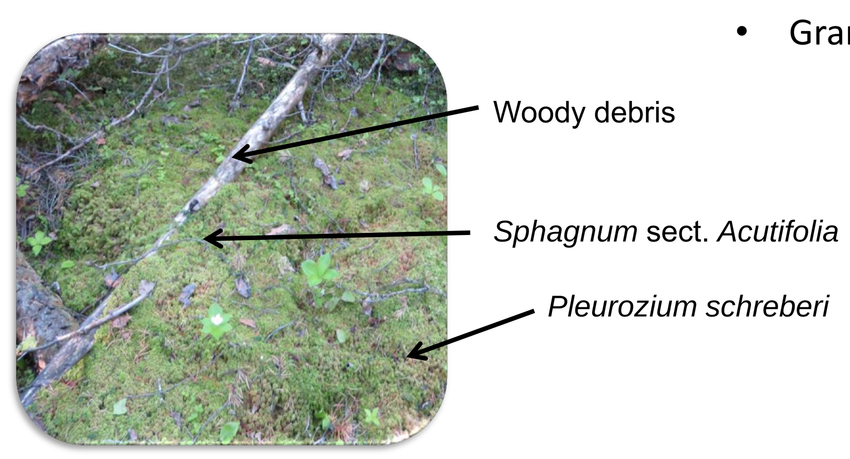
Ecosystem management in the Quebec boreal forests requires knowledge on natural forest dynamics in relation to ecological disturbances, climate and topography. **Paludification** is the most common process of peat initiation in the black spruce forest of western Québec and this is a major issue in forest management within the Clay Belt region. To better understand this process, it is necessary to take into account both spatial (**toposequence**) and temporal (**chronosequence**) dynamics. **Peat cores** provide continuous temporal records of ecohydrological changes and take into account the variability of abiotic factors on the site.

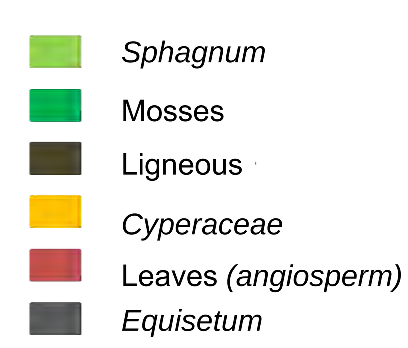
- **Paludification** is the most common process of peatland formation in boreal regions [1]. It is characterized by an **accumulation of thick organic layers over a former forested site** and is common on poorly drained deposits [2,3].



- **Successional paludification** results from the **gradual accumulation** in time of an organic matter layer and an increase of water table **independently of initial site factors** [3]. In comparison with **edaphic paludification** that is defined as an accumulation of organic matter on wet mineral deposits from recently deglaciated/emerged areas. Peat accumulation begins in **topographic depressions** and is followed by **lateral expansion** on the more or less pronounced slopes [4,5].







- **Hypothesis**: 1) low intensity fires and poor drainage (clay soils) promote peat initiation, topography influences organic matter thickness 2) natural forest succession is a factor of peat initiation independently of topography and drainage [2,3].

STUDY AREA AND SITES

Villebois region, James Bay Lowlands

- Slope < 3%
- Glacio-lacustrine clay
- Fire interval : 135 years (between 1850-1920) [6]
- Lake Ojibway drained around 8 200 cal a BP [7]
- Two toposequences:
  - Cochrane till: Villebois (not presented)
  - **Ojibway lake: Lac AB (results in this poster)**
- Mean annual precipitation 856 mm and mean annual temperature 0.8°C [8]

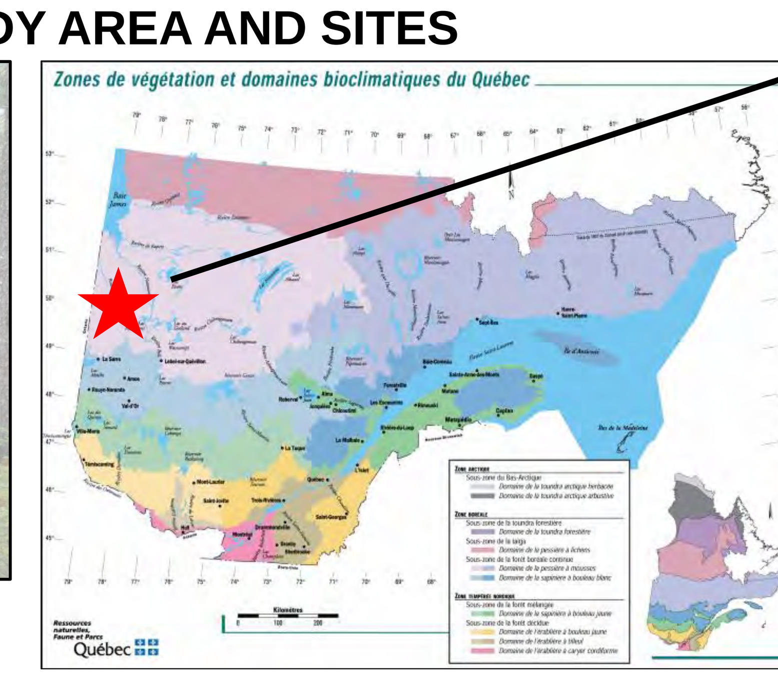


Fig. 1: Bioclimatic domains and study region location [9].

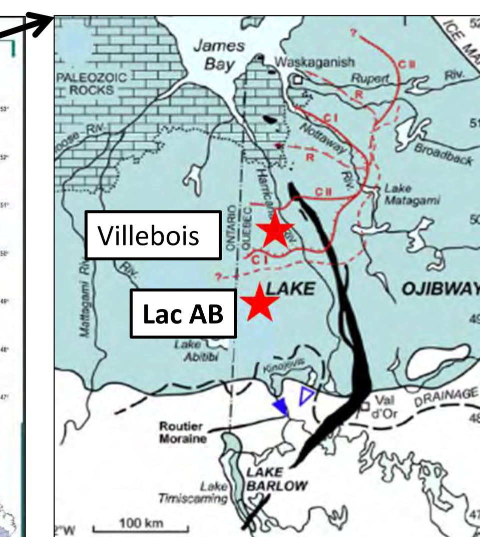


Fig. 2: The two geomorphological units in the James Bay Lowlands: Cochrane till and Ojibway Lake clay with study sites location [10].

METHODS

FIELD SAMPLING

- Peat cores were retrieved using a Box (monoliths) and a Russian corer (basal profiles);
- Toposequence Villebois: 7 basal profiles (50 cm every 25m along the transect) and 3 monoliths extracted randomly;
- Toposequence Lac AB: 3 basal profiles (50 cm every 50m along the transect) and 12 monoliths extracted randomly;
- Physical measurements were made for each toposequence: organic layer thickness, water table depth and relative surface altitude with a Ziplevel.

LABORATORY ANALYSES

- Plant macrofossil analyses (4 cm³; interval: 2 cm);
- Organic and mineral contents determined by loss-on-ignition (1 cm³ ; interval: 1 cm);
- Charcoal fragment taxonomic identification based on wood anatomy;
- ^{14}C dating (basal dates) and dendrochronology (peat initiation after fire);
- Granulometry (ANALYSETTE 22).

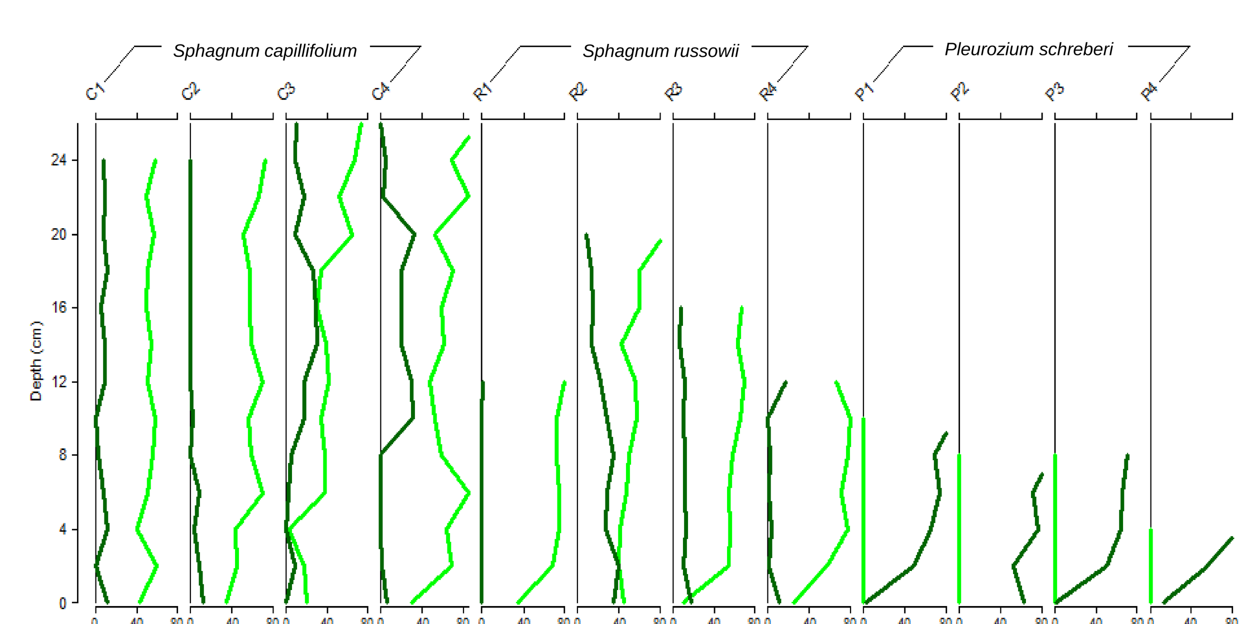


Fig. 5: Relative abundance (%) of *Sphagnum* and feather mosses after the last fire (AD1910) for the 12 monoliths of Lac 0m. (Pale green: *Sphagnum*, dark green: feather moss)

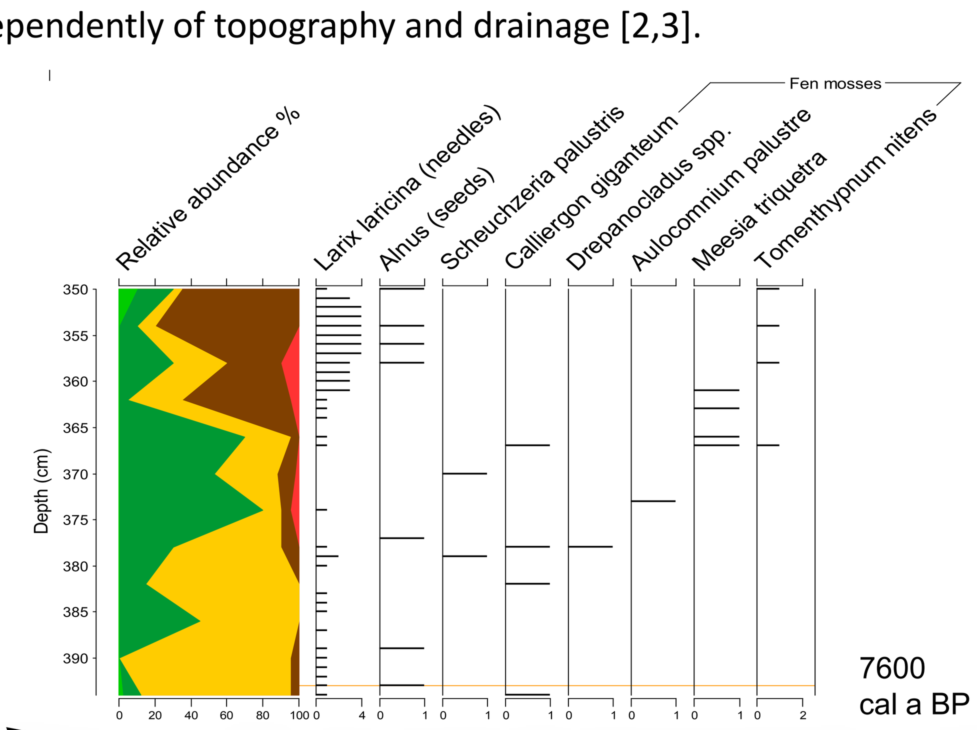


Fig. 3: Macrofossil diagram of Lac150m

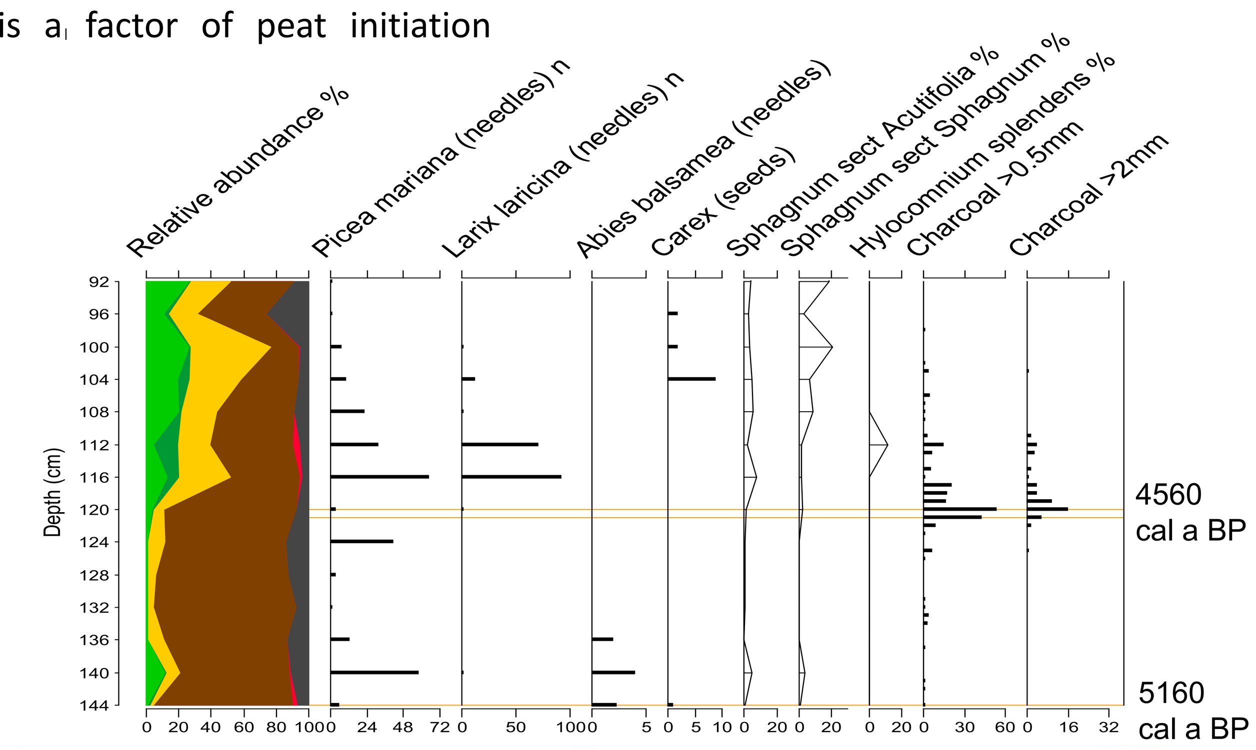
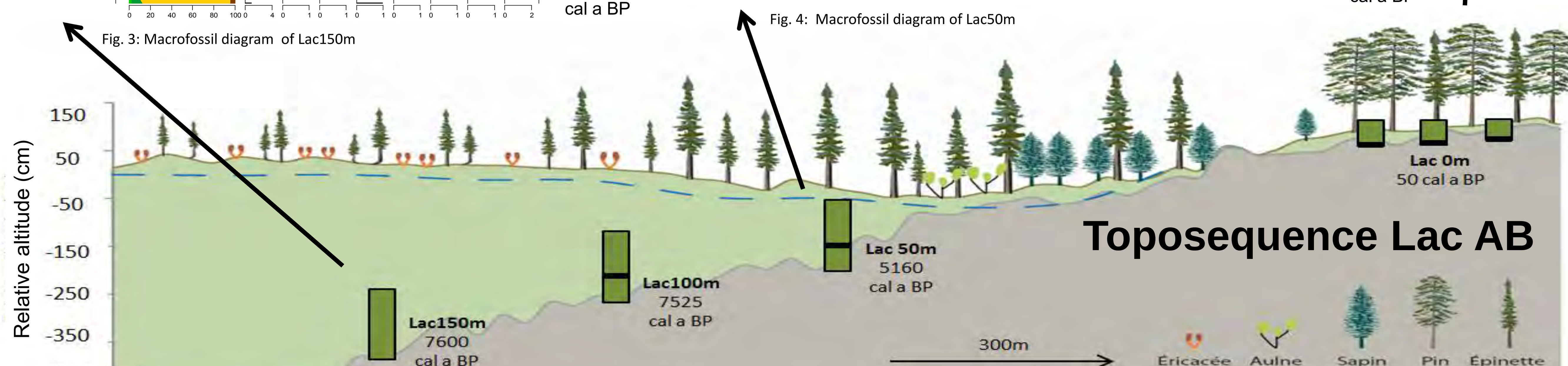
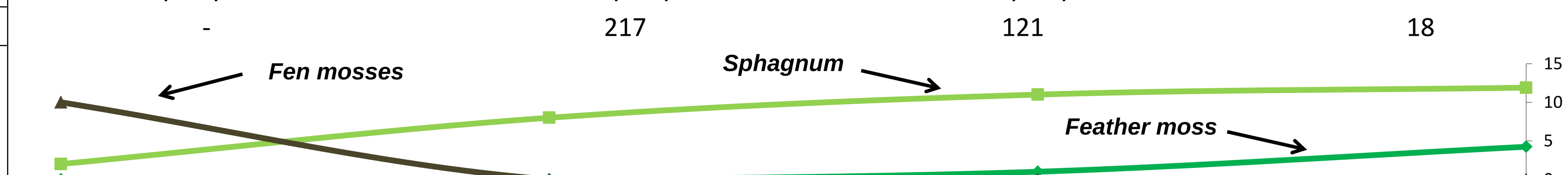


Fig. 4: Macrofossil diagram of Lac50m



Profile	Lac 150m	Lac 100m	Lac 50m	Lac 0m
Slope (%)	0.99	2.26	2.17	1.29
Thickness (cm)	395	241	145	19
Soil texture	Silty clay loam	Silty clay	Silty clay	Loam
Depth (cm) of the charred horizon	-	217	121	18
Basal vegetation (%)				

RESULTS/DISCUSSION

- Our data show that peat initiation started rapidly following the final draining of Lake Ojibway around 8.2 ka cal a BP in absence of fire in the lowest part of the toposequence. Plant macrofossils at the base (Lac 150m) indicate a rich minerotrophic (fen) environment colonized by fen mosses and *Larix laricina* trees (Fig.3). This is the process of edaphic paludification.
- At Lac 50m, peat formation started later (5160 cal a BP) and is characterized by a high abundance of wood remains and needles of black spruce at the base. A charred horizon is found at 24 cm above the mineral indicating that the fire did not completely burn the soil organic layer. *Sphagnum* and fen mosses established after the fire (Fig.4). This is the successional paludification.
- In the higher part of the toposequence the 12 monoliths (Lac 0m) (Fig.5) show that Sphagnum and feather mosses (e.g. *Pleurozium schreberi*) seem to have randomly colonized the site (stochastic process) over the mineral after the fire of AD1910 and there are no important variations in their abundance over the last 110 years of succession.
- The Lac AB toposequence is compared with the Villebois site (Cochrane till). Although slope was even lower in the Villebois transect and the total accumulation was lower, the basal composition of several profiles were similar to those of Lac AB toposequence.
- The James Bay lowlands region is also compared with the North Shore. The physical conditions of this region are very different with a different soil type and steeper slopes. In addition, the climate is very different with significantly higher precipitation and lower evapotranspiration. However, despite these differences in physical environment, the pattern of vegetation successions of several profiles were similar to those found in north-western Québec.

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