Archs Sci. Genève	Vol. 53	Fasc. 3	pp. 169-176	Décembre 2000

A SLOW ENVIRONMENTAL TRANSITION DERIVED FROM CHANGES IN SEDIMENTOLOGY AND POLLEN ASSEMBLAGES IN THE SENEGAL RIVER DELTA ABOUT 6000 yrs BP

BY

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(Ms. reçu le 3.4.2000, accepté le 20.7.2000)

ABSTRACT

A slow environmental transition derived from changes in sedimentology and pollen assemblages in the Senegal River Delta about 6000 yrs BP. - Palynological and mineralogical data from sections located in the N'Diael region, (Senegal River Delta) and exhibiting a peaty level overlain by reddish sands, are presented. First they give the opportunity to confirm the radiocarbon dated sedimentological transition of peat mangrove facies to clastic continental beds at ca. 6600-6400 yrs BP. Secondly, because the pollen assemblage of the sandy sediments overlying the mangrove peat level is characterized by a high percentage of Poaceae and the absence of marine palynomorphs a dry, continental environment appears to have replaced the coastal tidal lagoon one; moreover, the clay mineral association of sandy levels points to a clastic origin by reworking of the surrounding ferralitic cover. The overall data allow to conclude to the gradual setting in of continental conditions and aridification of the studied area that seems to have begun soon after 6400 yrs BP and have reached a maximum ca. 5000 yrs BP.

Key-words: Senegal, sedimentology, palynology, climatic, environmental, Mid-Holocene, changes

GEOGRAPHCAL, LITHOLOGICAL SETTING AND METHODS

Sedimentological and palynological data from two sections located in the N'Diael region, in the Senegal River Delta, are presented. The first section is situated five kilometers north-east of Ross Bethio, a few meters from the irrigation canal of the rice fields, north of the Ross Béthio - Richard Toll main road. The second section is 400 m north of the first one (Fig. 1). In this zone the zero of the surface is at 1.207 m above m.s.l. These two core-sections show a peaty level overlaid by reddish sands, and in the two sections, the top of the peat level is at -110 cm from the surface; but overlying beds vary in thickness and lithology (Fig. 2A).

Section 1 is 150 cm thick. Above a 40-43 cm thick peat level, it shows a 110 cm thick, finely sandy level with dm-thick pink-beige to orange-red coarser intercalations. The peat/sand transition starts at about 10 cm below the top of the peat with fine, sandy dark grey mm-thick intercalations.

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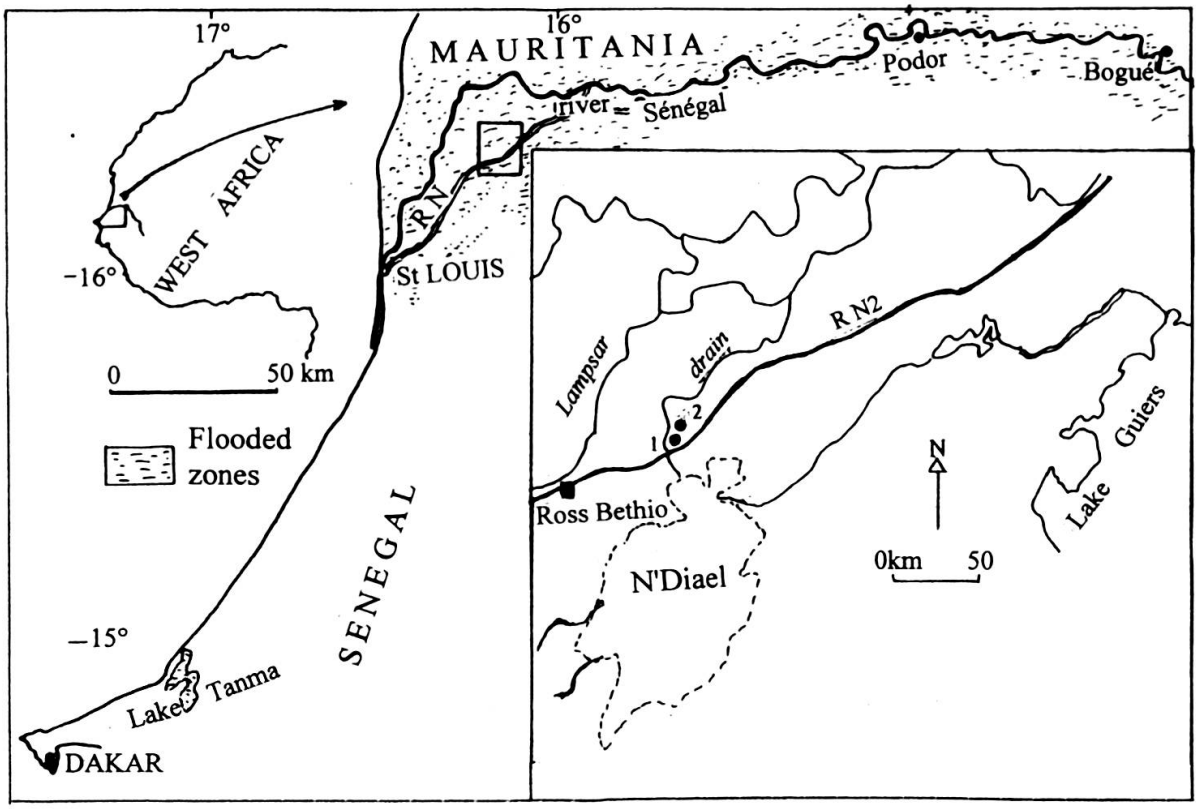


FIG. 1.

The N'Diael region in the Senegal River Delta showing the location of the studied sites (1 and 2).

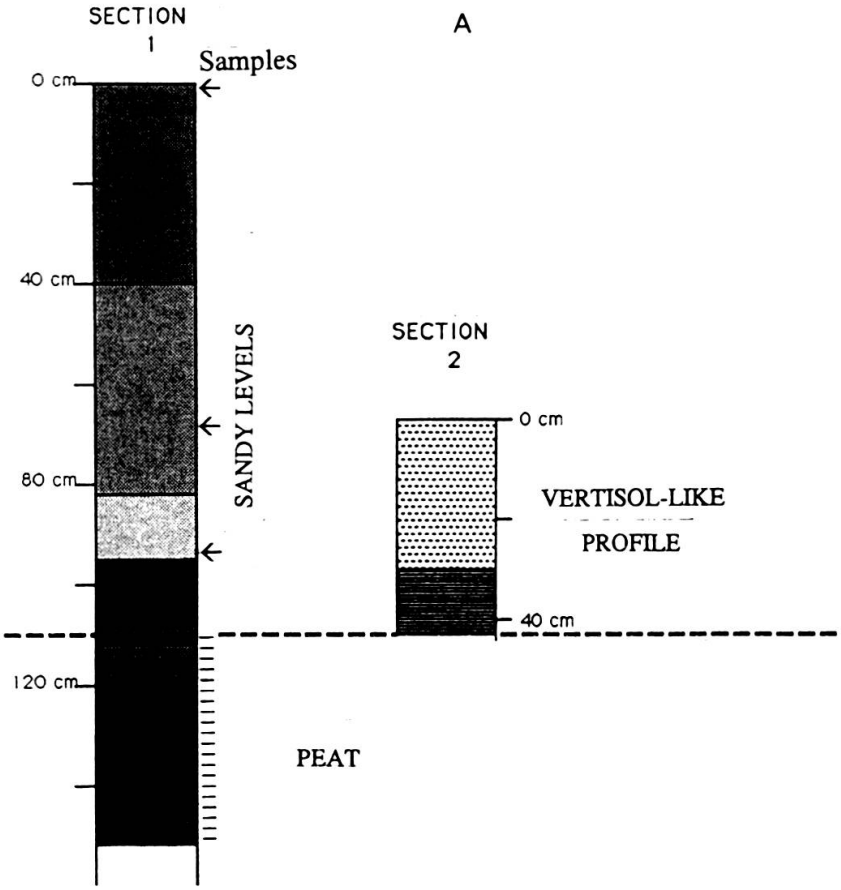
In section 2, the peat level was not sampled. It is overlain by a 43 cm thick, dark grey level of silts and clays with iron rust spots and root traces, suggesting a vertisol-like profile.

In section 1, the peaty level was sampled every 2 cm for the palynological study, whereas above the peat/sand transition, only the finer silty levels were sampled at 1.5, 6.00 and 14.8 cm in section 1 and at 3.5 cm in section 2. This last sample from section 2 yielded no palynomorph.

Sample processing for palynological preparation (FAEGRI & IVERSEN, 1964) included: HCl (35%, 1 day), HF (70%, 8 days), HNO3 (40%, 5'), NaOH (1N, 5').

The mineralogical composition of the < 2 µm clay fraction was determined by X-ray diffraction, using a Phillips 1729 diffractometer with a Co anthicatode, operating at 40 mA and 50 Kv. In order to distinguish the different clay minerals, the oriented clay specimens were analysed in four different forms (HOLTZAPFELL, 1985): natural sample, sample treated with ethylene glycol, or with hydrate, and sample treated at 490° C for 4 hours. Semi-quantitative estimates of the relative proportions of identified minerals were calculated by measuring the area of selected diffraction peaks.

Three conventional C14 datings were performed on bulk samples of peat, complemented by one C14 dating obtained by means of accelerator mass spectrometry (AMS) on a palynological residue composed of cuticles, cells, fragments of Algae and 5-10% of pollen grains.



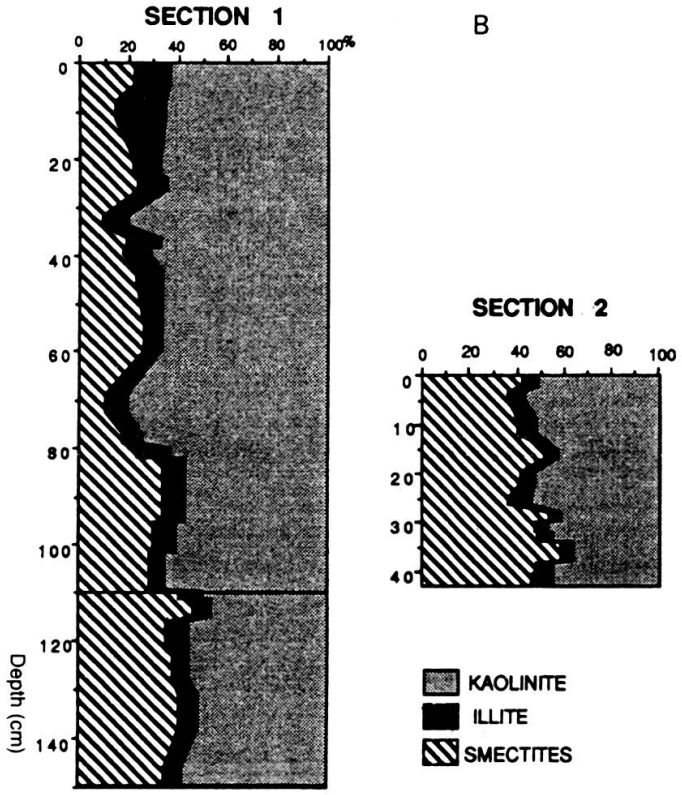


FIG. 2.

2A: The lithological colums of the sections; 2B: The clay associations and semi-quantitative estimates of their relative proportions in the two sections.

RESULTS

A.- *Radiocarbon datings*

Two C14 datings were performed on two samples of the peat level of section 1. One at the top (-110-115 cm) and the other at the base (-145-153 cm). They yielded an age of, respectively 7280±460 (Ly 5800) and 6450±150 yrs BP (Ly 5799). The C14 AMS dating of the sample taken between 5.5 and 6.5 cm above the peat gave an age of 5060±110 yrs BP (UTC 2361). Another peat sample taken in an excavation of the irrigation canal near section 1 yielded an age of : 6365±80 ans BP (Ly 5313). The similarity of dates Ly 5313 and Ly 5799 suggests that the radiocarbon date 7280+460 is not reliable and that the peat was probably deposited around 6400 yrs BP.

B.- *Clay mineral associations*

The analysis showed a constant association of three clay components, kaolinite-illite-smectites along the peat and the overlying sand (Fig. 2B). Using ratios between these three components two types of assemblages could be distinguished (Fig. 3A, B).

The first assemblage characterizes the peat in section 1 and the vertisol-like profile in section 2. It is marked by the dominance of smectites. The second assemblage corresponding to the sandy deposits overlying the peat in section 1, is characterized by the decrease in smectites and increase in kaolinite and illite. Furthermore, in this section, illite increases upwards whereas kaolinite decreases.

C.- *Palynology*

The palynological diagram (Fig. 4) shows the relative percentages of continental taxa calculated from the sum of pollen and spores and the relative percentages of marine palynomorphs calculated from the overall assemblage. Unprecise pollen determinations are indicated as generic pollen types (i.e. *Balanites* typ.). The same applies for pollen grains from the Guinean flora deposited by the sedimentary river transport (*Pentaphragma*, *Calvoa*), or some recycled pollen grains.

Rhizophora is dominant in peat assemblages. All grains belong to the *R. racemosa* type; but 10-20% have a size and apertural morphology similar to *R. harrisonii* and/or *R. mangle* (ASSÉMIEN, 1969). Combretaceae pollen grains are similar to those of *Conocarpus*. The presence of a few specimens of *Avicennia*, is noteworthy, because this taxon is normally rare or absent in Holocene palynofloras from Senegal (DEMARCQ & DEMARCQ, 1992). It is considered as relictual in mangrove which occurs nowadays in the Delta (ADAM, 1965).

At the peat/sand transition, marine palynomorphs (Foraminifera, dinoflagellates) completely disappear and *Rhizophora* decreases. But this sea-dependant taxon does not disappear when facies change and drier environmental arboreal taxa are noted (*Lannea*, *Diospyros*, *Phoenix*). Higher in the sandy level, the dominance of graminaceous pollen (Poaceae) is almost complete and *Piliostigma* is the only arboreal pollen just present in the 148 cm sample (not listed in the diagram).

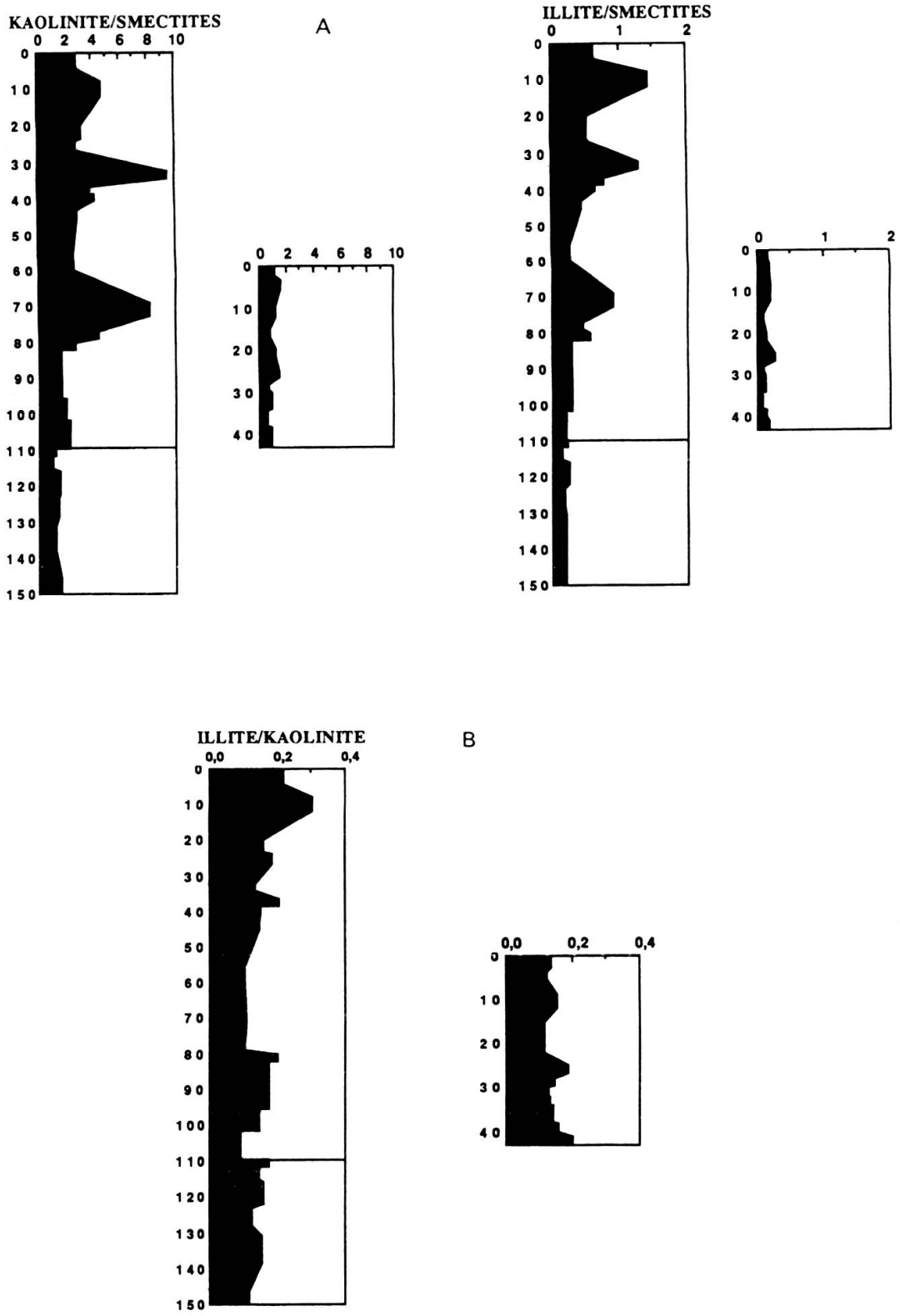


FIG. 3.

3A: The proportion of kaolinite and illite versus smectites in section 1 and in the vertisol-like profile of section 2; 3B: The proportion of illite versus kaolinite. It indicates that illite increased towards the top of the section 1 faster than kaolinite.

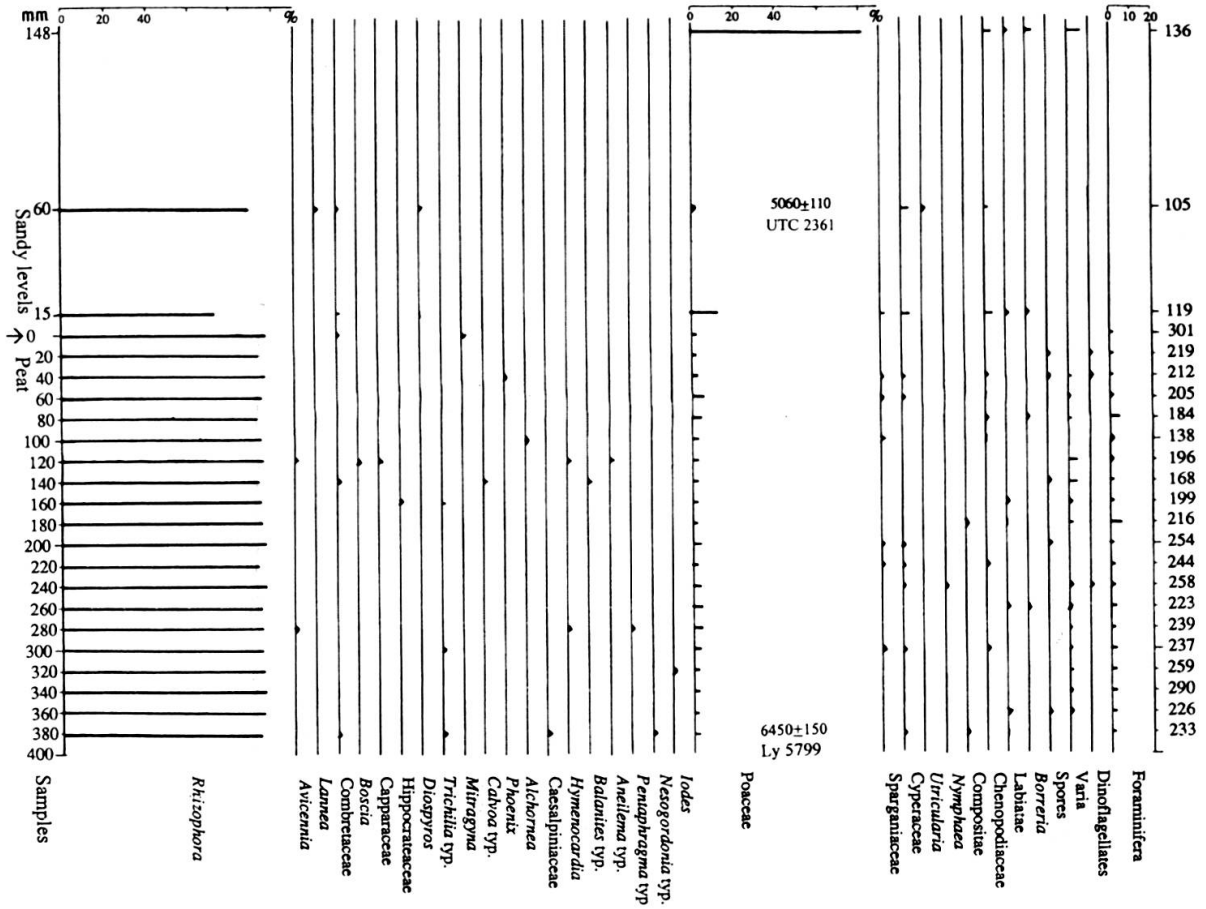


FIG. 4.

Pollen diagram of section 1. The zero refers to the top of the mangrove peat. Black triangles refer to percentages lower than 2%.

DISCUSSION

The pollen sum is sometimes low, particularly when considering the high quantity of *Rhizophora* or Poaceae. Nevertheless, in order to define environmental changes, only need to consider the importance of the variation between assemblages (JEKHOWSKY, 1958).

Percentages of around 95% *Rhizophora* throughout the peat, in association with marine palynomorphs are significative of a mangrove environment (ELLISON, 1989).

In the first sandy sample, 15 mm above the peat level, the absence of foraminifera and dinoflagellates, and the small increase in Poaceae and Sparganiaceae-Typhaceae, Cyperaceae and Chenopods, and the decrease in *Rhizophora* indicate a wider continental contribution. Nevertheless, the continuously high percentages of *Rhizophora* pollen grains up to 60 mm in sandy levels show that the sea still influenced the sedimentation. The change to the Poaceae-dominated assemblages, as suggested by the present-day vegetation (ADAM, 1965; MICHEL *et al.*, 1969) points to the complete regression of the sea from this area after ca. 5000 yrs.

In section 1, the increasing kaolinite and illite content with respect to smectites in the the sandy beds suggests that kaolinite as well as illite are detrital in origin and that they derive from the erosion of the surrounding ferralitic cover and/or of the nearby Late Pleistocene dunes (MONTEILLET, 1986). This sandy detrital phase, with illite and kaolinite, progressively replaces organic-mangrove sedimentation dominated by smectites, which may be provided by neighbouring coeval vertisols similar to those preserved in section 2.

To summarize, the environmental modifications recorded by lithological and palynological changes did not abruptly modify the local vegetation. The overall sequence is indicative of a rather smooth environmental modification, because of the ecological range of *R. racemosa* which can grow in low salinity or fresh water and/or in an inland environment for part of the year (ADAM, 1965; SCHNELL, 1971). Moreover, the presence in the mangrove pollen assemblage, of tree pollen such as *Hymenocardia*, *Lannea*, *Mitragyna*, usually characteristic of sahelian and sahelo-soudanian vegetation (MICHEL *et al.*, 1969; TROCHAIN, 1940) suggests a relatively dry climate even during peat sedimentation, ca. 6600-6400 yrs BP. The gradual setting in of continental conditions and aridification of the studied area seems to have begun soon after 6400 yrs BP and have reached a maximum ca. 5000 yrs BP (EINSELE *et al.*, 1974; FAURE & HEBRARD, 1977; MONTEILLET, 1986). It is interesting to note that the timing of this phase is supported by data from elsewhere in Senegal (GUIOT & MÉDUS, 1985; HOOGHIEMSTRA, 1988; LÉZINE & CASANOVA, 1989; MÉDUS, 1987; MONTEILLET, 1986).

ACKNOWLEDGMENTS

Both authors wish to acknowledge Prof. Mietton M (Centre d'études et de recherches éco-géographiques, Univ. Louis Pasteur, F-67083 Strasbourg Cedex) for having given sampling facilities for the study of the two cores.

RÉSUMÉ

TRANSITION ENVIRONNEMENTALE PROGRESSIVE DÉDUITE DES CHANGEMENTS SÉDIMENTOLOGIQUES ET PALYNOLOGIQUES ENREGISTRÉS DANS DEUX SÉQUENCES LITHOLOGIQUES DU DELTA DU FLEUVE SÉNÉGAL VERS 6000 ANS BP

Les données palynologiques et minéralogiques de deux coupes de terrain comportant un niveau de tourbe surmonté de sables rouges et situées dans le N'Diael, (Delta du fleuve Sénégal) sont présentées. Ces données donnent d'abord la possibilité de confirmer la date de la transition du faciès de tourbe de mangrove aux niveaux clastiques continentaux à environ 6600-6400 ans BP. Ensuite, le pourcentage élevé de Poaceae et l'absence de palynomorphes marins, qui caractérisent l'assemblage pollinique des sédiments sableux surmontant la tourbe, suggèrent qu'un environnement continental sec a remplacé l'environnement laguno-marin précédent; de plus, les minéraux argileux présents indiquent une origine des niveaux sableux par remaniement d'une couverture ferralitique.

L'ensemble des données permet de conclure à la mise en place progressive dans la zone étudiées des conditions continentales et de l'aridification qui paraît avoir atteind son maximum vers 5000 ans BP.

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