A preliminary report on palaeoenvironmental investigations in Iffe-Ijumu, southwestern Nigeria

Philip A. Oyelaran
Department of Archaeology and Anthropology
University of Ibadan, Nigeria

Introduction

The concept of 'derived savanna' was first applied by Jones (1945) to the type of vegetation belt that stretches across West Africa, between the rainforest to the south, and the fire-swept Guinea savanna to the north (Fig. 1). It is generally assumed that it has been derived from the deciduous forest at the northern limit of the rainforest zone. This derivation has been attributed to various agricultural activities, particularly bush burning (Clayton 1958, 1961; Keay 1959).

In terms of physiognomy, derived savanna is often difficult to distinguish from the southern part of the Guinea savanna. However, one notable feature of derived savanna is the occurrence of occasional "relict patches of high forest or forest trees (including oil palms) and climbers growing on relatively dry ground which receives water only from rain and none from streams or surrounding higher ground" (Keay 1959: 20). It is also characterised by little pockets of thickets, particularly in areas that have escaped bush burning and felling of trees, as well as on fallow lands (Clayton 1958; Hopkins 1965a, 1965b).

This paper presents a reconstruction of the vegetational history of Iffe-Ijumu and its environs in the southwestern part of Nigeria. This indicates that the present vegetation in the study area is due in part to human activities which led to the opening of the forest canopy as a result of a gradual elimination of fire-tender forest species through intensified burning and cultivation, and partly to a natural substitution by fire-tolerant savanna species, as well as an increase in oil palm.

Environmental setting

The study area is situated in the southwestern part of Nigeria, west of the confluence between the Niger and Benue rivers. Its geographical co-ordinates lie within latitudes 7°45'N - 7°55'N and longitudes 5°45'E - 5° 55' E.

Geology and geomorphology

The area is underlaid by Pre-Cambrian metamorphic rocks of the Basement Complex which form the geology of much of this part of Nigeria (Clayton 1958). The main relief units consist of 'stable land surface' in the north-east, and 'erosional land surfaces' in the south. The 'stable land surfaces' are characterised by level or gently undulating plains stretching eastward towards the Niger-Benue confluence, studded with a few isolated smooth, domed inselbergs (Clayton 1958). The 'erosional land surfaces' are more varied and complex. Their topography is characterised by clusters of inselbergs, some low-lying rock outcrops, and adjacent dissected plains, ranging from undulating to flat. These hills are believed to have been formed as an erosional residue arising from variations in the composition and lithology of the parent rocks that gave rise to them, and in the resistance of the rocks to weathering and erosion (Jeje 1978).

Climate

Nigeria's geographical location, size and shape cause it to experience most of the types of climate and weather of West Africa (Oguntoyinbo 1978). The over-riding climatic factor, as elsewhere in the tropics, is rainfall, particularly its distribution and duration. Thus the Nigerian climate exhibits marked wet and dry seasons with high temperatures all year round.

At present, the study area is located within the tropical seasonal climatic belt of Nigeria, characterised by distinct wet and dry seasons. The mean annual rainfall is 1510 mm. The wet season (eight months of rainfall from late March to mid-October) is characterised by relatively high humidity (70%) and an average temperature of 27° C, particularly in the months of July and August when cloud cover reduces the insolation.

The dry season lasts for four months, lasting from late December and until early March. It is typified by strong dusty and dry Harmattan winds from late December to late February. The region experiences maximum insolation at this period because of cloudless skies, particularly in February and March; the highest mean monthly temperature is about 34° C.

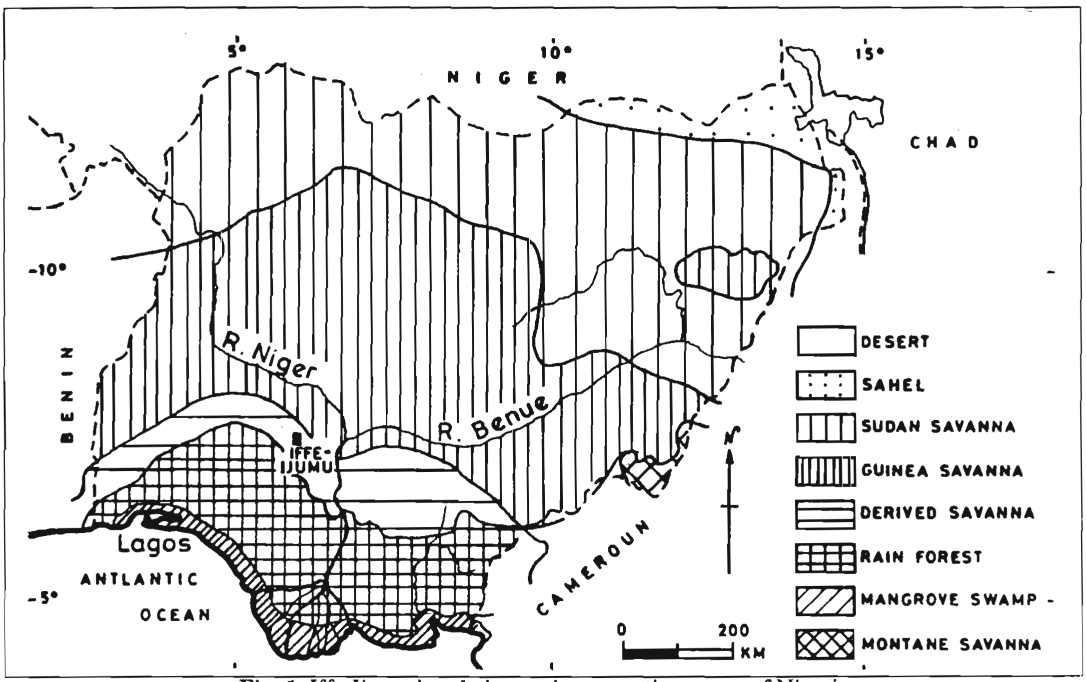

Fig. 1 Iffe-Ijumu in relation to the vegetation zones of Nigeria

Vegetation

The vegetation of the study area has been identified as 'derived savanna'. The term 'derived savanna' is defined by Clayton (1961) as a vegetation that has been induced by activities connected with farming, through which fire is admitted into non-inflammable or weakly-inflammable forest and transitional communities. The landscape comprises a mosaic of forest-savanna woodland intermingled with farmland, and cocoa and coffee plantations.

The complexity of the contemporary vegetation reflects both the changes induced by human activities and variations in relief. Relict forest is found at the foot of the ridges as well as along streams;

the characteristic trees include *Triplochiton scleroxylon*, *Hildegardia barteri*, *Ceiba pentandra*, *Alstonia booeni*, *Tacazzea apiculata* and *Chlorophora excelsa*.

The savanna woodland vegetation type is commonly found in areas adjacent to the gallery or hillside forests, especially on long-abandoned farmlands and/or on rocky ironstone outcrops. In this vegetation zone, grasslands are interspersed by a few scattered trees and shrubs, the most typical being *Daniellia oliveri*, *Albizia* spp., *Pterocarpus erinaceus*, *Butyrospermum paradoxum*, *Parkia biglobosa* and, occasionally, some scattered fire-scarred *Elaeis guineensis*. Typical grasses include *Monocymbium ceresiiforme*, *Imperata cylindrica* and *Pennisetum pedicellatum*.

Scattered fallow lands are found all over the landscape and are characterised by woody plant species such as *Newbouldia laevis* and *Albizia* spp. which often occur either as regrowth or stumps of small trees.

Material and methods

Pollen samples for this study were obtained from Esa I and II ponds on the western flank of Ogidi Hill. The hill is less than 500 m south-east of Iffe-Ijumu. Using a hand-driven Hiller peat sampler, samples were taken from Esa I and Esa II in December 1986, each being 80 cm deep. Sub-samples were taken at intervals of 10 cm. Two grams of sample were prepared for pollen analysis in the Palynology Laboratory of the Archaeology and Anthropology Department of the University of Ibadan and at the Institute of Archaeology, University College London, according to standard methods (Faegri and Iversen 1989).

Polleniferous residue from the final centrifugation was diluted with two times its volume of 100% glycerine to act as a mounting and storage medium. 30μl of well agitated mixture of polleniferous residue and glycerine was micropipetted onto a glass slide for microscopic examination.

The total number of pollen and spores counted per level ranged from 247 to 409 in the eight levels analysed. Only twelve pollen and spore types were identified. The particle size analysis and magnetic susceptibility measurements of the samples were carried out at the Institute of Archaeology, UCL, detailed descriptions of which will be reported elsewhere.

Pollen sum

Only pollen and spores that probably originated from the neighbourhood of the ponds were selected to constitute the pollen sum. These were most likely to provide a picture of the local vegetation history of the area, as pointed out by Hamilton (1972) and Moore and Webb (1978). Furthermore, the pollen of Compositae, Euphorbiaceae and Liliaceae were excluded from the pollen sum because of their divergent distributions (Hutchinson and Dalziel 1959, 1963, 1968).

The spores of *Ceratopteris* were excluded but its variation as a percentage of the pollen sum was estimated. This was because, as a shallow water plant (Germeraad *et al.* 1968), it could be used to provide information on the hydrological changes in the pond and, therefore, on the local conditions which are of crucial importance in a study centred round local, rather than regional, vegetation changes.

Results

Pollen analysis

The approach of Sowunmi (1981a, 1981b) has been followed in classifying the taxa into different ecological groups. Reference was made to Hutchinson and Dalziel (1958, 1963, 1968) and Germeraad *et al.* (1968) when placing the taxa in their modern ecological groups. The classification was based on the assumption that the physiology and environmental requirements of the fossil species were identical to those of present day taxonomic counterparts (Moore and Webb 1978; Ritchie 1987).

Because of their important ecological and diagnostic characteristics, certain species were treated separately. *Elaeis guineensis* was separately classified as "it is known to generate pollen only where abundant sunlight reaches the ground as in natural, open forest, or where man artificially creates a gap in an otherwise dense rainforest" (Sowunmi 1981a:144). Its presence in the Esa pollen spectra was therefore interpreted as indicative of the extent of the opening-up of the vegetation by people. It is pertinent to note the difficulty often encountered in interpreting the ecological significance of the Amaranthaceae/Chenopodiaceae pollen group as it is usually possible to identify the grains only to the family level. It is not certain whether the species represented here were natural weeds or those of arable land. Ferns, particularly those with monolete spores, were also separately grouped, as they were considered to have originated from the rainforest and to be indicators of humid conditions (Sowunmi 1981a, 1981b).

Sowunmi's classification identifies the following communities and characteristic taxa:

1. Moist southern Guinea savanna
   Khaya senegalensis

2. Riverine forest (southern Guinea savanna)
   Morelia senegalensis
   Tacazzea apiculata

3. Lowland rainforest
   Alstonia booeni
   Synsepalum dulcificum

4. Aquatic vegetation (shallow water)
   Ceratopteris sp. (Magnastriates howardii)

A summary of the pollen assemblages, based on the above groupings, is outlined below, starting at the oldest level.

70-80 cm. This level was characterised by the abundance of fern spores (mainly trilete and monolete) (34.7-27.5%) and pollen of lowland rainforest (17.6%). *Elaeis guineensis* (25.9%) was well represented. In contrast, pollen of the moist southern Guinea savanna (2.6%) and its riverine forest were scarce or absent.

60-70 cm. Fern spores continued to be well represented and there was a slight drop in the pollen of lowland rainforest types (13.4%), with a rise in the pollen of southern Guinea savanna and its riverine forest. There was no significant change in the proportions of *Elaeis guineensis* relative to other components of this assemblage.

50-60 cm. This level witnessed a slight decrease in fern spores, particularly those of monolete ferns (20%); but the rainforest group of taxa was still well represented. There was no significant change in elements of moist southern Guinea savanna. However, an increase in the pollen of *Elaeis guineensis* (33.3%) was apparent.

40-50 cm. This level showed a remarkable reduction in the pollen of species of the lowland rainforest (6.5-4.9%). There was a notable increase in the pollen of moist southern Guinea savanna types (5.2-3.2%). *Elaeis guineensis* continued to be well represented.

30-40 cm. The most notable aspect of this level was the drastic reduction in the proportions of lowland rainforest pollen (2.4%) and monolete spores (10.3%), while representatives of moist southern Guinea savanna (19.6%) showed a substantial increase. *Elaeis guineensis* (29.4%) pollen continued to be well represented.

20-30 cm. There was a relative decrease in the pollen of *Elaeis guineensis* (23.9%) and monolete spores (7.4%). The lowland rainforest group (1.3%) still remained low in proportion to southern Guinea savanna (17.6%), which by now had shown a very significant increase.

10-20 cm. This level was characterised by a further reduction in the amount of the lowland rainforest elements, with a continued rise in those of the moist southern Guinea savanna (22.8%). *Elaeis guineensis* (21.7%) witnessed a reduction compared with the preceding levels.

0-10 cm. The pollen types making up the moist southern Guinea savanna group (24.1%) reached their peak level and there was a further drastic reduction in pollen belonging to lowland rainforest (2.6%). Changes were also noticeable in the quantities of pollen of the fern spores (8%) and the moisture loving *Alchornea cordifolia*, both registering a further decrease. Pollen of *Elaeis guineensis* (18%) and Amaranthaceae/Chenopodiaceae were represented in comparatively high proportions, though the former made a slight increase over the latter.

Lithology

Detailed description of the lithological results of analysis of the sediments have been made in *West African Journal of Archaeology*, volume 22, 1991.

Discussion and interpretation of results:

Problems relating to the reconstruction of the environment on the basis of palynological evidence from the Esa ponds have been identified (Oyelaran forthcoming). Due notice have been taken of the limitations of the evidence and interpretation of the pollen spectrum has been undertaken cautiously. Three pollen zones were identified from the lithological and the palynological evidence:

Pollen zone 1 (80-50 cm). This zone is characterised by the abundance of wet-loving plant communities such as rainforest (17.6%), ferns (20-27.9%), the moisture loving *Alchornea cordifolia* (14.7%) and aquatic vegetation (39.3%). The pollen of the moist Southern Guinea savanna, though scantily represented at the bottom of the zone, made a minor progressive increase towards the top (from 2.6% to 5.9%). The presence of oil palm, already in appreciable quantities (25-30%) in this zone, suggests that there had already been some forest clearance. Amaranthaceae/Chenopodiaceae are also present in significant proportions (9.3-15.5%). Lithologically, the zone is characterised by greyish medium/ fine sand to silty clay grains and relatively low magnetic susceptibility values (13.5-24.4 $10^{-6}mkg^{2}$).

This greyish colour might be indicative of reducing conditions caused by poor drainage (Hassan 1978) and this could imply that the ponds were permanently waterlogged, in contrast to the periodic waterlogging that characterises them today. This evidence corroborates the results of pollen analysis, and it is reasonable to infer that the area adjacent to the pond was humid. It also seems likely that human activity in the catchment area had not reached such a stage as to cause the erosion of coarser material into the ponds, and to increase the magnetic susceptibility of the sediment by burning.

Pollen zone 2 (50-20 cm). This layer is lithologically characterised by yellowish-brown medium-to-coarse sandy material with comparatively high magnetic susceptibility values (40-60 $10^{-6}mkg^{2}$). It also has a high concentration of charcoal specks. The results suggest a change to an oxidising environment, probably as a result of periodic aeration associated with low water levels. The comparatively high magnetic susceptibility variations and increase in coarser materials in the sediments could be explained in terms of greater intensity of erosion of coarse and magnetically-enhanced materials into the ponds from the surrounding catchment area. This is likely to have resulted from an accentuated removal of vegetation in the catchment area which could have led to a destabilisation of the soil. Palynological evidence further corroborates the above inference, as there was an accelerated rise in pollen of southern Guinea savanna species (3.9-1.9%) with a corresponding decrease in rainforest pollen, monolete fern spores and *Alchornea cordifolia*. Spores of the aquatic fern spore (*Ceratopteris*), however, continued to be well represented. A remarkable feature of this layer is the increased occurrence of Amaranthaceae/Chenopodiaceae and the good representation of *Elaeis guineensis*. From this combined evidence one can infer that there was more opening of the canopy by a gradual elimination of fire-tender forest species by people through intensified bush burning and cultivation; thus resulting in a natural displacement by fire-tolerant savanna species as well as, an increase in oil palm.

Pollen zone 3 (20-0 cm). Both lithogically and in terms of the magnetic susceptibility values, there are sharp differences between levels 20-10 and 10-0 cm. While level 20-10 cm is characterised by yellowish-brown coarse sand with gravel and very high magnetic susceptibility values (68.36 $10^{-6}mkg^{2}$), level 10-0 cm is characterised by dark brown fine sand with silty clay and a magnetic susceptibility value of 25.59 $10^{-6}mkg^{2}$. These differences might be a consequence of a law prohibiting burning, in particular in the vicinity of the ponds in particular and Ogidi hill and its environs in general (Mr. Adeniyi, pers. comm. 1986). This has consequently reduced the amount of coarse and magnetic material in the topmost level (10-0 cm) of this layer. Lending credence to this view is the presence of only small quantities of charcoal specks in level 10-0 cm in comparison with the very high concentration in level 20-10 cm. Indeed level 20-10 cm contained the highest quantities of coarse materials and charcoal specks as well as the highest magnetic susceptibility value (60.87 $10^{-6}mkg^{2}$). The evidence for burning and erosion in pollen zone 2 and level 20-10 cm of pollen zone 3 implies that the regulation prohibiting burning had not yet been made. This significant difference in the two levels also seems to reflect a change in human activity within the catchment area of the ponds. Pollen zone 3 is characterised by a marked dominance of pollen of southern Guinea savanna (9.7-20.5%), whilst there was an overall reduction in the rainforest pollen (1.8-2%) and monolete ferns (8%). *Elaeis guineensis* (18-21.7%) and Amaranthaceae/Chenopodiaceae (15.7-22%) continued to be well represented. *Ceratopteris*, as well as *Alchornea cordifolia* underwent slight reductions. The apparent slight decline in *Ceratopteris* spores might be regarded as evidence of a deterioration in the hydrological condition of the ponds as the yellowish-brown colour of the soil (20-10 cm) indicates an oxidising environment which may have been a consequence of periodic aeration following very low water levels. The decreased percentage of rainforest pollen and fern spores might be interpreted as an appreciable replacement of rainforest vegetation by savanna. These suggestions are strongly supported by the lithological information and magnetic susceptibility values of pollen zone 3 (20-10 cm). Coarse gravely sand with the highest susceptibility value in the deposit indicates intensified removal of surface vegetation and soil destabilisation in the catchment area. It is probable that human activity was most intense during the period in which this layer was deposited.

Conclusion

In summary, the palaeoenvironmental investigation of Iffe-Ijumu in southwestern Nigeria by means of pollen and sediment analyses, indicates that man contributed to ecological changes in the area through increased burning of vegetation, probably for farming and hunting purposes.

The writer is hampered at the moment by the non-availability of dates which would enable the correlation of the sequence from the ponds with that of the two rock shelters of Itaakpa and Oluwaju. In the absence of dates, it is difficult to correlate these ecological changes with the period of settlement at these rock shelters. Nevertheless, the palynological evidence from Esa pond does not indicate the presence of undisturbed or primary forest at the time when the earliest levels were deposited. Rather it indicates that there were already traces of savanna species, Amaranthaceae/Chenopodiaceae and appreciable quantities of *Elaeis guineensis*.

Burning must have already occurred and as a consequence the closed forest was gradually being transformed into a more open forest in which *Elaeis guineensis* became a prominent component and in which there were probably patches of savanna vegetation. It seems, therefore, that the present vegetation in the area may not be entirely the result of climatic deterioration but also reflects extensive human interference.

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