SOME STUDIES ON THE TERTIARY DEPOSITS OF NIGERIA, WEST AFRICA

G. S. PURI

Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

ABSTRACT

Fossil leaves of Palms, *Terminalia* and *Combretum* have been described for the first time from tin mines of the Jos Plateau in Nigeria. These show affinities with modern vegetation of West Africa. However, *Terminalia* and Palms seem to have shifted away from the Jos Plateau, which at present has a dominant vegetation of Scrubby and Grassy growth. This is explained to be due to changes in the Soil and Climatic conditions. Some soil studies from the Jos Plateau are presented. The fossils are *Terminaliophyllum keayi* (new species), *T. faggei* (new species) and *Combretophyllum josiensis* (new species).

INTRODUCTION

THIS paper is based on some angiospermic fossil leaf impressions collected by the author in 1962-63 from tin mines of the Jos Plateau in Northern Nigeria.

The climate, vegetation and other features of Natural Resources development follow a more or less latitudinal pattern of distribution in West Africa. The differences in geology and soils bring in variations on local or regional scale. These are sometimes sufficient to mask the general effect of the major factors (KEAY, 1947, 1949). Some general observations have been made by Keay (1959) and others on the vegetation of Nigeria to give a broad picture of the habitat factors in vegetational development. But in the absence of any detailed study on the vegetation of the Plateau it is not possible at present to generalize the effect of the causal factors.

The fossil leaves are embedded in kaolinitic clay that is usually white, sometimes greyish or bluish in colour. The fossiliferous layer usually occurs in a narrow band, overlying, almost invariably, the layer of the tin ore in the mines studied (PL. 1, FIG. 1). (a) points to the layer of tin. (b) indicates the upper limit of the fossiliferous layer. Overlying this there are several layers of fluvio-volcanic sediments marked (c) in which no macro-fossils have so far been discovered. The uppermost layer marked (d) in the photo is laterite, which extends upwards to the surface.

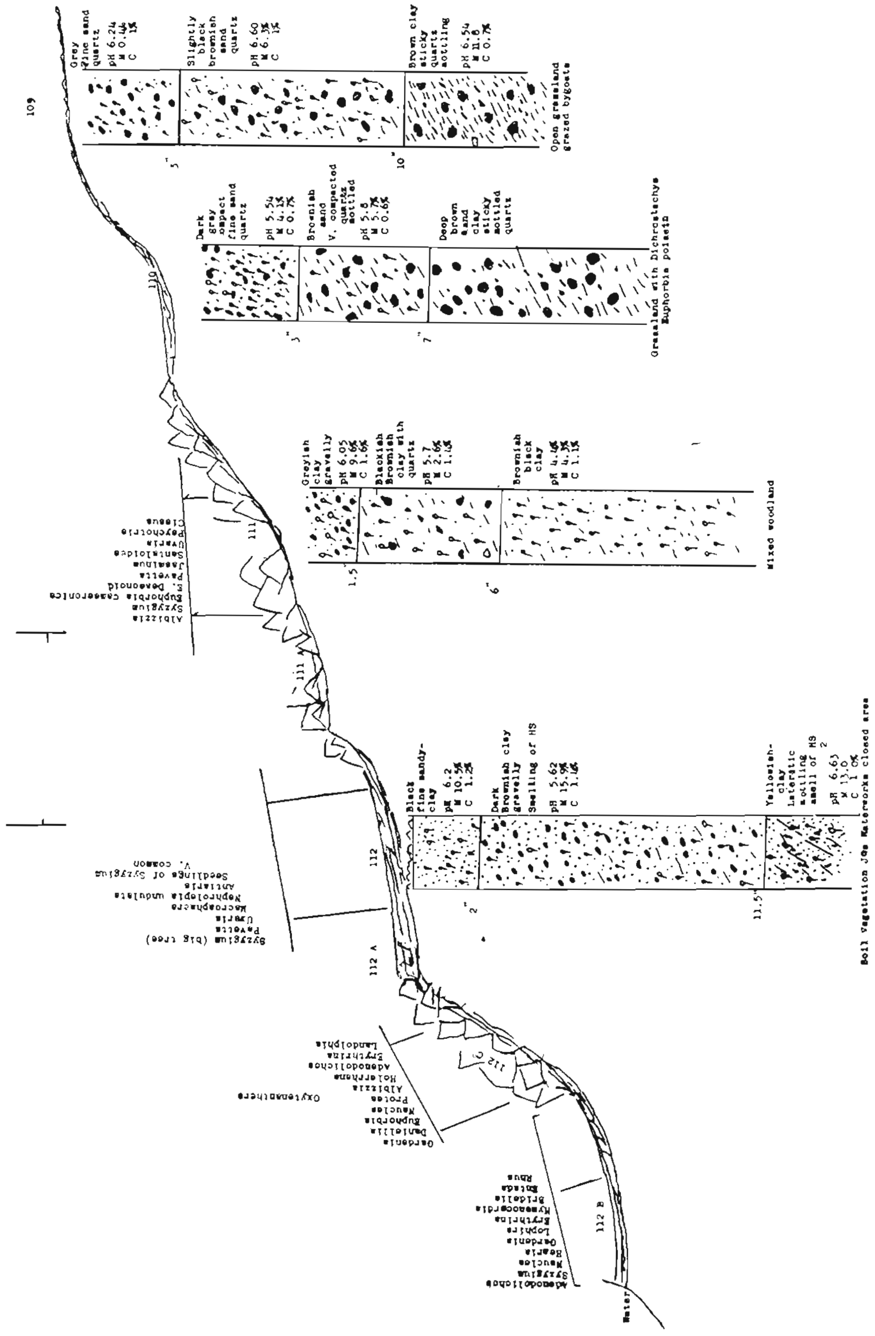
The depth of the fossiliferous layer varies considerably from 20-50 feet in different mines examined. In some mines on the Plateau there are two or three layers of fossiliferous clays, which are different in composition, structure and in nature of sedimentation. In one of the mines examined black, rich-in-humus clay was found in which leaf impressions, with or without bits of organic matter, were found.

During the summers of 1962 and 1963 a few collections of fossils were made from a number of tin mines. The study of this material may take sometime to complete, if further collections are made from the newly exposed mines on the Plateau. Some of the black clays are rich in microfossils and have shown pollen, bits of cuticles and wood. The pollen analytical studies of these clays, extracted from different depths in the mines will undoubtedly reveal an interesting sequence of volcanic activity, together with changes in vegetation development, as a result of fluctuations in one or the other factor of the ecosystem in the past. This is a long term study and may take several years to complete.

The present paper features only a few fossil specimens from two mines, with kaolinitic clays and is intended to bring to the notice of botanists attending the International meeting at Lucknow the vast field of research, that lies untouched in the tropics of Africa, in paleoecology and in the evolution in various factors of the ecosystem, since the Tertiary Period. I am, therefore, extremely grateful to Mrs. Savitri Sahni, the President of Institute for her kind invitation to present this paper at the meeting. In doing so I am also expressing my deep debt of gratitude to my late lamented teacher — Prof. Birbal Sahni.

GENERAL GEOLOGICAL FEATURES

The mainland of West Africa is formed of the Pre-cambrian rocks, which are grouped



TEXT-FIG. 1

together under the term " Basement complex ". The basement complex comprises a large zone of gneisses, mica-schists, schists and amphibolites, invaded by older granites. The granites form isolated peaks and hummocks in a typical inselberg terrain in many parts of West Africa. The inselbergs have at present a characteristic mountanous vegetation, that differs from the general country and is of considerable ecological interest (PURI, 1963 b; KEAY, 1959).

The Cretaceous and the Tertiary sediments are well developed in many parts of West Africa (FURON, 1963). The Tertiary system is rich in oil, lignite and peaty materials. The terrestrial Cretaceous deposits have abundant coal. The marine Cretaceous have lime-stone deposits. The Jos Plateau sediments appear to be Post-Eocene in age but there is very little evidence at present for a better dating of the fossils found in the tin mines (GROVE, 1952).

The solid geology of the Jos Plateau is formed of a chain of mountains, comprising gneisses, schists and granites. These mountains form, now, a very greatly dissected and eroded plateau.

During the course of development the basaltic rocks have been greatly decomposed and eroded and the materials got mixed with the clays, forming the fluvio-volcanic series.

The changes in the development of vegetation and/or climate during the past transformed the granite and gneissic soils into laterites, which, at some places, now outcrop in low hills on the plateau, and also occur in the tin mines sequence. The laterite hills are widespread. In the past there have occurred several periods of erosion, sedimentation and volcanic activity, as a result of which layers of tin gravels are believed to have been formed all over the plateau.

It is believed that the Jos Plateau is a relict, which assumed its present configuration during the Cretaceous times. The newly formed basaltic hills during the Tertiary are called the younger granites. The maximum altitude to which the laterites have been found on the plateau mountains is nearly 500 feet, above sea-level.

It is also considered that a number of climatic fluctuations resulting in the increase of rainfall occurred during the Pleistocene on the Plateau. Various archaeological materials found together with fossil trees further indicate that pluvial conditions in the past were widespread than now. There have been also several periods of denudation, due to high rainfall, the records of which are preserved in some tin mines.

There are several small rapids and waterfalls along the Plateau escarpment, which seem to indicate again a sequence of interesting changes in climate and vegetation conditions that the plateau had witnessed during the past geological periods.

Whereas, there is an indication of a sequence of geological changes during the Tertiary to Pleistocene on the Jos Plateau the exact dating of the formation of the layers with fossils is not possible at present.

Very little animal remains have been found in the tin mines and one has to rely mostly on the plant fossils that are now under study. It is, therefore, interesting to note that the present studies on plant fossils are likely to be of more than the usual interest in geological field, as well.

EARLY WORK ON PLANT AND ANIMAL FOSSILS

From the north and north-eastern parts of Nigeria, represented by the Provinces of Chad and Sokoto, several types of fossil echinoids, shells, mollusca, Ammonites, fishes and reptiles have been described belonging to the Eocene to Cretaceous ages (REYMENT, 1955, 1956; SWINTON, 1930; WHITE, 1926). The Nigerian Cretaceous and Tertiary Periods are known at present by their fauna only.

Very little information is available on the flora of these periods in West Africa. Some fossil fruits belonging to the family Anonaceae, Icacinaceae, and (?) Passifloraceae were described by Chesters (1955) from Nigeria and Sierra Leone. These were associated with some Eocene fauna described by White (1926), and have affinites with the modern genus *Anona*, and the form genera *Icacinicarya* and *Carpolithus*. This flora represents the same type of conditions as indicated by the London Clay flora (REID & CHANDLER, 1933) and the upper Cretaceous and Eocene floras of Egypt (CHANDLER, 1954).

Several angiospermic fossils belonging to the families Anonaceae, Menispermaceae, Capparidaceae, Anacardiaceae, Connaraceae, Apocynaceae (?), Lauraceae (?), Urticaceae, Sterculiaceae, Tiliaceae, Olacaceae, Ilaceinaceae, Combretaceae, Rubiaceae and Boraginaceae were described from the Miocene deposits of Eastern Africa on the Rusinga Islands in Kenya (CHESTERS, 1957). There are several modern genera represented in these collections. From the middle Tertiary of Uganda, Chaney (1933) identified fossil leaf impressions belonging to the Leguminosae and the Combretaceae.

The present day vegetation of the West and East African areas has a fairly prominent representation of the above families of plants that have been found as fossils and it was pobably for this reason that Berry (1918) and Kryshtofovich (1929) expressed the opinion that there had been very little change in the vegetation of the tropics from the Cretaceous and Tertiary Periods. Krystofovich is reported to have stated that "in the tropics of South-East Asia the Malayan type of Flora has remained unmolested since its first descent from its Cretaceous ancestors" (*see* CHESTERS, 1957, p. 32).

This statement needs modification in the light of several microfossils discovered from the Cretaceous and Tertiaries of Nigeria (PURI, 1963b). Pollen analytic studies are in progress, but the information collected up-to-date seems to reveal in the Cretaceous to Eocene of the Nigerian tropics a vegetation in which *Nothofagus*, *Podocarpus* and several form-genera, which seem to resemble *Araucaria* and other southern gymnosperms, were prominent, in common with the fossil vegetation of the same periods of Australia, New Zealand and the Indian mainland. This would show that there had been prominent changes in the vegetation of the tropics from the Cretaceous through Tertiary and Pleistocene. This is corroborated from the evidence presented by other workers (KRIGE, 1927; HAMMEN, 1954) on the changes of sea level in Africa and S. America during the Cretaceous and Tertiary Periods. It is argued that this brought about interesting changes in climate that must have greatly altered the environmental complex for the development of vegetation in the tropics.

From the brief review of available literature it follows that the study of fossil floras of the Tertiary period in West Africa promises to yield results of some importance in our knowledge of the evolution, migration and succession of vegetation in the tropics.

So far as the author is aware the Jos fossils have never been described before, and Chesters (1955, p. 1) recorded that "a large number of leaf impressions have so far been identified". Dr. Chesters has kindly checked this from the records of the Natural History section of the British Museum at my request. The only account that appeared was by the author (PURI, 1963c) for the first time in 1963.

DESCRIPTION OF THE FOSSILS AND THEIR IDENTIFICATIONS

All the fossils are leaf impression — fragments, in which details of venation are seen reasonably well. These are identified by comparison with the modern vegetation of West Africa. In this work possible sources of error have been carefully considered and avoided in the same way as was done in the author's work on the Pleistocene flora of the Kashmir Himalayas, in India (*see* PURI, 1948; 1960 and references therein). The methods of identification are mainly ecological.

Ecologically, leaf is a dynamic system and the conception of regarding it merely as a plant organ of use and importance only in morphology or taxonomy has been avoided in this study (MILTHORPE, 1956). Heredity and environment both control variations in the size, shape, area, etc. of an individual leaf and the several leaves on a growing branch (WENT, 1956), and in any interpretation of ecological conditions of a fossil flora one has to be extra cautious.

A paleobotanist has generally little or no information on the heredity variations of fossil leaf fragments, but a considerable amount of information now available on modern vegetation seems to show that there is a close relationship of leaf to its environment (GREGORY, 1956 in MILTHROPE, 1956; BLACKMAN, 1956; PENMAN, 1956). Leaf shapes in quantitative terms give a record of changes during life history and are expressed as a function of time (ASHBY, 1948). There is a definite relationship between leaf length and breadth with time and this is governed by day length and time of light intensity. Photochemical reaction and photosynthesis affect the assimilation rate and the average area of the leaf. Besides these factors, vitamins, auxins and minerals salts are also concerned in leaf shape, size and area. Thus, taxonomical variations in leaves can be interpreted in terms of physicochemical reactions. Soil and fertility are important factors to be considered in any interpretation of the environment complex.

From the above brief discussion it is clear that the task of paleobotanist in the identification of fossil leaves and the interpretation of environmental conditions from these remains is extremely difficult and this must be presented with the greatest caution.

MONOCOTYLEDONS

Family — Palmae

Genus — *Palmophyllum*

(Pl. 1, Figs. 2, 3)

Two leaf fragments of palms are illustrated in Figs. 2, 3. Fig. 2 represents a part with the rachis and the other is a portion from a different part of leaf. Venation is not well preserved. None of the fossils seem to resemble any known species of palms at present growing in the Nigerian forests, or Savanna.

In the Southern part of Nigeria *Elaeis* (the oil palm), is the commonest and in the north *Borassus* is found, in low areas, in valley bottom or hillsides. No wild palm occurs now in the Jos Plateau near the fossiliferous area. In the absence of any additional information the fossils are identified with the genus *Palmophyllum*, without any definite commitment to their relationship with any known living or fossil species of palms.

PROBABLE AFFINITIES AND DISTRIBUTION OF FOSSIL PALM LEAVES

Fossil Palm leaves have been described from many parts of the World. Kaul (1960) has recently given a summary of the available information and the following remarks are offered on the basis of his study.

Palmophyllum moleteinianum Krasser and Kubart* is described from the Cretaceous rocks of Europe.

Fossil leaves somewhat resembling the Nigerian fossil shown in Fig. 2 ascribed to *Sabal major* Ungor have been recognized from the Oligocene and the lower Miocene of the Kasauli Series in the Himalayas.

Heer* described *Sabal major* from the Miocene of Central Italy to North Germany. Small leaves were designated as *S. ziegleri* Heer and another species *S. haeringiana* Unger was also recorded from the same deposits.

*Reference to these are found in Kaul (1960).

Other known species of *Sabal* on fossil leaf impressions are *Sabal lamanonis* Brongn.*; *S. miocenica* Axelrod* and *S. nipponica**. It is extremely difficult to say whether the present discovery of the fan-like palm leaf fragment from Nigeria would extend the distribution of *Sabal* to the western edge of the African continent.

Several fossil leaf impressions belonging to the Palmae have been described from the upper Tertiaries of W. Java by Göppart*. The species enumerated are *Amesoneuron anceps, A. calyptrocalyx, A. dracopyllum, A. sagifolium, Flabellaria licualaefolia* and *Palmacites flabellata* Crié.

It is difficult at present to identify the Nigerian fossils with any of the palm fossil leaves. It may, however, be noted that the Nigerian fossil palms are found within the general limit of distribution of modern and fossil palms marked by Kaul in the world map in his paper.

DICOTYLEDONS

Family — Combretaceae

Fossil leaf fragments resembling several species of *Terminalia* and *Combretum* are found infairly large numbers in these deposits. While it may be possible sometimes to distinguish living leaves of *Terminalia* from *Combretum* on leaf features, the separation of species of the two genera, on the basis of fossil leaf fragments, is clearly impossible (KEAY, ONOCHIE & STANFIELD, 1960). I have, therefore, attempted the following account with a great deal of hesitation.

Genus — *Terminaliophyllum* Geylor 1887.

Fossil leaf fragments showing a general resemblance with leaves of *Terminalia* are described under this form genus (ANDREWS, 1955).

Terminaliophyllum keayi sp. nov.

(Pls. 1 & 2, Figs. 4a, b, c & 5)

This is a fragment of a large leaf that fits in general size, shape, venation and other characteristics with leaves of *Terminalia* sp.

*Reference to these are found in Kaul (1960).

in sheet No. FHI 14815 in the Forest Hebarium, Ibadan, Nigeria (PL. 3, FIG. 8).

Mr. Keay identified this as a hybrid between the two species of *Terminalia*, namely *T. macroptera* Guill. & Perr. and *T. laxflora* Engl. var. *pubescens*, both from Nigeria.

In the absence of relationship with any other plant from W. Africa the fossil is identified as a new species of *Terminaliophyllum keayi*, after Mr. R. W. J. Keay, the distinguished botanist, who is the author of several publications on the Nigerian vegetation and flora.

Terminaliophyllum faggei sp. nov.
(Pl. 2, Figs. 6, 7)

There are a number of leaf fragments of various sizes and shapes that show resemblance fairly closely with leaves of *Terminalia laxiflora* Engl. (PL. 3, FIG. 9). The leaves of this are smooth textured, quite unlike the pubescent variety. The lateral veins in *T. laxiflora* are arched upwards.

Although, there is some resemblance with the living species the fossils are described as *Terminaliophyllum faggei*, a new species, after Mr. B. Fagg, the Director of the Jos Museum, who first drew my attention to the fossils from these deposits and helped me in various ways in the collection of the material described in this paper.

Genus — *Combretophyllum* gen. nov.

Combretophyllum josiensis sp. nov.
(Pl. 3, Figs. 10, 11)

The leaf fragments figured here are selected from several dozens of specimens that are smaller in size than the *Terminalia* species. There is a distinct petiole preserved in some of these. The venation is not well marked, with laterals characteristically arching upwards. These leaves resemble in general appearance, size, shape and venation with several species of *Combretum* from W. Africa but do not show distinct affinities with any single species. The fossils are described as *Combretophyllum josiensis*, a new genus and species from the Jos Plateau.

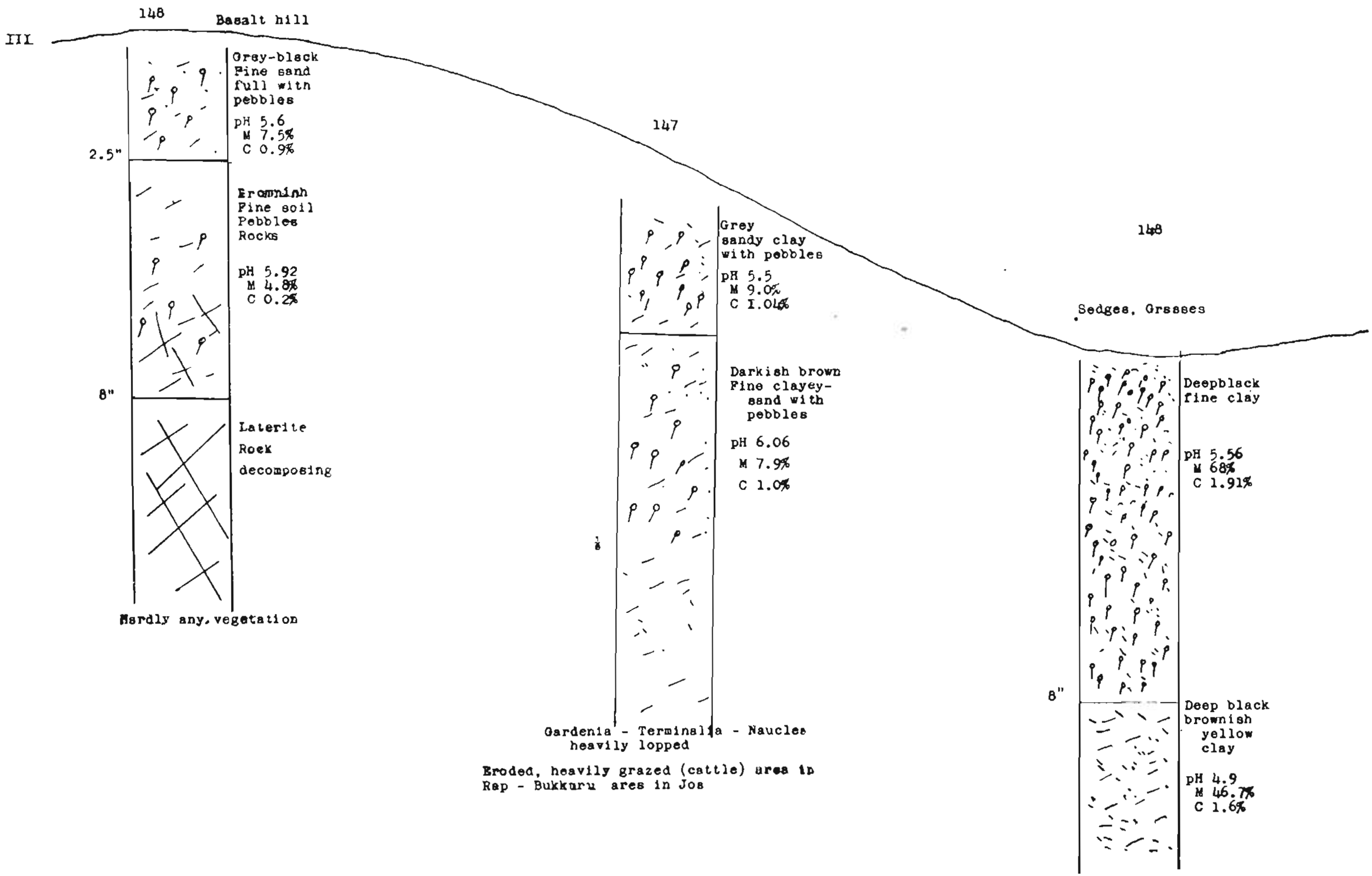
REMARKS ON THE PRESENT VEGETATION OF THE JOS PLATEAU

The Jos Plateau, as already stated, has two types of mountains, which are different in land form and geology. The younger granite mountains are at present almost completely bare of any tree or shrub vegetation. There are some grasses and weeds, and here and there, there may be some heavily grazed shrubs. Even without the biotic interference these younger granite mountains at top are usually devoid of tree vegetation. The strong wind and heavy erosion make conditions unsuitable for the development of tree vegetation at the mountain topes.

A sequence of vegetation is shown in Text-fig. 1 in one of the younger granite (basalt) hills, with bare topes. The soil profile has merged into rocks and finally laterite layer is reached. The depth of the laterite varies from a few inches from the surface to a few feet. The laterite rock is usually solid and there is little formation of soil. The profile on the surface as well as in the lower layer is acidic in reaction with low *p*H. The moisture content in the surface soil may not be low but the lower layer has very small percentage of water, with low carbon content and this factor may also be responsible for the poor development of any shrub or tree vegetation on the younger granite hills.

On the lower part of the slope of the basalt (younger granite) hill where the eroded soil, washed down from the above, settles, and the area is sheltered from strong winds, a scrubby vegetation with *Gardenia-Terminalia-Nauclea* is present. This is heavily lopped and browsed by cattle. In the nearby sites with little or no biotic interference the vegetation does not develop into a tree community of any dimension. The surface soil is sandy with high amount of carbon, but is acidic on reaction. The lower layer has got fine clayey-sandy soil, mixed with pebbles, and is less acidic to neutral in reaction.

In the valley bottom, where seepage and run off water collects, the soil is rich in humus. There has developed a vegetation of sedges and grasses. The surface soils are fine clayey, deep black in colour, with a very high amount of moisture content. The soil below 8 inches from the surface is also deep black with brownish and yelow clay. This is also acidic due to high content of soil water. The absence of tree and shrub vegetation in this part is due probably to the high moisture content and water-logged conditions, which are associated with low *p*H values.



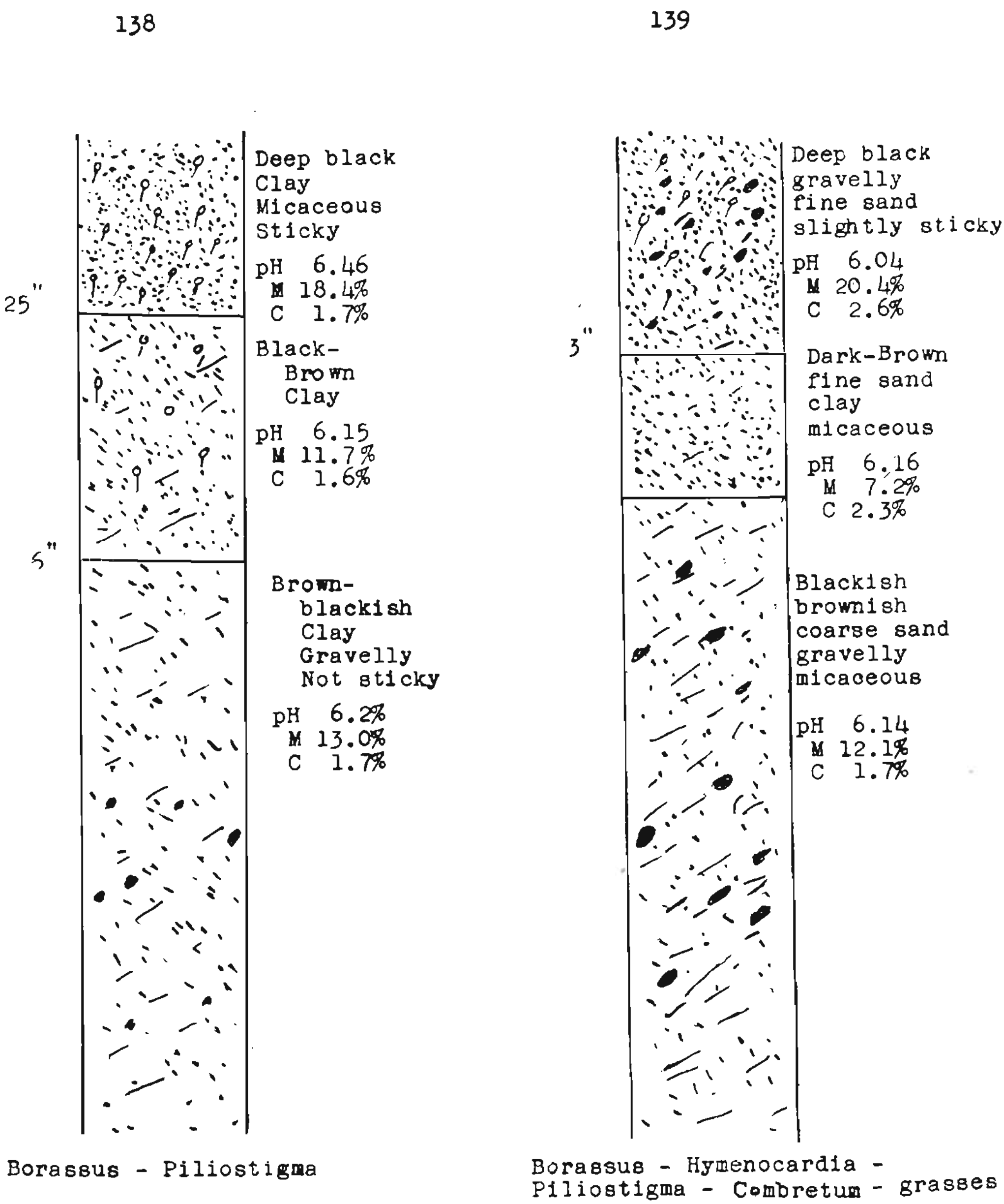
III
148
Basalt hill
Grey-black Fine sand full with pebbles
pH 5.6 M 7.5% C 0.9%
2.5"
Brownish Fine soil Pebbles Rocks
pH 5.92 M 4.8% C 0.2%
8"
Laterite Rock decomposing
Hardly any vegetation
147
Grey sandy clay with pebbles
pH 5.5 M 9.0% C 1.04%
Darkish brown Fine clayey-sand with pebbles
pH 6.06 M 7.9% C 1.0%
Gardenia - Terminalia - Nauclea heavily lopped
Eroded, heavily grazed (cattle) area in Rap - Bukkuru area in Jos
148
Sedges, Grasses
Deepblack fine clay
pH 5.56 M 68% C 1.91%
8"
Deep black brownish yellow clay
pH 4.9 M 46.7% C 1.6%

TEXT-FIG. 2

It may seem that on the younger granite hills the tree vegetation can develop only in sheltered parts of the slopes, where the soil is deep. Both the upper parts of the hills and valley bottoms have little or no tree vegetation for the reasons mentioned above.

Vegetation in another area on the Jos Plateau is represented in Text-fig. 2. Grassland vegetation is present on the upper parts of the slop, with some *Euphorbia* and other scrubby plants. The profile from these areas shows shallow soils, with quartz on the surface. Heavy grazing is also responsible for this poor vegetation in the area.

In the same area, however, mesophytic conditions may develop in pockets, behind



TEXT-FIG. 3

or in between rocks where plants like *Musa*, typical of southern Nigerian rain forests, have developed.

In the rocky areas several species of plants given in Text-fig. 1 form a dense community of trees and shrubs, and where soil is fine, sandy-clay, black with humus, trees like *Syzygium* form a community of evergreen plants, with ferns in the underground. Due to the collection of sub-soil water, there is a foul smell of H_2S, throughout the profile, and mottling is seen.

In the present vegetation of the Jos Plateau *Terminalia* and *Combretum* are rather rare. This is probably due to the early stages of colonization of these rocky mountains, with shallow soils. In the bottom of the valleys there is a lake on the banks of which the same type of plants are present.

A vegetation dominated by *Borassus* palm is present below the escarpment of the Jos Plateau in valley bottoms and on low hill-sides. Here, as shown in Text-fig. 3 soil is deep black and fine clayey in texture. It is sticky and throughout the profile carbon content is high, with moderate moisture content. Palms are accompanied by other shrubs, such as *Combretum* and *Piliostigma*. These soils are usually less acidic as compared to the Plateau soils studied in connection with the studies on vegetation reported above.

CONCLUSIONS

A brief survey of the present vegetation of the Jos Plateau seems to show that the palms and *Terminalia* communities occupy different types of landscapes, with the conditions of soil and moisture vastly different. It seems probable that the fossil palms and Terminalias belong to two different series, that may be associated either with successional sequence of vegetation development with the processes of land form transformation. Work on both the past and present vegetation of the Jos Plateau is in progress and further discussion of these questions will have to be left to a later date.

REFERENCES

ANDREWS, H. N (1955). Index of generic names of some plants — 1820-1950.

ASHBY, E. (1948). *New Phytol.*, **27**: 151-176.

BERRY, E. W. (1918). The fossil higher plants from the Canal Zone. *Bull. U. S. nat. Mus.*, **103**: 15-44.

BLACKMAN, G. E. (1956). Influence of light and temperature on leaf growth. (*In Milthorpe*, 1956)

CHANEY, R. W. (1933). A Tertiary Flora from Uganda. *J. Geol., Chicago*, **41** : 702-709.

CHANDLER, M. E. J. (1954). Some upper Cretaceous and Eocene fruits from Egypt. *Bull. Brit. Mus.* (*nat. Hist.*), *Geol.*, 2, **4**: 147-187.

CHESTERS, K. I. M. (1955). Some plant remains from the upper Cretaceous and Tertiary of W. Africa. *Ann. & Mag. nat. Hist.* Ser. 12, **8**: 1-7.

Idem (1957). The Miocene flora of Rusinga Island, Lake Victoria, Kenya. *Palaeontographica*, **99** B: 30-71.

FURON, R. (1963). Geology of Africa. Translated by A. Hallam and L. A. Stevens. *New York*.

GROVE, A. T. (1952). Land use and soil conservation on the Jos Plateau. *Bull. geol. Surv.. Nigeria, No.* 22.

HAMMEN, T. H. VANDER (1954). El Desarrollo de la Flora Colombiana En Los Periods Geologicos. I Maestrichtiano Hasta Terciario Mas Inferior. *Boletin Geologeo-Tomo II* (*i*): 49-106.

KAUL, K. N (1960). Anatomy of plants. Palms I. *Bull. nat. bot. Gdn. Lucknow.* **51**.

KEAY, R. W. J. (1947) Forest vegetation in the savana regions of Nigeria. Forest Dept. Nigeria.

Idem (1949). An example of Sudan Zone vegetation in Nigeria. *J. Eco.*, **37**(2): 335-64.

Idem (1959). An outline of Nigerian vegetation. *3rd ed. Lagos.*

KEAY, R. W. J., ONOCHIE C. F. A. & STANFIELD D. P. (1960). Nigerian trees. *Ibadan.*

KRIGE, A. V. (1927). An examination of the Tertiary and Quaternary changes of sea level in South Africa, with special stress on the evidence in favour of a recent world-wide sinking of Ocean-level. *Ann. Univ. Stellenbosch.* 5(A).

KRYSHTOFOVICH, A. N (1929). The evolution of the Tertiary flora in Asia. *New Phytol.* **28**: 303-312.

MILTHORPE, F. L. (1956). Edit. The Growth of leaves. *Proc. Third Easter Sch. agric. Sci. Univ. Nottingham, London.*

PENMAN, H. L. (1956). Weather and water in the growth of grass. (In *Milthorpe*, 1956).

PURI, G. S. (1948). Fossil plants and the Himalayan uplift. *J. Indian bot. Soc.*, **25**: 167-184.

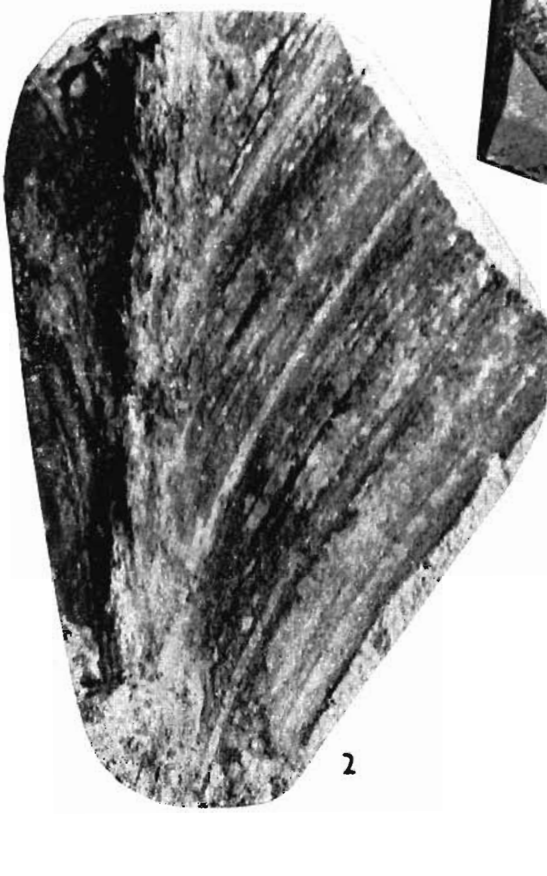
Idem (1960). Indian Forest Ecology. **1**, *New Delhi.*

Idem (1963a). Some plant fossils from Nigeria. *Cent. African Sci. & Med. Cong., Lusaka, N. Rhodesia, Abstract, p.* 17.

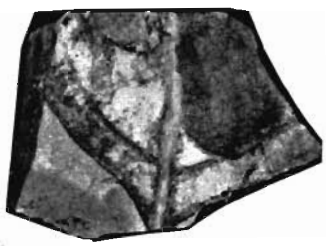
Idem (1963b). The geo-botanical indications of some plants from Nigeria and other regions. *Univ. Ibadan bot. Studies No.* 12. Mim. 1-16.

1

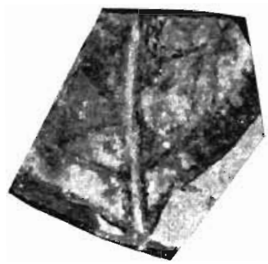
3



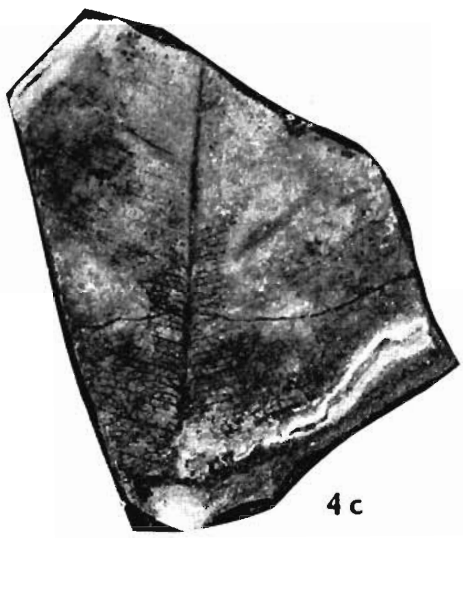
2



4 a

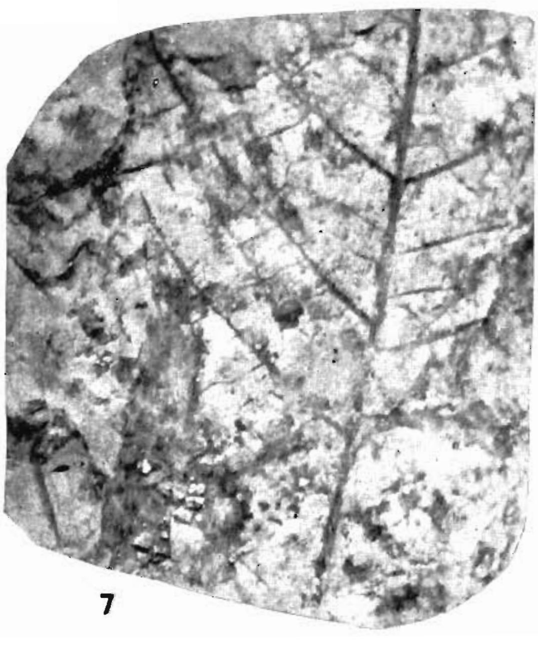


4 b



4 c

5

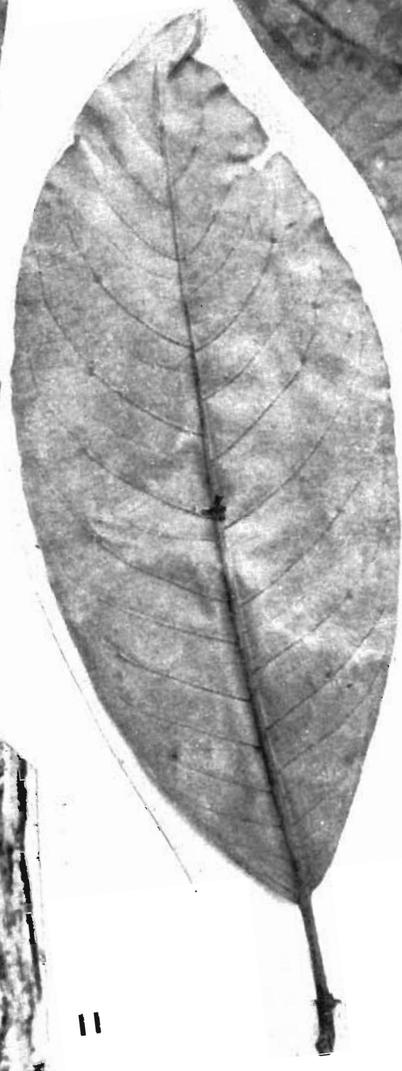


7

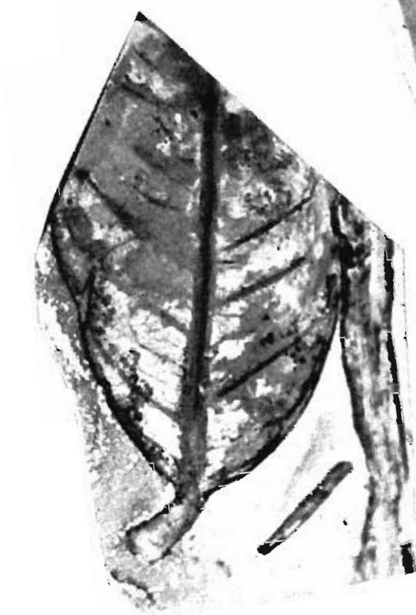
6

8

10



9



11

Idem (1963c). Fossil leaves of *Terminalia* and associated plant remains from the tin fields of Jos, N. Nigeria. *Proc. First meeting Geo. min. & met. Soc. Nigeria*, Oct. 1963.

REID, E. M. & CHANDLER, M. E. J. (1933). The London Clay Flora. *Brit. Mus. (nat. Hist.), London.*

REYMENT, R. A. (1955). Upper Cretaceous mollusca from Nigeria. *Col. Geol. Min. Res.*, **5** (2).

Idem (1956). On the stratigraphy and palaeontology of Nigeria and the Cameroons. *Geol. Foren. Stockh. Forh.*, **78**: 17-96.

SWINTON, W C. (1930). On fossil reptilia from Sokoto Province. *Bull. geol. Surv. Nigeria*, No. **13.**

WENT, F. W. (1956). The role of the environment in plant growth. *American Scientist*, **74**(4): 378-398.

WHITE, E. I. (1926). Eocene fishes from Nigeria. *Bull. geol. Surv. Nigeria*, No. **10.**

EXPLANATION OF PLATES

PLATE I

1 Section of the tin mines — Jos Plateau.

2. A part with the rachis ascribed to *Sabal major* Unger.

3. *Palmophyllum* sp.

4 a, b, c. *Terminaliophyllum keayi* sp. nov. × natural size.

PLATE 2

5. *Terminaliophyllum keayi* sp. nov. ×

6. *Terminaliophyllum faggei* sp. nov.

7. *Terminaliophyllum faggei* sp. nov.

PLATE 3

8. *Terminalia* sp. (Living)

9. *Terminalia laxiflora* Engl.

10. *Combretophyllum josiensis* gen. et sp. nov.

11. *Combretophyllum josiensis* × natural size.