SHALLOW SOILS AND THEIR VEGETATION IN THE REGION OF NAIROBI, KENYA

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INTRODUCTION

Shallow-soil areas are here defined as those where up to 20 cm. of soil covers the underlying rocks (fig. 1), and eleven such areas were studied in the Nairobi National Park. The vegetation of these shallow-soil areas is not much disturbed by human activities such as cultivation and road-making, and is very sensitive to drought; it only grows after the rains, remaining dormant during the dry months of the year. The present study was therefore started soon after the beginning of the short rains in October, 1967. Elongated areas of shallow soils are usually found on the side of a valley or the shoulder of a profile following the contour in the position of maximum slope. In the Nairobi National Park such areas are found mainly in the western wooded part which has many river valleys, but some occur near the Observation Point and near Hippo Pool. Shallow-soil areas are bordered by grassland and woody vegetation on one side or on both upper and lower edges.

Sampling Procedure

From a random throw within a shallow-soil area two transects were considered, one down the slope and the other up the slope. Along these transects the position of each sample was obtained by stratified random sampling within each consecutive 10 m. length. The number of quadrats in a transect varied from three to nine, depending on the length of the transect.

Having found the position of the sample a quadrant of 1×1 m. was marked. A sample of soil was taken from each quadrant from a depth of about 2-3 cm. for pH determination and the occurrence of every plant species was recorded.

The depth of the soil was determined by pushing a metal rod down into the soil until it reached the underlying rock. The depth to which it sunk was measured. In the deeper soils, if the rocky base was not struck by the metal rod the depth was entered as "more than 70 cm."

Identification of plants was aided by the use of Heriz-Smith (1962).

Soil Acidity

It was found that the soil in general is slightly acidic—pH ranging from 6.4 to 7.0—with the majority of the sites having pH 6.6 or 6.8. There is apparently no relation between the pH and the soil depth and therefore none between the pH and the vegetation, since the vegetation depends on the soil depth.

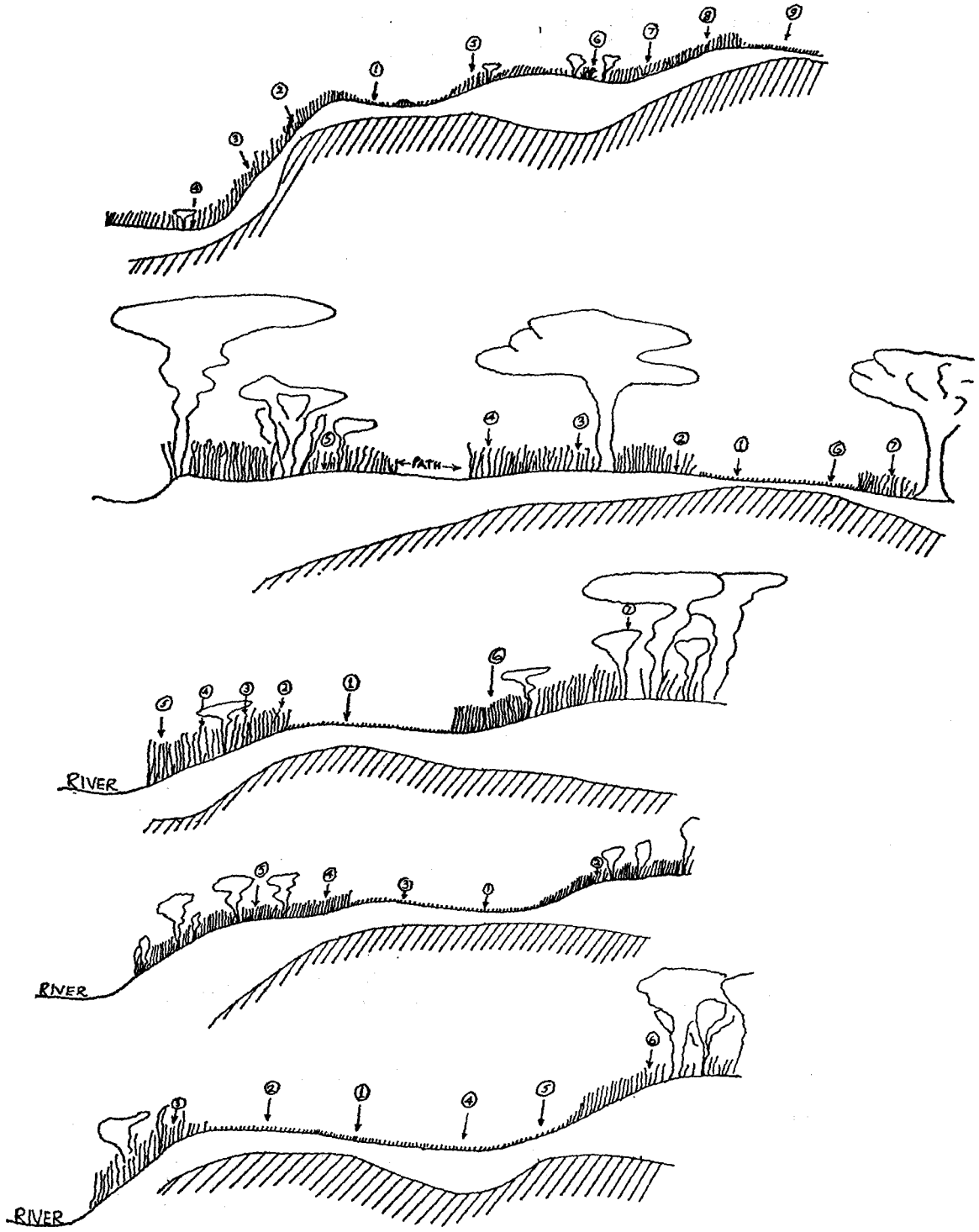

Figure 1.—Examples of the profiles of sites of shallow soil as studied near Nairobi. The horizontal scale is approximate but the vertical scale is more exact of 1:20. Bedrock is shaded. Numbers refer to stratified random sample positions.

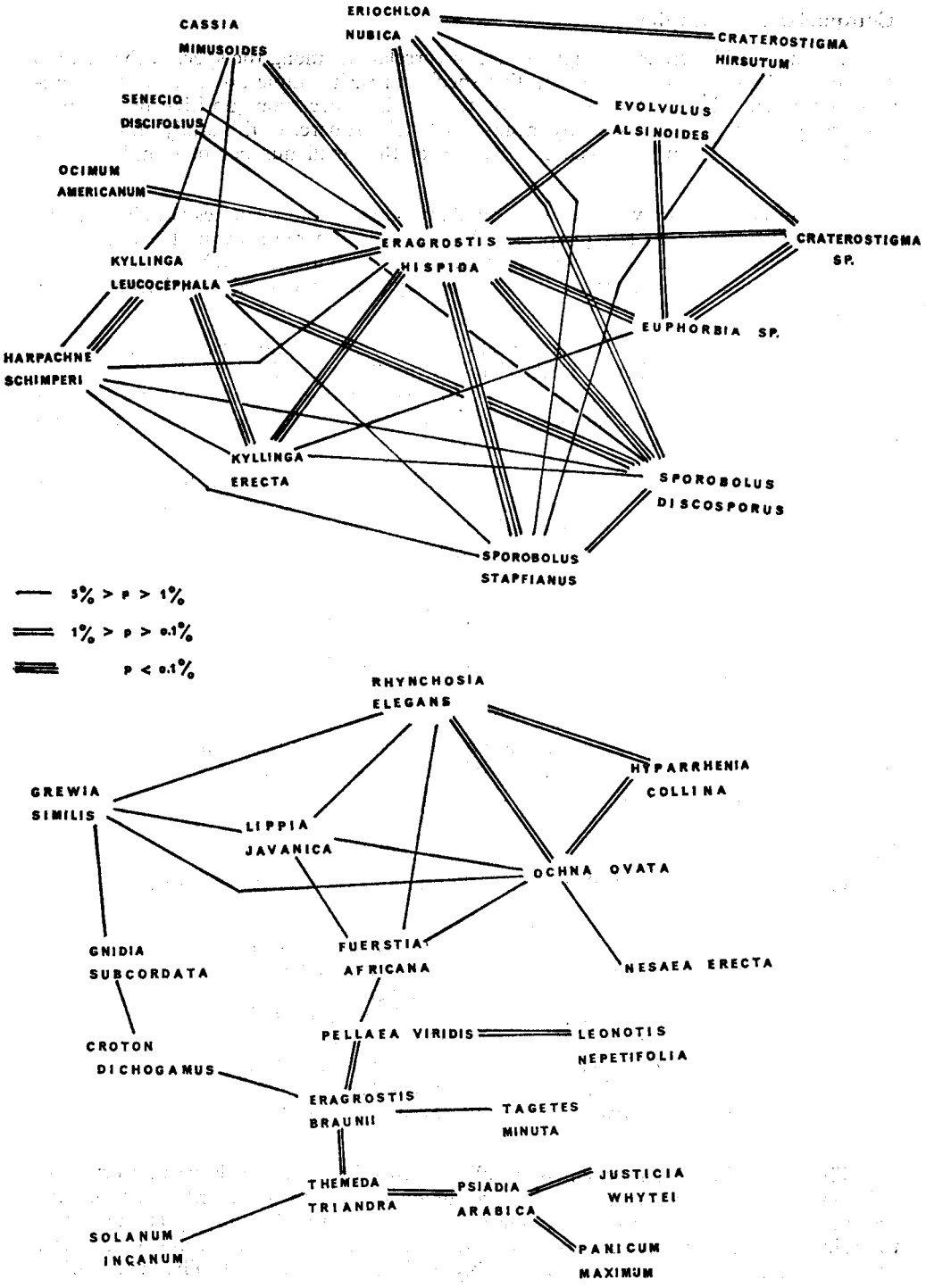

Figure 2.—Species diagram showing the relationships between species found on shallow and adjacent soils.

Comparison of samples

To find out if there is any significance of correlation among the species, the method adopted by Agnew (1961) was used. The species in each sample are treated on a presence or absence basis which consists of testing the correlation (positive or negative) of every species with every other by means of Chi (X^2) square. In this study only positive correlations were taken into account, because of the small number of samples finally obtained.

First of all, the data were reduced by eliminating all those species which occurred less than five times. This left 42 species. A table was prepared showing the occurrence of each species with every other. Then, by using 2×2 contingency tables, for each pair a chi-square value was calculated. The probability values were calculated from Fisher & Yates (1953).

For visual examination and appreciation of these correlations they were arranged as shown in Fig. 2, which is referred to as the "species diagram" (Agnew, 1961). It is a two-dimensional representation of positive correlations, the best possible arrangement being obtained by trial and error and it demonstrates some of the ecological relationships between species.

It is clear that some typical plants of the shallow-soil area show high positive correlations with each other, e.g. *Eragrostis hispida*, *Sporobolus discosporus*, *S. stapfianus*, *Kyllinga leucocephala*, *K. erecta*, *Euphorbia rivae*, *Evolvulus alsinoides*, *Craterostigma spp.*, *Eriochloa nubica*, *Cassia mimusoides*, and *Harpachne schimperi*, these plants are ecologically related and always occur together on the shallow-soil area.

Woody shrubs and trees show higher positive correlations with each other and so form a group of their own as can be seen from the diagram. *Ochna ovata*, *Grewia similis*, *Croton dichogamus* and *Gnidia subcordata* are small trees which are found among shrubs like *Lippia javanica*, *Fuerstia africana*, *Nesaea erecta*, *Psiadia arabica* and grasses like *Eragrostis braunii*, *Hyparrhenia collina* and *Panicum maximum*.

These two groups are not connected on the diagram by a common link, so they are apparently ecologically separated groups of plants, and in nature they hardly, if ever, intermingle with each other.

Discussion

The following is a list of plants generally found in the shallow-soil area.

Anthericum gregorianum
Cassia mimusoides
Coleus caninus
**Craterostigma hirsutum*
**Craterostigma* spp.
Cyperus spp.
Eragrostis hispida
**Eriochloa nubica*
Euphorbia rivae
Evolvulus alsinoides
Fimbristylis spp.
Harpachne schimperi
Ilysanthes pusilla
Kyllinga erecta
Kyllinga leucocephala
Oldenlandia herbacea
**Sporobolus discosporus*
S. stapfianus
Trachyandra saltii

The flora of the shallow soil is peculiar in that it contains a large proportion of poikilohydric species whose leaves dry up but do not die in dry months and become green as soon as they get wet; they flower soon after rain and again dry at the end of the rainy season. This property is an effective adaptation to the environment in these areas, and the poikilohydric species probably evolved in this habitat. They are marked with an asterisk in the list.

The woodland vegetation consists of small trees from 5-10 m. high. The most characteristic species are *Croton dichogamus, Dombeya burgessiae, Erythrococca bongensis, Gnidia subcordata, Grewia similis, Turraea mombassana, Strychnos usambarensis* and occasionally *Olea africana.* Of these *Croton dichogamus, Gnidia subcordata, Grewia similis* and *Turraea mombassana* are typically forest-edge trees. The dense ground flora up to about 50 cm. high usually consists of grasses, herbs like *Justicia whytei,* at times climbers like *Rhynchosia elegans,* and other dicotyledonous plants. Woodland in some places is closed; in others it is more open.

The grassland type of vegetation consists of the following species amongst others:

Aristida adoensis
Fuerstia africana
Hyparrhenia collina
H. filipendula
Justicia whytei
Leonotis nepetifolia
Lippia javanica
Panicum maximum
Pennisetum spp.
Psiadia arabica
Rhynchosia elegans
Rhynchelytrum repens
Senecio discifolius
Setaria verticillata
Themeda triandra

The three types of vegetation often occurred in one transect, which was orientated simply to pass through the shallow-soil area (fig. 1), and no attempt was made to sample the vegetation types separately. The species diagram (fig. 2) shows that there are high positive correlations among the species of the shallow-soil and that these species form a "ring" which is quite separate from the other group of woody plants on the deeper soil. There are no intermediates which link the two types and this suggests that they are ecologically fundamentally separated.

The shallow soils studied here were presumably formed by the filling-in of depressions and crevices in bare rock, much of which remains in these area. Further weathering of the exposed rocks should add to the volume of soil, and one would expect more soil to accumulate as pioneer plant species colonize and consolidate it.

In a normal succession, as soil depth increases, the pioneer species are gradually and continuously replaced by woody perennials, but in our shallow-soil areas there is apparently a discontinuity between successional stages. They have developed a specialized and characteristic flora, whose species are different from those of the surrounding woodland and/or grassland, and which are apparently a permanent and regular feature of East African vegetation. As mentioned above, shallow-soil areas usually occupy positions on the shoulders or sides of valleys, and apparently here erosion is capable of maintaining the soil depth at under about 25 cm.

Throughout the study virtually no interaction was observed between the bigger animals and the shallow-soil vegetation. In one place shoots of *Anthericum gregorianum* and *Trachyandra saltii* had been nipped off as if eaten by some herbivore, probably a bushbuck, *Tragelaphus scriptus* (Callas), which was seen grazing in the vicinity. Other plants like *Craterostigma spp., Cassia mimusoides, Evolvulus alsinoides, Ilysanthes pusilla, Euphorbia rivae* and *Oldenlandia herbacea* were not touched by the animals, because of either their small size or some unpalatable constituent. For reasons not known, some dwarf grasses like *Eragrostis hispida, Eriochloa nubica, Sporobolus discosporus,* and sedges like *Fimbfristylis spp.* and *Cyperus spp.,* were not touched either. The small size of these plants is perhaps an advantage to them, for herbivores may find it difficult to feed on small plants.

In the forest, the advantage of these shallow-soil areas could be that they would act as firebreaks as they would be devoid of combustible matter even in the dry seasons when the carpet of dried plants is too thin for fire to pass through.

SUMMARY

A study of shallow soils round Nairobi shows that the vegetation of these areas is not simply the first stage in a successional series, as one would expect, but a separate, specialized vegetation type discontinuous with neighbouring and successional communities. The vegetation of these areas is described and its biological significance discussed briefly.

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REFERENCES

Agnew, A.D.Q. 1961. The ecology of Juncus effusus L. in North Wales. J. Ecol. 49:83-102
Fisher, R.A. & Yates F. 1953, Statistical tables for biological, agricultural and medical research Oliver & Boyd, Edinburgh.
Heriz-Smith, S., 1962. The wild flowers of the Nairobi Royal National Park, Nairobi. D. A. Hawkins Ltd., Nairobi.

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