

THE MIST OASIS OF ERKWIT, SUDAN

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(With Plates 6 to 9 and one Figure in the Text)

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INTRODUCTION

Erkwit, a deserted summer resort, lies at about 45 km. (c. 28 miles) to the south-west of Suakin on the Red Sea, and about 30 km. (c. 20 miles) to the east of Sinkat on the railway line.

Topography and geology

The Erkwit plateau lies at the edge of a steep escarpment dropping abruptly (2000 ft., c. 600 m.) to the Red Sea plains. At the northern boundary are *Jebel Nakeet* (3921 ft., c. 1176 m.) and *Jebel Essit* (3810 ft., c. 1143 m.). The two jebels drop to *Khor Dahand* which separates the Erkwit oasis from the barren hills on the other side of the *Khor*. At the eastern boundary is *Jebel Sela* (4244 ft., c. 1273 m.) which is the highest evergreen mountain of the district. At the southern boundary are *Jebel Tatasi* (3967 ft., c. 1190 m.), *J. Lagagribab* (4030 ft., c. 1209 m.) and *Jebel Auliai* (3970 ft., c. 1191 m.) which are separated, by *Khor Amat*, from the barren mountains further south (*J. Erbab*, 5077 ft., c. 1523 m.). At the western boundary are *J. Hadast* (3826 ft., c. 1147 m.) and *J. Mashokriba* (3710 ft., c. 1113 m.) which drop to *Khor* that separates the Erkwit plateau from the desert plains to its east.

The plateau and the hills arising on its top are built of basement complex rocks: gneiss, basalt, granites, shales, marble, etc. Several khors (ephemeral water-ways) dissect the plateau. The khors usually contain alluvial deposits of different depth into which holes are dug to provide fresh water supplies. Permanently running water is found in *Khor Harasab* and *Khor Amat*. Calcareous deposits are found on the bot-

tom of khors at several sites. These tufaceous organic deposits are relicts of Quaternary formations that lie directly on the basement complex rocks (see Phot. 1).

Table 1. *Monthly rainfall records of Erkwit (Lat. 18° 46', Long. 37° 06', Alt. 3600 ft. O.D.) and mean monthly rainfall records of Suakin (Lat. 19° 07', Long. 37° 20', Alt. 15 ft. O.D.) and Sinkat (Lat. 18° 50', Long. 36° 50', Alt. 2800 ft. O.D.)*

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total | |
|--------------------|----------------------------|------|------|------|------|------|----------------|------|------|------|------|------|-------|--|
| 1905 | . | . | . | . | . | . | . | . | . | . | 227 | 132 | | |
| 1906 | 155 | 12 | 0 | 0 | 0 | 1 | 23 | 15 | 4 | 0 | . | . | | |
| 1907 | . | . | . | . | . | . | . | . | . | . | . | . | | |
| 1908 | . | . | . | tr. | 8 | 0 | 14 | 0 | tr. | 5 | 116 | 46 | | |
| 1909 | 102 | 49 | 25 | 10 | 9 | 6 | 10 | 18 | 2 | 0 | 66 | 0 | | |
| 1910 | 27 | . | . | . | (6) | 3 | 6 | 47 | 8 | . | . | . | | |
| 1911 | . | . | . | . | (0) | tr. | 74 | 0 | 0 | (11) | . | . | | |
| 1912 | . | . | . | . | (0) | 6 | 7 | 26 | 0 | (25) | . | . | | |
| 1913 | . | . | . | . | (13) | 0 | 2 | 10 | 0 | . | . | . | | |
| 1914 | . | . | . | . | . | 0 | 73 | . | . | . | . | . | | |
| 1915 | . | . | . | . | . | . | . | . | . | . | . | . | | |
| 1916 | . | . | . | . | . | . | 49 | 24 | 0 | . | . | . | | |
| 1917 | . | . | . | . | . | . | 0 | 0 | 7 | . | . | . | | |
| 1918 | . | . | . | . | . | tr. | 22 | 42 | 0 | 9 | . | . | | |
| 1919 | . | . | . | . | . | 0 | 35 | tr. | 0 | . | . | . | | |
| 1920 | . | . | . | . | . | 0 | 45 | 97 | 0 | . | . | . | | |
| 1921 | . | . | . | . | (41) | tr. | 18 | 96 | 0 | 71 | . | . | | |
| 1922 | . | . | . | . | . | tr. | 18 | 46 | 17 | 6 | . | . | | |
| 1923 | . | . | . | . | . | 12 | 94 | 108 | 16 | . | . | . | | |
| 1924 | . | . | . | . | . | tr. | 23 | 12 | 74 | . | . | . | | |
| 1925 | . | . | . | . | . | 3 | 1 | 8 | tr. | . | . | . | | |
| 1942 | Meteorology station opened | | | | | | | | | | | | | |
| 1943 | 85 | 72 | tr. | 6 | 6 | 0 | 40 | 0 | 0 | 61 | 17 | 1 | | |
| 1944 | 249 | 9 | 19 | 0 | 81 | 0 | 36 | 7 | 0 | 8 | 47 | 9 | 264 | |
| 1945 | 18 | 17 | 11 | tr. | 3 | 0 | 2 | 95 | 0 | 8 | 40 | 56 | 465 | |
| 1946 | 43 | 22 | 5 | 3 | 0 | 0 | 14 | 8 | 0 | 2 | 16 | 41 | 250 | |
| 1947 | 32 | 4 | 0 | 0 | 0 | 0 | 16 | tr. | 20 | 0 | 15 | . | 154 | |
| 1948 | 6 | 0 | 2 | 0 | 0 | 8 | 8 | 3 | 5 | . | . | 20 | | |
| 1949 | 6 | 0 | 0 | tr. | tr. | 2 | 0 | 5 | 10 | 0 | 32 | 80 | 135 | |
| 1950 | 25 | 20 | 37 | 74 | 2 | 45 | 23 | 418 | 0 | 0 | 0 | 35 | 679 | |
| 1951 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 25 | 0 | 40 | |
| 1952 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 10 | 15 | 20 | 90 | |
| 1953 | 5 | 10 | 0 | 5 | 5 | 0 | Station closed | | | | | | | |
| Erkwit (1942-53) | 44 | 14 | 7 | 8 | 9 | 5 | 14 | 52 | 3 | 11 | 23 | 28 | 218 | |
| Suakin (1890-1937) | 17 | 7 | 1 | 1 | 2 | 0 | 8 | 7 | 0 | 25 | 70 | 43 | 181 | |
| Sinkat (1919-37) | 0 | 0 | 0 | 2 | 10 | 10 | 19 | 58 | 19 | 7 | 2 | 0 | 127 | |

Rainfall

Table 1 gives the available rainfall records as contained in various reports (Lyons, 1907, 1909a, 1909b; Craig, 1910; Hurst, 1943) together with data for the period 1942-1953 provided by the Sudan Government Meteorological Department. Rainfall records show considerable variation from year to year. The annual rainfall varies from 40 mm. in 1951 to over 600 mm. in 1950 (an exceptionally wet year). The January rainfall varies from 5 mm. in 1951 to 249 mm. in 1944. The August rainfall varies from nil in 1908, 1911, 1917, 1943, etc. to about 100 mm. in 1920, 1921, 1923 and 1946. The August rainfall of 418 mm. recorded in 1950 is exceptional. Com-

parable variations may be noticed in other months. The great variability of the rainfall is perhaps a consistent feature of arid climate.

Erkwit receives a rainfall (218 mm.) greater than that of the neighbouring areas represented by the two towns: Suakin (181 mm.) to the north-east and Sinkat (127 mm.) to the west. Suakin, a Red Sea port, represents the coastal climate with winter rainfall. Sinkat, which lies on the inland plain, represents areas with summer rainfall. Erkwit lies in between (see Fig. 1) and receives both the summer and winter rainfalls.

As Tothill (1948, p. 55, footnote) suggests, '... the climate of Erkwit may be due to the happy combination of three things: latitude, situation and elevation'. Its latitude ($18^{\circ} 46' N.$) is close to latitude 19° which divides the Sudan into a desert region to the north and a tropical continental region to the south (Ireland, 1948). In the north prevail the dry northerlies and in the south the moist southerlies which cause the summer rainfall. Erkwit enjoys the maritime modification of the Red Sea: as the continental northerlies pass over the warm water of the sea they absorb a considerable amount of moisture. Being situated on a westerly bend of the Red Sea, Erkwit is exposed to about 650 km. (c. 400 miles) of open sea in the direction facing the northerlies (N.E. Trades). The moisture-laden wind meets no dissipating obstacle before impinging on the cool hills of Erkwit (3000-4000 ft. O.D.) and orographic rain consequently occurs. After passing over the Erkwit plateau the northerlies resume their dry continental characteristics.

During the winter months, the Erkwit plateau is frequently swathed in clouds for weeks. This entails considerable dew precipitation which is more marked the higher the elevation, and which supplies the vegetation with a valuable water resource.

Climatic history

The climate of Sudan was subject to secular changes during the Pleistocene. Such climatic events must have been more pronounced in the Erkwit district at large by reason of its situation.

The presence of tufa deposits on the bottom of khors at several sites indicates a period of heavier rains. Evidence for a sequence of pluvial periods alternating with periods of drought are presented by J. D. Tothill, G. Andrew and A. J. Arkell in their notes included in the *Report of the Soil Conservation Committee*, Sudan Government, 1944. As evidence to the latest major wet period at Erkwit we may quote the *Report*, p. 7. A residual dark clay deposit 20 ft. thick in Khor Harasab contains marine cowrie shells used as ornaments, a Neolithic type of pottery and obsidian flakes and large numbers of semi-fossil shells. The shells have been collected and studied by Tothill who says: 'Three species of pond snails that live upon aquatic plants are common: *Bullinus truncatus*, *Planorbis* and *Limnaea*, and there are a fair number of specimens of *Melanoides tuberculatus* that live only in permanent fresh water. There are land snails of a Mediterranean genus *Xerophylla*, and of a species now abundant at 6000-7000 ft. in Abyssinia: *Cerastus abyssinica*. The pond snails, land snails and *Cerastus* are now no longer common in the area. Their former presence in abundance shows that the environment was wet enough to support a forest cover with water meadows and ponds for the building by deposition, in quiet water, of clays during the Neolithic stage.'

Human interference has had, in recent times, a noticeable effect on the vegetation. B. Kennedy-Cooke states (*Soil Conservation Committee's Report*, p. 51): 'I can

testify from a close acquaintance extending over sixteen years, in which there has been no noticeable change in climate, that grasses and small plants have steadily diminished. While grass and most of the original herbs have decreased, there has been a considerable increase in aromatic and goat resistant families, such as *Labiatae*. Similar remarks are made by several men who have many years of experience with Erkwit.

General remarks

In this paper will be given a description of the vegetation of the Erkwit district: 48 sq. km. (c. 20 sq. miles). The writer paid two visits to Erkwit, December 1953 and April 1954. Herbarium samples of species recorded are deposited in the herbaria of the University College, Khartoum, Sudan, and the University of Cairo, Egypt. Prof. (Mrs.) V. Tackholm, D.Sc., checked the identification of all the species. This entailed the painstaking labour of comparing materials with those in the herbarium of Conservatoire et Jardin Botanique de Genève. To her the writer extends the warmest thanks for her unfailing help. Thanks are also due to Dr. K. N. G. MacLeay for identifying the ferns and to Prof. H. Sandon for revising the manuscript.

The following account will be more intelligible if we state here that, within the area of Erkwit, the nearer to the north-eastern boundary the wetter will be the habitat. The south and south-western boundaries merge into the inland arid plateau. Again, the higher the level, the more moist it will be. In consequence there is a marked zonation in the plant cover parallel to the north-eastern boundary-line, with local differences due to elevation.

Andrews (1948) suggests a tri-zonal pattern of the Erkwit vegetation: namely, an arid zone, a transitional zone and a moist zone, without attempting a detailed survey of the features of these zones. We shall here consider a systematic study of the area, and point out the features peculiar to each of five vegetational zones.

VEGETATION

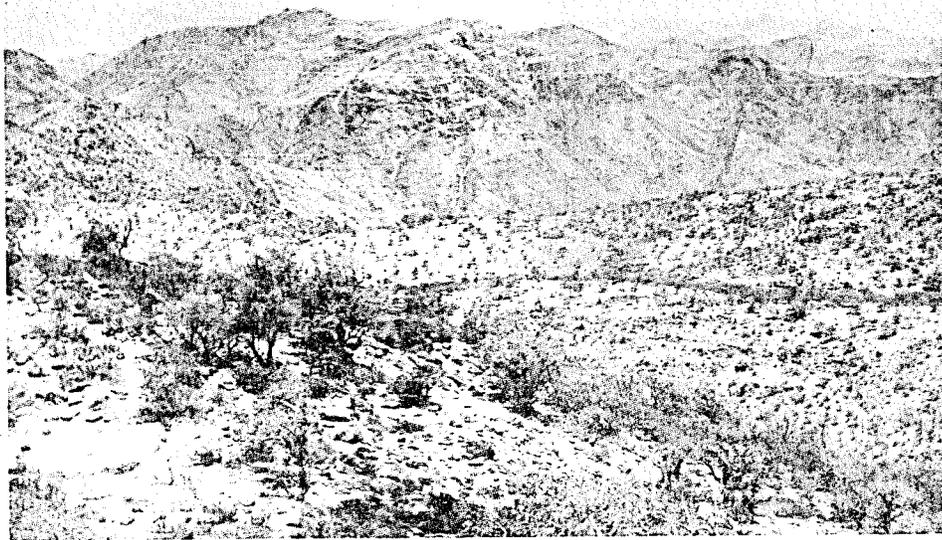
Zone I (Maytenus senegalensis)

Table 2 gives the floristic composition of ten stands representing the moist zone of Erkwit. This zone extends parallel to, and bounded by, the north-east border of the escarpment. By virtue of its position this zone faces directly the water-laden winds and sea mists as they roll inshore. The ten stands are actually ten hills (jebels): stand 1 is the top of J. Yamergermai at the north-western edge and hence less moist, stands 9 and 10 are J. Sela and J. Yoar and north-eastern boundary and hence wettest. The other stands lie in between these two extremities and include J. Essit (stand 4) and J. Manaweb (stand 6). See Photos. 2 and 3.

The vegetation is multilayered. A tree layer represented by *Diospyros mespiliiformis* is distantly open. This tree is found everywhere (within the zone) and is particularly abundant on J. Manaweb (stand 6). A shrub layer is well developed though its cover ranges from 30-40 per cent in stand 1 to 60-70 per cent in stands 9 and 10. *Maytenus senegalensis* is the dominant shrub. Associate shrubs that are characteristic of the zone are: *Euclea schimperi*, *Dodonaea viscosa*, *Rhus abyssinica*, *R. flexicaulis*, *Carissa edulis*, *Phoenix* sp. and *Ximenia americana*. *Acacia etbaica* is a common plant all over Erkwit and though present in 70 per cent of the stands of Zone I, it is not a noticeable member of the community. In other zones it is of greater significance.



Phot. 1. A general view of Essaraf which is a part of Khor Harasab showing the running water. In the middle may be seen relicts of tufa deposits on the basement complex rocks.



Phot. 2. From J. Nakeet looking west across Khor Dahiand. Note the contrast between the *Maytenus senegalensis*-covered jebels in the foreground and the barren jebels to the west of the Erkwit oasis.



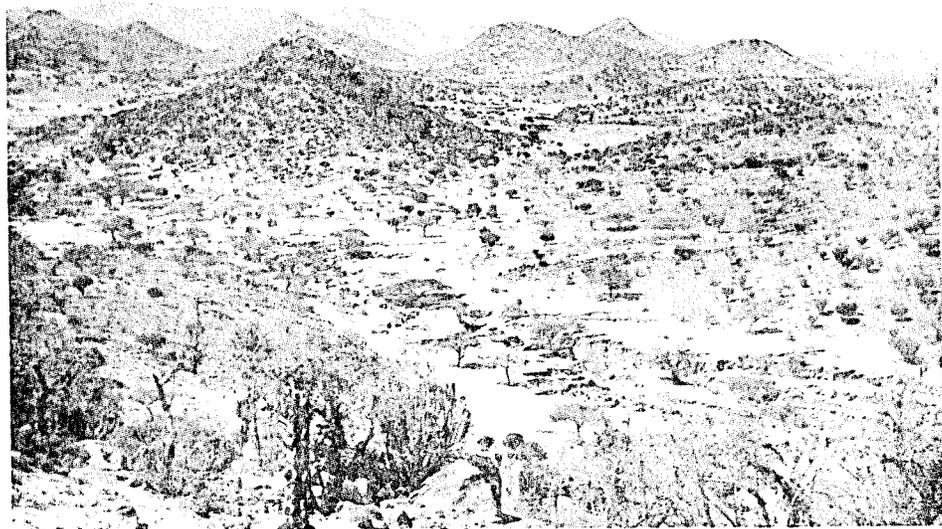
Phot. 3. A part of J. Manaweb showing the vegetation of Zone I dominated by *Maytenus senegalensis*.



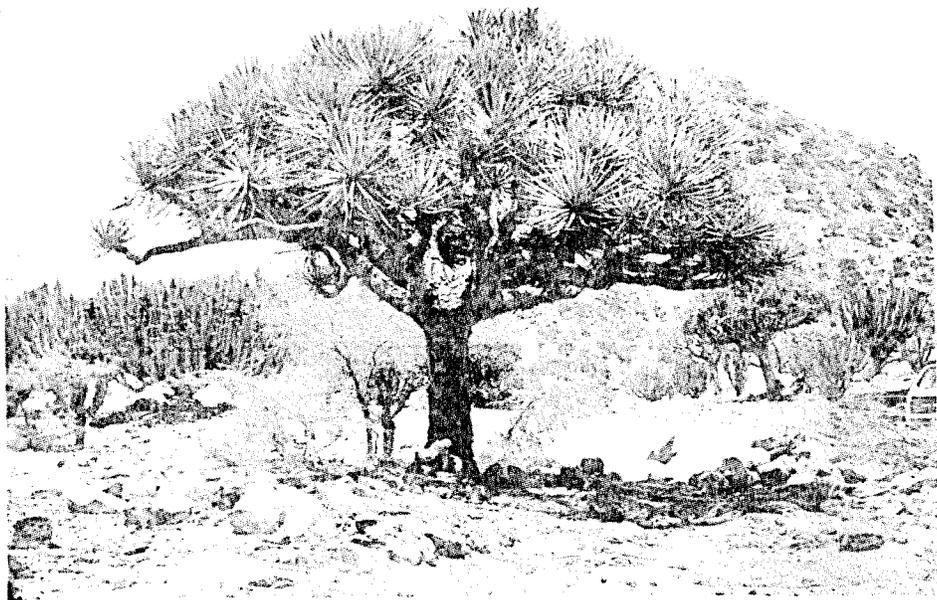
Phot. 4. From a stand in Zone II looking north-east towards Zone I. Note in the foreground the *Maytenus-Euphorbia* vegetation. In the background is shown part of Zone I.



Phot. 5. A stand in Zone III showing the vegetation dominated by *Euphorbia abyssinica*.



Phot. 6. From Zone II looking south-west towards Zone III. Note the water-way cutting down through the alluvial deposits. In the middle is one of the jebels of Zone III. In the far background are barren jebels to the south of Erkwit.



Phot. 7. In the foreground is a *Dracaena ombet* with *Acacia tortilis* and *Euphorbia abyssinica*. In the background is J. Auliai with vegetation dominated by *Dracaena*.



Phot. 8. A general view of a khor in Zone III. Note *Euphorbia abyssinica* in the foreground and *Acacia raddiana* in the khor (mid ground). The jebel in the background is at the southern boundary of Zone III; compare its cover with the jebel at the northern boundary of Zone III in the middle of Phot 6.

Table 2. Floristic composition of 10 stands representing the *Maytenus senegalensis* zone (Zone I)

| | Stands | | | | | | | | | | Pr. % |
|--------------------------------------|--------|----|------|------|------|----|----|----|------|----|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| <i>Trees and shrubs</i> | | | | | | | | | | | |
| <i>Maytenus senegalensis</i> | d. | d. | d. | d. | d. | d. | d. | d. | d. | d. | 100 |
| <i>Euclea schimperi</i> | c. | a. | a. | a. | a. | c. | c. | a. | a. | c. | 100 |
| <i>Dodonaea viscosa</i> | . | c. | c. | a. | c. | c. | c. | a. | a. | c. | 90 |
| <i>Diospyros mespiliiformis</i> | . | o. | o. | c. | c. | a. | o. | o. | c. | r. | 90 |
| <i>Rhus sbyssinica</i> | . | . | c. | r. | o. | o. | o. | o. | c. | c. | 80 |
| <i>R. flexicaulis</i> | o. | . | o. | o. | c. | o. | o. | o. | o. | . | 70 |
| <i>Carissa edulis</i> | . | . | o. | o. | r. | o. | o. | o. | o. | . | 70 |
| <i>Phoenix sp.</i> | . | o. | r. | o. | r. | o. | . | r. | l.a. | . | 70 |
| <i>Acacia etbaica</i> | o. | o. | r. | o. | r. | . | . | r. | r. | . | 60 |
| <i>Ximania americana</i> | . | r. | o. | o. | r. | . | o. | . | r. | . | 50 |
| <i>Olea chrysophylla</i> | r. | . | . | r. | . | . | . | r. | o. | r. | 40 |
| <i>Lannea schimperi</i> | . | o. | . | r. | . | . | r. | . | o. | . | 10 |
| <i>Balanites aegyptiaca</i> | . | . | . | . | . | r. | . | . | . | . | 20 |
| <i>Heeria insignis</i> | . | . | . | r. | . | . | . | . | r. | . | 20 |
| <i>Euphorbia abyssinica</i> | o. | r. | . | . | . | . | . | . | . | . | 10 |
| <i>Ficus glumosa var. glaberrima</i> | . | . | . | r. | . | . | . | . | . | . | 10 |
| <i>Maerua sp.</i> | r. | . | . | . | . | . | . | . | . | . | |
| <i>Undershrubs and herbs</i> | | | | | | | | | | | |
| <i>Coleus barbatus</i> | o. | c. | c. | c. | a. | a. | a. | a. | a. | a. | 100 |
| <i>Nepeta biloba</i> | c. | o. | c. | c. | o. | c. | o. | c. | c. | c. | 100 |
| <i>Kalanchoe glaucescens</i> | o. | c. | c. | c. | c. | a. | c. | o. | a. | o. | 100 |
| <i>Cissus cyphopetala</i> | . | . | c. | c. | r. | . | o. | o. | o. | c. | 70 |
| <i>Lavandula cornopifolia</i> | c. | . | o. | o. | . | . | o. | r. | c. | . | 60 |
| <i>Umbilicus botryoides</i> | o. | . | o. | c. | o. | . | c. | . | c. | . | 60 |
| <i>Echinops macrochaetus</i> | o. | o. | r. | r. | o. | r. | . | . | o. | . | 60 |
| <i>Geranium trilophum</i> | . | . | l.a. | o. | o. | . | . | r. | r. | r. | 60 |
| <i>Osteospermum vaillantii</i> | . | o. | o. | r. | . | . | r. | . | o. | . | 50 |
| <i>Leucas nubica</i> | . | o. | o. | o. | r. | o. | o. | . | r. | . | 50 |
| <i>Grewia ferruginea</i> | . | . | r. | o. | o. | o. | . | r. | r. | . | 50 |
| <i>Cenchrus pennisetiformis</i> | o. | . | r. | . | r. | . | . | r. | r. | . | 50 |
| <i>Pimpinella etbaica</i> | . | . | l.a. | o. | r. | . | . | r. | r. | . | 50 |
| <i>Micromeria biflora</i> | o. | . | o. | r. | . | . | . | r. | r. | . | 40 |
| <i>Anagallis arvensis</i> | . | o. | . | o. | r. | . | . | o. | o. | o. | 40 |
| <i>Teucrium nummularifolium</i> | . | . | . | o. | . | . | . | r. | o. | o. | 40 |
| <i>Oxalis anthelmintica</i> | . | . | . | o. | l.a. | . | . | . | o. | o. | 40 |
| <i>Urginea micrantha</i> | o. | . | r. | o. | . | . | . | r. | . | o. | 40 |
| <i>Haemanthus multiflorus</i> | . | . | . | r. | o. | . | o. | . | . | o. | 40 |
| <i>Asparagus racemosus</i> | . | . | . | r. | r. | . | r. | . | o. | . | 40 |
| <i>Elionurus royleanus</i> | l.a. | o. | . | . | . | o. | . | . | r. | r. | 30 |
| <i>Micromeria abyssinica</i> | . | . | o. | r. | . | . | . | . | r. | r. | 30 |
| <i>Cissus adenantha</i> | . | . | o. | . | . | . | r. | . | . | . | 30 |
| <i>Solanum incanum</i> | . | . | . | r. | . | . | o. | . | r. | . | 30 |
| <i>Momordica pterocarpa</i> | . | . | . | c. | r. | . | . | . | r. | . | 30 |
| <i>Cassia italica</i> | r. | . | . | . | r. | . | . | . | r. | . | 30 |
| <i>Withania somnifera</i> | . | . | . | r. | r. | . | . | . | . | r. | 30 |
| <i>Aerva javanica</i> | r. | r. | . | . | . | . | . | . | . | . | 30 |
| <i>Gallium sp. (near G. aparine)</i> | . | . | . | l.a. | . | r. | . | . | r. | . | 30 |
| <i>Romulea bulbocodium</i> | . | . | . | o. | c. | r. | . | . | . | . | 30 |
| <i>Scrophularia arguta</i> | . | . | r. | r. | . | . | . | . | r. | . | 30 |
| <i>Bonatea sudanensis</i> | . | . | . | o. | r. | . | . | . | r. | . | 20 |
| <i>Otostegia tomentosa</i> | r. | . | . | . | . | . | . | . | r. | . | 10 |
| <i>O. repanda</i> | . | . | . | r. | . | . | . | . | . | . | 20 |
| <i>Solanum nigrum</i> | . | . | r. | . | . | . | r. | . | . | . | 20 |
| <i>Linaria sagittata</i> | . | o. | . | . | . | . | . | . | o. | . | 20 |
| <i>Indigofera spinosa</i> | r. | . | . | . | . | . | . | r. | . | . | 20 |
| <i>Argemone mexicana</i> | . | . | r. | . | . | . | . | . | r. | . | 20 |
| <i>Erigeron crispus</i> | . | . | . | r. | . | . | . | . | r. | . | 20 |
| <i>Allium spathaceum</i> | . | . | . | r. | . | . | . | . | r. | . | 10 |
| <i>Commelina kotchyi</i> | . | . | . | . | . | r. | . | . | . | . | 20 |
| <i>C. forskalaci</i> | . | . | . | r. | . | . | . | . | r. | . | 20 |
| <i>C. krebsiana</i> | . | . | . | r. | . | . | . | . | . | . | 10 |
| <i>Cyperus bulbosus</i> | . | . | . | l.a. | . | . | . | . | . | . | 10 |
| <i>Kyllinga pumila</i> | . | . | . | l.a. | . | . | . | . | . | . | 10 |

| | Stands | | | | | | | | | | Pr. % | |
|--------------------------------------|--------|----|----|----|----|----|----|------|------|----|-------|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| <i>Undershrubs and herbs (cont.)</i> | | | | | | | | | | | | |
| <i>Oxygonum artiplicifolium</i> | . | . | . | . | r. | . | . | . | . | . | . | 10 |
| <i>Evolvulus</i> sp. | . | . | . | . | . | r. | . | . | . | . | . | 10 |
| <i>Conyza stricta</i> | . | . | . | . | . | . | r. | . | . | . | . | 10 |
| <i>Ferns</i> | | | | | | | | | | | | |
| <i>Actiniopteris radiata</i> | . | . | o. | o. | o. | c. | c. | . | c. | r. | . | 70 |
| <i>Cheilanthes farinosa</i> | . | . | . | o. | . | c. | c. | o. | c. | o. | . | 60 |
| <i>Onychium melanolepis</i> | . | . | . | r. | o. | c. | . | . | o. | . | . | 40 |
| <i>Mosses</i> | a. | a. | a. | a. | a. | a. | a. | a. | a. | a. | a. | 100 |
| <i>Liverworts</i> | . | . | . | o. | . | . | . | l.a. | l.a. | . | . | 30 |

Olea chrysophylla (*O. curupea* var. *nubica*) is found in 50 per cent of the stands. This is the highest presence-estimate of this species; in other zones it is found rarely. In Zone I there are a few trees of good size. According to local inhabitants this olive tree never produces fruit. It is particularly subject to cutting for stick-making and it is suspected to have been at one time more abundant on the Erkwit hills as it is still on the Tokar hills (*Soil Conservation Committee's Report*, 1944, p. 55).

Euphorbia abyssinica is a rarity within the moist Zone I. At the fringes of the zone, where it may be found, it grows into a pole-like growth-form with a long slender stem bearing a few branches at its top. This is apparently due to its being overcrowded by *Maytenus senegalensis* and its associates. In other zones, where *Euphorbia abyssinica* gains ascendancy, it grows into a much branched bush.

Among the undergrowth *Coleus barbatus* is the most preponderant; in certain localities it produces a dense growth. *Kalanchoe glaucescens* is found everywhere. It may grow gregariously in small colonies of 20-30 individuals but usually it grows as isolated individuals. It is found all over Erkwit but attains its greatest abundance and best growth of individuals in this zone. Among the characteristic species are: *Nepeta biloba*, *Cissus cyphopetala*, *Lavandula cornopifolia*, *Umbilicus botryoides*, *Echinops macrochaetus*, *Geranium trilophum* and the ferns *Actiniopteris radiata* and *Cheilanthes farinosa*. The following are species with presence-estimates lower than 60 per cent but which are elective to Zone I: *Grewia ferruginea*, *Momordica pterocarpa*, *Anagalis arvensis*, *Gallium* sp., *Cyperus bulbosus*, *Kyllinga pumila* and the fern *Onychium melanolepis*.

Mosses are found locally wherever small protected loci are provided. Liverworts are here recorded from the summits of J. Essit (stand 4), J. Sela-esserir (stand 8) and J. Sela (stand 9). Trunks and twigs of shrubs and trees are densely covered with lichen growth and so are surfaces of rock fragments and boulders.

Jebels Yamergermai (4020 ft.) and Sela (4244 ft.) deserve special notes. The western side of J. Yamergermai slopes down to Khor Arab which marks the western boundary of the Erkwit oasis. Its north and east sides are covered, from top down to about contour 3600, with vegetation represented by stand 1, Table 2. At lower levels and on the slopes facing south and west the plant cover indicates drier conditions, that is, less *Maytenus senegalensis* and abundant *Euphorbia abyssinica*.

J. Sela combines the virtues of being the highest mountain of the Erkwit oasis and being at the north-eastern edge of the escarpment. The vegetation, though containing all the elements of the zone, shows noticeable differences corresponding with the elevation. Nearest to the top there are: *Ximenia americana*, *Phoenix* sp.,

Table 3. Floristic composition of 10 stands representing the zone of *Maytenus senegalensis* - *Euphorbia abyssinica* (Zone II)

| | Stands | | | | | | | | | | Pr. % |
|---------------------------------|--------|-------|-------|-------|-------|-------|-------|----|-------|----|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| <i>Trees and shrubs</i> | | | | | | | | | | | |
| <i>Maytenus senegalensis</i> | d. | co-d. | co-d. | co-d. | co-d. | co-d. | co-d. | 8 | 9 | 10 | |
| <i>Euphorbia abyssinica</i> | a. | co-d. | co-d. | co-d. | co-d. | co-d. | co-d. | d. | co-d. | d. | |
| <i>Euclea schimperi</i> | c. | c. | c. | o. | o. | o. | c. | o. | o. | c. | |
| <i>Acacia etbaica</i> | o. | c. | c. | c. | c. | c. | c. | o. | c. | c. | |
| <i>A. tortilis</i> | . | . | r. | o. | . | r. | o. | . | . | o. | |
| <i>Dodonaea viscosa</i> | o. | r. | . | r. | r. | . | . | . | r. | r. | |
| <i>Carissa edulis</i> | . | r. | . | . | . | . | . | o. | o. | . | |
| <i>Rhus flexicaulis</i> | o. | . | o. | r. | . | r. | . | . | . | . | |
| <i>Diospyros mespiliformis</i> | o. | . | . | . | . | r. | r. | . | . | . | |
| <i>Balanites aegyptiaca</i> | r. | o. | . | . | . | . | . | . | . | r. | |
| <i>Lanena schimperi</i> | r. | . | . | . | . | . | r. | . | . | . | |
| <i>Ximenia americana</i> | . | . | . | . | r. | r. | . | . | . | . | |
| <i>Ziziphus spina-christi</i> | . | . | r. | . | . | . | . | . | r. | . | |
| <i>Rhus abyssinica</i> | . | . | . | r. | . | . | . | . | . | . | |
| <i>Phoenix sp.</i> | o. | . | . | . | . | . | . | . | . | . | |
| <i>Olea chrysophylla</i> | . | . | . | . | . | . | r. | . | . | . | |
| <i>Boscia angustifolia</i> | . | . | . | . | . | . | . | r. | . | . | |
| <i>Undershubs and herbs</i> | | | | | | | | | | | |
| <i>Lavandula cornopifolia</i> | o. | c. | c. | o. | c. | c. | c. | r. | r. | o. | |
| <i>Kalanchoe glaucescens</i> | c. | c. | c. | o. | o. | o. | c. | o. | o. | c. | |
| <i>Oxalis anthelmintica</i> | o. | c. | r. | o. | o. | c. | . | c. | c. | c. | |
| <i>Echinops macrochaetus</i> | o. | c. | o. | o. | o. | o. | . | r. | . | r. | |
| <i>Coleus barbatus</i> | c. | c. | o. | r. | r. | . | r. | . | r. | . | |
| <i>Cissus cyphopetala</i> | o. | o. | . | r. | r. | . | r. | o. | . | r. | |
| <i>Linaria sagittata</i> | o. | . | o. | r. | o. | . | o. | o. | r. | . | |
| <i>Indigofera spinosa</i> | . | . | o. | c. | c. | c. | . | c. | o. | r. | |
| <i>Urginea micrantha</i> | c. | c. | o. | r. | . | r. | . | r. | c. | . | |
| <i>Haemanthus multiflorus</i> | r. | r. | l.a. | . | o. | c. | . | . | r. | r. | |
| <i>Elionurus royleanus</i> | o. | c. | c. | . | o. | c. | c. | . | c. | . | |
| <i>Micromeria abyssinica</i> | . | o. | o. | r. | . | r. | . | o. | c. | . | |
| <i>Cenchrus pennisetiformis</i> | r. | r. | o. | c. | o. | c. | r. | . | . | . | |
| <i>Romulea bulbocodium</i> | . | . | c. | o. | o. | c. | r. | . | . | . | |
| <i>Nepeta biloba</i> | o. | r. | . | . | . | r. | r. | . | . | . | |
| <i>Pimpinella etbaica</i> | o. | o. | . | r. | . | o. | . | . | . | . | |
| <i>Solanum incanum</i> | r. | . | r. | r. | . | . | . | o. | . | . | |
| <i>S. nigrum</i> | r. | o. | . | r. | . | . | . | . | . | . | |
| <i>S. sp.</i> | . | r. | r. | . | . | . | . | . | . | . | |
| <i>Micromeria biflora</i> | o. | r. | r. | . | . | . | . | . | r. | . | |
| <i>Cassia italica</i> | . | . | o. | . | c. | . | . | . | . | . | |
| <i>Withania somnifera</i> | . | . | o. | o. | . | . | r. | . | . | . | |
| <i>Osteospermum vaillantii</i> | o. | r. | c. | . | . | . | . | . | o. | . | |
| <i>Ceranium trilophum</i> | . | . | l.a. | . | . | . | c. | . | . | . | |
| <i>Erodium malacoides</i> | . | . | . | r. | r. | o. | . | . | . | . | |
| <i>Asparagus racemosus</i> | . | o. | . | r. | r. | r. | . | . | . | . | |
| <i>Bonatea sudanensis</i> | o. | . | r. | r. | . | . | . | . | . | . | |
| <i>Farsetia longisiliqua</i> | . | . | . | . | . | r. | . | . | . | . | |
| <i>Tribulus pentandrus</i> | . | . | . | o. | r. | . | r. | . | r. | r. | |
| <i>Lencus nubica</i> | . | . | r. | . | . | . | . | r. | . | . | |
| <i>Cissus adenantha</i> | . | . | . | . | . | . | . | r. | r. | . | |
| <i>Aerva javanica</i> | . | . | . | . | r. | r. | . | . | . | . | |
| <i>Clematis inciso-dentata</i> | . | . | . | o. | . | . | o. | . | . | . | |
| <i>Striga orobanchoides</i> | . | r. | . | . | . | . | . | r. | . | . | |
| <i>Lotus montana</i> | . | . | . | . | . | . | . | r. | r. | . | |
| <i>Justicia flava</i> | . | . | . | . | . | . | . | r. | . | . | |
| <i>Loranthus curviflorus</i> | . | . | . | . | . | . | . | r. | o. | . | |
| <i>Heliotropium pterocarpum</i> | . | . | . | r. | . | . | . | . | r. | . | |
| <i>Cometes abyssinica</i> | . | o. | r. | . | . | . | . | . | r. | r. | |
| <i>Pupalia lappacea</i> | . | . | . | . | . | . | . | . | . | . | |
| <i>Ruellia patula</i> | . | . | . | r. | r. | . | . | . | . | . | |
| <i>Commelina forskalaei</i> | r. | . | . | . | . | . | r. | . | r. | . | |
| <i>C. krebsiana</i> | . | . | . | . | . | . | r. | . | . | . | |
| <i>Otostegia tomentosa</i> | . | . | . | . | r. | . | . | r. | . | . | |

| | Stands | | | | | | | | | | Pr. % | |
|--------------------------------------|--------|------|------|------|------|------|------|------|------|------|-------|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| <i>Undershrubs and herbs (cont.)</i> | | | | | | | | | | | | |
| <i>Argemone mexicana</i> | . | . | . | r. | . | . | . | . | . | . | . | 10 |
| <i>Aerva lanata</i> | . | . | . | . | r. | . | . | . | . | . | . | 10 |
| <i>Erigeron crispus</i> | . | r. | . | . | . | . | . | . | . | . | . | 10 |
| <i>Arnebia hispidissima</i> | . | . | . | . | . | . | r. | . | . | . | . | 10 |
| <i>Verbascum ternacha</i> | . | . | . | . | l.a. | . | . | . | . | . | . | 10 |
| <i>Achyrocline glumacea</i> | . | . | . | r. | . | . | . | . | . | . | . | 10 |
| <i>Andropogon faveolat</i> | . | . | . | . | . | . | . | . | r. | . | . | 10 |
| <i>Aloe abyssinica</i> | . | . | . | . | . | . | . | . | . | r. | . | 10 |
| <i>Hibiscus micranthus</i> | . | . | . | . | o. | . | . | . | . | . | . | 10 |
| <i>Asparagus africanus</i> | . | . | . | . | . | . | . | . | . | r. | . | 10 |
| <i>Ferns</i> | | | | | | | | | | | | |
| <i>Cheilanthes farinosa</i> | o. | r. | r. | . | r. | . | . | . | . | . | . | 40 |
| <i>Mosses</i> | l.a. | l.a. | l.a. | l.a. | l.a. | l.a. | l.a. | l.a. | l.a. | l.a. | l.a. | 100 |

Rhus abyssinica, *Diospyros mespiliformis*, *Euclea schimperi*, *Lannea schimperi* and *Maytenus senegalensis* with no obvious dominant. The top 100 ft. (c. 30 m.) are characterized by the abundance of ferns, mosses and liverworts. The part which lies between 100 and 200 ft. (c. 30 and 60 m.) from the summit is dominated by *Dodonaea viscosa*. Between 200 and 400 ft. (c. 60 and 120 m.) from top, *Euclea schimperi* is mostly dominant though *Dodonaea viscosa* is locally dominant. On the rest of the sloping sides, *Maytenus senegalensis* is dominant as is characteristic of Zone I.

Zone II (*Maytenus senegalensis* – *Euphorbia abyssinica*)

This zone lies in between the previously described moist Zone I and the *Euphorbia*-dominated Zone III. It differs from the former zone by the abundance of *Euphorbia abyssinica* and from Zone III by the abundance of *Maytenus senegalensis*. As a transitional zone it combines certain floristic features that are peculiar to each of the two zones on its sides. See Phot. 4.

Table 3 gives the floristic composition of ten stands representing Zone II. *Euphorbia* and *Maytenus* are equally abundant. *Euclea schimperi* and *Dodonaea viscosa* are among the shrubs commonly found in Zone I and Zone II. Other species that are characteristic of Zone I and less important in Zone II include: *Rhus abyssinica*, *R. flexicaulis*, *Diospyros mespiliformis*, *Carissa edulis* and *Ximenia americana*. *Acacia etbaica* is here more abundant. *Acacia tortilis* which is rarely found in Zone I is found in 50 per cent of the stands representing Zone II.

Among the undershrubs and herbs, *Cissus cyphopetala* and *Kalanchoe glaucescens* are nearly equally common in the two zones. *Coleus barbatus*, *Nepeta biloba* and the fern *Cheilanthes farinosa* are appreciably less abundant in Zone II than in Zone I. *Lavandula cornopifolia*, *Indigofera spinosa*, *Echinops macrochaetus*, *Oxalis anthemintica*, *Urginea micrantha*, *Haemanthus multiflorus* and *Elionurus royleanus* are more preponderant in Zone II than in Zone I.

Mosses are found locally in small patches covering locally protected niches but liverworts are not recorded. Lichens are commonly found on trunks and twigs of trees and shrubs though their growth is less dense than in Zone I.

Zone III (*Euphorbia abyssinica*)

This zone occupies the middle part of the Erkwit oasis. The outstanding feature is

the dominance of *Euphorbia abyssinica*. The plant cover is thinner than in the previous zones, the shrub growth not exceeding 30 per cent and the herbaceous cover being equally thin. See Phot. 5.

Table 4 gives the floristic composition of ten stands representing this zone. *Maytenus senegalensis*, which is dominant in Zone I and co-dominant in Zone II, is here a plant of lesser importance. Its individuals are small and less healthy shrubs with pungent spines and reduced leaves. *Euclea schimperi* is equally reduced. Other species that are characteristic of Zone I and common in Zone II and are here of minor status as members of the community, include: *Rhus* spp., *Dodonaea viscosa*, *Diospyros mespiliiformis*, *Carissa edulis* and *Ximenia americana*. *Phoenix* sp. is not recorded. *Acacia tortilis*, a species that is not recorded in Zone I and present in 50 per cent of the stands in Zone II, is here present in 80 per cent of the stands. *Acacia etbaica* is found everywhere: 100 per cent presence. *Dracaena ombet* shows its first appearance, a single tree recorded in stand 3 together with an individual of *Olea chrysophylla*.

Among the undergrowth *Coleus barbatus* is considerably reduced: 50 per cent presence in Zone III, 70 per cent in Zone II and 100 per cent in Zone I. *Lavandula cornopifolia*, *Micromeria abyssinica*, *Kalanchoe glaucescens*, *Echinops macrochaetus*, *Elionurus royleanus*, etc. are less common in Zone III than in Zone II. Several herbaceous species common in Zone I are not recorded in Zone III, e.g. *Nepeta biloba*, *Leucas nubica*, *Cissus* spp., *Momordica pterocarpa*, *Umbilicus botryoides*, *Haemanthus multiflorus*, *Urginea micrantha*, etc. Among the species found commonly in Zone III, rarely in Zone II and not recorded in Zone I, are *Cucumis prophetarum* (60 per cent), *Aloe abyssinica* (60 per cent), *Caralluma pincillata* (40 per cent), *Echidnopsis nubica* (30 per cent), *Capparis tomentosa* (40 per cent), etc.

Ferns that are characteristic of Zone I are not recorded in Zone III. Mosses are found locally in three stands. Liverworts are not recorded. The lichen growth is considerably thinner and mostly of the crustose type.

Jebel Nafeib (3787 ft., c. 1136 m.) deserves a special note. It lies on the boundary between Zones II and III and rises for about 200 ft. (c. 60 m.) above the level of the plateau. The east-facing slope of the jebel is covered by scrub dominated by *Euphorbia abyssinica* with abundant *Maytenus senegalensis*, *Diospyros mespiliiformis* and *Rhus abyssinica*. The west-facing slope is also dominated by *Euphorbia abyssinica* with rare individuals of the above-mentioned bushes. These were (April 1954) dry and depauperate as contrasted to those of the east-facing slope. Mosses are found locally on the east slope and very rare on the west slope.

Zone IV (*Dracaena ombet* - *Euphorbia abyssinica*)

This zone lies on the south-west boundary of the area and hence receives the sea mists and water-laden winds only after they have lost the greater part of their moisture. It is, however, less dry than the desert plateau that extends to the west of Erkwit. The zone includes a few high jebels: J. Lagaribab (4030 ft., c. 1209 m.), J. Tatasi (3967 ft., c. 1190 m.), J. Auliai (3970 ft., c. 1191 m.) and J. Dudia (3915 ft., c. 1174 m.). See Phot. 7.

The salient feature of the vegetation is the preponderance of *Dracaena ombet* associated with *Euphorbia abyssinica*. *Acacia etbaica* and *A. tortilis* are common shrubs. *Lycium arabicum*, which is not recorded in the previous zones, is here a

The characteristic species (sp. with Pr. = or >60 per cent) are: *Indigofera spinosa*, *Blepharis edulis*, *Euphorbia thi*, *Aloe abyssinica*, *Salsola baryosma*, *Fagonia myriacantha*, *Ostegia repanda*, *Seddera virgata*, *Caralluma pencillata*, *Solanum incanum*, *Capitania otostegoides* and *Euphorbia nubica*. Six of these species are not recorded in the previously described zones. There are about fourteen other species, included in the list of Table 5, that are peculiar to Zone IV as compared to Zones I, II and III. Noticeable among these are the several species of *Euphorbia*. Mosses and lichens are extremely scarce.

Zone V (*Euphorbia thi*)

To the west of Zone IV and separating it from the desert plain that extends west of Erkwit, is a fringing zone where *Euphorbia thi* is most common. The zone lies 'outside' the Erkwit oasis as it is cut off from the maritime effect by the Erkwit jebels. It is an erosion pavement of the *hamada* type. The ground is undulated into lowly hillocks covered with rock fragments and boulders. The plant cover of these hillocks represents Zone V.

Table 6 shows the floristic composition of four stands in Zone V. The plant cover is very sparse (5-10 per cent). *Euphorbia thi* is the most common species. Among the characteristic species are *Euphorbia cuneata*, *Lycium arabica*, *Acacia etbaica*, *Barleria acanthoides*, *Seddera virgata*, *Salsola baryosma*, *Indigofera spinosa* and *Fagonia myriacantha*.

Table 6. Floristic composition of four stands representing the zone of *Euphorbia thi* (Zone V)

| | Stands | | | | Pr. % |
|-------------------------------|--------|----|----|----|-------|
| | 1 | 2 | 3 | 4 | |
| <i>Euphorbia thi</i> | d. | d. | d. | d. | 100 |
| <i>E. cuneata</i> | c. | c. | c. | c. | 100 |
| <i>Acacia etbaica</i> | r. | r. | r. | r. | 100 |
| <i>Barleria acanthoides</i> | o. | c. | o. | o. | 100 |
| <i>Salsola baryosma</i> | o. | o. | o. | o. | 100 |
| <i>Lycium arabica</i> | . | o. | r. | o. | 75 |
| <i>Seddera virgata</i> | o. | . | r. | r. | 75 |
| <i>Indigofera spinosa</i> | o. | r. | . | o. | 75 |
| <i>Fagonia myriacantha</i> | o. | o. | . | o. | 75 |
| <i>Euphorbia abyssinica</i> | . | . | o. | r. | 50 |
| <i>Blepharis edulis</i> | . | o. | r. | . | 50 |
| <i>Capitania otostegoides</i> | o. | r. | . | . | 50 |
| <i>Caralluma pencillata</i> | r. | o. | . | . | 50 |
| <i>E. nubica</i> | . | o. | . | . | 25 |
| <i>Acacia tortilis</i> | . | . | r. | . | 25 |
| <i>Aloe abyssinica</i> | r. | . | . | . | 25 |
| <i>Kalanchoe glaucescens</i> | r. | . | . | . | 25 |
| <i>Panicum turgidum</i> | . | r. | . | . | 25 |
| <i>Calotropis procera</i> | . | . | . | r. | 25 |
| <i>Aerva lanata</i> | . | . | r. | . | 25 |

Khors

A khor is a dried stream which contains the run-off water. The khor vegetation varies from one zone to the other and in accordance with the size of the catchment area, the depth and texture of the bottom deposits, etc. Within Zone I, khors are not well marked except as valleys between jebels. The vegetation is similar to that of the zone. See Photos. 6 and 8.

In Zones II and III there is nearly always a line of spaced trees lining the sides of the khors. *Acacia raddiana* and *Balanites aegyptiaca* are very common. A few huge trees of *Acacia albida*, *Ficus sycomorus* and *Ficus* sp. are found locally. *Euphorbia abyssinica* and *Maytenus senegalensis* are occasionally found. *Withania somnifera* and *Argemone mexicana* are the most common undergrowth plants. Among the plants that are occasionally found are: *Lachnophyllis oppositifolius*, *Boscia angustifolia*, *Datura metel*, *D. stramonium*, *Calotropis procera*, *Panicum turgidum*, *Cyperus rotundus*, *Launaea* sp., *Boerhavia elegans*, *Commicarpus africanus*, etc.

In khors of Zone IV, *Acacia tortilis* is very common associated with species peculiar to the zone. In Zone V, *Euphorbia abyssinica* is very common in khors.

DISCUSSION AND COMMENTS

We have seen that the plant cover within the area of Erkwit shows discernible zonation. Table 7, which presents an abstract of data previously discussed, shows some of the noticeable differences between the zones and also some of the interzonal similarities. As expected, certain species have a wide range of amplitude and hence may be found in several zones; others have a more circumscribed range and are limited in their distribution.

Acacia etbaica, *Euphorbia abyssinica*, *Kalanchoe glaucescens* and *Indigofera spinosa* are perhaps the species with the widest range of distribution. Their relative abun-

Table 7. Summary of data contained in Tables 2-6 showing presence estimates (per cent) of different species in the different zones

| | Zones | | | | |
|------------------------------|-------|-----|-----|-----|-----|
| | I | II | III | IV | V |
| <i>Trees and shrubs</i> | | | | | |
| Maytenus senegalensis | 100 | 100 | 60 | 10 | . |
| Euclea schimperi | 100 | 100 | 60 | . | . |
| Dodonaea viscosa | 90 | 60 | 20 | . | . |
| Diospyros mespiliformis | 90 | 30 | 30 | . | . |
| Rhus abyssinica | 80 | 10 | 10 | . | . |
| R. flexicaulis | 80 | 40 | 30 | . | . |
| Carissa edulis | 70 | 40 | 30 | . | . |
| Phoenix sp. | 70 | 10 | . | . | . |
| Ximenia americana | 60 | 20 | 10 | . | . |
| Acacia etbaica | 70 | 100 | 100 | 80 | 100 |
| A. tortilis | . | 50 | 80 | 50 | 25 |
| Euphorbia abyssinica | 20 | 100 | 100 | 100 | 50 |
| Dracaena ombet | . | . | 10 | 100 | . |
| Lycium arabica | . | . | . | 60 | 75 |
| <i>Undershrubs and herbs</i> | | | | | |
| Coleus barbatus | 100 | 70 | 50 | . | . |
| Nepeta biloba | 100 | 40 | . | . | . |
| Lavandula cornopifolia | 60 | 100 | 60 | 40 | . |
| Kalanchoe glaucescens | 100 | 100 | 60 | 40 | 25 |
| Indigofera spinosa | 20 | 70 | 100 | 100 | 75 |
| Aloe abyssinica | . | 10 | 60 | 80 | 25 |
| Caralluma pencillata | . | . | 40 | 60 | 50 |
| Euphorbia thi | . | . | . | 100 | 100 |
| Blepharis edulis | . | . | . | 100 | 50 |
| Fagonia myriacantha | . | . | . | 70 | 75 |
| Salsola baryosma | . | . | . | 80 | 75 |
| Euphorbia cuneata | . | . | . | 50 | 100 |
| Seddera virgata | . | . | . | 70 | 75 |
| Barleria acanthoides | . | . | . | 20 | 75 |

dance and the growth of their individuals varied from one zone to the other. *Phoenix* sp. and *Nepeta biloba* are among the species limited to Zones I and II. Similarly, *Euphorbia thi*, *Salsola baryosma*, *Fagonia myriacantha* and several other species are limited to Zones IV and V.

Certain species with wide range of distribution show morphological variations indicative of habitat features. As an example we may mention *Maytenus senegalensis*. In Zone I individuals of this species are less thorny and their leaves are broader than those of Zones II and III. This shows that Zone I is less dry than the other three zones. *Diospyros mespiliformis* and *Carissa edulis* grow, in Zone I, into trees of considerable size but in other zones they are smaller and bushy in form.

The plant cover varies from 70 per cent in certain localities of Zone I to 5 per cent in Zone V. This indicates that the latter is a much drier zone. The distribution of ferns, mosses and liverworts and their limitation to Zones I and II add evidence of interzonal differences in water resources usually available to the roots. The limited distribution of lichen growth is also noticeable. The woody plants in Zone I are densely bearded with lichen growth, which is thinner in Zones II and III and negligible in Zones IV and V. This indicates that the atmospheric moisture is much greater in Zone I and that it gradually decreases towards Zones IV and V.

There are also noticeable differences between the vegetation of north and east slopes of jebels as compared to south and west slopes. This is especially noticed on jebels that lie at the boundaries between zones, and suggests that the seaward slopes receive greater amounts of moisture than leeward slopes. This shows, again, that the atmospheric humidity (mist and wind-borne water) may be an effective water resource.

Within the range of jebels that lie at the north-eastern edge of the escarpment (Zone I), the vegetation indicates wetter conditions at higher compared to lower levels. Had the rainfall been the only water resource, one would have expected the lower levels to be less dry as they receive run-off water. The actual pattern shows that the vegetation exploits the atmospheric moisture in forms apart from rain, e.g. dew, absorption through leaves, etc.

It is suggested that the conditions that made the limited area of Erkwit an oasis amidst arid country are: firstly, it combines the summer rainfall of the territory to its west and the winter rainfall of the Red Sea to its east; secondly, it receives sea-mists and wind-borne moisture which face no obstacle till they meet the edge of the Erkwit plateau. Within the area of Erkwit, local differences in water resources – due to physiographic factors and distance from the edge of the escarpment – cause the zonal pattern of the vegetation.

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