Bothalia 14, 3 & 4: 543–551

The phytogeography of Mount Kulal, Kenya, with special reference to Compositae, Leguminosae and Gramineae

F. N. HEPPER*

ABSTRACT

Mt Kulal, in the lowlying desert of NE Kenya, reaches an altitude of 2 295 m. A synopsis of the vegetation types occurring there is provided, with totals of the species recorded in each type. The three families are analysed phytogeographically and observations are made about their chorology. A conclusion is reached that Mt Kulal is a stepping stone for the distribution of montane plants between highland East Africa and Ethiopia and not an outlier of either bloc.

RÉSUMÉ

LA PHYTOGÉOGRAPHIE DU MONT KULAL, AU KENYA, EN SE RÉFÉRANT SPECIALEMENT AUX COMPOSEES AUX LÉGUMINEUSES ET AUX GRAMINÉES

Le Mont Kulal, dans le désert de basse altitude du nord-est du Kenya, atteint une altitude de 2 295 m. Un synopsis des types de végétation qui s'y rencontrent est établi, avec les inventaires complets des espèces relevées dans chaque type. Les trois familles sont analysées du point de vue phytogéographique et des observations sont faites sur leur chorologie. On arrive à la conclusion que le Mont Kulal est un relais dans la distribution des plantes montagnardes entre les hauts plateaux de l'africain et de l'Ethiopie et non un massif détaché de l'un ou l'autre bloc.

INTRODUCTION

The flora of the ancient basaltic outcrop known as Mount Kulal (c. 2°43'N, 36°55'E) in the Marsabit District of NE Kenya (Figs 1, 2 & 3) has been investigated in recent years to a degree considered sufficient for a preliminary phytogeographical analysis to be made. The basis for this study is a recently prepared annotated checklist (Hepper *et al.*, 1981). This list contains over 700 species of flowering plants and ferns. It is probably reasonably complete for the evergreen upland forest on its summit (Synnott, 1979), but the vast lower slopes are still imperfectly known; partly because of the ruggedness of the terrain which has hindered investigation of the vegetation, and partly owing to the rainfall being extremely erratic, causing the development of a highly adapted flora, with many species appearing or in a condition worth collecting for only a short time after rain when a collector may not be present.

However, a vegetation survey has been completed and a map of the mountain and surroundings in Marsabit District has been published (Herlocker, 1979) (Fig. 4). Therefore it is now possible to assign the plant species recorded on Mt Kulal to various vegetation types recognized by Herlocker (1979) as occurring there (Table 1). In spite of the comment made above about the lower slopes being imperfectly known, further collecting is unlikely to change the numerical superiority of the summit zones (Types 1–6 in Table 1), because they are very much moister than the middle and lower zones.

THE PHYTOGEOGRAPHICAL DIVISIONS OF AFRICA

Plant geographers now generally recognize the African divisions (regional phytochoria) published by White (1970), with the later boundary and nomenclatural modifications of Clayton & Hepper (1974), Wickens (1976) and Brenan (1978). These are shown in Fig. 5, whereas Table 2 provides a summary of the analysis of Compositae, Leguminosae and Gramineae. The groupings of the divisions have been made in order to combine those of lesser significance, while at the same time indicating aspects that are considered to be more important for this study. Thus the Afroriental Domain total is shown separate from the Sudano-Zambezian Region of which it is part. Endemics, however, are not

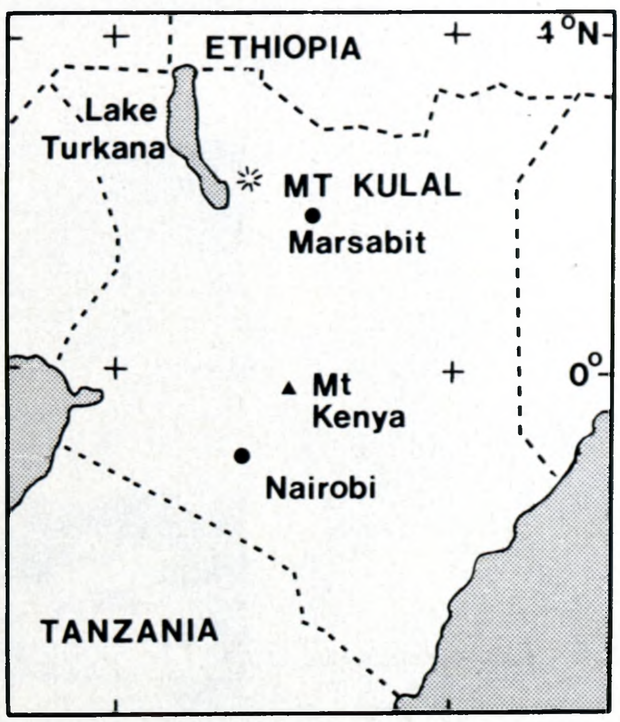

FIG. 1.—The location of Mt Kulal in East Africa.

* The Herbarium, Royal Botanic Gardens, Kew, Richmond TW9 3AE, Surrey, United Kingdom.

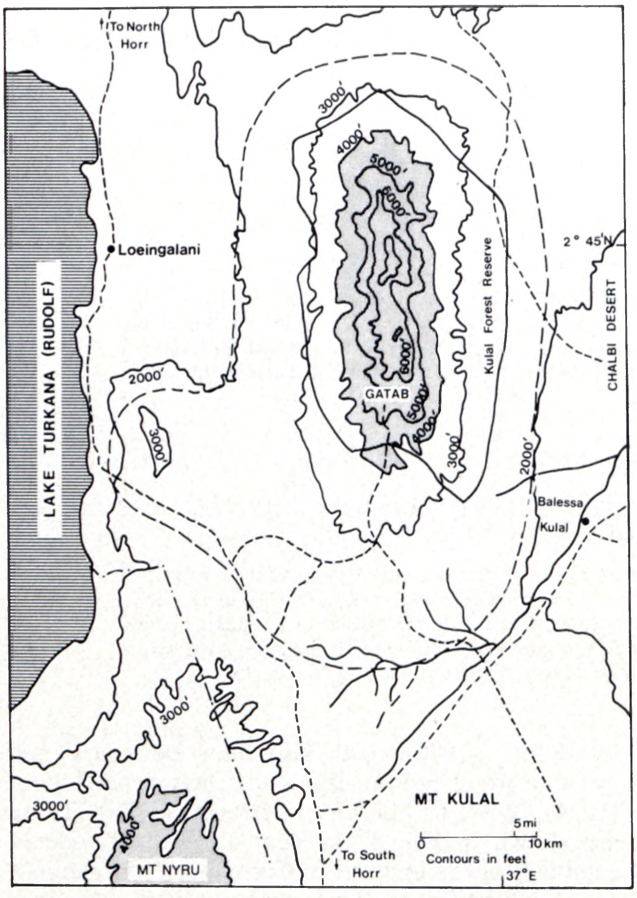

FIG. 2.—Contour map of Mt Kulal.

entered on the table, but they are mentioned in the following discussion. As might be expected from an isolated mountain situated in the driest desert area of eastern Africa, not one species is recorded for the Guineo-Congo element.

This analysis involves a total of 182 taxa i.e. species, subspecies and varieties, which is about 25% of the known Mt Kulal flora. There are 48 taxa belonging to the Compositae, 56 Leguminosae (in three subfamilies) and 78 Gramineae; these families have been selected for their large size and up-to-date taxonomy. However, in the discussion that follows examples are taken from other families when appropriate, because those three families have few woody species and they are poorly represented in the summit forest.

Saharo-Sindian Region

These are essentially desert or semi-desert plants having West-East distributions into the Sahara, e.g. *Oropetium minimum* extends from Chad to Somalia; *Tephrosia nubica* (Fig. 6) occurs from Niger to the Red Sea. Some reach as far east as India, e.g. *Eragrostiella bifaria, Eragrostis papposa, Indigofera coerulea* var. *occidentalis. Acacia senegal* (Fig. 7) has a wide distribution across Africa with a concentration in the Afroriental Domain.

Sudano-Zambezian Region

This encompasses the great arc of savanna around the humid Guineo-Congo Region from West Africa to East Africa, Angola and South Africa. However, this analysis shows there are surprisingly few species common to both the bulge of West Africa and to Mt Kulal, most of those entered for this region have a short westward extension. For example: *Helichrysum glumaceum* extends from Senegal to Tanzania in rather dry country of the Sahelian Domain, whereas *H. rhodolepis, Conyza pyrrhopappa* (Fig. 8) and *Crassocephalum mannii* occur at higher

FIG. 3.—Base of Mt Kulal, dry bed of Balessa River in foreground, basaltic slopes to right, summit hidden by clouds. Photo: F. N. Hepper.

FIG. 4.—Portion of the vegetation map of S.W. Marsabit District relating to Mt Kulal (after Herlocker, 1979). Original in colour; see Table I for explanation of vegetation types.

TABLE 1.—Vegetation types recognised on Mt Kulal

	Vegetation type (after Herlocker, 1979)	Compositae, Leguminosae and Gramineae; no. of taxa recorded i.e. species, subspecies and varieties
Type 1	Upland Evergreen Forest: *Cassipourea, Diospyros, Olea, Teclea*	192
	(Dense forest)	(143)
	(Open glades and grassland)	(49)
Types 3–6	Evergreen to semi-deciduous Bushland	
	3. Evergreen Bushland: *Carissa, Euclea, Rhus, Juniperus*	249
	5. Semi-deciduous Bushland: *Euclea, Lippia, Ormocarpum*	138
	6. Composite Unit (numerous deep, steep walled canyons): Continuum of deciduous bushland through evergreen forest	47
Types 7–14	Woodland	
	Deciduous with dwarf shrub understorey:	
	9. *Acacia drepanolobium* with *Duosperma*	94
	10. *Acacia etbaica, A. nilotica* with *Duosperma*	59
Types 15–19	Bushland	
	15. Composite units: continuum of deciduous bushland through evergreen to semi-deciduous bushland	47
	19. Deciduous with succulent dwarf shrub understorey: *Acacia mellifera, A. reficiens, Commiphora* with *Euphorbia, Plectranthus*	11
Types 20–33	Shrubland	
	Deciduous with dwarf shrub understorey:	
	29. *Acacia mellifera, A. reficiens, Commiphora* with *Duosperma*	24
	30. *Acacia mellifera, A. reficiens* with *Duosperma, Sericocomopsis*	13
	Deciduous shrubland with succulent dwarf shrub understorey:	
	32. *Acacia mellifera, Commiphora* with *Euphorbia, Plectranthus*	18
Types 33–44	Dwarf shrubland:	
	34. *Duosperma*	
	35. *Duosperma, Plectranthus*	
	36. *Duosperma, Indigofera*	53
	44. Wooded dwarf shrubland, *Duosperma* with *Acacia tortilis*	
Types 46–54	Perennial Grassland:	
	52. Wooded upland grassland: *Bothriochloa, Themeda* with *Juniperus*	11
Types 55–72	Annual grassland:	
	59. Dwarf shrub short: *Aristida* with *Duosperma, Indigofera Sericocomopsis*	
	63. Bushed dwarf short: *Cenchrus* with *Commiphora, Indigofera, Sericocomopsis*	50
	65. Bushed dwarf short: *Aristida* with *Acacia mellifera, Commiphora, Jatropha, Indigofera*	
	67. Bushed dwarf short: *Aristida* with *A. mellifera, A. reficiens, Duosperma, Sericocomopsis*	

altitudes from Cameroun to Malawi and/or Angola; *Rhynchosia minima* var. *prostrata* occurs from Ghana round to South Africa; *Andropogon schirensis* goes the whole way from Senegal to South Africa.

Sudano-Zambezian Region, with extensions to Madagascar, Mediterranean or Deccan Regions

The species in this category have an even wider distribution than those in the last one. Species extending to Madagascar include *Spilanthes mauritiana, Indigofera arrecta* and *Sporobolus pyramidalis*. *Chloris pycnothrix, Hyparrhenia hirta* and *Reichardia tingitana* (Fig. 9) extend to the Mediterranean Region, and *Delonix elata, Bothriochloa insculpta* and *Digitaria abyssinica* extend to the Deccan Region.

Afroriental and Zambezian Domains, with extensions to the South Arabian Domain and/or the Madagascan Region

As a sub-division of the Sudano-Zambezian Region this gathers together the species with a wider Eastern African distribution than the following subdivision. They have distributions extending from southern to north-eastern Africa, e.g. *Aspilia mossambicensis, Indigofera schimperi* and *Lintonia*

TABLE 2.—Analysis of taxa in African phytogeographical divisions

Chorological Zone	Compositae 48 taxa no.	%	Leguminosae 56 taxa no.	%	Gramineae 78 taxa no.	%	Sum of taxa	% of 182
Saharo-Sindian Region	0	0	5	8,9	11	14,1	16	8,8
Sudano-Zambezian Region	6	12,5	6	10,7	11	14,1	23	12,6
Sudano-Zambezian Region, with extensions to Madagascar, Mediterranean and/or Deccan Regions	3	6,2	4	7,1	14	17,9	21	11,5
Afroriental and Zambezian Domains, with extensions to Madagascar and/or South Arabian Region	7	14,6	13	23,2	10	12,8	30	16,5
Afroriental Domain	17	35,4	23	41,0	14	17,9	54	29,6
Afromontane Domain	9	18,7	1	1,7	1	1	11	6,0
Pantropical, Palaeotropical	6	12,5	4	7,1	18	23,0	28	15,4

nutans. Others extend beyond Africa, for example, *Senecio petitianus* and *Mucuna gigantea* subsp. *quadrialata* cross to Madagascar, whereas *Psiadia punctulata, Pterolobium stellatum* and *Cypholepis yemenica* reach southern Arabia.

Afroriental Domain

This accounts for those species occurring in the north-east and east of Africa (Ethiopia, Somalia, Kenya, Tanzania). The figures in Table 2 for each of the three families reveal that a high percentage of the Mt Kulal species come into this category. An attempt to divide them into those with distribution southwards and those whose distribution is northwards proved difficult on a numerical basis. This is because, although a species may be concentrated in Ethiopia, and therefore be regarded as a north-eastern species, there are often outlying records

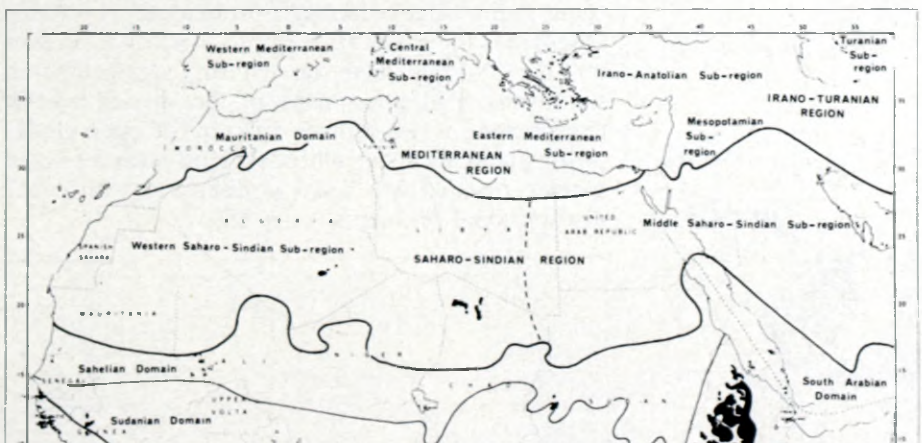

FIG. 5.—The phytogeographical divisions of Africa; the montane region in black (from Brenan, 1978).

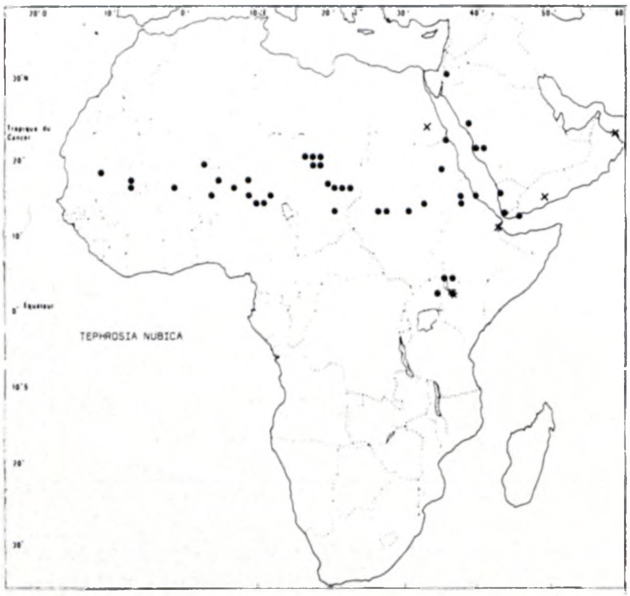

FIG. 6.—Distribution of *Tephrosia nubica*—Saharo-Sindian Region (from Lebrun, 1977).

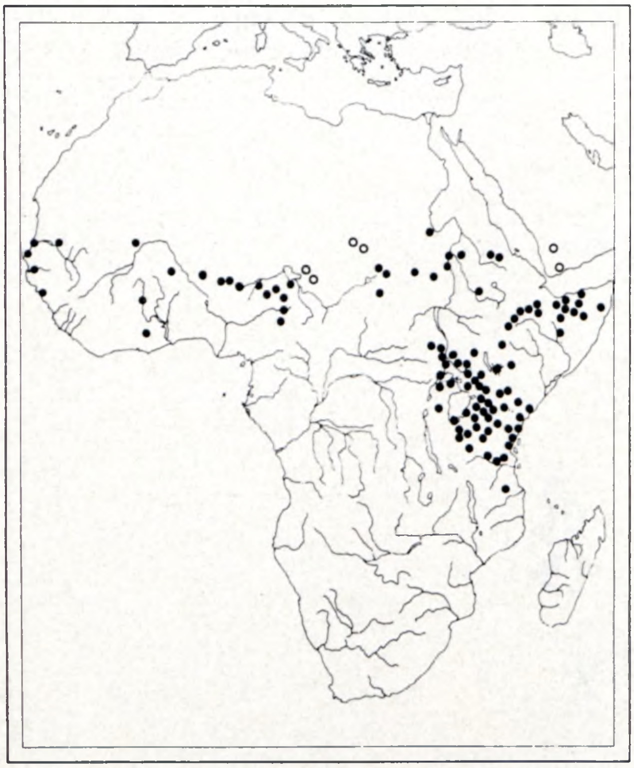

FIG. 7.—Distribution of *Acacia senegal* — Saharo-Sindian Region and Afroriental Domain (Wickens, 1976).

further south and vice versa which make it difficult to place on a presence or absence basis.

There is undoubtedly a very strong north-eastern element, including those occurring in the South Arabian Domain which is really a tropical extension into the Arabian Peninsula, e.g. *Senecio lyratipartitus, Cadia purpurea, Crotalaria emarginella, Tephrosia semipilosum, Eragrostis braunii, Pennisetum stramineum.*

Some of the species are highland, e.g. *Cadia purpurea,* whereas others occur in the dry low country, e.g. *Tephrosia polyphylla, Drake-Brockmania somalensis.*

Turning to those with a southwards distribution there are some legumes limited to East Africa proper, e.g. *Crotalaria balbi, Erythrina burttii, Vigna friesiorum.* Compositae and Gramineae, however, seem to have a wider distribution. Many of the species that would come into this category in fact extend even further southwards into the Zambezian Domain already dealt with.

Afromontane Domain

This is a particularly interesting category but, since it is not well represented by the three families analysed, we shall take examples from other families.

The Afromontane Domain is discontinuous, being present wherever the summits are high enough, hence White (1981) regards it as an archipelago. Mt Kulal supports a number of such species and their presence in isolation poses problems of dissemination which are discussed on p. 550. The summit forest is composed mainly of *Olea hochstetteri* (Figs 10 & 11) with *Teclea nobilis, T. simplicifolius, Cassipourea congoensis* and a herbaceous ground layer of many Acanthaceae. A notable absentee is the genus *Podocarpus* *, which is present on the Ndotos and on Nyiru, some 80 km southwards. Whereas many of the species inhabit the montane forest, others occur in the open glades or grassland at higher altitudes. How such montane species reached Mt Kulal is discussed with other distributional problems on p. 550.

FIG. 8.—Distribution of *Conyza pyrrhopappa* — Sudano-Zambezian Region (from Wickens, 1976).

* The sight record by Synnott (1979) is doubted by himself!

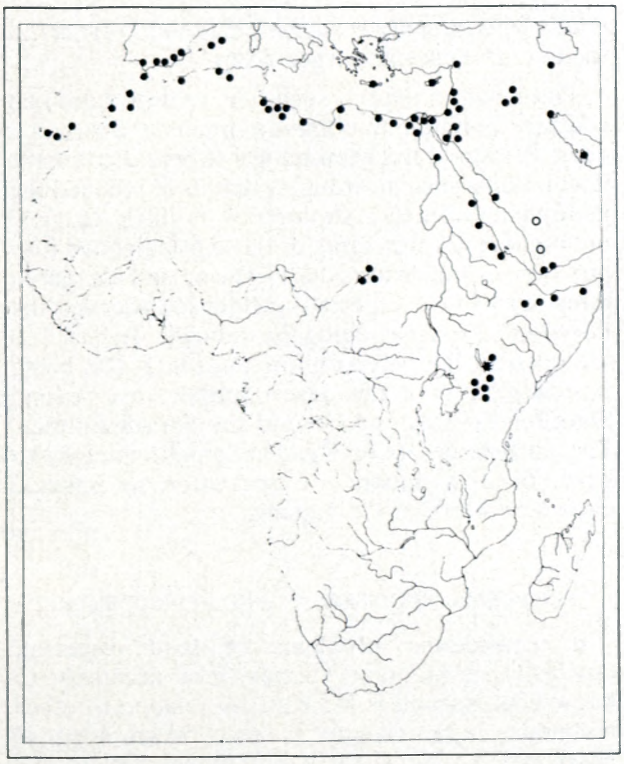

FIG. 9.—Distribution of *Reichardia tingitana* — Mediterranean and Saharo-Sindian Regions and the Afroriental Domain of the Sudano-Zambezian Region (from Wickens, 1976).

FIG. 10.—*Olea hochstetteri* forest with *Usnea* near summit of Mt Kulal. Photo: F. N. Hepper.

FIG. 11.—Glade with stream in montane forest below summit of Mt Kulal. Photo: F. N. Hepper.

Examples: *Cussonia holstii* (Araliaceae), *Silene burchelli* (Caryophyllaceae), *Cineraria grandiflora* (Compositae), *Crepis rueppellii* (Compositae) (Fig. 12), *Casearia battiscombei* (Flacourtiaceae), *Geranium arabicum* (Geraniaceae), *Xymalos monospora* (Monimiaceae), *Rapanea melanophloeos* (Myrsinaceae), *Rhamnus prinoides* (Rhamnaceae), *Psychotria orophila* (Rubiaceae), *Andropogon distachyos* (Gramineae) (Fig. 13).

Palaeotropical, pantropical, cosmopolitan

Some of the species are weeds unintentionally distributed by man. Mt Kulal has been settled for a relatively short time, although no doubt there have always been temporary dwellings and incursions by pastoralists, especially during prolonged droughts. With increasing contacts with the outside world through the Africa Inland Church and the United Nations project, an increase in the number of weedy species can be expected. Examples of weeds already occurring there are: *Stellaria media* (Caryophyllaceae), *Chenopodium murale* (Chenopodiaceae), *Ocimum suave* (Labiatae), *Malva parviflora* (Malvaceae), *Anagallis arvensis* (Primulaceae), *Physalis peruviana* (Solanaceae) and *Cynodon dactylon* (Gramineae). Two other grasses, *Eragrostis minor* and *Polypogon monspeliensis* are more temperate in requirements and have a Boreo-Atlantic distribution.

FIG. 12.—Distribution of *Crepis rueppellii* – Afromontane Domain, restricted to East Africa (from Wickens, 1976).

Other species having such wide distributions are not necessarily connected with man. They have occupied available habitats over a wide area and are of little interest from a phytogeographical point of view. Some are aquatics which have probably been distributed by water-birds, e.g. *Veronica anagallis-aquatica*. Others have fruits or seeds adapted for animal, especially bird, distribution, e.g. *Achyranthes aspera, Pupalia lappacea* (Amaranthaceae) and *Bidens pilosa* (Compositae). *Desmodium repandum* (Leguminosae) has a wide range in the palaeotropics as a plant of upland forest. Although most are herbaceous, some are woody, e.g. *Carissa edulis* (Apocynaceae), *Securinega virosa* (Euphorbiaceae) and *Scutia myrtina* (Rhamnaceae). It is significant that these bushes all have berries that are likely to be distributed by birds.

ENDEMICS ON MT KULAL

Insufficient is known about the number of endemics to be able to analyse them. However, there appear to be several endemics occurring at lower altitudes on the mountain, some of them are awaiting publication or assessment as to their taxonomic status. Several in the three families have been added to the Afroriental total. A tentative list of suspected endemics so far recorded is as follows: *Barleria* sp. (*Herlocker* 363), *Justicia* sp. (*Hepper & Jaeger* 6909), *Cadaba* sp. (*Bally* 5658), *Plectranthus* sp. (*Hepper & Jaeger* 7032), *Bidens* sp. (*Herlocker* 661, *Hepper & Jaeger* 6945), *Vernonia galamensis* (Cass.) Less. var. nov. (*Hepper & Jaeger* 6983), *Aloe* sp. 1 (*Bally* 5578, *Hepper & Jaeger* 7151), *Aloe* sp. 2 (*Bally* 5633, *Hepper & Jaeger* 7152) and *Polystachya* sp. nov. (Hepper & Jaeger 7086).

One would expect such an ancient base-rich volcanic mountain to possess more endemics than it does. Perhaps it has been subject to periodic climatic fluctuations, such as drought, that have reduced the mesophytes. Further exploration is likely to yield more endemics, yet some of those listed above may prove to be known elsewhere. The upland evergreen forest seems to be especially lacking in endemics, the *Polystachya* sp. nov. being the only one. In fact, it is the lowland that supports the endemics, this being especially true of the desert further east beyond Marsabit towards and beyond the Somali frontier. The ancient desert of Ogaden/Somalia appears to have been a centre of speciation unmatched elsewhere north of the Equator.

PROBLEMS OF DISPERSAL AND CONCLUSIONS

In considering problems of seed dispersal, especially of montane species, it is necessary to know how isolated is Mt Kulal in relation to other mountains in the vicinity. It lies c. 50 km north of Nyiru Mt, (2 752 m alt.); c. 110 km NW of the Ndotos (2 637 m alt.); c. 100 km W of Marsabit Mt (1 836 m alt.). Asie Hill lies only 20 km to the NE, but it is too low (1 070 m) to act as a stepping stone for montane plants. Likewise, the Hurri Hills (c. 100 km NE alongside the Ethiopian frontier) are not high enough (1 539 m) for forest, but do have upland grassland and a number of endemics.

The Afromontane species are therefore very discontinuous, as elsewhere in Africa (White, 1981).

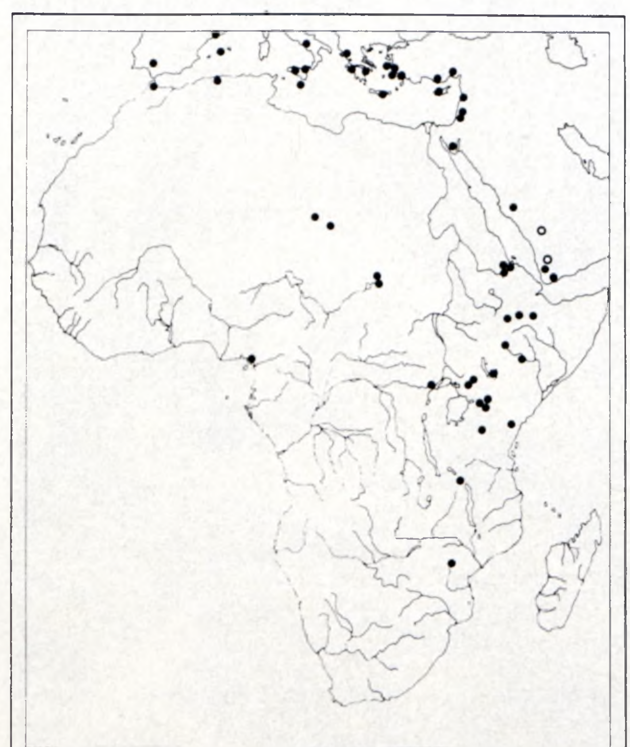

FIG. 13. Distribution of *Andropogon distachyos* — Afromontane Domain, extending to Mediterranean Region (from Wickens, 1976).

Some species such as *Halleria lucida* and *Myrsine africana* (Fig. 14) have an extremely wide distribution in tropical Africa and one wonders why this is so when other species are much more restricted. Wickens (1976) discussed long-range dispersal of seed of plants occurring on Jebel Marra and analysed the dispersal mechanisms of many species. It would be interesting to make a similar study of the Mt Kulal plants at all altitudes, but it is not practicable for this paper.

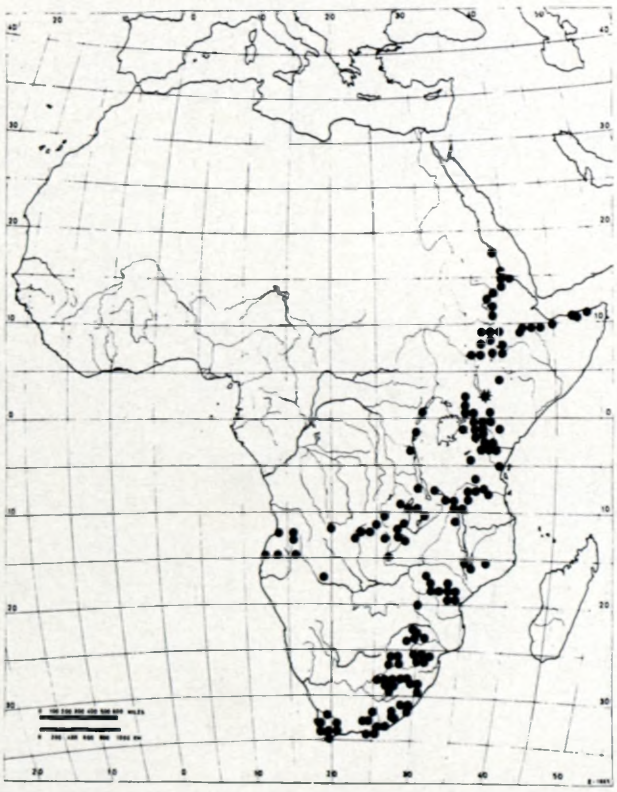

FIG. 14.—Distribution of *Myrsine africana* — Afromontane Domain, widespread in Africa (from White, 1981).

Species from the north have had to jump a considerable distance from the highlands of Ethiopia to Mt Kulal. However, there are so many species in common to both Ethiopia and the East African mountains that the desert of NE Kenya has not been a barrier. Gillett (1952) challenged the supposition then widely held that there was a gap between the highland floras of Ethiopia and E. Africa. Since the publication of his paper a great deal more knowledge of the floras has been acquired and his thesis is thoroughly vindicated.

The distances from the outlying mountains to the south are not so great. Until 1970's herds of elephants and other big game visited Mt Kulal and they were probably responsible for the distribution of certain plants. Birds are even more mobile, but Moreau (1963) has shown that many forest birds remain in relatively small areas on isolated mountains. Migrating birds, on the other hand, would be able to effect long distance seed dispersal. Much remains to be discovered about dispersal methods as well as the limitation of distribution owing to minimum/maximum temperatures, drought and the presence of pests. The effect of pests on the distribution of plants was first given prominence by Gillett (1962) whose ideas are now generally accepted.

Climatic changes have taken place which would have affected plant distribution across the region (Van Zinderen Bakker, 1967). Much of the low-level basalt is water-eroded, and evidence seems to indicate that even quite recently it was less dry in the plains. During such a wetter period there were sure to have been dispersal routes along numerous watercourses where riverine forest was likely to have developed. Temperature fluctuations would also affect distribution; a drop in temperature could have enabled some of the submontane species to spread across areas at present impassable. Distribution of desert species presents no problem as they can migrate eastwards or westwards with little difficulty. Floristically, however, there is a marked difference between the Marsabit District and Ogaden/Somali desert to the east — the much richer flora of the Ogaden is probably due to long stability of the environment there compared with fluctuations in the west involving volcanic activity.

CONCLUSION

In conclusion, the evidence favours Mt Kulal as a phytogeographical stepping stone between the highland mass of East Africa and Ethiopia, rather than an outlier of either of them.

REFERENCES

BRENAN, J. P. M., 1978. Some aspects of the phytogeography of tropical Africa. *Ann. Mo. bot. Gdn* 65: 437–478.

CLAYTON, W. D. & HEPPER, F. N., 1974. Computer-aided chorology of West African grasses. *Kew Bull.* 29: 213–234.

GILLETT, J. B., 1952. The relation between the highland floras of Ethiopia and British East Africa. *Webbia* 11: 459–466.

GILLETT, J. B., 1962. Pest pressure, an under-estimated factor in evolution. *Syst. Assoc. Publ.* 4: 37–46.

HEPPER, F. N., JAEGER, P. M. L., GILLETT, J. B. & GILBERT, M. G., 1981. *An annotated checklist of the plants of Mt Kulal, Kenya.* UNEP–MAB. Integrated Project in Arid Lands, Technical Report — D3. Nairobi.

HERLOCKER, D., 1979. *Vegetation of southwestern Marsabit District, Kenya.* UNEP–MAB. Integrated Project in Arid Lands. Technical Report — D1. Nairobi.

LEBRUN, J.-P., 1977. *Elements pour un atlas des plantes vasculaires de l'Afrique seche.* 1: map 24.

MOREAU, R. E., 1963. Vicissitudes of the African biomes in the late Pleistocene. *Proc. zool. Soc. Lond.* 141: 395–421.

SYNNOTT, T. J., 1979. *A report on the status, importance and protection of the montane forests of SW Marsabit Dist., Kenya.* UNEP–MAB. Integrated Project in Arid Lands, Technical Report — D2a. Nairobi.

VAN ZINDEREN BAKKER, E. M., 1967. Upper Pleistocene and Holocene stratigraphy and ecology on the basis of vegetation changes in sub-Saharan Africa. In W. W. Bishop & J. D. Clark, *Background to evolution in Africa.* Chicago: University of Chicago Press.

WHITE, F., 1970. In J. D. Chapman & F. White, *The evergreen forests of Malawi.* Oxford: Commonwealth Forestry Institute.

WHITE, F., 1981. The history of the Afromontane archipelago and the scientific need for its conservation. *Afr. J. Ecol.* 19: 33–54.

WICKENS, G. E., 1976. *The Flora of Jebel Marra (Sudan Republic) and its affinities. Kew Bull.* Addit. Ser. V.

WICKENS, G. E., 1976. Speculations on long distance dispersal and the flora of Jebel Marra, Sudan Republic. *Kew Bull.* 31: 105–150.