

Phytogeography of the tropical north-east African mountains

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ABSTRACT

The tropical north-east African mountains are tentatively divided into four phytochoria, the formal rank of which is not defined. The division is based on patterns of distribution and endemism in the region.

The recognition of a distinct Afromontane phytochorion is now well established (Chapman & White, 1970; Werger, 1978; White, 1978). However, there is still very little information on the phytogeography of the individual mountains or mountain systems. This study hopes to fill a little of the gap by analysing distribution patterns and patterns of endemism in the flora of the tropical north-east African mountains.

The north-east African mountain system is the largest in tropical Africa (see e.g. map in White, 1978). At the core of this system is the large Ethiopian massif, around which are located various mountains and mountain chains. These include the Red Sea Hills in the Sudan, the mountain chain in northern Somalia, the south-west Arabian mountains, and the Imatong mountains of south-east Sudan. The latter are often referred to the East African mountain system (White, 1978) but, as I will point out later, they also have a close connection with the south-west highlands of Ethiopia.

The paper presents some results of my study of the mountain flora of tropical north-east Africa, particularly the forest species. Where no source is indicated, the data are from my own unpublished studies.

RÉSUMÉ

LA PHYTOGÉOGRAPHIE DES MONTAGNES TROPICALES DE L'AFRIQUE DU NORD-EST

Les montagnes tropicales du nord-est africain sont divisées à titre d'essai en quatre phytochories, dont le rang n'est pas défini. La division est basée sur les modes de distribution et d'endémisme dans la région.

La reconnaissance d'une phytochorie afromontagnarde distincte est maintenant bien établie (Chapman & White, 1970; Werger, 1978; White, 1978). Cependant, il y a encore peu d'information sur la phytogéographie des montagnes individuelles ou des systèmes montagneux. Cette étude espère combler un peu cette lacune en analysant les modes de distribution et les modes d'endémisme dans la flore des montagnes tropicales du nord-est africain. Le système montagneux du nord-est africain est le plus grand de l'Afrique tropicale (voir carte dans White, 1978). Au coeur de ce système se trouve le grand massif éthiopien autour duquel sont situées des montagnes et des chaînes de montagnes variées. Celles-ci incluent les collines de la Mer Rouge au Soudan, la chaîne de montagnes de la Somalie du Nord, les montagnes du Sud-Ouest de l'Arabie et les montagnes Imatong du Sud-Est du Soudan. Ces dernières sont souvent mentionnées comme système montagneux de l'Est africain (White, 1978) mais comme je le soulignerai plus tard, elles ont aussi une étroite connection avec les hauts plateaux du Sud-Ouest de l'Ethiopie.

Le document présente certains résultats de mon étude de la flore de montagne du Nord-Est tropical de l'Afrique, particulièrement les espèces forestières. Là où aucune source n'est indiquée, les données proviennent de mes propres études non encore publiées.

PATTERNS OF ENDEMISM

The endemism of the tropical north-east African mountains can be divided into four geographical groups:

1. Endemics of the south-western part of the Ethiopian highlands.

The species in this group are associated with upland rain forest or humid evergreen bushland, and include:

<i>Aframomum korarima</i> (Pereira) Engl.	Fig. 1.
<i>Amorphophallus gambozianus</i> Pich.-Serm.	Same as Fig. 1.
<i>Cirsium englerianum</i> O. Hoffm.	Fig. 2; Friis, 1975.
<i>Cirsium dender</i> Friis	Fig. 2; Friis, 1975.
<i>Diaphananthe adoxa</i> Rasm.	Rasmussen, 1974.
<i>Dorstenia soerensenii</i> Friis	Friis, 1974.

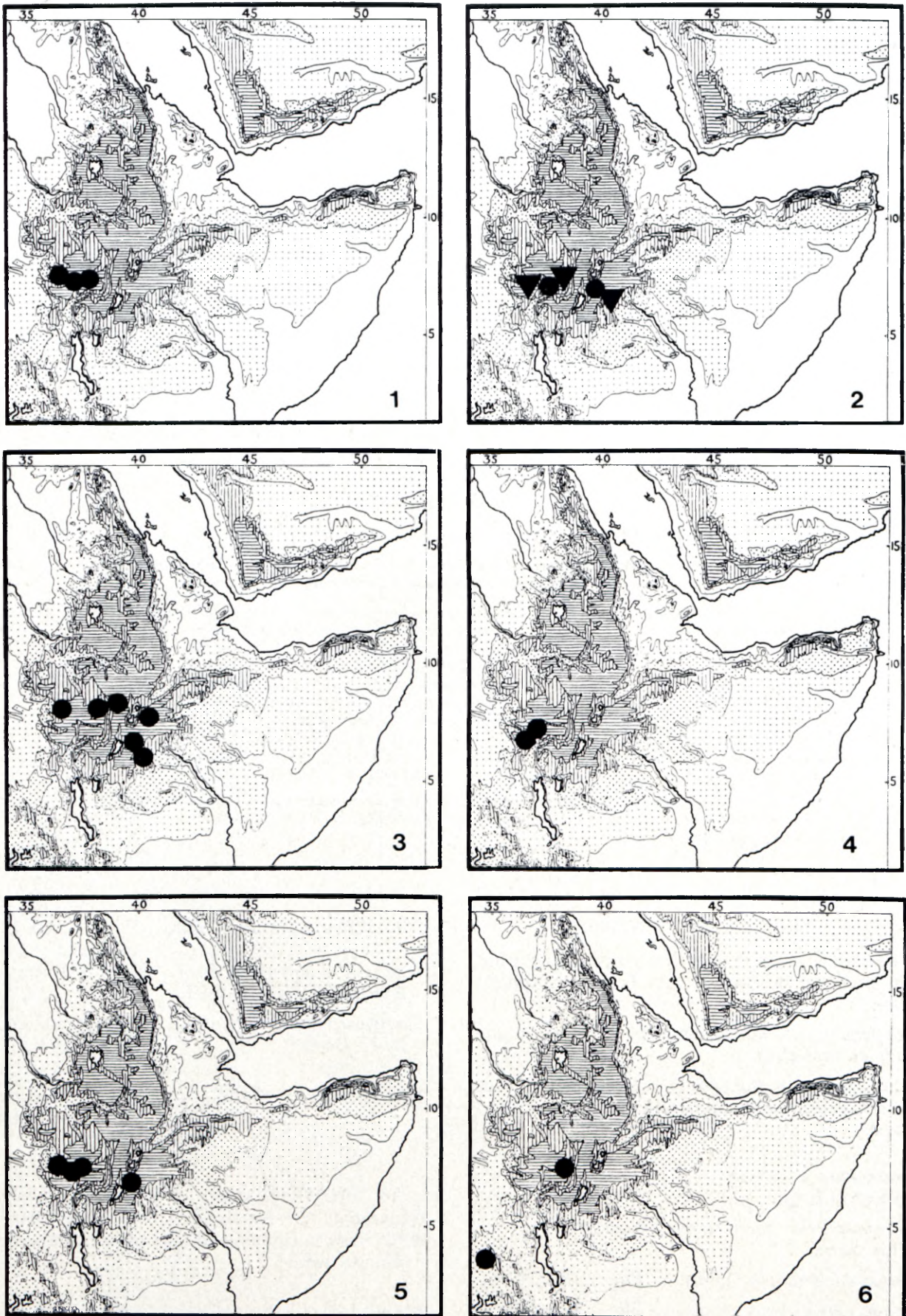
<i>Polystachya aethiopica</i> Cribb	Fig. 3; Cribb, 1978; own data.
<i>Scadoxus nutans</i> (Friis & Bjørnst.) Friis & Nordal	Friis & Bjørnstad, 1971.
<i>Streptocarpus phaeotrichus</i> B. L. Burt	Fig. 4; Hilliard & Burt, 1971; own data.
<i>Tiliachora troupinii</i> Cuf.	Fig. 5; Benvenuto, 1975; own data.

An interesting group of endemics, which is recognized here for the first time, is restricted to south-western Ethiopia and the Imatong mountains. Examples are:

<i>Bidens imatongensis</i> Sherff	Fig. 6.
<i>Guizotia arborescens</i> Friis	Friis, 1971.
<i>Impatiens ethiopica</i> Grey-Wilson	Fig. 7; Grey-Wilson, 1980; own data.

Senecio myriocephalus A. Rich. Fig. 8.

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FIGS 1–6.—Distribution of: 1, *Aframomum korarima* (Pereira) Engl. (c. 1 700–c. 2 000 m); 2, *Cirsium englerianum* O. Hoffm. (dots, 1 750–2 100 m), *Cirsium dender* Friis (triangles, 2 300–2 500 m); 3, *Polystachya aethiopia* Cribb (1 350–2 500 m); 4, *Streptocarpus phaeotrichus* B. L. Burtt (c. 1 600–1 800 m); 5, *Tiliachora troupinii* Cuf. (1 700–1 900 m); 6, *Bidens imatongensis* Sherff (1 700–2 300 m). The hatching on this and the following maps signifies: no hatching — under 500 m; open dots — 500–1 000 m; closed dots — 1 000–1 500 m; vertical hatching — 1 500–2 000 m; horizontal hatching — over 2 000 m.

Other connections exist, for example:

Coffea arabica L. South-west Ethiopia, Imatong Mountains and Mt Marsabit. Friis, 1979; own recent data.

2. Endemics of the high mountains of Ethiopia

Species in this group occur mainly in ericaceous bushland or in afro-alpine vegetation types. Examples are:

Jasminum stans Pax Fig. 9.

Rosularia semiensis (A. Rich.) H. Ohba Fig. 10.

Hypagophytum abyssinicum (Hochst.) Berger. Monotypic genus. Fig. 10.

Saxifraga hederifolia A. Rich. Rampi, 1973.

Philippia abyssinica Pich.-Serm. & Hein Pichi-Sermolli & Heiniger, 1953.

Lobelia rhynchopetalum (A. Rich.) Hemsl. Fig. 11.

A few endemics on the high mountains are found also on one other isolated mountain, for example:

Blaeria spicata A. Rich. Pichi-Sermolli & Heiniger, 1953.
Also on Jebel Marra.

3. Endemics of the Ethiopian plateau

Species in this group seem to be confined to the plateau of northern and central Ethiopia, and occur in comparatively dry vegetation types, e.g. on slopes, rocky outcrops and stony, well-drained soil. Examples are comparatively few when compared with other groups:

Cussonia ostinii Chiov. Bamps, 1974.

Polyscias farinosa (Del.) Harms Bamps, 1974.

4. Endemics of the eastern escarpment of the Ethiopian plateau and associated mountains.

Species in this group are more or less confined to the eastern escarpment of the Ethiopian plateau, the mountain chain in northern Somalia, and the south-west Arabian mountains. Some species in this group may also occur on Socotra and on Jebel Akhdar in Oman. The species occur in upland dry evergreen forest or in associated types of evergreen bushland. (These endemics should not be confused with the even more important group of endemics in the deciduous bushlands of the Ogaden and the Somalian lowlands.) The most notable example in this group is *Barbeya oleoides* Schweinf., representing a monotypic family (Fig. 12). Other examples are:

Mimusops laurifolia (Forssk.) Friis Fig. 13; Friis, 1981.

Buxus hildebrandtii Baill. Valenti, 1965.

Spiniluma oxyacantha (Baill.) Aubrev. Also penetrates the drier parts of the plateau; replaced on Socotra by the very closely related *S. discolor* (Radcliffe-Smith) Friis. Fig. 14; Friis, 1978.

Poskea Vatke. Endemic genus; three species in north-east Somalia, one also on Socotra. Morucchio, 1970

DISTRIBUTION OF NON-ENDEMICS

Non-endemics show patterns of distribution similar to the grouping of the endemics outlined above. Most notable are the south-western species and the species of the eastern Ethiopian escarpment.

1. South-western species

Examples of this group are:

Morus mesozygia Stapf. Fig. 20
Widespread in tropical Africa.

Trichilia dregeana Sond. Wilde, 1968.
Also East and South Africa.

2. Species of the Ethiopian high mountains

Examples are:

Subularia monticola Schweinf. Hedberg, 1962.

Ranunculus oreophytus Del. Hedberg, 1962.

Both species occur on the high mountains of East Africa.

3. Species of the Ethiopian plateau

Examples of this distribution may be found in the genus *Acacia*, but the taxonomy and distribution of the species of this genus in Ethiopia have not yet been published.

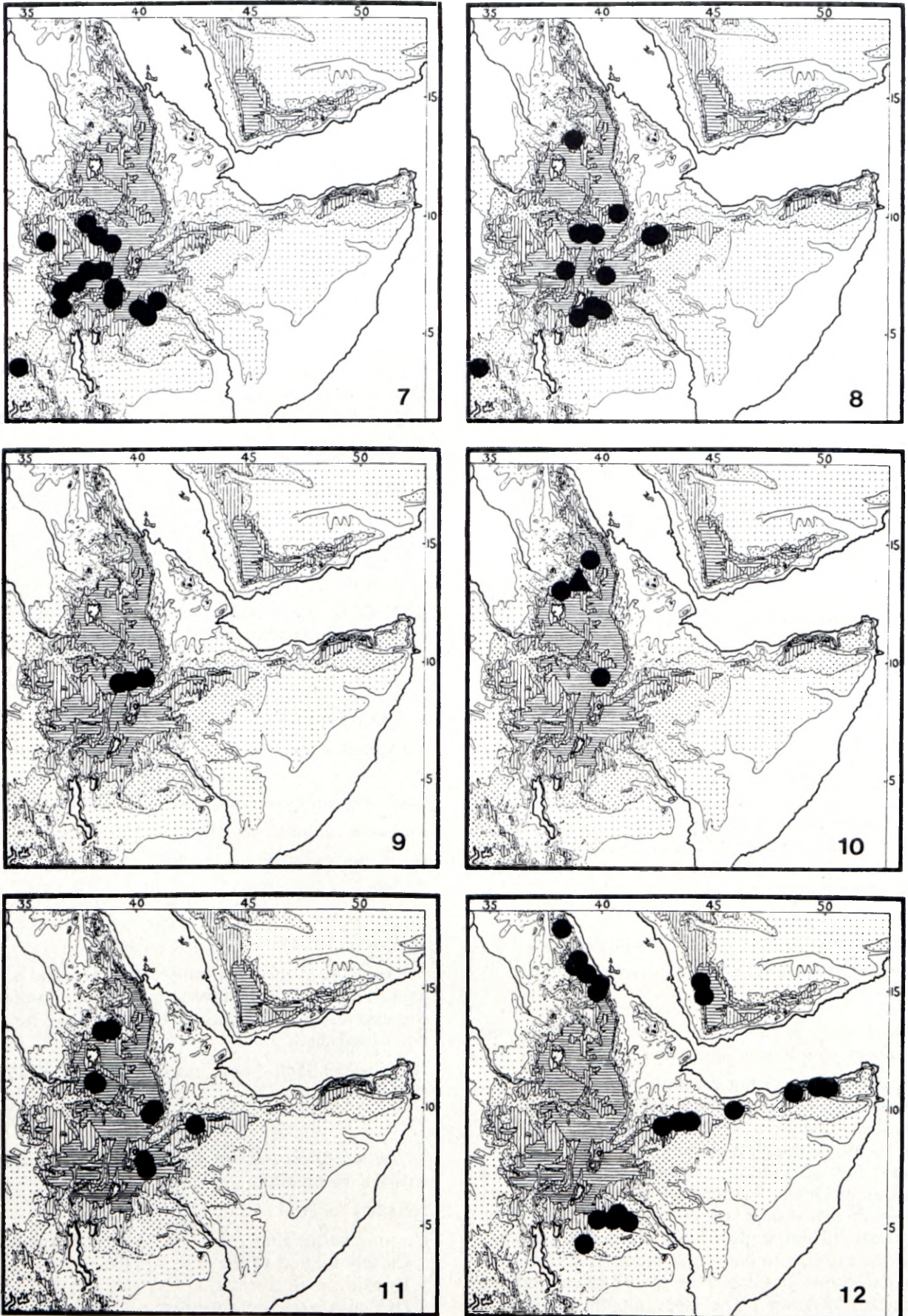
A. pilispina Pich.-Serm. may be a good example (Ross, 1979).

4. Species of the eastern Ethiopian escarpment and adjacent mountains

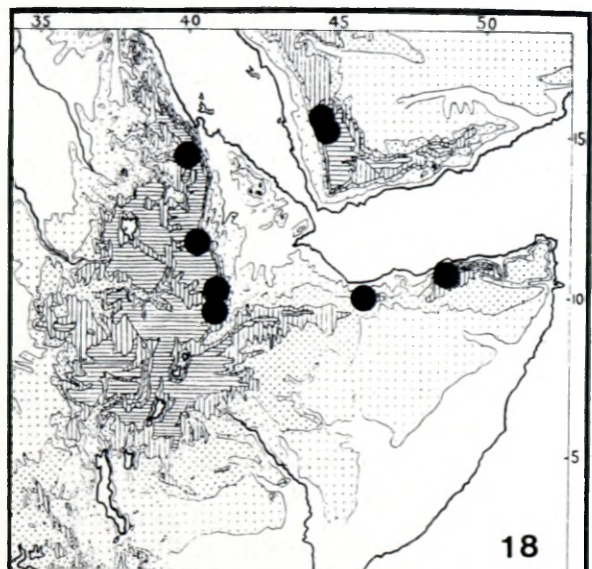
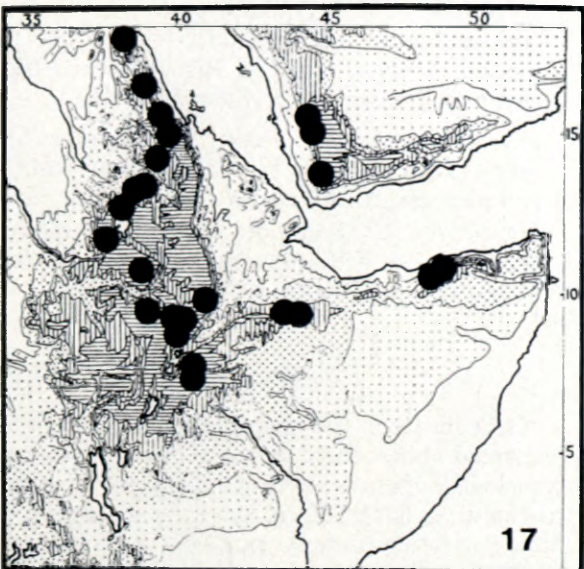
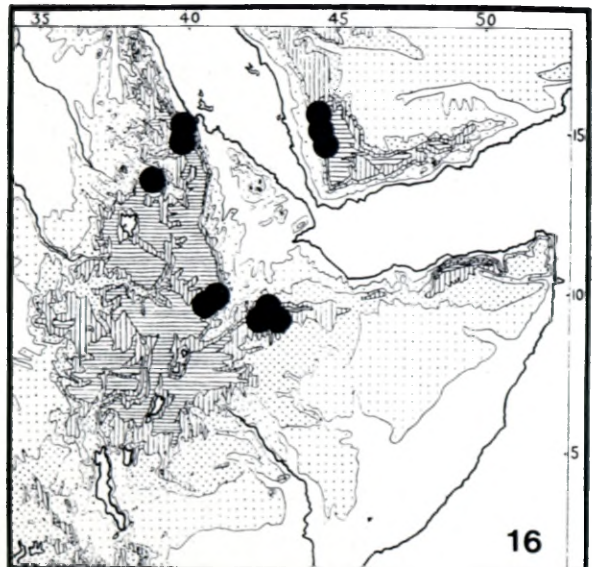
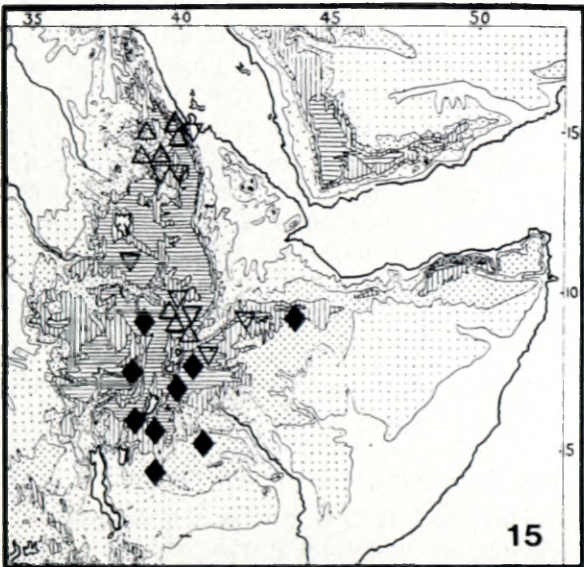
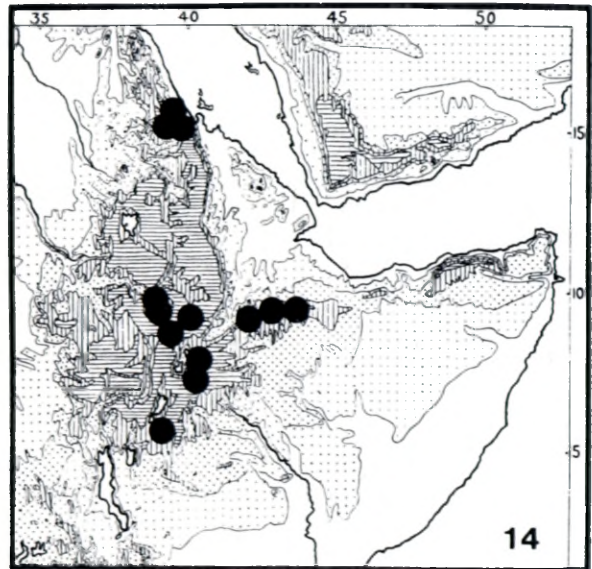
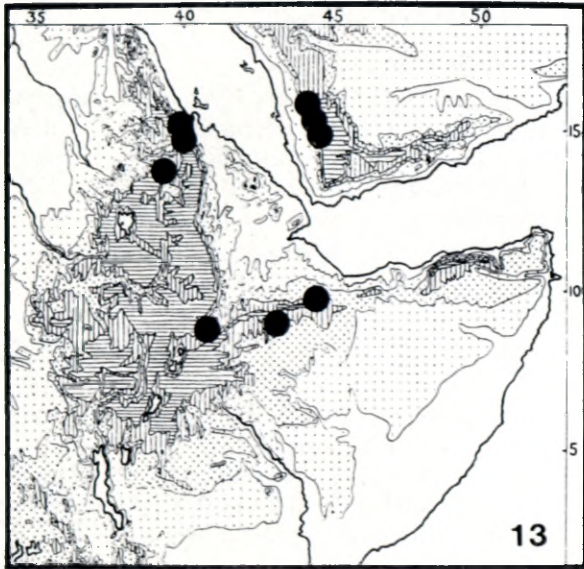
Examples are:

Berberis holstii Engl. Fig. 18; Polhill, 1966.
Closely related to the Himalayan *B. aristata* DC., also in the south-western Arabian mountains and East Africa.

Pistacia aethiopica Kokwaro. Fig. 19; Kokwaro & Gillett, 1980.
Related to the Mediterranean *P. lentiscus* L., also in East Africa.



FIGS 7–12.—Distribution of: 7, *Impatiens ethiopica* Grey-Wilson (1 300–3 200 m); 8, *Senecio myriocephalus* A. Rich. (c. 2 500–c. 3 100 m); 9, *Jasminum stans* Pax (c. 3 000 m); 10, *Rosularia semiensis* (A. Rich.) H. Ohba (triangle, above 3 000 m) and *Hypagophyllum abyssinicum* (A. Rich.) Berger (dots, also on same locality as *R. semiensis*, above c. 2 700 m); 11, *Lobelia rhynchopetalum* (A. Rich.) Hemsl. (2 790–4 080 m); 12, *Barbeya oleoides* Schweinf. (1 300–2 500 m).



FIGS 13–18.—Distribution of: 13, *Mimusops laurifolia* (Forssk.) Friis (500–1 800 m); 14, *Spiniluma oxyacantha* (Baill.) Aubrév. (1 800–2 800 m); 15, *Linum trigynum* L. (triangles pointing S, 2 000–2 750 m), *Linum corymbulosum* Reichb. f. (triangles pointing N, c. 1 000–c. 2 500 m), *Linum volkensii* Engl. (rhombi, 1 600–2 800 m); 16, *Debregeasia bicolor* (Roxb.) Wedd. (1 500–2 400 m); 17, *Rosa abyssinica* Lindl. (c. 2 500 m to above 3 000 m); 18, *Berberis holstii* Engl. (1 500–3 200 m).

- Juniperus procera* Endl. Fig. 21.
Penetrates the drier parts of the plateau; also in the south-west Arabian mountains and East Africa.
- Tarchonanthus camphoratus* L. Fig. 22.
Also in the south-west Arabian mountains and in East and South Africa.
- Monothecha buxifolia* (Falconer) A. DC. Also on Fig. 23; Friis, 1978.
Jebel Akhdar in Oman and in north-east Afghanistan and adjacent parts of Pakistan.
- Ceratonia oreothauma* Hillc., Hillcoat, Lewis & Lewis & Verdc. Also Verdcourt, 1980.
in Oman.

VICARIISM

It has been suggested that vicariism is extremely important in the Afromontane flora, and that species replace each other on different mountains. White, on the other hand, concludes (Chapman & White, 1970), from his analysis of the Afromontane tree flora of Malawi, that vicariism scarcely exists in that area.

A moderate degree of vicariism seems to exist between the Afromontane flora of tropical north-east Africa and that of other Afromontane areas. Of the endemics mentioned, only the following are not replaced by vicarious species either in the Mediterranean or temperate regions or on other African mountains:

Endemic genera: *Hypagophytum*, *Spiniluma*, *Barbeya* and *Poskea*. Endemic section: *Scadoxus* sect. *Gamolepis*; only species, *S. nutans*.

A case of local vicariism is found in *Linum* L.: the Mediterranean species *L. strictum* L. and *L. corymbulosum* Reichb. f. occur in northern and central Ethiopia, but seem in southern Ethiopia to be replaced by the Afromontane endemic *L. volkensii* Engl., which also occurs in East Africa (Fig. 15).

OUTLIERS

According to Gillett (1955) the flora of three-vegetation types in south Ethiopia is more closely related to the flora of the East African mountains than to the flora of northern Ethiopia. It would appear from this that elements of the northern and southern floras of Ethiopia might have a closer affinity to the floras to the north and south of them respectively. That this is correct, at least to some degree, is shown by a number of species or genera which reach their southernmost limit in Ethiopia and Somalia, but which occupy their main range in the temperate or Mediterranean areas, or in the Himalayas. Similarly, there are a number of species and genera which reach their northernmost limit in Ethiopia.

1. Southern limit species

Examples are:

Rosularia (DC.) Stapf. c. 25 species; distributed from the eastern Mediterranean to central Asia. The only African species is *R. semiensis* (Fig. 10), which reaches its southern limit in the Semien mountains.

Saxifraga L. c. 300 species; occurring in the temperate region and in the Himalayas. The only African species, *S. hederifolia*, reaches its southern limit in the Arussi mountains (Rampi, 1973).

Debregeasia Gaud. c. 17 species; a genus of tropical and subtropical Asia, with many species in the Himalayas. The only African species, *D. bicolor* (Roxb.) Wedd., is distributed from the western Himalayas to Harar and Shoa (Fig. 16).

Rosa L. c. 150 species; a widespread genus in the north temperate area. Only one African species, *R. abyssinica* Lindl., which is closely related to the *R. moschata* group of the Himalayas and western China. It occurs in the Yemen and Ethiopia as far south as Bale (Fig. 17).

Primula L. c. 500 species; a widespread genus in the north temperate region and the Himalayas. The only African species, *P. verticillata* Forssk. occurs in the south-west Arabian mountains and in Ethiopia, with a southern limit just south of Addis Ababa (Bizzari, 1970).

2. Northern limit species

There is a large number of southern Afromontane genera and species which reach their northern limit in Ethiopia and Somalia. A few examples taken from the Afromontane shrubs and trees are:

Schefflera J. R. & G. Forster. Three species of this genus are important in the forests of Ethiopia. Two of them, *S. volkensii* (Engl.) Harms and *S. myriantha* (Bak.) Drake, reach their northern limit at the latitude of Addis Ababa. The third species, *S. abyssinica* (A. Rich.) Harms, has its northern limit in Tigre (Bamps, 1974).

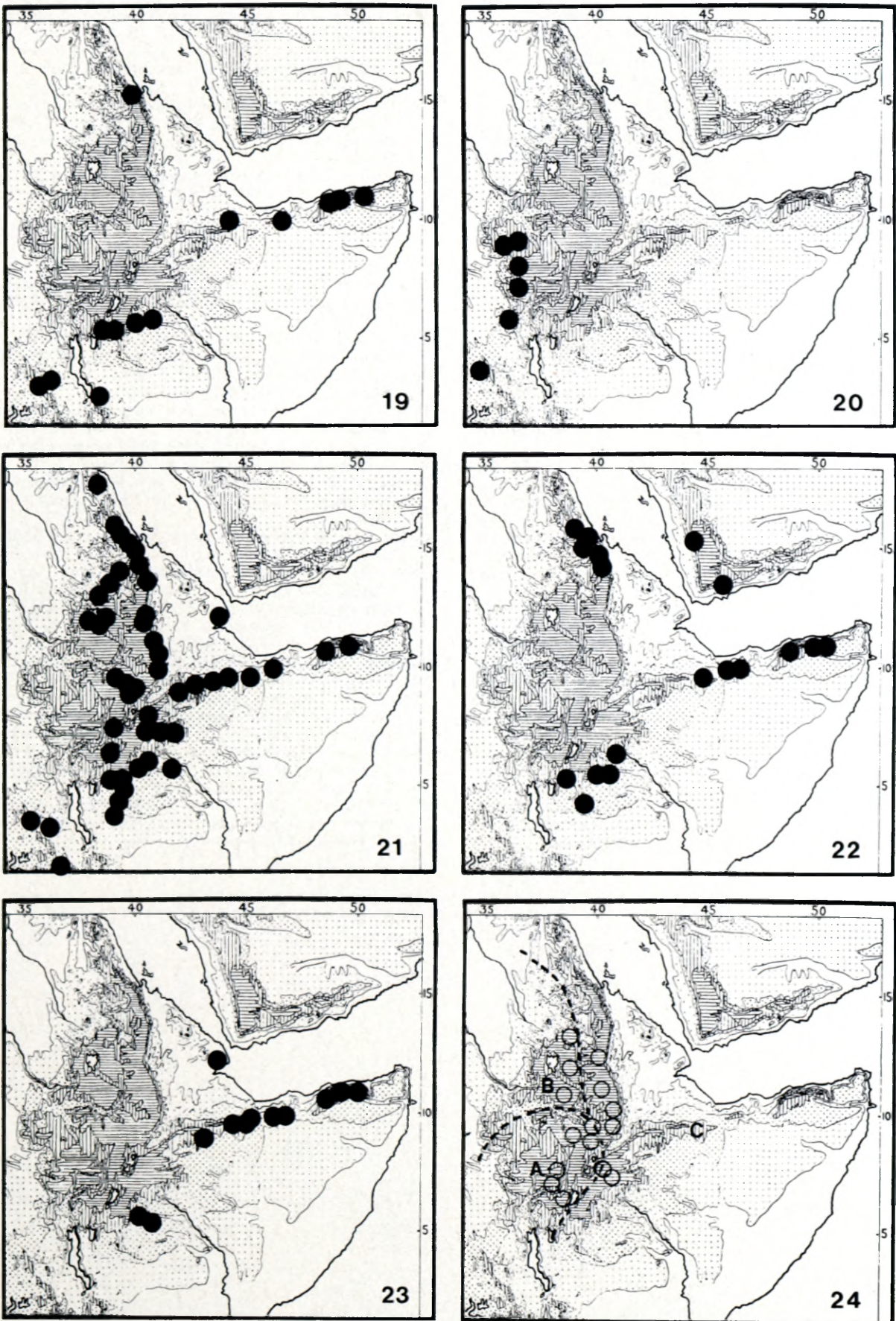
Psychotria orophila Petit. A common forest species with the same northern limit as *Schefflera volkensii* and *S. myriantha* (Petit, 1972).

Hypericum L. Examples similar to those of *Schefflera* can be found among the woody species of *Hypericum* (Bamps, 1971).

CONCLUSION

As seen from the distribution maps and data presented above, there seems to be reasonably good coincidence between the patterns of distribution revealed. It is therefore tempting to suggest that these patterns represent some kind of division of the tropical north-east African mountains into four phytochoria (Fig. 24).

Classical hierarchical biogeographical classifications have been less widely accepted in the recent years. White (1978) now prefers a less formal system of centres of endemism and transition zones and regional mosaics, rather than classifying the phyto-



FIGS 19–24.—Distribution of: 19, *Pistacia aethiopica* Kokwaro (1 100–3 200 m); 20, *Morus mesozygia* Stapf (c. 1 000–1 850 m); 21, *Juniperus procera* Endl. (1 200–3 100 m); 22, *Tarchonanthus camphoratus* L. (700–2 500 m); 23, *Monothecha buxifolia* (Falconer) A. DC. (1 250–2 150 m); 24, A tentative phytogeographical division of the tropical N. E. African highlands: A, south-western endemics and many southern Afromontane species; B, plateau endemics and some northern and southern species; C, eastern endemics and many northern and southern species; open dots, high altitude endemics and both northern and southern species.

choria in provinces, regions and domains. I tentatively suggest that the four phytochoria on Fig. 24 represent four local centres of endemism, with the Ethiopian plateau as the least marked one.

Croizat, Nelson & Rosen (1974) have suggested the term 'generalized track' for persistently repeated distribution patterns. Tracks indicated by a fraction of the total number of species are termed 'coincident individual tracks'. As seen from the data presented for non-endemics and outliers, the four phytochoria on Fig. 24 can also be taken to represent such coincident individual tracks.

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