

Notes on the phytogeographical affinities of the southern Kalahari

M. J. A. WERGER*

ABSTRACT

The chorological division of southern Africa as proposed by White (1965, 1971) and Volk (1966) is discussed. Reference is made to distribution patterns of some typical Karoo-Namib taxa as discussed by Volk and to the remarkable distribution of disjunct taxa in the arid zones of Africa. On the basis thereof and of the similarity in the floras of the southern Kalahari and the Karoo-Namib Region, the conclusion is drawn that the chorological division as proposed by Volk (1966) seems justified.

In the early days of phytogeography, chorological units were distinguished on extremely fragmentary evidence. For instance, Grisebach (1872) based his classification of the vegetation of the world largely on the information extracted from the limited number of diaries of early travellers and adventurers. Africa was divided by him into the following five floristically and physiognomically defined vegetation areas: Mediterranean, Sahara, Sudan, Kalahari and Cape. His Sudan area covers most of subsaharan Africa, whereas the Kalahari comprises South-West Africa, Botswana and most of the Transvaal and the Orange Free State. He regarded the Orange River as the boundary between the Kalahari and Cape areas, a decision he based on Burchell's observations. Subsequently extensive collections of herbarium material have contributed decisively to alter and refine the chorological classification of the world. Thus, progressing from the work of pioneers like Engler, Lebrun and others, in recent years a fairly satisfactory phytogeographical classification of the African continent has been achieved. Monod (1957) distinguished three major chorological units or "groupes" in Africa: the Mediterranean group, the tropical African group and the Cape group. The tropical African group he subdivided into four regions: I région soudano-angolane, II région guineo-congolaise, III région afro-alpine, and IV région Karoo-Namib. He further subdivided the Sudano-Angolan Region into three types, the Saharan Type covering North Africa, the Sahelian Type covering Sub-Saharan North Africa, Ethiopia, East Africa, and parts of Rhodesia, Botswana, Angola, South-West Africa and South Africa, and the Sudanian Type, covering the zone between the previous type and the West and Central African rainforest zone. His Sahelian Type is again subdivided into a northern and a southern part, the latter of which comprises the Kalahari, the Transvaal Lowveld and Bushveld, and the Highveld. Within the Karoo-Namib region Monod (1957) recognized three Domains: the Karoo Domain, comprising the area that is also geographically identified with that name except the coastal zone; the Namaqualand Domain, comprising a narrow inland zone in South West Africa along the escarpment, tapering out on the southern part of the Angolan coast; and the Namib Domain, covering the entire arid winter rainfall area of South Africa and the Namib desert.

This phytogeographical division of Africa was largely accepted by White (1965, 1971) and Volk (1966). White modified Monod's classification in so far as he renamed the Sudano-Angolan Region to the Sudano-Zambeian Region. He further regarded the northern Sahelian zone as an impoverished western extension of the Oriental Domain into the Sudanian Domain, whereas he combined the southern Sahelian zone with Monod's Angolo-Zambeian Domain into the Zambeian Domain of the Sudano-Zambeian Region. Besides the Afro-Alpine Region, White also distinguished an Afro-Montane Region (Fig.1).

It is generally accepted that the Central Kalahari has closer floristic affinities with the Zambeian Domain and should be incorporated into the Sudano-Zambeian Region, rather than into the Karoo-Namib Region (Bremekamp, 1935; Monod, 1957; Mendonca, 1961; White, 1965, 1971; Volk, 1966). White (1965) discussed the distribution of the tree species of the savannas and woodlands of the Zambeian Domain. He found that in the Kalahari this woody flora is poorly represented, and that the species usually occur as shrubs, whereas they form well-developed trees in the adjacent part of the Zambeian Domain. He suggested the Kalahari is transitional between the Sudano-Zambeian and Karoo-Namib Regions, but included it on his map in the former Region. Later, White (1971) accentuated this point, and drew the boundary between the two Regions within South Africa and South West Africa just north of the Orange River and from there northwards to southern Angola (Fig. 1). Thus, the south-western boundary between the two Regions coincided closely with the distribution boundary of *Acacia haematoxylon*. Volk (1966) accepted White's chorological division except for this south-western boundary between the Karoo-Namib and the Sudano-Zambeian Regions. He (Volk, 1964, 1966) discussed the distribution of several species belonging to what he called the Afro-Meridional-Occidental floral element, and thus supplied evidence for his suggestion to include the area of the Southern Kalahari as delineated by Leistner (1967) into the Karoo-Namib Region. Besides his discussion on the distribution of *Rhigozum trichotomum*, *Stipagrostis ciliata*, *Parkinsonia africana*, *Aloe dichotoma*, *Stipagrostis hochstetterana*, *Acacia haematoxylon* and *Sesamothamnus guerichii*, which he considered typical for the Afro-Meridional-Occidental or Karoo-Namib Region, Volk listed a considerable number of endemic, monotypic

* Botanical Research Institute, Department of Agricultural Technical Services, Private Bag X101, Pretoria.

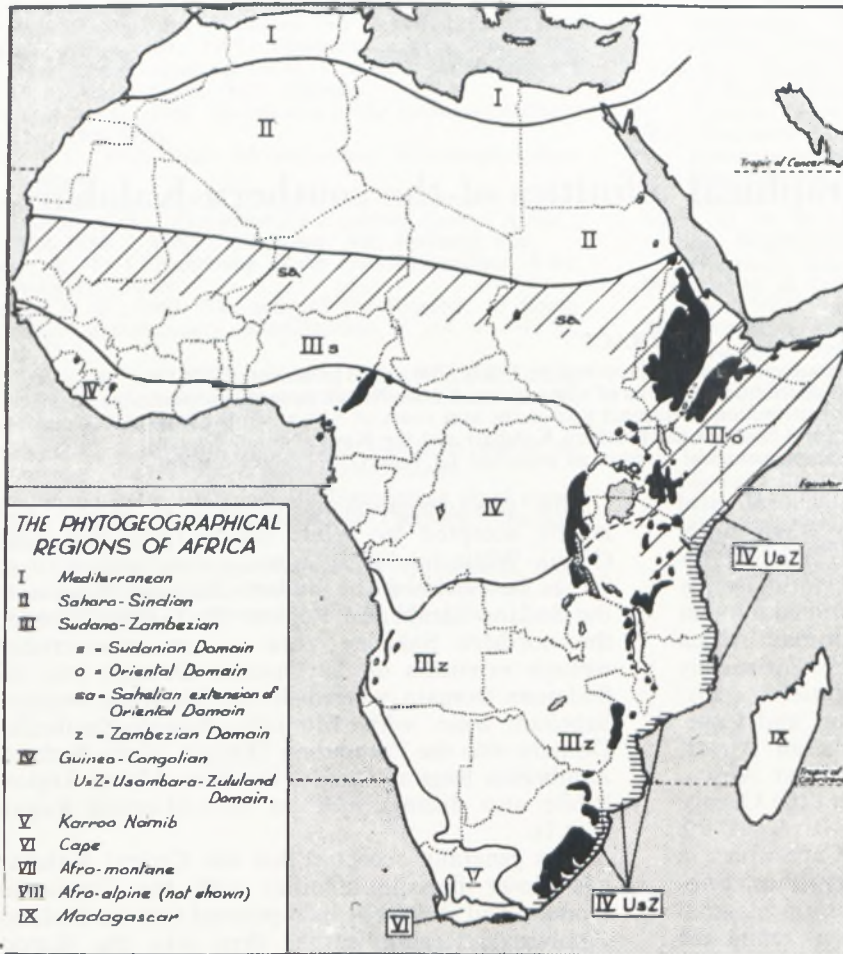


FIG. 1.—Phytogeographical Regions of Africa according to White (from White, 1971).

or small genera that characterize this Region. Based upon this evidence, he drew the boundary between the Sudano-Zambezian and the Karoo-Namib Regions north-east of the southern Kalahari, the western Kalahari Thornveld and the Vryburg Shrub Bushveld (Volk, 1966) (Fig. 2).

Apart from the distribution patterns discussed by Volk, there is another important feature of the flora of the southern Kalahari that supports its inclusion in the Karoo-Namib Region. As pointed out by Range (1932), De Winter (1966, 1971), Verdcourt (1969) and particularly by Monod (1971), a large number of taxa that occur in the Karoo-Namib Region also occur in the northern Sahelian zone, the Oriental Domain and the Saharo-Sindian Region. In southern Africa these disjunct taxa occur in the Karoo-Namib Region as delineated by White (1971) as well as in the areas that Volk (1966) has additionally included in this Region. However, these taxa are absent or virtually so in the remainder part of the Zambezian Domain as delineated by Volk (Fig. 2).

Recently Tolmachev (1971) pointed out that, in various floras of the same floristic region, the sequence of importance of those families that comprise most of the species of a flora is remarkably constant. Also the percentages of species contributed to a flora by these families are fairly constant. This is independent of the total number of species of a flora or the extent of its area. These premises provide a

means of testing the floristic affinity of the southern Kalahari with the two floristic Regions in question. Since Acocks's Veld Types (1953) are floristically well-circumscribed units (comp. Grunow & Morris, 1969), and rather complete species lists of several Veld Types are available, they provide a suitable basis for a comparison of their floristic composition with that of the southern Kalahari. Therefore, the composition of the flora of the southern Kalahari, based on the check-list produced by Leistner (1967), and a species list of the Vryburg Shrub Bushveld with invading Karoo species [Acocks, Veld Type 17 (2)], was compared with the floras of the Karroid Broken Veld (Acocks, Veld Type 26), the Central Upper Karoo (Acocks, Veld Type 27), the Arid Karoo (Acocks, Veld Type 29) and the Orange River Broken Veld (Acocks, Veld Type 32) as floras that form part of the Karoo-Namib Region, and with the flora of the Central variation of the Bankenveld (Acocks, Veld Type 61,b), the flora of the Jack Scott Nature Reserve, located in the Bankenveld (Coetzee, 1972), and the flora of the Pretoria magisterial district (B.R.I., n.d.), as floras that form part of the Zambezian Domain of the Sudano-Zambezian Region.

The numbers of species of the first nine families that contribute the most species to their floras are shown in percentages in Tables 1, 2 and 3.

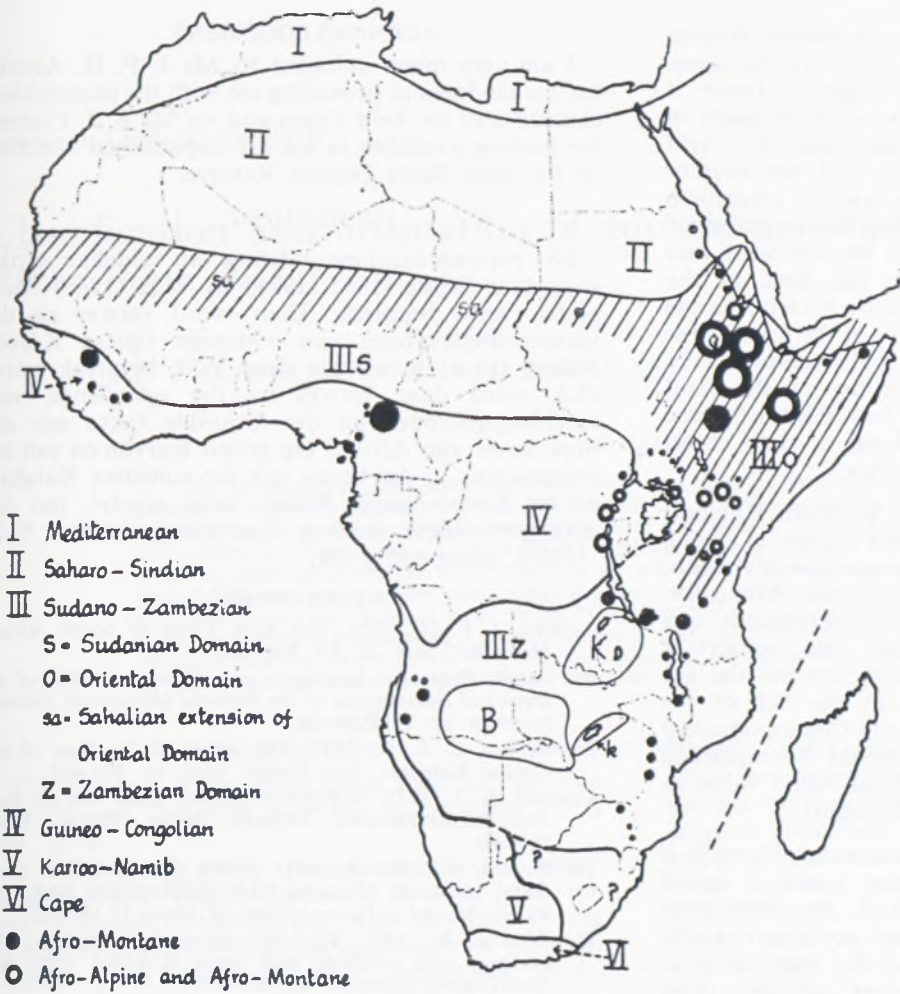


FIG. 2.—Phytogeographical Regions of Africa according to Volk (from Volk, 1966).

TABLE 1.—Karoo-Namib Region (number of species per family as percent)

Flora of Veld Type	26	27	29	32
Total No. of species	1 195	715	523	974
Asteraceae.....	17,9	20,7	16,8	13,5
Poaceae.....	8,4	10,8	9,8	9,5
Aizoaceae.....	11,1	6,9	9,4	7,6
Liliaceae.....	8,0	9,1	8,2	7,6
Scrophulariaceae.....	4,8	5,3	5,2	5,3
Fabaceae.....	3,6	2,9	4,8	5,0
Chenopodiaceae.....	—	2,7	3,4	—
Asclepiadaceae.....	2,6	—	3,1	3,5
Crassulaceae.....	4,4	2,5	—	3,0
Sterculiaceae.....	—	2,2	3,1	—
Euphorbiaceae.....	2,4	—	—	2,9
Total.....	63,2	63,1	63,8	57,9

TABLE 2.—Southern Kalahari and Vryburg Shrub Bushveld (Number of species per family as percent)

Flora	S. Kalahari	17 (2)
Total No. of species	438	709
Poaceae.....	14,6	12,6
Asteraceae.....	11,9	14,3
Fabaceae.....	7,8	5,9
Liliaceae.....	6,2	7,5
Aizoaceae.....	4,3	5,1
Scrophulariaceae.....	4,8	3,7
Sterculiaceae.....	2,7	3,1
Asclepiadaceae.....	—	2,7
Cucurbitaceae.....	2,5	—
Euphorbiaceae.....	2,3	2,4
Total.....	57,1	57,3

TABLE 3.—Zambeian Domain (Number of species per family as percent)

Flora	61, b	J. Scott	Pretoria
Total No. of species	1 045	N.R. 522	m.d. 1 666
Poaceae.....	13,2	16,1	13,2
Asteraceae.....	14,7	12,3	10,7
Fabaceae.....	7,8	6,7	8,9
Liliaceae.....	5,2	5,4	4,1
Cyperaceae.....	4,8	4,2	4,5
Asclepiadaceae.....	3,6	2,7	5,2
Scrophulariaceae.....	3,3	2,5	2,8
Rubiaceae.....	2,4	2,7	2,3
Euphorbiaceae.....	2,2	2,3	2,3
Total.....	57,2	54,9	54,0

From the tables it can firstly be noted that all the floras discussed have a striking similarity. Amongst the most important nine families, several are shared by all the floras. Also, the total percentage of species contributed to their floras by these first nine families is rather similar, although there tends to be a decrease in this figure from the more temperate floras in the south-western part of South Africa towards the more tropical north-eastern floras.

Of the four floras of the Karoo-Namib Region compared, the first four families listed are the same, although their sequence differs slightly. There is some variation in families that are sixth to ninth in the sequence. The Central Upper and the Arid Karoos have the Chenopodiaceae and the Sterculiaceae in common, whereas these families contribute respectively 1,9% and 1,8% of the total number of species in the flora of the Karroid Broken Veld, and respectively 1,9% and 2,1% in the flora of the Orange River Broken Veld. The family Asclepiadaceae is absent from the first nine families of the flora of the Central Upper Karoo, where it only scores 1,5%. Crassulaceae is absent from the list of the Arid Karoo, where it scores 1,3%, and Euphorbiaceae scores 1,4% and 1,7% in the floras of the Central Upper and Arid Karoos respectively.

Table 2 of the floras of the Southern Kalahari and the Vryburg Shrub Bushveld shows a strong similarity with Table 1 of the Karoo-Namib Region. Poaceae, Asteraceae, Fabaceae, Liliaceae, Aizoaceae, Scrophulariaceae, Sterculiaceae, Asclepiadaceae and Euphorbiaceae reappear amongst the important families, and the only major differences are the appearance of the Cucurbitaceae in the list of the Southern Kalahari and the absence of Chenopodiaceae and Crassulaceae, although it should be remarked that the Chenopodiaceae scored the same value as Euphorbiaceae in the Southern Kalahari.

Table 3 of the floras of the Zambezi Domain is considerably different from Tables 1 and 2. In all three lists represented in Table 3, the nine most important families are the same and occur in virtually the same sequence. Remarkable is the appearance of the Cyperaceae and the Rubiaceae amongst these nine most important families. In the floras of Table 1 these two families only scored between 0,6% and 1,8% and between 0,6% and 1,3% respectively, whereas in the floras of Table 2 these values were between 1,4% and 1,7% and between 1,0% and 1,6% respectively. Other remarkable differences between Tables 1 and 2 on the one hand and Table 3 on the other are the lower values scored by the Liliaceae and particularly the absence of Aizoaceae in Table 3. Aizoaceae scored only between 0,2% and 0,8% in the floras of Table 3. Chenopodiaceae, Sterculiaceae and Crassulaceae also scored low values here.

It is clear that comparison of the floras of the three different areas leads to the conclusion, that the floras of the southern Kalahari and the Vryburg Shrub Bushveld have considerably greater affinities with those of the Karoo-Namib Region than with those of the Zambezi Domain of the Sudano-Zambezi Region.

Thus, based upon the results of the comparison of floristic similarity, the distribution of the disjunct arid taxa and distribution patterns of several typical taxa as discussed by Volk (1964, 1966), Volk's (1966) inclusion of the southern Kalahari and the Vryburg Shrub Bushveld in the Karoo-Namib Region seems fully justified.

ACKNOWLEDGEMENT

I am very much indebted to Mr J. P. H. Acocks for his kindness in providing me with his unpublished checklists of six Veld Types and to Mr B. J. Coetzee for making available to me his unpublished checklist of the Jack Scott Nature Reserve.

OPSOOMING

Die plantegeografiese indeling van suidelike Afrika soos deur White (1965, 1971) en Volk (1966) voorgestel, word bespreek. Daar word verwys na die verspreidingspatrone van sommige tipiese Karoo-Namib taksa, soos hulle deur Volk bespreek word. Ook word daar verwys na die opvallende verspreidingspatrone van die disjunkte taksa oor die droë sones van Afrika. Op grond hiervan en van die ooreenkoms in die floras van die suidelike Kalahari en die Karoo-Namib Streek word afgelei, dat die plantegeografiese indeling soos voorgestel deur Volk (1966), geregverdig lyk.

REFERENCES

- ACOCKS, J. P. H., 1953. The Veld Types of South Africa. *Mem. Bot. Surv. S. Afr.* No. 28.
- BOTANICAL RESEARCH INSTITUTE. n.d. *Systematic list of the species of Angiosperms of the Pretoria Magisterial District.* mimeogr. pp. 19. Pretoria.
- BREMEKAMP, C. E. B., 1935. The origin of the flora of the Central Kalahari. *Ann. Transv. Mus.* 16: 443-455.
- COETZEE, B. J., 1972. 'n *Plantsosiologiese studie van die Jack Scott-Natuurreservaat.* Unpubl. M.Sc. Thesis. Univ. Pretoria.
- DE WINTER, B., 1966. Remarks on the distribution of some desert plants in Africa in VAN ZINDEREN BAKKER Sr., E. M. (ed.): *Palaeoecology of Africa* 1: 188-189.
- DE WINTER, B., 1971. Floristic relationships between the northern and southern arid areas in Africa. *Mitt. Bot. Staatssamml. München* 10: 424-437.
- GRISEBACH, A., 1872. *Die Vegetation der Erde nach ihrer klimatischen Anordnung.* 2 Bde. Leipzig: Engelmann.
- GRUNOW, J. O. & MORRIS, J. W., 1969. Preliminary assessment of ecological status of plant species in three South African veld types. *J. S. Afr. Bot.* 35: 1-12.
- LEISTNER, O. A., 1967. The plant ecology of the Southern Kalahari. *Mem. Bot. Surv. S. Afr.* No. 38.
- MENDONÇA, F. A., 1961. Índices fitocorológicos da vegetação de Angola. *Garcia de Orta* 9: 479-483.
- MONOD, T., 1957. *Les grandes divisions chorologiques de l'Afrique* Londres: C.C.T.A./C.S.A. Publ. No. 24.
- MONOD, T., 1971. Remarques sur les symmetries floristiques des zones sèches nord et sud en Afrique. *Mitt. Bot. Staatssamml. München.* 10: 375-423.
- RANGE, P., 1932. Die Flora des Namalandes. I. *Feddes Repert. (Repert. Spec. Nov. Regn. Veg.)* 30: 129-158.
- TOLMACHEV, A. I., 1971. Über einige quantitative Wechselbeziehungen der Floren der Erde. *Feddes Repert.* 82: 343-356.
- VERDCOURT, B., 1969. The arid corridor between the north-east and south-west areas of Africa in VAN ZINDEREN BAKKER Sr., E. M. (ed.): *Palaeoecology of Africa* 4: 140-144.
- VOLK, O. H., 1964. Die afro-meridional-occidentale Floren-Region in Südwestafrika. in KREEB, K. (ed.): *Beiträge zur Phytologie* p. 1-16.
- VOLK, O. H., 1966. Die Florengebiete von Südwestafrika. *J.S.W.A. Wissensch. Gesellsch.* 20: 25-58.
- WHITE, F., 1965. The savanna woodlands of the Zambezi and Sudanian Domains. *Webbia* 19: 651-681.
- WHITE, F., 1971. The taxonomic and ecological basis of chorology. *Mitt. Bot. Staatssamml. München* 10: 91-112.