AMONGST AFRICA'S GIANTS

Botanical notes from a journey to Mount Kilimanjaro.

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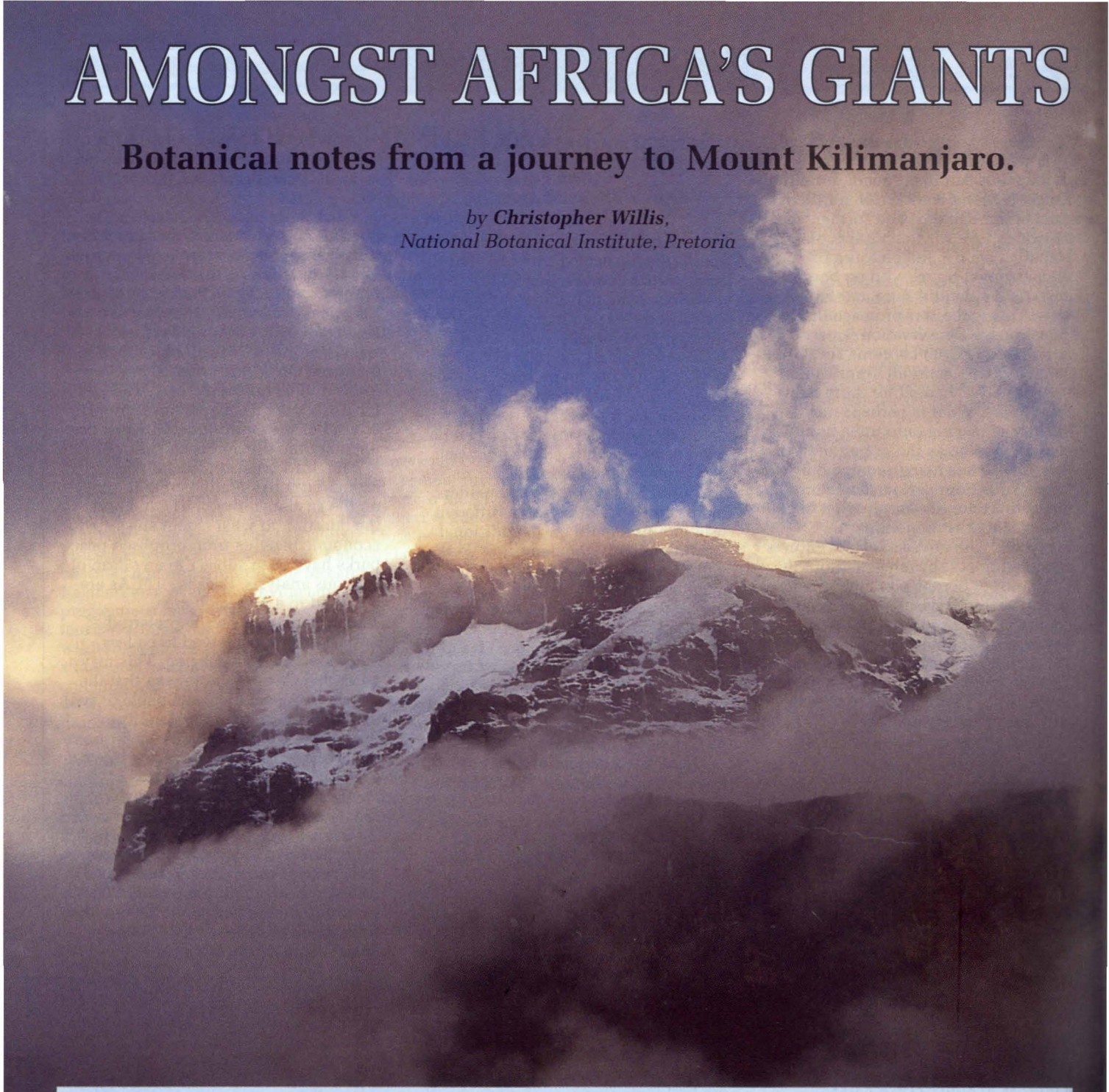
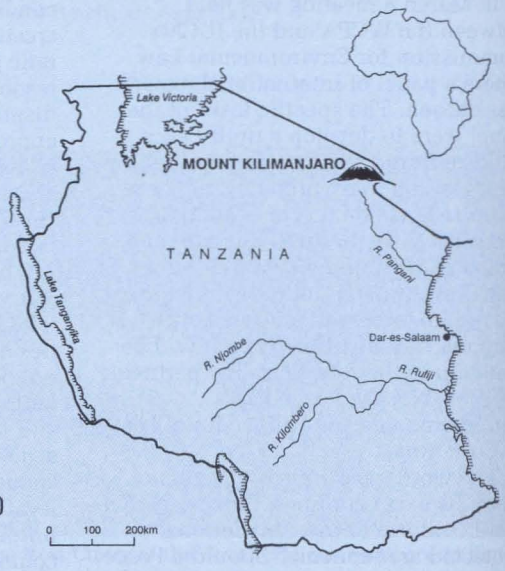


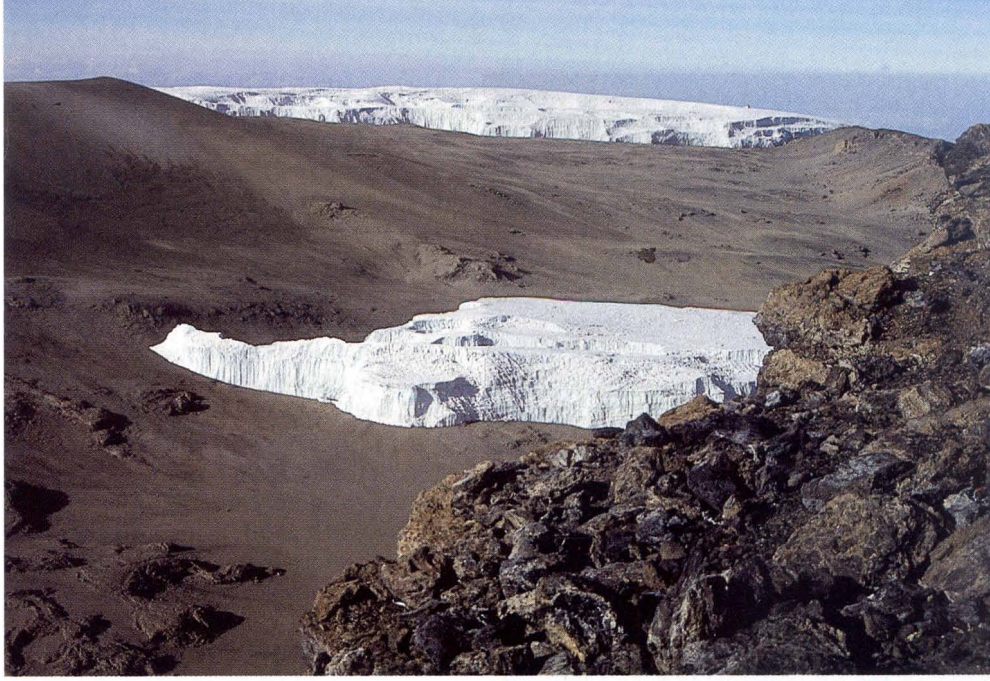
'Snow-capped mountains in eastern equatorial Africa? Impossible!' was the reaction of several members of the Royal Geographical Society in response to missionaries Rebmann and Krapf's accounts of snow-capped mountains close to the equator, published in the *Church Missionary Intelligencer* in 1849. It took another thirteen years for documents from an expedition in 1861 into the African interior by the German adventurer Baron Karl Klaus von der Decken, accompanied by a British geologist, Richard Thornton, to provide authoritative confirmation of their existence. Kilimanjaro is one of only three mountains in Africa that support glaciers, the other two being Mount Kenya and the Ruwenzoris. Glaciers cover only about twenty square kilometres on the African continent, and just four square kilometres on Mount Kilimanjaro. These are apparently diminishing, possibly because the equatorial sun is melting them, or because of the lack of snowfall in the rainy seasons or warming of the earth's surface over the last 200 years.



Mount Kilimanjaro is situated in north-eastern Tanzania, close to the Kenyan border. Amboseli National Park lies just across the border in southern Kenya. The northern slopes of Mount Kilimanjaro are often depicted in clichéd safari photographs (usually with elephants or giraffe amongst acacias in the foreground) taken with telephoto lenses from Amboseli National Park. Adapted by Suzanne Enslin from a map published (1991) in W.D. Newmark's *The Conservation of Mount Kilimanjaro.*

The ultimate challenge for any climber in Africa must surely be to reach the summit of the highest mountain in Africa, and one of the world's highest free standing mountains, Mount Kilimanjaro (affectionately known as 'Kili'). Situated three degrees and some 330 km south of the equator in northern Tanzania, Mount Kilimanjaro, with it's highest point, Uhuru Peak, measured at 5895 m (19 340 ft) above sea level, holds a unique place in both the Western and African psyche. The mountain has featured in stories, films and even popular songs, including 'Africa' by the group Toto, and 'Kilimanjaro' by Juluka. I had the opportunity, in February this year, to climb Africa's highest mountain – via the less popular, albeit more scenic, Machame Route (also known as the 'Whiskey' Route, as opposed to the more popular Marangu or 'Coca-Cola' Route), a total distance of about 80 km, with an altitudinal range of about 9500 m. To put the height of the mountain into perspective, southern Africa's highest point, Lesotho's, Thabana Ntlenyana, is a mere 3482 m. Walking seven to eight hours per day, single file on a well-worn path as part of a group of eleven climbers does not allow much spare time for botanizing. On days four and five, we reached the summit of Kilimanjaro and descended the same day, walking for twenty-three hours, with two hours sleep and covering an altitudinal range of 4740 m (from Barranco Camp at 3950 m via Barafu (4600 m) to the summit at 5895 m and back down to Mweka Camp at 3100 m)!

Despite its popularity (18 000 visitors each year which is more than 300 per week), very little popular literature is available on the flora of Mount Kilimanjaro and information remains scattered in inaccessible scientific journals or regional field guides. It is hoped that this account of the flora of Kilimanjaro will serve as useful background information for anyone interested in plants and attempting Kilimanjaro in the future.



Above. **Kilimanjaro's glaciers. The Furtwangler Glacier (*ca* 5750 m) in the centre and the large Northern Icefield can be seen on the horizon.**
Facing page. **Fire and ice. Sunset on Kibo, Mount Kilimanjaro.** Photos: C.K. Willis.

Kilimanjaro National Park and the 'Three Peaks'

A large portion of the mountain, the 756 km^2 area above the 2700 m contour, is conserved within the Kilimanjaro National Park, managed by Tanzania National Parks. The park was established in 1973 and officially opened in 1977. It has six corridors or rights of way through the Kilimanjaro Forest Reserve which was established in 1921. In recognition of its beauty, cultural and spiritual significance and size, Mount Kilimanjaro was declared a World Heritage Site in 1989. Mount Kilimanjaro is composed of three extinct volcanoes: Kibo (considered by some to be dormant, rather than extinct) at 5895 m in the centre, Mawenzi at 5149 m (16 893 ft) in the east; and Shira at 3962 m (13 000 ft) in the west. The three peaks represent three generations of volcanic activity, Shira the oldest (and most eroded), and Kibo the youngest. Whereas the older two have been largely destroyed by erosion, Kibo is a perfectly shaped cone with a caldera, about 2 km wide, in the centre of which is a small secondary eruption cone with its own crater. The majestic mountain, which ceased growing 450 000 years ago, rises 4800 m above the surrounding plains which average around 1000 m above sea level. The longest axes of Mount Kilimanjaro, running north-east to south-west, are about 60 km long and 40 km across.

Climate

Mount Kilimanjaro is regarded as the driest of the tall East African mountains. Unlike Mount Kenya and the Ruwenzoris, both of which have several small lakes or tarns, Kilimanjaro has only one permanent tarn, located close to Mawenzi. Rainfall varies both with aspect and altitude. Most rain falls between March and June, and it is during this period that rains fall at the base of the mountain, and snow falls at the top of the mountain. The shorter rainy period is from October to December. January and February are usually dry, warm and clear with brief rainshowers which make good climbing conditions.

Ninety six percent of the water on Kilimanjaro originates in the forest zone, where it percolates through the soil to emerge as springs lower down the mountain. Kilimanjaro's forests receive about 2000 mm rainfall per annum on the southern slopes, with the same forests receiving about 1000 mm on the northern and western slopes. Above 1500 m the rainfall decreases with altitude so that the alpine zone receives between 250 and 125 mm, resulting in an alpine desert in the upper reaches of the mountain. At the summit, most of the precipitation falls as snow, rather than as rain.

Botanical exploration

Several plant collections were made on Mount Kilimanjaro between 1861 and the early 1900s, the most notable being those of Von der Decken, Johnston, Meyer and Volkens. Many of the plants collected during the late 1800s on the mountain were described in Europe by Engler, and named after the individuals who collected them.* Many plants, as could be expected, have the species name 'kilimandscharica' or 'kilimanjari'.

Kilimanjaro's vegetation

Mount Kilimanjaro has a rich and diverse flora which includes over 1800 species of flowering plants

Above. **The endemic *Impatiens kilimanjari* subsp. *kilimanjari* (Balsaminaceae) growing in the montane forest belt on the southern slopes of Kilimanjaro.**

Below. ***Carduus keniensis*, a member of the Asteraceae family, growing in the ericaceous belt on Kilimanjaro. This species belongs to the same genus as the common European thistles.**

within 163 families and 760 genera, and an unusually high species diversity among lower plants of approximately 720 species of bryophytes (596 known species) and lichens (120 species).

Five vegetation belts can be recognized. Olov Hedberg, the renowned Swedish botanist who described the vegetation belts of the East African mountains in 1951, defined a vegetation belt as an 'altitudinal region' which can be traced on all (or most) mountains of sufficient height in a definite part of the world, as for instance the montane forest belt on the East African mountains. Although Hedberg only recognized three vegetation belts on Kilimanjaro (montane forest, ericaceous belt and the alpine belt), Mwasaga in 1991 included two additional vegetation belts, namely the woodland and bushland belt, and the cultivated belt.

The upper limit of the **woodland and bushland belt** ranges between 900 m (southern slopes) and 1500 m (northern slopes). It is characterized by a mosaic of *Acacia* bushland and *Combretum/Terminalia* woodland. The **cultivated belt** more or less encircles the mountain and reaches its highest point on the southern slope (1900 m), but in most areas extends no higher than 1700 m. Crops cultivated in this zone include coffee, bananas, maize, beans, millet, potatoes, cabbage, carrots, beets, onions and tomatoes.

The lower boundary of the **montane forest belt** is approximately 1700 m on the southern side and 2200 m on the northern side. The upper boundary reaches nearly 3000 m along the southern side and 2800 m on the western and northern sides. Trees characteristic of this belt include *Xymalos monospora*, *Tabernaemontana ventricosa*, *Macaranga capensis* var. *kilimandscharica*, *Myrica salicifolia*, *Maytenus undata*, *Prunus africana*, East African pencil cedar *Juniperus procera* and the East African redwood *Hagenia abyssinica*. Other tree species, several of which are also known from southern Africa, include *Ilex mitis*, *Podocarpus milanjianus*, *Ocotea usambarensis*, *Olea africana*, *Nuxia congesta*, *Agauria salicifolia*, the Cape Chestnut *Calodendrum capense* and *Hypericum revolutum*. The montane forest belt receives about 2000 mm of rainfall per annum on the southern slopes, and contains several endemic plants. One species which was flowering prolifically during our visit was *Impatiens kilimanjari* subsp. *kilimanjari* with its brilliant red and yellow flowers shining in the forest undergrowth. An endemic *I. kilimanjari* subsp. *pocsii* was described by Christopher Grey-Wilson from the upper montane forest on the northern side of Mt Kilimanjaro as recently as 1997. The pink-flowered *Impatiens pseudoviola* may also be seen here. Other shrubs and herbs include *Mimulopsis kilimandscharica* and *Solanecio mannii*. The forest zone includes many lichens (*Usnea*), mosses and ferns like *Asplenium actiniopteroides*, *A. volkensii* and tree ferns, *Cyathea* (see photo on p. 166). A unique community of bryophytes is known to develop on the stems of the tree fern *Cyathea manniana*. The giant *Lobelia giberroa* grows as scattered individuals along streams and moist depressions in the montane forest zone from 1550 m to 3000 m.

Bernard Verdcourt of the Royal Botanic Gardens, Kew, apparently first came across *Helichrysum meyeri-johannis* on reaching the top of Mount Kilimanjaro in the early 1970s. The story goes that the porters 'presented members of his team with bright garlands made from the capitula of this plant woven into a wreath of stems from a species of *Lycopodium*'. Verdcourt's 'wreath' can still be found amongst the collections in the Sir Joseph Banks Museum for Economic Botany at Kew. This species, named after Hans Meyer, is common in damp to dryish alpine grassland between 2600 and 4250 m. Flowering at almost any time of the year, it has also been recorded on Mount Elgon, Cherangani Hills and Mount Kenya. Drawing by Helen Haywood (from *Curtis's Botanical Magazine* 12(1), February 1995).

The forest zone on Kilimanjaro is less differentiated than on other East African mountains and contains neither a bamboo (*Arundinaria alpina*) nor *Hagenia-Hypericum* zone. On most other East African mountains, such as Mount Kenya (see Burrows & Burrows in *Veld & Flora* **80**(2), 1994), Mt Elgon and Mt Ruwenzori, there is a bamboo forest zone between 2200 and 3200 m. On Kilimanjaro a few very small patches are reported to exist only on the northern and north-western slopes. It has been estimated that 69% of the flowering plant species found above the cultivated zone on Mount Kilimanjaro are restricted to the montane forest. This figure is even higher for the bird (78%) and larger mammal species (80%).

The **ericaceous belt** extends from the upper limit of the forest zone, at about 3000 m, to an elevation of approximately 4000 m. The ericaceous belt of Kilimanjaro contains two zones, the moorland zone and the ericaceous-shrub zone. The moorland zone (between 2800 and 3250 – 3400 m) consists of tussock grassland with scattered low trees or shrubs of *Erica excelsa* and *Erica arborea*, together with *Artemisia afra*, *Stoebe kilimandscharica*, *Helichrysum newii*, *Helichrysum meyeri-johannis* (see accompanying painting) and the conspicuous spiny rosette plant *Carduus keniensis* also found on Mount Elgon, the Aberdares and Mount Kenya.

The dominant shrubs of the ericaceous-shrub zone are the same species as found in the moorland zone, intermingled with *Protea caffra* subsp. *kilimandscharica* (the commonest *Protea* species on the mountain), *Adenocarpus mannii*, *Anthospermum usambarense* and, in boggy areas and along streams, the sedge *Carex monostachya* (Cyperaceae), *Senecio johnstonii* subsp. *johnstonii* var. *cottonii* and *S. johnstonii* subsp. *johnstonii* var. *kilimanjari*. This zone extends from the upper limit of the moorland zone at about 3250 m up to 3900 m or 4000 m. It is generally accepted that the present appearance of the ericaceous belt has largely been attributed to fire, caused by man. As a result of frequent fires along the upper regions of the montane forest, the ericaceous belt has replaced the montane forest in many areas.

The **alpine belt** extends from the top of the ericaceous belt at about 4100 m to the upper altitudinal limit of plant growth. The highest recorded flowering plant on Kilimanjaro has been *Helichrysum newii* at 5670 m in Kibo's crater, demonstrating an ability to survive in highly adverse environments. Only about fifty-five species of higher plants have been recorded above 4000 m on Kilimanjaro, compared with many hundreds in the lower zones. Important genera include *Senecio, Lobelia*, the sclerophyllous shrubs *Alchemilla* and the everlastings *Helichrysum*, acaulescent (absence of an above-ground stem) rosette plants of the genera *Haplocarpha*, *Haplosciadium* and *Dianthoseris*, as well as grass tussocks of the genera *Festuca*, *Agrostis*, *Koeleria* and *Pentaschistis*. In its lowest part up to about 4300 m, a *Helichrysum* community dominates, composed mainly of *Helichrysum newii* and other *Helichrysum* species. Another important shrub of this belt is the yellow-flowered *Euryops dacrydioides*. This belt is also home to Kilimanjaro's giant senecios and lobelias.

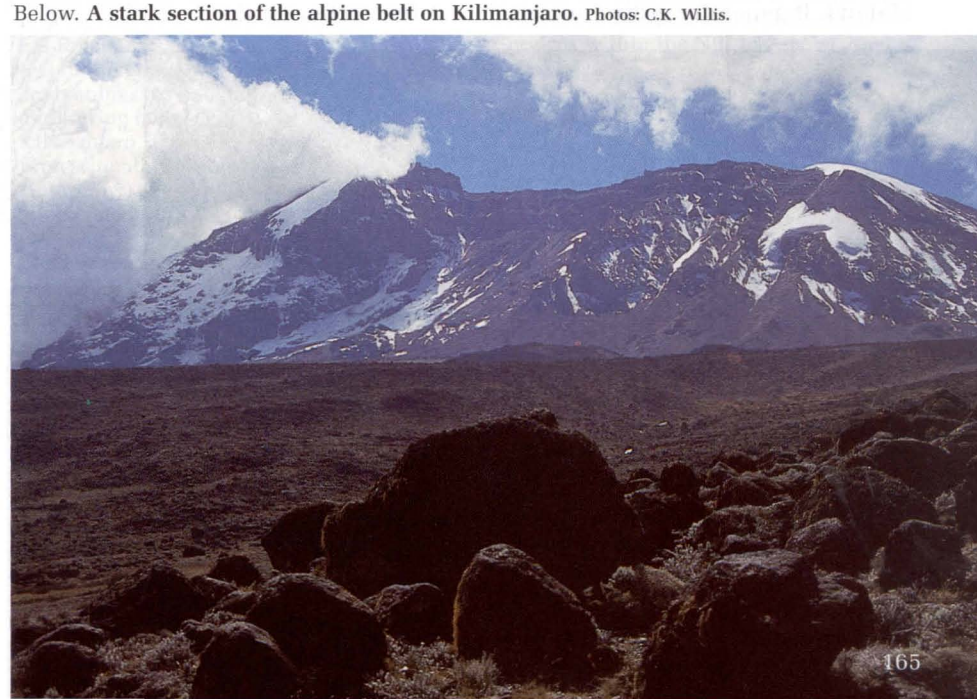
An interesting process is associated with the alpine belt. As a result of the nightly freezing and the daily thawing of the upper layer of the soil, ice crystals that form in the soil at night loosen and move the topsoil of the alpine semi-desert and desert. This form of 'solifluction' can be tolerated only by organisms that lie loosely on the ground and that can easily change their position. Some mosses (*Grimmia*) change their position daily as the soil surface moves, and as a result, ball-shaped colonies develop with shoot apices in all directions. Such 'moss balls' have been described in other arctic and desert areas of the world.

Mosses, liverworts and ferns

Of the 596 known bryophyte species, 415 are mosses and 181 species are liverworts. Twelve species of bryophytes are strict

Above. **One of the few flowering plants observed above 4600 m. This member of the Asteraceae was observed flowering at *ca* 4800 m, between Barafu Camp and Stella Point on Kibo.**

Below. **A stark section of the alpine belt on Kilimanjaro.** Photos: C.K. Willis.



endemics to Mount Kilimanjaro and represent 2% of the total bryoflora. In terms of Afroalpine endemics, though, there are eighty-three species of Afroalpine endemic mosses and twenty species of Afroalpine endemic liverworts. The lower plants serve an important function in terms of regulating the water flow and reducing the loss of water through evaporation on Mount Kilimanjaro. Work on the ferns of Mount Kilimanjaro has revealed that there are over 130 species of ferns and fern allies on the mountain, with the highest richness recorded in the montane forest belt on the southern slopes, especially between 2000 and 2300 m. The abundance of ferns decreases abruptly above 2900 m and below 1100 m. The highest fern on Kilimanjaro is *Cystopteris fragilis* (recorded by Hedberg at 4750 m), the highest pteridophyte of Africa and probably the hardiest of alpine ferns.

Africa's giants

The plants for which Kilimanjaro is most famous are the giant senecios or groundsels (previously classified in the genus *Dendrosenecio*), *Senecio johnstonii* subsp. *johnstonii* var. *johnstonii*, *Senecio johnstonii* subsp. *johnstonii* var. *cottonii* and *S. johnstonii* subsp. *johnstonii* var. *kilimanjari*, and the giant lobelias, *Lobelia giberroa*, *L. deckenii* subsp. *deckenii* (see cover) and *L. deckenii* subsp. *incipiens*. As a rule the giant senecios and giant lobelias grow in moist, open sites and possess an apical rosette of leaves.

Lobelia giberroa is certainly the most widespread of the giants, occurring from northern Ethiopia to the Viphya Mountains in northern Malawi. It generally grows in montane forests as scattered individuals between 1550 and 3000 m. The rhizomatous *L. deckenii* subsp. *deckenii* occupies moist sites in the ericaceous and alpine zones (3000–4000 m) whilst *L. deckenii* subsp. *incipiens* grows in the upper montane forest zone (2700–3150 m). *Senecio johnstonii* subsp. *johnstonii* var. *johnstonii* grows in the upper portion of the montane forest zone as a many-branched tree up to 8-10 m tall, and smaller individuals are found in the lower part of the ericaceous belt (2500–3100 m). The other two varieties of giant *Senecio* tend to have thicker stems, fewer branches, and persistent dead leaves (marcescent leaves) surround the thicker stems or branches. *S. johnstonii* subsp. *johnstonii* var. *kilimanjari* spans the ericaceous belt (3000–3800 m), whereas *Senecio johnstonii* subsp. *johnstonii* var. *cottonii* grows in the alpine zone (3700–4500 m). The most spectacular and largest population of giant groundsels I observed on the Machame Route was in the Barranco Valley, where *Senecio johnstonii* subsp. *johnstonii* var. *cottonii* grew alongside *L. deckenii* subsp. *deckenii*. Research on the giant groundsels has revealed that the average annual stem elongation rate is about 2.5 cm. Specimens can attain heights of 10 m: the tallest specimens are about 250 years old. (The weakly expressed seasons in the tropical alpine zone mean that annual rings or other rhythmical anatomical features cannot be used for age determination in these plants.) Tamás Pócs, a researcher on the bryophyte flora of Mount Kilimanjaro, has observed about forty epiphytic species on the giant *Senecio* trunks. Chloroplast DNA so far examined suggests that the giant senecios at high altitude originated on Mt Kilimanjaro, with subsequent dispersion to the adjacent Mt Meru, north to the Kenyan mountains (Aberdares, Mt Kenya, Cherangani Hills and Mt Elgon), west to the Ruwenzori Mountains, and then south to the Virunga Mountains and Mount Kahuzi. This dispersion and subsequent speciation all occurred in the past million years.

Convergent evolution has resulted in similar giant stem rosette plants evolving independently in the richest high-mountain flora of the world, the 'páramo' vegetation, which is restricted to the northern Andes of South America and adjacent southern Central America. Members of the genus *Espeletia* (Asteraceae), the *frailejón* (literally, 'big friar' - so called because of the greyish woolly coat of pubescence) are the classical example, very similar to the giant groundsels of eastern equatorial Africa.

Vegetation classification

Much has been written about the zonation of the vegetation on Africa's tropical mountains, as well as the links between the 'Cape' Flora, the Afromontane Region and the flora associated with the

Above. **Giant senecios or groundsels, *Senecio johnstonii* subsp. *johnstonii* var. *cottonii* on Kilimanjaro, likened by Otto Kersten to 'dancing spectres'. Taken from a translation of Otto Kersten's account of his journey up Kilimanjaro with Baron von der Decken in 1862. (Originally published in German in the 1870s. The translation was published in 1965 in *Tanganyika Notes and Records* 64.)**
Left **A grove of tree ferns in the montane forest belt on the Mweke Route, southern slopes.** Photo: C.K. Willis.

The giant senecio or groundsel, *Senecio johnstonii* subsp. *johnstonii* var. *cottonii* in the Barranco Valley, Kilimanjaro, at an altitude of about 3900 m. Photo: C.K. Willis.

Afroalpine or Alpine belt. The use of different terminologies by a range of scientists can easily be confusing to someone trying to make sense of the various floras and publications concerning Africa's temperate flora. Considering the similarities and differences between the various montane floras in sub-Saharan Africa, Prof. Peter Linder in 1990 indicated that 'The temperate flora of Africa shows a degree of homogeneity across its distribution range that suggests that its recognition as an "Afrotemperate Region" might be profitable. This homogeneity is reflected ecologically by similar vegetation structural changes in response to disturbance, and phytogeographically by a suite of genera of shrubby and herbaceous plants and species of trees that are common to all the Afromontane areas.' He went on to suggest that within this so-called 'Afrotemperate Region', various centres of endemism, such as the Cape Floristic Region, the Afromontane Centre and the Drakensberg and surrounding mountains, could be recognized. Much research still needs to be done to understand many aspects of Africa's temperate flora, but at least Linder's suggestion has the benefit of placing Africa's temperate vegetation into the context of a pan-African classification, as opposed to considering each area as a separate unit which is classified individually and not in relation to temperate vegetation in other areas of the African continent.

Mount Kilimanjaro, like all high mountains around the world, has many moods, and although it might not be the most diverse of Africa's high mountains in terms of plant diversity, it does nevertheless display very clearly the distinctive zonation of vegetation so typical of Africa's high mountains. It is certainly a must for anyone with an interest in phytogeography and mountains, particularly from an African perspective. Of course you can also climb it 'because it is there'.

Acknowledgements
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Further reading

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*A list of early Kilimanjaro plant hunters and some of the plant taxa commemorating them is available on request from the Publications Manager at the Botanical Society, Private Bag X10, Claremont, 7735. Tel (021) 797 2090, fax (021) 797 2376, e-mail <botsocsa@gem.co.za>.

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Christopher Willis is a graduate of the University of Cape Town and University of Pretoria. He spent six years lecturing in phytogeography and plant conservation at the University of Venda before taking up the post of Regional Coordinator of the Southern African Botanical Diversity Network (SABONET) Project in the National Botanical Institute (NBI), Pretoria, in 1996. He was appointed to the position of Director: Gardens and Horticultural Services within the NBI in August 2000.

Christopher Willis next to a giant lobelia between Machame and Shira Camps, Kilimanjaro (at about 3500 m).
Photo: E. Romanowska.