WELWITSCHIA MIRABILIS

by ***Ernst van Jaarsveld****, Kirstenbosch*

Naby Springbokwasser
het ek die vlate reg gelees?
Kan ysterslingers plante wees?
maar digterby weet ons gewis:
Welwitschia mirabilis
Hennie Oucamp

Remarkable evolutionary engineering has enabled a cone-bearing tree to adapt to life in the harsh Namib Desert. A once soaring tree has been re-designed as a stunted woody plant with two leaves, perfectly at home in its cool foggy desert. Nothing has been left out, and there are no unnecessary parts or functions in the design.

Welwitschia mirabilis was discovered by Austrian botanist Friedrich Welwitsch in 1862 in the Namib Desert of southern Angola, and described by J.D. Hooker in 1863. It was so bizarre that it was placed not only in a new genus but in a family of its own, the Welwitschiaceae, Hooker describing it as 'arrested in juvenility'. *Welwitschia* actually belongs to the gymnosperms, a group of cone-bearing plants that dominated the earth during the Jurassic period about 140 million years ago. An adult *Welwitschia mirabilis* plant consists of two leaves, a stem base and roots. That is all! But these two leaves are unique in the plant kingdom. They are the original seedling leaves and they just continue to grow, and are never shed. The plant has retained its juvenile state. Simple, but highly effective: small wonder that its species name is '*mirabilis*'. Its stem is low, woody, hollowed-out, 'obconical' and sturdy. It grows about 50 cm high, and the two broad leathery leaves lie on the ground and grow continuously. The sexes are separate, the females having larger tapering cones and the male smaller oblong cone-like flower structures. It is still common in its habitat and shows variability – a sign that it is far from extinction. Carbon dating of plants shows that it lives to a great age, some large specimens attaining 1500 years.

Coping in a desert

How would a tree best cope in a sandy desert with a rainfall of less than 25 mm per annum, but with regular cool fog in a subtropical situation with occasional high temperatures? Sounds an impossible task, but *Welwitschia* manages by adopting a few simple strategies.

By remaining low on the ground the plant can rapidly absorb thermal heat from the ground, one of the essential requirements for growth. This strategy is usually encountered in species growing in cool conditions like alpine plants on high mountain peaks or winter rainfall desert plants. Many of the geophytes in the winter rainfall Succulent Karoo produce large, broad opposite leaves for the short cool winter rainfall season. They make use of the weak winter sun, exposing their 'sun panels' to absorb the available energy, and these leaves are soon shed for the long, dry, hot summer. The dwarf mesembs from the same region have a compact alpine growth, rapidly absorbing energy from the winter sun, but shutting down and hiding within their shell of dry leaf remains in summer. *Welwitschia* has to cope with cool conditions not only in winter, but also during summer because of the adjacent cool ocean. It is hardly ever, and then only briefly, subjected to extremes of cold or heat. If the Namib was a hot inland desert, *Welwitschia* would soon succumb to high temperatures. The large leaves also use the available fog, which condenses on their surface and runs off onto the ground.

The species has essentially decapitated itself by arresting its central two-lobed growth point just after the first leaf pair (the cotyledon stage) forms. Growth can now proceed horizontally from the original stem base where the leaves are produced. The plant is thus arrested in a juvenile growth phase for the rest of its life. The only growth that takes place is in the leaf primordium surrounding the base of the leaf of a single node. The green, two-lobed growth plug (known as cotyledonary buds) gradually withers away after a few years, forming an obconical, v-shaped stem hollowed out in the

Above. **Near Springbokwasser in the fog belt of the Namib, a *Welwitschia* plant hugs the ground, its two continuously growing leaves fragmented into octopus-like tentacles.** Photo: E. van Jaarsveld.

Left. **Bending under the weight of their seed, these normally erect seed-bearing female cones will shortly release their seeds. Pollination takes place in midsummer, and seed is released about 9 months later in spring.** Photo: E. van Jaarsveld.

Below. ***Welwitschia* can be described as a stunted, headless, hollowed out tree. Large specimens make perfect armchairs! Kirstenbosch horticulturist Claire Bell relaxes in her 'Namib arm chair'.** Photo: Julie Thomas.

centre: a tree without a head but with all the sturdiness of a normal tree. The tree remains short yet high enough to protect the leaf primordium from heat exposure. Energy is only expended in producing leathery leaves for trapping the sun's energy. The mild temperatures and regular fog enable the plant to remain evergreen.

Broad leaves in a desert plant is unique but in the case of *Welwitschia* it makes sense as the distribution of the plant coincides with the fog belt (where fog from the coast condenses on the broad leaves providing extra water). With an average growth of about 15 cm per annum, in a life span of 1500 years, *Welwitschia* could produce a leaf as long as 225 m: easily the longest continually growing leaves in the world! However, the leaves are naturally torn and weathered as they grow, and remain at about 1 m in length. The leaves continue to broaden as the plant ages, but the cup-shaped or v-shaped stem base causes tearing, giving the appearance of several leaves - rather like the arms of an octopus.

The design of the leaves thus provides an effective fog trap and a thermal energy trap. These peculiar life forms brought about by the adjacent cold Atlantic Ocean (a cool, foggy climate in a subtropical latitude) are paralleled in the Galapagos fauna and flora. *Welwitschia* leaves are grazed by herbivores, like rhinos, but no insect has ever been recorded eating the leaves. Woolly aphids occasionally hide under the leaves, sucking sap.

Cork is a very effective insulator, and by producing a corky bark from a young age, the young plants are thus protected from overheating in hot sunny conditions as well as from fire. This is debatable, but in the northern part of the welwitschia's range it grows in an arid savanna where, in good rainy years, grass grows rapidly. Grasslands burn and the cork would be an effective insulator just as the corky trunk of the cork oak, *Quercus suber*, protects the tree from fire in the Mediterranean region. Research by palaeontologist shows that Namibia had wetter times and thus more grass, so a low, stunted tree would benefit from the cork.

In areas of higher rainfall in the north, *Welwitschia* is smaller than its southern relatives living in much dryer conditions. This could be because of fire (the old woody bark of older specimens burns well!) or competition from other plants. (Similarly, the leopard tortoise, *Testudo pardalis*, attains its largest

size in the Karoo and other dry regions where fire is not common.) The largest *Welwitschia* plants are found in the Mesum Crater in Namibia. Namibian botanist, W. Giess, recorded a plant with a height of 1.8 m, the largest ever recorded. Another was recorded with a stem diameter of 4 m! H. Bornman also reported an individual from the *Welwitschia* Flats with a height of 1.2 m and a stem circumference of 8.7 m.

In cultivation at Kirstenbosch plants flower from midsummer to autumn. Male and female parts develop nectar (50% sugar content measured). The male flower has a sterile, modified pistil-like structure, which exudes nectar from a modified stigma-like structure. This is clear indication of insect pollination. The female cone has exposed stigmas producing the same nectar droplet. Cone-bearing plants are often wind pollinated. The cones produce pollen in mass, and all at the same time. The female cones reach maturity in spring (about 9 months after fertilization).

Welwitschia has fairly large winged seeds (3.6 x 2.5 cm, including wings and 1.2 x 0.6 cm without wings) dispersed by wind. Seeds in habitat are often infected with a fungus *Aspegillus niger* that destroys the embryo. It is clearly visible as a black dusty powder on the seed. Seeds infected will not germinate. Once germination from healthy seeds takes place, the young seedling rapidly produces a taproot and after three months it becomes virtually impossible to transplant it. (They can be planted in containers but must stay in the container with the least root disturbance. See cultivation notes below.) Distribution indicates that *Welwitschia* is dependent on deep groundwater; hence its occurrence in dry riverbeds and watercourses, for which it needs a deep taproot. It also has many lateral roots just below the surface for taking advantage of surface moisture.

What does a highly reduced plant bearing such specific adaptation speak of? For me, it can only corroborate the great age of the Namib predicted by botanists and palaeontologists. The *Welwitschia* is truly a relic from the past. As you can imagine, this remarkable plant is in great demand by botanical gardens and keen horticulturists and gardeners all over the world. Kirstenbosch has been working to produce *Welwitschia* seed from cultivated plants to cope with this demand, and recently, we have achieved our goal.

THE CULTIVATION OF *WELWITSCHIA MIRABILIS* AT KIRSTENBOSCH

***Welwitschia* thrives as a pot plant but it is not a succulent and should be watered regularly.** Photo: NBI.

Kirstenbosch receives numerous requests for *Welwitschia* seed, and in 1985 a *Welwitschia* seed production house was erected - thanks to John Winter, Curator of the gardens from 1968 to 1997. The first seed was sown in the spring of 1985 in this small (4 x 8 m) building, and one solitary seedling emerged! A year later Margaret Thomas brought viable seed from the Ugap River in the Namib Desert in Namibia, and these were sown in September 1986. They germinated very well and today the house is filled with a dense colony of 81 *Welwitschia* plants in an area of 15 m².

THE SECRETS OF SUCCESS

Love your plants! Horticulturists require patience, persistence and devotion to their plants. Do not give up after the first failure, learn from your mistakes and persist. My staff and I have had the privilege of caring for and getting to know these plants from the first seeds that were sown in 1985 until today.

Provide warmth, sufficient light and air movement. Kirstenbosch is cooler than the Namib, so we installed a heating cable to keep temperatures above 20 °C. *Welwitschia* will grow in cooler conditions but growth and thus seed production will be lower.

Do not disturb the seedlings. Seed was sown by Mr Tommy Sardien (now retired) and me directly into the beds (filled with red sand from a nearby desert in the Western Cape) and kept moist. The beds are raised to about a metre from ground level. *Welwitschia* rapidly grows a taproot and if disturbed, it dies, so it is better to sow the seed where the plants will to remain for the long term. Sow during spring and keep well watered.

Provide moisture, nourishment and initial protection. Germination was rapid (from seven days) and the plants grew fast producing about 15 cm leaf growth per annum. *Welwitschia* is not very resistant to fungal infections at the seedling stage, coming as it does from an arid environment. We treated seeds with Apron C, a systemic fungicide, for the first six months. By that time the plant is sufficiently 'hardened-off' and the infection rate drops. During summer months we water thoroughly about every two to three weeks, and less so during winter. *Welwitschia* is a woody plant and not a succulent and will not survive if the soil is allowed to completely dry out. Most people kill their *Welwitschia* plants by providing too little water! At Kirstenbosch plants are also fed once every summer using a mild solution of Seagrow.

First fruits

The first male plant flowered two and a half years after sowing and the first female only after five years. (The cost of seed-production in a desert environment is high and less energy is expended in producing the smaller male flowers than the female ones.) Although a few females flowered regularly at first, it was only after fourteen years of growth that female cones produced enough seed to fulfil our dream of providing seed from a cultivated source to other botanical gardens. The five sexually active females produced enough seed to fill a container 15 x 15 cm, about forty seeds on average per cone. Plants now bear about eight cones per plant (about 480 seeds per plant!).

Pollination is done by hand in midsummer and in autumn, and is a very simple procedure. The yellow pollen, clearly visible on the male cones, is transferred by finger tip from the male stamens to the exposed stigmas on the female cones. (The stigmas are hair-like growths emerging between the scales of the female cone and are clearly visible.)

A seedling sown in September 1985 from Swakopmund grew rapidly and by September 1986 leaves reached a length of 22.5 cm. a width of 3 cm at the broadest point and a stem diameter of 2 cm. The same plant was measured during April 1990 had produced leaves of 125.5 cm long, and 10 cm wide. It was measured again in May 1999 and the leaves were 300 cm in length, 30 cm at its widest point and the stem diameter was 16 cm (9 cm high): an average rate of a little more than 20 cm leaf length per annum. (The rate is 15 cm per annum in the Namib.) Seedlings from Koigab sown in spring in 1986 had grown to a leaf height of 2-3 cm in three weeks after germination (with a taproot of 5-7 cm). By February 1987, five months after sowing, the average leaf length was 8-9 cm long (0.6-1.1 cm broad) and the diameter of the stem 0.4-0.6 cm. In May 1999 the average leaf length of the Koigab plants were between 160-280 cm with a stem diameter of between 7-17 cm and leaf width of between 12-28 cm.

Welwitschia is best cultivated in open beds or, if your climate permits, out of doors. They have successfully been grown outside in the Karoo National Botanical Gardens in Worcester - which is subject to winter rain and light frost. Grow them in containers with a deep base (at least 30 cm) to provide space for their roots. Clay pots are best. Ensure that the container has sufficient drainage holes in the base. Use sandy, gravely soil, low in organic material; they thrive in a succulent plant mixture, and don't mind whether it is slightly acid or alkaline. Sow the seed directly into the container, just covering it with gravel or sand, and keep moist.

Top. **Inside the *Welwitschia* seed production house at Kirstenbosch, our eighty-one *Welwitschia* plants produce enough seed for distribution to other botanical gardens.**
Above. **The same house in 1987 the plants still small.**
Right, above. **Seed produced during 1999.**
Right below. ***Welwitschia* meets Rasta! Andrew Jenkins of Kirstenbosch inspecting the plants in the *Welwitschia* seed production house.**
Photos: E. van Jaarsveld.

Acknowledgements
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Further reading

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Van Jaarsveld, E. J. 1992. *Welwitschia mirabilis* in cultivation at Kirstenbosch. *Veld & Flora* **78** (4), 118-120. (Note that the captions are incorrect: the male plant is shown on p.119, the female on p. 120).