DINTERIA NR. 19 — WINDHOEK SWA. — MAI 1987

Injury and recovery of *Welwitschia mirabilis*

E. Brinckmann and D.J. von Willert

ABSTRACT

Welwitschia mirabilis is a highly protected plant of the Namib desert. Nevertheless, it has to withstand hard wear in its natural environment. Whilst grazing by animals and strong sandstorms apparently do not damage the plants irreversibly, the population decreases, however, by imprudence of man.

ZUSAMMENFASSUNG

Welwitschia mirabilis steht unter striktem Naturschutz in ihrem Lebensraum, der Namib Wüste. Sie ist jedoch starker Beanspruchung in ihrer natürlichen Umgebung ausgesetzt. Aber während vollständiger Kahlfraß durch Antilopen oder heftige Sandstürme offensichtlich ohne weiteres überstanden werden, wird ihre Population durch Leichtsinnigkeit des Menschen von Jahr zu Jahr kleiner.

OPSOMMING

Die *Welwitschia mirabilis* plant van die Namib woestyn is 'n beskermde plant. In sy natuurlike omgewing is dit aan groot uiterstes blootgestel. Alhoewel dit heeltemal stomp gevreet word deur wildsbokke en hewige sandstorms klaarblyklik goed kan weerstaan is dit egter die onverskilligheid van die mens wat 'n bedreiging vir hierdie populasie, wat van jaar tot jaar kleiner word, inhou.

RESULTS AND DISCUSSION

The ancient relict plant of the northern and central Namib desert, *Welwitschia mirabilis* Hook.f., is a subject to various stresses by its natural environment and by man. *Welwitschia* overcomes the harshest of the desert stresses, the lack of regular precipitation, by developing a comparatively extensive, shallow root system which supplies the transpiring leaves with water (Giess, 1969). The water loss during the day can be considerably high (von Willert et al., 1982) but plays an important role in adjusting the energy balance of the large leaves (von Willert et al., 1983, Eller et al., 1983).

This very effective adaptation strategy to drought stress results in a great danger for the plant during prolonged dry periods: besides the vegetation in the river beds and some salty bushes of *Arthraerua leubnitziae* and *Zygophyllum stapffii, Welwitschia* is the only living plant in this part of the desert and, thus, attracts grazing animals. In August 1981 we observed Oryx antilopes which had left the dry barren grassland further inland and came into the Welwitschia flats 45 km east of Swakopmund for grazing. They bruized the *Welwitschia* leaves at the base and sucked the cell sap out. The remainder of the leaf fell to the ground and dried out (Fig. 1a). Thus, only 5 to 10 cm long parts of the leaves were left at the trunk. In some cases, the leaf was even pulled out of the stem (Fig. 2a). Interestingly, the animals chew only the part of the leaf where sodium content is low (100-300 μmol/g d.w.) compared to older parts of the leaf (up to 700 μmol/g d.w.). The potassium concentration is higher at the base (up to 1 mmol/g d.w.) than at the tip of the leaf (500 μmol/g d.w.). Of course, the higher water content at the leaf base could have been most attractive for the animals: the water content is there about 150% of dry matter declining rapidly with leaf age towards the tip to values around 100% (von Willert, 1985).

In March 1986, five years later, the leaves had recovered completely: they reached now 100 cm in length (Fig. 1b) and only the pruned ends of the leaves showed evidence of grazing. Even pulling the leaf out of the stem did not hurt the basal leaf meristem as leaves appeared normal in shape and colour (Fig. 2b). The growth rate (leaf length) of 0.5 mm per day was higher at this plant compared to other plants in the Brandberg region (Tab. 1). A leaf marked 1977 on a plant located 15 km from the coast near the junction of the road to Brandberg West Mine grew until 1981 40 cm (0.25 mm per day) and until 1986 further 58 cm (0.35 mm per day). A plant in the grassland at the western side of the Brandberg exhibited similar growth rates during the same periods of time (0.20 and 0.34 mm per day). Table 1 obviously illustrates dry (1977-1981) and less dry periods (1981-1986). Walter and Breckle reported 1984 similar data of L. Moisel (Swakopmund) who found growth rates of 0.23 to 0.82 mm per day in the Welwitschia Vlakte between 1971 and 1980. The highest values were measured after rainfall.

The higher growth rate of the plant in the Welwitschia plain could be either due to better water supply of this location or to the sudden increase of root to leaf ratio as the top was lost by grazing. Thus, a large root system had to supply a small leaf area. It is possible that the transpiration rates, which were determined 1981 with strips of such grazed plants (von Willert et al., 1982) were to some extent overestimated because of the disturbed leaf to root ratio.

Apparently, the leaves of *Welwitschia* are damaged by sandstormes more often than by grazing. In 1984 nine sandstorms were visible on satellite images as dust clouds were blown by east wind several hundred kilometers into the Atlantic ocean. Wind speeds of 120 km/h were measured at Walvis Bay during the sandstorm of 1-3 September 1981. The abrasive power of the sand particles is illustrated by the fact that during this storm the quartz glass cover of a light measuring instrument became tarnished on the windward side. The instrument was mounted about 15 cm above the ground in the hight of a *Welwitschia* plant. After the storm the wind-exposed sur-

faces of *Welwitschia* leaves appeared yellowish to light-brown, after a few days also redish. Surprisingly the epidermis and the cuticle were not damaged at the injured parts of the leaf, but the subepidermal cell layer showed structural damage in the scanning electron microscope and the accumulation of a red substance (Eller et al., 1983). The opposite surface of the leaf, however, as well as the older, non-exposed parts of the leaf above the injured part remained green.

The sandstorm of July 1985 which was also visible on Meteosat images, at least from 12 to 15 July, damaged the leaves even more. Besides the change of colour, big ruptures appeared on the wind-exposed surfaces. Not only the upper surface of the leaves was injured (Fig. 3a) but also the lower side as the strong wind pushed upwards some leaves which usually grew nearly horizontal (Fig. 3b). The water and solute transport system seemed to be intact between the ruptures since the older parts of the leaf above the injured part remained green. The leaf meristem, however, was not affected by the sandstorm as it was protected in the stem. After the storm, the leaves grew quite normally out of the stem groove and thus a sharp boundary between the injured surface and the new leaf tissue marked the end of the sandstorm (Fig. 3b). This natural mark was used to determine the leaf growth: 9.6 cm length increase from July 15 (1985) to March 30 (1986), i.e. 0.37 mm per day.

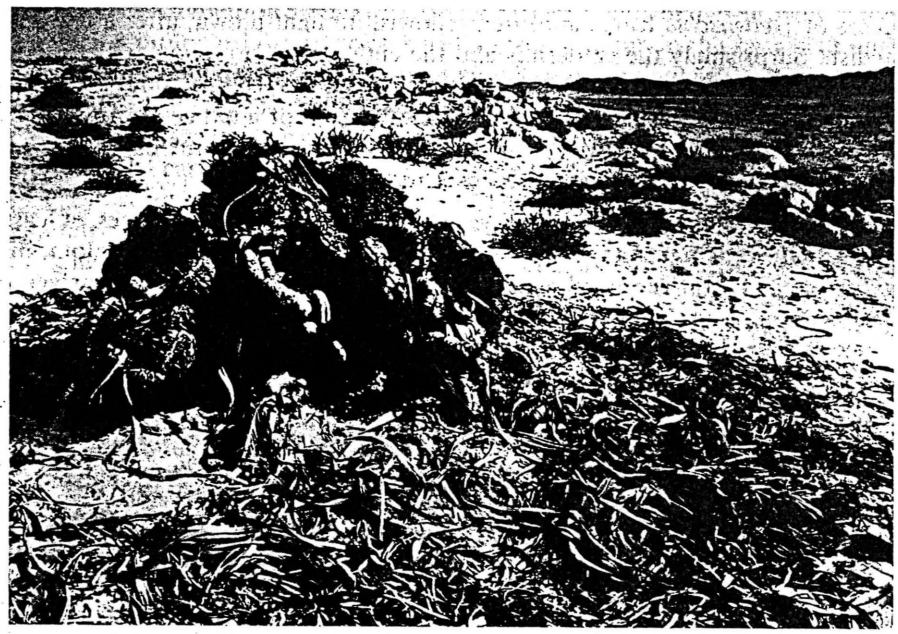
Although *Welwitschia* is highly protected by law, the most serious and irreversible damage of this species is done by man. 215 plants were mapped in 1981 in the Welwitschia plains next to a road to the famous "Groot Welwitschia". Only 207 plants were counted 1986 at the same place (Fig. 4). Five individuals grew formerly just apart the road; in 1986 their stands were identified on that road which has been broadened in the meantime. One dead trunk was found within the tracks of road work vehicles next to the road. Two other individuals could not be located; a track of a heavy car was visible at their former stands as depicted on a map. The question arises if it was really necessary to broaden the road for tourism at the expense of 8 Welwitschia plants. The reason why a heavy car was driven over the plants eradicating two of them instead of using the road also remains questionable. Further protection and better supervised road works are an urgent need in that area for the survival of a plant which is so well adapted to its harsh environment.

Table 1: Length growth of *Welwitschia* leaves at different sites in the Namib desert during various periods of time.

Site	Period	Leaf growth (cm)	Growth rate (mm/day)
Welwitschia Vlakte	1981+	0,8+	0.4
	1981-1986	100	0.5
Junction to Brandberg West			
Mine	1977-1981	40	0.25
	1981-1986	58	0.35
Brandberg	1977-1981	32	0.2
	1981-1986	56	0.34

+measuring period: 3 weeks

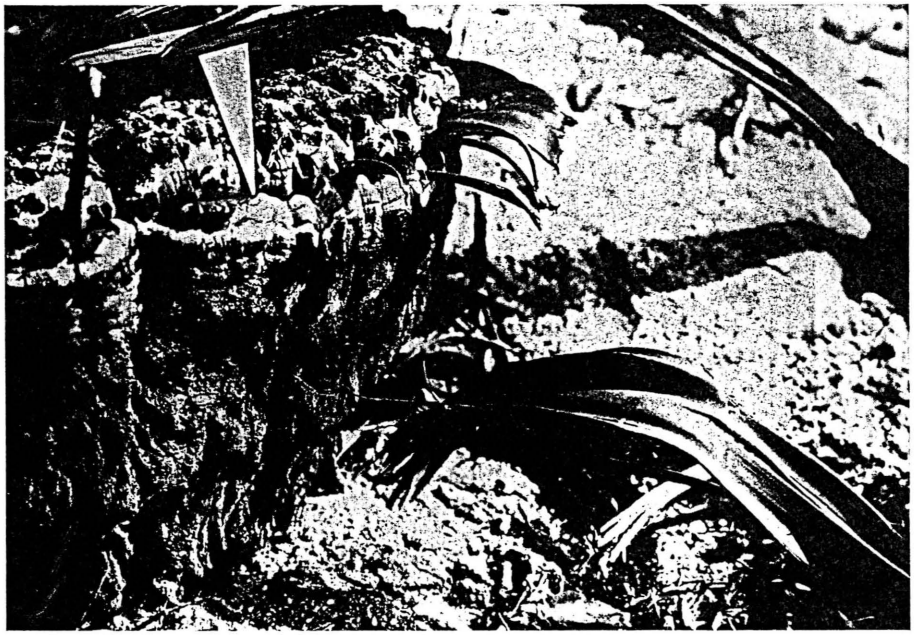
a)



b)

Figure 1: a) A very old specimen of *Welwitschia mirabilis* photographed 1981 in the Welwitschia plain 45 km east of Swakopmund. Oryx antilopes have bitten off all the leaves.
b) The same specimen in March 1986 with 1 m long new leaves.

a)



b)

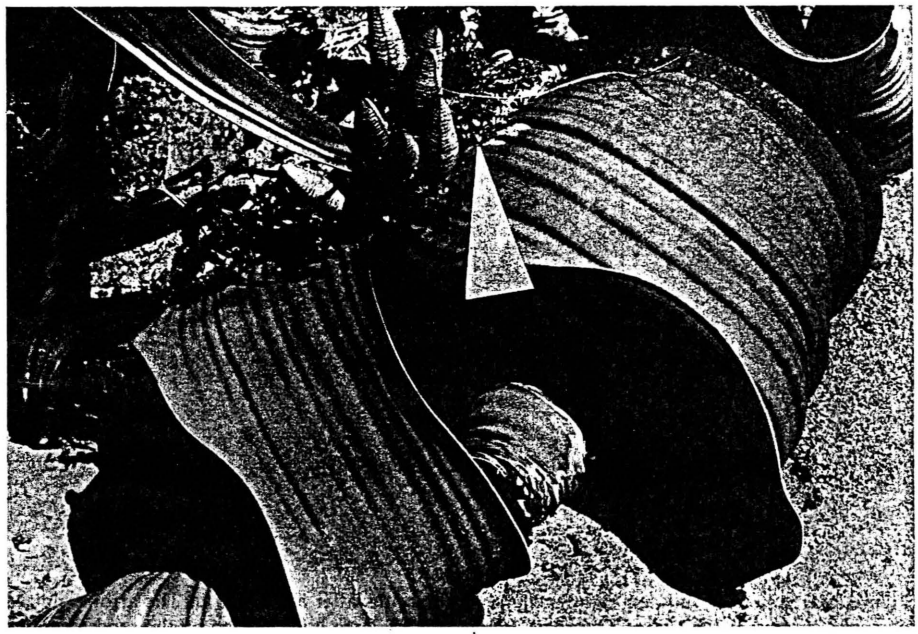
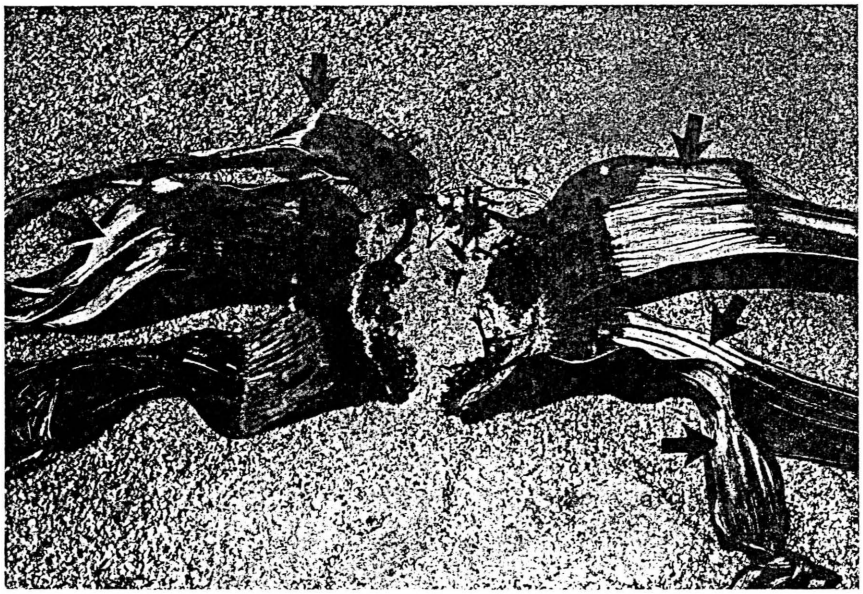


Figure 2: a) Only short leaf strips remained at the *Welwitschia* plant after grazing by Oryx antilopes. Sometimes the leaf was completely pulled out of the stem (arrow).
b) An intact leaf developed at the same site of the stem (arrow) shown in a).

a)



b)

Figure 3: a) A severely injured *Welwitschia* plant 9 months after a sandstorm. The arrows indicate the damaged surface of the leaves. The lower left leaf shows large holes caused by the sandstorm.
b) A sharp boundary (arrow) marks the end of the sandstorm which injured the older parts of the leaf (above the arrow); during the 9 months after the sandstorm a normal leaf with intact surface grew out of the stem (below the arrow).

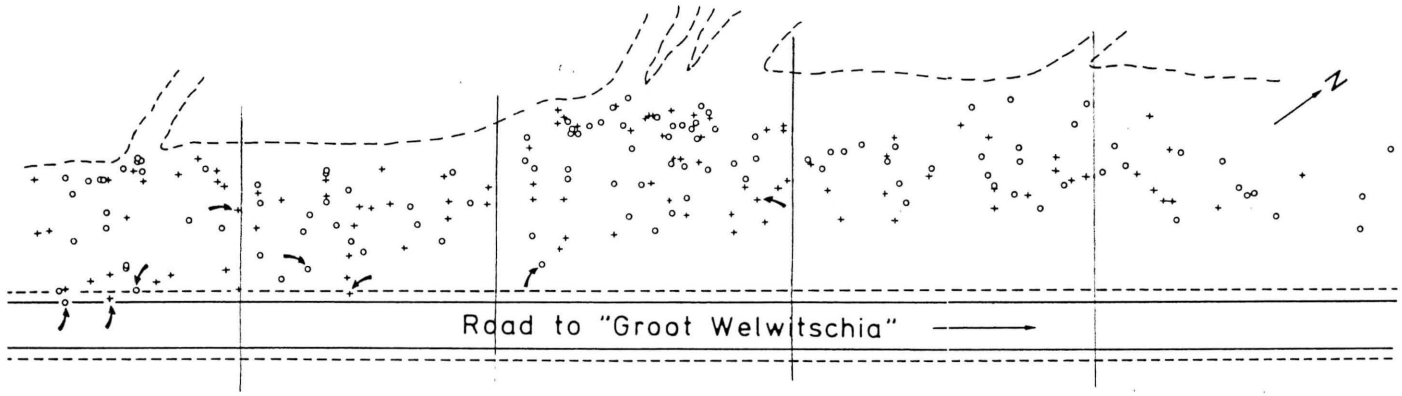


Figure 4: Map of 215 *Welwitschia* plants which were investigated 1981 in the Welwitschia plain (o = male, + = female plant). The arrows indicate the individuals which disappeared until March 1986.

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