Frost damage to wild sycamore fig trees in the Namib-Naukluft Park, Namibia

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ABSTRACT

Wild sycamore figs *Ficus sycomorus* suffered extensive frost damage in 1989, being the first known occurrence in 25 years. Twenty-five fig trees were moniroted for 21 months and the effects of frost were related to minimum temperatures in the river-bed. Sub-zero temperatures affected 20 of the trees and caused up to 90% frost damage to leaves. Foliage affected by frost remained moribund and attached to the branches for the monitoring period. Frost may limit the distribution of sycamore figs in the Namib.

INTRODUCTION

Wild sycamore figs *Ficus sycomorus* L. form part of the riverine woodland community in the lower Kuiseb River in the Namib-Naukluft Pa;rk, a conservation area of the Namib Desert in Namibia. During winter 1989 extensive leaf damage by frost was noted on these fig trees (M>K> Seely, pers. comm.) This initiated a study (1989-91) aimed at investigating and quantifying the damage, as well as monitoring the degree of recovery.

STUDY AREA

A 15 km section of the Kuiseb River in the vicinity of the Namib Research Institute at Gobabeb was selected (Fig. 1). The Namib is a cool, coastal desert extending in a narrow strip of about 200 km wide and 2 000 km long from Mocamedes in Angola to the Olifants River in South Africa (Seely 1987). The Kuiseb River rises in the central Khomas Hochland area of Namibia. It has a catchment area of approximately 15 000 km^2 and traverses the Namib for a length of about 440 km before ending at the Atlantic at Walvis Bay (Huntley 1985). Gobabeb lies on the middle section of the Kuiseb River (23°34'S, 15°03'E) at an altitude of 407m. The annual average rainfall (n = 30 years) is 18,8 mm (Weather Office records). About 37 days of fog occur per year (Lancaster, Lancaster & Seely 1984).

The Kuiseb is an ephemeral river that flows sporadically past Gobbeb during the period January to April of most years. The riverine woodland comprises *Faidherbia albida, Acacia erioloba, Salvadora persica, Euclea pseudebenus, Tamarix usneoides* and *Ficus sycomorus*. The latter species is sparsely distributed along the river, with only 25 trees occurring within the 15 km liner study area. The riverine vegetation is utilized by domestic stock

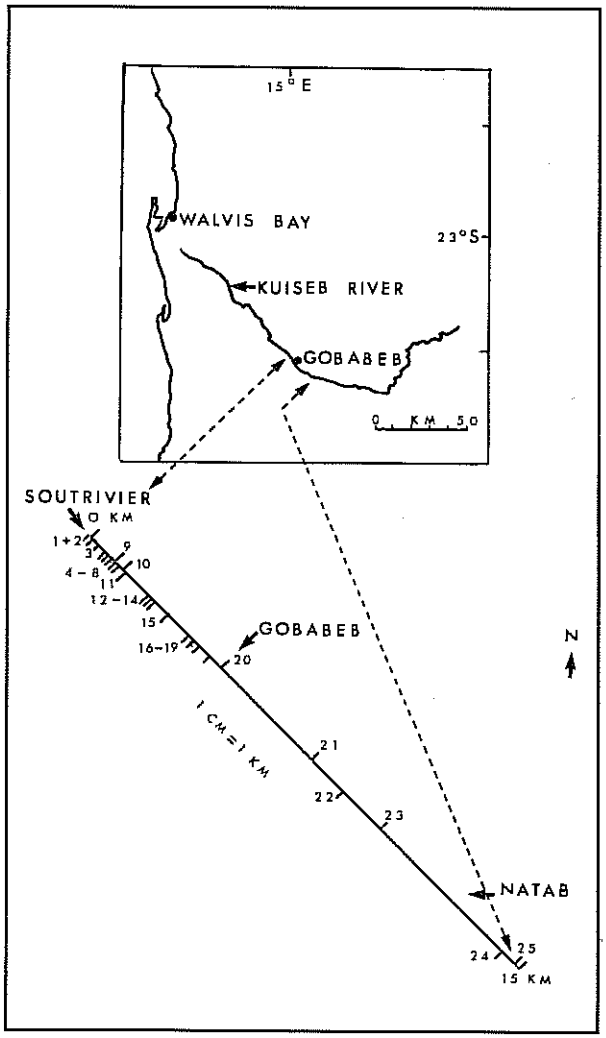

FIGURE 1: Map of the central Namib region showing the study area in the Kuiseb River (inset), together with a detailed, schematic diagram of the location of 25 fig trees which were monitored for frost damage.

belonging to communities of Topnaars – goats, sheep, cattle and donkeys – as well as gemsbok *Oryx gazella*, springbok *Antidorcas marsupialis*, steenbok *Raphicerus campestris* and ostrich *Struthio camelus*. In addition to excessive grazing and browsing pressure on most of the riverine vegetation, goats inflict additional damage to fig trees by feeding on their bark.

METHODS

All fig trees occurring in the study area were monitored at irregular intervals from September 1989 to May 1991. Twenty-five trees were tagged and numbered with plastic strips. Five large specimens, ranging from 5-15 m in height, which showed no frost damage served as controls. The height of each tree was subjectively estimated to the nearest metre. Frost damage was assessed by estimating the total amount of foliage killed on each tree according to a rating of 0-10 where:

0	=	no damage			
1	=	<10%	6	=	51-60%
2	=	11-20%	7	=	61-70%
3	=	21-30%	8	=	71-80%
4	=	31-40%	9	=	81-90%
5	=	41-50%	10	=	91-100%

The extent of damage in relation to the circumference of the tree's canopy was estimated and expressed as a percentage of 360°. The height of the dead foliage above ground level was recorded as well as its position in relation to the river-bed. To assess re-growth, trees were rated on a scale of 0-4, based on fresh foliage production, where 0 - no re-growth, 1 = trace, 2 = low, 3 = medium, 4 = high. Because neighbouring trees may protect fig trees from frost by shielding or forming a protective canopy over the fig trees, the distance of neighbouring species from the fig trees and the extent to which they protected the fig trees was expressed as a percentage.

Absolute maximum and minimum screen temperatures and absolute grass minimum temperatures were obtained from Gobabeb. Taking these data for the period when the frost was throught to have occurred in winter 1989, the minimum temperatures for the river-bed at this time were estimated. This was achieved by comparing absolute minimum grass temperature at the weather station with that measured in the river-bed.

RESULTS AND DISCUSSION

The measurements of 25 fig trees, their damage by frost and subsequent re-growth, and their relationship to other tree species are given in Table 1. Twenty out of 25 fig

TABLE 1: Frost damage and other parameters measured on 25 fig trees in the Kuiseb River, Namib-Naukluft Park (1989-91)

Tree no. and location (N or S)		Estimated height (m)	Average rating (0-10)	Frost Damage degree (% of 360°)	Frost Damage height (m)	Percentage protection	Re-growth of foliage (0-4)	Distance from other trees (m)
1	S	15	0	0	0	25	Control	8
2	S	10	0	0	0	0	Control	8
3	S	9	1	25	3-6	0	2	2
4	S	9	1	15	2-5	0	3	6
5	S	15	1	50	1-5	25	3	8
6	S	8	1	25	1-5	0	3	5
7	S	10	1	50	1-7	0	3	4
8	S	10	1	40	2-7	0	3	3
9	N	4	5	100	2-4	100	3	0
10	N	9	2	50	2-7	50	2	1
11	S	7	5	100	0-7	0	2	1
12	S	8	0	0	0	100	Control	3
13	S	5	0	0	0	100	Control	5
14	S	9	0	0	0	0	Control	1
15	S	6	2	15	2-3	50	1	2
16	S	10	2	60	2-6	100	3	0
17	S	10	3	50	1-8	50	3	1
18	S	12	2	50	0-5	100	3	1,5
19	S	10	1	5	4-6	0	3	3
20	N	5	3	50	2-5	0	3	25
21	N	6	2	50	1-5	50	3	2
22	S	6	1	50	2-5	0	3	5
23	N	6	9	100	1-6	0	4	15
24	S	8	1	15	1-7	50	3	1
25	N	10	2	50	0-8	50	4	3

trees (80%) showed some degree of frost damage. After two years of monitoring, leaves killed by frost were still attached to the fig trees. Estimated frost damage for most fig trees during the monitoring period varied from 0 to 90%. The tree with the highest frost damage recorded (No. 23), namely 81-90% had no protection from other trees. The greatest extent of leaf damage occurred on those parts of the trees facing the river, but three trees showed frost damage on their entire circumference of foliage. One of these trees (No. 11) had complete canopy protection whereas the two remaining trees had none. Another tree (No. 20), which grew 25 m from the nearest other tree, showed frost damage to 50% of its circumference. Consequently it appears that the shelter provided by other trees did not decrease the amount of frost damage. Frost damage did not occur above the height of 8 m in any of the trees. Although medium to high regrowth rates occurred on 16 of 20 trees, complete recovery from frost damage was not recorded in any of the affected fig trees when monitoring ended 21 months later. The effect which frost may have had on fruiting could not be established because of the highly subjective nature of estimating fruit production and subsequent shedding of fruit.

TABLE 2: Comparison between sub-zero minimum grass temperatures in the Kuiseb river-bed and Gobabeb weather station (May '91 to October '91)

Date	Min. grass temp. (°C)		Difference (°C)
	River-bed	Weather Station	
28 June	-1,1	2,7	3,8
19 Aug.	-2,7	-1,1	1,6
20 Aug.	-1,0	1,1	2,1
Mean	-1,6	0,9	2,5

Sub-zero grass minimum temperatures were measured at the weather station on two occasions in winter 1989: -0,8°C in June and 01,5°C in July. Since grass minimum temperatures in the river-bed were on average 2,5°C lower than those at the weather station (Table 2), frost damage was probably severest during June/July 1989 when the lowest temperatures occurred and may have declined to -3,3°C and -4,0°C in the river-bed. Similarly, a second episode of frost may have occurred during August 1990 when an absolute grass minimum of -0,5°C was measured at Gobabeb's weather station, indicating an absolute grass minimum of -3,0°C in the river-bed. This makes it possible to predict frost damage to fig trees in the river-bed when grass minimum temperatures at Gobabeb approach zero.

The mustard bush *Salvadora persica*, which is abundant in the study area, and sycamore figs, which are the least common of the riverine trees, are the only broad-leafed tree species of the Kuiseb riverine community. Both *S. persica* and *F. sycomorus* showed severe frost damage, whereas the remaining tree species have greatly reduced leaf surface area, which rendered them less susceptible to frost. No frost damage was evident in these remaining tree species.

CONCLUSIONS

Frost damage to wild figs in the Kuiseb river-bed is an infrequent phenomenon and has been observed once in the period 1967-91 (M.K. Seely, pers. comm.). Therefore frost in this region of the Namib Desert can be considered an episodic event which may exert considerable stress on fig trees. For example, frost events may kill seedling fig trees and it is noteworthy that no seedlings were recorded in the study area. Since the smallest fig tree measured 4 m in height (Table 1), it appears likely that recruitment to the population is curtailed by periodically unfavourable weather conditions, one of which could be frost. This would affect tree species composition in the river-bed by favouring narrow-leafed species which appear more tolerant to frost. From the observations made in the river-bed, it can also be predicted that the distribution of sycamore fig trees in the Namib may be limited to areas where frost is infrequent or absent.

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