

A FIRST ATTEMPT TO MEASURE TEMPERATURES OF FIRE IN FYNBOS

Veld fire research is being conducted in Cape mountain fynbos, Acocks's (1975) Veld Types 69 and 70, to determine the effect of fire on vegetation and streamflow and to establish how fire should be used in managing catchments. As previous workers (Kenworthy, 1963; West, 1965; and Kayll, 1966) have pointed out, one of the most important things to know

about fire is its intensity as expressed by its temperature duration. This may be measured accurately but expensively with thermocouples (Kenworthy, 1963; Kayll, 1966), or indirectly by recording the water loss from blackened metal canisters (Beaufait, 1966). Where inadequate resources preclude duration measurements, temperature measurements alone must

suffice. Temperature without duration has been measured either by using thermocolors* (pigments that change colour distinctly at certain temperatures) as was done by Pratt (1961) in Kenya and by Whittaker (1961) in Scotland; or by means of Tempils† (pellets that melt at different temperatures) which have been used in the Kruger National Park (Anon., 1960).

Temperatures were measured during a routine burn in 1966 on the Jakkalsvlei firebreak in the Jonkershoek State Forest situated about 10 km south-east of Stellenbosch, Cape Province, with the object of obtaining a crude index of fire intensity for comparative purposes. The firebreak has been burnt since 1958 at four-year intervals. This investigation was part of an intensive study of the regeneration and phenology of the vegetation of the firebreak undertaken by one of us (H.C.T.) between the burns in 1962 and 1966.

A 7 ha rectangular area, with altitude varying from 365 m to 460 m above sea-level, south-east aspect, and slopes of between 0% and approximately 45%, was selected for study. The lower third of the area is a rock-strewn valley bottom, more or less level, and the remainder is a rounded granitic ridge, without rocks, running from north-east to south-west.

The area has a Mediterranean-type climate. Strong south-easterly winds, frequent in the hot, dry summer, often deposit moisture on the vegetation. Mean annual rainfall at this point in the valley is about 2 000 mm.

The vegetation consists of Cape sclerophyll scrub, or fynbos, typical of the mountains of the South-Western Cape (Taylor, 1972 and in press).

As the temperature measurements in the Kruger National Park appear to be the first made on veld fires in South Africa, Tempil pellets were used in the present trials to make our results roughly comparable with those in the Park. The pellets record temperatures of 125°F (52°C) and from 200°F (93°C) to 1 200°F (650°C) at 100°F (about 55°C) intervals. The same apparatus used for measuring temperature profiles in the Kruger National Park (P. van Wyk pers. comm., 1963) was used in our trials. It consists of a tubular aluminium tripod which holds a vertical aluminium tube. The latter bears horizontal tubular aluminium arms, 1,8 m long, which may be raised or lowered as desired. Holes are drilled at intervals in these arms and a wire loop through each hole bears the metal spring from a wooden clothes-peg. A Tempil is clipped between the arms of this spring. The apparatus was used to measure the temperature at a point at ground-level, one at 45 cm and one at 90 cm above ground-level. As the vegetation seldom exceeds 1,2 m in height, measurements at the higher levels were unnecessary.

Two sets of temperature profile measurements were made in this way, one at a randomly selected location on the granite ridge and a second on the valley bottom. In view of limited time, funds and equipment, no further profile measurements were done, but to supplement the two profiles, ground-level readings were made at 34 randomly distributed locations. At each location 12 pellets covering the full range of temperatures were placed in a mica envelope of 100 mm × 37 mm, consisting of mica sheets about 0,2 mm thick, held together with wire clips.

Estimates of the height and density of the vegetation, litter cover, stoniness, aspect and moisture conditions at each location were noted with a brief description of the surrounding vegetation.

Burning took place on October 19th, 1966. The envelopes were collected and the highest temperature in each was recorded.

Meteorological conditions just before and during the burn, recorded at a station about 2,8 km north-west of Jakkalsvlei, are shown in Tables 2 and 3.

TABLE 2.—Data from Biesievlei Meteorological Station

Date	Relative humidity at 08h00	Temp. (°C)		Hours sunshine
		Max.	Min.	
15.10.66	71%	24,4	7,8	9,7
16.10.66	82%	26,1	7,1	9,7
17.10.66	47%	24,4	9,7	9,7
18.10.66	58%	31,3	16,5	9,7
19.10.66	59%	32,8	17,0	

TABLE 3.—Wind speed and direction, Biesievlei Meteorological Station

Date	Direction	Duration		Average speed (metre/second)
		From	To	
15.10.66	S.E.		13h00	—
	S.W.	13h00	24h00	—
16.10.66	S.W.	00h00	13h00	—
	N.W.	13h00	22h00	1,4
	S.E.	22h00	24h00	2,0
17.10.66	S.E.	00h00	14h00	2,5
	S.W.	14h00	22h00	2,6
	S.E.	22h00	24h00	3,3
18.10.66	S.E.	00h00	16h00	2,3
	Variable	16h00	23h00	1,1
	S.E.—S.W. N.E.	23h00	24h00	1,0
19.10.66	N.E.	00h00	10h30	0,8

The last rain before the burn was a fall of 4,5 mm on October 10th. The south-easterly winds did not deposit moisture on the vegetation. Preceding conditions of high temperatures, low relative humidity and strong winds had probably desiccated the vegetation. The fire was started at 08h20 at the top south-eastern corner, and burned mainly downhill along the side. On spreading inward it turned and burned uphill. The fire proceeded quickly on the granite slopes where a clean burn was obtained, but rather slowly on the valley bottom, where small patches were left unburnt. The burning operation was completed in about two hours. During this time the sky was clear, and air temperature rose to about 32°C in the shade on the site. Relative humidity at 09h15 was 33% and at 10h00 27%. Winds were very light and variable.

The two sets of temperature profile measurements agreed exactly. At ground-level 371°C was recorded; at both 45 cm and at 90 cm 316°C was recorded.

Ground temperatures ranged from 149°C to 371°C, with the mode at 316°C. The mean ground temperature was 291°C with a standard deviation of 42°C. The data did not fit the normal distribution. Consequently the Mann-Whitney test, a non-parametric test (Freund, 1962), was applied in analysis. The data

* Manufactured by Faber-Castell, West Germany.

† Manufactured by Tempil Corporation, 132 West 22nd Street, New York City, U.S.A.