EFFECT OF ADDING WATER TO MALLEEFOWL MOUNDS DURING A DROUGHT

Malleefowl *Leipoa ocellata* use heat produced by organic decomposition and the sun to incubate their eggs in mounds (Frith 1962). In a normal year the birds begin mound renovation in April by digging out the mounds and forming a 2.5 to 3.5 m crater. During June and July plant litter is scraped into windrows and piled into the crater. When wetted by rain, microbial decay begins and the birds manipulate the litter and shape an egg chamber (mid-late August). Late in August or early in September incubation temperature is approached and the mound covered in a layer of sand. Egg laying is usually started in the second or third week of September. Laying may continue until the end of January. Microbial heat continues until the litter dries out, in late December or early January. The birds then utilize solar heat to maintain mound incubation temperature until the end of the breeding season (Frith 1957, 1962). Thus the decaying litter provides most of the incubation heat at the beginning of the breeding season and appears to be a critical element in the onset of laying (Frith 1956). Breeding does not occur if the litter is not wet by rain in drought years (Bennett, in Campbell 1901; Mattingley 1908; Lewis 1939; McGilp 1948; Frith 1959a, b). In droughts birds begin to renovate mounds, but abandon them after the litter has been piled into the crater.

Frith (1959b) suggested that the increase in mound temperature stimulates birds to complete mounds and begin egg-laying. According to this hypothesis, the failure of microbial heat production in drought years prevents the birds from breeding. A second possibility could be that rain influences the abundance of available food and contributes to the success of breeding adults and their hatchlings. It is possible to test the former hypothesis by adding water to excavated mounds during a drought year. The exceptional drought conditions that occurred over much of south-eastern Australia during 1982 provided an opportunity to carry out this test.

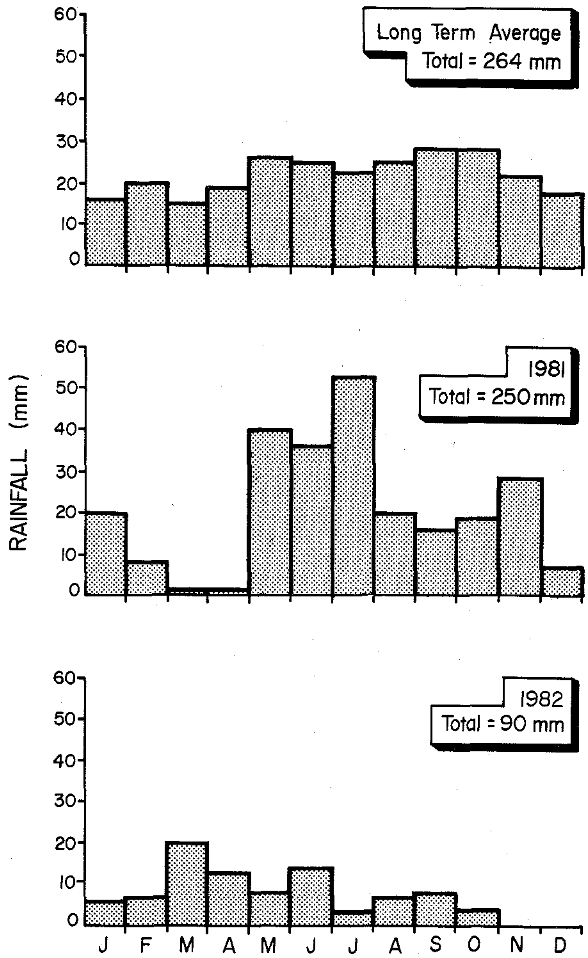

Figure 1. Monthly distribution of rainfall for Renmark in 1981 and 1982 compared to the long term average normal pattern.

During 1981, a year of average rainfall, eight active mounds were located in a 650 ha study site 10 km west of Renmark, South Australia. In 1982, a drought year, only four of these mounds were found to be worked by the birds. When the mounds were visited several times over the period of mound preparation in both years, mound temperature profiles were recorded by inserting a fibreglass rod with thermocouples placed at 10 cm intervals along its length into the mound. Mean mound temperature was calculated by averaging profile temperatures. Samples of litter were taken from mounds for water content analysis. Samples were dried at 70°C for 24 h. Percentage water content was calculated on a wet weight basis [100 (wet wt − dry wt)/wet wt]. Rainfall and temperature data were obtained from a Commonwealth weather station located at Renmark.

The pattern and amount of rainfall was similar in 1981 as in previous years (Fig. 1). However, in 1982, total rainfall was about 34% of normal.

RESULTS AND DISCUSSION

In 1981, mound temperatures increased from July through to October and there was no obvious relation-

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ship between litter water content and mound temperature (Fig. 2). All mounds showed a peak in water content at the end of July in 1981, following heavy rains in winter (Fig. 1). Water content gradually dropped until a stable level of about 9% was reached in mid-September (Fig. 2). The first eggs appeared in the mounds in mid-September and on 28 October all mounds were covered in sand and contained eggs.

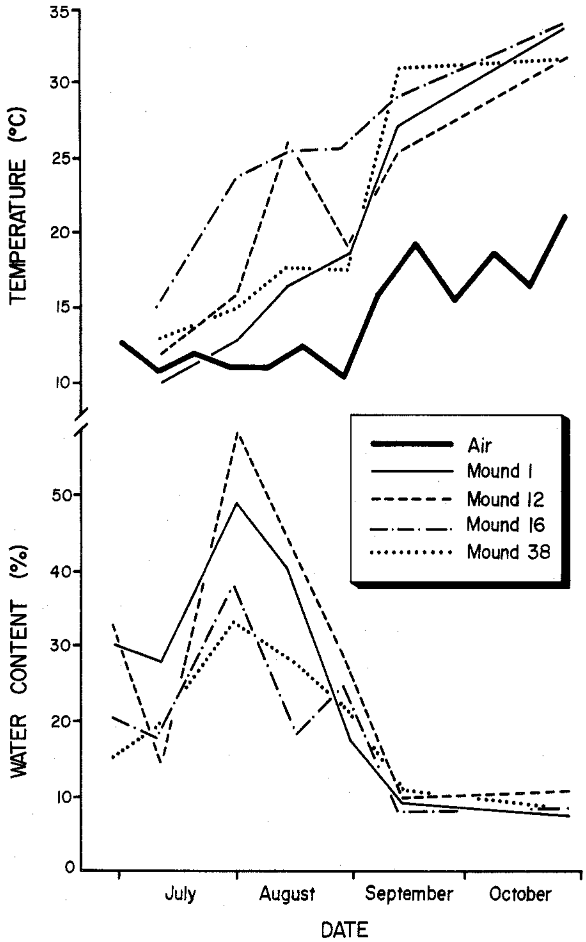

Figure 2. Water content of mound litter material, mean mound and air temperature of four typical Malleefowl mounds over the period leading up to egg-laying in the 1981–82 breeding season.

In 1982 very little rain fell (Fig. 1) and consequently the water content of litter was low (Fig. 3). Mounds were first visited in late August when litter was being piled into the crater. By 14 October only a little more scratching of litter into mounds had occurred. On this visit we added 15 l of water to the litter of two of the four mounds. This is equivalent to a rainfall of about 2 mm over each mound. The other two mounds were left unwatered as controls. On the next visit, 22 October, the temperature of the two watered mounds had not changed significantly, so an additional 400 l of water (*ca.* 57 mm of rain) was added to each mound from a water tanker. Birds continued to visit the two unwatered mounds up until about 12 November (indicated by the presence of fresh foot-prints, scratchings and faeces), but then the mounds were abandoned. The two watered mounds were visited and worked by birds until about 6 December, but were then abandoned also. Neither watered nor unwatered mounds were covered by sand and no eggs were laid.

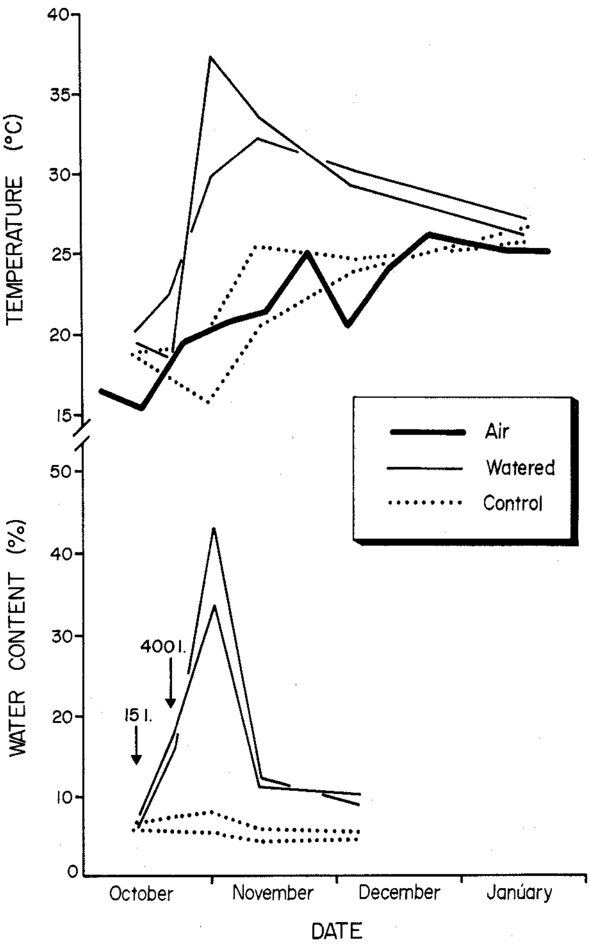

Figure 3. Water content of mound litter material, mean mound and air temperature of the four worked Malleefowl mounds over the period leading up to the aborted 1982–83 breeding season.

In 1981 the thermogenic effect of microbial decay began to raise mound temperature above mean air temperature by mid-July (Fig. 2). The mound temperature increased steadily until mid-September when an 8–10°C gradient existed between mean air temperature and mound temperatures (Fig. 2). In contrast, temperatures of the two unwatered mounds during 1982 rose with increasing air temperature, but never greatly exceeded it (Fig. 3). The dry litter failed to decay and no heat was generated. The addition of 400 l of water in October had a dramatic effect on mound temperature (Fig. 3). The increase in water content, to levels similar to those in previous years (cf. Figs. 2, 3), immediately triggered microbial respiration and heat production. When the litter dried out in late November and December, microbial heat production ceased and mound temperature once again approached air temperatures.

Birds responded to mound watering by thoroughly mixing the litter material and constructing egg chambers. However, despite mound temperature rising to and remaining at suitable incubation levels for at least one month (a period long enough to stimulate commencement of egg laying: Frith 1959b), the birds failed to cover these mounds with sand and begin egg-laying. Apparently the heating of mound material *per se* does not trigger Malleefowl to complete mounds and start egg-laying.

It is significant that Malleefowl are able to obtain and maintain correct incubation temperatures in mounds that do not contain any litter at all (Frith 1956, 1959b). This is possible during the summer and autumn when the birds manipulate the mound to heat it with solar radiation (Frith 1956, 1959b). Solar heat is usually only utilized by birds towards the end of the breeding season, in February and March (Frith 1956, 1957, 1959b). The fact that Malleefowls do not make use of entirely solar heated mounds during droughts suggests that factors other than mound temperature influence egg-laying.

Breeding in a drought year is disadvantageous because of poor primary production and a consequent reduction in food resources (Mattingley 1908; Frith 1959b; Earle 1982). Females may have difficulties in finding enough food to form the very large eggs they lay, and chicks hatching at the end of summer may starve (Frith 1959b). Breeding in birds requires a large energy investment (Ricklefs 1974; Earle 1982), especially in a species like Malleefowl which produces an abnormally large mass of eggs each season (Lack 1968) and works on the mound for several months (Frith 1959b). It is of selective advantage for birds to anticipate the environment at the time when chicks will hatch and to avoid egg-laying if conditions are likely to be unfavourable. This may be difficult in Malleefowl because there is a two month time-lag between egg-laying and hatching. Therefore the cue for egg-laying is more likely to be certain aspects of the environment that are related to seasonal climatic patterns rather than to mound temperature alone. As we have demonstrated, the mounds may warm to incubation temperatures following brief rainfall of only 52 mm, an amount possibly insufficient to provide adequate resources for successful breeding.

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