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THE BIOLOGY AND SURVIVAL OF STARVED CATTLE AND GOAT BITING LICE (MALLOPHAGA) AT DIFFERENT TEMPERATURES AND RELATIVE HUMIDITIES

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SUMMARY

The biting louse of cattle (**Damalinia bovis**) and the biting louse of goats **D. caprae**) were studied **in vitro.** They were sub jected to temperatures of 25°C, 30°C and 35°C at relative humidities of 10, 50 and 90%. No food was supplied.

Adult lice of both species lived longest at 25°C. The temperature at which the majority of eggs hatched was regarded as the optimum temperature for that species. On this basis, **D. caprae** had an optimum temperature of 30°C and **D. bovis** preferred 35°C.

Relative humidity appeared to play little part in the processes studied, although humidity preferences were more marked during oviposition.

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INTRODUCTION

Damalinia bovis (Linnaeus, 1758) and **D. caprae** (Gurlt, 1843) are Mallophaga infesting cattle and goats respectively in New Zealand. The ability of lice to survive away from the host has practical application for the farming industry. Where lousy animals are held in saleyards or trucks, the chance of louse-free animals becoming infested at a later date would be greater, the longer lice could survive without food. Similarly, lice could be carried on the clothes of persons in contact with livestock and so be transferred to clean hosts. These considerations focus attention on the treatment of yards and buildings in addition to the treatment of livestock.

MATERIALS AND METHODS

Lice were collected from 2 heifers and a goat kept at Wallaceville Animal Research Centre.

In the laboratory, lice were sorted and placed in small containers held in incubators over various concentrations of sulphuric acid to provide the required relative humidities (Solomon, 1952). The lice were held at temperatures of 25°C, 30°C and 35°C and relative humidities of 10%, 50% and 90%. All the temperatures used are likely to be experienced in the field in New Zealand during later winter, spring and summer.

The lice were examined every 24 hours where possible and deaths recorded. Eggs laid in the containers were left to hatch **in situ.**

RESULTS

Survival of adult female lice

Data on survival of adult female lice of both species are expressed as both an LT_{50} and mean longevity. The former is the time required for half the lice to die at a particular combination of temperature and relative humidity (Andrewartha and Birch, 1964). This gives the most precise estimate of the effect of environmental conditions on mortality. Mean longevity is the mean of the times taken for 100% mortality in each experiment.

The LT_{50} at 25°C was 59 and 61 hours for **D. bovis** and **D. caprae** respectively. At 30°C and 35°C, the LT_{50} for **D. bovis** was 50 and 42 hours respectively and for **D. caprae** 30 and 38 hours. Relative humidity had little or no effect on death rate.

TABLE I

Mean longevity of **D. bovis** and **D. caprae** female lice ± Standard deviation (in hours). Figures are the mean longevity data in each replicate.

D. bovis

	Temperature (°C)			
RH(%)	25	30	35	Mean
10	115±11.8	91± 1.3	72± 2.8	91
50	115±11.8	108±11.1	82± 9.0	102
90	103± 9.2	96± 8.8	84± 9.0	94
Mean	113	98	79	

D. caprae

	Temperature (°C)			
RH(%)	25	30	35	Mean
10	118±25.0	70± 0	82±12.3	90
50	139±19.8	70±11.8	62± 0	79
90	118±29.9	46± 0	82±14.6	84
Mean	122	65	74	

In agreement with the LT_{50} data, the figures in Table 1 show that humidity has little effect on longevity. Both species of lice survived longest at 25°C.

Analysis of variance on LT_{50} data and the data in Table 1 showed highly significant difference between temperatures ($P < 0.001$), a significant difference between species ($P < 0.05$) but no difference between relative humidities. There was no significant interaction between the 3 main effects (temperatures, species and relative humidities).

Survival of nymphs

Data on the survival of the three nymphal instars of both species were complicated by the fact that moulting occurred at all combinations of temperature and relative humidity.

The nymphs of both species lived 4-6 days but numbers were not sufficient to detect any significant temperature effects. Relative humidity appeared to have no effect on survival or ecdysis.

Oviposition and hatching

The number of eggs found at each observation was recorded and the eggs were examined every 24 hours where possible. Eggs were laid readily by the lice at all temperatures and relative humidities although the eggs laid per female was highest for **D. bovis** at 35°C and for **D. caprae** at 30°C. At both temperatures a 10% relative humidity was preferred for oviposition.

D. bovis eggs did not hatch at 25°C or 90% relative humidity. **D. caprae** eggs on the other hand, did not hatch at 25°C or 35°C. At 30°C fewer **D. caprae** eggs hatched at 90% than at 10% or 50% relative humidity. Incubation periods at optimum conditions were 11 days for **D. bovis** and 8-10 days for **D. caprae.** The mean percentage hatch was 59% for **D. bovis** at 35°C and 56% for **D. caprae** at 30°C.

DISCUSSION

Longevity of starved arthropods is governed to a large degree by their metabolic rate and this is, in turn, dependent upon temperature. Metabolic rate in most poikilotherms is directly proportional to environmental temperatures over a limited range. This accounts for the increased longevity in both **D. bovis** and **D. caprae** adults at the lowest temperature used in these experiments.

Matthysse (1946) reported that **D. bovis** first, second and third instar nymphs with food and under optimum conditions, had instars of 7, 5½ and 6 days mean duration respectively.

In the present study, longevity was approximately 6, 5 and 6 days duration for first, second and third instars, respectively, kept at 30°C and without food. Many nymphs died during ecdysis; presumably the lack of food and energy necessary for moulting contributed to these deaths.

The nymphal instars of **D. caprae** had a duration of 4, 4½ and 4½ days for first, second and third instars respectively. Under normal conditions on the host, the length of time between instars is probably close to these figures, indicating a shorter life cycle (egg to egg) for **D. caprae** than for **D. bovis.**

Matthysse (1946) gives the optimum environmental conditions for **D. bovis** at 35°C and 70-84% relative humidity. Under these conditions, eggs took 6-9 days to hatch, with an average of just over 7 days. The eggs of **D. bovis** in the present study hatched at approximately 11 days at 35°C and 10 and 50% relative humidity. None hatched at 90%. The drier atmosphere is at variance with Matthysses' findings, although Murray (1957) found that the sheep biting louse **(D. ovis)** will choose a dry atmosphere for oviposition.

For **D. caprae** hatching occurred only at 30°C suggesting perhaps that this is near the optimum environmental temperature. According to Wigglesworth (1961) a more definite conception of an optimum temperature is possible in considering the development of the egg or pupa.

The incubation time for **D. caprae** eggs was 8-10 days duration, somewhat shorter than for **D. bovis,** inferring a shorter life cycle time for **D. caprae.** The goat louse produced more eggs per female than **D. bovis.** Matthysse (1946) found that **D. bovis** produced on the average, one egg every 35 hours. From the present results, **D. caprae** (could be expected to produce one egg every 24 hours. The newly emerged first stage nymphs lived no longer than 12 hours in both species. No data for **D. bovis** have been seen but Thorold (1963) noted that **D. caprae** nymphs lived only 5-6 hours after hatching at 18-25°C.

Despite the different temperatures preferred for successful incubation, both species of lice laid more eggs at 30°C than at the

other temperatures. It is known (Patton, 1963) that rate of egg production is governed by metabolic rate. Furthermore, nutrition affects fertility of the female, and the demand for nutrients during egg production is great. In the present study, the response to an increased metabolic rate was seen as an increased oviposition rate up to 30°C. At 35°C a further increase in metabolic rate coupled with a lack of available nutrients resulted in a drop in egg production.

Louse populations are very low during the summer months, but the results above suggest that louse transference and survival off the host in summer could occur just as readily as in the more favourable conditions of autumn and winter.

It is considered that a chance of transfer of lice from host to host via the medium of inanimate objects, is very low. However, the results above suggest that a 14 day period (based on the incubation time of the egg) or 7 days (if only adults are considered), would be sufficient to ensure absolute protection in the absence of any additional control by chemical or physical means.

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