SOME EFFECTS OF MICROCLIMATE ON THE LONGEVITY AND DEVELOPMENT OF *DERMATOPHAGOIDES PTERONYSSINUS* (TROUESSART)

BY

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INTRODUCTION

Dermatophagoides pteronyssinus, the House-dust mite is important as a source of allergens which cause respiratory complaints in sensitive subjects (SPIEKSMA, 1967). Microclimate seems to be of great importance in determining the intensity of infestation of the mites in any particular habitat and several workers have studied the growth of cultures kept under different combinations of temperature and relative humidity (SPIEKSMA, 1967 ; KOEKKOEK & BRONSWIJK, 1972 ; MURTON & MADDEN, 1977). The durations of the separate stages of the life cycle at 25°C/80 % relative humidity and of the larval, protonymphal and tritonymphal stages at 20°C/80 %RH were measured by SPIEKSMA (1967) and in the present paper the results of observations on the longevity of the adult mites and on the development of the immature stages over a wide range of temperatures and relative humidities are reported. A more complete knowledge of the effects of microclimate on the life history of the species seems a pre-requisite to a full understanding of its ability to survive and reproduce in various habitats.

METHODS

Pairs of newly emerged adult mites, taken from a stock culture at 25°C/80 % RH, were placed in modified " Robertson " cells (SOLOMON & CUNNINGTON, 1964) and maintained in the following microclimates 5°, 10°, 15°, 20°, 25°, 30°, 35° and 40°C combined with relative humidities 60 %, 80 % and 100 %. Observations were made daily and newly laid eggs were transferred to similar cells kept in the same conditions so that the progress of individuals through the life cycle could be followed. Cells containing active stages were provided with a little of a 9 : 1 mixture of electric razor clippings and dried yeast as food. The cells were stacked in racks in " Kilner " jars containing salt solutions giving the specified atmospheric humidities and the closed jars were placed in incubators at constant temperatures.

RESULTS

Statistical considerations.

The values for duration of the various stages in the life cycle varied greatly between individuals, the standard deviations correlated strongly with the arithmetic means and the frequency distributions were almost always positively skewed. Analyses were therefore carried out on

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logarithmically transformed variates (log (x + 1)) and geometric means with asymmetrical confidence limits are quoted throughout.

Adult mites.

Mean longevities, after equalisation of microclimatic treatment numbers to 9 by random selection, and 95 % confidence limits are shown in Table 1. Analysis of variance enabled effects of temperature, relative humidity and sex to be evaluated separately along with their interactions. Temperature was clearly the most important variable (variance ratio, F, 7/398 d.f. ; 239, $P < 0.001$), longevity being maximal from 10°-20°C and decreasing at progressively higher temperatures. At 40°C life was brief. There was also a marked difference between the longevities of the sexes, females living, on average, about 1.4 times as long as males (F, 1/398 d.f. ; 35.5, $P < 0.001$). The effects of relative humidity were of comparatively minor importance and differed at different temperatures (F, " RH × T interaction ", 14/398 d.f. ; 4.9, $P < 0.01$) so no generalised statement can be made. The maximum observed adult longevities in any treatment were 253 and 324 days for males and females respectively at 10°C/80 % RH.

TABLE 1.

Mean longevities of adult *Dermatophagoides pteronyssinus* in various microclimates (days).

Temperature °C	Relative Humidity %. 60		80		100	
	♂	♀	♂	♀	♂	♀
5	18.2	25.2	25.6	78.0	30.7	85.6
10	90.0	119.9	127.2	106.6	81.5	96.0
15	67.4	106.9	79.0	102.1	52.5	75.9
20	64.2	75.9	68.7	88.2	58.0	77.6
25	25.1	40.6	27.3	38.7	31.6	42.1
30	15.2	15.3	11.5	15.8	15.4	18.5
35	9.9	12.5	9.5	19.3	16.6	19.0
40	2.2	1.8	2.3	3.1	2.2	4.6

95 % confidence limits of all means $\overset{\times}{\div}$ 1.6.

Eggs and immature stages.

The data on the incubation periods of eggs and on the duration of the immature stages will be considered piecemeal because, due to great variation in the numbers of eggs laid and in mortality during development the numbers of individuals available for observation in different treatments differed greatly.

At 5°C only one egg was laid and this died without sign of development. A 10°C 83 eggs were laid and of these 3 hatched but died as larvae. At 15°C none of the eggs laid at either 60 % or at 100 % RH survived but 24 out of 33 laid at 80 % RH hatched. All died as larvae.

At higher temperatures, except at 35°C/60 % RH and at 40°C where no eggs were laid, production was more regular and from 31 to 96 eggs were available for separate treatments. Complete development through the life-cycle occurred at 20°, 25°, 30° and 35°C but deaths caused a progressive and unequally distributed depletion of numbers and in the 100 % RH cells at 25°, 30° and 35°C no individuals survived to reach maturity. Survival and egg productivity were both maximal at 25°C/80 % RH.

TABLE 2.

Mean developmental periods of eggs and immature stages of *Dermatophagoides pteronyssinus* in various microclimates and 95 % confidence limits (days).

Temperature °C	RH %	Egg	Larva	Protonymph	Tritonymph
20	60	10.1 ± 1.1	11.8 ± 1.1	13.3 ± 1.2	12.3 ± 1.2
	80	7.5 ± 1.1	10.5 ± 1.2	9.4 ± 1.5	(17.8)
	100	14.3 ± 1.1	12.2 ± 1.2	11.4 ± 1.1	16.7 ± 1.3
25	60	4.7 ± 1.1	5.4 ± 1.1	4.7 ± 1.1	5.1 ± 1.2
	80	4.6 ± 1.1	4.1 ± 1.1	3.5 ± 1.1	4.5 ± 1.1
	100	4.9 ± 1.1	11.3 ± 2.1	(14.0)	—
30	60	3.5 ± 1.1	5.2 ± 1.1	3.2 ± 1.2	4.5 ± 1.1
	80	3.7 ± 1.1	3.7 ± 1.2	4.7 ± 1.3	4.5 ± 1.2
	100	3.9 ± 1.1	—	—	—
35	60	—	—	—	—
	80	3.4 ± 1.1	3.8 ± 1.3	3.2 ± 1.5	(2.6)
	100	3.4 ± 1.2	(7.1)	—	—

Significance tests (a) between humidities : (probabilities)

Temp. °C	Egg	Larva	Protonymph	Tritonymph
20	< 0.001	N.S.	N.S.	N.S.
25	N.S.	< 0.001	< 0.001	N.S.
30	N.S.	< 0.01	< 0.01	

(b) between temperatures :

RH %	Egg	Larva	Protonymph	Tritonymph
60	< 0.001	< 0.001	< 0.001	< 0.001
80	< 0.001	< 0.001	< 0.001	N.S.
100	< 0.001			

Mean durations and their 95 % confidence limits for temperatures from 20° to 35°C are shown in Table 2 together with the results of significance tests. Values based on less than 6 individuals are placed in brackets and have been excluded from the analyses. Temperature was clearly the most important factor affecting duration and, as might be expected, development generally proceeded more rapidly with each successive increment. Relative humidity was inconsistent in its effects but in 8 out of 12 instances where a comparison could be made the observed development at 80 % RH was more rapid than at the other humidities and in 4 of these the difference was highly significant.

Although immature mites can not be sexed the complete life history of 92 individuals could be followed from egg to adult. No differences in the developmental rates of males and females were observed.

Discussion

Adult mites showed great differences in longevity at different temperatures and their ability to survive for long periods at low temperature is of particular interest as it has a direct bearing on the ability of the species to persist in habitats with climates temporarily unsuitable for breeding. Their ability to produce viable eggs at temperatures as low as 10°C and 15°C is also of interest even though no individuals survived the larval stage. Hoekkoek & Bronswijk (1972) found that cultures of mites kept at 15°C/75 % RH increased slowly and it seems possible that at these low temperatures relative humidity may have a critical effect on survival.

The values for duration of the immature stages at 20°C/80 % RH observed here agree closely with those recorded by Spieksma (1967) but those observed at 25°C/80 % RH were some 30 % shorter. It may be noted however that the diagrams given by this author to show the frequency distributions of values for duration of immature stages at 25°C/80 % RH (Spieksma, 1967 ; Fig. 4.2) show a positive skew as observed here. The adult longevities recorded here for 25°C/80 % RH were less than one third of those noted by Spieksma (1967) but it is agreed that female adults live considerably longer than males and that the immatures of both sexes develop at similar rates. According to Spieksma (1967), Koekkoek & Bronswijk (1972) and Murton & Madden (1977) maximal population growth occurs around 25°C/75-80 % RH. Here the maximal egg productivity and minimal mortality combined with the fairly short life cycle at 25°C/80 % RH also gave maximal population growth.

Cultures kept at 35°C/75 % RH by Koekkoek & Bronswijk (1972) declined but Murton & Madden (1977) found that slow growth still occurred at 37°C/75 % RH. Here viable eggs were produced at 35°C/80 % and 100 % RH and at 80 % RH complete development could occur. The upper temperature limit for survival is probably between 37° and 40°C.

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Summary

All stages of *Dermatophagoides pteronyssinus* (Trouessart) were observed at temperature intervals of 5° from 5° to 40°C combined with relative humidities 60 %, 80 % and 100 %. Temperature greatly

affected adult longevity which was maximal from 10° to 20°C and minimal at 40°C. Eggs were laid from 5° to 35°C but the life cycle was completed only between 20° and 35°C, the rate of development increasing with temperature. Relative humidity had a comparatively minor effect but development tended to be most rapid at 80 % RH and premature mortality to be high at 100 % RH. Maximum population growth was at 25°C/80 % RH. Adult females lived longer than males but their immature stages developed at similar rates.

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