FOLIA PARASITOLOGICA (PRAHA) 32: 83—88, 1985.

THE EFFECTS OF TEMPERATURE, RELATIVE HUMIDITY AND HOST FACTORS ON THE ATTACHMENT AND SURVIVAL OF BOOPHILUS DECOLORATUS AND BOOPHILUS GEIGYI LARVAE TO SKIN SLICES

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Abstract. Attachment and survival of *Boophilus decoloratus* and *B. geigyi* larvae were examined using skin slices from cattle, sheep and goats. Results indicate that *B. decoloratus* has a wider range of temperature (24—40 °C) at which more than 50 % of larvae would attach to bovine skin, while *B. geigyi* has a narrower range (24—30 °C). The larvae of both species had two peaks of attachment—the 4th and 20th hour, the value for the second peak being greater than the first. The influence of humidity on larval attachment was only apparent where the temperature was high, and in such cases more than 70 % of *B. decoloratus* larvae attached, while less than 20 % of *B. geigyi* larvae attached by the 20th hour. Less than 50 % of larval attachment was recorded on both sheep and goats. The results are related to the geographical distribution of both species in Nigeria, and to the problems of tick water balance, stimuli for tick attachment and host specificity.

The continuity of generations upon generations of ixodid ticks in the field depends solely on the adequacy of the parasite-host finding process. Various factors such as temperature, relative humidity and those of the host affect this process. A variety of in vitro experiments on the responses of several tick species to stimuli from the host were reported. Attraction and attachment of ixodid ticks to host skin were shown by Lees (1948) and Gregson (1973) to be triggered by thermal and olfactory stimuli. Argasid ticks, on the other hand, easily attached to the warmed artificial membranes (Galun and Kindler 1968, Tawfik and Guirgis 1969). Kemp et al. (1975) found that attachment and feeding of *B. microplus* occurred on thin slices of cattle skin maintained at 35 °C, but not on artificial membranes. Recently, Doube and Kemp (1979) reported the range of temperature (31—38 °C) within which a high proportion (70—80 %) of B. *microplus* larvae attached to thin slices of bovine skin. Their experiments also showed that low humidity killed larvae which were denied access to skin, but many more survived either when the humidity was raised or when larvae were allowed to feed. There has not been any previous information on the attachment and survival capabilities of larvae od *B. decoloratus* and *B. geigyi* which are the predominant species in Nigeria (Dipeolu 1975). This paper deals with the in vitro studies on the influence of temperature, relative humidity and host factors on the attachment of larvae of the two last mentioned species (*B. decoloratus* and *B. geigyi*).

MATERIALS AND METHODS

The skin slices and serum used in this study were obtained from local (white Fulani) cattle, West African dwarf goat and Yankassa sheep, all of the Teaching and Research Farm, University of Ibadan and Veterinary Control post, Bodija, Ibadan. The materials and methods were a modified form of those of Doube and Kemp (1979), the only modification being the use of

finely perforated transparent nylon used in place of the disc. About 100 larvae (4—6 days old) of *B. decoloratus* and *B. geigyi* respectively, which had hatched from eggs kept in an incubator at 24 °C and 85 % relative humidity, were placed in feeding chambers and confined by the finely perforated nylon. The skin temperature and ambient temperature were kept constant in an incubator and the required relative humidities maintained by using saturated salt solutions in dessiccators (Winston and Bates 1960). Each treatment was investigated by a minimum of 3 replicates. The number or percentage of larvae attached was ascertained by the method described by Doube and Kemp (1979). Skin slices were taken from different parts of the animal's body and no attempt was made to observe the rate of larval attachment to skin from different parts of the animal's body. Serum from cattle, sheep and goat as well as phosphate buffered saline (PBS) of pH 7.2 were all used accordingly.

RESULTS

The influence of temperature on attachment

Larvae held in feeding chambers were exposed to five different temperatures and the proportion attached was scored after 20 hrs. All were maintained at 85 % relative humidity. As shown in Fig. 1, more than 50 % of *B. geigyi* larvae attached only at 24 and 30 °C respectively, while those of *B. decoloratus* attached at all the temperatures of maintainance except at 15 °C. The highest level of attachment of *B. geigyi* larvae occurred at 24 °C while that of *B. decoloratus* was at 30 °C.

The proportion attaching with time after infestation

Larvae in feeding chambers were held at 24 °C and 85 % relative humidity. At intervals of every 1 hour for the first 4 hrs, and every 4 hrs for the rest of the experiment, 3 chambers each of *B. decoloratus* and *B. geigyi* were removed and scored. The results showed that attachments in both reached a first peak of over 70 % at 4 hrs. This remained more or less the same until the 12th hour. Thereafter, there was a gradual increase in the level of attachment of *B. decoloratus* larvae to reach a second peak of over 90 % by the 20th hour; followed by a small decrease to about 85 % by the 24th hour. The larvae of *B. geigyi*, on the other hand, the period between the 12th and 16th hour showed a small decrease in attachment and this was followed by a sharp increase to a level of about 88 % by the 20th hour; but by the 24th hour the figure dropped to a level below 80 % (Fig. 2).

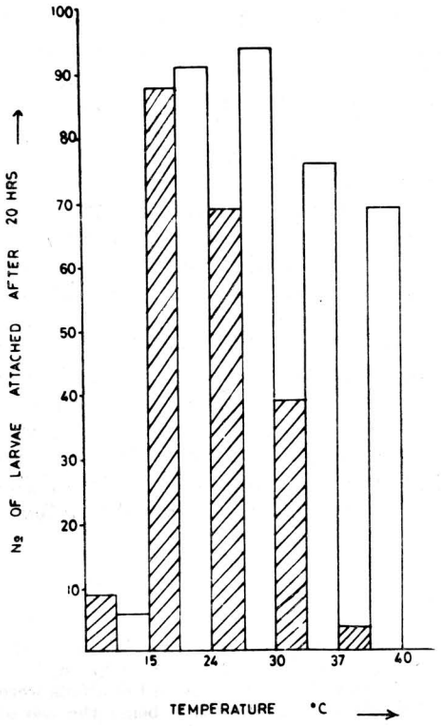

Fig. 1. The influence of temperature on attachment of larvae of *B. geigyi* and *B. decoloratus* (dashed columns *B. geigyi*, white columns *B. decoloratus*).

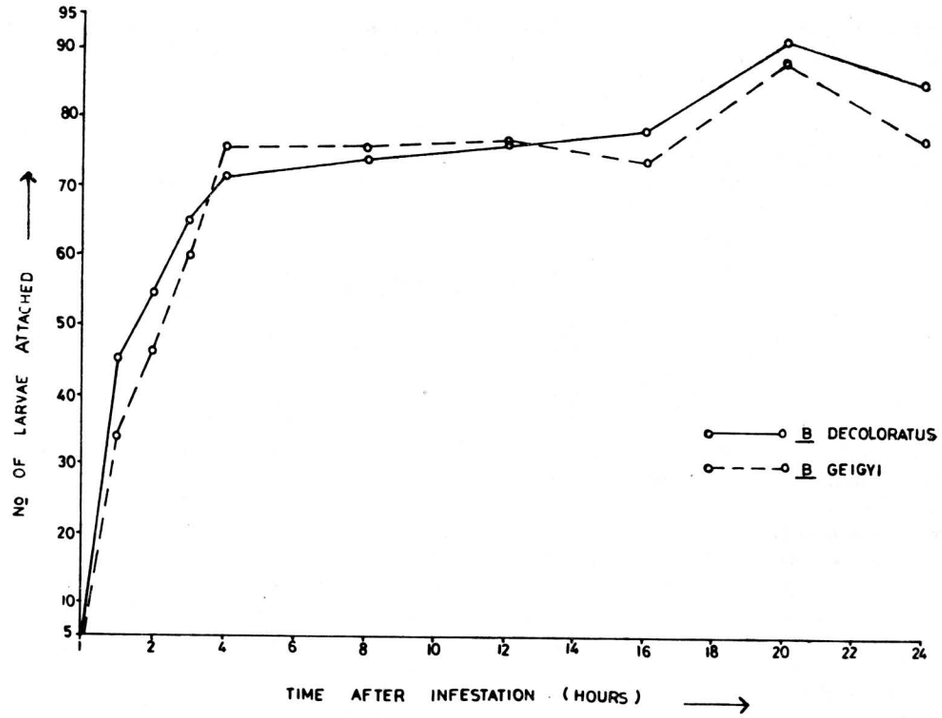

Fig. 2. Number of larvae attaching with time after infestation.

The influence of relative humidity on attachment and survival

Table 1 shows the proportion of attached larvae of *B. decoloratus* and *B. geigyi* at high and low humidities. Larvae in feeding chambers were held at 20 % and 85 % relative humidities at two constant temperatures (24 °C and 37 °C). At the lower temperature, there was no appreciable difference in attachment of larvae of the two species of *Boophilus*, both at 85 % and 20 % RH, but where the saturation deficit was high (37 °C; 20 % RH), more than 70 % of *B. decoloratus* larvae attached, while in *B. geigyi* the figure of attachment was initially high, 64 % by 4th hour and reached a low level of 17.7 % by the 20th hour.

The influence of the medium beneath the skins on attachment

Table 2 shows the proportion of attached larvae when different media were used beneath the skin slices. In both species the highest attachment values were reached when bovine serum was used, and the lowest ones with no medium.

Influence of goat and sheep skin on attachment of larvae of *B. decoloratus* and *B. geigyi*

Table 3 shows the proportion of larvae attached to both goat and sheep skin maintained at 24 °C and 85 % RH. The results show that less than 50 % of the larvae

of both *B. decoloratus* and *B geigyi* attached by 4 hrs. and this was even further reduced by the 20th hr. at both times, a greater percentage attached to sheep than goat skin.

Table 1. Proportion of *B. decoloratus* and *B. geigyi* larvae attached to fresh bovine skin at high and low relative humidity and at high and low temperature

t°	Time	85 % rel. humidity		20 % rel. humidity	
		B. decoloratus	*B. geigyi*	*B. decoloratus*	*B. geigyi*
24 °C	4 hrs	71.3 (3.05)	75.6 (1.52)	42.3 (4.09)	41.0 (4.35)
	20 hrs	91.3 (11.75)	88.0 (7.0)	41.3 (1.15)	39.0 (1.0)
37 °C	4 hrs	69.6 (10.2)	48.6 (6.1)	73.0 (5.56)	64.0 (6.0)
	20 hrs	76.0 (2.64)	39.0 (2.64)	71.6 (3.78)	17.7 (3.51)

Figures in brackets = standard deviation.

Table 2. Influence of the medium on the % attachment of larvae of *B. decoloratus* and *B. geigyi* to bovine skin slices at 24 °C and 85 % RH after 20 hrs.

Species	Bovine serum	Phosphate buffered saline	No medium
B. decoloratus	91.3 (11.7)	71.3 (9.07)	57.7 (2.51)
B. geigyi	88.0 (7.0)	66.3 (2.08)	44.0 (3.6)

Table 3. Proportion (%) of larvae of *B. decoloratus* and *B. geigyi* attached on sheep and goat skin slices at 24 °C and 85 % RH at 4 and 20 hrs.

Species	Time	Sheep	Goat
B. decoloratus	4 hrs	37.0 (3.6)	18.0 (3.0)
	20 hrs	18.3 (2.51)	11.3 (3.05)
B. geigyi	4 hrs	15.7 (3.51)	8.0 (1.0)
	20 hrs	8.7 (1.52)	4.0 (2.0)

DISCUSSION

In these in vitro experiments, larvae of *B. decoloratus* showed a wider range of temperature at which they attach (24—40 °C), with a peak at 30 °C; while those of *B. geigyi* showed a narrow range at which more than 50 % larvae would attach (24—30 °C). This observation partly explains the distribution pattern of both *B. decoloratus* and *B. geigyi* in Nigeria as described by Dipeolu (1975). Because of its wider range of temperature tolerance, *B. decoloratus* occurs in all ecological zones in the country and is the predominant species in the Sahel zone where the temperature approaches 40 °C for most of the year. Also, both species intermingle in the savannah and derived savannah zones where the ambient temperature is around 30 °C. *B. geigyi* has also been reported to be the predominant species in the forest zone. But these in vitro experiments showed that there was no appreciable difference in the rate of attachment of larvae of both *B. geigyi* and *B. decoloratus* at 24 °C which is the ambient temperature of the forest zone of Nigeria. The experiments also showed that the first peak of attachment rates was reached at 4 hours in the two species and the second peak by the 20th hour. Kemp et al. (1976) reported that larvae of *B. microplus* had a complex attachment behaviour when free on the host and the same might be said of larvae of *B. decoloratus* and *B. geigyi* as our experiments indicated. The behaviour of larvae in vitro might be similar since it was observed that repeated detachment and reattachment occurred when larvae were confined in small chambers on the host (Roberts 1971). The relative humidity at the skin surface influenced the proportion of attached larvae only at high temperatures. This was because at a low saturation deficit (24 °C, 20 % Rh) there was no difference in the rate of larval attachment at 4 and 20 hrs respectively. But in the condition where the saturation deficit was high (37 °C, 20 % RH), while more than 70 % of *B. decoloratus* larvae attached at 4 and 20 hrs, those of *B. geigyi* dropped from 64 % at 4 hrs. to 17.7 % by the 20th hour. Thus, the reductions in attachment might be due to the high skin temperature and the subsequent dessications of the larvae as a result of low humidity. Roberts (1971) found that relatively high skin temperature generates an environment which can dessicate ticks, though, dessication on the host has been suggested as a potential contributor to tick mortality (Roberts 1971, Tatchell 1972). These experiments also showed that when confined in a small space, as it is in a feeding chamber, larvae of *B. decoloratus* and *B. geigyi* attached on both sheep and goat skin, though the percentages attached were less than 50 % in both cases. Since the percentage of *B. geigyi* larvae attached was lower than that of *B. decoloratus* in vitro by the 20th hour, it might be possible that *B. geigyi* larvae would completely detach on the live host (sheep, goat) at a longer infestation time than the 20 hours in the in vitro experiment. In addition, the percentages of both *B. decoloratus* and *B. geigyi* larvae that attached to sheep and goat were considerably lower than those attached to cattle skin at the same conditions of maintainance. This observation holds true of the results obtained in the field where less or very few numbers of attached ticks are found on sheep and goats grazing on the same pasture with cattle which are heavily infested with ticks. Thus, it may be suggested that there are some responses from the host which trigger attachment and detachment of larvae; this may be responsible for the low infestation of ticks on sheep and goats as observed by Beaton (1939) and Dipeolu (1975).

ВЛИЯНИЕ ТЕМПЕРАТУРЫ, ОТНОСИТЕЛЬНОЙ ВЛАЖНОСТИ И ХОЗЯИННЫХ ФАКТОРОВ НА ПРИСАСЫВАНИЕ И ВЫЖИВАНИЕ ЛИЧИНОК *BOOPHILUS DECOLORATUS* И *BOOPHILUS GEIGYI* НА СЛОЯХ КОЖИ

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Резюме. Присасывание и выживание личинок *Boophilus decoloratus* и *B. geigyi* изучали при помощи тонких слоев кожи, срезанных у крупного рогатого скота, овец а коз. Результаты показали, что у вида *B. decoloratus* более широкий диапазон температуры (24—40 °C), при которой более чем 50 % личинок присасывалось к бычачей коже, в то время как у *B. geigyi* этот диапазон ниже (24—30 °C). У личинок обоих видов оказались два пика присасывания — на 4-ом и 20-ом часу, причем показатели второго пика были выше чем

у первого пика. Влияние влажности на присасывание личинок проявлялось только при высокой температуре, когда более чем 70 % личинок *B. decoloratus* и менее чем 20 % личинок *B. geigyi* присасывались в течение 20 часов. Как у овец так и у коз зарегистрировано менее чем 50 % присосавшихся личинок. Результаты касаются географического распространения обоих видов в Нигерии и вопросов водного баланса у клещей, стимулов для их присасывания и специфичности их в отношении хозяев.

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Received 9 September 1983.

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