GOATS AS ALTERNATIVE HOSTS OF *BOOPHILUS MICROPLUS* (ACARI: IXODIDAE).

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SUMMARY:Experimental infestations in goats, by larvae of *Boophilus microplus* originated from engorged females obtained from a naturally infested goat were carried out during two generations. Data on the life-cycle (parasitic and non-parasitic phases) and distribution of females on the body of the hosts were obtained in order to evaluate the role of goats as alternative hosts for *B. microplus*. Engorgement of larvae and larva-nimph ecdisis ranged from 5 to 7 days, engorgement of nimphs and nimph-adult ecdisis averaged 9 days and the engorgement of adults leasted 6,7 ± 1,7 days. The parasitic phase leasted 22.5 ± 1.7 days. The regions of the body with higher infestations rates were: internal region of the thigh (39.0%), hindleg (26.3%) and udder (12.6%). The non-parasitic phase (1st and 2nd laboratory generations) under laboratory conditions (27 ± 1°C relative humidity above 80% and scotophase) was as follows: engorged females weight (204.7 and 198.0 mg), pre-oviposition period (3.13 and 3.1 days), oviposition period (13.9 and 12.0 days), egg mass weight (103.1 and 92.1 mg), female weight after ending oviposition (62.1 and 67.4 mg), female survival period (26.2 and 26.5 days), incubation period (22.7 and 22.7 days), hatching period (7.7 and 8.1 days), hatching (94.3 and 93.6%), larval mortality period (47.0 and 53.9 days), larval longevity period (87.3 and 97.8 days), egg production index (49.2 and 46.1%) and nutrient index (70.8 and 70.6%). These results clearly suggest that goats might be used as alternative hosts under certain circumstances, therefore they should be included in control programs in farm or areas where goats and cattle are raised together.

KEY WORDS: *Boophilus microplus*, goats, parasitic phase, non-parasitic phase, sites of attachment.

INTRODUCTION

Boophilus microplus (Canestrini, 1887), the cattle tick, has been reported parasitizing goats by various researchers around the world (TATE, 1941; SHARMA & SHARMA, 1974; TONGSON *et alii*, 1981; BALOG; 1984; BHAT *et alii*, 1986; KHAN, 1986; CHHABRA *et alii*, 1988; SHAH *et alii*, 1990; PRATAP *et alii*, 1991; KUMAR *et alii*, 1994). In Brazil, the presence of infestations with *B. microplus* in goats was reported by ROHR (1909), ARAGÃO (1936), ROCHA (1985), BITTENCOURT *et alii* (1990) and CARDOSO & OLIVEIRA (1993). Among the mentioned authors, only TATE (1941) supplied information on the biological cycle of this tick in goats, determining the duration of each parasitic stage, by means of experimental infestations.

With the increase in goat breeding all over the country in recent years, especially in the Northeast region, (MENEZES, 1988), the State of Rio Grande do Sul (CARDOSO & OLIVEIRA, 1993) and the mountain region of the State of Rio de Janeiro (FONSECA, 1996), it is necessary the development of studies aiming at a better understanding of the parasitoses which affect these animals. Special emphasis should be given to the parasitism with *B. microplus*, since goats are not a target of the current control programs, and then may represent a source of pasture recontamination, compromising the efficacy of the control of *B. microplus* in cattle.

The present work aimed at verifying the possibility of infestations with *B. microplus* in goats for various generations, determining the biological parameters of the parasitic and non-parasitic phases and also to assess the preferred attachment sites of this tick on the host body.

MATERIALS AND METHODS

The experiment was carried out at the W.O. Neitz Experimental Station for Parasitological Research, Department of Animal Parasitology, Universidade Federal Rural do Rio de Janeiro, in the period from October, 1996 through June, 1997.

Larvae proceeding from a naturally *B. microplus*-infested goat were used to experimentally infest an adult crossbred doe. Approximately 2000 *B. microplus* larvae, 15 days old, were deposited on the dorsal line of the animal, which was stabled during the parasitic period. After natural detachment of the engorged females, these were taken to the laboratory, where they were cleansed and weighed. Thirty females were placed in Petri dishes, kept in chambers with controlled environment (27 + 1°C, relative humidity higher than 80% and scotophase), to study the biological parameters of the non-parasitic phase of the first laboratory generation of *B. microplus* from caprine origin. Every 24 hours after the beginning of oviposition, the egg masses were separated from the females. At the end of the oviposition process, the egg masses of each female were weighed and then pooled, then aliquots of 100 mg were transferred to plastic syringes with their extremities cut-off and sealed with cotton plugs, kept under the same conditions as the females. Three days after the end of oviposition, each female was weighed and kept in an incubator until death was detected. The syringes were observed daily to verify the hatching process. After this process ended, part of the material remained in the laboratory being examined weekly to follow the process of larval mortality. The remaining material was used for new infestations.

Experimental infections were carried out in another three adult, crossbred does. Each animal was infected three times. The first consisted of approximately 2000 larvae per animal; the second, also with 2000 larvae, was done seven days after the first. The third, with approximately 10000 larvae per animal, was performed 28 days after the first; in all infestations, larvae were spread along the back line of the animal. During the entire experimental period the animals were stabled, and were fed a balanced concentrate, green forage and water *ad libitum*. Strategies to restrict animal movement, to prevent their attempts to rid themselves of the larvae were not employed.

The goats were examined daily for observation and following of the processes of fixation, engorgement and ecdysis of the various parasitic stages of the tick, as well as for registering the location of the individuals in each region of the host body, until the natural detachment of the engorged females, which were then taken to the laboratory, where they were cleansed and weighed. Ten females from each infestation were selected, making up a total of 30 females, which were placed on Petri dishes, kept in incubators under the same conditions described earlier, to follow the non-parasitic phase of the second laboratory generation of *B. microplus* of caprine origin. The Student's " t" test, at a significance level of 5%, was used to verify the existence of significant differences among the parameters of the non-parasitic phases of the two laboratory *B. microplus* generations.

RESULTS AND DISCUSSION

From the initial infestation, in which a single goat was used, 37 engorged *B. microplus* females were recovered. From the subsequent infestations 95 engorged females were recovered from the three animals, being 26 from the first infestation, 13 from the second and 56 from the third. The low number of recovered females might have resulted from the mechanical action of the animals that, by grooming or scratching at the walls, managed to rid themselves from a considerable number of ticks, specially larvae that had not started the process of fixation. The caprine immune reaction of goats, which are not considered preferential hosts for *B. microplus* should also be considered. RIEK (1959), in studies on the reaction of animals to tick infestations, stated that hosts which are less often used by certain tick species, when infested, develop a series of immune reactions that culminate with high larval mortality, a fact that was confirmed by ROBERTS (1968). The negative effect of mechanical action of the animals on tick parasitism was assessed by SNOWBALL (1956), who related the decrease in production of engorged females to the self-grooming by cattle. GONZALES *et alii* (1974), in experimental *B. microplus* infestations in cattle, considered that the low number of engorged females obtained was due to high larval mortality, to a possible host immune reaction of the host, and to self-grooming and vigorous tail movements . In the caprine species, BITTENCOURT (1990), attributed the failure of the first attempts of infestation to the mechanical removal of larvae with the habit of scratching, due to the large quantity of hairs found on the walls and floor of the stalls; the obtention of a few engorged females was only possible by sedating the animals before the infestation, impairing by this way the mechanical defensive action against parasitism.

The larval engorging and larva-nymph ecdysis periods in the three infestations varied between 5 and 7 days, the 7th day being considered the modal day for the obtention of nymphs; the nymphal engorging and nymph-adult ecdysis occurred in approximately 9 days, varying from 8 to 10 days. The engorging of adults took place in 6.7 ± 1.7 days, varying in an interval of 3 to 12 days. The first two values had to be estimated, due to the difficulty to count the large number of larvae and nymphs present on the animals, in the three infestations. On the other hand, in the adult stage, the smaller quantity and larger size of the specimens allowed for more precise results. In Table 1 are presented the periods of duration of the parasitic phase of *B. microplus* in each infestation. The collection of engorged female occurred from 19 to 28 days after the infestations, with a means of 22.5 ± 1.7 days. In the literature, only TATE (1941), in Puerto Rico, provided data on the duration of each parasitic stage of *B. microplus* in goats. In experimental infestations with *B. microplus* larvae, the author

obtained periods of 7 to 18 days for engorging of larvae and larva-nimphecdysis, 7 to 27 days for engorging of nymphs and nimph-adult ecdysis and 6 to 20 days for engorging of adults. The maximum periods for each interval, considerably long, were determined for a few specimens of each stage of the tick biological cycle, because most engorged females was collected between 22 and 24 days post-infestation. The author also verified that the minimum duration periods for each stage of *B. microplus* in goats, sheep and dogs were practically the same as those found in cattle. Despite the chronological and geographical distance, those periods were similar to the obtained in the present experiment, and that might suggest stability in *B. microplus* populations.

Table 1 - Periods between infestation with larvae and detachment of *B. microplus* engorged females in experimental goat infestations.

Infestation	Periods (days) Mean ± standard deviation	Limits
First	22.6 ± 1.8	19.0-26.0
Second	23.2 ± 1.5	20.0-26.0
Third	22.4 ± 1.7	21.0-28.0
Mean	22.5 ± 1.7	19.0-28.0

Means did not statistically differ at a 5% significance level (ANOVA).

Upon studying the parasitic cycle of *B. microplus* in cattle, HITCHCOCK (1955), in Australia, observed that the larval stage lasted 5.5 days on average and that the interval between the infestation and nymphal moult was approximately 13.9 days (therefore, the duration of the nymphal stage would be of nymphs approximately 8.4 days on average). Finally the author obtained, for the interval between the infestation and detachment of engorged females an average of 21.9 days, what means that the engorging period was approximately 8 days. GONZALES *et alii* (1974), also in experimental infestations with *B. microplus* in cattle, mentioned that the modal days for the appearance of nymphs, appearance of young adults and collection of engorged females were, respectively, the 8th, 15th and 21st days (therefore the periods of duration of each stage would be 7 days for engorgement of larvae and larval-nimph ecdysis, 7 days for engorgement of nimphs and nimph-adult ecdysis and 6 days for adult engorgement). BITTENCOURT (1990), upon infesting cattle with *B. microplus* larvae, observed that the parasitic period varied between 21 and 23 days, obtaining a larger number of engorged females on the 23rd day after the experimental infestation, but did not determinate the periods of duration of each parasitic stage. In spite of being obtained from distinct hosts and in different times and geographical regions, the literature records, in particular that of GONZALES (1974), are similar to those obtained in the present experiment, what might confirm the above cited stability of *B. microplus* populations relative to parasitic behavior. It might also be suggested that the periods of duration of each parasitic stage of *B. microplus* are intimately related to the parasite, independent of the host species on which engorgement takes place.

In Figure 1, the percentages of parasitism of *B. microplus* females are presented according to the region of the host body. It was observed that the posterior region of the goats' body received the higher concentration of ticks. The most infested regions were the inner thigh, hocks and udder, with percentages of parasitism of 39.0, 26.3 and 12.6%, respectively, while the lowest infestations were observed in the earrings (3.2%), ears (3.2%), armpits (2.1%) and palpebrae (1.0%). BENNETT (1975), evaluating the distribution of *B. microplus* on the body surface of cattle, also observed an increased tendency of the females to attach to the posterior regions of the host body, mentioning that each stage of the tick biological cycle has its "preferred zones" for attachment or most favorable survival locations. Therefore, when carrying out the control of *B. microplus* it is recommended to pay special attention to the hind body of the host.

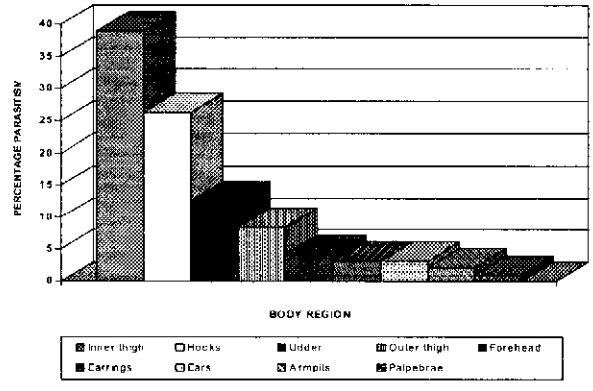

Fig. 1 - Percentage parasitism of *Boophilus microplus* females according to host body region, in naturally infested goats.

The biological parameters of the non-parasitic phase of the two laboratory generations of *B. microplus* of caprine origin are presented in Table 2. Using the Student's "t" test with a 5% significance level, the existence of significant differences between the generations was observed only in the oviposition period (shorter in the second generation) and in larval longevity (shorter in the first generation). By comparing the parameters of the present experiment with the literature records, obtained in *B. microplus* proceeding from cattle of the same physiographic region as the animals used in this experiment, it is observed that the weight of engorged females in goats (204,7 and 198,0 for the first and second laboratory generations, respectively) was lower than that of females from bovine origin, determined by COSTA (1982), BITTENCOURT *et alii* (1990) and GLÓRIA *et alii* (1993), who found respectively 223.30 mg, 258.2 mg and 240.70 mg. On the other hand, the oviposition period of the females from

caprine origin (13.9 and 12.0 days for the first and second generations, respectively) was longer than the periods registered for females from bovine origin. COSTA (1982) reported that the oviposition took place in 7.4 days on average, while BITTENCOURT *et alii* (1990) and GLÓRIA *et alii* (1993) obtained periods of 11.1 and 11.06 days, respectively, for the process of oviposition. Another parameter in which differences were found according to host was the female survival period (from female detachment until its death). While in the present experiment the females survived for approximately 26 days, COSTA (1982) and GLÓRIA *et alii* (1993) recorded periods of 14.3 and 19.88 days, respectively, for *B. microplus* females from bovine origin.

Table 2 - Biological parameters of the non-parasitic phase of two laboratory generations of *Boophilus microplus* from caprine origin, at 27 ± 1°C, relative humidity higher than 80% and scotophase.

Parameter	Means ± standard deviation	
	1st generation	2nd generation
Engorged female initial weight (mg)	204.7 ± 56.1	198.0 ± 59.0
Pre-oviposition period (days)	3.3 ± 1.0	3.1 ± 1.1
Oviposition period (days)*	13.9± 2.8*	12.0 ± 2.0*
Egg mass weight (mg)	103.1 ± 38.1	92.1 ± 32.0
Weight of female at end of oviposition (mg)	62.1 ± 25.2	67.4 ± 19.7
Female survival period (days)	26.2 ± 6.7	26.5 ± 7.5
Incubation period (days)	22.7 ± 1.9	22.7 ± 1.5
Hatching period (days)	7.7 ± 1.7	8.1 ± 1.7
Hatching (%)	94.3 ± 5.3	93.6 ± 5.3
Larval mortality period (days)	47.0 ± 7.8	53.9 ± 8.8
Larval longevity (days)*	87.3 ± 7.0*	97.8 ± 7.7*
Reproductive efficiency index (%)	49.2 ± 7.3	46.1 ± 5.8
Nutritional efficiency index (%)	70.8 ± 10.2	70.6 ± 8.6

*There was significative diferences between generations (Student "t" test at 5%).

The reproductive and nutritional efficiency indexes are also noteworthy. The reproductive efficiency indexes (49.2 and 46.1 for the first and second generations, respectively) were inferior, but close to those recorded in literature, by BITTENCOURT *et alii* (1990) and GLÓRIA *et alii* (1993), who found 58.5% and 58.07% respectively, working with *B. microplus* from bovine origin, which proceeded from the same region as the ticks used in this experiment. The nutritional efficiency index (approximately 70% for both generations) showed a similar behavior, with lower values which were close to those obtained by GLÓRIA *et alii* (1993) (78.60%). These values indicate that goats, while not the ideal ones, are suitable hosts for the development of *B. microplus*.

The remaining parameters of the non-parasitic phase were similar to those recorded in literature (COSTA, 1982; BITTENCOURT *et alii*, 1990; FURLONG; 1990; GLÓRIA *et alii*, 1993).

The alterations in some parameters of the non-parasitic phase of ixodids, when engorged in unusual hosts, reflect an attempt of adaptation and survival of the parasite in another host species and were already observed by DAEMON & SERRA-FREIRE (1987) and by BITTENCOURT *et alii* (1990), respectively, in *Anocentor nitens* and *B. microplus* from both bovine and equine origin. Analyzing these alterations in the non-parasitic phase and the relative stability in the periods of the parasitic phase in distinct hosts, it is curious that while some parameters of the non-parasitic phase of *B. microplus* are influenced by the host, the parasitic phase seems to be an intrinsic characteristic of the parasite, independent of the host.

From the analysis and interpretation of the results obtained in the present experiment, it is observed that for at least three generations (one from the field and two laboratory generations), *B. microplus* is capable of infesting goats, producing larvae that were suitable for use in new infestations. It should be emphasized that the hosts used were not immunosuppressed, as in the case of the horse which was naturally infested with *B. microplus*, whose immune response was suppressed by anti-inflammatory medication (BITTENCOURT, 1990). In the present experiment, the animals were healthy, well nourished and were easily infested, without the need for restraining. Therefore, goats should be considered alternative hosts and a secondary source of contamination for cattle, specially in properties and/or areas in which the two species are raised together, and then should be included in *B. microplus* control programs.

SUMÁRIO

A partir de fêmeas ingurgitadas de *Boophilus microplus* provenientes de um caprino naturalmente infestado, foram realizadas infestações experimentais por duas gerações em caprinos, com o objetivo de verificar a possibilidade de infestações por esta espécie de carrapato em caprinos, determinar os parâmetros biológicos das fases parasitária e não-parasitária e ainda estabelecer os sítios preferenciais de fixação deste carrapato no corpo do hospedeiro. O período de ingurgitamento e ecdise larva-ninfa variou entre 5 e 7 dias, o ingurgitamento e ecdise de ninfa-adulto foi realizado em 9 dias, em média e o ingurgitamento de adultos se processou em 6,7 ± 1,7 dias. O período parasitário foi de 22,5 ± 1,7 dias, em média. As regiões do corpo de maior concentração de parasitismo, foram face interna da coxa (39,0%), jarrete (26,3%) e úbere (12,6%). Os parâmetros biológicos da fase não parasitária (obtidos a 27 + 1°C, umidade relativa superior a 80% e escotofase) da primeira e segunda gerações de laboratório foram, respectivamente: peso da fêmea ingurgitada (204,7 e 198,0 mg), período de pré-postura (3,3 e 3,1 dias), período de postura (13,9 e 12,0 dias), peso de postura (103,1 e

92,1 mg), peso da fêmea ao final da postura (62,1 e 67,4 mg), período de sobrevivência da fêmea (26,2 e 26,5 dias), período de incubação (22,7 e 22,7 dias), período de eclosão (7,7 e 8,1 dias), percentual de eclosão (94,3 e 93,6%), período de mortalidade de larvas (47,0 e 53,9 dias), longevidade larval (87,3 e 97,8 dias), índice de eficiência reprodutiva (49,2 e 46,1%) e índice de eficiência nutricional (70,8 e 70,6%). A análise dos resultados indica que, nas condições deste experimento, *B. microplus* foi capaz de infestar caprinos, o que pode causar efeitos negativos sobre os programas de controle atuais, direcionados para bovinos.

PALAVRAS-CHAVE: *Boophilus microplus*, caprinos, fase parasitária, fase não parasitária, sítios de fixação.

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