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Instar Development and Disengagement Rate of Engorged Female Winter Ticks, *Dermacentor albipictus* (Acari: Ixodidae), Following Single- and Trickle-Exposure of Moose (*Alces alces*)

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ABSTRACT

Drew, M.L. and Samuel, W.M., 1989. Instar development and disengagement rate of engorged female winter ticks, *Dermacentor albipictus* (Acari: Ixodidae), following single- and trickle-exposure of moose (*Alces alces*). *Exp. Appl. Acarol.*, 6: 189–196.

Seven hand-reared moose (*Alces alces*) calves and one yearling were infested with 30 000 larvae each of the winter tick, *Dermacentor albipictus*, either by single- or trickle-exposure (1000/day). They were examined weekly for instar changes from September/October until late May. By 2 and 3 weeks post-exposure, most larvae on single- and trickle-infested moose, respectively, had fed and molted to nymphs. Thereafter, tick development was similar between both infestation techniques. Nymphs dominated the tick population from October to mid-February, and adults from mid-February to May. The peak of host disengagement by engorged females was late March in both years. Weights of engorged females from calf moose declined over time during the disengagement period.

INTRODUCTION

The winter tick, *Dermacentor albipictus* (Packard), is a one-host tick found commonly on North America members of the Cervidae. In Canada, moose are the major host for the tick (Addison et al., 1979; Samuel and Barker, 1979). Epizootics of winter ticks, often concurrent with mortality, have occurred sporatically in many North American moose populations (see Anderson and Lankester, 1974; Samuel and Barker, 1979).

The tick–moose contact process works to the advantage of the tick in Alberta where prevalence of infestation approaches 100% and intensity levels usually exceed 10 000 (Samuel and Barker, 1979; and unpublished data, 1988). Larvae

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ascend to the tips of vegetation in September; there they aggregate in clumps (Drew and Samuel, 1985). Peak numbers of aggregating larvae coincide with the period of mate-seeking by moose. In November, numbers of larvae on vegetation decline rapidly (Drew and Samuel, 1985).

The dynamics of larval transfer to moose are not known. One would assume that moose are exposed to either small numbers over the exposure season or to many clumps of larvae in a short time. Therefore, the objective of the present study was to examine the rates of instar development on moose and disengagement from moose of *D. albipictus* following exposure to few larvae repeatedly or to a single high number of larvae.

MATERIALS AND METHODS

Young moose calves were captured or obtained as orphans and hand-reared using techniques of Welch et al. (1985). Three calves, and four calves and one yearling were used for experimental infestations with winter ticks in 1981 and 1982, respectively. All moose were housed at the University of Alberta Biomedical Animal Centre in individual outdoor pens with concrete floors and solid wooden partitions between pens.

To determine the appearance and duration of instars of *D. albipictus* in response to exposure period, the eight moose were infected using two techniques. Because larvae of *D. albipictus* tend to clump on vegetation approximately 1 m off the ground (Drew and Samuel, 1985), they were placed on moose in sites where ticks were assumed to be acquired naturally. Three calves were infested with 30 000 larvae each on 15 October, 1981 (single-exposure). Six lots of 5000 larvae were placed low on the shoulders, mid-abdomen and thigh. One calf and one yearling (infested in 1981) were infested in the same manner on 15 October, 1982. Three calves were infested with 1000 larvae per day for 30 days from 15 September to 15 October, 1982 (trickle-infested). Larvae were placed low on alternate shoulders each day. Moose were not restrained from grooming during the experiment. Larvae moved immediately from the hair surface to deeper within the hair coat, and none were observed dropping from the host.

Larvae for these infestations were progeny from engorged females collected from moose experimentally infested the previous year. These engorged females were placed in incubators at 25°C and 85–90% relative humidity and allowed to oviposit. Larvae were counted using a small vacuum apparatus.

All animals were examined weekly throughout the infestation to determine development of ticks. The left side of each calf was divided into sections (neck, shoulder, side and rump), excluding the head and legs. Beginning at the cranial end of the dorsal midline of each section, a line transect was searched by parting the hair. Ticks were counted and classified to instar (larvae, engorged larvae, nymph, engorged nymph, male, female, engorged female). Additional parallel transects approximately 10 cm apart were searched until the ventral midline was reached. Numbers of ticks counted per section varied from zero to over 400, depending on the time of year. All instars were relatively easy to see due to the sparse undercoat of moose, particularly when compared to other hosts we have examined such as deer (*Odocoileus* spp.), wapiti (*Cervus elaphus*) and bison (*Bison bison*). Obviously, smaller instars were more difficult to see than larger instars. Engorged females were collected from the pens of each moose four times per week from mid-February to late May 1982 and 1983 by combing through the bedding by hand.

Data analysis was conducted using MIDAS (Michigan Interactive Data Analysis System; Fox and Guire, 1976). Tests (Student *t*-tests, covariance, linear regressions, Pearson's coefficient of correlation and *F*-tests for linear analysis of variance) were conducted following Sokal and Rohlf (1969) and Johnson (1980). Significance levels of $P < 0.05$ were accepted unless otherwise indicated.

RESULTS

Most larvae on single- and trickle-exposed moose fed and molted to the nymph instar by 22 and 50 days post-infestation, respectively (Fig. 1). Most larvae on trickle-exposed moose were nymphs 21 days after the last exposure

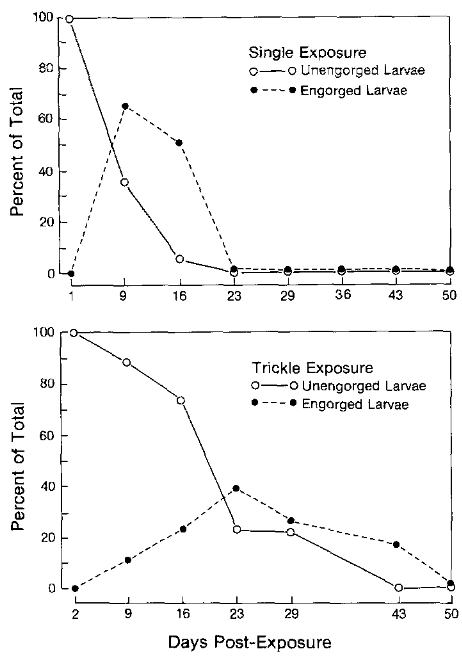

Fig. 1. Sequence of development of *Dermacentor albipictus* larvae on five single- and three trickle-infested moose. Each point represents a percentage of the total number of ticks aged that day.

to larvae. Using a linear analysis of variance, only nine of 264 comparisons of tick development between the two groups of moose were significantly different over the course of the experiment, and three of these occurred in the first counting period. Thus, results for development of nymph and adult ticks were combined (Fig. 2).

Nymphs dominated the tick population of all moose from November to mid-February (Fig. 2). Adult males appeared in small numbers on all moose by early December, but only 1–2 males moose^{-1} week^{-1} were counted until after January (Fig. 2). Males preceded females by 2–3 weeks and persisted much longer, comprising 100% of the few ticks still on moose in May. Adult females

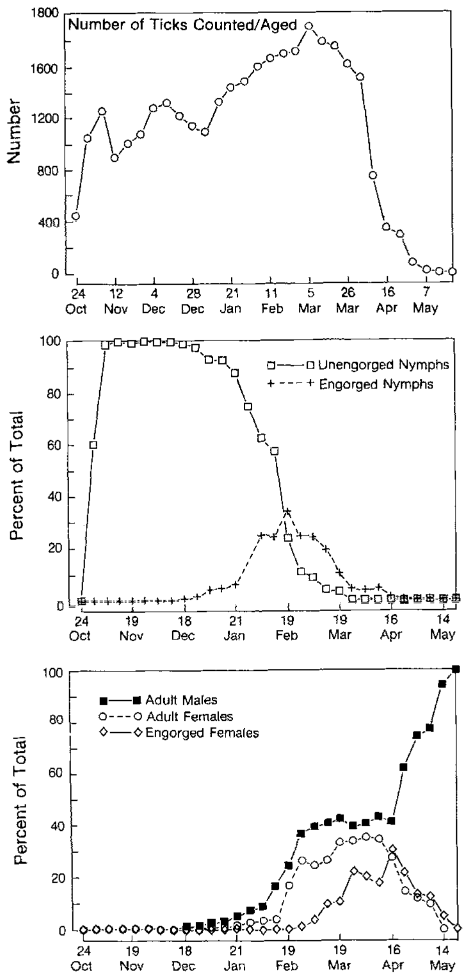

Fig. 2. Sequence of instar changes of *Dermacentor albipictus* on eight moose each infested with 30 000 larvae. Each point represents a percentage of total number of ticks aged on that date.

appeared in late January and peaked in numbers in late March and early April (Fig. 2). Engorged females were not found until late February and peaked in numbers in April. The length of the disengagement period was approximately 9–10 weeks.

Engorged females did not drop from moose at a constant rate. The major peak of engorged female disengagement was late March, regardless of year or infestation technique (Fig. 3).

No difference was found in the mean weight of engorged females collected

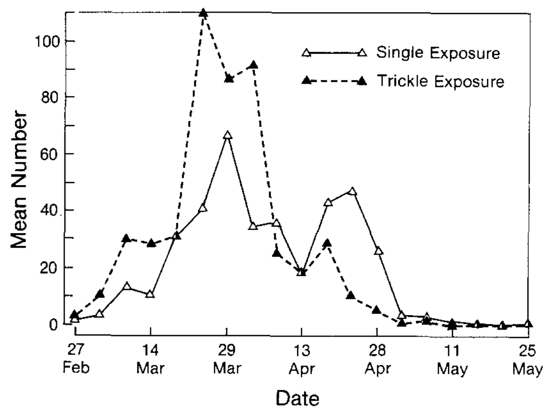

Fig. 3. Sequence of disengagement by engorged female *Dermacentor albipictus* from moose. Each point represents the mean number of ticks shed by the five single- and three trickle-exposed moose for a 5-day period (example, 27 February=25 February–1 March).

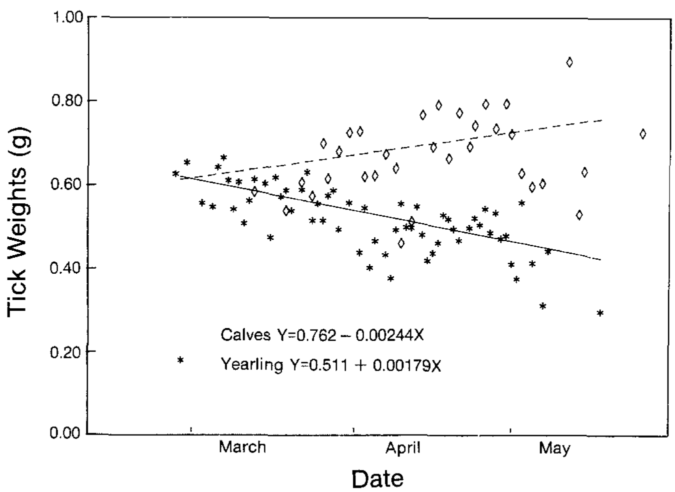

Fig. 4. Weights of engorged female *Dermacentor albipictus* collected from seven moose calves (*; 3091 engorged females) that groomed extensively and one yearling moose (◇; 222 engorged females) that did little grooming. Each symbol represents the mean weights of ticks collected that day.

from pens of single- and trickle-infested calves ($\bar{x}=530\pm183$ and 537 ± 162 mg, respectively; $t=1.13$, $P>0.05$). The weight of engorged females from all calves declined ($r^2=0.0394$) over time (Fig. 4); there was no difference in the rate of decline between single- and trickle-exposed calves (covariance, $F=0.0016$, $P=0.968$). The weight of engorged females from the reinfested yearling increased ($r^2=0.025$) over time (Fig. 4).

DISCUSSION AND CONCLUSIONS

Results of this study do nothing to resolve whether or not moose encounter many clumps of *D. albipictus* larvae in a short time (an exposure window that might be predicted in our northern situation where early snow and cold are common) or fewer clumps daily over a longer period. However, based on present results and those of Glines and Samuel (1984) and Drew and Samuel (1985, 1986), what can be stated is that there are many constant developmental features in this tick in Alberta and this constancy results in a predictable annual cycle (Fig. 5).

The exposure of moose to tick larvae over a long period of time (trickle-infestation) resulted in a longer duration of larvae and engorged larval instars when compared to moose with a short exposure period (single-infested). This difference was a direct result of the infestation technique used. Thus, whatever the exposure mechanism, the nymph stage is reached about 3 weeks later.

The long parasitic phase (October to May) and long nymphal stage (late October to mid-February) observed in this study is consistent with other reports from the northern range of *D. albipictus* (Cameron and Fulton, 1926–1927; Fenstermacher and Jellison, 1933; Lamson, 1941; Addison et al., 1979;

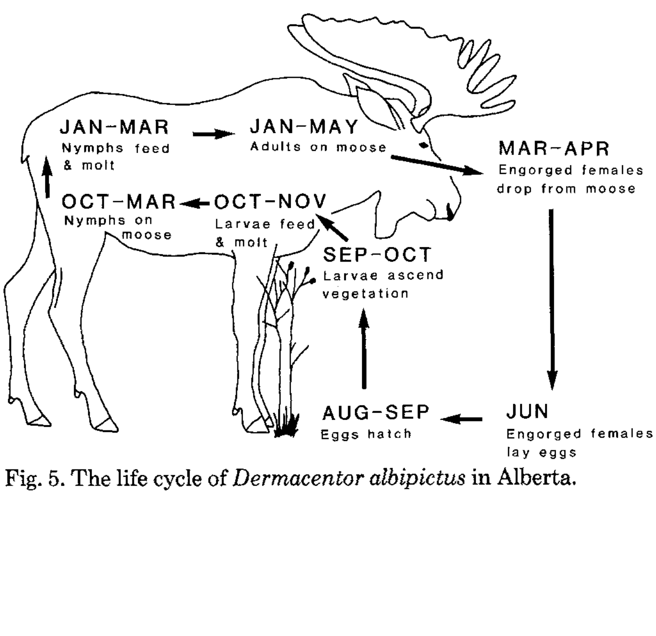

Fig. 5. The life cycle of *Dermacentor albipictus* in Alberta.

Samuel and Barker, 1979; Glines and Samuel, 1984). The long nymphal stage on moose may function to synchronize development of engorged females with more favourable conditions for reproduction in spring and to synchronize the appearance of adult males and females, as suggested by Belozerov (1982) for other northern one-host and winter-season ticks.

In contrast, there is apparently no long nymphal stage in the southern range. There, winter ticks can complete the parasitic phase of the life-cycle in as little as 21 days (Drummond et al., 1969), 30 days (Ernst and Gladney, 1975), and 30–33 days (Howell, 1940) on cattle housed under constant-temperature conditions.

Grooming by moose dislodges feeding ticks (data not presented) and probably accounts for the gradually-decreasing weights of engorged female ticks during the disengagement period. Late March and early April are periods when moose rub, bite, lick and scratch extensively (data not presented), presumably in response to blood-feeding by adult ticks (McLaughlin and Addison, 1986; Glines and Samuel, 1989, this volume). In contrast to the calves, engorged female ticks from the only reinfested yearling increased in weight over time (data not presented). This moose was sickly throughout the experiment; it groomed very little and lost almost no hair. Other possible but unlikely explanations for the declining weights include the effect of freezing, thawing and exposure to sunlight on the shed engorged females and the possibility that engorged nymphs that molt late produce small adult females.

The seasonality of the drop-off period of engorged females has not been studied extensively, although diurnal drop-off rhythms of engorged females in response to photoperiod (George, 1971) and other factors have been examined (Hadani and Rechav, 1969; Wharton and Utech, 1970; Beloerov, 1982). In the present study, engorged female *D. albipictus* dropped from moose from late February to mid-May, with the peak occurring in late March in both years. The synchrony of the peak drop-off between animals and years suggests that the seasonal pattern may be influenced by photoperiod as suggested by Patrick and Hair (1977) for *Amblyomma americanum.*

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