STUDIES OF WINTER TICK, *DERMACENTOR ALBIPICTUS*, ON THE BELL OF MOOSE IN NORTHWESTERN ONTARIO

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Abstract: The winter tick, *Dermacentor albipictus* (Packard, 1869), was found on 94% of 54 moose bells examined 7 October to 15 December, 1976 and 1977. The density of ticks was greater on the narrow tail portion than on the broad dewlap portion of the bell. Tick densities on the tail of the bell were similar on male and female moose but were greater on calves (up to 10.9 ticks/cm^2) than on older animals.

Most ticks recovered (99% of 4,093) were in the nymphal stage but adult ticks were seen as early as 22 October and larvae as late as 3 December.

The tail portion of some bells with large numbers of ticks was partially denuded of hair. In sections of skin, an amorphorus pink-staining material was always present between the keratinized layer and the stratum granulosum beneath attached ticks and, eosinophils were numerous in the underlying dermis.

Counts of ticks on the tail portion of bells may provide a conveniently obtained index of the relative numbers of *D. albipictus* on moose.

The winter or moose tick, *Dermacentor albipictus* (Packard, 1869), is distributed throughout the range of moose, *Alces alces* L., in North America with the possible exception of Alaska (see reviews by Anderson and Lankester 1974, Samuel and Barker 1979). Because this ecto-parasite has been seen in unusually large numbers on dead or dying moose, it has been considered by many authors to be a serious pathogen of moose but direct evidence supporting this opinion has been lacking. The best evidence to date was provided by Samuel and Barker (1979) and Dr. E. M. Addison (Ontario Ministry of Natural Resources, Maple, Ontario unpublished data, March, 1979) who observed considerable moose mortality during epizootics of *D. albipictus* in Elk Island National Park, Alberta and in Alfred Bog, Ontario, respectively.

While studying the anatomy and morphogenesis of the bell or dewlap of moose in northwestern Ontario, Timmermann (1979) frequently observed large numbers of *D. albipictus* on the pendulus tail portion of the bell. Some of these observations may be of interest to workers conducting more intensive studies of the importance of *D. albipictus* as a cause of moose mortality.

METHODS

The bells from 54 moose (22 ♂♂, 32 ♀♀) collected 7 October to 15 December, 1976 and 1977 were examined for ticks. Moose were aged by counting cementum lines on incisor teeth (Sergeant and Pimlott 1959).

The hair on the bell was removed by cutting to within 0.5 cm of the skin using heavy-duty electric clippers (Sunbeam Clip Master, model S10A). The shaved bell was cut off from beneath the lower jaw, examined for scars and areas denuded of hair, and then preserved in 10% formalin. Later, the bell was removed from the preservative, allowed to dry and cut into two pieces separating the broad proximal dewlap portion from the narrow more distal tail portion. The junction between the dewlap and tail (Fig. 1) was arbitrarily defined as that point (cd) where the bell was twice its minimum width (ab). Variable amounts of the whole dewlap were obtained when bells were cut from moose heads.

The profiles of the dewlap and tail portions of the bell were traced on paper. The area of the profiles was measured using a planimeter (Electronic Graphics Calculator, Numonics Corp., Lansdale, Pa., Model 276-137) and the measurement doubled to approximate the total surface area. The dewlap and tail of the bell were digested separately in a 5% solution of sodium hydroxide at 60^{o}C for 24-48 hr to dissolve hair and soft tissue (Addison *et al.* 1979). The resulting fluid was strained through a 0.5 mm mesh. Ticks were washed from the mesh and the various developmental stages counted using a dissecting microscope.

Tissue samples from the tail of the bell were examined histologically. The tissue was fixed in buffered formalin, dehydrated in an ethanol series, embedded in paraffin, cut at a thickness of 5-14 μm, and stained with Lillie's A+B stain (Lillie 1954) or Harris' hematoxylin-eosin.

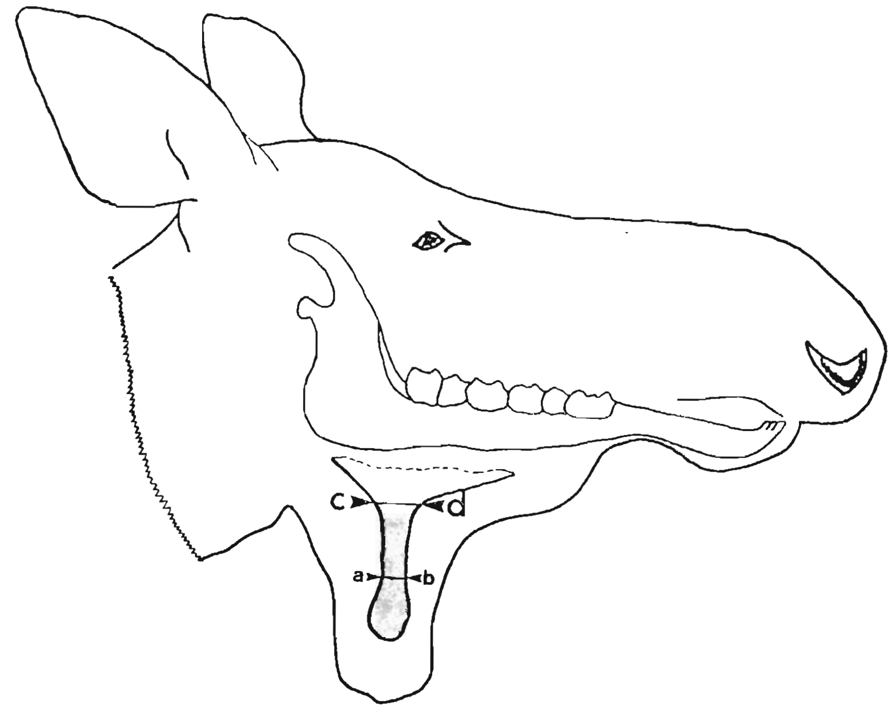


Fig. 1. Head of female moose showing profile of the bell with and without hair. The narrow bell tail was separated from the more proximal dewlap portion of the bell at a level (cd) which was twice the minimum width (ab).

Statistical methods followed Steele and Torrie (1960). Analyses of variance and t-tests were applied as outlined in Statistical Package for the Social Sciences (Nie *et al.* 1975).

RESULTS

Dermacentor albipictus was present on the tail of all but three of the 54 bells examined in 1976 and 1977 (Tables 1 and 2). The three animals without ticks were killed early in the hunting season, 7 to 12 October, 1977. Most ticks (98.8%) found throughout the hunting season were nymphs. However, a small number of larval or seed ticks was present on animals killed in October and November and as late as 3 December. A total of seven adult ticks was present on the bells of seven moose killed 22 October to 6 December.

Variable amounts of the whole dewlap were obtained when bells were cut from the moose heads but the bell tail as defined, was always discernable. The density of ticks was greater on the tail of the bell (1.3 *per* cm^2) than on the dewlap (0.4 *per* cm^2) ($t=5.57$, $P<0.01$, Table 3). The highest density found on the bell tail was 10.9 ticks per cm^2 on a male calf shot 13 November. The density of ticks was similar on males and females but calves had higher densities on the tail of the bell than older animals ($t=3.62$, $P<0.025$). The numbers of ticks on the bell tails of one family group were remarkably similar. An adult female moose and twin female calves shot 3 December, 1976 had 81, 88, and 96 ticks respectively (1.9, 6.4, and 4.3 *per* cm^2) (Table 2).

Some bell tails with large numbers of ticks were partially

Table 1. Number of Dermacentor albipictus on the tail portion of the bell of 22 male moose

Age (yrs)	Time Killed Date	Mo.	Yr.	Bell surface area (cm^2)* Dewlap	Tail	Number nymphs (density/cm^2) Dewlap	Tail	Number Larvae	Adults
0.5	11	10	77	33.2	21.0	0 (0.0)	0 (0.0)	-	-
	29	10	77	110.2	33.8	21 (0.19)	113 (3.34)	-	1♂
	13	11	77	25.8	20.6	110 (3.91)	225 (10.92)	-	-
	14	11	77	34.8	29.0	6 (0.17)	23 (0.79)	1	-
1.5	26	10	77	67.4	27.4	14 (0.21)	30 (1.09)	-	-
	28	10	77	184.2	44.4	3 (0.02)	4 (0.09)	-	-
	3	11	77	128.2	47.4	39 (0.30)	33 (0.70)	-	-
	6	11	77	50.6	38.4	54 (1.07)	22 (5.76)	12	-
	12	11	77	121.2	54.2	44 (0.36)	100 (1.85)	1	1♀
	27	11	77	83.2	29.2	43 (0.52)	35 (1.20)	-	1♂
	12	12	77	48.8	28.8	7 (0.14)	15 (0.52)	-	-
2.5	22	10	77	89.6	45.6	16 (0.18)	18 (0.39)	-	1♂
	11	11	77	242.8	52.8	60 (0.25)	42 (0.80)	-	1♂
	28	11	77	190.6	50.4	203 (1.07)	186 (3.69)	-	-
3.5	15	10	77	154.6	55.6	88 (0.57)	71 (1.28)	17	-
4.5	26	10	77	292.4	76.2	49 (0.17)	33 (0.43)	-	-
5.5	17	11	77	190.4	56.0	59 (0.31)	92 (1.64)†	1	-
	19	11	77	357.4	35.6	256 (0.72)	123 (3.46)	-	-
6.5	30	10	77	53.6	49.8	13 (0.24)	24 (0.48)	-	-
7.5	19	11	77	61.4	28.2	29 (0.47)	36 (1.28)	-	-
9.5+	11	10	77	79.4	49.4	1 (0.01)	2 (0.04)	-	-
	13	10	77	110.6	56.2	1 (0.01)	4 (0.07)	-	-

* Profile area doubled to approximate total surface.

† Bell with small areas denuded of hair.

Table 2. Number of Dermacentor albipictus on the tail portion of the bell of 32 female moose.

Age (yrs)	Time Killed Date,Mo.,Yr.	Bell tail surface area (cm^2)** Dewlap	Bell tail surface area (cm^2)** Tail	Number nymphs (density/cm^2) Dewlap	Number nymphs (density/cm^2) Tail	Number Larvae	Number Adult
0.5	29 10 77	38.2	8.4	1 (0.03)	0 (0.0)	-	-
	03* 12 76	46.0	13.8	33 (0.72)	88 (6.37)	-	-
	03* 12 76	40.4	22.1	37 (0.92)	96 (4.34)	1	-
1.5	16 10 77	225.2	52.2	6 (0.03)	4 (0.08)	-	-
	22 10 77	61.4	24.8	2 (0.03)	15 (0.60) †	2	-
	1 11 77	67.8	29.8	9 (0.13)	54 (1.81)	1	-
	5 11 77	41.0	22.6	10 (0.24)	55 (2.43)	-	-
	26 11 77	116.8	41.8	30 (0.26)	8 (0.19)	-	-
	27 11 77	49.8	40.4	1 (0.02)	7 (0.17)	-	-
	6 12 76	55.2	23.4	143 (2.59)	178 (7.61)	-	1♂
	6 12 77	41.4	17.2	3 (0.07)	32 (1.86)	-	-
2.5	20 10 77	31.8	22.0	0 (0.0)	1 (0.05)	-	-
	6 11 77	18.0	19.0	5 (0.28)	23 (1.21)	-	-
	11 11 77	72.2	40.6	1 (0.01)	10 (0.25) †	-	-
	7 10 77	89.6	33.4	0 (0.0)	0 (0.0)	-	-
3.5	11 10 77	108.4	25.4	1 (0.01)	1 (0.04)	-	-
4.5	12 10 77	131.2	32.2	0 (0.0)	0 (0.0)	-	-
5.5	13 10 77	120.8	46.8	64 (0.53)	42 (0.90)	-	-
	22 10 77	92.4	31.4	8 (0.09)	17 (0.54)	-	1♂
	22 10 77	94.4	44.0	2 (0.02)	2 (0.05) †	-	-
	12 11 77	81.0	40.4	5 (0.06)	5 (0.12)	-	-
	27 11 77	39.8	32.8	14 (0.35)	41 (1.25)	-	-
	29 11 77	38.6	21.6	24 (0.62)	41 (1.90)	-	-
6.5	13 11 77	70.6	29.8	11 (0.16)	20 (0.67)	-	-
7.5	14 11 77	57.0	38.0	36 (0.63)	98 (2.58)	3	-
8.5	27 11 77	94.6	31.6	8 (0.08)	17 (0.54)	-	-
	27 11 77	51.6	27.4	9 (0.17)	36 (1.31)	-	-
	2 12 77	70.8	30.6	4 (0.06)	15 (0.49)	-	-
9.5+	28 10 77	69.6	31.6	65 (0.93)	95 (3.01)	2	-
	3* 12 76	188.4	42.0	47 (0.25)	81 (1.93) †	-	-
	6 12 77	33.0	22.0	7 (0.21)	9 (0.41)	-	-
	15 12 77	122.2	30.6	8 (0.07)	13 (0.42) †	-	-

* Twin calves and female

** Profile area doubled to approximate total surface.

† Bell with small areas denuded of hair.

TABLE 3. Density of Dermacentor albipictus nymphs on the dewlap and tail portions of the bell of infected moose†

Age (yrs)	Sex	N	Dewlap Tick density*	Dewlap Range	Tail Tick density*	Tail Range
0.5	♂	3	1.42±2.15	(0.17-3.91)	5.02±5.27	(0.79-10.92)
	♀	3	0.56±0.47	(0.03-0.92)	3.57±3.26	(0 - 6.38)
1.5	♂	7	0.37±0.32	(0.02-1.07)	1.60±1.92	(0.09- 5.76)
	♀	8	0.42±0.88	(0.02-2.59)	1.84±2.50	(0.08- 7.61)
2.5	♂	3	0.50±0.50	(0.18-1.07)	1.63±1.80	(0.39- 3.69)
	♀	3	0.10±0.16	(0.0 -0.28)	0.50±0.62	(0.05- 1.21)
3.5,4.5	♂	4	0.44±0.25	(0.31-0.72)	1.58±1.14	(0.43- 3.46)
& 5.5	♀	7	0.24±0.26	(0.01-0.62)	0.69±0.71	(0.04- 1.90)
6.5,7.5	♂	2	0.36±0.16	(0.24-0.47)	0.88±0.57	(0.48- 1.28)
& 8.5	♀	5	0.22±0.23	(0.06-0.63)	1.12±0.88	(0.49- 2.58)
9.5+	♂	2	0.01±0.00	(0.01-0.01)	0.06±0.02	(0.04- 0.07)
	♀	4	0.37±0.38	(0.07-0.93)	1.44±1.27	(0.41- 3.01)
Total	♂	21	0.52±0.83	(0.01-3.91)	1.90±2.53	(0.04-10.92)
	♀	30	0.32±0.51	(0.0 -2.59)	1.44±1.85	(0.0 - 7.61)

* Mean/cm^2 ± S.D.

denuded of hair and considerable debris sloughed from the skin surface was usually apparent (Fig. 2 and 3). In sections of skin, an accumulation of amorphous pink-staining material was always present between the keratinized layer and the stratum granulosum of the epidermis beneath attached ticks (Fig. 4). Eosinophils were numerous among the collagen fibres of the underlying dermal papillary layer.

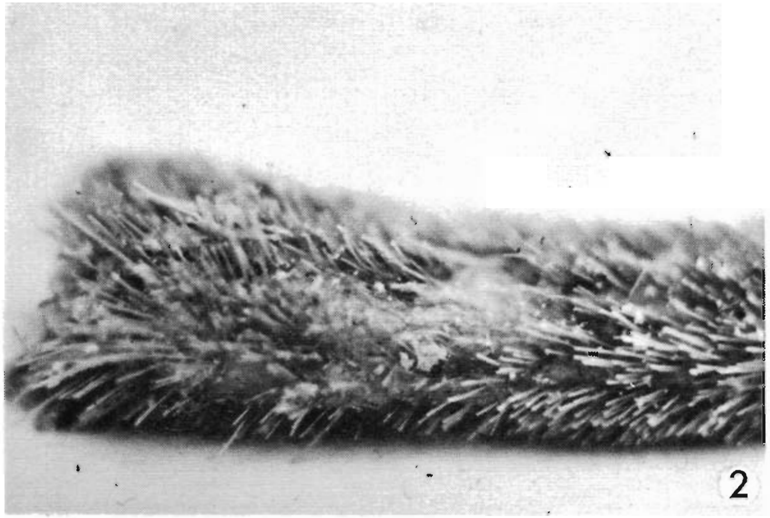
A few moose killed in spring by vehicles were examined to confirm that adult ticks engorged while attached to the tail of the bell (Fig. 5).

On 3 May 1977, numerous engorged female *D. albipictus* were found on the ground in Sibley Provincial Park, 64 km south-east of Thunder Bay, Ontario. Recent signs of moose activity indicated the ticks had fallen off the host within 24 hr of being collected. The female ticks were placed in a jar on a piece of moist filter paper and kept in the dark at 20°C. On 10 May, the females began to lay eggs. On 14 June, larval ticks began to emerge from the eggs which opened like the valves of a clam shell.

DISCUSSION

Counts of *D. albipictus* on the bell suggest that male and female moose of all ages have similar numbers of ticks but calves, because of their smaller size, experience the greatest densities of these ecto-parasites. Similar conclusions were reached by Samuel and Barker (1979) after conducting laborious sampling of whole moose hides for ticks.

Figs. 2 and 3. Tail of the bell from a 1.5-yr-old male moose killed early in December, 1977. The hair on the bell has been clipped to reveal small hairless patches and attached *D. albipictus*. Fig. 2. Distal tip of bell tail. Attached nymphal ticks are difficult to see. Fig. 3. Proximal half of bell tail with exudate and epidermal debris in small denuded area.



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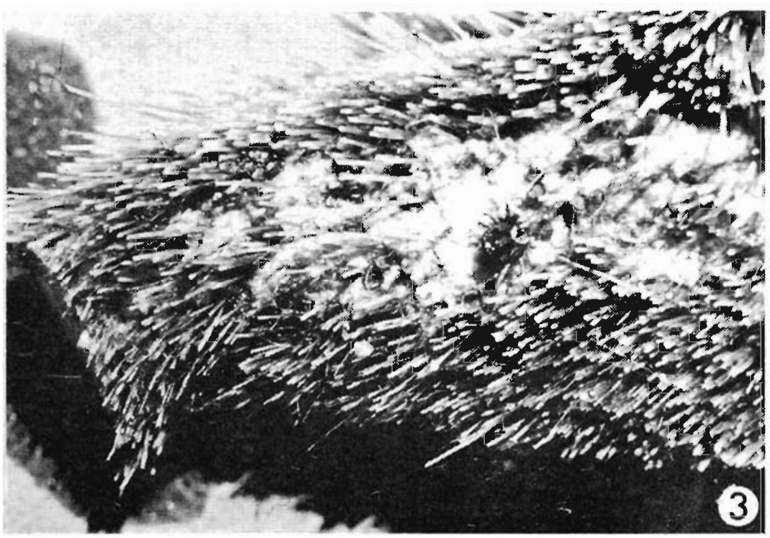

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Winter ticks are not distributed randomly on moose but are found more frequently on certain regions of the body and are clumped or aggregated within these regions (Samuel and Barker 1979, Addison *et al.* 1979). Samuel and Barker (1979) found the greatest densities of ticks in areas with long, coarse, less dense hair, particularly on the neck, withers, shoulders, and near the anus. Addison (pers. comm., 1979) found the highest densities on the neck (including the bell) and on the shoulders. Fewer ticks were found however, on the back or saddle region of moose despite hair type and density similar to that in regions where ticks were dense (Samuel and Barker 1979, Addison *et al.* 1979). Concentrations of ticks on the head, particularly around the ears, have been reported by several authors (Wallace 1934, Cowan 1951, Ritcey and Edwards 1958).

In the present study, ticks were more dense on the tail than on the dewlap of the bell suggesting they may exhibit a positive geotropic movement once on a moose. However, this suggestion is not strongly supported by the published literature although large concentrations of ticks are found on the chest between the front legs and in the inguinal region, particularly in late winter (personal observations). Other explanations for the distribution of ticks on the bell are equally tenable. Ticks may attach more readily to moose at the dangling tip of the bell. They may be attracted to the well vascularized bulbous end of the bell (Timmermann 1979) or simply may be more difficult to dislodge from this site.

Samuel and Barker (1979) showed that regions of the body of moose that prematurely lose hair in late winter (April - May) cor-

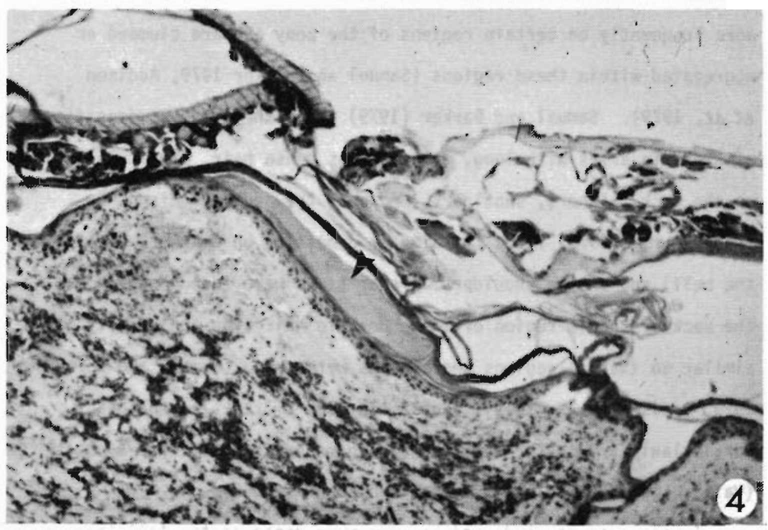

Fig. 4. Longitudinal section of two *D. albipictus* nymphs attached to the epidermis of the tail portion of a bell from a 2.5-yr-old female moose. H and E, X 63. Note the accumulation of amorphous pink-staining material ▲ present between the keratinized layer and the stratum granulosum of the epidermis beneath the feeding tick and numerous eosinophils among the collagen fibres of the underlying dermal papillary layer.

Fig. 5. The tail portion of the bell from a 4-yr-old male moose killed on May 10, 1976. The hair on the bell has been clipped. Note the large number of engorged adult *D. albipictus* removed from the skin surface, X 1.

respond with those having highest tick densities during December, March and April suggesting ticks are responsible for the alopecia. If hair loss is caused by high tick densities, a localized skin reaction rather than a systemic effect is therefore suggested. Rubbing by moose in response to irritation caused by ticks may ultimately be the way in which hair is removed from the skin (Samuel and Barker 1979). High densities of ticks on the bell caused dermatitis and some small hairless patches of skin were occasionally seen. The amorphous pink-staining material seen in tissue sections may be cement secreted from the salivary glands of ticks as described by Moorhouse (1969).

The bell presumably is a difficult organ for moose to rub and may provide a site at which the localized tissue changes caused by high tick densities can be studied while excluding effects caused by an animal's attempts to dislodge ticks. We suggest that counts of winter ticks on the tail of the bell may provide a conveniently obtained index of the abundance of *D. albipictus* on moose. The bell is a good organ to sample for several reasons. Considerable information on sex and age specific differences in the morphology of the moose bell is available (Timmermann 1979). The tail portion of the bell can be described in a standardized way. Ticks are less likely to be removed from the bell by animals rubbing. The organ can be reliably collected by hunters or field staff and large samples of bells can be processed and examined for ticks with relative ease. Studies designed to determine the degree of correlation between the numbers of ticks on the bell tail and on the entire body would be of value.

ACKNOWLEDGEMENTS

Our appreciation is extended to all hunters who submitted material and the staff of the check stations who recorded the information.

We are also grateful to Mr. R. Sandhu, MNR, for ageing animals, Mr. B. Hewlett, McKellar General Hospital, Thunder Bay for histology, and photomicrography, Dr. A. B. Bubenik for originally suggesting the bell as a research problem and to Mr. J. Timmermann for converting colour slides into black and white prints.

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