

ECTOPARASITES FROM ELK (*CERVUS ELAPHUS NELSONI*) FROM WYOMING

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ABSTRACT: Hides of nine elk, collected during the winter of 1986-1987 from the National Elk Refuge, Wyoming (USA) were examined for ectoparasites. Parasites recovered were mites, *Psoroptes* sp. (five elk); lice, *Solenopotes ferrisi* and *Bovicola (Bovicola) longicornis* (seven elk); and winter ticks, *Dermacentor albipictus* (nine elk). Three elk with severe scabies had an estimated 0.6×10^6 , 3.8×10^6 and 6.5×10^6 mites, respectively. Densities of mites were much higher in skin regions with severe dermatitis. Skin lesions on elk with scabies consisted of dense, often moist, scabs extending along the dorsal and lateral thoracic regions of the body. Lesions attributed to winter ticks consisted of broken hair and alopecia on the dorsal portion of the lower neck, often extending in a "collar" around the neck.

Key words: Rocky Mountain elk, *Cervus elaphus nelsoni*, ectoparasites, scabies, *Psoroptes* sp., lice, winter tick, dermatitis, intensity, distribution.

INTRODUCTION

Although reports of external parasites from elk (*Cervus elaphus nelsoni*) are common (Murie, 1951; Worley and Greer, 1976; Kistner, 1982), there is no documentation of parasite numbers, distribution on the host, concurrent infestations, or relationship of species of parasite to damage to the hair coat. Such information should be valuable given that at least two arthropod parasites reported commonly from elk, the scab mite (*Psoroptes* sp.) and winter tick (*Dermacentor albipictus*), may be important pathogens. On the National Elk Refuge in northwestern Wyoming (USA), *Psoroptes* sp. causes a progressive and severe exudative dermatitis in adult male elk (Murie, 1951; Smith, 1985), and some animals die each winter with clinical scabies (Smith, 1985). Infestations of winter ticks have resulted in reports of morbidity and mortality (Banfield, 1949; Cowan, 1951; Murie, 1951; Stelfox, 1962).

The purposes of the present study on the National Elk Refuge were to identify and determine numbers and spatial distribution of ectoparasites from elk, and to relate this information to two patterns of dermatitis and alopecia seen on elk in winter.

MATERIALS AND METHODS

Carcasses of eight elk found dead between 26 January and 26 February 1987, were located at

dawn during a daily supplemental feeding program, which is done annually on the National Elk Refuge (43°28' to 43°38'N, 110°35' to 110°45'W) (Smith, 1985). Although carcasses could have been dead for as long as 24 hr prior to collection of the hide, no parasites left the host between death and hide collection because temperatures on the Refuge were very cold between January and March. Because coyotes (*Canis latrans*) scavenged all carcasses (thus precluding detailed necropsy), the relatively untouched hide from the lateral side on the snow was collected. The hide from a recently captured elk from the Refuge that died on 19 March 1987 was also included.

Hides were removed from the right or left lateral half of each carcass. This was done by cutting along the dorsal and ventral midlines of the body and along the medial surface of each limb. Portions of the skin covering the lower legs and head were not collected. Each hide was then frozen in a plastic bag. Later, it was thawed, marked into 10 cm × 10 cm quadrats, and dissolved in 5% potassium hydroxide solution following the technique of Welch and Samuel (1989). All quadrats from each half-hide were examined for ectoparasites, again following Welch and Samuel (1989). Ectoparasites were sorted according to type, counted, and ticks were assigned to age-class. The chewing and sucking lice were not separated during the counting process, so data for them were lumped. For three elk with obvious severe scabies, numbers of mites were based on a 1 cm × 1 cm subsample of hide that was removed from the corner of the larger quadrat and digested.

Analysis of variance was used to compare densities of mites on quadrats with extensive

TABLE 1. Summary of numbers of ectoparasites found on elk of the National Elk Refuge, Wyoming, 1987.

Elk no.	Sex and age ^a	Extent of hair damage (%) ^b	Estimated number of ectoparasites ^c (×2)		
			Mites Total (number/cm ²)	Lice Total (number/cm ²)	Ticks Total (number/cm ²)
1	Unknown	0	0	2,967 (0.16)	6,071 (0.32)
2	M/Ad	29	0.6 × 10 ⁶ (23)	8 (0.0003)	776 (0.03)
3	M/Ad	0	6 (0.0005)	48 (0.004)	2,510 (0.10)
4	F/Ylg	3	0	355 (0.02)	9,333 (0.43)
5	M/Ad	22	6.5 × 10 ⁶ (240)	0	1,310 (0.06)
6	F/Ad	0	0	2,928 (0.14)	50 (0.002)
7	M/Ca	9	0	18,240 (1.97)	5,251 (0.56)
8	Unknown/Ca	0	4 (0.0003)	13,229 (0.96)	5,845 (0.42)
9	F/Ad	25	3.8 × 10 ⁶ (194)	0	1,610 (0.08)

^a M, male; F, female; Ad, adult; Ylg, yearling; Ca, calf.

^b Percent of the silhouette of the torso covered by damaged hair.

^c Ticks, *Dermacentor albipictus*; mites, *Psoroptes* sp.; lice, *Bovicola (Bovicola) longicornis* and *Solenopotes ferrisi*.

hair damage and on those with little or no damage.

The extent of obviously damaged hair and alopecia was determined for each half-hide by making a detailed diagram, then determining the damaged portion of the torso from the diagram using a digitizer (Bit pad two; Summagraphics Corporation, Fairfield, Connecticut 06430, USA). To summarize data on spatial distribution of ectoparasites on elk, a representative half-hide was selected for each parasite type. The quadrats for each half-hide were listed in order of increasing parasite density and divided into quartiles. All quadrats falling within the first quartile (0 to 25%) represented areas of low parasite density, while quadrats falling in the fourth quartile (>75%) represented high density. Other quadrats were considered to represent moderate density.

Specimens of mites, ticks and lice were removed from carcasses of several elk shortly after death and preserved in 95% ETOH. Mites and ticks were deposited in the University of Alberta Parasite Collection (Department of Zoology, Edmonton, Alberta, Canada T6G 2E9; Accession Numbers UAPC 11398 and 11399, respectively) and the Biosystematics Research Centre (Ottawa, Ontario, Canada K1A 0C8; Numbers 125 and 126, respectively). Sucking and chewing lice were deposited in the University Collection (UAPC Numbers 11396 and 11397, respectively), Biosystematics Research Centre (Numbers 121 and 123, respectively), and The Frost Entomological Museum (The Pennsylvania State University, University Park, Pennsylvania 16802, USA). The classification of Lyal (1985) was followed for the chewing louse. Although psoroptic mites of elk have been given several names in the literature (see Worley and Greer, 1976), species identification is not pos-

sible until detailed morphometric analysis is completed (cf. Boyce et al., 1990; W. Boyce, pers. comm.).

RESULTS

The scab mite (*Psoroptes* sp.), chewing lice (*Bovicola (Bovicola) longicornis*), sucking lice (*Solenopotes ferrisi*), and winter tick (*Dermacentor albipictus*) were recovered from five, seven, and nine elk, respectively (Table 1). Three elk had severe scabies and many mites (Table 1). The skin surface of all three individuals was covered with dense, thick, moist scabs. Dermatitis and alopecia was most evident on the dorsal and lateral thoracic region of the body of these animals (Fig. 1, 2a). Obvious lesions were approximately bilaterally symmetrical. Distribution of mites on the body corresponded with the distribution of alopecia and severe dermatitis (Fig. 2a). Densities of mites were higher in quadrats with severe dermatitis than in quadrats where the hair appeared slightly damaged or undamaged ($P < 0.001$).

Two elk, both calves, had large numbers of lice (Table 1). Unfortunately, the two species of lice were not counted separately at the time of examination; thus, it was impossible to determine the numbers of distribution of each species. Highest densities of lice occurred on the rump, back, and between the front legs (Fig. 2b). Few lice (actually, eight on one elk) were pres-



FIGURE 1. Adult male elk from the National Elk Refuge, Wyoming, with severe psoroptic scabies.

ent on elk with scabies, but lice were present on five other elk and abundant on two calves (Table 1).

Although all nine elk had winter ticks, maximum numbers were considered only moderate with a maximum density of 0.56 ticks/cm² skin surface (Table 1). Most ticks (86%) were unengorged nymphs; 8% were engorged nymphs, 4% were adult males and 2% were adult females. Highest densities were found on the top of the shoulder, dorsal base of the neck, and between the rear legs (Fig. 2c). One animal (Fig. 2c) with over 9,000 ticks had broken hair and some alopecia at the dorsal base of the neck, which produced a characteristic "notch" of damaged hair.

DISCUSSION

The external parasites found in this study have been reported previously from elk. The elk scab mite (*Psoroptes* sp.) is known from only three areas of North America: northern Idaho (Colwell and Dunlap, 1975), Minnesota (Fashingbauer, 1965 in Worley and Greer, 1976) and northwestern Wyoming and adjoining parts of Montana (Skinner, 1928; Mills, 1936; Murie, 1951; Worley and Barrett, 1964; Worley et al., 1969; Smith, 1985).

The sucking louse *S. ferrisi* is reported from Rocky Mountain elk of Jasper National Park (Alberta, Canada) (Spencer, 1966) and from "*Cervus elaphus* (elk)" (Kim et al., 1986). Another louse (*Linognathus* sp.) is reported previously from

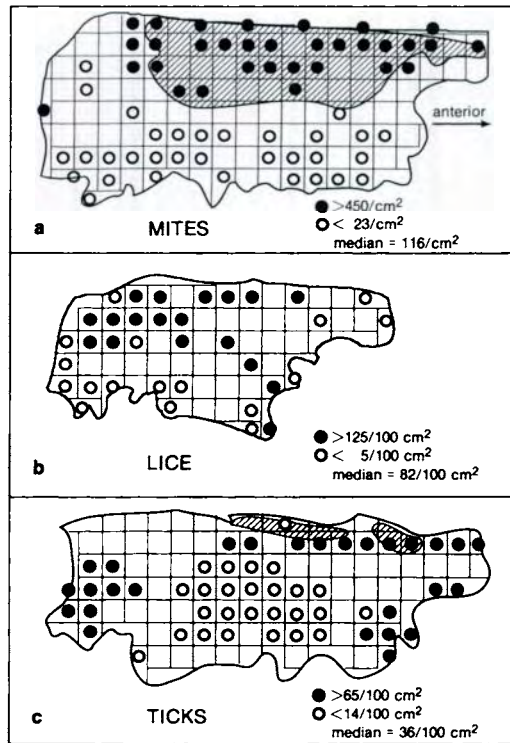


FIGURE 2. Summary of the spatial distribution of *Psoroptes* sp. (a), *Solenopotes ferrisi* and/or *Bovicola (Bovicola) longicornis* (b), and *Dermacentor albipictus* (c) on elk from the National Elk Refuge, Wyoming. Blank quadrats represent densities of parasites between the high and low values shown. ▨, areas of dermatitis and alopecia.

three elk calves from the National Elk Refuge (Thorne and Bergstrom, 1982). These specimens might have been misidentified because *Linognathus* and *Solenopotes* are closely related genera being the only two representatives in the family Linognathidae, and only *Solenopotes* spp. are common parasites of cervid mammals (Kim et al., 1986). Thorne and Bergstrom (1982) report hair damage to the dorsal portion of the lower neck and withers (where lice and winter ticks were found) on these calves; it was probably caused by winter ticks (Welch et al., 1991).

Chewing lice are reported from elk under a variety of names (partial list in Kistner, 1982). According to the most recent treatise on classification of trichodectid lice of mammals (Lyal, 1985), only two species

(*Bovicola (Bovicola) concavifrons* and *B. (B.) longicornis*) are valid. *Bovicola (B.) longicornis* was described originally from red deer (*Cervus elaphus*) in Europe. *Bovicola americanum*, a chewing louse described from elk (Jellison, 1935), and the name most commonly seen in the elk literature (Worley and Greer, 1976), was placed in synonymy with *B. longicornis* by Hopkins (1960). *Bovicola longicornis* has been reported previously from elk of Alberta (Hopkins, 1960), Washington, Pennsylvania, and Wyoming (Jellison, 1935).

In Canada, winter ticks have been reported from elk from Manitoba to British Columbia (Kennedy and Newman, 1986). In the United States, infested elk have been reported from six western states and Minnesota (Worley and Greer, 1976). Infestations of winter ticks on elk may cause morbidity and mortality (Banfield, 1949; Cowan, 1951; Murie, 1951; Stelfox, 1962), though critical studies are lacking. Numbers of ticks reported from elk in this study are much lower than those reported from moose (*Alces alces*) (Samuel and Barker, 1979; Welch and Samuel, 1989).

Mites of the genus *Psoroptes* are pests of wildlife and domestic animals in many countries (Lange et al., 1980; Welch and Bunch, 1983; Kirkwood, 1986; Cole and Guillot, 1987). The effects of *Psoroptes* sp. on elk have not been studied as extensively as those of *Psoroptes ovis* on domestic cattle (Stromberg and Fisher, 1986; Stromberg et al., 1986; Cole and Guillot, 1987; Stromberg and Guillot, 1989), but pathogenic events are probably similar. Severity of clinical disease in cattle is determined by mite density (Stromberg et al., 1986). Adult female mites lay many eggs in a short time and in cattle at least, mite infestation can result in severe exudative dermatitis and death 7 and 9 wk after infestation, respectively (Cole and Guillot, 1987). Domestic cattle with >15% of the skin surface manifesting dermatitis have reduced daily weight gains while those with 40% or more of the skin involved may die



FIGURE 3. Yearling male elk from Banff National Park, Alberta, with winter tick-induced alopecia.

(Cole et al., 1984). For each 10% increase in affected body surface, maintenance energy requirements increase significantly meaning that "calves with severe *P. ovis* infestations may have difficulty in consuming sufficient amounts of feed to meet maintenance energy requirements and therefore may be highly susceptible to hypothermia" (Cole and Guillot, 1987).

A variety of stress factors that might lower resistance to scab mites in elk that overwinter on the Elk Refuge include: rutting activity, poor nutrition during and possibly following the rut, cold weather, crowding, and other disease. Clinical signs could include: secondary bacterial infection, skin damage resulting in heat and fluid loss thus increasing the amount of energy needed to maintain body core temperature, hypothermia, and anemia (Stromberg et al., 1986). A study of the pathogenesis of psoroptic scabies in elk is needed.

A dermatitis different from that resulting from mite infestation, and characterized by broken hair and alopecia at the base of the neck is prevalent in elk (Fig. 3), particularly calves, cows and young males, in winter on the Elk Refuge, and in Yellowstone (Wyoming, USA), Jasper, and Banff National Parks (Alberta, Canada) (W. M. Samuel, pers. obs.). Lesions either appear as a "notch" of hair damage or loss at the dorsal portion of the lower neck or as a "collar" of damage or loss around the neck. In an experimental study, captive antlerless male elk were infested with winter ticks (*D. albipictus*) (Welch et al., 1991). Elk groomed (cf. Samuel, 1991) until a characteristic notch or collar-like alopecia appeared at the base of the neck.

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LITERATURE CITED

- BANFIELD, A. W. F. 1949. An irruption of elk in Riding Mountain National Park, Manitoba. *The Journal of Wildlife Management* 13: 127-134.
- BOYCE, W., L. ELLIOTT, R. CLARK, AND D. JESSUP. 1990. Morphometric analysis of *Psoroptes* spp. mites from bighorn sheep, mule deer, cattle, and rabbits. *The Journal of Parasitology* 76: 823-828.
- COLE, N. A., AND F. S. GUILLOT. 1987. Influence of *Psoroptes ovis* on the energy metabolism of heifer calves. *Veterinary Parasitology* 23: 285-295.
- , ———, AND C. W. PURDY. 1984. Influence of *Psoroptes ovis* (Hering) (Acari: Psoroptidae) on the performance of beef steers. *Journal of Economic Entomology* 77: 390-393.
- COLWELL, D. A., AND J. S. DUNLAP. 1975. Psoroptic mange in a wapiti. *Journal of Wildlife Diseases* 11: 66-67.
- COWAN, I. M. 1951. The diseases and parasites of big game mammals of western Canada. *Proceedings of the Annual British Columbia Game Conference* 5: 37-64.
- HOPKINS, G. H. E. 1960. Notes on some Mallophaga from mammals. *Bulletin of the British Museum (Natural History) (Entomology)* 10: 75-90.
- JELLISON, W. L. 1935. A new species of *Bovicola* (Mallophaga). *The Journal of Parasitology* 21: 81-82.
- KENNEDY, M. J., AND R. A. NEWMAN. 1986. Synopsis of the parasites of vertebrates of Canada: Ectoparasites of terrestrial mammals. Publication of the Animal Health Division, Alberta Agriculture. Queen's Printer, Edmonton, Alberta, Canada, 109 pp.
- KIM, K. C., H. D. PRATT, AND C. J. STOJANOVICH. 1986. The sucking lice of North America: An illustrated manual for identification. The Pennsylvania State University Press, University Park, Pennsylvania, 241 pp.
- KIRKWOOD, A. C. 1986. History, biology and control of sheep scab. *Parasitology Today* 2: 302-307.
- KISTNER, T. P. 1982. Diseases and parasites. In *Elk of North America: Ecology and management*, J. W. Thomas and D. E. Towell (eds.). Stackpole Books, Harrisburg, Pennsylvania, pp. 181-217.
- LANGE, R. E., A. V. SANDOVAL, AND W. P. MELENEY. 1980. Psoroptic scabies in bighorn sheep (*Ovis canadensis mexicana*) in New Mexico. *Journal of Wildlife Diseases* 16: 77-82.
- LYAL, C. H. C. 1985. A cladistic analysis and classification of trichodectid mammal lice (Phthiraptera: Ischnocera). *Bulletin of the British Museum of Natural History (Entomology)* 51: 187-346.
- MILLS, H. B. 1936. Observations on Yellowstone elk. *Journal of Mammalogy* 17: 250-253.
- MURIE, O. J. 1951. *The elk of North America*. Stackpole Company, Harrisburg, Pennsylvania, and The Wildlife Management Institute, Washington, D.C., 376 pp. (reprinted, 1979, Teton Bookshop, Jackson, Wyoming, 83001, USA).
- SAMUEL, W. M. 1991. Grooming by moose (*Alces alces*) infested with the winter tick (*Dermacentor albipictus*) (Acari): A mechanism for premature loss of winter hair. *Canadian Journal of Zoology* 69: In press.
- , AND M. J. BARKER. 1979. The winter tick, *Dermacentor albipictus* (Packard, 1869) on moose, *Alces alces* (L.), of central Alberta. Pro-

- ceedings of the North American Moose Conference and Workshop 15: 303-348.
- SKINNER, M. P. 1928. The elk situation. *Journal of Mammalogy* 9: 309-317.
- SMITH, B. L. 1985. Scabies and elk mortalities on the National Elk Refuge, Wyoming. *In Proceedings of the 1984 Western States and Provinces Elk Workshop*, Alberta Fish and Wildlife Division, Edmonton, Alberta, Canada, pp. 180-194.
- SPENCER, G. J. 1966. Anoplura from British Columbia and some adjacent areas. *Journal of the Entomological Society of British Columbia* 63: 23-30.
- STELFOX, J. G. 1962. Liver, lungs & larvae: Parasites and disease in moose, deer and elk in Alberta. *Land—Forests—Wildlife* 5: 5-12.
- STROMBERG, P. C., AND W. F. FISHER. 1986. Dermatopathology and immunity in experimental *Psoroptes ovis* (Acari: Psoroptidae) infestation of naive and previously exposed Hereford cattle. *American Journal of Veterinary Research* 47: 1551-1560.
- , AND F. S. GUILLOT. 1989. Pathogenesis of psoroptic scabies in Hereford heifer calves. *American Journal of Veterinary Research* 50: 594-601.
- , W. F. FISHER, F. S. GUILLOT, J. H. PRUETT, R. E. PRICE, AND R. A. GREEN. 1986. Systemic pathologic responses in experimental *Psoroptes ovis* infestation of Hereford calves. *American Journal of Veterinary Research* 47: 1326-1331.
- THORNE, E. T., AND R. C. BERGSTROM. 1982. Order Anoplura (sucking lice). *In Diseases of wildlife in Wyoming*, 2nd ed., E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom (eds.). Wyoming Game and Fish Department, Cheyenne, Wyoming, p. 254.
- WELCH, D. A., AND W. M. SAMUEL. 1989. Evaluation of random sampling for estimating density of winter ticks (*Dermacentor albipictus*) on moose (*Alces alces*) hides. *International Journal of Parasitology* 19: 691-693.
- , AND C. J. WILKE. 1991. Suitability of moose, elk, mule deer and white-tailed deer as hosts for winter ticks (*Dermacentor albipictus*). *Canadian Journal of Zoology* 69: In press.
- WELCH, G. W., AND T. D. BUNCH. 1983. Psoroptic scabies in desert bighorn sheep (*Ovis canadensis nelsoni*) from northwestern Arizona. *Journal of Wildlife Diseases* 19: 342-344.
- WORLEY, D. E., AND R. E. BARRETT. 1964. Studies on the parasites of the northern Yellowstone elk herd. *In Rumen physiology and parasitology of the northern Yellowstone elk herd*, R. H. McBee (ed.). Progress Report, National Park Service, Mammoth, Wyoming, pp. 10-28.
- , AND K. R. GREER. 1976. Parasites and diseases of North American elk (*Cervus* spp.): An annotated bibliography. Joint Contribution of the Federal Aid Wildlife Restoration, MT Proj. W-120-R(6083), Wildlife Laboratory, and Veterinary Research Laboratory, Agricultural Experiment Station, Montana State University, Bozeman, Montana, 48 pp.
- , R. E. BARRETT, P. J. A. PRESIDENTE, AND R. H. JACOBSON. 1969. The Rocky Mountain elk as a reservoir host for parasites of domestic animals in western Montana. *Bulletin of the Wildlife Disease Association* 5: 348-350.

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