PARASITES AND DISEASES OF THE WELLS GRAY MOOSE HERD

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Studies begun in 1950 of the moose *(Alces americana)* herd in Wells Gray Park, British Columbia, have included a program of taking moose for autopsy. To date there are records of 34 such examinations. These, when augmented by incomplete data from approximately 100 moose harvested annually by hunters, have given some data on disease and parasites associated with this herd.

The record is of special interest because the area inhabited by these moose appears to be one of the most productive ranges supporting moose in this province. The result is that, with few exceptions, moose in this area have been in good condition the year round during the study period. Almost without exception, cow moose taken in the hunting season are reported as fat, and comparable in this respect to medium fat beef. Bulls are not so fat, but are usually regarded as in good condition. Even in March or April, autopsied cows are usually recorded as with considerable deposits of fat on the omentum, and often with as much as 3/4 to 1 inch of fat covering the kidneys. Kidney fat indices, as described by Riney (1955), were obtained from five moose in 1956. Here an index of 100, indicating that the weight of kidney fat is equal to the weight of the kidney, probably indicates heavy reserves of fat. Two cows killed in January had indices of 256 and 159. A mature bull taken in late February had an index of 106. A cow killed in March had an index of 201, and another taken in April had an index of 121. It is worth noting that the winter of 1955-56 is considered to have been one of the severest as to temperature and snow depth since the beginning of the study.

Moose are numerous in the park. In summer the population is scattered through extensive subalpine forests. In winter there is concentration into old lowland burns, rich in willow and birch browse where, locally, there may be up to 100 moose per square mile for extended periods of weeks. In 1952, aerial and ground census indicated a population of 2000 on winter range (Edwards, 1952, 1954) with an average stand of about 30 per square mile over about 60 square miles of the winter range then in use. Since then, annual track counts of migrating moose account for about 1000 animals, which are known to constitute only part of the herd.

The country inhabited by this herd has a foothill topography penetrated by wide valleys with flat bottomlands. Mature lowland forest consists of cedar *(Thuja plicata),* hemlock *(Tsuga heterophylla),* spruce *(Picea engelmanii),* and balsam fir *(Abies lasiocarpa).* This is the forest of the norther portion of the Interior Wet Belt. Most lowlands in the park have been burned, however. Fire has created extensive stands of willow *Salix* spp.), aspen (*Populus tremuloides),* and birches *(Betula papyrifera* and *B. glandulosa).* The fauna associated with this moose herd contains relatively good densities of mule deer *(Odocoileus hemionus),* caribou *(Rangifer arcticus),* goat *(Oreamnos americanus),* grizzly bear *(Ursus horribilis),* black bear *(Euarctos americana),* wolf *(Canis lupus),* and coyote *(Canis latrans).* There are also good populations of marten *(Martes americana),* fisher *(Martes pennanti),* lynx *(Lynx canadensis),* wolverine *(Gulo luscus),* mink *Mustela vison),* beaver *(Castor canadensis),* and a host of lesser mammals. Cougar and bobcat *(Felis concolor* and *Lynx rufus)* are present but not numerous. The area is rich faunistically, a result of fertile soils and a diversity of habitats due to variations in successional stage and in elevation, and the influences of a diversified topography.

Most autopsies were performed in winter under the rough field conditions which must accompany most research in wild areas. It is entirely possible that, in performing examinations on such large

animals in cold weather and in deep snow, some diseases, parasites, and abnormalities have been overlooked. There may be parasites and diseases in this herd yet to be recorded, and the incidences of infection of those conditions found may be higher than the data indicate.

We are indebted to the administrative personnel of Wells Gray Park, and to Messrs. Ted and Roy Helset, for their assistance in many winter autopsies; and to the many guides and hunters who co-operated in examining moose killed in hunting seasons.

PARASITES ENCOUNTERED

Moose tick, Dermacentor albipictus: This tick is the only ectoparasite recorded from the herd. It is common, and can be easily found on most animals from about late February to May when the female ticks are engorged. The abundance of these ticks varies considerably among host moose, and the frequency with which heavy tick loads are encountered is quite variable from year to year.

Our experience with this tick is confined chiefly to the spring. Few ticks have been found during numerous autopsies from September to about mid-February, presumably because the gross methods of examination we must usually employ are not efficient enough to detect ticks of a small size. Early in 1956, Ritcey endeavoured to find ticks on several moose killed for autopsy. He found none, even after plucking hairs from large areas and using a dissecting microscope for close examination. By contrast, ticks are obvious on these moose from late February to May, engorged females seeming to appear coincident with the appearance through the snow of the first bare ground, and with the beginning of pelage molt in the hosts.

Ticks cause considerable irritation. In 1952, a year of heavy tick loads, moose were observed shaking their heads, scratching heads and ears with hind feet, and even thrashing their heads in willow bushes.

On the snow of late spring, moose beds frequently contain live ticks as well as blood patches. The frequencies of occurrence of ticks in beds are shown in Table 1. These numbers represent ticks not eaten by birds, a variable loss which may render such counts inaccurate beyond indicating tick abundance in a general way. Robins, flickers, crows, and “a small grey bird” (probably junco) have been observed to take ticks from moose beds.

Table 1 - Annual occurrence of ticks observed in moose beds in snow, March and April

Year	Number of Beds Examined	Number of Ticks Seen	Number of Ticks per Bed
1953	66	95	1.4
1954	230	112	0.5
1955	157	21	0.1
1956	262	0	0.0

At this time of year, ticks and blood are not confined to beds. Both may be dropped by moose as they forage or migrate. Occasionally, areas up to five feet square are spotted with blood, as if from moose shaking themselves. In 1953, R.G. Miller followed the trail of a bull moose for 300 yards through snow. In that distance, the moose had dropped 240 engorged ticks plus six flat ticks, the

last probably males. The moose had lain in two beds, so the time interval during which ticks were lost was at least several hours.

There is annual variation in the abundance of ticks on these moose. In the springs of 1952 and 1953, tick loads were heavy. They were moderate in 1954, and light in 1955 and 1956. In years of heavy loads, some extreme conditions have been been recorded. Through late March and early April in 1952, most moose beds were bloodstained and contained ticks. Thirty-one ticks were found in one bed. In that year a weak calf, reported by Patrolman C. E. Gaglardi, was captured and examined. It had ticks over most of the body with the exception of the back and shoulders. Forty to fifty engorged ticks were packed about the anus in an area about 4 inches in diameter. Similar patches, estimated at 60 ticks each, were located inguinally next to the thighs. There was little space for more ticks on the ears, inside or out. The body was dotted with clusters averaging three or four ticks each.

It will be apparent that most of our data on ticks is obtained when snow is on the ground. Our experience may therefore be limited to the first part of the period when ticks are most active on moose. Not only is snow an aid to recording signs of tick occurrence and abundance, but with the disappearance of snow, most moose migrate out of the area where it is possible to study them with some intensity. For this reason, our knowledge probably covers only part of the engorging period. This may account for our not being entirely sure that we are observing the life history of this tick as it is described in the literature. Hearle (1938) recorded that engorged females drop to the ground in spring. Seed ticks hatch and remain there until cold weather in autumn stimulates them to climb vegetation to contact passing hosts. These remain on the host through the winter. In Wells Gray Park, most engorged females are dropped on the bottomlands of the valleys. Moose do not return to these bottoms until they are covered with snow in late autumn or early winter. Most moose must be reinfected, then, from seeds hatched from a relatively few female ticks that are carried to higher elevations in late spring.

There must be heavy annual mortality among these ticks. Engorged females begin to drop in numbers when patches of bare ground are beginning to show through the snow, but large numbers fall on snow where they are conspicuous and are fed upon heavily by birds of several species. Most females dropped are strewn across range which will not be inhabited again by appreciable numbers of moose until early winter. Unless the seed ticks produced by these females can remain active in cold weather and a foot of snow, the bulk of them have little chance of finding hosts on which to complete their life cycles. Perhaps here is yet another example of the heavy mortality which parasites can withstand, yet still flourish. Perhaps such losses are easily offset by a high reproduction potential, for Hearle (1938) recorded that females lay about 4000 eggs.

In our experience, heavily infested moose are not seriously weakened by ticks alone, although there is some evidence that moose weakened by other means, as by malnutrition or age, may carry particularly heavy tick loads which are an additional threat to the survival of the host. Presumably healthy moose are resistant to heavy loads of ticks, employing the same combative mechanism used against any parasite entering its tissues.

Nose fly, Cephenemyia sp: Larvae of this fly, probably *C. jellisoni,* have been found in only two moose autopsied. In both cases, only one larva was found. By contrast, deer in many parts of British Columbia are heavily infested by this species (Cowan, 1951). The few mule deer autopsied in Wells Gray Park have yielded only one larva of this parasite.

Both records from moose were obtained in 1953, one from a mature cow containing a larva among the posterior nasals, one from a 22-month-old cow containing one larva in the esophagus. Both larvae may have moved upon the death of their hosts.

Bladderworm, Cysticercus tenuicollis: This larval cestode has been found in most moose autopsied. Excluding two autopsied animals in which decomposition was too advanced to search effectively for these cysts, the bladderworm has been found in 84 percent of the remaining 32 moose. The mean number of cysts per infected animal was 4.6; the mode was 2. We have found ten or more cysts in three moose, all of them with much worn teeth and probably over nine years old. Sixteen cysts were found in one of them.

Of 125 cysts found, loci were are follows: liver 89, omentum 25, heart 7, one each for pancreas, mesentary near liver and mesentary near kidney. Some of these cysts were beginning to calcify. In addition, numerous well-calcified bodies have been found, mainly in livers, which were suspected of being old cysts of this organism. One calf about nine months old had three of these cysts on its liver.

As noted by Cowan (1951) the presence of this parasite is the rule rather than the exception. Coyotes are common on this moose range, and wolves are present. These are probably the hosts of the adult form, the tapeworm *Taenia hydatigena.* We have never observed pathogenic symptoms to be associated with these cysts in moose.

Measles, Cysticercus sp.: Small, hard cysts, probably either *C. krabbei* or *C. ovis,* have been found in two animals autopsied, and have been reported from several of the hundreds of moose that have been taken by hunters. When present, it is usually most common in the muscles of the thigh. There is one record of many of these cysts in the brisket, and one cyst has been found in a heart. Thigh infestations may be heavy, with cross sections consistently striking 1 - 6 cysts. Moose harboring the parasite have appeared healthy.

Hydatid cysts, Echinococcus granulosus: This cyst has been found in 68 percent of autopsied moose. The mean number of cysts per infected animal was 7.7; the mode was 1.0. Old animals tend to have the most cysts. Of 164 cysts found, 158 were located in lungs, five in liver, and one in a kidney.

Two very heavily infected animals have been examined. One cow, 8 to 10 years old, had 32 cysts on the lungs. The animal appeared to be in good health, with heavy fat deposits about the kidneys. She was killed in late January. Her kidney fat index was 159.

Another cow, on March 6, 1955, was trapped in a large corral for tagging. As men approached the trap, she advanced with defiant behaviour, stopped, began to tremble violently, then sank slowly to the ground, breathing heavily. Breathing became weaker, and the animal was dead in four minutes. Autopsy revealed she was about four years old. She had the heaviest hydatid infection that we have encountered. There were three hydatid cysts in the liver and at least 30 in the lungs, ranging from 1/4 to 2 inches in diameter. The cow was pregnant with twin calves, had heavy fat deposits on the omentum, and fat 3/4 to 1 inch thick over the kidneys. The only unusual feature found, aside from the cysts, was an excessive amount of fluid in the pericardial sac.

The incidence of hydatid cysts is heavier on the moose range than in most game ranges studied by other workers. Rausch (1952) found conditions similar to those in Wells Gray Park and stated "I would expect to find that nearly every aged moose in southern Alaska would harbour *Echinococcus* larvae." Green (1949) reported on large numbers of elk examined in Banff National

Park. From 1.7 to 6.8 percent were infected in different years. Cowan (1948) found it in one of the many coast deer he examined and (1951) recorded it from one mule deer in Jasper National Park. Fenstermacher (1934) found hydatid cysts in 8 of 19 moose examined in Minnesota. Miller (1953) quoted Hatter's estimate that 50 per cent of moose in British Columbia carry these cysts, while Sweatman (1952) found 59 percent of 29 moose in Ontario infected. Peterson (1955) calls *Echinococcus* the most common parasite found in Ontario moose. Harper *et al.* (1955) studied hydatid infections in Saskatchewan. They found 30 percent of 96 moose infected. They suspect that the incidence of infection in moose may be higher than their data suggests since most material examined was submitted by hunters.

We have no data suggesting that heavy loads of these cysts have much influence upon either the physical condition or life span of hosts, except possibly the case of the animal which "died of fright" as described above. Rausch (1952) reported "The larvae of *E. granulosus* appear to be essentially non-pathogenic in their natural mammal host."

Parts of this moose range are heavily hunted in autumn, and part is inhabited sparingly by people on small farms. The abundance of this parasitic organism constitutes some danger to humans in the area. Canids are probably the main alternate hosts. Coyotes are fairly common throughout the range. Wolves, on the other hand, confine most of their activities to areas remote from the heavily hunted and farmed areas. Domestic dogs probably constitute the most serious danger in transmitting this organism to humans.

Work in Ontario has shown that fisher, *Martes pennanti*, can carry the adult tapeworm (Sweatman, 1952). It is possible, then, that mustelids generally may be potential hosts. The moose range in question contains populations of wolverine, otter, marten, fisher, mink, and two weasels, all of which are suspect as hosts of adult worms.

The abundance of *Echinococcus* in Wells Gray Park is probably not unique in central British Columbia. Hatter's statement given above (*vide* Miller, 1953) is based on experience throughout a large part of the province.

In this park, any control measures based upon control of the abundance of hosts of adult worms would be unrealistic. The expense involved in applying such controls to wild canids alone would be prohibitive relative to the benefits to be expected. In addition, the size of the area involved and the variety and number of predators in it preclude much hope of success in any event. If mustelids are hosts, any program directed at reducing their numbers would seriously affect the livelihood of trappers deriving a large part of their annual income from these mammals. Practicable control measures should be aimed at education of people as to the dangers of hydatid disease and how to avoid infection.

It has been suggested that control measures to reduce the abundance of this parasite would be accomplished by reducing the wolf population. There is no evidence to suggest that such control would assure fewer *Echinococcus* organisms, and in the final analysis there are many people who would rather have "wolf country" than an area where the slight chance of getting hydatid disease is made only a little slighter.

Legworm, Wehrdickmansia cervipedis: We have failed to find this subcutaneous parasite in only two adult moose, and in three calves all 9 months old or younger. Of 27 moose examined for this organism, and over one year old, 95 per cent were infected.
Most common sites of infection are on the feet and the brisket. In several cases, when especially numerous, large patches have been found on the shoulders and sides. One case of three worms

per square inch over part of the brisket has been noted. In no case have we noted inflammation to be associated with sites inhabited by this nematode.

OTHER CONDITIONS

Actinomycosis: Actinomycotic-like lesions of jaw bones, particularly about the teeth, are frequently encountered in these moose. The most severe cases are found in old animals with worn teeth. Impacted food, fibrous in nature, is usually associated with this disease in severe cases.

Two examples of severe infections in old animals are given below. In May 1950, P.W. Martin examined an aged cow that was very thin. Severe necrosis was found between two molars in bone, gums, and cheek tissue. Both molars were loose. The cheek lesion perforated the cheek, forming a hole an inch wide. Food had been passing through this hold from the mouth. The necrotic area between the teeth was impacted with a large amount of fibrous vegetable matter.

In 1952 an old cow died in early winter. Her remains were examined the following spring. There was severe bone necrosis about the upper teeth. Two teeth had fallen from decayed sockets, and a third was hanging by one root. Quantities of tightly packed fibrous material were packed into necrotic cavities.

We have found this condition in five autopsied animals, and it is observed regularly in animals taken by hunters. This disease seems to be confined mainly to aging animals with worn teeth.

Contagious warts: Warts have been encountered on only two animals autopsied. Infected animals have been seen in the field, and hunters report these growths occasionally. A severe case has yet to be noted. From February 2, 1953 to January 30, 1956, 51 moose trapped were negative for these warts.

Other diseases, injuries and abnormalities: Symptoms of bacterial, fungus, or virus disease have been encountered occasionally. There has been little opportunity to identify causative organisms. Several cases of swollen legs and feet, sometimes with lesions visible, are on record. One liver examined had seven rice-like bodies resembling those of *Sarcocystis,* and another liver had extensive healed lesions, presumably from bacterial infection. There is one records of numerous kidney stones. Skin lesions, probably from mechanical injury, and scar tissue from such wounds that have healed, are frequent. Healed rib fractures are common. Healed fractures of the leg have been noted. Four blind eyes and one with a foreign object imbedded in it have been examined. One case of twins, each blind in one eye, suggest an inherited deformity. Also on record are a deformed hoof (elongated), a branching renal artery entering the kidney in two places, and several cases of supernumerary teeth.

Careful search in most animals autopsied has failed to reveal nematode lungworms.

SUMMARY

A moose herd in British Columbia, which appears to be inhabiting exceptionally good range, harbours the following organisms in some abundance: moose ticks, bladderworm, hydatid cysts, and legworm. Also present are nose fly, measles, contagious warts, and actinomycosis. Bladderworm, hydatid cyst, and legworm were found in 84, 68, and 95 percent respectively, of the moose examined.

LITERATURE CITED

Cowan, I. McT. 1948. The occurrence of the granular tapeworm *Echinococcus granulosus* in wild game in North America. Jour. Wildl. Mgt., 12: 105 -106
_____ 1951. The diseases and parasite of big game mammals of western Canada. Proc. 5th Ann. B.C. Game Conv. : 39 - 64

Edwards, R.Y. 1952. An aerial moose census. B.C. For. Ser. Res. Note 23, 9 pp
_____ 1954. Comparison of an aerial and ground census of moose. Jour. Wildl. Mang. 18: 403 - 404

Fenstermacher, R. 1934. Diseases affecting moose. Ohio State Univ. Alumni Quart. 22 (3): 81-84

Green, H.A. 1949. Occurrence of *Echinococcus granulosus* in elk *(Cervus canadensis nelsoni)* Banff National Park, Canad. Field-Nat., 63: 204-205

Harper, T.A., R.A. Rutton, and W.A. Benson 1955. Hydatid disease (*Echinococcus granulosus)* in Saskatchewan big game. Trans. N. Amer. Wildl. Conf., 20: 198-207

Hearle, E. 1938. Insects and allied parasites injurious to livestock and poultry in Canada. Canad. Dept. Agric. Publ. 604, 108 pp

Miller, M.J. 1953. Hydatid infection in Canada. Canad. Medic. Assn. Journ., 68: 4223-434

Peterson, R.L. 1955. North American moose. Univ. Toronto Press, Toronto

Rausch, R. 1952. Hydatid disease in boreal regions. Actic, 5: 157-174

Riney, T. 1955. Evaluating condition of free-ranging red deer *(Cervous elaphus)* with special reference to New Zealand. NZ Jour. Sci. Tech., Sec. B, 38: 429-463

Sweatman, G.K. 1952. Distribution and incidence of *Echinococcus granulosus* in man and other animals with special reference to Canada. Can. Jour. Public Health, 43: 480-486

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