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LUNGWORM LARVAE DISCHARGE LEVELS WITHIN THE URAL-TWEED BIGHORN SHEEP POPULATION

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Abstract: Seasonal and annual variation in lungworm (Protostrongylus spp.) infection and larvae shedding within a population of bighorn sheep indigenous to the coniferous forests of northwestern Montana are examined. Fecal samples were collected in 1976 to 1978 after a severe die-off and the bighorn population was at a low, and 1985 to 1987 after a period of population recovery. Lungworm prevalence for the 2 periods were similar, averaging 84.4% and 81.5% respectively. Larvae shedding was also similar with very low numbers of larvae per gram of sheep feces. Ninety percent of the fecal samples examined contained <30 larvae per gram of sheep feces. Significant variation between months was observed for both the prevalence and larvae output.

The potential role of the lungworm-pneumonia complex as an important mortality factor in Rocky Mountain bighorn sheep has long been recognized (Buechner 1960, Forrester 1971, Stelfox 1976). Monitoring and evaluation of both lungworm prevalence and levels of discharge of first-stage larvae (L_1) in the feces have become a regular part of bighorn sheep management programs and studies. Often these collections and associated analyses are of short duration or conducted only during a particular season. Two studies of the Ural-Tweed bighorn sheep population have provided yearlong collections of fecal material for analysis of lungworm levels within the population.

The Ural-Tweed bighorn sheep population, the only native herd remaining in northwestern Montana, occupies a long, narrow band of over-steepened, heavily-timbered terrain (9,470 ha) along the east shore of Lake Koocanusa between Libby and Eureka, Montana. This herd numbered approximately 150-200 sheep during the 1950s and early 1960s (Blair 1955, U.S. Dep. Inter. 1965). During the late 1960s and early 1970s, the population suffered a die-off and numbered 25-40 animals in 1978 (Brown 1979). Currently the population is undergoing steady growth and numbers approximately 100 animals (Yde, unpub. data). The first of the 2 studies was conducted by Brown from 1976 to 1978 at a time when the population was at a low level following the die-off. The second set of data was collected by Yde from 1985 to 1987 as the population started to recover. The information on lungworm prevalence and L_1 larvae discharge rates that has been collected will provide a baseline for comparison as the population continues to grow and responds to large-scale habitat treatments, which are being completed on the range.

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METHODS

Fecal material was collected from known bighorn sheep defecations. From October 1976 through April 1977, a total of 50 fecal pellet groups were collected; 23 in 1976 and 27 in 1977. During 1978, 240 fecal pellet groups were collected at a rate of 20 samples per month. From May 1985 through December 1987, 3-34 samples were collected monthly, with the exceptions of October 1985, and March and June 1986 when no samples were collected. During the 1985-87 study period, direct observation of bighorn sheep defecations were made as conditions permitted. This resulted in classification of the fecal samples to bighorn sheep sex and age class. During both studies the individual samples were stored in paper bags at approximately 4°C until they were processed at the Montana Veterinary Research Laboratory, Bozeman, Montana. The Baermann technique (Baermann 1917) was used to determine the number of lungworm larvae per gram fecal material.

Postmortem examination of the respiratory tracts obtained from 8 sheep mortalities - road kills, predation, poaching and natural - provided supplementary data on the lungworm infection level within the population. Methods of examination are explained in Worley et al. (this publication).

RESULTS

A total of 556 of 672 fecal samples (82.7% were infected with lungworms during the 2 study periods. There was no significant difference ($P > 0.81$) among complete years (1978, 1986 and 1987). The data from all years were combined to illustrate the monthly and seasonal variation in the prevalence of infection (Fig. 1). This figure illustrates there were significant variations in prevalence between months ($P < 0.005$) and season ($P < 0.05$). Figure 2 illustrates the prevalence as determined for sex and age class of bighorn sheep during the 1985 to 1987 study period. Statistical analysis of the prevalence determined there were no significant differences between the rates for the 2 sexes ($n = 383$, $P > 0.89$), age class ($n = 311$, $P > 0.51$) and sex age class ($n = 311$, $P > 0.65$).

Figure 3 illustrates the frequency distribution of shedding rates (L_1 larvae/g fecal material -- hereafter designated LPG) observed during 2 periods of study. Low levels of larval output were observed throughout the 2 study periods, with more than 90% of the samples containing <30 LPG. Figure 4 illustrates the shedding rates by month, season and year. Analysis indicated there were significant differences in larval shedding rates between months ($P < 0.001$) and season ($P < 0.001$).

Postmortem examination of respiratory tracts from 8 bighorn sheep collected from the Ural-Tweed population was conducted (Brink 1941, Brown

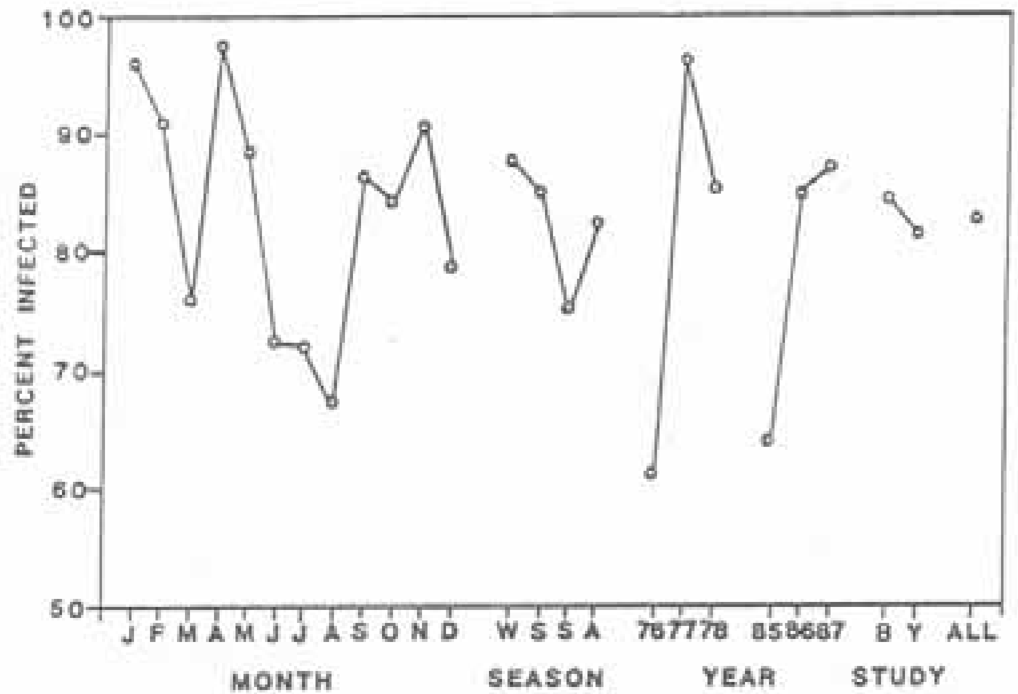

Fig. 1. Prevalence of lungworm infection for the Ural-Tweed bighorn sheep population, as determined by combining all fecal samples (n=672) collected from 1976-87. B=Brown; Y=Yde.

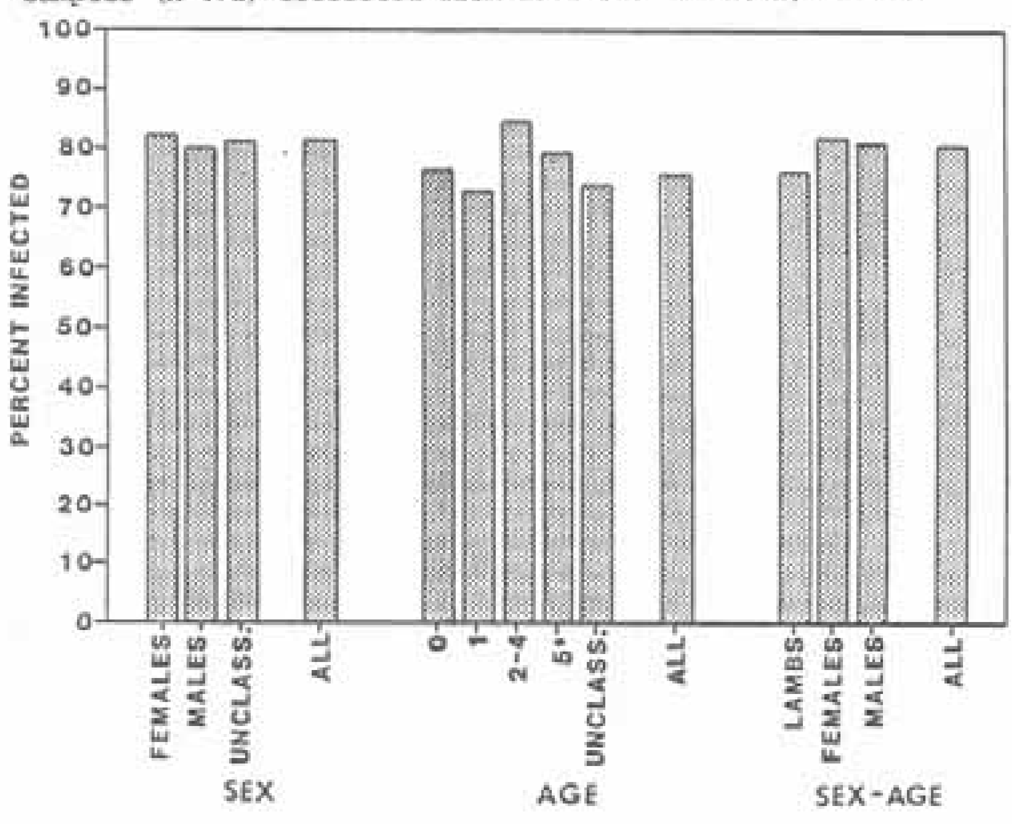

Fig. 2. Lungworm infection for sex, age and sex-age class of bighorn sheep, Ural-Tweed population, 1985-87.

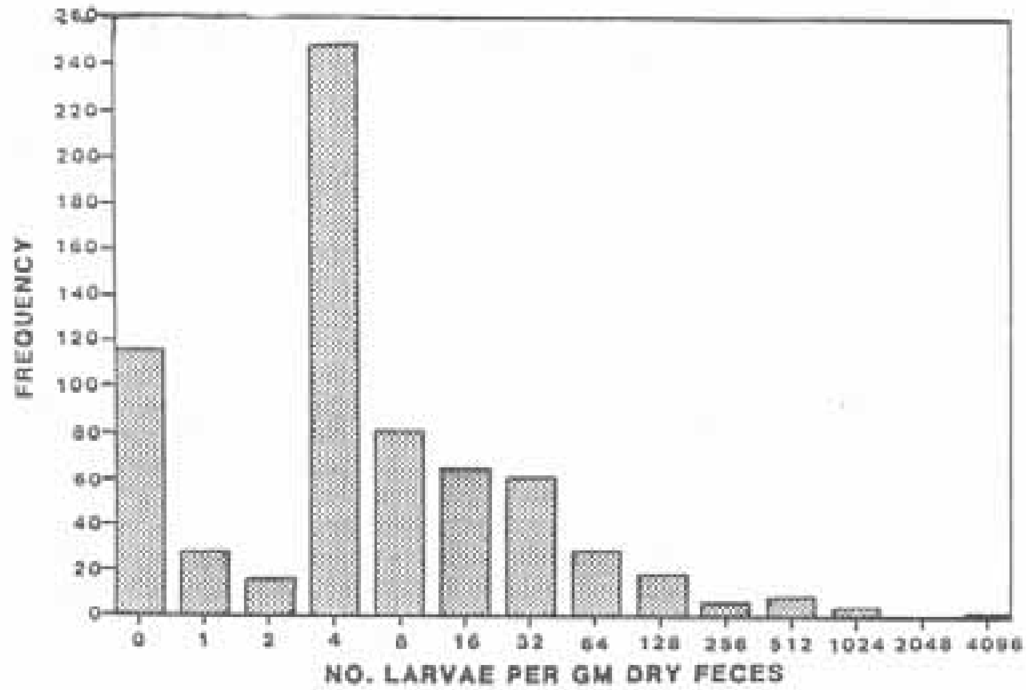

Fig. 3. Distribution of <u>Protostrongylus</u> spp. larvae in fecal samples for the Ural-Tweed bighorn sheep population, 1976-87.

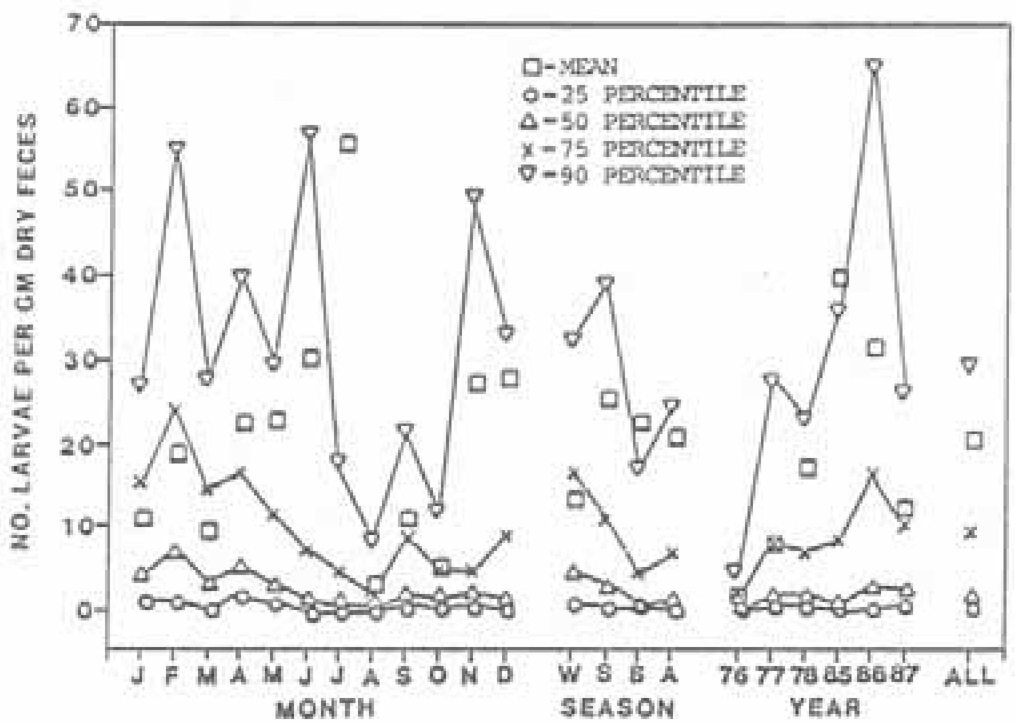

Fig. 4. Monthly, seasonal and annual variation in lungworm shedding rates for the Ural-Tweed bighorn sheep population, 1976-87. Mean and percentiles are illustrated by separate graphs.

1979, Yde, unpub. data). Seven adult bighorn sheep were infected with Protostrongylus spp. adults. Adult lungworms, identified as P. rushi werefound in 6 of the 8 respiratory tracts. Adult P. stilesi were found in conjunction with P. rushi in one animal (Brown 1979). Lungworms found in 1 of respiratory tracts were identified only to genus. One adult female bighorn infected by P. rushi carried a near full-term fetus, which was not infected by lungworms. Forrester and Senger (1964) reported that 5 hunter-killed Ural-Tweed rams examined from 1959 to 1962 contained both P. rushi and P. stilesi within the lung tissue.

DISCUSSION

The Ural-Tweed bighorn sheep herd is currently undergoing a population increase following a catastrophic decline in the late 1960s and early 1970s. The high prevalence of lungworms (84.4%) reported by Brown (1979) after the die-off has remained during the current period of population recovery. Similar levels of infection were previously reported for the Ural-Tweed population (Couey 1950, Forrester and Senger 1964), as well as the other bighorn populations (Couey 1950, Buechner 1960, Forrester and Senger 1964, Forrester 1971, Uhazy et al. 1972, Stelfox 1976). The high level of infection was found in all sex and age classes, including the lamb segment. The high prevalence among lambs indicates that lungworms are acquired at an early age, possibly even through transplacental migration. Postmortem examination of an adult female and associated near-term fetus indicated no transplacental migration of lungworms. This method of infection, however, has been documented for bighorn sheep (Forrester and Senger 1974, Hibler et al. 1972, 1974).

Lange (1974) reported there are often small areas of habitat that contain large concentrations of infected snails. Frequent use of these areas by bighorn sheep increases their exposure to the infected snails, thereby providing for the continued infection and reinfection of the population. Telemetry data collected by Brown (1979) and Yde (unpub. data) indicate the sheep utilize the entire Ural-Tweed range, concentrating in selected seasonal-use areas. Within these areas of seasonal concentration, there are sites preferred by the bighorn sheep. These preferred sites are routinely visited by bighorn sheep as they utilize or travel through a given area. The presence of 1 or more snail concentration areas, as described by Lange (1974), within these preferred sites would increase the likelihood of a particular sheep becoming infected with lungworms.

The continued high prevalence of infection within the population indicates the parasite is an integral part of the ecology of the Ural-Tweed bighorn sheep population. Because of the pattern of habitat use, any non-infected bighorn sheep have a high risk of being infected by the parasite. The prevalence level has remained high during a period of population growth. This indicates that unless a treatment of a bighorn sheep population for lungworm infection is completely successful, reinfection of a majority of the population will occur within a relatively short period of time.

Shedding rates for lungworm larvae were low: 90% of the fecal samples that were analyzed contained <30 LPG. This level of output is considerably below the level previously reported for the Ural-Tweed population (Couey 1950, Forrester and Senger 1964).

Significant seasonal variations in both the prevalence and larval output of lungworm were observed during the 2 studies. Peaks in prevalence were found in January, April and November (Fig. 1), while larval output peaked in February, June and November (Fig. 4). Monthly lungworm larval output from the Wildhorse Island, Montana, bighorn sheep population peaked in February and May (Forrester and Senger 1964). Uhazy et al. (1973) reported a similar peak from January through March. The peaks that have been observed correspond to periods of high stress, i.e., the rut, mid-winter concentration, and parturition. This may indicate a relationship between the life cycle of the parasite and they physiology of the host. The greatest level of larvae were shed on areas of bighorn sheep seasonal concentration, thus increasing the potential to reinfect the bighorn population. The spring increase in larval output may also be related to the shift to more succulent vegetation. Gevondyan (1958) found that such a shift increased the amount of Muellerius capillaris larvae shed by sheep.

The seasonal variation in the infection and larval output rates, indicate that caution should be utilized when considering the collection and analysis of lungworm related data. If the data are to be collected only from a short seasonal period, the collecting period should coincide with one of the peak periods of larval shedding. The mid-winter and spring periods appear to be the best periods to collect the fecal samples; the sheep are concentrated and the larvae output rates are maximized. Collection during these periods should produce the most reliable indicator of what the levels of infection and larvae output actually are. Additionally, data collected from a specific period should probably only be compared with the results from comparable periods.

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