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EXPOSURE TO *PSOROPTES* SP. MITES IS COMMON AMONG BIGHORN SHEEP (*OVIS CANADENSIS*) POPULATIONS IN CALIFORNIA

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ABSTRACT: Sera (n = 806) from 50 populations of bighorn sheep (*Ovis canadensis*) in California (USA) were evaluated for antibodies to *Psoroptes* sp. mites using a kinetic enzyme-linked immunosorbent assay (ELISA). Test values for each sample were determined to be either positive or negative at each of two ELISA cutoff values that provided either 100% sensitivity (low cutoff) or 100% specificity (high cutoff), respectively. One hundred sixty-eight (20.8%) sera were seropositive at the low cutoff value, and 87 (10.8%) of these sera also were seropositive at the high cutoff value. Eleven populations were designated as scabies-suspect and 25 populations were designated as scabies-positive because they had at least one seropositive animal at the low and the high cutoff values, respectively. Based on these results, exposure to *Psoroptes* sp. mites appeared to be widely distributed among bighorn sheep populations from 1980 to 1990 and infested animals may have been present prior to 1980.

Key words: *Psoroptes* sp., mites, scabies, bighorn sheep, *Ovis canadensis*, ELISA, seroprevalence.

INTRODUCTION

Psoroptic scabies has been regarded as an important disease of domestic and wild ungulates in western North America for at least 100 years (National Research Council, 1979), and mite infestations have been documented recently in bighorn sheep in Arizona, California, Idaho, Oregon, New Mexico, Washington, and Wyoming (USA) (DeVos et al., 1980; Foreyt et al., 1985; Jessup, 1985; Clark et al., 1988; Muschenheim et al., 1990; Hoban, 1990). However, the actual distribution, prevalence, and incidence of *Psoroptes* sp. infestations in bighorn sheep are not known because sampling free-ranging animals is difficult and expensive, and because subclinical infestations involving small numbers of mites may be overlooked (Meleney and Christy, 1978). Furthermore, active relocation programs for bighorn sheep may inadvertently modify the distribution of infectious diseases such as psoroptic scabies. We recently developed a kinetic enzyme-linked immunosorbent assay (ELISA) that detects antibodies to *Psoroptes* sp. mites (Boyce et al., 1991). Our objective in this study was to determine the distribution of mite-exposed bighorn sheep in California using this ELISA test.

MATERIALS AND METHODS

Between 1980 and 1990, sera were collected from 806 free-ranging bighorn sheep representing 50 populations in California as part of a health surveillance program conducted by the Wildlife Investigations Laboratory, California Department of Fish and Game. At the time of capture, animals were briefly examined for *Psoroptes* sp. mites, and suspected mite infestations were evaluated by microscopic examination of skin scrapings and ear swabs. Sampling efforts were not uniform among years, population locations, age groups or sexes. A small number of animals were re-sampled in subsequent years, and repeat samples were excluded from this study to avoid a bias in the results.

Antibody responses to *Psoroptes* sp. mites were determined by kinetic ELISA as described by Boyce et al. (1991). Twenty test and three control sera (strong positive, weak positive, negative) were evaluated in quadruplicate on each plate, and kinetic rate (Vmax) values on each plate were multiplied by correction factors (Boyce et al., 1991), ranging from 0.96 to 1.04, so that comparisons among plates were valid.

Intra-assay and inter-assay reproducibility were assured by maintaining coefficients of variation <10% for replicate samples both within (test sera and control sera) and among (control sera) plates. Mean Vmax values for each test sample were evaluated using both low and high positive/negative cutoff values (Vmax = 27.3 and 40.5), because Boyce et al. (1991) previously had shown that these values resulted in assay sensitivity and specificity of 100% and 97.7% (low cutoff), and 94.6% and 100% (high cutoff), respectively. Odds ratios (OR) were used to measure the strength of association between seropositivity and the factors of age (0 to 2 yr and >2 yr) and sex (males and females) using the high cutoff value (Fleiss, 1981).

RESULTS

Of 806 bighorn sheep sera tested, 168 (20.8%) were positive using the low cutoff value and 87 (10.8%) of these also were positive using the high cutoff value (Table 1). Using the high cutoff value, 15 populations contained at least two positive animals during a given year, and 10 additional populations contained one positive animal in one or more years. Mites were found on bighorn sheep from six of the populations with positive individuals at the high cutoff value (Table 1); while these mites could be classified as *P. ovis* by the method of Sweatman (1958), we choose to refer to these mites as *Psoroptes* sp. pending further examination of this genus (Boyce et al., 1990; Boyce and Brown, 1991). Using the low cutoff value, five additional populations were identified that contained multiple positive animals within a given year, and six additional populations contained one positive animal in one or more years. In all, 25 of 50 populations (50%) were designated scabies-positive and 11 populations (22%) were designated scabies-suspect because they contained at least one positive animal using either the high or low cutoff value, respectively (Fig. 1). The 14 populations without positive animals were classified as scabies-negative (Fig. 1). No significant association (OR = 1.1; 95% confidence interval = 0.68 to 1.80) was found between seropositivity and sex. However at the high cutoff, animals >2 years old were 2.7 times more likely to be exposed to *Psoroptes* sp. mites than younger animals (OR = 2.7; 95% confidence interval = 1.30 to 5.60).

DISCUSSION

Classification of ELISA test values as positive or negative is relative and depends on the positive/negative cutoff value. We chose to use both low and high cutoff values because they provided 100% sensitivity and 100% specificity, respectively (Boyce et al., 1991). The high cutoff value minimized false positives and increased the predictive value of positive test results (Courtney and Cornell, 1990). The low cutoff value decreased the potential for false negatives, albeit at the expense of specificity, and thus provided a more sensitive indicator of exposure to infestation. Based on these considerations, the 25 populations with individuals testing positive at the high cutoff were designated scabies-positive, and the 11 populations with positive individuals only at the low cutoff were classified as suspect (Table 1, Fig. 1). Results from the 14 populations classified as scabies-negative should be interpreted with caution because only a small number of animals were tested relative to population sizes. For example, two animals (both negative) were tested from the Panamint Range population that had an approximate herd size of 30 animals. In this case, we cannot be certain that this population had not been exposed to scabies; we can only be 95% confident that the prevalence of exposure was less than ten percent (Hanley and Lippman-Hand, 1983).

Prior to 1988, psoroptic scabies had not been reported from bighorn sheep in California for over 50 years (Clark et al., 1988). However, since 1988, *Psoroptes* sp. mites have been collected from animals in six populations, and we found animals from at least 25 populations in California that were exposed to mites (Table 1, Fig. 1). This widespread distribution of seropositive animals was unexpected, and we propose that subclinical infestations of *Pso-*

TABLE 1. Locations of sample populations (latitude and longitude), sample sizes for each population, and numbers of *Psoroptes* sp.-exposed bighorn sheep in California as determined by kinetic ELISA using low and high cutoff values.

Population location	Latitude	Longitude	Number sampled	Number positive	
				Low[a]	High[b]
Imperial County					
Chocolate Mountains	33°27'N	115°34'W	7	3	3
Julian Wash	33°05'N	114°42'W	5	2	0
Pichaco Peaks	32°58'N	114°39'W	5	2	1
Inyo County					
Black Mountains	36°08'N	116°39'W	4	3	2
Death Valley[c]	36°14'N	116°50'W	11	6	3
Dry Mountain	36°54'N	117°35'W	6	2	1
Funeral Mountains	36°27'N	116°38'W	4	0	0
Grapevine Mountains	36°57'N	117°08'W	3	0	0
Hunter Mountains	36°32'N	117°30'W	3	3	3
Inyo Mountains	36°56'N	118°02'W	4	0	0
Last Chance Range[d]	37°08'N	117°36'W	3	2	2
Mt. Baxter Herd	36°51'N	118°21'W	95	2	0
Nopah Range[d]	36°00'N	116°04'W	4	2	1
Panamint Butte[d]	36°26'N	117°21'W	9	7	4
Panamint Range	36°16'N	117°02'W	2	0	0
Sierra Nevada Range	36°32'N	118°27'W	2	0	0
Tin Mountain	36°53'N	117°27'W	7	5	4
Tucki Mountain	36°29'N	117°07'W	2	0	0
Los Angeles County					
San Gabriel Mountains	34°18'N	117°55'W	64	10	2
Modoc County					
Lava Beds National Monument[c]	34°39'N	116°22'W	6	2	0
Warner Mountains	41°37'N	120°17'W	4	0	0
Mono County					
White Mountains	37°34'N	118°13'W	15	3	3
Riverside County					
Coxcomb Mountains	33°56'N	115°20'W	3	0	0
Eagle Mountains	33°51'N	115°33'W	5	0	0
Haystack Mountain	33°40'N	116°27'W	1	1	0
Joshua Tree National Monument	33°07'N	116°02'W	7	1	1
Little San Bernardino Mountains	33°58'N	116°18'W	2	0	0
Orocopia Mountains	33°34'N	115°40'W	4	0	0
San Jacinto Mountains	33°49'N	116°40'W	2	1	1
Santa Rosa Mountains	33°25'N	116°13'W	22	1	0
San Bernardino County					
Avawatz Mountains	35°30'N	116°17'W	5	0	0
Cady Mountains	34°55'N	116°24'W	13	6	4
Clark Mountains	35°34'N	115°33'W	10	9	8
Clipper Mountains	34°45'N	115°24'W	10	5	0
Dead Mountains[d]	34°59'N	114°44'W	5	5	2
Granite Mountains	34°39'N	115°39'W	11	0	0
Kelso Mountains/Old Dad Peak	35°06'N	115°51'W	149	15	5
Kingston Range[d]	35°47'N	115°54'W	23	20	15
Marble Mountains	34°36'N	115°33'W	96	9	3
Newberry Mountains	34°45'N	116°45'W	4	1	0
New York Mountains	35°19'N	115°12'W	2	2	1

TABLE 1. Continued.

Population location	Latitude	Longitude	Number sampled	Number positive	
				Low[a]	High[b]
Old Dad Mountains	34°46'N	115°49'W	66	3	1
Old Woman Mountains	34°32'N	115°12'W	28	3	0
Piute Mountains	34°46'N	115°03'W	1	0	0
Providence Mountains	35°01'N	115°31'W	7	2	0
Sacramento Mountains	34°49'N	114°49'W	2	1	0
San Bernardino Mountains[d]	34°12'N	116°58'W	25	21	15
Turtle Mountains	34°17'N	114°50'W	19	2	0
Woods Mountains	35°02'N	115°19'W	5	3	1
San Diego County					
Jacumba Mountains	32°43'N	116°10'W	14	3	1
Total			806	168	87

[a] Number of animals seropositive at the low cutoff value (100% sensitivity).
[b] Number of animals seropositive at the high cutoff value (100% specificity).
[c] Seropositive animals noted as early as 1980, the first year for which sera were available.
[d] *Psoroptes* sp. mites recovered during one or more sampling periods.

roptes sp. mites may have been present in populations of bighorn sheep in California prior to 1980. This hypothesis is supported by the fact that: a) all documented infestations in bighorn sheep in California have been confined to the ears, and severe clinical lesions have not been seen despite intensive survey and capture efforts by the California Department of Fish and Game over the last 10 years (Bleich et al., 1990), and b) while only a small number of populations were sampled early in the study period, positive or suspect animals were identified in different populations every year from 1980 to 1985 (Table 1).

In a separate study, mite-infested bighorn sheep seroconverted to a negative status <6 mo after treatment (Boyce et al., 1992). Therefore, the ELISA results of this study probably reflect relatively recent infestations rather than long-term convalescent antibody titers. The association between bighorn sheep age and exposure was not surprising because it is likely that the probability of avoiding exposure declines as an animal ages. From a practical viewpoint, the most important implication of this finding is that differences in the age distribution of sampled populations should be considered when making comparisons among populations.

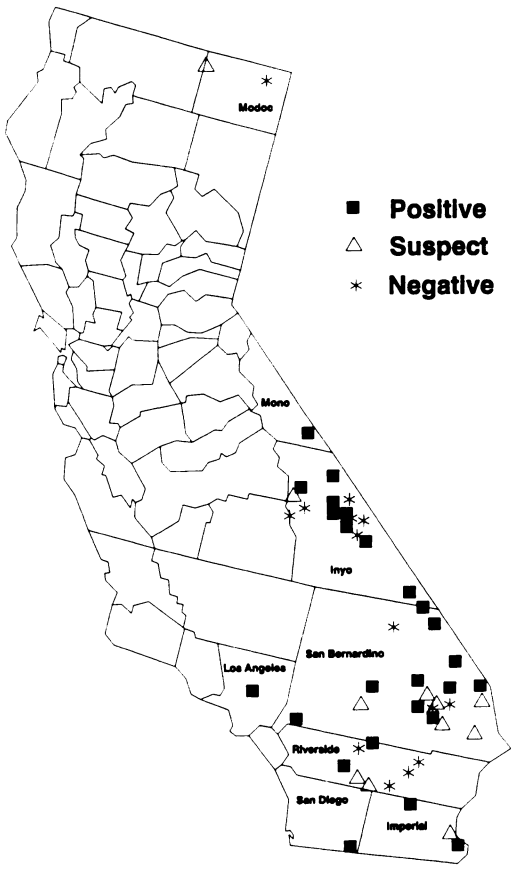

FIGURE 1. Distribution of scabies-positive, scabies-suspect, and scabies-negative bighorn sheep (*Ovis canadensis*) populations in California as determined by ELISA.

An epizootic of scabies at the San Andres National Wildlife Refuge in New Mexico resulted in the decline of a desert bighorn sheep population from more than 200 to approximately 25 individuals between 1978 and 1989 (Fisher and Humphreys, 1990; Hoban, 1990). It is not known whether this epizootic resulted from mites being introduced into a previously naive population, or whether a particularly virulent strain of mites evolved from an existing population. Although mite-induced mortality has not been reported in California, the severity of the San Andres epizootic suggests that the status of scabies in bighorn sheep in California should be closely monitored, especially since there is no evidence of morphometric or antigenic differences between mites found on bighorn sheep in New Mexico and California (Boyce et al., 1990; Boyce and Brown, 1991).

The unexpected widespread distribution of *Psoroptes* sp.-exposed bighorn sheep in California, coupled with the apparent pathogenicity of phenotypically similar *Psoroptes* sp. mites in New Mexico, illustrate the importance of monitoring the distribution and prevalence of exposure to mites in existing bighorn sheep populations and in screening animals prior to relocation. Without this information, wildlife managers interested in translocating animals run the risk of moving infested animals into non-enzootic areas. Not only might this practice contribute to the spread of scabies, but managers could face political and legal ramifications associated with potential disease transmission between bighorn sheep and other domestic and wild ungulates (Jessup, 1985; Boyce et al., 1990; Boyce and Brown, 1991). There is no evidence to indicate that the distribution of *Psoroptes* sp. mites among bighorn sheep in California has been affected by the states' active translocation program (Bleich et al., 1990). However, it is prudent to prophylactically treat all translocated bighorn sheep with a miticidal compound at the time of capture to reduce the chances of inadvertently spreading mites to new areas (Boyce et al., 1992).

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LITERATURE CITED

BLEICH, V. C., J. D. WEHAUSEN, K. R. JONES, AND R. A. WEAVER. 1990. Status of bighorn sheep in California, 1989, and translocations from 1971 through 1989. Desert Bighorn Council Transactions 34: 24–26.

BOYCE, W. M., AND R. A. BROWN. 1991. Antigenic characterization of *Psoroptes* spp. (Acari: Psoroptidae) mites from different hosts. The Journal of Parasitology 77: 675–679.

———, L. ELLIOTT, R. CLARK, AND D. A. JESSUP. 1990. Morphometric analysis of *Psoroptes* spp. mites from bighorn sheep, mule deer, rabbits and cattle. The Journal of Parasitology 76: 823–828.

———, J. A. K. MAZET, J. MELLIES, R. A. CLARK, AND D. A. JESSUP. 1991. Kinetic ELISA for detection of antibodies to *Psoroptes* sp. (Acari: Psoroptidae) in bighorn sheep (*Ovis canadensis*). The Journal of Parasitology 77: 692–696.

———, J. A. MILLER, D. A. JESSUP, AND R. K. CLARK. 1992. Treatment of psoroptic scabies in free-ranging bighorn sheep with ivermectin implants. Journal of Zoo and Wildlife Medicine 23: 211–213.

CLARK, R. K., D. A. JESSUP, AND R. A. WEAVER. 1988. Scabies mite infestation in desert bighorn sheep from California. Desert Bighorn Council Transactions 32: 13–15.

COURTNEY, C. H., AND J. C. CORNELL. 1990. Evaluation of heartworm immunodiagnostic tests. Journal of the American Veterinary Medical Association 197: 724–729.

DEVOS, J., R. L. GLAZE, AND T. D. BUNCH. 1980. Scabies (*Psoroptes ovis*) in Nelson desert bighorn sheep of northwestern Arizona. Desert Bighorn Council Transactions 24: 44–46.

FISHER, A. S., AND D. HUMPHREYS. 1990. Status of desert bighorn sheep in New Mexico, 1989. Desert Bighorn Council Transactions 34: 29–30.

FLEISS, J. L. 1981. Statistical methods for rates and

proportions, 2nd ed. John Wiley and Sons, New York, New York, pp. 71–75.

FOREYT, W. J., V. COGGINS, AND T. PARKER. 1985. *Psoroptes ovis* (Acarina: Psoroptidae) in a Rocky Mountain bighorn sheep (*Ovis canadensis*) in Idaho. Journal of Wildlife Diseases 21: 456–457.

HANLEY, J. A., AND A. LIPPMAN-HAND. 1983. If nothing goes wrong, is everything all right? Interpreting zero numerators. Journal of the American Medical Association 249: 1743–1745.

HOBAN, P. A. 1990. A review of desert bighorn sheep in the San Andres Mountains, New Mexico. Desert Bighorn Council Transactions 34: 14–22.

JESSUP, D. A. 1985. Diseases of domestic livestock which threaten bighorn sheep populations. Desert Bighorn Council Transactions 29: 29–33.

MELENEY, W. P., AND J. E. CHRISTY. 1978. Factors complicating the control of psoroptic scabies of cattle. Journal of the American Veterinary Medical Association 173: 1473–1478.

MUSCHENHEIM, A. L., E. T. THORNE, E. S. WILLIAMS, S. H. ANDERSON, AND F. C. WRIGHT. 1990. Psoroptic scabies in Rocky Mountain bighorn sheep *Ovis canadensis* from Wyoming. Journal of Wildlife Diseases 26: 554–557.

NATIONAL RESEARCH COUNCIL. 1979. Psoroptic cattle scabies research: An evaluation. National Academy of Sciences, Washington, D.C., p. 167.

SWEATMAN, G. K. 1958. On the life history and validity of the species in *Psoroptes*, a genus of mange mites. Canadian Journal of Zoology 36: 905–929.

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