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# Prevalence of antibody to caprine arthritis-encephalitis virus in goats in the United States

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**Summary:** Goats from 28 states were tested for antibodies to caprine arthritis-encephalitis virus. Of 3,790 goats, 1,175 (31%) tested positive, and of 196 herds tested, 143 (73%) had 1 or more seropositive members. This prevalence, based on serum samples from all goats in the participating herds, was lower than most rates reported in other studies. Such studies were based on fewer samples, incomplete sampling of herds, or smaller geographic base. Prevalence was highest in western Pacific and northern plains regions, increased with age to 3 years, was highest among goats on family-owned farms, and was lowest in the Angora breed. Differences in prevalence were not related to gender or size of herd.

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Caprine arthritis-encephalitis (CAE) is a multi-systemic disease of goats, caused by a lentivirus. The disease is most commonly recognized as chronic lymphocytic and degenerative polyarthritis, interstitial mastitis, or chronic encephalomyelitis of adult goats, but occasionally is seen as acute lymphocytic leukoencephalomyelitis of neonatal goats.<sup>1-5</sup> Many infected goats do not manifest clinical signs of disease, but are persistently infected and are positive for specific antibody.

Two serologic studies of the prevalence of CAE viral infection in goats in the United States have been reported.<sup>4,6</sup> A study of 1,160 goats from 24 states indicated prevalence of 81%.<sup>4</sup> However, results were considered biased because 836 of the 1,160 samples were submitted for diagnostic purposes from herds with clinical evidence of arthritis.<sup>7</sup> The other 324 samples were from 19 herds in Washington and Idaho. A study of goats from 13 dairies in California indicated prevalence of 53% in 2,826 goats, with range of 39 to 80% among herds.<sup>6</sup> Some of these goats were involved in a program for eradication of the CAE virus.

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The objective of the study reported here was to test 3,790 goats from 28 states for antibodies to CAE virus. Our objective was to expand over previous studies the number and distribution of goats tested to obtain a more comprehensive estimate of the prevalence of CAE virus infection in the United States.

## Materials and Methods

Blood samples were collected from 196 herds of goats in 28 states. From 1982 to 1988, samples were collected by the owners or local veterinarians from 3,790 goats aged 4 months through 15 years. In most instances, the entire herd was tested. Herds were selected because of the interest of owners in a pilot field eradication study. At the time of blood sample collection, the goats were not involved in an organized control program although they were being selectively culled by the owner. Comparisons were made among regions, states, age, gender, breed, and owner type.

States were grouped into 6 regions: northern Atlantic, comprising Connecticut, Maine, New Jersey, New York, Vermont, and West Virginia; northern plains, comprising Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin; Rocky Mountain, comprising Colorado, Montana, and Wyoming; southern Atlantic, comprising Arkansas, Georgia, Louisiana, North Carolina, and Tennessee; southern plains, with the single state of Arizona; and western Pacific, including Oregon and Washington. Only states with at least 5 goat herds were compared individually.

Serum samples were tested for precipitating antibodies to CAE virus, using an agar gel immunodiffusion test described for detection of ovine progressive pneumonia virus.<sup>8</sup> Minor alterations in the procedure consisted of using 7 ml of 0.8% agarose containing 0.4% polyethylene glycol (MW 6,000) rather than 6 ml of 1% agarose without polyethylene glycol as originally reported. Antigen was the ovine progressive pneumonia virus isolate WLC-1 prepared as described.<sup>8</sup> Antigenic cross-reactivity has been documented between the glycoprotein and the internal proteins of ovine progressive pneumonia and CAE viruses<sup>9</sup> (unpublished

Table 1—Prevalence of goats with antibody to caprine arthritis-encephalitis (CAE) virus among regions, states, ownertypes, and herd size

Group	Proportion of goats seropositive (%)	No. of goats tested	Proportion* of herds seropositive (%)	No. of herds tested	Mean† group size
<b>Region‡</b>					
Northern Atlantic	24	654	78	18	36
Northern plains	41	1,210	68	81	15
Rocky Mountains	25	1,077	78	64	17
Southern Atlantic	22	659	63	16	41
Western Pacific	49	87	00	10	9
<b>State§</b>					
Arkansas	44	216	80	5	43
Arizona	49	103	71	7	15
Colorado	28	703	76	55	13
Iowa	45	261	78	18	15
Illinois	48	62	100	6	10
Kansas	36	140	60	5	28
Michigan	4	48	17	6	8
Minnesota	49	254	88	8	32
Missouri	44	70	100	5	14
Montana	21	322	88	8	40
North Carolina	54	24	50	6	4
Nebraska	21	152	63	8	19
New York	34	236	71	7	34
Ohio	29	98	67	12	8
Oregon	68	19	100	5	4
Washington	44	68	100	5	14
Wisconsin	74	102	50	10	10
Other	15	912	70	20	46
<b>Owner type</b>					
Farm family	36	2,812	73	190	15
Private institution	12	472	75	4	118
Public institution	19	513	100	2	257
<b>Herd size</b>					
1 to 10	33	488	57	115	4
11 to 50	35	1,344	95	66	20
> 51	27	1,958	100	15	131
All	31	3,790	73	196	19

\*Herds with at least 1 seropositive goat. †Mean number of goats in each category within different groups. ‡Southern Plains Region omitted because only Arizona was represented. §States with 5 or more herds tested. ||States with less than 5 herds tested: Connecticut, Georgia, Indiana, Louisiana, Maine, New Jersey, Pennsylvania, Tennessee, Vermont, West Virginia and Wyoming.

observations). Test results were read as positive only when complete lines of identity were formed with a known positive serum. Only 13% of the sera produced incomplete lines and were considered negative for the purpose of this study. When some such goats were tested 1 or more years later, 49% had positive results and 22% continued to have suspicious results. Results were analyzed as percentage of seropositive goats and as percentage of herds with seropositive members. Prevalence rates for breeds and their herd mates were computed for herds with more than 1 breed.<sup>10,11</sup> Herd mate comparisons were also used for other categories as needed.

## Results

Prevalence of goats with antibody to CAE virus varied among regions and among states, but association with herd size was not apparent (Table 1). Among individual herds, seropositivity ranged from 0 to 100%. Size of herds with all seropositive goats ranged from 1 to 56, and that of herds with no seropositive goats ranged from 1 to 17. Prevalence of goats with specific antibody among family-owned farm herds was about twice the rate of public or private institutional herds (Table 1). This difference was observed in all age groups from 0 to 6

years. Mean  $\pm$  SD difference was  $21 \pm 6\%$  (*t* test;  $P < 0.01$ ).

Age, gender, or breed identification was missing for approximately 30% of the goat records, but prevalence of goats in the unknown age, gender, or breed categories (Table 2) did not differ greatly from the overall mean of 31%. Prevalence of goats with antibody to CAE virus increased with age (Table 2). Mean increase, approximately 14%/yr, based on a linear regression analysis, was statistically significant ( $R^2 = 74\%$ ;  $P < 0.01$ ). Average herd size decreased by approximately 22%/yr, based on linear regression analysis ( $R^2 = 96\%$ ;  $P < 0.01$ ). Females and sexually intact males had almost identical average prevalence and age specific rate patterns. In wethers, prevalence was less than half that in sexually intact males, but compared with herd mates, the difference was only  $11 \pm 8\%$  and was not statistically significant. Prevalence among breeds of goats with specific antibody was similar, except for the 9 herds of Angora that had approximately a third the average prevalence. Computation of herd mate differences confirmed low prevalence in the Angora breed, (*t* test;  $P < 0.01$ ; Table 3).

Prevalence of goats with antibody to CAE virus was computed for each herd, and herds were clas-

Table 2—Prevalence of goats with antibody to CAE virus among age groups, genders, and breeds

Group	Proportion of goats seropositive (%)	No. of goats tested	Proportion* of herds seropositive (%)	No. of herds tested	Mean† group size
Age (years)					
<1	18	610	47	75	8
1	28	838	63	116	7
2	34	525	74	91	6
3	45	281	66	77	4
4	41	217	75	60	4
5	48	115	67	39	3
≥6	43	182	65	84	2
Gender					
Female	33	2,463	81	146	17
Male	34	232	58	77	3
Wether	14	191	33	24	8
Unknown	27	904	51	69	13
Breed					
Alpine	39	473	69	42	11
Angora	11	28	22	9	3
LaMancha	39	87	67	9	10
Nubian	32	823	72	81	10
Oberhasli	25	172	100	3	57
Pygmy	37	19	50	6	3
Saanen	37	378	67	30	13
Toggenburg	33	322	72	29	11
Crosses	22	322	55	49	7
Unknown	27	1,166	60	91	13

\*Herds with at least 1 seropositive goat. †Mean number of goats in each category.

Table 3—Prevalence of antibody to CAE virus among goat breeds and among members of herds comprising more than 1 breed

Breed	No. of herds tested	Proportion of breed seropositive (%)	Proportion of herdmember seropositive (%)	Herdmember difference (SEM; %)
Alpine	34	39	37	02 (04)
Angora	9	7	37	-30* (07)
LaMancha	8	25	29	-04 (09)
Nubian	52	31	24	07 (04)
Oberhasli	2	57	71	-14 (72)
Pygmy	4	23	23	0 (18)
Saanen	25	28	36	-08 (06)
Toggenburg	25	46	35	11 (07)
Crosses	44	28	31	-03 (05)

\*Herdmember difference is significant ( $P < 0.05$ ).

Table 4—Distribution of female and male goats in herds of low, medium, and high seroprevalence to CAE virus

Relative prevalence	No. of herds	Proportion seropositive (%)	Average herd size
Females			
Low*	85	6	20
Medium†	31	32	15
High‡	78	69	15
Male			
Low*	36	2	3
Medium†	18	42	4
High‡	23	87	3

\*Herd prevalence > 0.5 sd below group mean. †Herd prevalence within 0.5 sd of group mean. ‡Herd prevalence > 0.5 sd above group mean.

sified as low, medium, or high prevalence if values were at least 0.5 sd below the mean, within 0.5 sd of the mean, or at least 0.5 sd above the mean, respectively (Table 4). This procedure, which should classify the herds into 3 approximately equal groups (31, 38, and 31%) on the basis of a normal

distribution, revealed obvious clustering. For either gender, most of the herds were the high or low prevalence groups. The medium prevalence group had the fewest numbers of herds.

## Discussion

In this serologic study of the prevalence of antibody to CAE virus in goats in the United States, we have documented the overall prevalence to be about half that previously reported.<sup>4,6,7</sup> This difference probably relates to our testing of younger goats, all goats in most herds, more clinically normal goats, and a wider distribution of goats. Our finding of 49% prevalence in the western Pacific region closely parallels the 53% prevalence reported in goats in California.<sup>6</sup> Prevalence of seropositive goats among states was within a factor of 2 except for Indiana and Michigan, which had the lowest prevalence, and for Oregon and Wisconsin, which had the highest prevalence. The high prev-

alence rate (74%) in Wisconsin was attributable mostly to 1 herd of 56 goats in which 100% of the members were seropositive. The remaining 9 herds of 46 goats had 41% seropositivity. Prevalence in the western and middle parts of the country was about twice that in the eastern and Rocky Mountain areas of the country. As reported in previous studies, prevalence increased with age; however, in our study, leveling-off was evident after 3 years of age. The reason prevalence increased with age is not known, but may have resulted from lateral transmission of virus between adults or from delayed seroconversion after virus was transmitted to neonates. The plateauing of seroprevalence at 3 years of age may be the result of the owner culling clinically affected goats. The 2 to 3 times higher prevalence in family-owned farm herds than in other owner types may be related to greater movement of goats among family farm owners, as well as other management practices. Differences in prevalence among breeds was not significant except for the lower prevalence in the Angora breed. Lower prevalence in the Angora breed was reported from Australia.<sup>12</sup> To our knowledge, prevalence in Pygmy goats has not previously been reported, but in this study, paralleled that seen in most other breeds.

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## Book Review: A Concise Survey of Animal Behavior

This book is a short overview of animal behavior, with a focus on acquainting the reader with the basic fundamentals of ethology. The authors use the first chapter to review the history of the study of animal behavior from Greek philosophy to the work of early 20th century scientists. The second chapter outlines the concepts used by ethologists: behavior as adaptation to an environment, evolution as it may explain the appearance of a particular behavior, mechanisms controlling the initiation of behavior, and how a behavior develops and changes. The next chapter addresses some common ethologic research areas. These include: biological rhythms, migration, hormonal control of behavior, and social behavior. Brief discussions are also included regarding the issues of animal reasoning, animal rights, and human-animal interactions. The final chapter gives the reader an ethologist's view of the most important aspects of normal behavior for domestic ruminants, nonruminants, carnivores, birds, and exotic pets. A supplemental reading list is provided at the end of the book referencing a number of *Scientific American* articles of historical interest.—[*A Concise Survey of Animal Behavior*. By E.K. Honore and P.H. Klopfer. 186 pages; illustrated. Academic Press Inc, 1250 Sixth Ave, San Diego, CA 92101. 1991. Price \$29.95]—  
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