EPIDEMIOLOGY OF CANINE BLASTOMYCOSIS IN WISCONSIN

by

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ABSTRACT

An epidemiologic study was designed to investigate the increasing number of canine blastomycosis cases being reported in Wisconsin. From January 1980 through July 1982, 200 cases of canine blastomycosis from 39 Wisconsin counties were examined to assess epidemiologic and environmental aspects of this disease. Based on a survey of 176 dog owners, principal disease characteristics for canine blastomycosis were anorexia, lethargy, shortness of breath, chronic cough, and weight loss. High incidence areas of canine blastomycosis occurred in the southeast, central, northwest, north central and northeast regions of Wisconsin. The central and northeast regions are new enzootic areas defined in this study. Sporting breeds accounted for the largest percentage of cases among the various breeds of dogs in Wisconsin. The majority of cases occurred among dogs three years of age and under. There did not appear to be a sexual predilection of dogs with blastomycosis in this study. Canine blastomycosis cases occurred from late spring through late fall. Enzootic areas, except for the southeast region of Wisconsin, occurred in sandy, acid soils. Results of this study suggest a possible association of enzootic areas with waterways, especially impoundments. Serum sampling resulted in the identification of a positive serologic reactor to blastomycosis in an adult timber wolf (Canis lupis).

ACKNOWLEDGMENTS

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INTRODUCTION

Blastomycosis is a pulmonary disease of man, dogs, and occasionally other animals (2,46,48). It was first identified in man in 1894 (12), and in a canine in 1916 (31). Until 1952, there had been only 16 reported cases of canine blastomycosis in the U.S. (37). Since that time, there has been a gradual increase in the number of documented cases in man and in canines in the U.S., especially east of the Mississippi River. The etiologic agent of blastomycosis is Blastomyces dermatitidis, a dimorphic fungus which appears in a mold phase in nature or on culture media incubated at temperatures between 22°C and 30°C. It may appear in the yeast phase in animal tissue or when grown on specially enriched media at 37°C.

Canine blastomycosis is characterized by a chronic cough, shortness of breath, weight loss, anorexia, listlessness, lameness, ocular or nasal drainage, or cutaneous lesions. Dogs may exhibit any or all of these signs, and if unchecked, this disease often results in death. The severity and deteriorating nature of the disease in dogs is difficult to resolve with therapy and presents a potential danger to dog owners. Euthanization of dogs is often recommended upon confirmation of the disease (1).

Blastomycosis has been recognized as an endemic disease of humans in Wisconsin since the 1950's (41). In canines, McDonough and Kuzma (30) reported three enzootic areas in: 1) southeastern Wisconsin (Kenosha, Racine, Milwaukee, Ozaukee, Walworth, Washington, and Waukesha counties); 2) north central Wisconsin (Vilas and Oneida counties); and 3) northwestern Wisconsin (Douglas and Washburn counties). Sarosi, et al. (38) also reported canine blastomycosis to be enzootic in the northwestern region of the state.

Despite the growing number of confirmed canine blastomycosis cases in Wisconsin, reliable information on its clinical characteristics, and source of infection was not available. As a result, this study was undertaken to:

1) Identify the geographic distribution of canine blastomycosis in Wisconsin, and determine enzootic areas.
2) Characterize blastomycosis in dogs.
3) Examine select environmental characteristics of enzootic areas.

MATERIAL AND METHODS

Disease Characterization and Distribution - Two hundred cases of canine blastomycosis in Wisconsin were identified and studied, from January 1980 through July 1982. Cases were identified by examining the records of the Wisconsin Animal Health Laboratory (Wisconsin Dept. of Agriculture, Madison, WI), correspondence with veterinarians, and by personal contact with owners of infected dogs.

Cases of canine blastomycosis were identified initially by reviewing the records of the Wisconsin Animal Health Laboratory. Confirmation of disease was based on histopathology, cytology, serology, clinical diagnosis, or combinations of these clinical features (TABLE 1).

Veterinarians submitting clinical specimens from which B. dermatitidis was reported, were contacted for further information such as clinical signs, and the names and addresses of owners of infected dogs.

Letters describing the study and its objectives were mailed to 748 veterinarians with small animal practices in the spring of 1981 (FIGURE 1). The veterinarians were asked to respond if they had encountered or diagnosed cases of canine blastomycosis. The 66 veterinarians reporting positive cases were then contacted and interviewed.

TABLE 1. Criteria Used to Confirm Canine Blastomycosis Cases.

	Test	No.	%
1.	Histopathology	57	28.5
2.	Smear (Cytology)	56	28.0
3.	Serology (Immunodiffusion)	57	28.5
4.	Histopathology/Serology	8	4.0
5.	Smear/Serology	7	3.5
6.	Histopathology/Smear	1	0.5
7.	Clinical Diagnosis	14	7.0
		200	100.0

FIGURE 1

Dear Dr.

In an attempt to locate endemic areas of canine blastomycosis, I will be sending out over 700 of these letters in 67 counties throughout the state. I am presently a graduate student at U.W.-Stevens Point. Prior to my return to school, I spent 10 years as a public health microbiologist working with infectious mycotic agents.

The objectives of my research will be to:

1. Locate endemic areas of blastomycosis in the state.
2. Determine the incidence of blastomycosis in dogs.
3. Identify factors contributing to the spread of the disease.
4. Make veterinarians and the public aware of the current status of the disease.

Because the disease is not considered a "reportable" disease, I feel it is essential to make every effort to contact as many veterinarians and owners of dogs with blastomycosis, in as many areas, as possible. If you have had any cases, and would be willing to provide me with the names of the owners of the infected dogs or would like more information, simply fill out the form at the bottom of this page and send it to the following address:

John R. Archer
2423 White Oak Circle
Oregon, WI 53575

Thank you for your time, consideration and cooperation.

John R. Archer

CANINE BLASTOMYCOSIS SURVEILLANCE

Veterinarian: _____

Address: _____

City: _____

County: _____

Telephone: _____

Owners of infected dogs were interviewed. Veterinarians frequently telephoned the owners and made them aware of the study and its objectives. Information was obtained by having the owner complete a questionnaire (FIGURE 2). Of the 176 owners interviewed in this study, 78 (44.3%) were by personal contact; 72 (40.9%) were by telephone; and 27 (14.8%) were by letter with an enclosed questionnaire (FIGURE 3). Cases were plotted on county maps to identify geographic or enzootic regions.

FIGURE 2

Blastomycosis Surveillance Case No._____

Owner: _____ Phone: ( ) _____

Address: _____

City: _____ County: _____

Veterinarian: _____ Phone: ( ) _____

Address: _____

City: _____

Breed of dog: _____

Size of dog: (1) Less than 25 lbs. ____
(2) 25 - 50 lbs. ____
(3) More than 50 lbs. ____

Age of dog: _____

Sex of dog: (1) Male _____ (2) Female _____

How long had dog lived at present address? _____

Previous location (County) of dog: _____

Date of onset (month): _____

Date of onset (year): _____

Length of illness (days): _____

Was disease fatal? (1) Yes ____ (2) No ____

Did dog die naturally? (1) Yes ____ (2) No ____
Was dog euthanized? (1) Yes ____ (2) No ____

Was animal treated? (1) Yes ____ (2) No ____

Diagnosis:

FIGURE 2 (con't.)

Symptoms:

(1) _____ Shortness of breath
(2) _____ Chronic cough
(3) _____ Lethargy
(4) _____ Weight loss
(5) _____ Loss of appetite
(6) _____ Lameness
(7) _____ Fever
(8) _____ Eye or nasal discharge
(9) _____ Lesions
(10) _____ Others: _____

Did dog have other diseases? (1) Yes ____ (2) No ____

If yes, what was the disease? _____

Was dog allowed to roam? (1) Yes ____ (2) No ____

Was dog penned? (1) Yes ____ (2) No ____

Did dog live in the house? (1) Yes ____ (2) No ____

If yes, hours/day: _____

Did owner have other dogs? (1) Yes ____ (2) No ____

If yes, were other dogs infected? (1) Yes ____ (2) No ____

Did owner and dog frequent other areas within the state?

(1) Yes ____ (2) No ____

If yes, which counties? _____

Were other dogs in the area sick? (1) Yes ____ (2) No ____

Population size of local community:

(1) _____ Population less than 1,000
(2) _____ Population 1,001-10,000
(3) _____ Population 10,001-50,000
(4) _____ Population more than 50,000

Was anyone in the household sick? (1) Yes ____ (2) ____

If yes, was illness blastomycosis? (1) Yes ____ (2) No ____

Additional information: _____

_____

FIGURE 3

(To owners)

John R. Archer
College of Natural Resources
University of Wisconsin - Stevens Point
Stevens Point, WI 54481

Dear

For the past two years I have been conducting research into canine blastomycosis throughout Wisconsin. I received your name from . I would appreciate your help in filling out the enclosed questionnaire. I am particularly interested in dates, tests used for diagnosis, areas traveled with the dogs, whether or not you live near any bodies of water and how far from these bodies of water, or any information you might feel is significant to this disease.

Once I have completed collecting my cases, I will be sending out the results to all those owners and veterinarians who were helpful enough to provide me with the information which I requested.

Thank you for your time and assistance. If you should have any further questions, please feel free to contact me.

Sincerely,

John R. Archer

Soil Sampling and Testing - In 1982, from May through July, 126 soil samples were collected from 14 sites within three enzootic areas and tested for soil pH and texture, as well as cultured for B. dermatitidis. Collection sites were selected where four or more cases of canine blastomycosis had occurred within a square mile area. The soil sample sites were from: 1) Portage County along the Plover River (T23N-R8E); 2) Vilas County along the junction of the Eagle and the Wisconsin Rivers (T4ON-R10E); and 3) Washburn County along the Namekagon River (T4ON-R12W).

Soil samples were collected from the yards of owners with infected dogs and areas which appeared to be free of fertilizers, herbicides, and fungicides. A garden trowel and bucket auger were used to collect soil samples. Samples were taken at depths of 0-5 cm., 6-10 cm., and 11-20 cm. The samples were placed in sterile polyethylene bags and refrigerated until analyzed. Each sample was split and tested for pH and soil texture (24).

To isolate B. dermatitidis, soil samples were placed in 200 ml. of sterile distilled water, thoroughly mixed and allowed to settle for 15 minutes. One ml. aliquot of the supernatants were aspirated with a sterile pipette and plated on three agar plates: 1) Brain heart infusion agar with penicillin, streptomycin, and cycloheximide; 2) Sabouraud's dextrose agar with penicillin, streptomycin; and 3) Sabouraud's dextrose agar with penicillin, streptomycin, and cycloheximide. The plates were incubated at 30°C and examined weekly for four weeks for growth of B. dermatitidis.

Serum Sampling - Serum samples were collected from four timber wolves (Canis lupis) and one coyote (Canis latrans) in the northwest enzootic region of Wisconsin. The animals were live-trapped according to the method of Mech (32). A 10 ml. sample of blood was drawn from the brachial artery and refrigerated until delivered to the laboratory or field station. The blood was centrifuged and three to four ml. of serum was obtained. The sera were sent to the Centers for Disease Control (U.S. Public Health Service) in Atlanta, GA and tested for the presence of antibodies to blastomycosis by the immunodiffusion test (20).

RESULTS AND DISCUSSION

Identifying Geographic Distribution - The 200 cases of canine blastomycosis were located in 39 counties in Wisconsin (TABLE 2, FIGURE 4). Almost half, 91 (45.5%), occurred in four counties (Portage, Waupaca, Vilas and Washburn). Within these four counties, 51 (25.5%) cases occurred along four major waterways: 1) The Plover River in Portage County; 2) the Pigeon River in Waupaca County; 3) the junction of the Eagle and the Wisconsin Rivers in Vilas County; and 4) the Namekagon River in Washburn and Sawyer counties. The Namekagon River site was implicated in an outbreak of blastomycosis in a group of canoeists in 1979 (4). The enzootic area along the Plover River was under investigation due to an outbreak of human blastomycosis in 1982. Currently, the enzootic area along the Eagle and the Wisconsin Rivers in Vilas County is implicated in two outbreaks involving school children from other areas of Wisconsin that attended a camp in the Eagle River area.

The geographic distribution of the cases confirmed the enzootic areas established by McDonough and Kuzma (30) and Sarosi (38), and identified two new enzootic areas: 1) Portage and Waupaca counties in the central region, and 2) Florence County in the northeastern region of Wisconsin. Only seven cases of confirmed canine blastomycosis were recorded in Florence County, however, additional cases were reported by veterinarians in adjacent counties across the Menominee River in Upper Michigan.

TABLE 2. Frequency of Canine Blastomycosis Cases by Counties.

	County	No.	%
1.	Ashland	1	0.5
2.	Bayfield	3	1.5
3.	Brown	1	0.5
4.	Burnett	1	0.5
5.	Calumet	1	0.5
6.	Chippewa	1	0.5
7.	Crawford	1	0.5
8.	Dane	6	3.0
9.	Dodge	1	0.5
10.	Douglas	3	1.5
11.	Florence	7	3.5
12.	Fond du Lac	1	0.5
13.	Grant	1	0.5
14.	Iron	1	0.5
15.	Jefferson	3	1.5
16.	Kenosha	4	2.0
17.	Langlade	2	1.0
18.	Lincoln	4	2.0
19.	Manitowoc	1	0.5
20.	Marathon	5	2.5
21.	Marinette	2	1.0
22.	Milwaukee	14	7.0
23.	Outagamie	5	2.5
24.	Ozaukee	3	1.5
25.	Portage	32	16.0
26.	Price	2	1.0
27.	Racine	12	6.0
28.	Rock	4	2.0
29.	Sawyer	5	2.5
30.	Shawano	4	2.0
31.	Sheboygan	2	1.0
32.	Vilas	26	13.0
33.	Walworth	1	0.5
34.	Washburn	15	7.5
35.	Washington	1	0.5
36.	Waukesha	4	2.0
37.	Waupaca	18	9.0
38.	Winnebago	1	0.5
39.	Wood	1	0.5

o Canine Blastomycosis Cases

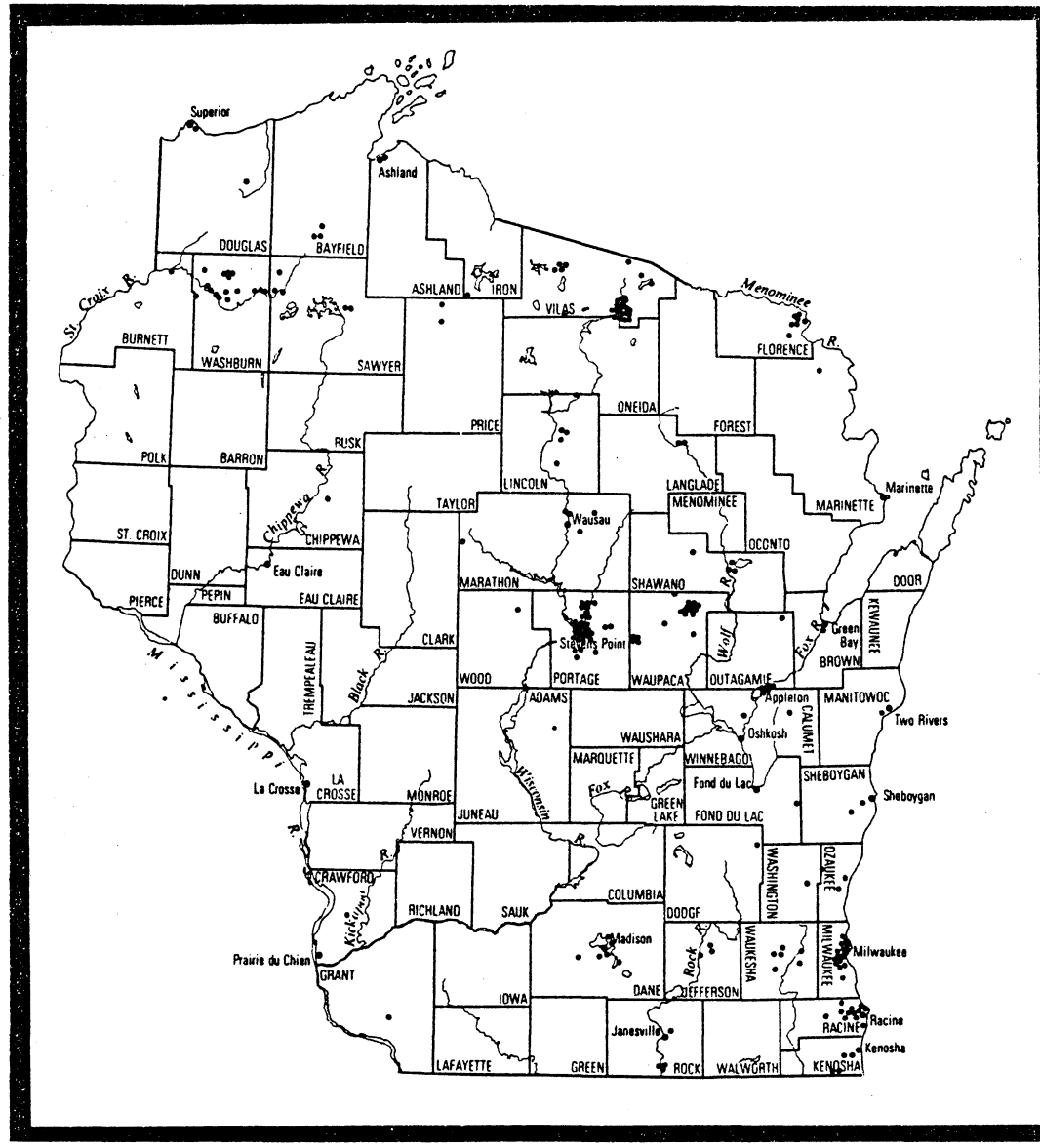

FIGURE 4. Distribution of Canine Blastomycosis Cases in Wisconsin, 1/77-7/82.

Breeds - Pure bred dogs accounted for 144 (72.0%) of the cases of blastomycosis. When classified according to the American Kennel Club (AKC), 90 (45.0%) were sporting breeds and hounds, 38 (19.0%) were working breeds, and 16 (8.0%) were terriers, toys, and non-sporting breeds (TABLE 3). Mixed breeds accounted for 56 (28.0%) of the cases.

The large number of cases reported among pure bred dogs may be related to the monetary value of the dogs, and/or specialization of the dogs. Pure bred dogs generally receive more attention from the owners, with frequent trips to the veterinarian.

The fact that sporting breeds and hounds accounted for the greatest number of cases is not surprising because these breeds spend more time in the field, and have greater opportunities to become infected by the spores of B. dermatitidis.

Among the sporting breeds and hounds, the Labrador retrievers and golden retrievers accounted for 40 (44.4%) of the cases. Since Labrador retrievers and golden retrievers are water dogs, and 137 (68.5%) of the 200 cases of canine blastomycosis in this study occurred on or near a body of water, these breeds might have had greater opportunities for exposure to B. dermatitidis. The large number of cases among these breeds might also be related to the popularity of the breeds as determined by the AKC (16,17).

TABLE 3. Frequency of Breeds of 200 Cases of Canine Blastomycosis in Wisconsin (1/77 - 7/82)

Group		Number	%
Group I. Sporting Breeds			
1.	Labrador Retriever	25	12.5
2.	Golden Retriever	15	7.5
3.	Irish Setter	12	6.0
4.	Springer Spaniel	10	5.0
5.	German Shorthaired Pointer	9	4.5
6.	Cocker Spaniel	3	1.5
7.	Brittany Spaniel	2	1.0
8.	English Setter	2	1.0
9.	German Wirehaired Pointer	1	0.5
10.	Chesapeake Bay Retriever	1	0.5
11.	Weimaraner	1	0.5
		81	40.5
Group II. Hounds			
1.	Beagle	8	4.0
2.	Bassett	1	0.5
		9	4.5
Group III. Working Breeds			
1.	German Shepherd	11	5.5
2.	Doberman Pinscher	6	3.0
3.	Collie	4	2.0
4.	Great Dane	4	2.0
5.	Samoyed	3	1.5
6.	Sheltie	3	1.5
7.	Old English Sheepdog	2	1.0
8.	Akita	1	0.5
9.	Alaskan Malamute	1	0.5
10.	Newfoundland	1	0.5
11.	St. Bernard	1	0.5
12.	Siberian Husky	1	0.5
		38	19.0
Group IV. Terriers			
1.	Cairn Terrier	2	1.0
2.	Miniature Schnauzer	4	2.0
		6	3.0

TABLE 3 (continued)

Group	Number	%
Group V. Toys		
1. Shih Tzu	1	0.5
Group VI. Non-Sporting Breeds		
1. Poodle	4	2.0
2. Dalmation	2	1.0
3. Lhasa Apso	2	1.0
4. Chow-Chow	1	0.5
	9	4.5
Mixed Breeds		
1. More than 50 lbs.	28	14.0
2. 25 to 50 lbs.	19	9.5
3. Less than 25 lbs.	9	4.5
	56	28.0

Age and Sex - The age range of infected dogs was five months to 13 years. The majority of blastomycosis cases (54.5%) occurred among dogs three years of age and under (TABLE 4). The median age for both males and females was three years. This predilection toward younger dogs has been previously noted (11,34,35,36).

No statistically significant differences were found in the sexual distribution of infected dogs. Slightly more males (53.5%) than females (46.5%) were infected (TABLE 4). Previous investigators found a significantly higher percentage of males infected (TABLE 5). In Wisconsin, there has been an increase in the female segment of the canine dogs licensed from 1977 to 1982 (TABLE 6). The results of this study might merely reflect population trends.

TABLE 4. Age Distribution of 200 Canine Blastomycosis Cases (January 1977 - July 1982)

Age - Years (Months)	Male	Female	Total	Percent
Less than 1 (5-11)	14	12	26	13.0
1 (12-23)	16	18	34	17.0
2 (24-35)	17	11	28	14.0
3 (36-47)	11	10	21	10.5
4 (48-59)	10	12	22	11.0
5 (60-71)	12	4	16	8.0
6 (72-83)	11	5	16	8.0
7 (84-95)	6	3	9	4.5
8 (96-107)	5	7	12	6.0
9 (108-119)	1	3	4	2.0
10 (120-131)	1	1	2	1.0
Over 10 (132-)	2	6	8	4.0
Unknown	1	1	2	1.0
	107 (53.5%)	93 (46.5%)	200	100.0

TABLE 5. Comparison of Sex Ratio Among Five Previous Researchers vs. Archer Investigation.

Investigator/Date	No.	Males	%	Females	%
Menges/1960	83	56	67.0	27	33.0
Menges et al./1965	79	48	61.0	31	39.0
Menges et al./1969	110	72	65.0	38	35.0
Furcolow et al./1970	247	165	67.0	82	33.0
Legendre, et al./1981	47	34	72.0	13	28.0
Archer/1984	200	107	53.5	93	46.5

TABLE 6. Dogs Licensed in Wisconsin from 1977 to 1982.

Year	Males (%)	Females (%)	Total
1977	246,502 (67.4)	119,178 (32.6)	365,680
1978	249,502 (66.5)	125,656 (33.5)	375,076
1979	253,061 (67.0)	124,500 (33.0)	377,561
1980	239,247 (65.1)	128,388 (34.9)	367,365
1981	221,466 (60.0)	148,882 (40.0)	370,348
1982	190,004 (52.0)	175,601 (48.0)	365,605

Seasonal Incidence - The month of onset of illness was recorded. The number of cases increased in late spring through early fall (TABLE 7). This seasonal distribution has been noted previously (35,36,44). There was a second peak in cases during late fall and early winter. Since the incubation period for canine blastomycosis has been shown to be approximately two to ten weeks (39,47), the time of exposure would be September and October. These periods coincide with the hunting seasons in Wisconsin and may also help explain the greater number of cases occurring in the hunting breeds in this study.

TABLE 7. Seasonal Incidence of 200 Cases of Canine Blastomycosis in Wisconsin (1/77 - 7/82).

Season	Month of Onset	Number	Seasonal Total	%
Spring	March	9	41	21.0
	April	13		
	May	19		
Summer	June	16	58	29.7
	July	20		
	August	22		
Fall	September	21	54	27.7
	October	12		
	November	21		
Winter	December	21	42	21.5
	January	12		
	February	9		
	Total	195*	195	

* Date of onset of 5 cases unknown

Mortality Rate in Dogs - Canine blastomycosis is a very severe and deteriorating disease. In this study only 65 (32.5%) of the 200 dogs with blastomycosis survived (TABLE 8).

The large number of euthanizations may have been influenced by the cost and problems associated with the treatment of choice at the time of this study. Amphotericin B is very expensive and the cost of prolonged treatment, inconvenience of administering the drug intravenously, and possible side effect of nephrotoxicity may have contributed to the high rate of euthanization (15).

In 1982, a new drug, ketoconozole (3) became available for the treatment of blastomycosis. This drug had the advantage of being administered orally, and it was not nephrotoxic. Although ketoconozole is successful in containing blastomycosis (8,9), it is not as effective as amphotericin B for systemic blastomycosis (22). A combination of amphotericin B and ketoconozole should reduce the cost of treating infected dogs, decrease mortality to nephrotoxicity and reduce the number of dogs that die naturally or are euthanized.

TABLE 8. Mortality Rate in Dogs with Blastomycosis.

	Fate of Animal	No.	Percent
1.	Animals that died	61	30.5
2.	Animals euthanized	74	37.0
3.	Animals successfully treated	65	32.5
		200	100.0

Clinical Signs - Although clinical signs varied, the most characteristic features reported were anorexia, lethargy, shortness of breath, chronic cough, and weight loss (TABLE 9). Most signs reflected respiratory involvement because the portal of entry for the spores of B. dermatitidis is via the respiratory tract and initial growth of the fungus occurs in the alveoli of the lungs. The presence and prevalence of clinical signs documented in this study parallel those of previous studies (23,35,43).

TABLE 9. The Frequency of Signs Observed in 200 Cases of Canine Blastomycosis (1978-1982).

	Clinical Signs	No.	%
1.	Anorexia	144	72.0
2.	Lethargy/Listlessness	139	69.5
3.	Shortness of Breath	119	59.5
4.	Chronic Cough	115	57.5
5.	Weight Loss	115	57.5
6.	Lesions (Cutaneous)	79	39.5
7.	Lameness	77	38.5
8.	Eye/Nasal Drainage	52	26.0
9.	Loss of Motor Control	12	6.0
10.	Other*	65	32.5

* Dull coat, diarrhea, gastric rupture, convulsions, vomiting, increased thirst.

Multiple Cases of Blastomycosis and Human Exposures - Ninety (51.1%) of the 176 owners interviewed in this study owned more than one dog; only 20 (11.9%) of those owners had more than one dog with blastomycosis. Generally, blastomycosis occurred simultaneously among different dogs of an owner. In several cases, owners had dogs which became sick over an extended period of time, i.e. up to several years.

The mode of transmission of canine blastomycosis remains unknown. Menges (36) reported that normal dogs housed with infected dogs did not become infected. It has been suggested that when multiple cases occur in dogs, there may be common point sources in nature (38). This appeared to be the pattern of the cases in this study.

Three (1.7%) of the dog owners contacted in this study had blastomycosis. One owner stated he contracted blastomycosis shortly after his two dogs were diagnosed as having the disease. Another owner, with three infected dogs, acquired blastomycosis approximately six months after his last dog became sick. In the third case, an adult female had blastomycosis three and one-half years before her dog had the disease.

In the past, blastomycosis was considered a disease which could be transmitted from dogs to man (1), and several cases of blastomycosis have been reported being transmitted from dogs to man through bites (13,18,42). Today however, most researchers feel that the disease is most likely acquired from the same point sources in nature (35,36,38). This would help explain why there was no consistent correlation in cases of blastomycosis occurring among infected dogs and owners with blastomycosis in this study.

Soils - The soil texture and pH of 126 soil samples (each representing an average of two values per sample site) are summarized in TABLES 10, 11, and 12.

The soil texture of the 126 samples in this study was predominantly sandy. The high incidence areas of canine blastomycosis in Wisconsin occurred in the regions of the southeast (Kenosha, Racine, Milwaukee, Ozaukee, Walworth, Washington, and Waukesha counties); central (Portage and Waupaca counties); northwest (Washburn and Douglas counties); north central (Vilas County); and northeast (Florence County). Except for the southeast, these areas are within the region of the northern sandy uplands and plains described by Hole (14). Based on soil types, these sandy, acid soils are similar to the enzootic areas of southwest Arkansas identified by Menges (38).

There was a noticeable absence of blastomycosis cases in the "Driftless area" of southwestern Wisconsin, and the Door County region in eastern Wisconsin. These areas consist of alkaline and calcium based soils. In a earlier study, Menges (35) found that areas of limestone, sandstone, and shale do not appear to be satisfactory for the growth of B. dermatitidis.

The median pH was 5.0 (range of 3.7 to 6.7). Buckman and Brady (5) reported that fungi establish quite readily in acid, neutral, or alkaline soils, however, many favor a low pH. Schuepp and Frei (40) demonstrated that most fungi susceptible to fungistasis were less inhibited in soils with low pH.

The soil pH may also have an effect on the microorganisms which influence the growth of B. dermatitidis. McDonough (26,27,28) demonstrated that B. dermatitidis was lysed in soils by streptomycetes, actinomycetes, and certain Bacillus sp. In the sandier, more acid soils, there would be fewer of these microorganisms, due to the lower pH of the soil, which may allow B. dermatitidis to become established and persist longer in the environment.

TABLE 10. pH and Soil Texture Analysis, Soil Sample Location 1, Portage County, (T23N-R8E)

Collection Site	Sample	Depth of Sample 0-5 cm.	6-10 cm.	11-20 cm.	Soil Texture
	A	5.1	4.5	4.4	Loamy Sand
1 (WH)	B	4.9	4.4	4.1	Loamy Fine Sand
	C	4.8	4.8	5.4	Loamy Sand
	A	3.9	4.0	4.2	Sandy Loam
2 (MM)	B	4.7	4.8	4.8	Loamy Sand
	C	4.7	4.5	5.4	Loamy Sand
	A	4.9	6.1	5.7	Loamy Sand
3 (FA)	B	6.7	5.2	6.1	Loamy Sand
	C	4.3	5.1	5.9	Loamy Sand
	A	*	4.4	6.1	Loamy Sand
4 (JJ)	B	3.7	4.2	6.0	Loamy Sand
	C	3.7	4.3	4.6	Sand
	A	5.1	5.0	4.5	Loamy Sand
5 (DKH)	B	5.1	4.9	5.0	Loamy Sand
	C	5.2	5.0	5.5	Loamy Sand

* Excessive woody material and debris.

TABLE 11. pH and Soil Texture Analysis, Soil Sample Location 2, Vilas County, (T40N-R12E)

Collection Site	Sample	Depth of Sample 0-5 cm.	6-10 cm.	11-20 cm.	Soil Texture
	A	6.5	6.2	6.2	Loamy Sand
1 (SC)	B	5.5	5.2	5.0	Loamy Sand
	C	5.0	5.0	4.9	Loamy Sand
	A	5.3	4.5	5.4	Loamy Sand
2 (RR)	B	5.2	4.6	4.4	Loamy Sand
	C	*	*	*	Loamy Sand
	A	4.4	5.0	5.0	Fine Sand
3 (JS)	B	5.8	5.0	5.0	Fine Sand
	C	6.4	5.0	4.8	Sand
	A	6.9	5.4	5.1	Loam
4 (TM)	B	6.0	5.2	4.5	Loamy Sand
	C	5.9	5.8	4.5	Sandy Loam
	A	4.5	4.2	4.4	Loam
5 (TG)	B	5.6	4.8	4.8	Loamy Sand
	C	5.6	5.2	5.0	Sand

* Excessive woody plant material and debris.

TABLE 12. pH and Soil Texture Analysis, Soil Sample Location 3, Washburn County, (T40N-R12W)

Collection Site	Sample	Depth of Sample 0-5 cm.	6-10 cm.	11-20 cm.	Soil Texture
1 (DB)	A	5.4	5.4	5.7	Loamy Sand
	B	*	*	*	Loamy Sand
	C	4.9	4.7	4.6	Loamy Sand
2 (LM)	A	5.0	5.3	5.0	Loamy Sand
	B	4.9	4.7	4.9	Loamy Sand
	C	4.6	5.4	5.8	Loamy Sand
3 (TK)	A	5.2	4.8	4.6	Loamy Sand
	B	4.7	4.3	4.2	Loamy Sand
	C	5.9	4.8	5.2	Loamy Sand
4 (TVB)	A	4.9	4.4	5.0	Loamy Sand
	B	5.7	4.8	5.1	Loamy Sand
	C	5.5	5.0	5.2	Loamy Sand

* Excessive amounts of woody material and debris.

Soil samples cultured for B. dermatitidis were negative. Previously, extensive attempts to isolate B. dermatitidis from natural soils have also met with little or no success (25,35). Denton, however, was successful in isolating B. dermatitidis from soil (6,7), although some researchers question the validity of his isolations (19).

Proximity to Water - Of the 200 cases of canine blastomycosis in this study, 137 (68.5%) dogs lived within 500 yards of water (TABLE 13).

Twenty-five of the 200 cases were located along four waterways: 1) The Plover River; 2) the Pigeon River; 3) the junction of the Eagle and the Wisconsin Rivers; and 4) the Namekagon River (FIGURES 5,6,7,8). Each of these waterways had clusters of cases on or near impoundments. These sites are characterized as damp, moist, and humid with water tables near the soil surface. These areas possess abundant organic matter and nutrients, providing ideal conditions for fungal growth. Menges (33) demonstrated that the growth of B. dermatitidis was dependent on humidity, and noted the organism grew faster and produced larger colonies on moist substrates.

In addition to the nutrients deposited along the shorelines on impoundments, there may be an accumulation of nutrients through the droppings of wildlife, especially birds or waterfowl, that congregate along shorelines. Smith and Furcolow (45) demonstrated stimulated growth and sporulation of B. dermatitidis with the addition of starling (Sturnis vulgaris) manure to soils. Schlosser (39) also implied that birds may play a role in the growth of B. dermatitidis by providing an enriched medium for growth through their droppings.

Shorelines may also play an important role in spore transmission of B. dermatitidis. McDonough (29) reported that spore liberation of B. dermatitidis was greatly increased in the presence of water vapor, and speculated that infective spores may be released and transported along shorelines by fog and mist.

TABLE 13. Residence of Owners of Infected Dogs from a Body of Water (Lake, River, Stream, Pond, etc.)

	Distance from Water	No.	Percentage
1.	Under 100 yards	102	51.0
2.	100 to 500 yards	35	17.5
3.	500 yards to one mile	20	10.0
4.	Over one mile	42*	21.1

* Of the owners in this group, 21 (50.0%) stated that they had visited enzootic areas of blastomycosis with their dogs.

o Canine Blastomycosis Cases

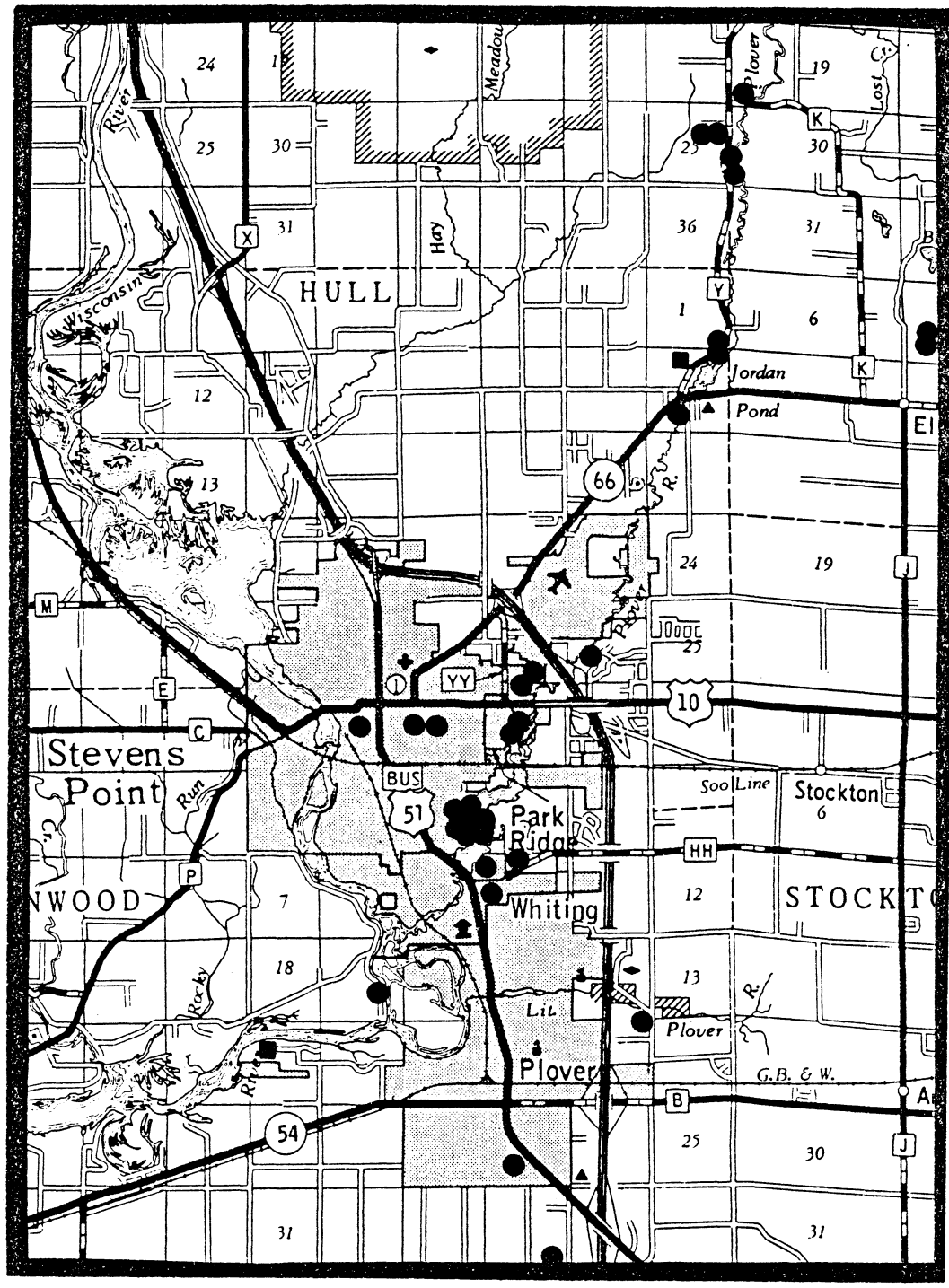

FIGURE 5. Canine Blastomycosis Cases, Portage Co., January 1977-July 1982.

o Canine Blastomycosis Cases

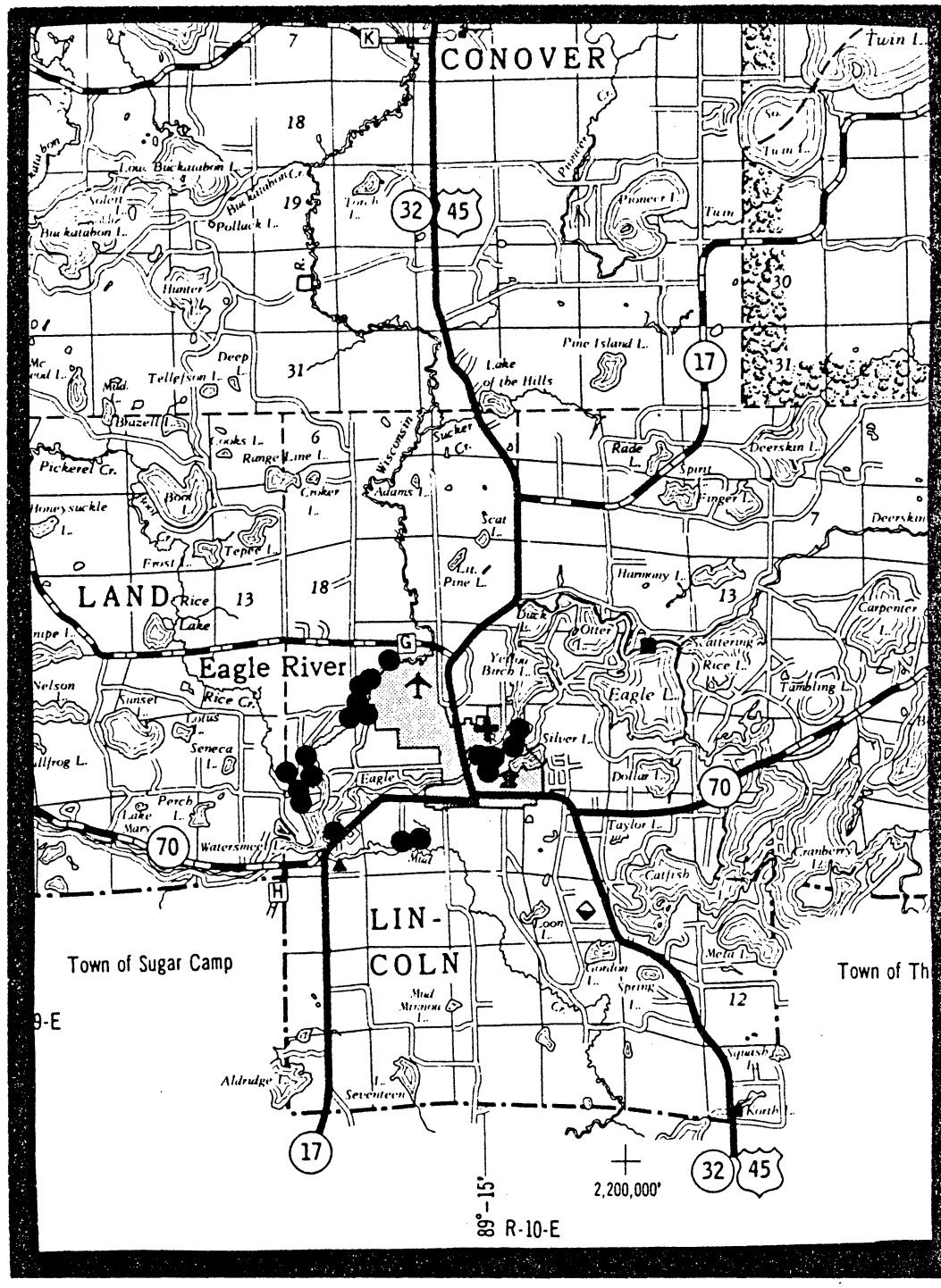

FIGURE 6. Canine Blastomycosis Cases, Vilas Co., January 1977-July 1982.

o Canine Blastomycosis Cases

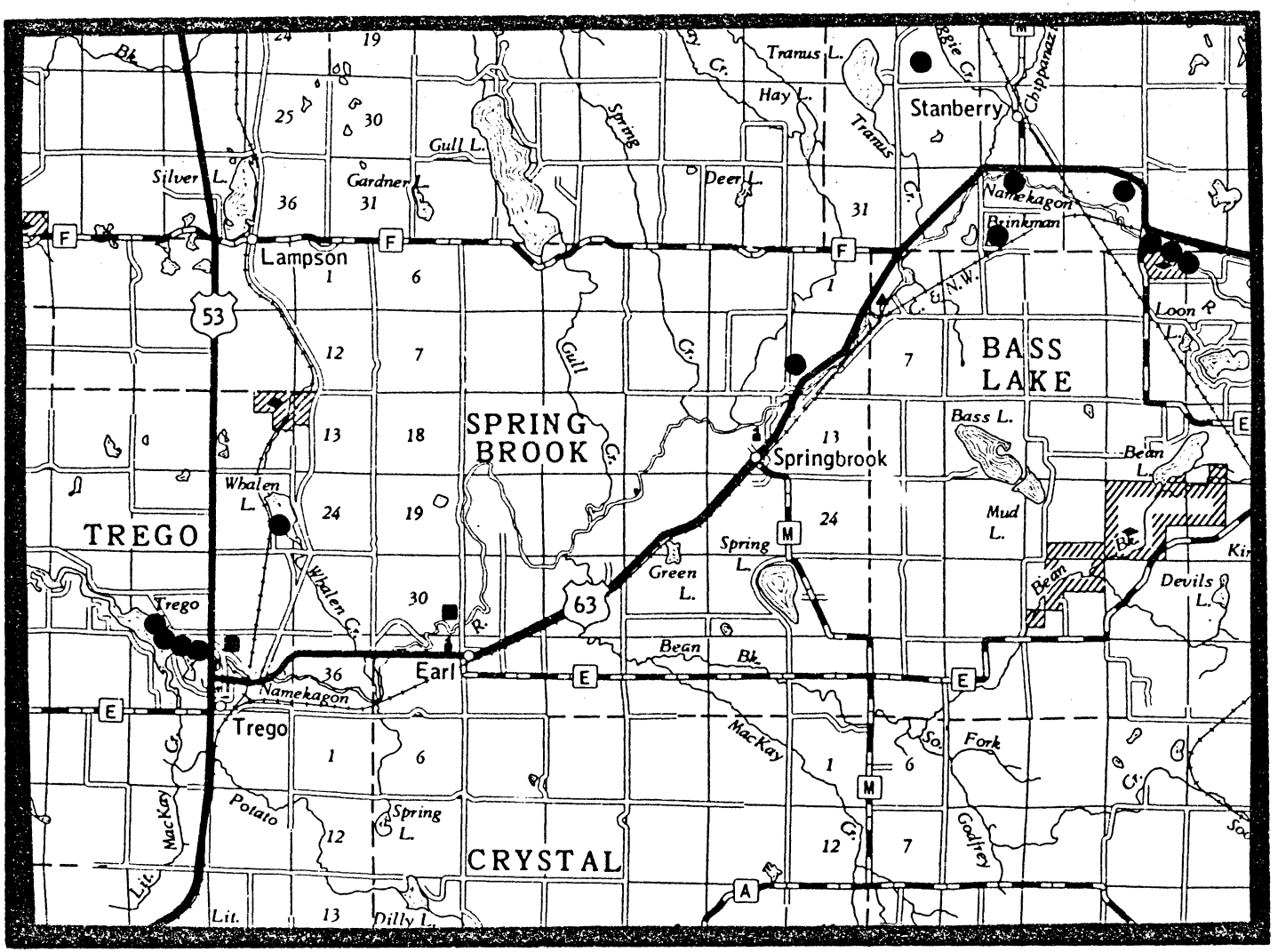

FIGURE 7. Canine Blastomycosis Cases, Washburn Co., January 1977–July 1982.

o Canine Blastomycosis Cases

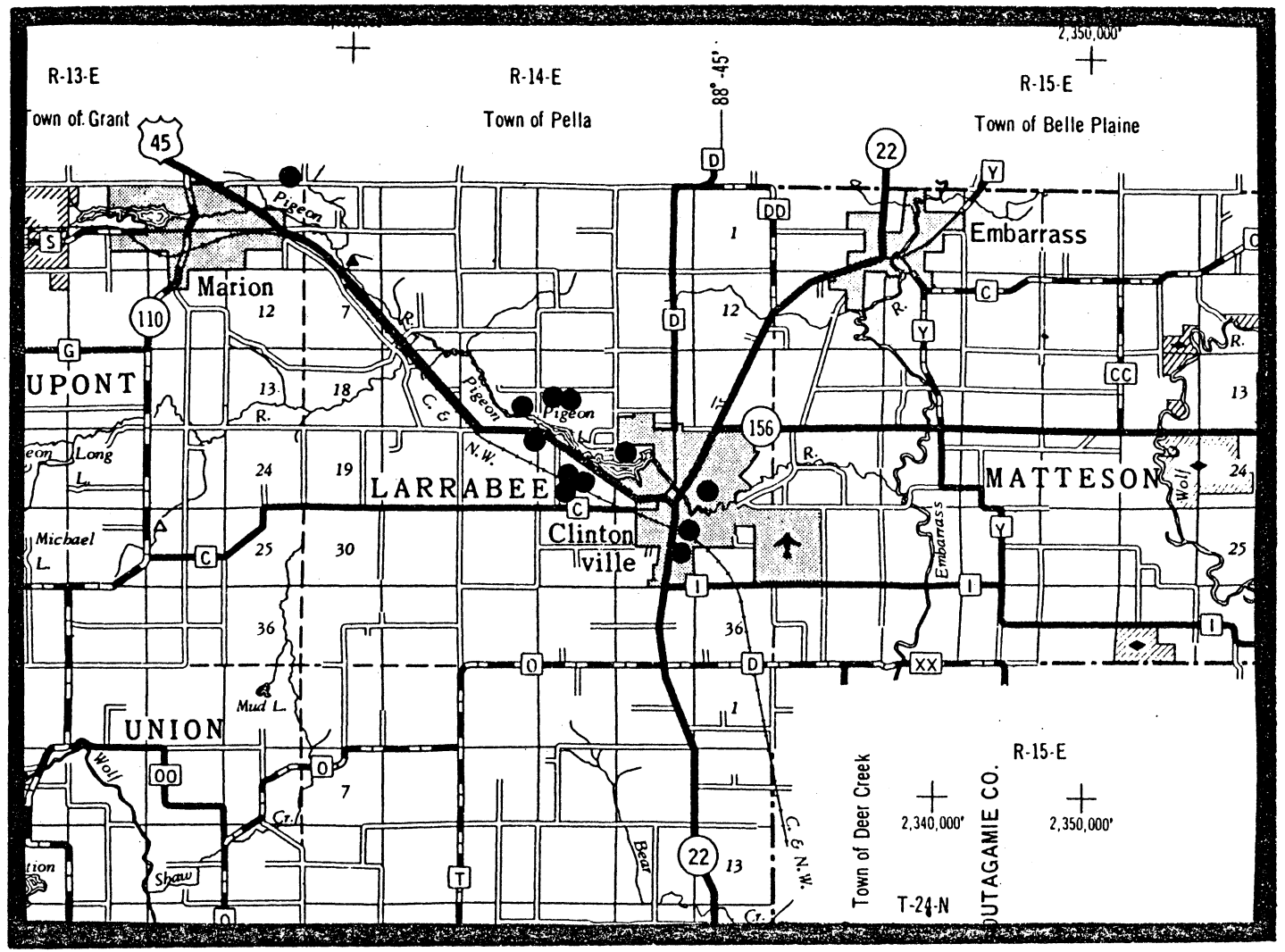

FIGURE 8. Canine Blastomycosis Cases, Waupaca Co., January 1977-July 1982.

Serum Sampling - Serum samples were collected from three timber wolves and one coyote from an enzootic area in northwestern Wisconsin. All four animals appeared in good physical condition with no cutaneous lesions or respiratory signs. Serologic testing performed at the Centers for Disease Control (U.S. Public Health Service) in Atlanta, GA, revealed that one of the timber wolves demonstrated an A precipitin specific for blastomycosis (21). The tests suggest that the wolf had subclinical blastomycosis.

SUMMARY

In this study, 200 cases of canine blastomycosis from 39 Wisconsin counties were examined to assess epidemiologic and environmental aspects of this disease. Locations of cases were recorded, disease characteristics were compared, and soils, as well as serums from wildlife, from within enzootic areas were tested for blastomycosis.

High incidence areas of canine blastomycosis occurred in the southeast, central, northwest, north central, and northeast regions of Wisconsin. The central and northeast regions are new enzootic areas defined in this study.

Although most cases displayed respiratory involvement, clinical signs varied from case to case, making diagnosis on clinical signs alone difficult. Knowledge of the locations of enzootic areas of canine blastomycosis, and the diversity of signs are an aid to veterinarians in their diagnosis.

Sporting breeds accounted for the largest percentage of cases among the various breeds of dogs in Wisconsin. This may be a reflection of their popularity and the fact that these breeds are larger dogs which spend more time out-of-doors or in the field, which would allow for greater opportunities for exposure to infective spores of Blastomyces.

Although dogs of all ages became infected, the results of this study concur with previous findings that most cases occur in dogs three years of age and under.

Unlike previous studies, this study did not find a sexual predilection for this disease. The reason for the increased percentage in female cases is unknown, but may be due to an increased portion of females in the canine population.

Canine blastomycosis cases occurred throughout the year, although somewhat more cases occurred from late spring through late fall. This time frame may reflect periods of optimal temperatures for the growth of B. dermatitidis and periods of outdoor activity for the dogs. Two-thirds of the cases that occurred in

the late fall were in sporting breeds and hounds. During the hunting season, these breeds are in the field greater periods of time, and range over greater areas.

Enzootic areas, except for the southeast region of Wisconsin, occurred in areas of acid, loamy sand soils.

Results of this study suggest a possible association of enzootic areas with waterways, especially impoundments. Clusters of cases occurred in areas that have damp, moist conditions, and areas of concentrated nutrients.

Serum sampling resulted in the identification of a positive serologic reactor to blastomycosis in an adult timber wolf (Canis lupis).

RECOMMENDATIONS FOR FUTURE RESEARCH

This study was done to add to our "pool of knowledge" of canine blastomycosis in Wisconsin, and it accomplished this objective. To further clarify the status of this disease the following research should be conducted:

A. Serological survey of dogs throughout Wisconsin to determine the true prevalence of canine blastomycosis.

B. Serological survey of wildlife to establish its presence and prevalence in Wisconsin. Wildlife might be useful to detect enzootic areas and act as monitors of blastomycosis in the state.

   1. Reactions in larger mammals, with larger home ranges, might indicate the presence of blastomycosis over broader areas.

   2. Reactions in smaller mammals with smaller, denoted home ranges might indicate specific enzootic areas.

C. Collect, culture, and microscopically examine the droppings of waterfowl in enzootic areas. The presence of the fungus may incriminate waterfowl as a reservoir for this organism in nature.

D. Expand efforts to isolate B. dermatitidis from soil once specific locations of enzootic areas are defined.

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