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Source: Journal of Wildlife Diseases, 10(4) : 310-316

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-10.4.310

CONTROL OF BOVINE RABIES THROUGH VAMPIRE BAT CONTROL

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Abstract: An area 30 by 50 km was selected for destruction of vampire bats (*Desmodus rotundus*). The area was located in the path of an advancing epizootic of vampire bat-borne bovine rabies which had been moving southward at the average rate of 40 km per year for 14 years. The bats were exterminated in their roosts in water wells with cyanide gas, and the wells were sealed with wire mesh frames. The epizootic did not pass through the control area, but did pass it by to the west. It is concluded that strategic elimination of vampire bats may be used for control of bovine rabies when vampires are the sole vector.

INTRODUCTION

The vampire bat (*Desmodus rotundus*) abundant throughout its range from Mexico to Argentina, is an important vector of bovine rabies in this area, causing an estimated 500,000 cattle deaths each year.[1] Control of the disease is achieved through vaccination with any of several effective vaccines.[4] However, bovine rabies control through vaccination of cattle has certain disadvantages. Because cattle play no role in the epizootiology of the disease in the vampire population, rabies epizootics in vampires continue unabated, presenting a hazard to man and any unvaccinated animals. Vaccination requires periodic rounding up of the cattle with the attendant cost added to the cost of the vaccine. Frequently vaccine is not available because irregular demand provides insufficient stimulus for the producer.

An alternative to cattle vaccination is control of vampire bat populations. The low rate of vampire bat reproduction, possibly only one young per female per year, results in slow population recovery and consequently potentially effective control. Decimation of vampire bats has been achieved by a variety of methods including gassing, smoking and dynamiting roosts.[2] Poisoning bats has been applied successfully by applying the poison to bite wounds on cattle, taking advantage of their tendency to return nightly to feed on the same wound.[11] Anticoagulant mixed with petroleum jelly and applied to the backs of captured vampires results in the poisoning of entire bat colonies through their social grooming habits.[7] All these techniques have advantages and disadvantages and selection of the most appropriate technique in a given area depends on application of knowledge of the relation of the vampire to its ecosystem.

Bovine rabies has been known in Argentina since 1929.[8] Outbreaks appear and move slowly across the provinces, lasting many years. In 1959, an outbreak appeared in the north of the Province of Salta bordering on Bolivia.[8] During the following 14 years this outbreak has moved steadily southward 500 km at an

* The senior author, formerly of Servicio de Luchas Sanitarias (SELSA), Buenos Aires, Argentina, lost his life during the final stage of this project. As chief, in charge of all field aspects, he was inspecting a gassed well when his mask failed and he fell to his death.

average rate of 40 km per year (Figure 1). The estimated loss of cattle is 5,000 head per year. The present position of the outbreak at the time of writing this paper (April, 1974), is approximately 40 km north-east of Las Termas de Rio Hondo, Province of Santiago del Estero, which places it about 500 km north of the known southern limit of the range of vampires in Argentina.

The area where the disease has been occurring for the past several years is classified as the western Chaco sub-zone.[6] It is flat, arid (near desert) region supporting a vegetation of thorny bushes, scrub-like trees and cactus. All vampire roosts in this area are located in wells dug for water. The wells are approximately 2 meters in diameter and vary between 10 and 50 meters in depth. If square, they are usually shored with timbers, and if round they are fitted with sections of concrete.

A collaborative effort by the Ministry of Agriculture, Argentina, Servicio de Luchas Sanitarias (SELSA) and the Pan American Zoonoses Center (CEPANZO) of the Pan American Health Organization was established. The objective of this project was to determine the utility of vampire bat population control as a measure for prevention of bovine rabies. Vampires were destroyed in an area located in advance of the rabies epizootic, after which surveillance indicated the subsequent course of the epizootic.

METHODS

An experimental control area 50 km long by 30 deep was established in advance of the southward moving epizootic (Figure 2). An attempt was made to find all water wells in the control area and an estimated 95% were located. The wells were gassed with cyanide gas when known or suspected to have vampire bats.

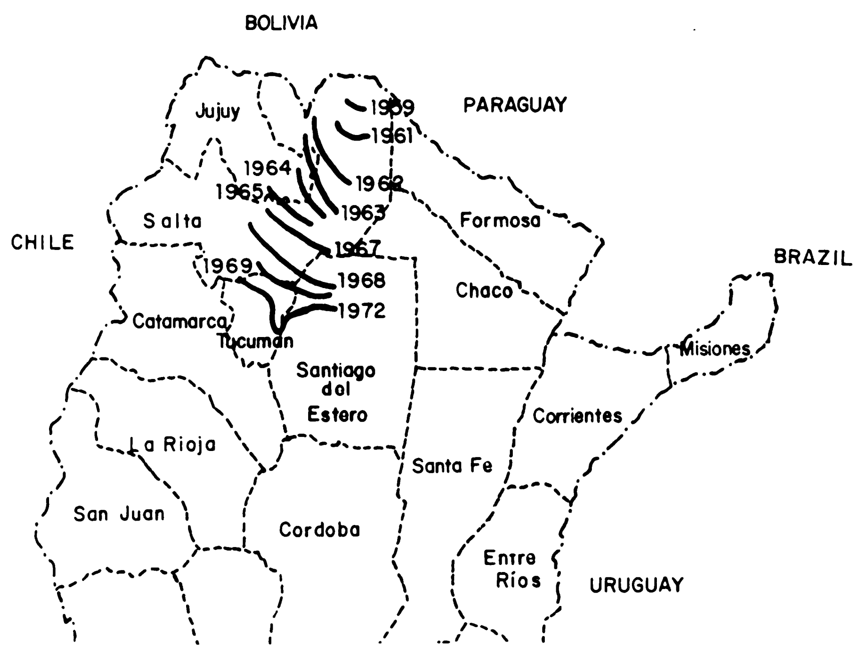

FIGURE 1. The course of a bovine rabies epizootic in Northwestern Argentina, 1957 to 1972.

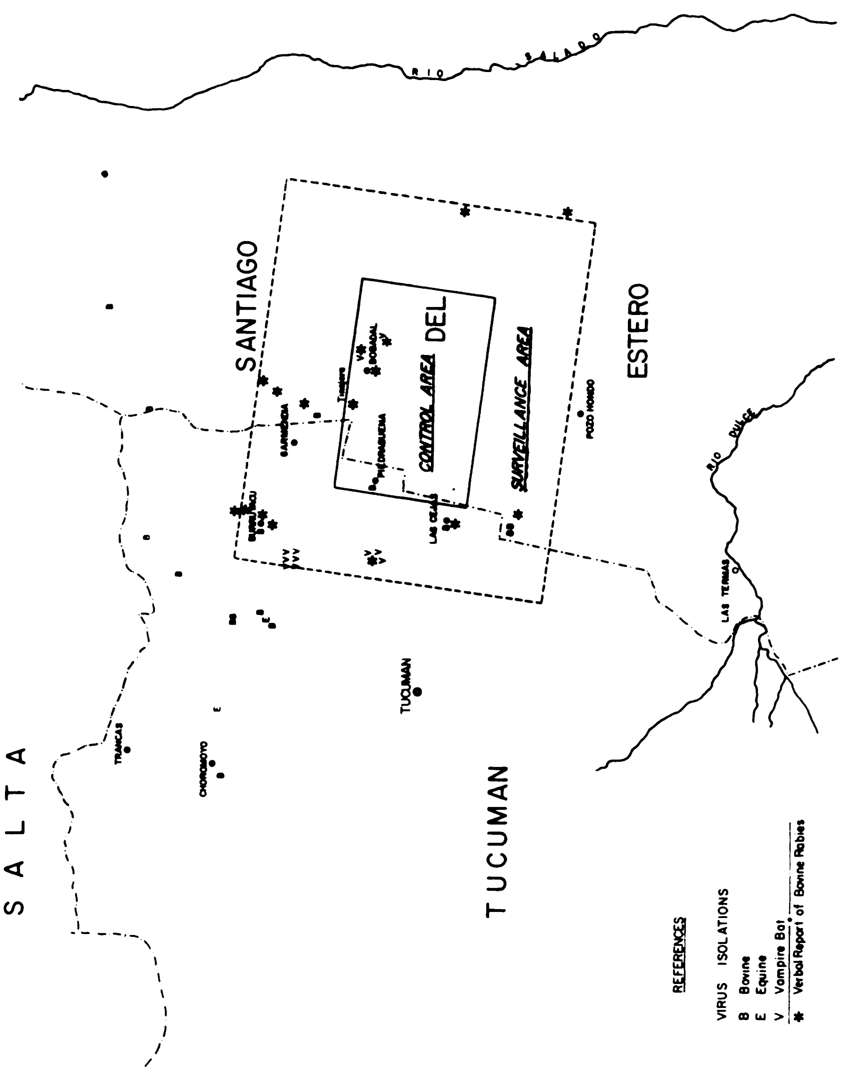

FIGURE 2. Vampire bat and bovine rabies control and surveillance areas established in advance of an approaching epizootic in Northwestern Argentina.

The gas is dispersed through pumps which mix air with potassium cyanide and deliver it into the wells through flexible pipes.

Before gassing wells, a canvas apparatus resembling an inverted umbrella was placed near the bottom and opened to catch the dead bats. These bats were tested for rabies virus.

To determine the efficiency of the cyanide gas, wells estimated to have relatively large populations of bats were censused before and after gassing. The census used was the standard recapture method.[3] Vampires were caught in nylon mist nets, (12 m long and 2.5 m high, placed 1-5 m distant from the wells) banded and released. A week later the wells were re-netted to provide data on the proportion of bats banded during the first netting period. One month following gassing, this census technique was repeated and these bats were bled and killed. Within the next 8 weeks the wells were sealed with frames of hardware cloth and users were requested to replace the frames each time after drawing water.

Brain, salivary gland, brown fat and saliva from bats sacrificed during the second netting period were tested for virus; sera were tested for rabies neutralizing antibody and will be reported later in another study. All virus isolation attempts were made by the mouse inoculation technique,[5] and the brains of all mice dying after 5 days post-inoculation were studied by the rabies immunofluorescence test as described elsewhere.[6]

After censusing, gassing, and sealing the wells during the period August to September surveillance for rabies was maintained from October to November both inside the control area and in a 20 km wide surveillance area around the control area (Figure 2). Whenever bovine rabies was reported the site was visited and when possible, brain material taken for virus isolation. Likewise, in the surveillance area, vampires were gassed and collected from wells near the reported cases of bovine rabies to determine the extent of infection of the bat colony.

Later a systematic survey was conducted of farms both in the control area and in the surveillance area to further ascertain the course the epizootic had taken, as well as to establish the similarity between the control and surveillance areas. A surveillance form was used by the surveying personnel who queried the land occupants as to livestock disease, populations, species composition, etc.

RESULTS

In the search for wells within the control area, a total of 169 wells were found, 45 of which were clearly used by vampire bats. A total of 128 wells were fumigated and sealed. This included all wells which were thought to be of potential use by vampire bats. In gassing the wells, 363 vampires were known to have been killed, of which 208 were tested for rabies virus. In the northern part of the control area near Bobadal (Figure 2) virus was isolated from two of 33 gassed vampires (Table 2, 19.X.71).

Recapture census results (Table 1) show populations varying between 11 and 125 animals. Two other wells where censuses were attempted had too few vampires to permit calculations and rain nullified censuses of two additional wells.

Subsequent census attempts 1 month after gassing of the wells resulted in too few captures to permit calculations of populations, but indicated drastic population reduction. In wells 128 and 130, six vampires were captured the first netting night and two the following week. In the well "El Azul" only two vampires were captured, and in wells 147 and 148, seven vampires were captured. This is an average reducation of 95% for these wells. Other wells were examined, but evidenced no sign of bats.

During the surveillance period, virus was isolated from a dead cow from the control area, near Piedrabuena (Table 2 and Figure 2) only 4 km from the boundary of the area. Cases of bovine rabies were reported from Tinajera (Figure 2) also very close (1 km) to the boundary

TABLE 1. Recapture census results.

Well	No. Banded (date)	No. caught 2nd capture (date	No. with bands	Population Calculated
No. 27	20 (16.8.71)	14 (23.8.71)	8	35
No. 25	23 (16.8.71)	16 (23.8.71)	7	53
El Rincón	35 (17.8.71)	29 (24.8.71)	23	44
San Antonio	12 (18.8.71)	6 (25.8.71)	5	14
El Azul	63 (19.8.71)	44 (26.8.71)	35	81
Las Lajas	23 (20.8.72	14 (27.8.71)	10	32
No. 148	30 (13.9.71)	34 (20.9.71)	11	121
No. 147	8 (13.9.71)	23 (20.9.71)	7	69
No. 143	23 (14.9.71)	9 (21.9.71)	3	125
No. 128	52 (15.9.71)	64 (22.9.71)	38	108
No. 130	13 (15.9.71)	13 (22.9.71)	2	50
No. 151	54 (13.10.71)	36 (20.10.71)	18	11
No. A03	22 (14.10.71)	18 (21.10.71)	8	
No. 3 & 4	5 (18.10.71)	9 (26.10.71)	4	

TABLE 2. Rabies Virus Isolations.

Date	Species	Location
15.X.70	Bovine	Quebrach Coto, Pellegrini, Santiago del Estero
1.XI.70	Bovine	El Morado
1.XII.70	Bovine	Requelme, Burruyacú, Tucumán
11.III.71	Bovine	El Nogalito, Burruyacú, Tucumán
12.III.71	Bovine	El Nogalito, Burruyacú, Tucumán
18.III.71	Bovine	Nueva Esperanza, Pellegrini, Santiago del Estero
28.VI.71	Bovine	Siete Arboles, Jiménez, Santiago del Estero
6.X.71	Bovine	Agua Colorada, Burruyacú, Tucumán
17.XI.71	Bovine	Padre Monti, Burruyacú, Tucumán
8.III.72	Bovine	Piedrabuena, Burruyacú, Tucumán
29.III.72	Bovine	Padre Monti, Burruyacú, Tucumán
29.III.72	Equine	Padre Monti, Burruyacú, Tucumán
30.III.72	Equine	San Vicente, Trancas, Tucumán
3.IV.72	Bovine	Choromoro, Trancas, Tucumán
13.IV.72	Bovine	Potrerillo, Burruyacú, Tucumán
11.VII.72	Bovine	La Tablada, Cruz Alta, Tucumán
19.X.71	Vampire	El Azul, Jiménez, Santiago del Estero
19.X.71	Vampire	Rincón del Carmen, J iménez, Santiago del Estero
17.V.72	Vampire	Tala Pozo, Burruyacú, Tucumán
17.V.72	Vampire	Tala Pozo, Burruyacú, Tucumán
17.V.72	Vampire	Tala Pozo, Burruyacú, Tucumán
24.V.72	Vampire	Taruca Pampa, Burruyacú, Tucumán
24.V.72	Vampire	Taruca Pampa, Burruyacú, Tucumán
24.V.72	Vampire	Taruca Pampa, Burruyacú, Tucumán
24.V.72	Vampire	Taruca Pampa, Burruyacú, Tucumán
24.V.72	Vampire	Taruca Pampa, Burruyacú, Tucumán
24.V.72	Vampire	Taruca Pampa, Burruyacú, Tucumán

of the area. Bovine rabies was reported from Rincón del Carmen, San Pedro and El Azul, all close to Bobadal and those aforementioned wells where rabies positive bats were found during fumigation. No other evidence of rabies was found within the control area.

In the surveillance area surrounding the control area, rabies virus was isolated from 15 cattle, 2 horses and 9 vampires (Table 2). The location of the bovine isolations ranged from the north and west of the control area early in the study to southwest of the control area by the termination of the study. Six virus isolations were made from 20 vampire bats which were gassed in a well (Taruca Pampa) located about 20 km northwest of the control area. Attention was called to this area because of the occurrence of bovine deaths. Three other virus isolations were made from 30 vampire bats gassed in a well (Tala Pozo) in an area of reported bovine deaths (Table 2).

In the systematic surveillance of the control area and the surrounding surveillance area, reported cases of bovine rabies closely paralleled those where virus isolation had been made from bats and cattle (Figure 2). This inquiry did not reveal any cases of bovine rabies within the control area other than from those same localities already mentioned. In the surrounding surveillance area some cases were reported from a zone to the south east of the control area, a region from which no virus isolations have been made. Whether these cases are truly rabies remains in doubt. In this inquest a total of 483 farms were visited; 161 from the control area and 322 from the surveillance area. In addition to seeking information about rabies, each farmer was queried as to the number and type of livestock he possessed. This survey revealed that farming practices and farm sizes were similar throughout both areas.

DISCUSSION

The objective of this project, to determine the utility of vampire bat population control as a measure for prevention of bovine rabies, appears to have been successfully achieved. The destruction of vampire bats in the wells reduced the population by 95%. Although the epizootic appears to have already begun in the area near Bobadal in the north of the control area by the time the gassing of wells started, the elimination of the bats seems to have confined losses in the control area to that region immediately adjacent to the north border (Fig. 2). The only other bovine rabies cases within the control area were noted near the border, within easy flight range of bats residing in wells located outside of the area.

The fact that some live bats were found after gassing the wells can be attributed to the normal custom of the bats to visit between neighbouring wells. Apparently a few bats escaped gassing by being in some other well on the day of fumigation, returning later after dissipation of the gas. These few individuals were ultimately denied refuge when their wells were sealed with hardware cloth.

The nature of rabies epizootics in vampire bats to move relatively slowly offers the possibility of controlling bovine rabies outbreaks through selective extermination of vampire bats. Establishment of the size, form and direction of movement of outbreaks is obtainable through suveillance of bovine rabies cases. Selection of the vampire control area should take into account, besides the information provided by surveillance, the fact that the virus is probably at least 20 km in advance of the last reported case of bovine rabies. If possible, a survey of the location of rabies in the vampire population could provide more detailed information for selection of the control area. The most appropriate method of vampire destruction depends on the nature of the terrain. In areas where roosts are difficult to locate, use of anticoagulant applied to the back of bats appears to be the method of choice. However, in areas where bats roost in water wells, gassing of the wells is recommended.

Systematic application of vampire bat control offers the possibility of controlling outbreaks of bovine rabies by blocking spread through the vampire populations.

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Received for publication 3 February 1974