ber of the family or persons in the community (composed of 12 dwellings) became ill or noticed enlarged lymph nodes on themselves.

In case No. 5 the patient also had a clear history of contact with wild rodents. The girl and seven other persons in her family lived in a desolate area of the reservation. They had set up their camp, consisting of several tents, in this area only a week before the onset of the patient's illness. A visit to the site revealed that the tents were almost entirely surrounded by an extensive prairie dog colony (fig. 2). The patient's father stated that the family was accustomed to hunting prairie dogs for food, and that several dead animals (including prairie dogs, rabbits, and a squirrel) had recently been found on the ground near the tents.

The family had continued to hunt prairie dogs until shortly before the patient's illness, when they allegedly discontinued this practice because of repeated warnings over the Navajo radio station that these animals might be infected. The child often played in the fields around the house, and her parents noticed that she frequently had insect bites on her body. There were four dogs in the camp; they apparently lived on table scraps. No other members of the family had become ill. A search of the region surrounding the tents quickly revealed many fresh prairie dog carcasses. Carcasses were collected and sent to the San Francisco Field Station for examination.

The child's illness apparently began with an insect bite on the chest wall, and she subsequently had regional lymphadenitis. *P. pestis* was recovered from the ulcerating wound. This patient seemed to have acquired plague by the bite of an infective flea. There was ample evidence of an extensive epizootic in prairie dogs surrounding her home.

Members of the family of the patient in case No. 6 were interviewed while they were being retained for observation at the hospital following his death. The parents were notably reluctant to discuss the situation, but two of his brothers stated that the patient had hunted prairie dogs shortly before onset of his illness. This was further corroborated by a family that lived near the patient; members of the family indicated that hunting prairie dogs was a common practice of the victim and his friends.

Epidemiologic Features and Results of Field Studies

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THE 1965 epidemic of bubonic plague revealed certain unique epidemiologic features of great interest to persons concerned with Indian health and to students of communicable disease.

The epidemic, as is common in human infections associated with sylvatic sources, was related to epizootics among wild rodents, primarily prairie dogs. The history of wild rodent plague in this country is replete with accounts of prairie dog die-offs, and it has become fairly well established that whenever plague occurs among prairie dogs the colony is decimated. In many instances "dog towns" have been wiped out over hundreds of square miles. A recent summary of the literature on prairie dogs and plague appears in an account of an epizootic in Colorado (*9*).

Materials and Methods

Field. During the epidemic, field observations and field collections were made in areas associated with cases in human beings and in other areas located on and adjacent to the Navajo Indian Reservation in New Mexico and Arizona. Briefly, the following methods were used.

1. A search was made for evidence of epizootics and die-offs of rodents. Each dead animal, regardless of its condition, was placed in a plastic bag, labeled, and packed with dry ice for shipment to the San Francisco laboratory.

2. Burrows of prairie dogs in epizootic areas were swabbed for fleas with flannel cloths attached to 6-foot-long wires. Swabs were placed in cloth sacks that were tightly closed and labeled. Subsequently, the fleas were etherized and placed in vials containing 2 percent saline solution.

3. Live-catch traps (Sherman) baited with cereal were set for overnight collection of small rodents in the area where prairie dog mortality had been observed. The trapped animals were

etherized and blood for serology was obtained by cardiac puncture. Each exsanguinated animal then was placed in a plastic bag and held in dry ice for shipment. Fleas dropping off the animal were placed into vials with 2 percent saline and appropriately labeled by host. Fleas remaining on the host were removed subsequently in San Francisco.

4. Similar operations were conducted in other areas not necessarily associated with human cases, such as areas of reported die-offs of prairie dogs, camping grounds where Indian ceremonials were to be held, and the Fort Wingate Army Depot at Gallup.

In field investigations of this type, special emphasis is placed upon the so-called indicator or sentinel animals. Wherever epizootic die-offs occur, the victim population is composed of highly susceptible animals (prairie dogs, pack rats, and rabbits). At the same time, other rodent species living in the area usually contain high percentages of resistant individuals. The deer mouse, *Peromyscus maniculatus*, is a ubiquitous species that has been found resistant to the lethal effects of plague but frequently shows serologic evidence of infection. Thus, theoretically, the deer mouse can be used in seroepidemiologic investigations to determine the presence of *P. pestis*. The domestic dog functions as a predator of various rodents and rabbits in wild areas such as the Indian reservation. Dogs appear to be resistant to plague, and blood samples can be conveniently taken from them. If positive serums are obtained, this is acceptable as evidence of plague activity in the vicinity.

Laboratory. Fleas collected in the field were identified in the laboratory. Individual fleas, or pools of up to 25 fleas, were triturated in mortars and then inoculated subcutaneously into laboratory mice. The same procedure was followed with fleas combed from animal carcasses shipped to the laboratory for study.

The animal carcasses, preserved by dry ice during shipment from the field to the laboratory, were received in various stages of decomposition. Animals found freshly dead or those dying when blood samples were being drawn were autopsied, and their tissues—primarily the spleen and liver—were cultured on blood agar and also inoculated subcutaneously into laboratory mice. Animals found after some decomposition had taken place were autopsied, but their tissues were tested only by inoculating them into laboratory mice. Finally, some specimens were received which consisted only of skeletal remains. Smears were made of samples of marrow, scraped from the femurs or other long bones, and the marrow was rehydrated with sterile physiological saline when necessary. The fluorescent antibody staining technique (*10*) was used to examine these smears. Successful demonstration of *P. pestis* antigen in skeletal remains or in mummified mammalian carcasses has been reported previously (*5*, *11*).

Pure bacterial cultures were obtained from the mice which died after they were inoculated with the flea or tissue samples. These cultures were then identified as *P. pestis* by standard cultural, biochemical, and serologic methods (*12*).

The passive hemagglutination test for *P. pestis* Fraction I-specific antibodies was used to measure serum titers. The method employed was the microtechnique used in previous studies of plague seroepidemiology (*7*). Serum was harvested in the field from undiluted blood (domestic dogs) or from blood diluted with an equal volume of buffered saline (rodents). Thus, in serum from dogs or other large mammals, the minimal titer tested and considered positive was 1:16. In serum from small rodents, the minimal titer tested and considered positive was 1:32. Past experience with wild rodent serum at the San Francisco laboratory led us to choose 1:32 as a significant titer, since in the normal distribution of positive titers obtained in field rodents less than 1 percent fall below this point. Because sufficient data are not available for this type of analysis of positive titers in dogs, a somewhat lower level of significance was chosen. The level of 1:16 is still somewhat higher than the 1:10 cutoff point recommended for human serum by the Hooper Foundation.

Findings

During the summer of 1965 reports were received from a variety of sources that prairie dogs were suffering die-offs in southern Utah, southern Colorado, and in widespread areas of Arizona and New Mexico. Much of the evidence for those epizootics was based upon information gathered by personnel of the U.S. Bureau of

Sport Fisheries and Wildlife assigned to the Navajo Tribe at Window Rock, Ariz. These observations were substantiated during field investigations of the epidemiology of the human plague cases. Areas in New Mexico and Arizona were investigated and the factual information that emerged is shown in figure 3.

The information presented in figure 3 is limited by the amount of work that could be accomplished. Additional investigations undoubtedly would have revealed an equal number, or perhaps a substantially greater number, of prairie dog colonies subjected to epizootics of plague. The map shows the widespread nature of both the distribution of prairie dogs and of the disease affecting them. The areas around Gallup, the Zuni Indian Reservation, and many centers in the Navajo Reservation represent places where the human risk is greatest. No investigation was made within the Hopi Indian Reservation, but the map indicates that plague epizootics were occurring in prairie dog colonies not far from this settlement (to the southeast in the Dilkon and Castle Butte areas and to the northeast in the Salina area near Chinle).

During these field investigations, specimens of wild rodents, occasional rabbits, and their fleas were collected and tested for infection with *P. pestis*. The data in figure 3 show that collections covered a rather extensive area in New Mexico and Arizona. Table 5 summarizes the laboratory findings in tests of all specimens of vertebrate hosts and fleas collected.

These data emphasize the virtually complete dominance in the epizootics of prairie dogs, *Cynomys gunnisoni zuniensis*, and their fleas,

Figure 3. Prairie dog colonies observed in Arizona and New Mexico during summer of 1965

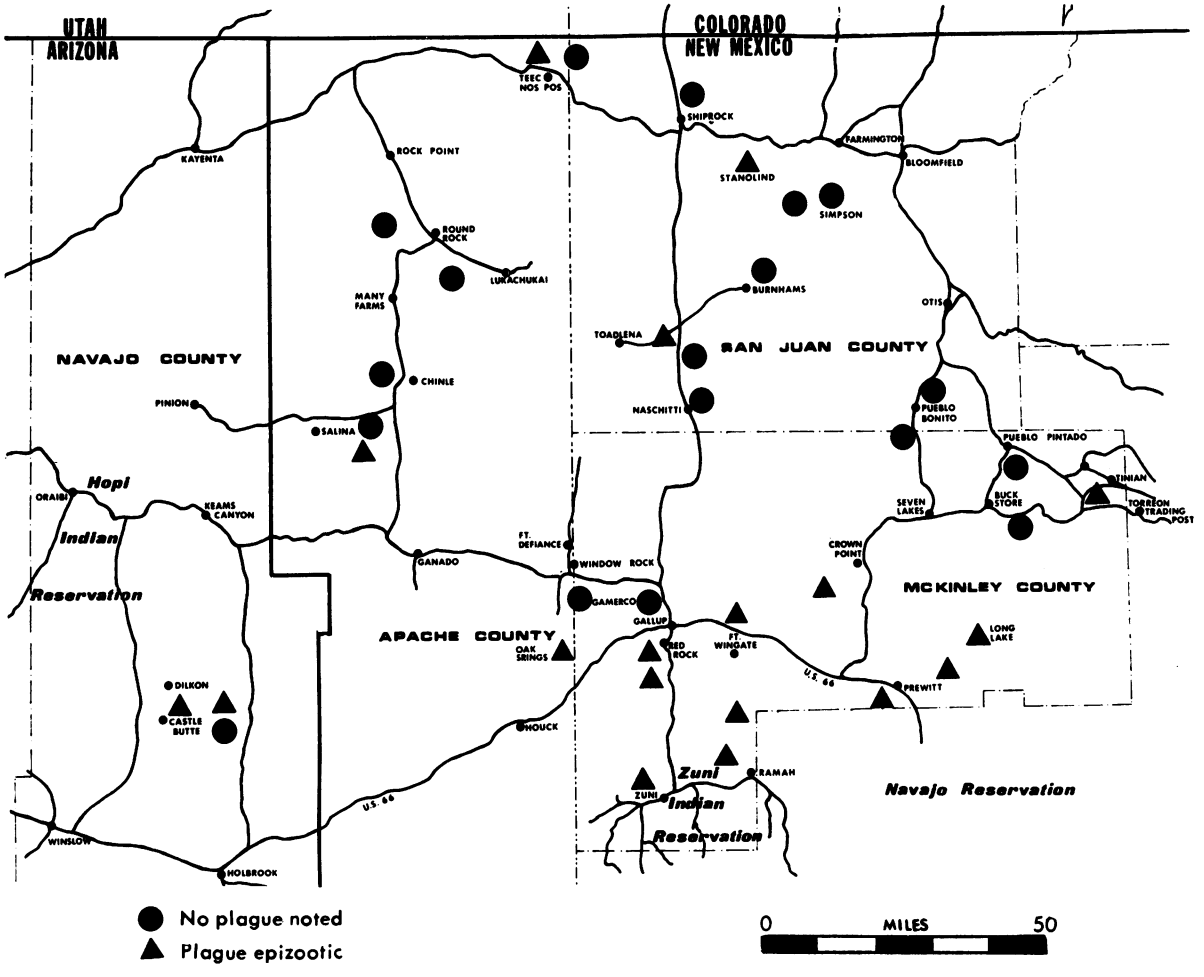


Table 5. Results of examination of mammals and fleas for *Pasteurella pestis* infection, New Mexico and Arizona, 1965

State and month	Mammals			Fleas		
	Number examined	Number positive	Percent positive	Number examined	Number positive	Percent positive
New Mexico	125	4	3.2	2,068	89	4.3
August	106	[1] 4	3.7	1,472	[2] 67	4.5
September	19	0	0	596	[2] 22	3.6
Arizona	34	5	14.7	580	10	1.7
August	1	[1] 1	100.0	135	[2] 3	2.2
September	24	[3] 3	12.5	445	[2] 7	1.5
November	9	[1] 1	11.1	0	--------	---------

[1] *Cynomys gunnisoni zuniensis* found dead.
[2] *Opisocrostis hirsutus* from prairie dog burrows, except for 4 positive fleas (species unknown) from a deer mouse, *Peromyscus boylii*, in New Mexico in August.
[3] 2 *Cynomys gunnisoni zuniensis* and 1 *Sylvilagus nuttallii* found dead.

Opisocrostis hirsutus, that were located by a search for rodent carcasses. In most instances the infected fleas were swabbed from burrows where the prairie dogs obviously had disappeared or had been found dead nearby. A noteworthy finding in relation to the prairie dog epizootics was the discovery of a dead infected cottontail rabbit, *Sylvilagus nuttallii*, at Oak Springs, Ariz., during the middle of September. The dead rabbit was found in an area that had suffered an extensive epizootic among prairie dogs (fig. 3). The significance of the infected rabbit is obvious in terms of plague epidemiology in New Mexico where more human cases have been associated with rabbits than in any other State (*5*). The site at Oak Springs is about 13 miles north of the Houck area where in December 1963 an Indian sheepherder died of plague after contact with rabbits. Both the Oak Springs and Houck areas are close to the New Mexico State line and represent a continuous ecosystem that covers a wide region in both States.

The field investigations were concerned primarily with animal and flea populations affecting areas where the human cases occurred. Thus, most of the specimens obtained for examination represented these areas. Of 125 mammals and 2,068 fleas collected in New Mexico (table 5), 84 percent and 53 percent respectively were from areas connected with the human plague cases. Table 6 summarizes data from laboratory examination of the field specimens associated with the human cases.

The data show that prairie dogs were the only infected mammals found to be associated with the cases of plague. The specimens were carcasses taken from sites where epizootics had occurred (table 6, cases 3 and 5). A total of 42 other mammals, listed below, was collected from the areas associated with the human cases and examined. None was infected.

Case 1: 1 *Peromyscus boylii*, 3 *Peromyscus maniculatus*

Case 2: 9 *Mus musculus*, 2 *Citellus spilosoma*, 1 *Dipodomys ordii*

Case 3: 1 *Lepus californicus*, 1 *Sylvilagus nuttallii*, 1 *Eutamias* species, 4 *Peromyscus maniculatus*, 1 *Peromyscus boylii*, 4 *Perognathus hispidus*, 3 *Reithrodontomys megalotis*, 1 *Dipodomys ordii*

Case 6: 10 *Peromyscus maniculatus*

The situation in case 3 is fairly typical. The victim had hunted prairie dogs at Long Lake, about 8 miles northeast of Prewitt. The site was a prairie dog colony completely devoid of live inhabitants. Many carcasses, either mummified or partially skeletonized, were seen near burrow entrances. The burrows contained numerous fleas and a sample of these revealed an infection rate of 7 percent (table 6). The fleas (*O. hirsutus*) were swabbed from prairie dog burrows at Long Lake during August 1965 and April 1966. In one area a total of 1,493 fleas

(*O. hirsutus*) was collected from 36 uninhabited burrows during April 1966. One flea pool was positive for *P. pestis*; thus one burrow of 36 (2.8 percent) contained infected fleas. Assuming that the positive pool contained at least one infected flea, 0.06 percent of the total fleas collected was positive. This finding confirms former observations that infected fleas can live in uninhabited burrows for many months after a prairie dog die-off (*9*).

Evidence of a prairie dog epizootic also was found in the vicinity where case 1 occurred. The die-off had occurred either during the early summer of 1965 or possibly late in the previous summer. Infection with *P. pestis* was found in fleas taken from several of these prairie dog burrows. Table 6 indicates that several field mice (*Peromyscus*) were trapped at this site. Interestingly, although none of these rodents was infected, four fleas from a *P. boylii* were found infected with plague organisms. This suggests that the infection was probably present in populations of field mice and their fleas. A similar phenomenon has been noted in the San Francisco Bay area (*13*).

The areas presumed to be associated with case 2 yielded few specimens, and 75 percent of these specimens were domestic house mice which have never been implicated as significant rodents in plague epidemiology in the United States (*14*). The epidemiologic evidence in case 6 was vitiated by an unfortunate loss during shipment of 57 fleas taken from burrows where it appeared that an epizootic among prairie dogs had occurred. The victim was known to have hunted prairie dogs in the colony located about 1 mile from his home. Some bleached bones were found at a few burrow openings and the area appeared typical of a plague epizootic, as in case 1. There seems little reason to doubt that some of the fleas collected from the burrows would have proved infected with *P. pestis*.

Epidemiologic evidence from the field also consisted of serologic tests with serums taken from various wild and domestic mammals. In some cases, the evidence from fleas and tissues was confirmed and in at least one case serology was the only positive evidence. Thus, as indicated in table 7, serum from a domestic dog associated with case 2 showed a titer for *P. pestis*. Domestic dogs associated with cases 1 and 5 also showed evidence of contact with the plague organism. Data from specimens collected in Fort Wingate were included in table 7 because they strengthen the evidence obtained from domestic dogs.

The serologic data in table 7 show that all serums from 65 wild rodents, representing 12 species, were negative for *P. pestis* antibodies. On the other hand, of 27 domestic dogs tested, 18 percent had titers of 1:16, 22 percent were 1:32, and 7 percent were 1:64. The positive serologic evidence in domestic dogs suggests that these animals had contact with the plague

Table 6. Results of examination for *Pasteurella pestis* infection in prairie dogs and fleas from sites specifically associated with human plague cases in McKinley County, N. Mex., August–September 1965

Case No.[1] and location	Prairie dogs			Fleas		
	Number examined	Number positive	Percent positive	Number examined	Number positive	Percent positive
1: Red Rock	0	--------	--------	183	[2] 9	4.8
2: Gamerco	0	--------	--------	0	--------	--------
3: Prewitt	[3] 58	[4] 2	3.4	[5] 921	68	7.3
5: Tinian	[3] 2	2	100.0	0	--------	--------
6: Red Rock	0	--------	--------	[6] 9	0	0
Total	60	4	6.6	1,113	77	6.9

[1] Case No. 4 was determined retrospectively from serologic evidence.
[2] 4 from *Peromyscus boylii* and 5 from *Cynomys* burrows.
[3] *Cynomys gunnisoni zuniensis* found dead (mummified and skeletonized).
[4] Determined by fluorescent antibody staining.
[5] *Opisocrostis hirsutus* from *Cynomys* burrows.
[6] From *Peromyscus maniculatus*.

organism in infected wild mammals (probably prairie dogs or rabbits) at some time in the past. How long in the past is unknown since studies are lacking on this point. Another possibility is that a dog could have been infected via an infective wild rodent flea.

The lack of serologic evidence from wild rodents may not be too difficult to interpret. Infected fleas from a *Peromyscus boylii* were found at the Red Rock area (case 1, table 6). This certainly indicates that the infection was present in field mice. Nevertheless, studies with field voles (*Microtus californicus*) have shown good correlations between the isolation of *P. pestis* from fleas and the prevalence of *P. pestis* Fraction I-specific antibody (*7*). Although antibodies appear after infected fleas are found, the time needed for a serologic response is too short to account for the negative results obtained here. The only explanation suggested by the data is a lack of sufficient numbers of specimens tested from species that are known to be relatively resistant to plague but not to infection with *P. pestis*. Species of *Peromyscus* have been demonstrated to have *P. pestis* antibodies which show a definite seasonal cycle in California and Utah (*7*, *15*). The number of *Peromyscus* specimens collected in our study were few, and they were

Table 7. Prevalence of *Pasteurella pestis* Fraction I-specific antibodies, determined by the passive hemagglutination test, in wild and domestic mammals from sites associated with human plague cases, McKinley County, N. Mex.

Wild and domestic rodents			Domestic dogs	
Species and case No.	Number of rodents	HA titer	Number of dogs	HA titer
Case No. 1, Red Rock:				
Peromyscus boylii	1	Negative	3	Negative.
Peromyscus maniculatus	3	Negative	2	1:16
			1	1:32
Case No. 2, Gamerco:				
Mus musculus	8	Negative	8	Negative.
Citellus spilosoma	2	Negative	1	1:64
Dipodomys ordii	1	Negative	----------	
Case No. 3, Prewitt:				
Perognathus hispidus	4	Negative	0	
Peromyscus boylii	1	Negative	----------	
Peromyscus maniculatus	17	Negative	----------	
Reithrodontomys megalotis	5	Negative	----------	
Case No. 5, Tinian:				
None	----------	----------	1	Negative.
			2	1:32
			1	1:64
Case No. 6, Red Rock:				
Peromyscus maniculatus	2	Negative	0	
Fort Wingate:[1]				
Peromyscus maniculatus	7	Negative	2	Negative.
Thomomys bottae	1	Negative	3	1:16
			3	1:32
Neotoma mexicana	7	Negative	----------	
Neotoma species	3	Negative	----------	
Perognathus parvus	1	Negative	----------	
Onychomys leucogaster	1	Negative	----------	
Dipodomys ordii	1	Negative	----------	

[1] Other situations.

taken during a period of the year when the percentage of positive serums and the titer levels have been shown to be low (*7, 15*). Other rodents shown in table 7 known to be quite susceptible to plague (*Neotoma, Reithrodontomys*) would not be expected to survive an infection; only two specimens of the known resistant rodents (*Dipodomys*) were tested.

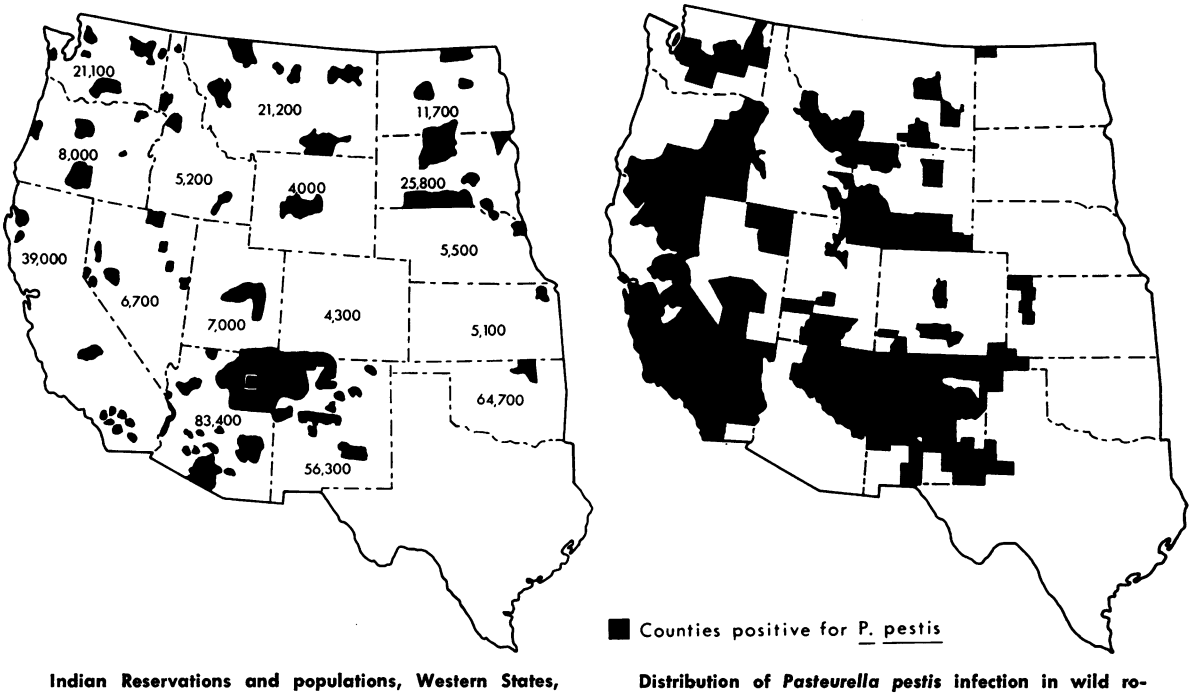
Wild Rodent Plague

The preceding data established the association of plague in wild rodents and its attendant risk to Indian peoples living in areas where epizootics occur among prairie dogs and perhaps other mammals. Figure 3 reveals evidence of such epizootics which occur almost every year but seem to become more widespread and more intense in certain years. The ecologic factors responsible for geographically widespread epizootics are not clearly understood. In 1965, epizootics of plague were known to occur in Colorado, Utah, Arizona, New Mexico, California, and Nevada. In the first four of these States prairie dogs were the most prominent mammals involved, whereas in California and Nevada chipmunks and ground squirrels were implicated.

Plague epizootics usually are noted in the larger and more conspicuous rodents, such as prairie dogs, that are quite susceptible to the disease. Smaller susceptible species such as chipmunks are observed usually in resort areas or national and State parks where large numbers of people spend short periods. Obviously, the susceptible rodent populations represent victims of the disease and are not considered to be "true" reservoirs that are characterized by a relative resistance to plague but a susceptibility to infection with *P. pestis*. In many areas the true reservoirs still need to be defined.

The Western United States harbor a vast, inveterate focus of wild rodent plague (*14*). The plague organism has been isolated from numerous species of wild mammals and their fleas in more than 130 counties of 15 western States. During the period 1908–65, 110 confirmed hu-

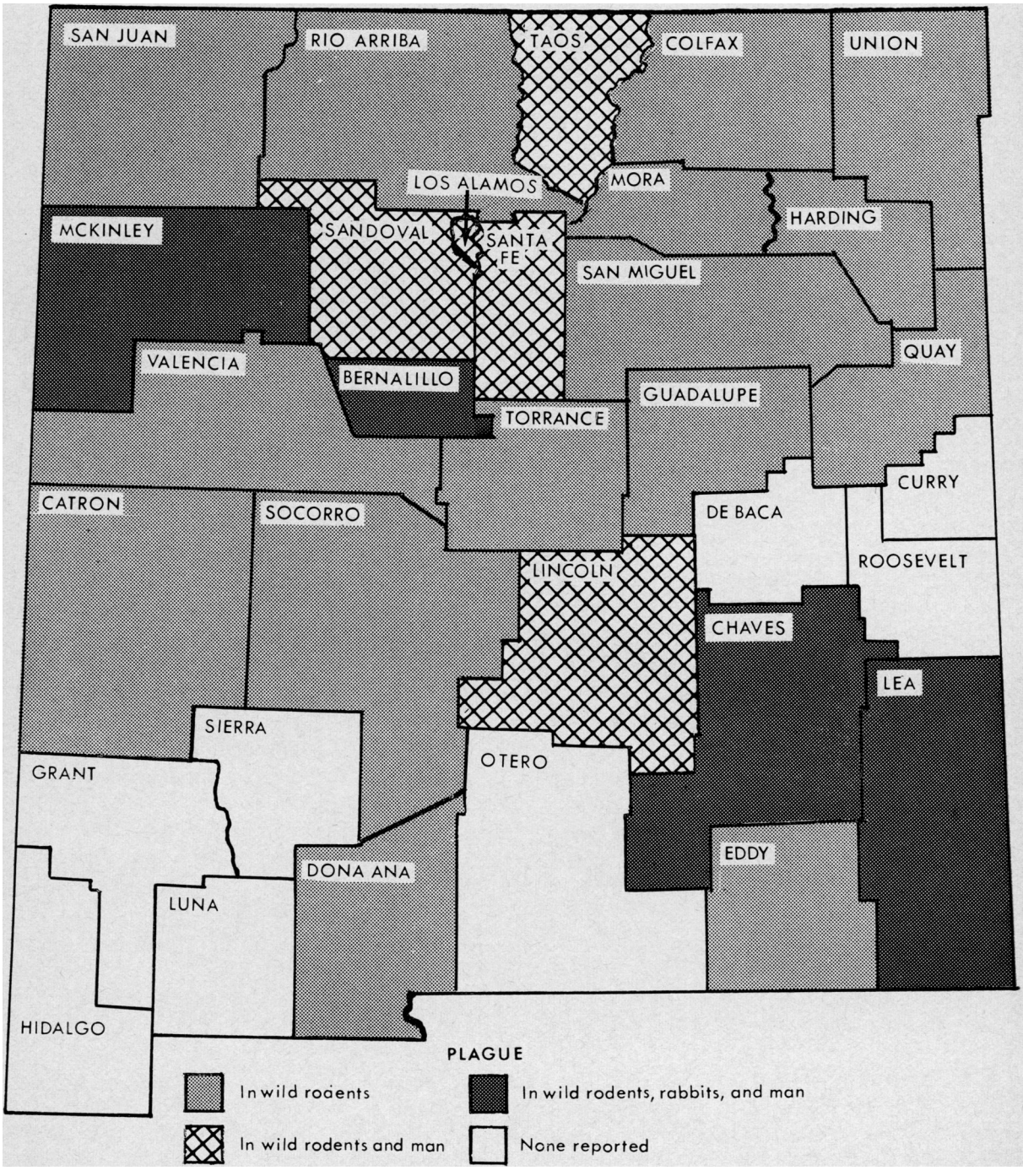
Figure 4. Location of Indian reservations in relation to distribution of wild rodent plague in the United States



Indian Reservations and populations, Western States, 1960

Distribution of *Pasteurella pestis* infection in wild rodents and fleas, 1908–65

Figure 5. New Mexico counties in which man, wild rodents, and rabbits were known to have been infected with *Pasteurella pestis* of sylvatic origin during 1938–65



SOURCE: Reference 5.

man infections resulted in 64 deaths. The 1965 plague epidemic in New Mexico focused attention for the first time upon the relation of American Indians and plague as a problem of both immediate and long-range importance.

Figure 4 compares the distribution of wild rodent plague with locations of Indian reservations and Indian populations in the same regions. An overlay map would show this more clearly, but the conjunction of many reservations with enzootic plague areas is clear. Especially noteworthy is the close identification of reservation limits and the distribution of sylvatic plague in New Mexico, Arizona, and in southern Utah and Colorado. Considering that the majority of Navajo, Hopi, Zuni, and other Indian tribes still live deep within the confines of their respective reservations, the potential for future plague outbreaks appears significant.

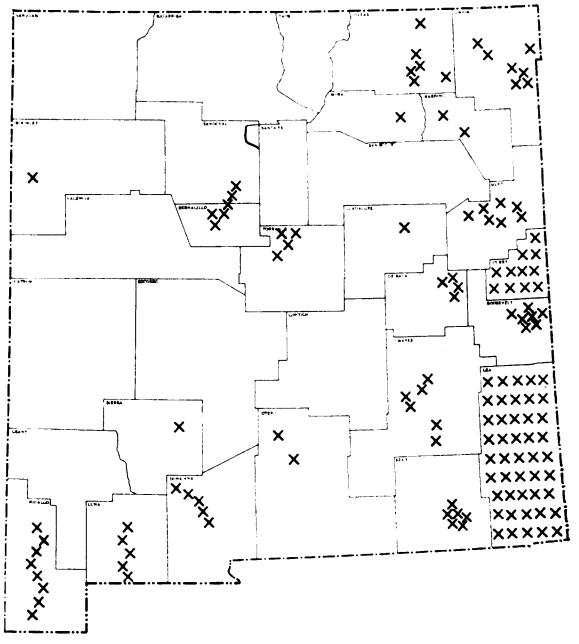
The history of human plague in New Mexico was summarized earlier in this paper. An overall view of the plague situation in New Mexico is shown in figure 5. The map indicates that by 1965 few counties in the State were free of plague or *P. pestis* infection. There is little doubt that an intensive search for *P. pestis* in wild rodents or a serologic survey would uncover evidence of infection in several or all of the apparently plague-free counties.

The wild rodent plague situation in Arizona to a great extent parallels that in New Mexico since the ecosystem is uniform across the State line. Figure 4 shows the recorded distribution of sylvatic infection in northern and eastern Arizona continuous with the New Mexico focus. Since 1938, *P. pestis* infection has been found in tissues and fleas from prairie dogs, ground squirrels, deer mice, wood rats, and in rabbit tissues. In 1965, as already noted, extensive epizootics occurred in prairie dogs (table 5, fig. 3). Of the two confirmed cases of human plague in Arizona, the first was reported from the Navajo Medical Center at Fort Defiance in August 1950, and the second was reported in December 1963 from the Indian Hospital at Gallup as having been contracted on the Navajo Reservation in the vicinity of Houck. Both of these cases occurred in Apache County, Ariz., and both were located close to the New Mexico State line in the Navajo Reservation (fig. 3).

Domestic rats apparently never have been associated with epizootics of wild rodent plague in the interior of the United States. Nevertheless, in coastal areas, such as the San Francisco Bay region, infected domestic rats are found occasionally (*16*), and the transfer of the infection from wild rodents to domestic rats has been observed (*17*). These findings underline the potential for spread of the infection wherever wild rodents and domestic rodents commingle in areas of enzootic plague.

In New Mexico domestic rats have been found in 21 counties (fig. 6). A comparison of figure 6 with the map of plague distribution (fig. 5) reveals that 12 counties have both wild rodent plague and domestic rats. All of the counties shown in figure 6 have *Rattus norvegicus* and Dona Ana County has both the Norway rat and *Rattus rattus*. Whether or not there is commingling between wild and domestic rodents in any of these areas is not known. For the present, this information merely provides a basis for the assumption that the transfer of *P. pestis* from wild to domestic rodents is possible in some areas of New Mexico. Under favor-

Figure 6. New Mexico counties in which domestic rats have been trapped and observed



SOURCE: New Mexico Department of Public Health.

Photograph from National Aeronautics and Space Administration

Prairie dog

able conditions this situation is a potential threat to people living at a low socioeconomic level with inadequate sanitation. The Indians would be one of the main populations at risk, especially in the environs of towns.

Special Character of Plague Epidemic

The 1965 plague epidemic among Navajo Indians in New Mexico is yet another example that demonstrates the protean nature of this disease, a characteristic prominently displayed in its history. This epidemic was the largest recorded in the United States in which each case in man was associated with a separate infective source in wild rodents. The episode contrasts sharply with the usual course in this country where an average of about two cases per year have occurred and where each case is relatively isolated and unrelated to other cases in both time and space.

In cases of plague affecting non-Indians, the victim usually has an accidental contact with the source of infection, a sick or dead wild rodent or a bite from an infective wild rodent flea. Few non-Indians have consistent and intimate contact with wild rodents.

The Navajo Indian society has been, and still is to a large extent, based upon intimate association with nature. This is reflected in daily life, in religion, in ceremonials, and in the tribal myths and tales passed on by each generation. Of the 35 principal Navajo ceremonials, the majority are preoccupied primarily with diseases. However, there is no word for plague and no concept of plague as a specific clinical entity. In fact, there is no word for germ in the Navajo language and tuberculosis, for example, is believed to be caused by lightning (*18*).

The Navajo not only has lived and continues to live close to wild animals, but he traditionally has used many of these animals as food. The rabbit and the prairie dog always have been among the most favored of these wild animal sources of protein (*19*). A photograph published in the *San Francisco Chronicle*, July 2, 1967, shows President Theodore Roosevelt visiting the Navajos in 1913. The caption mentions that two of the Indians offered to share a couple of spit-roasted prairie dogs with him. The Indians have not changed their eating habits. During the 1965 epidemic when certain control measures were necessary, the following statement appeared in a local Indian newspaper: "We are sorry that it is necessary to issue this warning about the plague. We are sorry that the prairie dogs, rabbits, and other small animals are sick with the plague, but we are even more sorry for ourselves because we sure like roasted prairie dogs" (*20*).

An analysis of the eating habits and nutrition of the various Indian tribes would be interesting. Many Indian groups undoubtedly have sim-

ilar habits. For instance, the Hopi Indians' only important source of wild animal protein is reported to be rabbit and, to a limited extent, deer and quail (*21*). It seems quite clear that prairie dogs and rabbits constitute an important food source. The fatal case of plague in 1963 at Houck, Ariz., was associated with rabbits caught for food during sheepherding. In the winter, when prairie dogs hibernate, the rabbit becomes an important epidemiologic link in the chain of *P. pestis* infection reaching from wild rodents to man (*5*).

The intimate association of the Navajo Indians with prairie dogs and other mammals is not limited solely to their use as food. Abundant evidence was obtained that Navajo children trap prairie dogs as a form of play, and we were told that children handle "pet" prairie dogs. At a site near Gallup, a steel trap that had been placed by Indians was seen at a prairie dog burrow. This could have been set to capture a "pet" or to obtain food.

House dogs or sheep dogs also are a possible epidemiologic factor. The domestic canine population is at least equal to, if it does not outnumber, the human population. Most of these dogs are poorly fed and must continually forage for themselves. Rabbits and prairie dogs make up a portion of their diet and domestic dogs occasionally bring these wild mammals back to the home area. Domestic dogs have been implicated in cases of human plague via their association with small mammals, and these dogs as well as others not directly implicated have been shown to have significant *P. pestis* hemagglutination titers in their serums (table 7). Thus, dogs on the Navajo reservation and elsewhere may possibly act as a bridge for infected mammals or their fleas, or both. In this connection, dogs were seen hunting in prairie dog colonies where the animals had died from plague. The dogs would poke their heads into burrow openings, many of which contained fleas that were later determined to be infected with *P. pestis*. The transport of rodent fleas by dogs has been observed (*22*). An analogous situation involving domestic dogs, ticks, and tularemia was found recently on the Rosebud and Pine Ridge Indian Reservations of South Dakota (*23*).

The preceding brief exposition suggests that plague in the Navajo Reservation, and possibly in other reservations and areas where Indians live, has unique epidemiologic characteristics. Theoretically, Indians always have been subjected to plague, because the current consensus is that wild rodent plague has been entrenched in the Western Hemisphere since prehistoric times. The comparison of the location of Indian reservations in the Western United States with the distribution of sylvatic plague (fig. 4) shows areas of geographic coincidence that are pertinent to both an historic perspective and to a view of the current situation.

We conclude, based on evidence from the 1965 epidemic, that although observed cases of plague among the Navajos did not have a familial character, the cases nevertheless were community oriented on the basis of cultural and socioeconomic factors. Thus the 1965 cases of plague can be conceived as constituting a community cluster. We can postulate that plague will continue to occur among Navajo Indians when a certain level of the disease is present in wild rodent populations. If this characteristic is borne out by additional observations, much weight will be added to the hypothesis that the Navajo Indian community presents a special epidemiologic framework in relation to wild rodent plague that sets it apart from the epidemiologic situations that have become well recognized in the United States.

An Emergency Program To Control Plague

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BECAUSE of certain unique features, discussed previously, the plague epidemic was a serious hazard to the local population. Thus for the first time in at least four decades emergency measures were applied to control an epidemic of plague in this country. The control operations were based on the epidemiologic, medical, and ethnologic information assembled