Public Health Reports

Vol. 66 • DECEMBER 28, 1951 • *No. 52*

Observations on Rat Ectoparasites and Typhus Fever in San Antonio, Texas

By David E. Davis*

Studies on the control of typhus fever conducted in San Antonio, Tex., found that rats containing complement-fixing antibodies for typhus fever were widely distributed in the city (*1*, *2*). DDT dust to reduce rat fleas was used and resulted in a reduction of human cases of typhus fever (*3*, *4*). Observations on rats and typhus fever (*5*) showed that 35 percent of the roof rats and 51 percent of the Norway rats contained typhus complement-fixing antibodies.

Observations on the ectoparasites are presented to make data available on abundance of ectoparasites in the southwestern portions of the area where typhus is endemic. The recent decline in typhus fever (*6*) makes a comparison possible of the data on fleas for the years 1944–45 of high typhus fever rates with data for recent years. These data apparently are the most extensive collected before the reduction in typhus began. Hill and Ingraham (*7*) presented data for the periods of high typhus rates for rural Alabama.

Observations on Fleas

Several species of fleas are found on rats in San Antonio. *Xenopsylla cheopis*, the Indian rat flea, is the most common species and is found wherever there are rats. *Leptopsylla segnis*, the so-called mouse flea, is regularly present and *Echidnophaga gallinacea*, the chicken flea, is common on rats caught in poultry houses and chicken coops. *Ctenocephalides* spp., the cat and dog fleas, are frequently found on rats, especially where cats or dogs are present. *Nosopsyllus fasciatus*, the northern rat flea, is rare. *Pulex irritans*, the human flea, is occasionally present.

Ctenocephalides sp. is the only flea in San Antonio which commonly becomes a pest to humans. This species is the cause of complaints

*Johns Hopkins School of Hygiene and Public Health, Baltimore 5, Md.

that fleas are regularly found in houses and yards. One infestation of *P. irritans* in a shed was observed.

Changes in numbers of fleas found in relation to the seasonal occurrence of typhus fever are of interest. Throughout the southern United States, murine typhus is known to reach a maximum in the summer, shortly after the greatest abundance of rat fleas. For a study of seasonal changes in abundance of fleas in San Antonio, rats were collected systematically throughout the year. The rats were captured in number 0 steel traps, placed alive in a bag, and chloroformed in the laboratory. The rats were carefully combed to obtain all ectoparasites. The ectoparasites were identified under a binocular dissecting scope and then preserved in alcohol.

The rats were collected principally from the southern part of the city. The houses and stores are one-story frame structures. The stores are generally corner groceries. Rats caught in usual places (barns, for example) are not included. An attempt was made to have the sample of rats as comparable as possible from season to season. The collections are probably as random a sample as is practicable. Both Norway rats (*Rattus norvegicus*) and roof rats (*R. rattus*) are represented.

The rats are divided into adult and immature, according to reproductive state (*5*). The indices are calculated according to mean number of fleas per rat and to percent of rats infested as recommended (*8*). Indices are not recorded when less than five rats are in a category.

Table 1 shows that seasonal changes in abundance of *X. cheopis*

Table 1. ***Seasonal changes in abundance of*** **Xenopsylla cheopis** ***(1944–45)***

	May–June			July–August			September–October			November–December		
	Rats	Mean[1]	Percent[2]	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	4	-------	-------	27	3.5	67	15	3.4	66	6	1.3	66
Immature	8	8.1	88	31	9.0	77	29	1.3	48	26	2.5	42
Norway rats:												
Adults	27	14.1	96	43	11.5	95	22	2.7	73	12	5.1	66
Immature	13	13.9	100	13	10.9	100	17	5.0	88	2	-------	-------

	December–January–February			March–April			May–June			July–August		
	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	53	0.7	34	62	1.3	69	22	3.2	59	19	7.2	68
Immature	58	.9	38	77	1.1	45	63	3.8	70	45	8.4	49
Norway rats:												
Adults	27	1.8	41	60	5.1	58	19	14.7	79	57	8.5	74
Immature	5	6.6	80	34	5.4	65	16	10.0	56	40	8.6	82

1 Mean number of fleas per rat.
2 Percent of rats with fleas.

Table 2. *Seasonal changes in abundance of* Leptopsylla segnis *(1944–45)*

	May–June			July–August			September–October			November–December		
	Rats	Mean [1]	Percent [2]	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	4	------	------	27	0	0	15	0	0	6	0.8	50
Immature	8	0	0	31	0	0	29	0	0	26	.8	4
Norway Rats:												
Adults	27	4.0	37	43	.2	2	22	.4	4	12	.4	8
Immature	13	3.8	31	13	0	0	17	.6	6	2	------	------

	December–January–February			March–April			May–June			July–August		
	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	53	1.2	37	52	2.6	75	22	0.4	18	19	0	0
Immature	58	1.5	36	77	2.2	45	63	.4	27	45	0	0
Norway Rats:												
Adults	27	.2	18	60	7.1	63	19	9.0	47	57	0	0
Immature	5	1.2	20	34	9.4	65	16	.6	37	40	0	0

[1] Mean number of fleas per rat.
[2] Percent of rats with fleas.

reaches a peak from May to August and drops to a minimum in the winter. The indices are shown to be higher in July and August 1944, than for the same months in 1945.

Table 2 shows the seasonal changes in abundance for *L. segnis*. The maximum abundance occurs in May and June and the species is practically absent in July and August.

The chicken flea, *E. gallinacea*, was frequently found on rats at all seasons of the year, but no conclusions concerning seasonal abundance can be made from this study as no attempt was made to get monthly samples of rats from poultry houses or chicken coops.

N. fasciatus was found in very small numbers (total of 25) most commonly in March and April. None was found in July and August.

Ctenocephalides sp. was found regularly in suitable places. No conclusions as to seasonal abundance can be drawn from the collections on rats, but judging from the number of complaints to the health department of flea infestations in yards and houses, it seems that cat fleas are most common in May and June.

The human flea, *P. irritans*, is rare on rats. A total of eight was collected, mostly between April and July.

From these observations on fleas, it is clear that the maximum abundance occurs in May and June, but that, because of different peaks of abundance of two species, fleas are common in San Antonio for about 6 months.

For the comparison of abundance of ectoparasites, the rats were classified according to three types of establishments, residences, stores, (cafes, groceries, theaters, drug stores) and mills (grain and peanut mills) in order to group the rats from similar habitats. The data show no consistent differences in the numbers of fleas on rats from different types of establishments (tables 1 and 2). These studies, however, were not planned to clarify this problem. Especially designed collections of rats from carefully selected establishments are required to determine if differences exist. It appeared true, however, that greater variation from rat to rat in the number of fleas was present in grain mills than elsewhere. Totals of over a hundred fleas on a rat are common in such places. The record of 423 fleas (mostly *L. segnis*) was obtained on a crippled rat caught in a peanut mill.

In addition to seasonal changes in abundance, other aspects may affect the role of fleas in typhus fever. The total fleas, according to species and sex of rat are shown in table 3 which includes all adult rats irrespective of season or place. It is at once clear that the Norway rat in the San Antonio area had more fleas than did the roof rat.

Table 3. ***Total fleas on rats—San Antonio***

Species	Sex	Number rats	Arithmetic		Geometric		Percent with fleas
			Mean	Standard error	Mean	Standard error	
Norway	Male	147	11.84	1.46	4.93	0.051	85
	Female	138	9.79	1.19	3.66	.055	69
Roof	Male	95	4.68	.71	2.39	.060	76
	Female	117	2.69	.45	1.43	.045	65

The number of fleas (*X. cheopis*) found on rats caught outside buildings is known to be small. In this investigation few rats were caught outside of buildings, but in two places rats were living out in the grass and feeding in nearby sheds. Rats caught in these places did not have fleas. However, rats caught near the buildings in which they live had as many fleas as rats caught in the buildings.

It is of interest to compare the number of fleas found on male with those found on female rats. Table 3 presents the arithmetic means and their standard errors for all adult Norway rats and roof rats of each sex. In both cases the males had more fleas than did the females. However, the fact that the number of fleas observed are not in a normal distribution, and that the arithmetic mean is very much influenced by the occasional extreme values in these distributions, makes the mean hard to interpret. An alternative centering constant free of this difficulty is the geometric mean (table 3).

For roof rats the difference between the sexes is 2.99 times its standard error, and hence is considered significant. For Norway rats the difference between sexes is only 1.71 times the standard error of the difference, but the fact that the difference is in the same direction as in roof rats lends support to the idea that male rats have significantly more fleas than do females in this situation.

The sex ratio of the fleas is of possible importance in the knowledge of the life history of the fleas. The ratios for *X. cheopis* and for *L. segnis* are given in table 4. Analysis of the sex ratios in different types of establishments (not presented here) give very similar results. The recent work of Cole (*9*) shows a correlation between the temperature and the sex ratio of fleas (*X. cheopis*) found on rats. On cold days there are more females than males and on warm days there are more males than females. The sexes were equally represented at about 75° F. in several towns in the southern United States. A seasonal calculation for San Antonio confirms this observation (table 5). The percent of female fleas on Norway rats in the warmer seasons was lower than that in the colder seasons. It is interesting to note that apparently the same temperature relation occurs in *L. segnis* which is collected only in the colder months and has a very small proportion of males (tables 4 and 5).

Table 4. *Sex ratio of* Xenopsylla cheopis

	Rats	Mean of male fleas per rat	Mean of female fleas per rat	Total fleas	Percent male fleas
Roof rats:					
Adults	104	1.9	2.5	457	43
Immature	175	2.7	3.3	1,049	43
Norway rats:					
Adults	208	5.7	5.4	2,301	51
Immature	137	5.2	4.2	1,386	51

Sex ratio of Leptopsylla segnis

	Rats	Mean of male fleas per rat	Mean of female fleas per rat	Total fleas	Percent male fleas
Roof rats:					
Adults	54	1.1	2.3	186	34
Immature	71	1.3	2.5	271	34
Norway rats:					
Adults	65	5.8	9.5	991	38
Immature	33	4.6	15.2	393	39

The sex ratios for both species of fleas differ on the two kinds of rats. Roof rats have fewer male fleas than do Norway rats (table 4). The explanation may be that when fleas leave the rats, they gravitate toward the floor and, assuming that male fleas spend less time on rats than do female fleas, then there should be fewer male fleas in the upper parts of buildings. Therefore, roof rats should have a smaller proportion of male fleas than do Norway rats, as is the case. Since *L. segnis* is collected only in the cold months, it is obvious that more female fleas will be found on the rats.

Table 5. *The percentage of females of two species of fleas by seasons*

Months 1944–45	*Xenopsylla cheopis*				*Leptopsylla segnis*			
	Roof rats		Norway rats		Roof rats		Norway rats	
	Fleas	Percent females	Fleas	Percent females	Fleas	Percent females	Fleas	Percent females
May–June	79	66.0	471	43.7	7	----------	139	51.7
July–August	267	54.3	579	46.4	0	----------	1	----------
September–October	80	48.8	126	36.9	0	----------	1	----------
November	18	50.0	4	----------	3	----------	39	71.7
December–January–February	83	53.0	95	63.2	128	69.5	21	66.6
March–April	166	66.3	430	63.6	283	64.0	964	67.8
May–June	302	49.0	438	47.4	37	67.5	41	63.4
July–August	426	51.4	779	46.9	0	----------	0	----------
September–October	62	45.2	556	45.7	8	----------	3	----------

Observations on Mites

The following observations on mites are included in order to add to our knowledge of the ectoparasites of rats. *Liponyssus bacoti,* the tropical rat mite, the most common mite in San Antonio, is at no time as common as are fleas. *Laelaps nuttali* is present in fair abundance; possibly some individuals of *Eulaelaps stabularis* are included in these totals because of misidentification. *Echinolaelaps echidninus* is a rare species. Frequently, the mites may occur in great numbers on a rat. If the rat has any mites, it usually has either very few or very many.

The population changes are grouped in accordance with the seasons (tables 6 and 7). The peak in numbers of *L. bacoti* is in March and April and the minimum occurs in July and August. Some individuals are present in all months of the year. *Laelaps* in contrast, reaches maximum abundance in July and August and a minimum in the winter months, although it is not common at any time. The few *Echinolaelaps echidninus* were found principally in the spring.

The roof rats appear to have more *L. bacoti* than do the Norway rats. In contrast *Laelaps* is more common on Norway rats than on roof rats (tables 6 and 7). There is no consistent difference between the number of mites found on immature and on adult rats.

Observations on Lice

The rat louse, *Polyplax spinulosa,* was frequently present on rats and sometimes in large numbers. When present in numbers, many hundred or even more than a thousand lice could be collected. One Norway rat was gray in color because of the large number of lice and nits. In these investigations an arbitrary total of 50 was recorded when lice were abundant, because the task of collection and counting was tremendous. Hence the data have limited usefulness.

Table 6. *Seasonal changes in abundance of* Liponyssus bacoti *(1944-45)*

	May-June			July-August			September-October			November		
	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	4	------	------	27	0.1	7	15	3.9	60	12	5.7	83
Immature	8	0.9	38	32	.3	12	29	1.2	.4	27	3.8	59
Norway rats:												
Adults	22	4.1	32	44	.2	9	22	1.0	45	17	2.0	70
Immature	13	4.0	28	13	.6	39	17	4.2	35	4	------	------

	December-January-February			March-April			May-June			July-August		
	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	49	10.0	80	62	14.6	80	12	18.0	66	18	1.0	28
Immature	59	8.7	75	75	12.9	80	57	3.8	60	43	1.3	44
Norway rats:												
Adults	26	3.3	46	60	10.0	85	19	.7	31	65	.4	9
Immature	7	14.5	71	35	10.9	74	16	2.4	44	32	.1	6

Table 7. *Seasonal changes in abundance of* Laelaps nuttali *(1944-45)*

	May-June			July-August			September-October			November		
	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	4	------	------	27	0	0	15	0.1	7	12	0	0
Immature	8	0.1	12	32	.2	6	29	1	10	27	.2	18
Norway rats:												
Adults	22	.2	9	44	.1	7	22	.5	23	17	.5	23
Immature	13	.5	28	13	1.1	15	17	.2	17	4	------	------

	December-January-February			March-April			May-June			July-August		
	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	49	0.6	4	62	0.1	2	12	0	0	18	0.1	6
Immature	59	.1	7	75	.1	8	57	.1	2	43	.1	4
Norway rats:												
Adults	26	.1	11	60	.3	16	19	0	0	65	1.7	37
Immature	7	0	0	35	.3	15	16	.4	19	32	1.7	40

The abundance is recorded according to seasons (table 8). The maximum occurs in the winter season and the minimum in the summer, but lice are present at all seasons. Norway rats have more lice than do roof rats, as shown by the total percentage calculated from the seasonal percentages in order to take account of different numbers of rats in each season.

Interrelations of Rats, Fleas, and Typhus

The differences in seasonal abundance of the various species of ectoparasites are such that there is considerable overlapping and

972999—51——2

at no time does the number of ectoparasites reach the vanishing point. It will be seen that the maximum abundance of fleas begins in May and lasts till August (tables 1 and 2). This increase is 2 months before the maximum number of typhus cases is noted in humans in San Antonio. (Table 9, compiled from the Weekly Morbidity Reports, shows the trend of cases in San Antonio by 4-week periods for 1944.) This lag seems to be more than would be expected if the fleas are equally infected with typhus at all seasons of the year. It seems possible that in the spring the percent of fleas that are infected, as well as the number of fleas, is increasing.

Table 8. *Seasonal changes in abundance of lice*

Season	Species of rat	Rats combed	Percent of rats infested
May–June 1944	Roof	12	8
	Norway	38	71
July–August 1944	Roof	59	3
	Norway	57	10
September–October 1944	Roof	49	14
	Norway	39	31
November 1944	Roof	39	33
	Norway	20	30
December–January–February 1944–45	Norway	113	36
	Roof	33	73
March–April 1945	Roof	140	37
	Norway	94	30
May–June 1945	Roof	90	25
	Norway	35	37
July–August 1945	Roof	63	21
	Norway	89	33
Total	Roof	565	21.8
	Norway	405	39.4

These observations of seasonal abundance are obviously based upon the abundance of ectoparasites on rats which is the important point in enzootic studies. However, the relation between the number of ectoparasites on rats and the number in a building (absolute abundance) needs investigation. It is not known that the seasonal changes herein described represent the changes in absolute abundance in a building. Clarification of this problem would help to explain the persistence of typhus from year to year. Recent work (*9*) refers to this subject and it may be concluded that the increase in fleas on rats in the warm months is in part due to the greater frequency of feeding by the males.

The maintenance of murine typhus fever obviously depends primarily on the frequency of contacts among the rats and fleas. This frequency will depend upon the number of rats and upon the number of fleas on each rat. It is of considerable importance to know the threshold of flea abundance below which typhus cannot maintain itself. Some observations upon this problem have been made in San Antonio by analysis of complement fixation test results and flea indices. The numbers of ectoparasites found on "positive" and "negative" rats are shown in table 10. It is clear that there is a difference in the numbers for positive and negative rats. This situation occurs in spite of the fact that typhus has occurred in nearly every building with rats.

Table 9. *Typhus cases reported in San Antonio, 1944*

Month	4-week period	Typhus cases	Month	4-week period	Typhus cases
January	1	2	July	8	20
February	2	2	August	9	11
March	3	2	September	10	14
April	4	3	October	11	17
May	5	4	November	12	6
June	6	3	December	13	5
June-July	7	5			

A comparison of the differences in the numbers of fleas on immature positive and immature negative rats with the numbers on the corresponding adults is of interest. By averaging the totals for both sexes, it is found that, in the Norway rat, the positive adults have 1.85 times as many fleas as the negative adults although the positive immature rats have only 1.37 times as many fleas as the negative immature rats. This is to be expected since immature rats may be living in heavily infested buildings but have not lived long enough to have become infected. A similar situation occurs in the roof rats. Studies of this type suffer the deficiency of comparing the numbers of fleas on rats at a time after the rat became infected and are hence only a suggestive relation.

Table 10. *Number of fleas found on "positive" and "negative" rats in San Antonio (1944–45)*

	Positive complement fixation test						Negative complement fixation test					
	Male			Female			Male			Female		
	Rats	Mean [1]	Percent [2]	Rats	Mean	Percent	Rats	Mean	Percent	Rats	Mean	Percent
Roof rats:												
Adults	28	4.4	64	34	4.4	62	37	2.6	73	68	2.2	65
Immature	4			29	5.7	83	83	3.9	51	84	2.7	57
Norway rats:												
Adults	43	13.3	84	53	10.5	76	57	7.5	74	53	5.2	66
Immature	20	15.3	95	23	9.2	87	37	6.5	84	35	11.4	86

[1] Mean number of fleas per rat.
[2] Percent of rats having fleas.

All surveys of presence of antibodies in rats are biased in favor of positive rats because typhus is more likely to be present where there are many rats and rats are more easily caught in such places. A survey of rats in places where rats are rare would be difficult but would probably show all negative rats.

Summary

Commensal rats were collected in San Antonio, Tex. from May 1944 to September 1945 and examined for ectoparosites.

The rat flea, *Xenopsylla cheopis,* is most abundant on rats from May to August. The mouse flea, *Leptopsylla segnis,* is most abundant in March and April and is almost absent in the summer. The chicken flea, *Echidnophaga gallinacea,* is frequently found and the northern rat flea, *Nosopsyllus fasciatus,* was present in small numbers in the spring. A few cat fleas (*Ctenocephalides* sp.) and human fleas (*Pulex irritans*) were collected. The maximum abundance of fleas occurs in the spring season, but because of overlapping of maxima for various species, fleas are abundant for almost 6 months.

Norway rats have more fleas than have roof rats. For adult rats of both species, the males had more fleas than the females. The number and sex ratios of fleas in stores, mills, and residences were very similar. For both *X. cheopis* and *L. segnis* a high sex ratio in favor of females occurred in the cool seasons.

The mite, *Liponyssus bacoti,* was most abundant in March and April. *Laelaps nuttali* was most abundant in July and August. A few *Echinolaelaps echidninus* were found in May and June.

The rat louse, *Polyplax spinulosa,* was most common from December to February.

Because of the overlapping of months of abundance, ectoparasites are present on rats in all months of the year. The increase in human typhus cases lags about 2 months behind the increase in flea abundance. Rats positive for typhus have more fleas than have rats negative for typhus.

REFERENCES

(*1*) Davis, David E., and Pollard, Morris: The distribution of murine typhus in rats and in humans in San Antonio. Am. J. Trop. Med. **26:** 619–624 (1946).

(*2*) Davis, David E., and Pollard, Morris. Prevalence of typhus complement-fixing antibodies in human serums in San Antonio, Tex. Pub. Health Rep. **61:** 928–931 (1946).

(*3*) Davis, David E.: The control of rat fleas (*Xenopsylla cheopis*) by DDT. Pub. Health Rep. **60:** 485–489 (1945).

(*4*) Davis, David E.: The use of DDT to control murine typhus fever in San Antonio, Tex. Pub. Health Rep. **62:** 449–463 (1947).

(*5*) Davis, David E.: Observations on rats and typhus in San Antonio, Tex. Pub. Health Rep. **63:** 783–790 (1948).

(*6*) Mohr, Carl O.: Results of cooperative State-Federal typhus control programs. CDC Bull. **9:** 1–5 (1950).

(*7*) Hill, Elmer L., and Ingraham, S. C.: A study of murine typhus fever in Coffee County, Alabama. Pub. Health Rep. **62:** 875–881 (1947).

(*8*) Rumreich, A. S., and Koepke, J. A.: Epidemiological significance of seasonal variations in rodent-ectoparasite distribution. Pub. Health Rep. **60:** 1421–1428 (1945).

(*9*) Cole, L. C.: The effect of temperature on the sex ratio of *Xenopsytta cheopis* recovered from live rats. Pub. Health Rep. **60:** 1337–1342 (1945).

Use of Warfarin-Treated Oats as a Plague Suppressive Measure in Hawaii

By Bertram Gross, Robert H. Baker, and David D. Bonnet*

The rodenticidal possibilities of warfarin-treated oats under Hawaiian field conditions were investigated by Doty (*1*) in three tests conducted on the island of Kauai. The results of these field tests showed that warfarin was readily accepted by rodents in this form and that the period of exposure in bait stations should be at least 17 days or until consumption reaches zero. Doty concluded that warfarin had a place in the over-all plantation field program. He suggested that a system using lines of fairly permanent poison-bait stations along gulches and wasteland, where migration is more or less continuous, would be very effective.

Eskey (*2*) pointed out that *Rattus hawaiiensis* undoubtedly plays an important role in maintaining the endemic rural type of rodent plague which is present in Hawaii. The determination of the value of warfarin-treated oats as an additional plague suppressive measure in field areas where large numbers of *R. hawaiiensis* were present became, therefore, a matter of considerable interest and importance to plague control workers in the Territory of Hawaii.

To evaluate this problem in a known endemic plague region in Hawaii, a field experiment was undertaken to find out what effect the continuous application of warfarin-treated oats, over an extended period of time, would have on the rodent population of a limited area.

The area selected for this purpose, field 109, is located in plague work zone 3A, Hamakua, Hawaii. This field (fig. 1) was chosen because reports received from plantation field workers indicated that rats had been causing severe cane damage, and the Bureau of Rodent Control trapping records showed that a high rodent population was present.

Approximately 78 acres of this land are utilized by the Honokaa Sugar Company to cultivate sugar cane. At the time the experiment was initiated, the sections under cultivation were covered with a dense growth of mature cane (variety 32–8560) which was 17 months old and was scheduled to be harvested in a few months. The remainder of the area, approximately 60 acres, was not under cultivation. In these wasteland sections many species of fruit trees, shrubs, and grasses are found, several of which, in addition to sugar cane, may serve at one time or another as a source of rodent food supply.

*Chief, Bureau of Rodent Control, Supervising Rodent Control Inspector, Hamakua, and Medical Entomologist, respectively, Division of Sanitation, Department of Health, Territory of Hawaii.

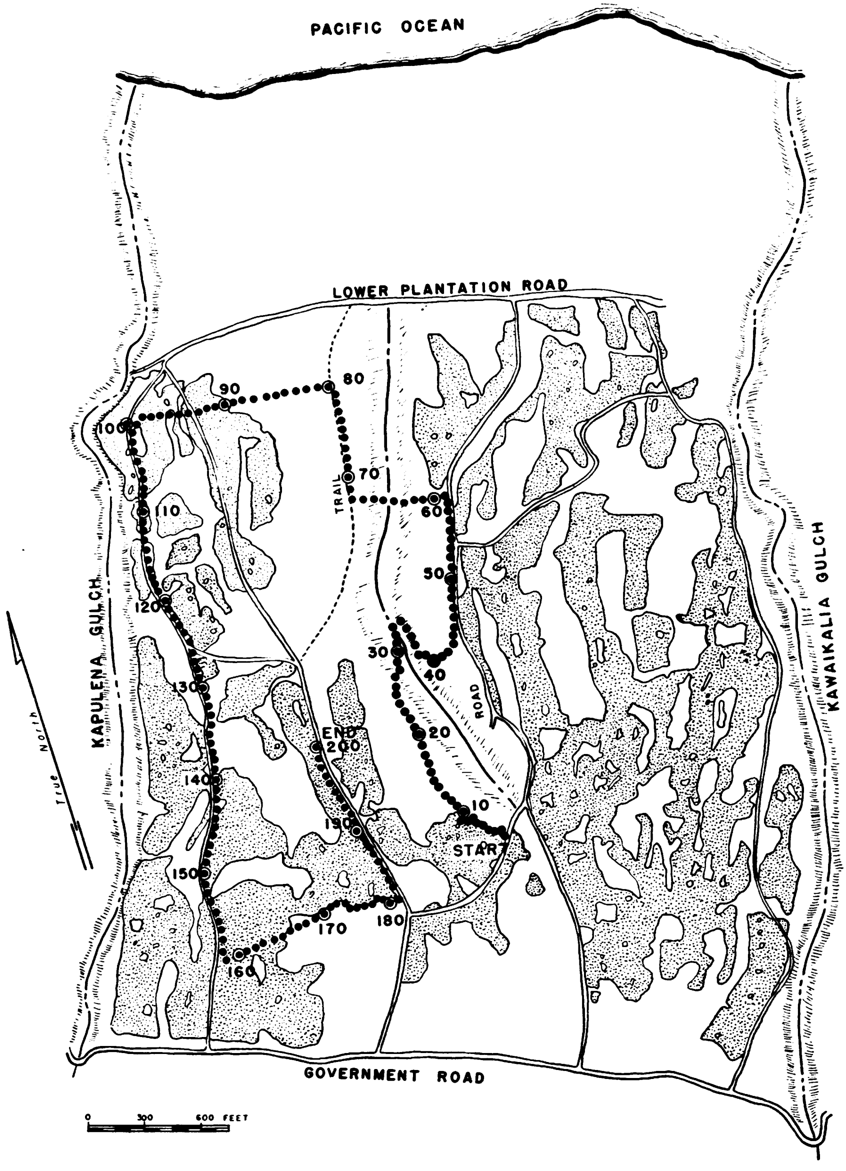

Figure 1. Field 109, Hamakua District, Hawaii, T. H., selected for rodenticidal experiment.

Many rock piles and a few rock walls are scattered throughout the wasteland sections. The experiment began February 3, 1951, and ended June 8, 1951.

Methods

To obtain a relative measurement of the rodent population, 200 numbered snap traps baited with coconut squares were set at intervals of 35 to 50 feet throughout the area. These traps were serviced each working day, and records were kept of the rodent catch by individual station. At the end of a 1-week period the traps were removed and portable bait stations were substituted. These stations consisted of empty sardine cans (6½ x 4¼ x 1½ inches) and a numbered, curved covering hood (12 x 13 inches) similar to that described by Doty (*3*).

Unpoisoned oats were not used at any time during this experiment. When the poison stations were first distributed, 4 ounces by weight of warfarin-treated oats [1] were placed in each bait pan. Thereafter, all stations were checked at 3-to 5-day intervals. The presence of fecal pellets, blood stains, and dead rats was noted, and bait consumption was recorded. The bait supply was replenished up to 4 ounces whenever indicated. This poisoning phase of the test was carried on for 91 consecutive days. At the end of this time the poison stations were replaced with snap traps. Snap trapping was continued for 4 weeks to obtain data that could be compared with pretrapping data. Unfortunately post-trapping activities could not be conducted over a longer period of time as field 109 was harvested a few days later.

Results

The total number of rodents retrieved during the pre-poisoning period show that field 109 was heavily infested (table 1). In addition, the trapping data indicate that *R. alexandrinus* was the predominant species of rat present in the area, that large numbers of *R. hawaiiensis* were also present, that *R. norvegicus* and *R. rattus* were less abundant, and that approximately half (47.9 percent) of the rodents found in the area were mice.

When the warfarin-treated oats were exposed, many stations became active within a few days (table 2). Throughout the poisoning

Table 1. ***Species composition of trapped rodents***

	Pre-poisoning period		Post-poisoning period [1]							
Species	First week		First week		Second week		Third week		Fourth week	
	Number trapped	Percent	Number trapped	Percent	Number trapped	Percent	Number trapped	Percent	Number trapped	Percent
R. alexandrinus	76	24.28	4	4.26	7	4.93	3	2.78	7	4.14
R. rattus	8	2.56	0	0	0	0	0	0	0	0
R. norvegicus	21	6.71	2	2.13	0	0	5	4.63	4	2.37
R. hawaiiensis	58	18.53	82	87.23	111	78.17	73	67.59	120	71.00
Total Rats	163	52.08	88	93.62	118	83.10	81	75.00	131	77.51
M. musculus	150	47.92	6	6.38	24	16.90	27	25.00	38	22.49
Total Rodents	313	100.00	94	100.00	142	100.00	108	100.00	169	100.00

[1] Warfarin-treated rolled oats exposed for 91 consecutive days.

[1] The poisoned oats consisted of a commercial product, prepared according to the formula of Doty, and contained by weight 0.025 percent warfarin, 11.0 percent mineral oil, 0.25 percent para-nitro-phenol (a mold deterrent), and 88.73 percent rolled oats.

Table 2. *Average daily consumption of warfarin-treated oats*

[200 bait stations]

Interval (days)	Number stations showing some acceptance	Percent stations showing some acceptance	Total bait consumed (gm.)	Average daily consumption (gm.)
4	145	72.5	3,997	999
3	159	79.5	7,002	2,334
3	185	92.5	9,830	3,277
4	162	81.0	6,790	1,698
3	131	65.5	3,352	1,117
4	154	77.0	5,401	1,350
3	135	67.5	4,132	1,377
4	131	65.5	4,061	1,015
3	160	80.0	4,210	1,403
4	135	67.5	4,387	1,097
3	139	69.5	4,097	1,366
3	101	50.5	2,814	938
5	169	84.5	7,258	1,452
3	131	65.5	3,558	1,186
3	151	75.5	3,877	1,292
4	161	80.5	5,705	1,426
3	122	61.0	3,622	1,207
4	149	74.5	5,521	1,380
3	138	69.0	4,897	1,632
4	175	87.5	7,655	1,914
3	146	73.0	4,486	1,495
4	171	85.5	8,115	2,029
3	170	85.0	6,350	2,117
4	154	77.0	7,782	1,946
3	150	75.0	6,081	2,027
4	185	92.5	8,455	2,114

phase, 316 pounds of the bait were consumed, and a high percentage of the stations continued to remain active. During this period, rodent droppings were observed in the bait pans on 549 different occasions. In addition, blood-stained oats were noted 28 times, and 11 rodents, showing signs of having consumed the poisoned grain, were found dead in, or immediately adjacent to, the stations. There was no evidence that any animal except rodents consumed the bait.

The average daily total consumption of the warfarin-treated oats remained at a low level for the first 4 days of exposure (fig. 2). During the following 6 days, consumption rose sharply. The two subsequent recordings, covering a period of 7 days, show that there was a sharp decline in the amount of poison bait eaten. At this time (17 days), the average daily total consumption of bait was 1,117 grams. Thereafter, the consumption curve showed a series of fluctuations with a gradual upward trend, indicating that large numbers of rodents were still present in the test area.

Examination of the results obtained during the post-trapping period shows that a radical change had occurred in the species composition of the rodents present in the area. The first week, there were marked reductions in the numbers of trapped *R. alexandrinus*, *R. rattus*, *R. norvegicus* and *M. musculus*. In contrast, the number of trapped *R. hawaiiensis* increased. Results obtained for the succeeding 3 weeks show that the species composition of the rats in the area remained relatively the same. The number of mice retrieved during this period showed a gradual increase. These data

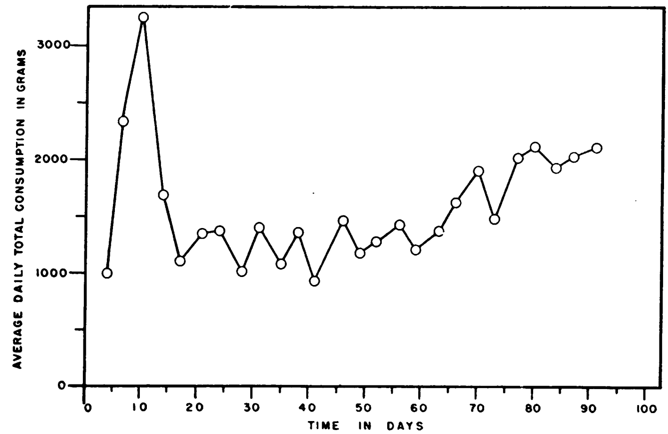

Figure 2. Consumption of warfarin-treated oats at 200 bait stations, field 109, Hamakua District, Hawaii, T. H., February 9 to May 11, 1951.

indicate clearly that the application of warfarin-treated oats resulted in control of all rodent species present except the native Hawaiian rat, *R. hawaiiensis*.

Discussion

Results of cage tests undertaken in Honolulu approximately 6 weeks after the Hamakua field experiment had begun, demonstrated that *R. hawaiiensis* accept warfarin-treated oats and die from the effects (see article following). The poison mix utilized for these cage tests was identical with that offered in the field experiment. The cage-test animals, however, did not have an extensive choice of food.

All species of rodents which were present in the field test area had a multiple choice of foods. After the poison bait was distributed, undoubtedly many of these rodents continued to feed to some extent on the various types of food normally available to them. As effective control of *R. alexandrinus*, *R. rattus*, *R. norvegicus*, and *M. musculus* was achieved through the use of warfarin-treated oats, it is apparent that most of these rodents also found the poison bait attractive and ingested quantities which eventually killed them.

The daily consumption of poison bait continued to remain at a high level throughout the poisoning period, indicating that *R. hawaiiensis* was also feeding on the warfarin mix. This conclusion is supported by the fact that 59.8 percent of the *R. hawaiiensis* rats trapped during the first week of the post-poisoning period showed evidence of hemorrhage on autopsy. Since the Hawaiian rat was not controlled effectively, it is not unlikely that this species fed sporadically on the warfarin-treated oats but did not consistently ingest sufficient quantities to produce death.

It is quite possible that the failure of the warfarin preparation to control *R. hawaiiensis* is related to the question of food preferences. In the field, *R. hawaiiensis* may be more selective in its choice of foods than the other species of rodents. In addition, this species may consistently prefer a greater variety of foods. These speculations indicate the desirability of conducting further investigations to determine the food preferences of *R. hawaiiensis*.

Another possibility is that the *R. hawaiiensis* population was not controlled because of extensive migrations from adjacent areas. However, if one assumes this, it is difficult to explain why the other species of rodents were so drastically reduced. Perhaps the increase in the number of *R. hawaiiensis* was partially related to the radical decrease in the number of the *R. alexandrinus*, *R. rattus* and *R. norvegicus*. Since these species are larger and undoubtedly compete with the Hawaiian rat, it is not improbable that a reduction in their numbers would result in *R. hawaiiensis* being subjected to less biological pressure, thereby giving this species a much greater chance of survival. This would apply to both *R. hawaiiensis* present in the area and to those migrating into it. The younger rats of this species would be benefited particularly by such conditions.

R. hawaiiensis is primarily a field rodent and prefers to live in rock piles or in thickly vegetated areas. It is timid and rarely infests human habitations. The other species of rodents are also found in the fields. However, they are more aggressive and occasionally infest buildings where they and their fleas come into intimate contact with people. In the communities, therefore, *R. alexandrinus*, *R. rattus*, *R. norvegicus*, and *M. musculus* are more directly implicated in the transmission of plague to humans than is *R. hawaiiensis*.

As previously noted, warfarin-treated oats effectively controlled all species of rodents in the test area except *R. hawaiiensis*. It is probable, therefore, that the extensive application of this rodenticide in field areas and in communities might have considerable value as a means of reducing the plague potential for the entire endemic region. However, large numbers of *R. hawaiiensis* are found in all areas of the plague district and plague infection is detected more often in this species than in any other rodent present. Thus, *R. hawaiiensis* and its ectoparasites would continue to be the reservoir of plague infection in the cane fields and wastelands.

The important role played by *R. hawaiiensis* in the epidemiology of plague in Hawaii focuses attention on the necessity of conducting additional laboratory and large-scale field tests to determine a suitable warfarin bait which will effectively control this species.

Summary

1. The purpose of this experiment was to determine the value of warfarin-treated oats as an additional plague suppressive measure

in field areas in Hawaii where large numbers of *Rattus hawaiiensis* were present.

2. The test was conducted in a sugar cane field located in the endemic plague region of the Hamakua District, island of Hawaii, T. H.

3. Trapping results obtained before warfarin-treated oats were exposed show that this field was heavily infested with rodents. The results indicated that *R. alexandrinus* was the predominant species of rat present in the area, that large numbers of *R. hawaiiensis* were also present, that *R. norvegicus* and *R. rattus* were less abundant and that approximately half (47.9 percent) of the rodents found in the area were *M. musculus*.

4. Warfarin-treated oats were exposed continuously at 200 bait stations for a period of 91 days. During this time 316 pounds of bait were consumed, and a high percentage of the stations remained consistently active, indicating that large numbers of rodents were still present in the test area.

5. Trapping results obtained immediately after poisoning activities showed that a radical change had occurred in the species composition of the rodents present in the area. There were marked reductions in the numbers of *R. alexandrinus*, *R. rattus*, *R. norvegicus*, and *M. musculus*. In contrast, the number of trapped *R. hawaiiensis* increased.

6. The data indicate clearly that the application of warfarin-treated oats resulted in control of all rodent species present except the native Hawaiian rat, *R. hawaiiensis*.

7. The extensive application of warfarin-treated oats in field areas and communities to control *R. alexandrinus*, *R. rattus*, *R. norvegicus*, and *M. musculus* might have considerable value as a means of reducing the plague potential for the entire endemic region. However, *R. hawaiiensis* and its ectoparasites would continue to be the reservoir of plague infection in the fields. It is indicated, therefore, that a more suitable warfarin bait be found which will effectively control this species.

REFERENCES

(*1*) Doty, R. E.: Warfarin (Compound 42) A promising new rodenticide for cane fields. Hawaiian Planters' Rec. **54**: 1–21 (1950).

(*2*) Eskey, C. R.: Epidemiological Study of Plague in the Hawaiian Islands. Public Health Bulletin No. 213, pp. 1–70 (1934).

(*3*) Doty, R. E.: Rat control on Hawaiian sugar cane plantations. Hawaiian Planters' Rec. **49**: 74–239 (1945).

Cage Tests With Warfarin on the Hawaiian Rat, *Rattus hawaiiensis* Stone, and the House Mouse, *Mus musculus* Linn., in Hawaii

By David D. Bonnet, Edward S. C. Mau, and Bertram Gross*

A previous report by Doty (*1*) has given the results obtained with warfarin-treated rolled oats as a rodenticide in cage tests in Hawaii on *Rattus norvegicus* (Erxleben), *Rattus alexandrinus* (Geoffroy), and *Rattus rattus* Linn. This paper reports a similar series of tests undertaken in Honolulu, T. H. on the Hawaiian rat, *Rattus hawaiiensis* Stone, and the house mouse, *Mus musculus* Linn. Data on the effectiveness of warfarin-treated rolled oats against these two additional species were particularly desired because an extensive field experiment in which this poison bait was used was already in progress in a rural plague area, where large numbers of both species were known to be present (see preceding report in this issue).

Rats and mice were captured during March and April 1951 near Honolulu, in live cage traps baited with squares of coconut meat. They were transferred to individual cages and provided with unlimited drinking water and pieces of coconut. Each cage contained nesting material and a suitable shelter. A record was made of the species, sex, and weight of each rodent.

Tared petri dishes containing weighed quantities of rolled oats were placed in the cages each day. These dishes and their contents were reweighed on each subsequent day and the amount consumed was determined by difference. Unpoisoned rolled oats were presented for approximately seven consecutive days, after which poisoned oats were substituted. Preliminary tests had demonstrated that a pretest period of 1 week was more than sufficient for the caged wild rodents to become accustomed to laboratory life and to consume regular amounts of food. The poisoned oats consisted of a commercial product, prepared according to the formula of Doty, and contained by weight 0.025 percent warfarin, 11.0 percent mineral oil, 0.25 percent para-nitro-phenol (a mold deterrent), and 88.73 percent rolled oats.

*Medical Entomologist, former Supervising Rodent Control Inspector, Oahu, and Chief, Bureau of Rodent Control, respectively, Division of Sanitation, Department of Health, Territory of Hawaii.

Note: 3 (alpha-phenyl-beta-acetyl ethyl)-4-hydroxycoumarin, or warfarin, is a chemical discovered, by Dr. K. P. Link and associates of the Wisconsin Alumni Research Foundation, to have lethal anti-coagulant properties in mammals.

Results

A summary of the results obtained is presented in the table. There was a difference in the quantity of food eaten by the male and female rats, but when calculated on a body weight basis, the difference was not significant. The poisoned oats were not quite as acceptable as unpoisoned oats, since the daily food consumption dropped significantly on the first 2 days after presentation of the poison. After the second day there was an even further drop in consumption (fig. 1), probably indicating that the poison was beginning to take effect. The increased daily consumption as shown in figure 1 after the sixth day is the result of consumption by those animals which lived beyond the mean day of death (7.9 days). The animals in this group, constituting 50 percent of the population, ate a smaller quantity of warfarin oats (4.9 gm.) during the first 2 days of the experiment, and were still consuming small quantities of poisoned bait at the same time that early mortalities were eliminating a portion of the population. Therefore, the food consumption, as percent of body weight, is warped and indicates an artificial increase which is not significant. This avoidance of the poisoned bait by some individuals may account in part for the longer survival of this group.

The mean day of death (7.9) is somewhat greater in *R. hawaiiensis* than that reported by Doty for the other species of rodents found in Hawaii (*R. norvegicus*, 5.4 days; *R. rattus*, 5.8 days; and *R. alexandrinus*, 6.8 days). This would appear to indicate a greater resistance of *R. hawaiiensis* to the effects of the poison. However,

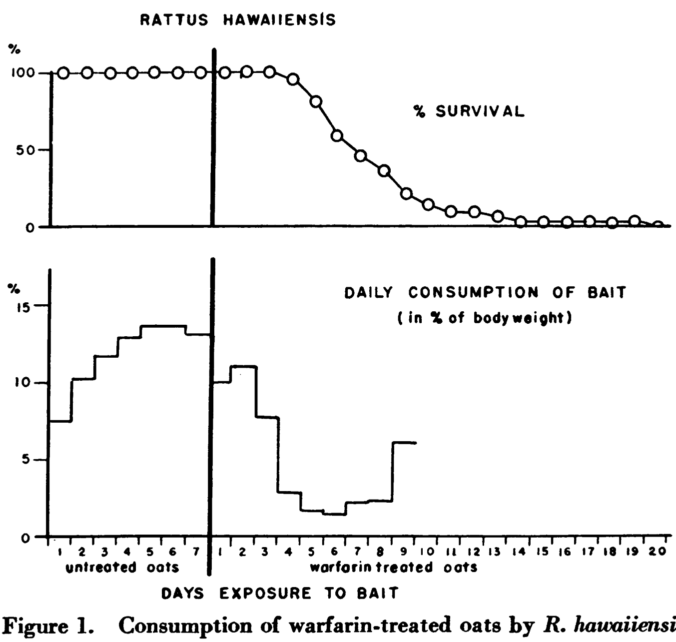

Figure 1. Consumption of warfarin-treated oats by *R. hawaiiensis*.

the amount of poisoned oats ingested by this species in percentage of body weight was 38.9 ± 1.3 percent. This quantity is not significantly different from the amounts ingested by *R. alexandrinus* in Doty's tests. None of the animals in this series refused to accept the warfarin-poisoned oats, and all died from the effects.

Results of cage tests with warfarin, in Hawaii, March and April 1951

Item	*Rattus hawaiiensis*	*Mus musculus*
Number	42	15.
Total body weight	2,313.8 gm	198.2 gm.
Mean body weight	55.1±1.2 gm	13.2±1.0 gm.
Mean daily consumption of unpoisoned rolled oats	7.1±0.2 gm	2.3±0.3 gm.
Mean daily consumption as percent of body weight	12.9±0.8 percent	17.4±3.0 percent.
Total warfarin-oats eaten	899.0 gm	143.0 gm.
Mean daily consumption of warfarin-poisoned oats on 1st and 2d day of presentation.	5.6±0.2 gm	1.4±0.4 gm.
Total warfarin-oats as percent of total body weight	38.9±1.3 percent	72.2±6.5 percent.
Mean day of death	7.9±0.5 days	8.6±1.0 days.

The earliest that death occurred was 4 days after the initial presentation of poison. The maximum survival was 20 days. By the eleventh day, 90 percent of the experimental animals had succumbed to the effects of warfarin.

Autopsies were performed on all animals after death, and hemorrhages were found in various organs of the body, including the heart,

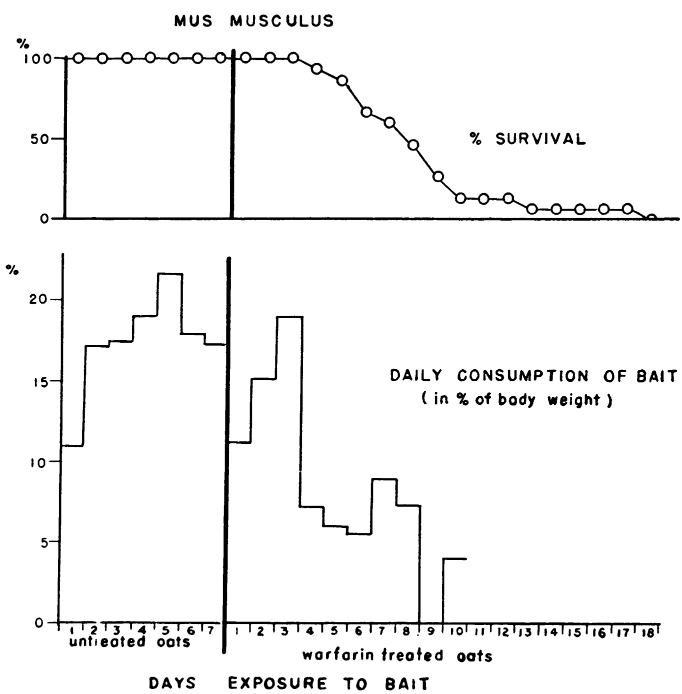

Figure 2. Consumption of warfarin treated oats by *M. musculus*.

lungs, mesenteries, brain, skin, muscles, and genitourinary systems. In most instances, more than one system was involved. It is noteworthy, however, that 69 percent of the rats showed extensive hemorrhages in the pectoral-cervical region. Hayes and Gaines (*2*) have stated that for the white rat the perioesophageal and cervical bleeding was possibly the result of mild experimental trauma due to stomach tube application of the poison. Our results indicate that in *R. hawaiiensis* cervical involvement occurs naturally and with high frequency.

As would be expected in a smaller animal, the food consumption of mice in terms of percentage of body weight, was greater than that found in the rats (fig. 2). The mean day of death for *Mus musculus* was 8.6 days, which is significantly greater than that found for *Rattus hawaiiensis* or for the three species tested by Doty. The ingestion of warfarin by mice continued for a longer period and resulted in a high consumption of poisoned rolled oats (72.2 ± 6.5 percent) when computed in terms of percentage of body weight. Ninety percent of the mice were dead as a result of the poison by the end of the thirteenth day. The earliest death occurred on the fourth day, and the maximum survival of any individual mouse was 17 days.

REFERENCES

(*1*) Doty, R. E.: Warfarin (Compound 42) A promising new rodenticide for cane fields. Hawaiian Planters' Rec. **54:** 1–21 (1950).

(*2*) Hayes, Wayland J., Jr., and Gaines, Thomas B.: Control of Norway rats with residual rodenticide warfarin. Pub. Health Rep. **65:** 1537–1555. (1950).

Incidence of Disease

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

---

Announcement

A New *Morbidity and Mortality Weekly Report*

The new monthly PUBLIC HEALTH REPORTS (see back cover) will publish from time to time, as appropriate, reports, tabulations, and articles dealing with morbidity statistics, both domestic and foreign. The present weekly "Incidence of Disease" section, however, will be discontinued as of December 31, 1951.

Current provisional morbidity data on notifiable diseases for the United States now appear in summary form and in tabulations by States and cities in the *Weekly Morbidity Report* issued by the National Office of Vital Statistics of the Public Health Service. Beginning on January 11, 1952, the Public Health Service through the National Office of Vital Statistics will issue a *Morbidity and Mortality Weekly Report* presenting these morbidity data as well as certain mortality data for selected cities.

Libraries and agencies that have depended upon PUBLIC HEALTH REPORTS for current morbidity statistics for the United States may continue to receive the same data by writing to the National Office of Vital Statistics, Public Health Service, Washington 25, D. C., requesting that they be placed on the mailing list for the new *Morbidity and Mortality Weekly Report*. Individuals who wish to be placed on the mailing list should indicate how and to what extent they will make use of this publication.

Since the *Weekly Epidemiological Record* and other publications of the World Health Organization, Geneva, Switzerland, contain morbidity data for foreign countries, tabulations of notifiable diseases occurring outside the United States and its Territories will not appear regularly in National Office of Vital Statistics publications.

UNITED STATES

Reports from States for Week Ended December 8, 1951

The incidence of measles declined slightly for the current week as compared with the previous week but was about 66 percent higher than for the same week in 1950. The greatest concentration of cases continues to be in the northeastern section of the country.

The number of cases of scarlet fever (1,530) for the current week is about 30 percent higher than for the same week last year. The 5-year median is 1,837.

A slight decrease in poliomyelitis cases was reported. The cumulative total for the calendar year is now 27,975 as compared with

32,473 for the same period in 1950. The cumulative total since the seasonal low week is 26,757 as compared with 31,342 in 1950.

Diphtheria incidence was lower for the current week than for the same week last year. The disease continues to be concentrated in the southern States.

Two cases were erroneously reported as smallpox in Nebraska last week because of a clerical error. They were cases of chickenpox.

Nine cases of rabies in animals were erroneously reported for New Jersey for the week ended November 24 because of an error in transmitting the report.

One case of leprosy was reported by Minnesota.

Only eight cases of malaria in civilians were reported, two in New York and six in Texas. The number from military establishments was also smaller as compared with previous weeks.

Epidemiological Reports

Gastroenteritis

Dr. J. P. Ward, Arizona Director of Public Health, has reported an outbreak of gastroenteritis consisting of 40 cases which occurred at a church social. All food stuffs served at the meal were examined bacteriologically and *Staphylococcus* was isolated from a sample of cole slaw. Mayonnaise was suspected of containing the organism and improper refrigeration was thought to be a contributing factor.

Dr. H. W. Stevens, Massachusetts district health officer, has reported an outbreak of gastroenteritis caused by *Salmonella montevideo*. Nine cases occurred after an incubation period of 18 to 24 hours following the eating of chocolate eclairs. The illness lasted from 1 to 2 weeks. Because of a marked delay in reporting the cases, investigation of the bakery where the eclairs were prepared, and of its personnel, did not reveal the source of infection.

S. V. Dugan, Kentucky Department of Health, has reported an outbreak of gastroenteritis in a public school which presumably followed the eating of wieners in the cafeteria. About 45 to 50 pupils out of a total of 98 who ate in the cafeteria became ill after an incubation period of 3 to 10 hours. A sample of uncooked wieners, when examined in the laboratory, showed the presence of a weakly hemolytic alpha prime type *Streptococcus*. Fifty grams of the sample fed to a kitten caused marked diarrhea 24 hours later.

Reports have been received that construction workers and other personnel on a project in Nevada were affected twice within 2 weeks by outbreaks of gastroenteritis, presumably food-borne. Sixty persons were affected in the first and 100 or more in the second instance. Some article of food in box lunches, which included meat sandwiches, is suspected of being the vehicle of infection.

Rabies in Animals

Rabies has been reported in a number of species of animals over the past few months in South Dakota. Prior to 1951, no cases in animals had been observed for about 13 years. Since the disease appeared in April 1951, laboratory confirmation has been obtained on the following species of animals: dogs, cats, skunks, muskrats, squirrels, rats, and mice. The infection has been found more frequently in skunks than in dogs or other domestic animals.

Psittacosis

Dr. Albert Milzer, Collaborating Laboratory of the Influenza Study Program, has reported a complement fixation titer of 1 to 64 in acute phase serum, and 1 to 256 in convalescent serum for the psittacosis-pneumonitis group in a woman who owns a pet shop in Chicago. The patient who sells parrots and parakeets had clinical findings of an atypical pneumonia and responded successfully to aureomycin therapy.

Comparative Data for Cases of Specified Reportable Diseases: United States

[Numbers after diseases are International List numbers, 1948 revision]

Disease	Total for week ended—		5-year median 1946–50	Seasonal low week	Cumulative total since seasonal low week		5-year median 1945–46 through 1949–50	Cumulative total for calendar year—		5-year median 1946–50
	Dec. 8, 1951	Dec. 9, 1950			1950–51	1949–50		1951	1950	
Anthrax (062)	------	1	1	(1)	(1)	(1)	(1)	57	43	48
Diphtheria (055)	90	132	220	27th	1,910	2,573	4,518	3,918	5,701	9,129
Encephalitis, acute infectious (082)	26	20	11	(1)	(1)	(1)	(1)	999	953	608
Influenza (480–483)	1,695	1,210	1,210	30th	8,045	11,097	11,097	124,100	149,864	139,295
Measles (085)	6,059	3,008	3,008	35th	31,341	18,254	18,238	500,252	306,425	584,626
Meningitis, meningococcal (057.0)	76	80	69	37th	804	741	709	3,865	3,540	3,253
Pneumonia (490–493)	1,089	1,551	(2)	(1)	(1)	(1)	(1)	56,221	76,282	(2)
Poliomyelitis, acute (080)	378	480	322	11th	[3] 26,763	31,342	26,666	[3] 27,975	32,473	27,016
Rocky Mountain spotted fever (104)	------	1	1	(1)	(1)	(1)	(1)	328	452	558
Scarlet fever (050) [4]	1,530	1,194	1,837	32d	11,662	11,673	15,898	65,048	51,843	72,259
Smallpox (084)	------	------	1	35th	[5] 1	11	11	[5] 12	37	53
Tularemia (059)	20	16	22	(1)	(1)	(1)	(1)	613	841	962
Typhoid and paratyphoid fever (040,041) [6]	53	54	51	11th	2,553	2,798	3,238	2,988	3,307	3,723
Whooping cough (056)	1,502	1,967	2,227	39th	11,286	16,964	16,964	65,061	114,159	93,755

[1] Not computed. [2] Data not available. [3] Addition: Kentucky, 6 cases, delayed reports—not allocated. [4] Including cases reported as streptococcal sore throat. [5] Deduction: Nebraska, week ended Dec. 1, 2 cases. [6] Including cases reported as salmonellosis.

Reported Cases of Selected Communicable Diseases: United States, Week Ended Dec. 8, 1951

[Numbers under diseases are International List numbers, 1948 revision]

Area	Diphtheria (055)	Encephalitis, infectious (082)	Influenza (480–483)	Measles (085)	Meningitis, meningococcal (057.0)	Pneumonia (490–493)	Poliomyelitis (080)
United States	**90**	**26**	**1,695**	**6,059**	**76**	**1,089**	**378**
New England		**1**	**4**	**1,094**	**5**	**44**	**5**
Maine			2	129		9	1
New Hampshire				46	1	4	
Vermont				137			
Massachusetts		1		439			3
Rhode Island				91	3	1	
Connecticut			2	252	1	30	1
Middle Atlantic	**6**	**4**	**1**	**2,394**	**19**	**102**	**19**
New York	3	4	(1)	1,368	10		9
New Jersey			1	294		40	
Pennsylvania	3			732	9	62	10
East North Central	**19**	**9**	**5**	**1,035**	**14**	**94**	**46**
Ohio	9			230	5		11
Indiana	8	2		33			6
Illinois	1	3	3	306	3	78	6
Michigan	1	4	2	364	6	16	16
Wisconsin				102			7
West North Central	**7**	**1**	**7**	**129**	**5**	**212**	**36**
Minnesota			1	47	1	13	13
Iowa				7	1		2
Missouri	6		1	5	1		6
North Dakota		1	5	35		198	
South Dakota				9	1		1
Nebraska				16			4
Kansas	1			10	1	1	10
South Atlantic	**29**	**3**	**75**	**508**	**8**	**123**	**27**
Delaware				1			
Maryland	1		1	231		33	3
District of Columbia				31		17	1
Virginia	3	2		65	3	40	4
West Virginia	4	1		44	1		3
North Carolina	3			7	4		4
South Carolina	1		44	14		4	
Georgia	13		30	91		29	5
Florida	4			24			7
East South Central	**17**	**1**	**14**	**243**	**10**	**53**	**40**
Kentucky	2		2	168	3	2	5
Tennessee	1	1		44	5		5
Alabama	12			17	1	37	8
Mississippi	2		12	14	1	14	22
West South Central	**8**	**1**	**203**	**81**	**4**	**287**	**79**
Arkansas			97	15		31	13
Louisiana			1	1		31	7
Oklahoma	1		105	6	2	9	2
Texas	7	1		59	2	216	57
Mountain	**1**		**1,357**	**283**	**3**	**85**	**35**
Montana			25	41	1		2
Idaho	1			5			6
Wyoming				1		3	4
Colorado			1,117	24		20	5
New Mexico				10	1	1	1
Arizona			215	145		61	2
Utah				57	1		13
Nevada							2
Pacific	**3**	**6**	**29**	**292**	**8**	**89**	**91**
Washington	2		4	103	1	2	10
Oregon			13	14	2	39	6
California	1	6	12	175	5	48	75
Alaska		1					
Hawaii			32	784			

1 New York City only.

Reported Cases of Selected Communicable Diseases: United States, Week Ended Dec. 8, 1951—Continued

[Numbers under diseases are International List numbers, 1948 revision]

Area	Rocky Mountain spotted fever (104)	Scarlet fever [1] (050)	Smallpox (084)	Tularemia (059)	Typhoid and paratyphoid fever [2] (040, 041)	Whooping cough (056)	Rabies in animals
United States		**1,530**		**20**	**53**	**1,502**	**129**
New England		**85**			**4**	**200**	
Maine		4				33	
New Hampshire		9				12	
Vermont		2				41	
Massachusetts		48			3	85	
Rhode Island		1				14	
Connecticut		21			1	15	
Middle Atlantic		**258**		**1**	**4**	**216**	**7**
New York		173			3	100	3
New Jersey		19				40	
Pennsylvania		66		1	1	76	4
East North Central		**528**		**6**	**5**	**281**	**10**
Ohio		151			1	100	4
Indiana		64		1	1	13	1
Illinois		99		2	1	29	2
Michigan		171		3	1	81	1
Wisconsin		43			1	58	2
West North Central		**77**		**2**		**85**	**19**
Minnesota		18		2		1	10
Iowa		5				6	4
Missouri		23				26	5
North Dakota		1				4	
South Dakota		3				2	
Nebraska		4				24	
Kansas		23				22	
South Atlantic		**179**		**2**	**7**	**145**	**28**
Delaware							
Maryland		32				9	
District of Columbia		13			1		
Virginia		23		1	2	24	3
West Virginia		17				67	2
North Carolina		69			1	14	12
South Carolina		2					3
Georgia		11		1	3	13	8
Florida		12				18	
East South Central		**49**		**3**	**2**	**109**	**29**
Kentucky		23		3		45	4
Tennessee		25				28	11
Alabama					1	32	6
Mississippi		1			1	4	8
West South Central		**49**		**5**	**9**	**334**	**32**
Arkansas		6		4	1	11	2
Louisiana		4				3	
Oklahoma		9		1	1	11	2
Texas		30			7	309	28
Mountain		**50**		**1**	**3**	**40**	
Montana		10				4	
Idaho		8				11	
Wyoming		1		1		2	
Colorado		7			1	17	
New Mexico		3			1	1	
Arizona		4			1	4	
Utah		12				1	
Nevada		5					
Pacific		**255**			**19**	**92**	**4**
Washington		20			1		
Oregon		29				8	
California		206			18	84	4
Alaska		1					
Hawaii					3		

[1] Including cases reported as streptococcal sore throat. [2] Including cases reported as salmonellosis.

FOREIGN REPORTS

CANADA

Reported Cases of Certain Diseases—Week Ended Nov. 24, 1951

Disease	Total	New-found-land	Prince Ed-ward Island	Nova Scotia	New Bruns-wick	Que-bec	On-tario	Mani-toba	Sas-katch-ewan	Al-berta	Brit-ish Co-lum-bia
Brucellosis	2					2					
Chickenpox	1,228	6		33	4	189	508	56	95	185	152
Diphtheria	12					11				1	
Dysentery:											
Amebic	3					3					
Bacillary	3						3				
Encephalitis, infectious	1								1		
German measles	167			82		22	23		12	13	15
Influenza	16			12			2	1	1		
Measles	793	14			6	154	97	20	2	358	142
Meningitis, meningococcal	10					4			1	1	4
Mumps	718	1			2	130	388	38	47	60	52
Poliomyelitis	20			2		8	3		5	1	1
Scarlet fever	385				2	122	31	23	44	44	119
Tuberculosis (all forms)	271	33		10	2	123	23	35	10	12	23
Typhoid and paratyphoid fever	5					5					
Venereal diseases:											
Gonorrhea	301	6		3	3	74	57	26	33	41	58
Syphilis	68	5		5	1	36	10	2	1	1	7
Primary	6					3	1				2
Secondary	5					3	1			1	
Other	57	5		5	1	30	8	2	1		5
Other forms	1							1			
Whooping cough	257					116	60	16	15	32	18

MADAGASCAR

Reported Cases of Certain Diseases and Deaths—September 1951

Disease	Aliens		Native	
	Cases	Deaths	Cases	Deaths
Beriberi			1	
Bilharziasis			86	
Dysentery:				
Amebic	2		153	
Bacillary	2		21	
Diphtheria	1		9	
Erysipelas			6	
Influenza	2		3,388	13
Leprosy			24	
Malaria	103	2	24,824	113
Measles	2		229	4
Mumps			100	
Meningitis, meningococcal			6	3
Plague			25	20
Pneumonia (all forms)	4	1	691	70
Puerperal infection			8	1
Tuberculosis, respiratory	8	1	109	15
Typhoid fever			3	
Whooping cough	7		293	

REPORTS OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER RECEIVED DURING THE CURRENT WEEK

The following reports include only items of unusual incidence or of special interest and the occurrence of these diseases, except yellow fever, in localities which had not recently reported cases. All reports of yellow fever are published currently.

Cholera

India. During the week ended December 1, cholera was reported as follows: Calcutta, 77 cases; and Madras, 8.

Pakistan. For the week ended December 1, 20 cases of cholera were reported in Dacca.

Plague

Madagascar. There were more cases (25) of plague reported during the period November 11–20 than for any previous 10-day period this year. Only 9 cases were reported for the period November 1–10.

Union of South Africa. One case of septicemic plague was reported during the week ended November 24, in the Bothaville District, Orange Free State.

Smallpox

Algeria. One case of smallpox was reported during the period October 21–31. This is the first case since August 21.

Burma. Smallpox was reported for the week ended December 1, as follows: Mergui, 27 cases; Moulmein, 2; and Rangoon, 1.

India. During the week ended December 1, smallpox was reported in ports of India as follows: Madras, 8 cases; Calcutta, 5; Bombay, 2; and Cawnpore, 1.

Indochina. The incidence of smallpox in Hanoi, Viet Nam, has increased from 33 cases reported for the week ended November 24, to 208 for the following week.

Yellow Fever

Gold Coast. The three cases of yellow fever reported in Suhum for the period August 2–9, were confirmed on November 30.