Public Health Reports

Vol. 64 • JULY 29, 1949 • No. 30

Transmission of *Salmonella enteritidis* by the Rat Fleas *Xenopsylla cheopis* and *Nosopsyllus fasciatus*

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During the course of culturing flea feces to determine the presence of plague infection, it was discovered that a number of fleas were excreting *Salmonella enteritidis* (Gaertner), which had invaded the laboratory mouse colony. This accidental infection of the fleas initiated this study.

Varela and Olarte (1) state that they were able to infect *Pulex irritans* Linnaeus, and *Ctenocephalides canis* (Curtis) by feeding them on *S. enteritidis* infected mice, but failed to transmit the disease with these ectoparasites. Parker and Steinhaus (2) report that they infected ticks, *Dermacentor andersoni* Stiles, with *S. enteritidis* and that these arachnids were capable of transmitting the infection to guinea pigs. Body lice removed from patients were found infected with *S. enteritidis*, according to Huang, Chang, and Lien (3).

Infecting Fleas

The white mouse proved to be a very desirable animal to use for infecting fleas with *S. enteritidis*. Of several procedures used to infect mice, the most satisfactory method and the one adopted in the tests was the subcutaneous inoculation of 0.1 cc. of a 5 cc., 24-hour tryptose hormone broth culture. Intraperitoneal inoculation was not satisfactory because most of the animals died from the local reaction. Mice infected with contaminated drinking water were unsuitable because of the irregularity with which septicemia appeared. In one instance, satisfactory results were obtained by feeding fleas on a mouse which was infected by the bites of fleas, thus demonstrating that the infection can be transmitted from mouse to mouse by fleas.

Fleas used in the experiments were bred in the laboratory and were starved for 48 hours or longer before placing them on infected mice. They were not exposed to infection until a blood smear from the tail of the mouse revealed the presence of at least three or four organisms per smear. In most instances, only a small percentage of fleas exposed

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to this low degree of septicemia were found to harbor the *Salmonella* organisms afterwards. Best results were obtained when mouse blood smears contained five or more bacteria per microscopic field. The results from exposing various groups of fleas to infection by feeding on different mice varied from 3 to 98 percent flea infection. This was true in the case of both species of fleas used in this study, *Xenopsylla cheopis* (Roths.) and *Nosopsyllus fasciatus* (Bosc.) Upon removal from infected mice, each flea was placed in a clean test tube and stored in an incubator at 72° F. A high humidity was maintained by keeping an open pan of water in the incubator.

Method of Determining Flea Infection

As soon as fecal material was observed in the test tube after a flea had fed on an infected mouse, the flea was transferred to a clean tube. The fecal matter was emulsified with a drop of hormone broth, and then streaked with a platinum loop on *Salmonella Shigella media* (Difco). When the first feces culture was negative, the flea was usually discarded or fed on another infected mouse; occasionally, a second test was performed. To determine the persistence of the infection, droppings from each flea were cultured at weekly intervals until death, at which time the flea was triturated and plated.

Duration of Flea Infection

A considerable number of fleas excreted all the *Salmonella* organisms in their first fecal deposits following exposure to infection, while others became free of the infection at various periods as shown in the table below. *N. fasciatus* tended to harbor the infection longer than *X. cheopis*.

	<i>X. cheopis</i>		<i>N. fasciatus</i>	
	Number	Percent	Number	Percent
Free of infection after 1 positive feces.....	16	25.8	16	11.6
Free of infection by end of second week.....	12	19.4	7	5.1
Free of infection by end of fourth week.....	1	1.6	17	12.3
Free of infection end of eighth week.....	2	3.2	6	4.3
Total becoming free of infection.....	31	50	46	33.3
Retained infection until death or killed.....	31	50	92	66.6

Length of Life of Infected Fleas

S. enteritidis infection unquestionably shortened the life of *X. cheopis*. None of this species that remained infected until death survived over 40 days. Only 26 percent lived more than 30 days. The average length of life of the 31 fleas still infected at death was 24 days. Three uninfected *X. cheopis*, one male and two females carried as controls, were killed after 63 days' observation.

N. fasciatus were more resistant to the infection than *X. cheopis* as 38 percent of them survived the infection over 40 days. In fact, 18 percent lived more than 8 weeks. However, it is believed that many of the *N. fasciatus* died as the direct result of the *Salmonella* infection.

Symptoms of Infection

Many infected fleas of both species developed symptoms of an inflammatory condition of the gastro-intestinal tract. For instance, there were generally about twice as many fecal deposits during the last week of life as during the first week after infection. Over 20 percent of *N. fasciatus* developed a bloody diarrhea, a condition not observed among the *X. cheopis*. This diarrhea appeared as red splotches of bloody material deposited in the bottom of the test tubes with as many as four or five excretions in 24 hours. Most of the *N. fasciatus* died a few days following the appearance of diarrhea; but, in a few instances, the condition disappeared, and the fleas lived many days afterward. In one case, the flea became free of infection after excreting bloody material for 2 or 3 days.

A second noticeable feature in connection with *S. enteritidis* infection of fleas was the prolonged efforts made by many of them to feed. Numerous bites of infected fleas were frequently from 10 to 20 minutes duration. Normal fleas of both species used in this study rarely required more than 5 minutes to satisfy their appetites, although, on rare occasions, they remained attached to their hosts 10 minutes, or slightly longer. The bites of 45 percent of the *Salmonella* infected *X. cheopis* which survived over 2 weeks averaged 8.7 minutes per bite as compared to 2.8 minutes for the normal fleas.

The bites of infected *N. fasciatus* did not tend to be as prolonged as those of *X. cheopis*. However, the average length per feeding of 54 percent of *N. fasciatus* which survived 2 weeks or more was 6.6 minutes as compared to an average of 3.8 minutes per bite for 10 uninfected fleas of this species which were under observation for 3 to 6 weeks. Prolonged efforts to feed occurred at almost any period during the life of infected fleas, that is, during the first week after infection, or at any intermediate period during life. Not infrequently the last attempt to feed before death was unusually prolonged because of the weakened condition of the flea.

Microscopic Evidence of *S. enteritidis* Infection

At varying intervals, a large series of infected fleas were examined microscopically, and colored photomicrographs were made of many of them. The following conditions observed in these studies are believed to be the result of *S. enteritidis* infection.

Evidence of bacterial growth in the stomach. The contents of a normal flea's stomach immediately after feeding has a uniformly bright red appearance unless there is present some residue of the previous meal. This residue usually appears as a very dark substance which follows the contour of the posterior end of the stomach, or, in some instances, it may be seen as rather coarse granular material which is mixed more or less with the recently ingested blood. In the case of *S. enteritidis* infected fleas, the recently ingested meal generally has a definitely dark cloudy appearance which involves practically all of the distended stomach and which is believed to be due to the multiplication of the *Salmonella* organisms. Variation in the intensity of the discoloration in different zones is more characteristic of *X. cheopis* than *N. fasciatus*. In the case of the former species, the dark discoloration tended to be most intense around the periphery, next to the stomach wall, thus producing a nearly clear central zone. This condition may be due to adherence of the bacterial formations to the stomach wall, or to a tenacity of the material which prevents its diffusion throughout the ingested blood as it enters the stomach.

Stippling of the esophagus. In a number of fleas, very fine dark specks outlined nearly the entire length of the esophagus. As this condition does not occur in normal fleas, it would seem that it was produced by the *Salmonella* infection.

Invasion of the body cavity by the infection. In many infected fleas of both species, brownish discolored areas of varying intensity and size were observed in the posterior third of the body cavity. In some instances, these brownish formations appeared to involve the rectal pouch, or to envelop it. In normal fleas the outlines of the rectal pouch are generally visible, but in a great many of those infected with *S. enteritidis*, it was impossible to discern this structure.

Loss of tissue tone or elasticity. From the microscopic appearance of a number of fleas, it seemed that the *Salmonella* infection resulted in a loss of tone of the structures forming the alimentary tract. Dilatation of the esophagus by freshly ingested blood was observed in microscopic examination of several *N. fasciatus*. The blood in the esophagus of these fleas was continuous with that in the stomach through a patent proventriculus. In other instances, the esophagus was dilated after feeding, but did not contain any blood. Excessive dilatation of the stomach following feeding was observed in both *X. cheopis* and *N. fasciatus*. There were also instances in which the rectal pouch was much more distended than ever observed in normal fleas. Occasionally, fleas died in a very short time after dilatation of one or more of the alimentary structures was observed. Prolonged efforts to feed may have been due to loss of muscle tone in some cases.

Transmission by Feeding Fleas Individually on Mice

In these experiments, groups of 3 to 15 *S. enteritidis* infected fleas were fed individually on separate mice. Eight of the mice upon which these fleas were fed died of the Salmonella infection. Before mice were used in the experiments, the feces of each mouse were examined for *S. enteritidis*. A total of 58 mice was used because of the frequent shifting of each group of fleas to a fresh mouse. Whenever the feeding of infected fleas was discontinued, the mouse was set aside for observation for about a month. Then it was killed and examined for evidence of infection. The nature of the infection was proved in every mouse by macroscopic and microscopic examination, and by the cultural characteristics of the isolated Salmonella organisms. Mice were kept in sterilized individual glass jars, and the metal tubes in which they were held while fleas fed on them were sterilized before being used for another mouse.

From the results of feeding individual fleas on mice, it would seem that *N. fasciatus* were more efficient vectors of *S. enteritidis* than *X. cheopis* since 138 of the former species transmitted the infection to 7 of 43 mice upon which they were fed as compared to one transmission by 46 *X. cheopis* which were fed on 15 mice.

In experiments of this type, it was impossible to determine which particular flea or bite resulted in the transmission of the infection. In some instances, the bites of two or more fleas may have been infectious. In three cases, fleas defecated from one to three times on mice that became infected. There is a possibility that these three mice might have contracted their infection by licking off the infectious feces. As none of the fleas defecated on the other five mice, it may be assumed that these mice were infected by the bites of the fleas.

The mechanism involved in the transmission of *S. enteritidis* through a flea bite is unknown. The abnormally long efforts many fleas spent in feeding suggest that the blood meal could not enter the stomach in a normal manner. This may have resulted in the regurgitation from the esophagus with the concomitant inoculation of the host. However, the microscopic examination of many fleas failed to reveal a single instance of complete blockage of the stomach such as occurs in plague-infected fleas.

Following is a short summary of four experiments which resulted in the infection of mice by *S. enteritidis* infected fleas:

Experiment 1. Between November 29 and December 4, 1948, 10 *N. fasciatus*, which were infected November 27, fed 28 times on a mouse that died December 7, 1948. During the 6 days the fleas fed on the mouse, one bite from each of six different fleas was of abnormal duration varying from 6 to 12 minutes. One flea that fed for 12

minutes on December 1, or 6 days prior to the death of the mouse, was dead when examined the next day.

Experiment 2. The mouse used in this experiment was found to be excreting *S. enteritidis* in its feces December 15. A positive blood culture was obtained from the mouse December 22, and it was dead on December 23. This mouse was exposed to the bites of three *N. fasciatus*, all of which had previously fed on the animal infected in experiment 1. Between December 10 and 13, inclusive, the fleas fed six times. The longest of these bites was one of 6 minutes duration on December 11, or 4 days before *Salmonella* organisms were found in the feces of the mouse. The flea responsible for this bite refused to feed the next day and was dead when examined December 13. The fleas used in this experiment were infected 14 days before they were fed on the mouse.

Experiment 3. Between January 24 and February 5, 1949, 13 *N. fasciatus* fed 80 times on a mouse that died of *S. enteritidis* infection on February 9. The fleas were infected January 14, or 10 days before they fed on the mouse. None of the flea bites could be considered abnormal. Two fleas died during the experiment, and one ceased excreting *Salmonella* organisms after January 31. Therefore, the record of the experiment does not provide any information regarding the time of the infectious bite or the flea or fleas responsible for the infection of the mouse. However, it is possible that the mouse may have been infected by flea feces as one flea defecated on its abdomen January 25, and a second one, on February 2.

Experiment 4. In this experiment, nine *X. cheopis*, which were infected December 29, 1948, were fed on a mouse that died February 4, 1949. The fleas were not fed on the mouse until 6 days after their infection. One positive feces had been obtained from each flea before the experiment was begun. However, the feces of four fleas were negative when tested the next time so that they had ceased to harbor *Salmonella* organisms before they had a chance to bite the mouse. The feces of a fifth flea was free of *S. enteritidis* after January 6, or after it had fed once on the mouse. As it is unlikely that this flea could have infected the mouse, the transmitting agent was probably one of the remaining four fleas. Two of these four fleas became free of infection during the course of the experiment—one after January 17, and the other after January 31. However, the bites of both these fleas could have been infectious prior to the dates that they ceased to excrete *Salmonella* organisms. Each of the four suspected fleas fed for abnormally long periods on the mouse on two or more occasions—the efforts to feed were of 10 minutes or more duration. The bite of one flea on January 7, or 28 days prior to the death of the mouse, lasted 24 minutes. The flea was dead 3 days later, having

refused to feed once in this interval. Excessively long bites were made by the other three fleas, 25, 22, 14, 11, and 8 days, respectively, before the death of the mouse. Which of these suspicious bites could have resulted in transmission of the *Salmonella* infection is unknown. As none of the fleas defecated on the mouse, it must have contracted the infection through the agency of one or more flea bites.

Transmission by Fleas Placed on Mice in Jars

The method most frequently employed for testing the ability of ectoparasites to transmit an infection from one animal to another is that of placing infected ectoparasites en masse on a susceptible animal in a jar or cage and then waiting for the results. Experiments of this type have certain disadvantages because it is impossible to decide whether the infection was contracted from the bites of the ectoparasites or by some other method, such as oral infection which may follow crushing the infected ectoparasite in the mouth, and possibly swallowing it; or by licking infectious feces from the body. Infected ectoparasites' feces may also contaminate the food of the test animal.

During this study, mass transmission tests were carried out by placing 206 fleas on 24 mice which were kept in separate glass jars. No more than 10 fleas were placed on any one mouse. At least two positive feces tests should be obtained before starting experiments of this type because of the large percentage of fleas that did not harbor *S. enteritidis* after the first fecal examination. Every 7 to 10 days the mice and any fleas remaining on them or in their bedding material were transferred to clean sterilized jars. At this time mouse feces were collected for cultural tests. The mice were killed, autopsied, and cultures made of their spleens, livers, and blood at the end of 5 or 6 weeks. None of the mice subjected to this routine examination showed any evidence of *Salmonella* infection. Before the final disposal of the mice, each mouse and the contents of the jars were searched for fleas. A total of 13 *N. fasciatus* and 9 *X. cheopis* were recovered at this time. Feces collected from these fleas and the crushed bodies were cultured. None of the fleas recovered were infected with *S. enteritidis*, indicating that all those that did not become free of the infection before the experiments ended had died.

In the *N. fasciatus* experiments 125 infected fleas were placed in lots of 5 to 10 on 13 mice. Only one mouse was infected. *S. enteritidis* was cultured from the feces of the mouse on the eleventh day, and it died on the fifteenth day. The results of these experiments did not equal those obtained by feeding *N. fasciatus* individually.

The results obtained with *X. cheopis* in the jar experiments were practically the same as those resulting from feeding individual infected fleas of this species on mice since 81 fleas infected 2 of 11 mice in jars.

One mouse upon which three infected fleas were placed died 20 days after the start of the experiment. The *Salmonella* organisms were not isolated from the feces of this mouse prior to its death. The feces of the other mouse were found infected 19 days after eight *X. cheopis* were placed on it. As the mouse showed signs of recovering from the infection, it was killed a week later. This was the only mouse known to have been infected through the agency of fleas that did not die from the infection.

Significance

Salmonella enteritidis is one of the agents responsible for outbreaks of acute gastroenteritis which is characteristic of the so-called food poisoning diseases. In severe cases, there is great prostration and the final outcome may be fatal. Various factors such as diseased meat and food contaminated by unsanitary conditions, including the infected feces of rats and mice, are generally considered the sources of human infection.

The experimental transmissions detailed above indicate that the two common fleas found on rats in the United States may play an important part in the dissemination of *S. enteritidis* among rodents and from them to man. Human infection could be contracted directly from the bite of the fleas, or infectious flea feces may contaminate food.

Summary

The investigation demonstrates that the two common rat fleas, *Xenopsylla cheopis* and *Nosopsyllus fasciatus* may be infected with *Salmonella enteritidis* when feeding on infected mice and that the fleas may transmit the infection from one mouse to another by their bites. Furthermore, the feces of infected fleas also contain viable organisms in large numbers and provide an additional means by which the infection may be disseminated. Many fleas become free of the infection, but over half of them remain infected until death. *S. enteritidis* infection appears to produce certain pathological conditions in the alimentary canal of fleas that tend to shorten the lives of many of them. However, some fleas survived the infection for more than 2 months. The mechanism by which the flea infects its host by its bite is unknown, but probably results from the regurgitation of infectious material from the esophagus.

NOTE.—Some experimental investigations were conducted with *Salmonella typhi-murium* (Loeffler) similar to those reported above. Fleas were found susceptible to this infection but neither of the two strains of *S. typhi-murium* employed produced as high a degree of septicemia in mice as *S. enteritidis*. No attempt was made to transmit *S. typhi-murium* with infected *N. fasciatus* by feeding fleas individually on mice, and only 12 infected *X. cheopis* were tested

in this manner. Twenty-five infected *N. fasciatus* were placed on 5 mice in jars, and 104 *X. cheopis* were similarly tested on 11 mice. No evidence of *S. typhi-murium* was found in any of the mice when autopsy examination and cultures were made a month later. These studies only proved that fleas may be infected with *S. typhi-murium*.

REFERENCES

- (1) Varela, G. and Olarte, J.: A transmission of *Salmonella enteritidis* by *Pulex irritans* and *Ctenocephalus canis*. *Science* **104**: 2692 (1946).
- (2) Parker, R. R. and Steinhaus, Edward A.: *Salmonella enteritidis*: experimental transmission by the Rocky Mountain wood tick *Dermacentor andersoni* Stiles. *Pub. Health Rep.* **58**: 1010 (1943).
- (3) Huang, C. H., Chang, H. C., and Lien, V. T.: *Salmonella* infection. A study of 17 cases of *S. enteritidis* septicemia. *Chinese Med. J.* **52**: 345-366 (1937).

Preliminary Field Trials With Laboratory-Tested Molluscacides

By M. O. NOLAN and E. G. BERRY*

During the past year, screening tests of chemical compounds have been conducted in this laboratory in a search for suitable agents to destroy aquatic snails that serve as intermediate hosts for the schistosomes and other trematode parasites of man. In these laboratory trials, more than 400 chemicals, mostly organic compounds, were screened. Details of the tests will be published separately.

The planorbid snail, *Australorbis glabratus*, was used as the test animal in all of the laboratory experiments. This snail is native to Puerto Rico and some of the other Caribbean islands, and is found also in Venezuela, the Guianas, and Brazil. In some of these areas, it serves as the only intermediate host and in others as the principal intermediate host of *Schistosoma mansoni*. The species is easily raised in the laboratory, and mature specimens were thus provided for all the screening tests. *A. glabratus* has not become established in the continental United States, although one species of *Tropicorbis* from Louisiana has been shown experimentally to be a potential host for *S. mansoni* (1). Members of the genus *Tropicorbis* are closely related both morphologically and ecologically to species of *Australorbis*. Close similarities are present in the genital structures of members of the two genera, as well as in other organs, a fact which has led Pilsbry (2) to suggest that *Australorbis* might be considered a subgenus of *Tropicorbis*. Both genera are found in streams, ponds, lakes, borrow pits, and roadside ditches, and representatives of each (*A. glabratus* and *T. centimetralis*) serve as natural intermediate hosts of *S. mansoni*. It was noted also that members of both genera reacted similarly to chemical compounds in the limited number of tests performed in the laboratory. A decision was therefore made to test the molluscacides on a species of *Tropicorbis* in the field.

Members of the genus *Tropicorbis* are found in Louisiana and southern Texas. A snail survey of these States had been made in 1946 by Berry (3) so that information concerning the species and ecology of endemic snails was available. The vicinity of Brownsville, Texas, was chosen for the preliminary field trials, since *Tropicorbis obstructus donbilli* is common in most of the fresh waters of this area.

Materials and Methods

More than 80 compounds were active in varying degrees against *A. glabratus* in the laboratory. From this number, the following were selected for the preliminary field trials made in January 1949.

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Compound and Supplier

Survey
No.

- 19 Acetamide, *N*-cyclohexyl-2,3,4,6-tetrachlorophenoxy- ("Tetramide A")
(Kilgore Chemicals, Inc.)

- 293 Acetic acid, benzenethiol ester
(Chemical and Biological Coordination Center, University of Illinois)

- 186 Benzene, 1-bromo-2,4-dinitro-
(Eastman Kodak Co.)

- 406 Guanidine, 1-dodecyl-, acetate
(American Cyanamid Co.)

- 198 1,4-Naphthoquinone, 2,3-dichloro-
(U. S. Rubber Co.)

- 44 1,4-Naphthoquinone, 2-methyl-
(Merck & Co.)

- 246 Phenol, pentabromo-
(Dow Chemical Co.)

- 270 Phenol, pentachloro-, Na salt, monohydrate ("Dowicide G")
(Dow Chemical Co.) "85 percent active ingredients"

- 78 Phenol, 2,3,4,6-tetrachloro- ("Dowicide No. 6")
(Dow Chemical Co.) Glass grade

- 131 Pseudourea, *S*-(β-[*p*-*tert*.-octylphenoxy-β-ethoxy]ethyl)-thio-,
HCl, hemihydrate
(Parke, Davis & Co.)

The areas selected for the field trials were those in which *T. obstructus donbilli* predominated over snails of other genera and species. However, in observing the toxic effect of the compounds, consideration was given also to the other species present in the area, viz, *Drepanotrema cultratum labrosum*, *Helisoma trivolvis*, and *Aplexa nitens*. Since the toxicity of the compounds to mammals had not been determined, it was necessary to select bodies of water in which the trials could be conducted without danger to man or domestic animals. The combination of these factors presented many difficulties, and it was impossible to find suitable small bodies of water that could be treated completely. Consequently, only measured sections of large ponds or ditches were dosed. The measured sections were staked and outlined by running heavy twine from one stake to another just above the surface of the water. The depth of the measured area was systematically determined and the mean depth computed. Volume or cubic content was then calculated. In one series of tests, all chemical compounds were dissolved in acetone, or/and alcohol (95 percent) and applied to the measured areas at the rate of one gram of chemical per 100 liters of water (10 parts per million). With all but one of the compounds, namely, pentabromophenol, there was noticeable crystallization of the chemicals on the surface of the water. Consequently, in a second series of tests, emulsions of the compounds with Tween 80 were used. These emulsions were also applied at the rate of one gram of chemical per 100 liters of water.

The calculated amounts of the compounds were dispersed, by means of "Sure-Shot" spray guns powered by compressed air, about an inch or two below the surface of the water of the measured areas. (This was a better method than the one used in the beginning of holding the gun close to the surface of the water and spraying downward.)

In order to be certain that there were sufficient numbers of *Tropi-corbis* in any given area, snail populations of areas were determined before treatment with the chemicals. By use of a metal sieve fitted with a straight handle, the snails were collected from the aquatic vegetation in the water and then returned after the counts had been made. After spraying, especially with the more effective chemicals, snails could be found only in the mud on the bottom.

Local conditions for testing were much the same for all of the compounds. All but one of the compounds were tested in ponds or borrow pits, shallow marshes, and roadside ditches within a radius of 12 miles of Brownsville. The one exception was in a large shallow pond, or borrow pit, located between McAllen and Hidalgo, approximately 50 miles west of Brownsville. The aquatic vegetation was dense and numerous globular and filamentous algae were present. The compound, acetic acid, benzenethiol ester, was applied in acetone solution to a section of this pond.

An extensive drainage pond, located on the property of the Douglas Dairy Farm, approximately 7 miles south of Brownsville, was used for the testing of 7 compounds applied in acetone solutions. The area had been abandoned as a watering place for cattle and had been enclosed within a fenced area. The pond had a mud and grass bottom and was more than 370 feet long; the width varied from several to 25 feet, and the depth from 1 inch to more than 2 feet. The aquatic vegetation was variable, thicker in some spots than in others, and consisted of plants, tall grasses, cattails, duckweed (*Lemna*) and algae. There were many species of aquatic insects and insect larvae, such as water boatmen, beetles, dragonfly and mosquito larvae, as well as tadpoles and ostracods. Two species of snails, viz, *Tropicorbis obstructus donbilli* and *Drepanotrema cultratum labrosum*, were abundant in the pond, but unevenly distributed; because of this fact several hundred *Tropicorbis* from nearby areas were introduced into sections of this pond prior to chemical treatment.

Three compounds were tested in shallow marshes which were extensions of a very large resaca, located on the grounds of the Brownsville Country Club, north of town. The marshes were similar to the pond just described.

All emulsions of compounds, together with an acetone solution of pentabromophenol (2d test) were tested in roadside ditches located more than 11 miles north of Brownsville. They were shallow and filled with seepage waters, without current, with grass bottom, aquatic plants, and tall grasses. The ditches extended for several hundred yards along both sides of a main highway. Their width varied from 4 to 12 feet or more. The *Tropicorbis* in these ditches were numerous and unusually large specimens. *Drepanotrema*, *Helisoma* and *Aplexa* were less abundant. Small bivalves were present, as were frogs and tadpoles, a few salamanders, and various species of aquatic insects and larvae.

Results of the tests were checked at 24-hour intervals for a period of 3 or 4 days. With the chemicals that were especially effective, this period was extended to 5 or 6 days. In a few instances, the regular 24-hour checks had to be postponed for a day because of rainy or sleety weather. With each examination of the area after spraying, snails were collected and transferred to fresh water in beakers and observed for viability. The examinations at 24 hours and 48 hours were deliberately spotty because of unwillingness to stir up currents of water within the treated areas and thus to dilute the concentrations of the chemical. The 72-hour check was considered the most important, and at that time snails were systematically searched for in the entire treated area, and large numbers collected.

During the field tests, temperature readings of the water were taken during the day and ranged from 7° to 24° C. The average tempera-

ture during a 3-week period was 16.5° C. The pH of the water ranged from 7.2 to 7.9.

Results

The criterion of molluscacidal activity was based on the presence of live snails in the treated area at the end of a 3-day period. The circumstances and conditions under which the trials were conducted did not allow a mathematical expression of the results. There was no way of determining with accuracy the snail population prior to the treatment of the area or of recovering with certainty all snails following treatment. However, the 72-hour post-treatment check was carried out in a thorough and systematic manner and every effort was made to determine the presence of any snails which might have escaped the action of the chemical.

Results of the tests are shown in the table. Pentabromophenol and pentachlorophenol, Na salt, monohydrate ("Dowicide G") were the only compounds that proved to be good molluscacides in the field trials.

The first trials with these two compounds were in the pond on the Douglas Dairy Farm. The two sections treated with the chemicals were more than 60 feet apart. There was rather dense vegetation between the areas and no flow of water. Both compounds were lethal to a proportion of the snails (*Tropicorbis* and *Drepanotrema*) within the first 24 hours. Of the small numbers of snails collected in the area treated with pentabromophenol, at 24 hours, the majority were dead; at 48 hours, all snails collected were dead. At 72 hours, numerous snails were collected from the entire area, and all were dead. There was no collection of snails at 96 hours, but on the 5th day the area was again systematically dipped for snails. Snails were found with difficulty and, of those collected, all but 1 *Tropicorbis* were dead. In the area treated with pentachlorophenol, at 24 hours, the majority of snails collected were alive; at 48 hours, very few live snails were found; and at 72 hours, all were dead. At 96 hours, all snails collected were dead, with the exception of 2 *Drepanotrema*. With both compounds, snails outside the treated area (up to approximately 6 feet) were dead; beyond 6 feet, live snails were collected.

In the second trials, in the roadside ditches, results with pentabromophenol throughout the 72-hour examination were similar to those in the first trial. The snails in these ditches included *Tropicorbis*, *Drepanotrema*, *Helisoma*, and *Aplexa*. *Helisoma* appeared more resistant to the chemical than the other species of snails during the first 48 hours; at 72 and 96 hours, all species of snails were dead. Also, on the 6th day no live snails could be found in the area. The results with an emulsion of pentachlorophenol were not so good as

Results of field tests of potential molluscicides

Compound	Solution	Chemically treated area				Tropicorbis found			
		Size (square feet)	Mean depth (feet)	pH of water	Temp. range of water (° C.)	24 hours	48 hours	72 hours	96 hours
Acetamide, <i>N</i> -cyclohexyl-2,3,4,6-tetrachlorophenoxy-("Tetramide A")	Acetone.....	143	0.6	7.9	16-22	+	+	+	-----
	Emulsion.....	180	0.4	7.2	7-16	±	±	-----	±
Acetic Acid, benzenethiol ester..	Acetone.....	1,350	0.7	7.5	18-20	+	+	+	-----
Benzene, 1-bromo-2,4-dinitro....	Acetone.....	220	0.8	7.8	12-16	+	+	+	-----
	Emulsion.....	120	0.4	7.2	7-15	+	+	-----	+
Guanidine, 1-dodecyl-, acetate..	Alcohol.....	150	0.6	7.4	14-22	+	±	+	-----
	Emulsion.....	300	0.6	7.2	12-24	±	+	+	-----
1,4-Naphthoquinone, 2,3-dichloro..	Acetone and alcohol.	60	1.1	7.8	12-22	±	±	+	-----
1,4-Naphthoquinone, 2-methyl..	Acetone.....	150	0.6	7.4	14-22	-	+	+	-----
	Acetone.....	40.5	0.2	7.8	12-24	-	-	+	-----
	Emulsion.....	160	0.5	7.2	7-15	+	±	-----	±
Phenol, pentabromo-.....	Acetone.....	150	1.4	7.8	12-16	±	-	-	-----
	Acetone.....	450	0.4	7.2	7-22	±	-	-	-
Phenol, pentachloro-, Na salt, monohydrate ("Dowicide G").	Acetone.....	399	0.6	7.8	12-24	±	±	-	-
	Emulsion.....	120	0.3	7.2	7-16	±	-----	±	-----
Phenol, 2,3,4,6-tetrachloro- ("Dowicide No. 6").	Acetone.....	90	0.5	7.8	19-24	±	±	±	-----
Pseudourea, <i>S</i> -(β -[<i>p</i> -tert-octylphenoxy- β -ethoxy]ethyl)-thio-, HCl, hemihydrate.	Acetone and alcohol.	75	0.9	7.8	12-22	+	+	+	-----
	Emulsion.....	180	0.6	7.2	7-16	+	-----	+	-----

- = dead snails.

+ = live snails.

± = more dead than live snails.

± = more live than dead snails.

No sign = no collection of snails.

were those with the acetone solution. Only a few live *Tropicorbis* and *Drepanotrema* were found at 72 hours, although many snails were collected. It is possible that sleety weather and low temperature conditions may have played a role in preventing the compound from exerting its lethal effect on the snails.

So far as is known, these are the first trials of pentabromophenol as a molluscicide. Sodium pentachlorophenate has been reported by McMullen, Ishii, and Mitoma (4) to give excellent control of the operculate snail, *Oncomelania nosophora*, in the field in Japan. Both of the compounds we employed are caustic, and, in addition, pentachlorophenol causes persons to have a choking sensation with much coughing. Insects and plants in treated areas appeared unaffected by both compounds; frogs and tadpoles were rapidly affected and died; small bivalves were found dead.

In screening tests in the laboratory, the most rapidly lethal of the 10 compounds tested in the field were 1-bromo-2,4-dinitrobenzene, 1-dodecylguanidine acetate, and the three phenols. In such tests, these compounds at concentrations of 10 parts per million and at average temperatures of 78° to 80° F. killed snails within 24 hours.

Under natural conditions in the field, 1-bromo-2,4-dinitrobenzene had no effect whatever on snails but it did kill both culicine and anopheline larvae. 1-Dodecylguanidine acetate was mostly ineffective against the snails, while 2,3,4,6-tetrachlorophenol ("Dowicide No. 6") was lethal to some. Only the last-named compound affected aquatic plants and algae.

In the field trials with *N*-cyclohexyl-2,3,4,6-tetrachlorophenoxyacetamide in acetone solution, snails were normal at all examinations; when it was used in emulsion, some dead snails were found at all examinations. The compound was lethal to tadpoles and salamanders. 2-Methyl-1,4-naphthoquinone appeared to be slightly toxic to snails. 2,3-Dichloro-1,4-naphthoquinone was mostly ineffective; benzenethiol ester of acetic acid and *S*-(β -[*p*-*tert*.-octylphenoxy- β -ethoxy]ethyl)-thiopseudourea were ineffective.

Aplexa nitens, a large snail belonging to the family Physidae, was affected very rapidly by the more effective of the compounds. *Drepanotrema cultratum labrosum*, a small, flat planorbid snail with a tiny aperture, appeared to be the most resistant.

All the compounds were tested under rigid conditions in the field. For the most part, temperatures were surprisingly low. Brownsville and the Rio Grande Valley, along with most of southwestern United States, suffered from unusually cold weather in January. There were strong winds, rain, and, during the final trials, freezing weather. Since only measured sections of a pond or ditch were treated, there was undoubtedly some dissipation of the chemicals outside the measured areas. As stated previously, all compounds were applied at the rate of 10 parts per million based on measured areas, but it is probable that under conditions of the test, the final concentrations of the chemicals in dosed areas were less than 10 parts per million.

Summary

In preliminary field trials, the following 10 organic compounds were tested as potential molluscicides: *N*-cyclohexyl-2,3,4,6-tetrachlorophenoxyacetamide; benzenethiol ester of acetic acid; 1-bromo-2,4-dinitrobenzene; 1-dodecylguanidine acetate; 2,3-dichloro-1,4-naphthoquinone; 2-methyl-1,4-naphthoquinone; pentabromophenol; pentachlorophenol, Na salt, monohydrate ("Dowicide G"); 2,3,4,6-tetrachlorophenol ("Dowicide No. 6"), and *S*-(β -[*p*-*tert*.-octylphenoxy- β -ethoxy]ethyl)-thiopseudourea, HCl, hemihydrate.

The compounds were applied in the form of an emulsion or acetone solution in concentrations of 10 parts per million to ponds, borrow pits, shallow marshes, or roadside ditches, where the predominant snail was *Tropicorbis obstructus donbilli*. Members of this planorbid genus are closely allied both morphologically and ecologically with *Australorbis glabratus*, the principal intermediate host of *Schistosoma mansoni* in the Western Hemisphere.

Pentabromophenol and pentachlorophenol were the only compounds that showed promising molluscacidal activity. Both compounds are caustic and irritating to the mucous membrane of the respiratory tract in humans. Additional studies are needed to determine whether these chemicals can be employed with safety and whether they may be of practical value in the control of the planorbid intermediate hosts of various species of schistosomes.

REFERENCES

- (1) Cram, E. B. and Files, V. S.: Laboratory studies on the snail host of *Schistosoma mansoni*. Am. J. Trop. Med. **26**: 715-720 (1946).
- (2) Pilsbry, H. A.: Review of the Planorbidae of Florida, with notes on other members of the family. Proc. Acad. Nat. Sc. Philadelphia **86**: 29-66 (1934).
- (3) Berry, E. G.: Snails collected for the schistosomiasis investigations. Nat. Inst. Health Bull. No. 189, U. S. Government Printing Office, 1947, pp. 55-69.
- (4) McMullen, Donald B., Ishii, N. and Mitoma, Y.: Results of screening tests on chemicals as molluscacides. (Abstract) J. Parasitol. **34**: Sect. 2, 33 (1948).

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

UNITED STATES

REPORTS FROM STATES FOR WEEK ENDED JULY 9, 1949

Summary

A total of 684 cases of poliomyelitis was reported, as compared with 479 last week (an increase of 43 percent), 510 for the corresponding week last year (representing an increase of 41 percent), and a 5-year (1944-48) median of 288. Totals for the 9 geographic divisions, all showing increases, are as follows (last week's figures in parentheses): New England 24 (13), Middle Atlantic 24 (16), East North Central 76 (39), West North Central 101 (61), South Atlantic 31 (19), East South Central 57 (29), West South Central 271 (243), Mountain 32 (21), Pacific 68 (38). States reporting the largest numbers are Texas 121 (last week 118), Oklahoma 74 (last week 51), Arkansas 70 (last week 59), California 58 (last week 29), and Minnesota 38 (last week 25). Other States reporting increases of more than 8 cases are Indiana (7 to 24), Mississippi (0 to 13, next earlier week 9), Kansas (13 to 25), Tennessee (10 to 21), Maine (0 to 10). The total reported since March 19 (average week of seasonal low incidence) is 2,957, same period last year 2,530, 5-year median 1,028.

Of 112 cases of typhoid fever (last week 74, 5-year median 101), 14 occurred in Texas, 12 in Georgia, 10 in Pennsylvania, 7 each in Virginia and Kentucky, 6 each in Ohio, Arizona and California. Only 3 other States reported more than 3 cases each.

No occurrence of anthrax or smallpox was reported.

A total of 9,359 deaths was recorded during the week in 94 large cities in the United States, as compared with 8,978 last week, 8,483 and 8,970, respectively, for the corresponding weeks of 1948 and 1947, and a 3-year (1946-48) median of 8,810. The total for the year to date is 256,134, as compared with 258,627 for the corresponding period last year. Infant deaths recorded during the week totaled 695, as compared with 686 last week and a 3-year median of 747. The cumulative figure is 17,548, as compared with 18,249 for the same period last year.

Telegraphic case reports from States for week ended July 9, 1949

[Leaders indicate that no cases were reported]

Division and State	Diphtheria	Encephalitis, infectious	Influenza	Measles	Meningitis, meningococcal	Pneumonia	Polio-myelitis	Rocky Mountain spotted	Scarlet fever	Small-pox	Tularemia	Typhoid and paratyphoid fever	Whooping cough	Rabies in animals
NEW ENGLAND														
Maine.....				20		3	10		4				5	
New Hampshire.....				6		4	1						1	
Vermont.....				35					3			1		
Norfolk.....	3			124	1		8		25			1	47	
Rhode Island.....	1			6		4	1						1	
Connecticut.....				151		12	4		5				12	
MIDDLE ATLANTIC														
New York.....	4		(*)	545	2	115	16	2	440			1	165	4
New Jersey.....	1		1	455	1	22	2	1	9				35	1
Pennsylvania.....	4	1	(*)	497	8		6	1	24		1	10	100	
EAST NORTH CENTRAL														
Ohio.....	3			699	2	25	12		35				49	1
Indiana.....	4	2	7	73	1	4	24	1	8			6	42	10
Illinois.....		1		267	1	65	19		20			2	128	3
Michigan.....	3	1		202	3	30	11		23				29	
Wisconsin.....				765	1		10		12				49	
WEST NORTH CENTRAL														
Minnesota.....		1		20	1	11	38		4				2	
Iowa.....	1			32	2		8		6				6	1
Missouri.....				4	1	2	17		3			3	4	
North Dakota.....				4			5		2					
South Dakota.....				6	1		2							
Nebraska.....			5	19	1		6		14			5		
Kansas.....	1	1	2	48		6	25		6		1	2	6	
SOUTH ATLANTIC														
Delaware.....	1			4										
Maryland.....	3		2	47		19		1	46				1	
District of Columbia.....				11	1	13			5				14	
Virginia.....	5		46	166	2	36	4	3	6		2	7	22	2
West Virginia.....			6	9	3				3				19	
North Carolina.....				105	1		5	3	8			3	38	
South Carolina.....	6		88	98	1	37	5						11	2
Georgia.....	3		3	23	1	14	7	1	2		1	12	3	8
Florida.....	1		3	50		15	6		1		2	2	1	

Telegraphic case reports from States for week ended July 9, 1949—Continued

[Leaders indicate that no cases were reported]

Division and State	Diphtheria	Encephalitis, infectious	Influenza	Measles	Measles, meningococcal	Pneumonia	Poliomyelitis	Rocky Mountain spotted	Scarlet fever	Smallpox	Tularemia	Typhoid and paratyphoid fever *	Whooping cough	Rabies in animals
EAST SOUTH CENTRAL														
Kentucky.....	3	—	—	57	—	8	13	—	3	—	—	7	8	9
Tennessee.....	5	—	2	48	2	24	21	3	4	—	—	3	40	—
Alabama.....	5	—	—	37	1	9	10	—	9	—	—	2	28	10
Mississippi.....	5	—	1	11	2	15	13	—	7	—	1	2	13	—
WEST SOUTH CENTRAL														
Arkansas.....	2	—	49	25	1	15	70	—	1	—	4	3	35	—
Louisiana.....	2	—	1	10	—	24	6	—	2	—	—	4	—	1
Oklahoma.....	—	2	3	96	—	29	74	1	5	—	1	4	6	4
Texas.....	6	1	267	164	8	200	121	—	16	—	—	14	108	17
MOUNTAIN														
Montana.....	—	—	—	41	—	2	14	—	2	—	—	—	7	—
Idaho.....	1	—	5	37	—	—	—	—	4	—	—	—	—	—
Wyoming.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Colorado.....	1	—	12	96	1	13	10	—	4	—	3	1	14	3
New Mexico.....	—	—	—	13	—	6	5	1	2	—	2	—	3	—
Arizona.....	1	—	13	38	—	6	2	1	1	—	—	6	8	1
Utah.....	—	—	—	34	—	—	1	1	2	—	1	—	30	—
Nevada.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PACIFIC														
Washington.....	—	—	3	78	1	—	5	—	5	—	—	—	19	—
Oregon.....	—	—	5	211	1	35	5	—	3	—	—	—	33	—
California.....	11	—	3	257	2	25	58	—	4 25	—	—	6	72	—
Total.....	80	10	527	5,742	54	848	694	20	369	—	19	112	1,295	—
Median, 1944-48.....	138	8	526	4,299	65	—	298	20	823	—	18	101	2,172	—
Year to date 27 weeks.....	3,768	279	74,712	574,613	2,046	50,951	3,881	268	56,970	—	659	1,405	28,706	—
Median, 1944-48.....	6,297	239	186,732	526,914	4,029	—	1,425	193	82,937	—	503	1,087	51,223	—
Seasonal low week ends.....	—	—	(30th) July 31	(35th) Sept 4	(37th) Sept 18	—	(11th) Mar 19	—	(32nd) Aug 14	—	—	(11th) Mar 19	(39th) Oct 2	—
Since seasonal low week.....	8,862	—	110,962	627,006	2,890	—	2,957	—	79,668	—	—	945	38,796	—
Median, 1943-48.....	13,663	—	332,941	561,860	5,533	—	1,028	—	121,508	—	—	1,212	82,489	—

* Period ended earlier than Saturday.

b The median of the 5 preceding corresponding periods; for poliomyelitis and typhoid fever the corresponding periods are 1944-45 to 1948-49, inclusive.

c New York City and Philadelphia only, respectively.

d Including cases reported as streptococcal infection and septic sore throat.

e Including paratyphoid fever; currently reported separately, as follows: Ohio 1, West Virginia 1, Georgia 2, Florida 1, Kentucky 1, Tennessee 1, Oklahoma 1, Texas 2, Arizona 4, California 1. Cases reported as salmonella infection, not included in the table, were as follows: New York 4, Massachusetts 2.

f Alaska: Influenza 1, pneumonia 4, streptococcal throat 11.

g Hawaii Territory: Influenza 2, measles 8, lobar pneumonia 1, typhoid fever 1.

PLAGUE INFECTION IN BEAVERHEAD COUNTY, MONT.

Under date of July 8, plague infection was reported proved in specimens of tissue and ectoparasites from ground squirrels collected in Beaverhead County, Mont., on a ranch 24 miles northwest of Dillon on the Jackson road, as follows:

In a pool of 31 lice from 28 ground squirrels, *Citellus columbianus*, shot June 22 (a pool of 30 fleas from the same animals failed to be proved infectious); in pools of 75 fleas and 21 lice, inoculated separately, from 53 ground squirrels, *Citellus richardsonii elegans*, shot June 23, and in 2 specimens of tissue, inoculated separately, from 2 of the same 53 ground squirrels; and in pools of 62 fleas and 55 lice, inoculated separately, from 44 ground squirrels, *C. richardsonii elegans*, shot June 24.

DEATHS DURING WEEK ENDED JULY 2, 1949

[From the Weekly Mortality Index, issued by the National Office of Vital Statistics]

	Week ended July 2, 1949	Correspond- ing week, 1948
Data for 94 large cities of the United States:		
Total deaths.....	8,978	8,963
Median for 3 prior years.....	8,079	
Total deaths, first 26 weeks of year.....	246,775	250,144
Deaths under 1 year of age.....	686	646
Median for 3 prior years.....	630	
Deaths under 1 year of age, first 26 weeks of year.....	16,853	17,637
Data from industrial insurance companies:		
Policies in force.....	70,356,854	71,015,454
Number of death claims.....	12,139	11,615
Death claims per 1,000 policies in force, annual rate.....	9.0	8.6
Death claims per 1,000 policies, first 26 weeks of year, annual rate.....	9.5	9.9

TERRITORIES AND POSSESSIONS

Panama Canal Zone

Notifiable diseases—May 1949.—During the month of May 1949, certain notifiable diseases were reported in the Panama Canal Zone and terminal cities as follows:

Disease	Residence ¹									
	Panama City		Colon		Canal Zone		Outside the Zone and terminal cities		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Chickenpox.....	14		2		10		7		33	
Diphtheria.....	5	2		1					5	3
Dysentery:										
Amebic.....							1		1	
Bacillary.....	1				1				2	
German measles.....					2				2	
Hepatitis, infectious.....	2				1		2		5	
Leprosy.....				1						1
Malaria ²	2				11		94	2	107	2
Measles.....			2		6		1		9	
Meningitis, meningococcal.....							1		1	
Mumps.....							1		1	
Pneumonia.....		7		1	13			4	³ 13	12
Poliomyelitis.....	1				1				2	
Relapsing fever.....							1		1	
Scarlet fever.....	1								1	
Tetanus.....	1						1		2	
Tuberculosis.....		11		1	1	2		7	³ 1	21
Typhoid fever.....			1				1		2	
Typhus fever (endemic).....	2								2	
Yaws.....	1								1	

¹ If place of infection is known, cases are so listed instead of by residence.

² 3 recurrent cases.

³ Reported in the Canal Zone only.

Puerto Rico

Notifiable diseases—4 weeks ended June 25, 1949.—During the 4 weeks ended June 25, 1949, cases of certain notifiable diseases were reported in Puerto Rico as follows:

Disease	Cases	Disease	Cases
Chickenpox.....	51	Tetanus.....	21
Diphtheria.....	21	Tetanus, infantile.....	4
Gonorrhea.....	122	Tuberculosis (all forms).....	569
Influenza.....	100	Typhoid fever.....	12
Malaria.....	23	Typhus fever (murine).....	10
Measles.....	18	Whooping cough.....	195
Syphilis.....	58		

FOREIGN REPORTS

CANADA

Provinces—Notifiable diseases—Week ended June 18, 1949.—During the week ended June 18, 1949, cases of certain notifiable diseases were reported by the Dominion Bureau of Statistics as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Chickenpox.....		35	3	168	430	40	109	62	134	981
Diphtheria.....				2						2
German measles.....		15		163	63	13	44	82	28	408
Influenza.....		19			2	4				25
Measles.....		61	17	274	380	277	198	341	410	1,958
Meningitis, meningococcal.....				1				1		2
Mumps.....		49	1	38	217	31	2	20	127	495
Polio myelitis.....				7	2		1		1	11
Scarlet fever.....		1	2	62	45	2		10	16	138
Tuberculosis.....		3	22	101	20	33	19		58	256
Typhoid and paratyphoid fever.....				4						4
Undulant fever.....				2	5					7
Veneral diseases:										
Gonorrhoea.....		8	12	77	76	24	21	32	72	322
Syphilis.....		9	5	46	44	8	2	2	19	135
Whooping cough.....		13		46	41	3	1		3	107

WORLD DISTRIBUTION OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

From consular reports, international health organizations, medical officers of the Public Health Service, and other sources. The reports contained in the following tables must not be considered as complete or final as regards either the list of countries included or the figures for the particular countries for which reports are given.

CHOLERA

(Cases)

NOTE.—Since many of the figures in the following tables are from weekly reports, the accumulated totals are for approximate dates.

Place	January- April 1949	May 1949	June 1949—week ended—			
			4	11	18	25
ASIA						
Burma.....	62	116	16	1	5	
Bassein.....	14	114	15		5	
Moulmein.....		2				
Rangoon.....			1	1		
Ceylon.....		1	1			
India.....	38,962	8,138	1,297	1,793	1,242	1,109
Allahabad.....	4	1				
Bombay.....	1		1	1		
Calcutta.....	3,244	725	49	59	57	56
Cawnpore.....	26	19	17	9	16	16
Cuddalore.....	2					
Lucknow.....	9	11	2	3		
Madras.....	24	33	5	4	4	6
Masulipatam.....			1			
Negapatam.....	25	1				
New Delhi.....					1	1
Raj Samand.....		10				30
Tuticorin.....	14					

CHOLERA—Continued

Place	January- April 1949	May 1949	June 1949—week ended—			
			4	11	18	25
ASIA—continued						
India (French):						
Karikal	55					
Pondicherry	100					
Indochina (French):						
Annam	53					
Cambodia	32	2	2		4	2
Cochinchina	3	1	1	3	1	
Pakistan	16,751	2,251	3	7		
Chittagong	54	9	1	7		
Dacca	69	21	2			
Lahore	5	6				
Siam		8		1		
Bangkok		8				

¹ Preliminary figures. ² In ports only. ³ Imported. ⁴ Includes imported cases. ⁵ May 1-14, 1949

PLAGUE

(Cases)

AFRICA						
Basutoland	12					
Belgian Congo	6				1	
Costermansville Province					1	
Stanleyville Province	6					
British East Africa:						
Kenya	1	1				
Tanganyika	15					
Madagascar	60	4				
Tananarive	3					
Rhodesia, Northern	2					
Union of South Africa	33			1	1	1
ASIA						
Burma	1,386	10				1
Mandalay	1					
Moulmein	14	5				
Rangoon	14	1				1
China:						
Chekiang Province	7					
Wenchow	7					
Fukien Province	20					
Kiangsi Province	9					
India	23,679	425	76	51	32	
Indochina (French)	63	11	1	1	1	
Annam	7	10			1	
Cambodia	20					
Cochinchina	28	1	1	1		
Laos	3					
Java	5					
Siam	148	3		1		
EUROPE						
Portugal: Azores	3	1				
SOUTH AMERICA						
Brazil ¹						
Peru:						
Lambayeque Department	7					
Lima Department	3					
Piura Department	6					
Venezuela:						
Aragua State	1					
OCEANIA						
Hawaii Territory: Plague infected rats ²						

¹ Includes imported cases. ² Imported. ³ Preliminary figures. ⁴ Includes cases of pneumonic plague. ⁵ Delayed reports show a total of 391 cases of plague with 54 deaths in Brazil in 1948. The figures published in Public Health Reports for April 29, 1949, p. 546, include reports only through August 1948. ⁶ Plague infection has been reported in Hawaii Territory as follows: On Mar. 12, 1949, in a mass inoculation of 2 pools of tissue from 10 rats (8 and 2), taken on Maui Island; on Mar. 16, 1949, in mass inoculation of 3 pools of 29 fleas (7, 12, and 10) from rats trapped on the Island of Hawaii.

SMALLPOX

(Cases)

(P=present)

Place	January- April 1949	May 1949	June 1949—week ended—			
			4	11	18	25
AFRICA						
Algeria.....	98	14				
Angola.....	1 239					
Belgian Congo.....	1 742	199	1	47		
British East Africa:						
Kenya.....	15	6	1	1		
Nyassaland.....	688	84	34	25		
Tanganyika.....	122					
Uganda.....	32					
Cameroon (British).....	9					
Cameroon (French).....	30	22	1			
Dahomey.....	185	43	7		10	
Egypt.....	3					
Ethiopia.....	4					
French Equatorial Africa.....	6	15				
French Guinea.....	1					
French West Africa: Haute Volta.....	57	5	16		17	
Gambia.....	40	9				
Ivory Coast.....	169	25	13		2	
Morocco.....	8					
Mozambique.....	83	28	8			
Nigeria.....	4, 712	768	5	14	15	
Niger Territory.....	252	145	4			
Portuguese Guinea.....	1					
Rhodesia:						
Northern.....	4		1			
Southern.....	182					
Senegal.....	15	1				
Sierra Leone.....	98	1				
Sudan (Angelo-Egyptian).....	29	38	14	8	18	
Sudan (French).....	151					
Togo (French).....	57	7	8		18	
Union of South Africa.....	124	P	P	P	P	P
ASIA						
Afghanistan.....	24					
Arabia.....	34					3
Bahrain Islands.....	44	1	1			
Burma.....	1, 209	48	6	6	1	2
Ceylon.....						1
China.....	800	36	3		4	4
India.....	39, 535	6, 884	1, 074	539	339	
India (French).....	1					
India (Portuguese).....	175	5	4			
Indochina (French).....	2, 116	82	8	9	9	11
Iran.....	175	7	2			
Iraq.....	263	47	2	34	11	3
Israel.....	2					
Japan.....	39	54	9	8		
Korea.....	544					
Lebanon.....	121	12	3	2		
Malay States (Federated).....	43					
Netherlands Indies:						
Java.....	3, 170	968	276	247	265	251
Riouw Archipelago.....		2				
Sumatra.....	49	19	6	9	2	9
Pakistan.....	2, 547	216				
Philippine Islands:						
Mindoro Island.....	11					
Rombion Province.....	4					
Portuguese Timor.....	4					
Siam.....	37					
Straits Settlements: Singapore.....	2					
Syria.....	262	58	3	20	8	3
Transjordan.....	142	23	8	6	5	2
Turkey. (See Turkey in Europe).....						
EUROPE						
Belgium.....					1	
Great Britain: England and Wales.....	16	4				
Italy.....	2	90		5		
Portugal: Lisbon.....	3					
Spain.....	1	1				
Canary Islands.....		6				
Turkey.....	87	1			1	

SMALLPOX—Continued

Place	January- April 1949	May 1949	June 1949—week ended—			
			4	11	18	25
NORTH AMERICA						
Cuba: Habana.....	4	1	1			
Guatemala.....	1					
Mexico.....	14	12		9	1	
SOUTH AMERICA						
Argentina.....	54	25				
Bolivia.....	35					
Brazil.....	64	5	1		3	
Chile.....		2				
Colombia.....	1,024	290				
Ecuador.....	407	43				
Paraguay.....	14	1				
Peru.....	685					
Venezuela.....	531	33	14		2	

¹ Includes alastrim. ² June 1-10, 1949. ³ June 11-20, 1949. ⁴ In Lagos only. ⁵ Includes imported cases. ⁶ Imported. ⁷ In ports only. ⁸ Preliminary figures. ⁹ May 1-14, 1949. ¹⁰ In Rome January 1-May 27, 1949 (varioid). ¹¹ In Rome May 28-June 10, 1949 (varioid). ¹² May 15-June 11, 1949. ¹³ April 1-May 31, 1949. ¹⁴ Alastrim.

TYPHUS FEVER *

(Cases)

(P = present)

AFRICA						
Algeria.....	39	4				
Basutoland.....	5					
Belgian Congo.....	¹ 41					
British East Africa:						
Kenya.....	1					
Nyasaland.....			4			
Egypt.....	152	18		2		
Eritrea.....	35	5	2	2	3	
Ethiopia.....	208	45				
Libya.....	98	35				
Madagascar: Tananarive.....	¹ 5					
Morocco.....	10	1	¹ 1		¹ 1	
Sierra Leone.....		¹ 1				
Tunisia.....	53	2				
Union of South Africa.....	⁴ 42	P	P	P	P	P
ASIA						
Afghanistan.....	1,269					
Arabia: Aden.....	¹ 2					
Ceylon: Colombo.....	¹ 2	¹ 1		¹ 1		
China.....	22	1				
India.....	¹ 112	¹ 1		1		
India (Portuguese).....	8	2				
Indochina (French).....	3	3	2	1	1	
Iran.....	111	4				
Iraq.....	⁴ 21	⁴ 5	1	1	1	
Japan.....	75	7	3	1		
Korea.....	142					
Lebanon.....	¹ 1					
Pakistan.....	500	62	3	17	5	2
Palestine.....	100					
Philippine Islands: Manila.....	1					
Straits Settlements: Singapore.....	⁴ 2					
Syria.....	2	13	4	1		
Transjordan.....	42	8	3		2	
Turkey. (See Turkey in Europe.)						
EUROPE						
Belgium.....	1				4	
Bulgaria.....	165	85	10	15		
Czechoslovakia.....	8	9	1	1	1	
France.....	2					
Great Britain: Island of Malta.....	¹ 3					
Greece.....	22	4	1		2	2
Hungary.....	15	2		1	2	
Italy.....	27		¹ 2			
Sicily.....	13					
Poland.....	179	1				
Portugal: Lisbon.....	4					
Rumania.....	382	35				

See footnotes at end of table

TYPHUS FEVER—Continued

Place	January- April 1949	May 1949	June 1949—week ended—			
			4	11	18	25
EUROPE—continued						
Spain.....	1	1				
Turkey.....	91	18	3	5	3	2
Yugoslavia.....	103	27				
NORTH AMERICA						
Costa Rica ¹	13	2		13		
Cuba ¹	2	1				
Guatemala.....	11					
Jamaica ¹	6					
Mexico ⁴	61	8		2	3	
Panama Canal Zone.....	3	2				
Puerto Rico.....	7	3	2	2	2	4
Salvador, El ¹						
SOUTH AMERICA						
Argentina ¹	1					
Bolivia ¹	53					
Brazil.....	2					
Chile ¹	74	32	9	5		
Colombia.....	970	208				
Curacao ¹	4			1		
Ecuador ⁴	107	15	2	3		
Peru ¹	7					
Venezuela ¹	15	4	1			
OCEANIA						
Australia ¹	50	16	5	1		
Hawaii Territory ¹	3				2	

* Reports from some areas are probably murine type, while others include both murine and louse-borne types.

¹ Murine type. ² June 1-10, 1949. ³ June 11-20, 1949. ⁴ Includes murine type. ⁵ Includes imported cases. ⁶ Imported. ⁷ Delayed reports. Additional reports of cases of typhus fever received since publication of figures for the year 1948 in Public Health Reports for April 29, 1949, p. 549, show the following totals for that year for the countries listed as follows: El Salvador 2 cases (1 fatal); Bolivia 159 cases; Chile 817 cases; Peru, 1,863 cases; Venezuela 200 cases.

YELLOW FEVER

(C=cases; D=deaths)

AFRICA						
Belgian Congo:						
Stanleyville Province.....	D	5				
Gold Coast.....	C	1	2	1		
Birim District.....	C	1	1			
Komenda Village ²	D		1			
Osekrome Village ²	D			1		
Nigeria:						
Lagos.....	D	2				
NORTH AMERICA						
Panama:						
Pacora.....	C	8				
SOUTH AMERICA						
Brazil:						
Amazonas State.....	D	1				
Para State.....	D	2				

¹ Suspected. ² Near seaport of Sekondi. ³ Cases admitted to Lagos Hospital from ship that arrived from two other ports in Nigeria—Warri and Burutu. ⁴ Reported January 15, 1949. Date of occurrence November 11–December 30, 1948. Five cases, all fatal, confirmed; 3 suspected cases.