Public Health Reports

Vol. 65 • AUGUST 11, 1950 • *No. 32*

The Physiological Response to Dust From Mine Locomotive Traction Material

By LAWRENCE T. FAIRHALL, Ph.D,* BENJAMIN HIGHMAN, M.D.† and VERNON B. PERONE*

Silicosis as an occupational disease among locomotive operators in mines has been attributed to the traction material in common use. This traction material, which in many cases is ordinary sand, is systematically distributed on the rails in order to afford sufficient traction for the locomotive. The spinning and grinding action of the wheels necessarily produces dust which, in the confined space of entries or tunnels, may rise to high atmospheric concentrations. In the case of sand, the free silica content of the atmospheric dust may be far in excess of the maximum amount permissible in dusty trades.

Various substances other than sand have been proposed for traction material (*1*). Some of these substances, however, are not sufficiently hard for the purpose, or have other physical characteristics, such as packing or the tendency to absorb moisture, which have limited their usefulness. Economic factors are obviously of importance also, as the tonnage of traction material required for ordinary operation is large. Among the substances which have been proposed or used are certain mine tailings and also various metallurgical slags.

A number of such substances [1] having the requisite hardness and availability were selected and injected intraperitoneally into guinea pigs, according to the method of Miller and Sayers (*2*, *3*, *4*), to determine from the character of the peritoneal reaction the likelihood of their producing pneumoconiosis in man. Miller and Sayers described an absorptive, a proliferative, and an inert type of reaction. Dusts of the absorptive group produce peritoneal nodules on the anterior abdominal wall which progressively decrease in size as the interval between injection and examination increases, while dusts causing a proliferative type of reaction produce nodules which progressively increase in size.

---

*Scientist Director, and Medical Technologist, respectively, Bureau of State Services. †Senior Surgeon, Laboratory of Pathology and Pharmacology, National Institutes of Health.

[1] We are indebted to Dr. R. R. Sayers, Chairman, Medical Advisory Board, Welfare and Retirement Fund, United Mine Workers of America, and to J. J. Forbes, Chief, Health and Safety Division, Bureau of Mines, United States Department of Interior, for making available certain of the materials used and for analytical and X-ray diffraction study of these products.

The nodules produced by the inert group become flattened with irregular edges, but the amount of dust found in the peritoneal cavity 1 year after injection is essentially the same as that noted in 7 days. There was some evidence that silica mixed with an inert dust causes a modified proliferative reaction (*2*). Miller and Sayers state that, with this biological method of classification, which in a number of instances has been correlated with clinical observations and industrial surveys, it is quite possible to determine the pneumoconiotic potentialities of a dust in a relatively short time, usually 60 days. According to these investigators, an absorptive reaction may indicate that the dust is relatively harmless, while a proliferative reaction, characteristic of pure silica (quartz), may be associated with definite ability to produce a nodular type of pulmonary fibrosis. Dusts causing inert reactions should be considered as potentially harmful, though not as dangerous as those causing a proliferative response.

Experimental Technique

In the present study, each of the selected minerals was ground very finely in a ball mill. The resulting powder completely passed through a standard 325-mesh sieve in all cases and had an average particle size under 11 microns. No attempt was made to separate the dust into fractions by air-elutriation, since the 325-mesh screened material has been found to be adequate for this type of study. One gram portions of the dust were weighed out into small bottles containing glass beads, sterilized by heating 1 hour at 160° C., and suspended in 10 ml. of added sterile physiological saline solution. Two ml. of the suspension were injected intraperitoneally into each guinea pig. The hair

Table 1

Material injected	Amount injected intraperitoneally	Average particle size	Total animals injected	Percent gain in weight		
				35 days after injection	70 days after injection	105 days after injection
	Gram	*Microns*				
Calcite crystals	0.2	5.9	13	37.0	61.0	80.0
Quartz crystals	.2	7.1	13	33.0	36.0	51.0
Anthracite mineral	.2	6.3	12	2.0	44.0	81.0
Bituminous mineral	.2	8.3	12	.7	51.0	45.0
Lodestone ore	.2	8.9	15	15.0	30.0	68.0
Magnetite ore	.2	7.8	13	11.0	62.0	79.0
Hematite ore	.2	7.6	12	.6	25.0	45.0
Slag No. 1 (B. M. No. 49-397)	.2	10.7	12	14.0	93.0	84.0
Slag No. 2 (B. M. No. 49-398)	.2	10.0	12	.6 (loss)	19.0	14.0
Slag No. 3 (B. M. No. 49-367)	.2	10.8	12	24.0	21.0	23.0
Slag No. 4 (B. M. No. 49-303 (3))	.2	8.9	15	21.0	45.0	33.0
Slag No. 5 (B. M. No. 49-153)	.2	9.0	13	26.0	46.0	60.0
Slag No. 6 (B. M. No. 49-154)	.2	10.4	14	.6	22.0	67.0
Lyon Mountain ore tailings (B. M. No. 49-310 (4))	.2	8.1	16	22.0	36.0	35.0
Trap rock (B. M. No. 3088)	.2	8.8	12	15.0	.3	16.0
Obsidian	.2	8.7	12	16.0	12.0	37.0
Vitreous silica	.2	8.7	12	.6	21.0	65.0
Silica sand	.2	10.9	12	18.0 (loss)	13.0	51.0

was clipped over the abdomen, tincture of iodine applied, the injection made, and more tincture of iodine swabbed over the site of the injection. Twelve animals were used for each of the 18 test substances (table 1), and in those cases where early deaths occurred, the animals were replaced. Usually, three animals were killed for pathologic study at intervals of 35, 70, and 105 days. A few guinea pigs remained on test for a much longer period.

DESCRIPTION OF THE DUSTS STUDIED

Calcite. Selected, clear crystals of pure mineral calcite. Finely ground in a ball mill. Average particle size, 5.9 microns. Chemical analysis: acid insoluble material, 0.0 percent; silica, 0.0 percent.

Quartz. Selected Brazilian quartz crystals of mineral specimen quality. Finely ground. Average size of particles, suspended in normal saline solution for intraperitoneal injection, 7.1 microns.

Vitreous Silica. Fragments of vitreous silica. Made at Albany, Oreg., Station, U. S. Bureau of Mines, from Ottawa silica sand. Average particle size of injected material, 8.7 microns. X-ray pattern negative, indicating absence of crystalline material.

Silica Sand. Ottawa silica sand. Finely ground. Average size of suspended particles, 10.9 microns.

Obsidian. Pure mineral obtained from the Smithsonian Institution. X-ray diffraction pattern negative in general, but contained a trace of crystalline material. Average particle size, 8.7 microns.

Bituminous Coal. Pennsylvania mineral specimen. Average particle size, 8.3 microns.

Anthracite. Pennsylvania mineral specimen. Average particle size, 6.3 microns.

Magnetite., variety lodestone. Selected masses of native mineral. Average particle size, 8.9 microns.

Magnetite. Clifton Mines, St. Lawrence County, N. Y., mineral specimen. Average particle size, 7.8 microns.

Hematite, variety kidney ore. Mineral specimen. Average particle size, 7.6 microns.

Iron Ore Tailings. Lyon Mountain. U. S. Bureau of Mines No. 49-310 (4). Albany, N. Y. Eleven percent free silica, quartz (hardness, 7). Small amount orthoclase, $KAlSI_3O_8$ (hardness, 6). Small amount of magnetite, Fe_3O_4 (hardness, 7.4). Small amount unidentified crystalline material. Average particle size, 8.1 microns.

Trap Rock. U. S. Bureau of Mines No. 3088. Four percent free silica, alpha quartz. Large amount of feldspar, probably mostly labradorite, $n NaAlSi_3O_8$, $m CaAl_2Si_2O_5$. Medium amount of pyroxene, probably hedenbergite, $CaFe(SiO_3)_2$. Traces of magnetite, dolomite, and unidentified crystalline material. Average particle size, 8.8 microns.

Slag No. 1. U. S. Bureau of Mines No. 49-397. Water-quenched granulated slag. One percent free silica, SiO_2, alpha quartz. Small amount of melilite, $Na_2(Ca,Mg)_{11}(Al,Fe)_4(SiO_4)_9$. Trace of hematite, Fe_2O_3. Trace of aluminum calcium oxide, $Al_2O_3{\cdot}3CaO$. Trace of unidentified crystalline material. Average particle size, 10.7 microns.

Slag No. 2. U. S. Bureau of Mines No. 49-398. Air-cooled screenings. One percent free silica. Large amount of melilite. Small amount of pseudowollastonite, $CaSiO_3$. Trace of aluminum calcium oxide. Trace of unidentified crystalline material. Average particle size, 10.0 microns.

Slag No. 3. U. S. Bureau of Mines No. 49–367. Quenched blast-furnace slag. One percent free silica, SiO_2, alpha quartz. Possibly a trace of melilite, $Na_2(Ca,Mg)_{11}(Al,Fe)_4(SiO_4)_9$. Trace of unidentified crystalline material. Average particle size, 10.8 microns.

Slag No. 4. U. S. Bureau of Mines No. 49–303(3). Copper slag, Tennessee Copper Co., Ducktown, Tenn. Less than 1 percent free silica, quartz. Large amount of fayalite, Fe_2SiO_4. Considerable amount of unidentified crystalline material. (Hardness of this material not available.) Average particle size, 8.9 microns.

Slag No. 5. U. S. Bureau of Mines No. 49–153 (West Virginia). Crushed slag, ferro-chrome process, used for traction material at Alloy Mine, Alloy, West Virginia (not commercially available). Eighteen percent free silica, SiO_2, alpha quartz. Large amount of forsterite, Mg_2SiO_4. Large amount of spinel, $MgAl_2O_4$. Trace of unidentified crystalline material. Average particle size, 9.0 microns.

Slag No. 6. U. S. Bureau of Mines No. 49–154. Silico-manganese slag, Alloy, West Virginia. One percent free silica. Remainder—unidentified crystalline material. Hardness, 7.5. Average particle size, 10.4 microns.

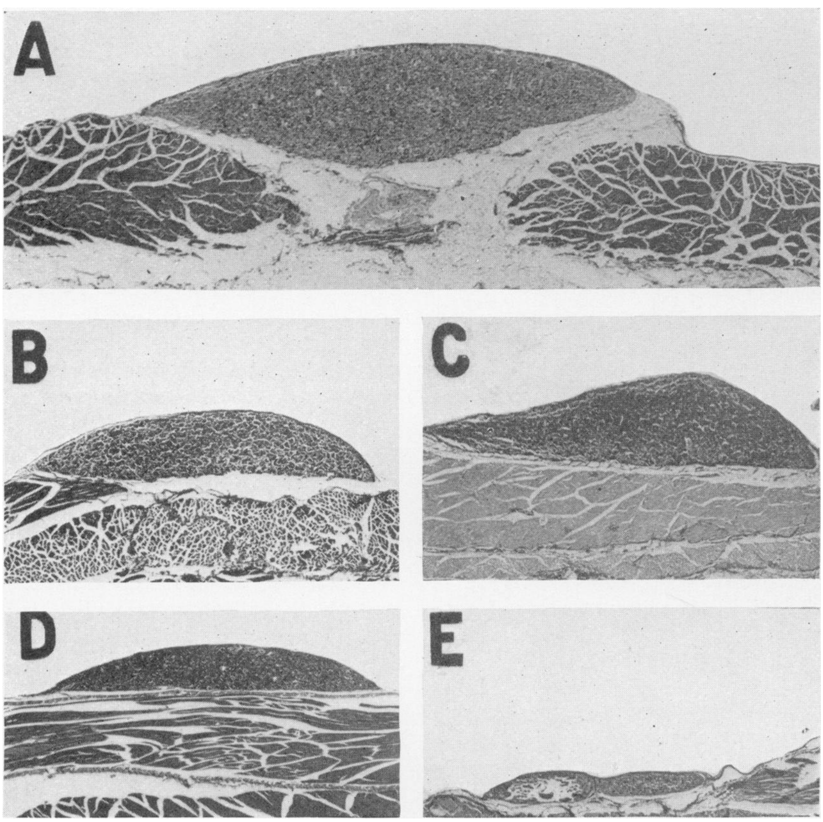


Figure 1. Peritioneal nodules in guinea pigs killed 35 days after injection of dust (× 10). A. Quartz. B. Slag No. 5. C. Lyon Mountain ore tailings. D. Anthracite. E. Calcite.

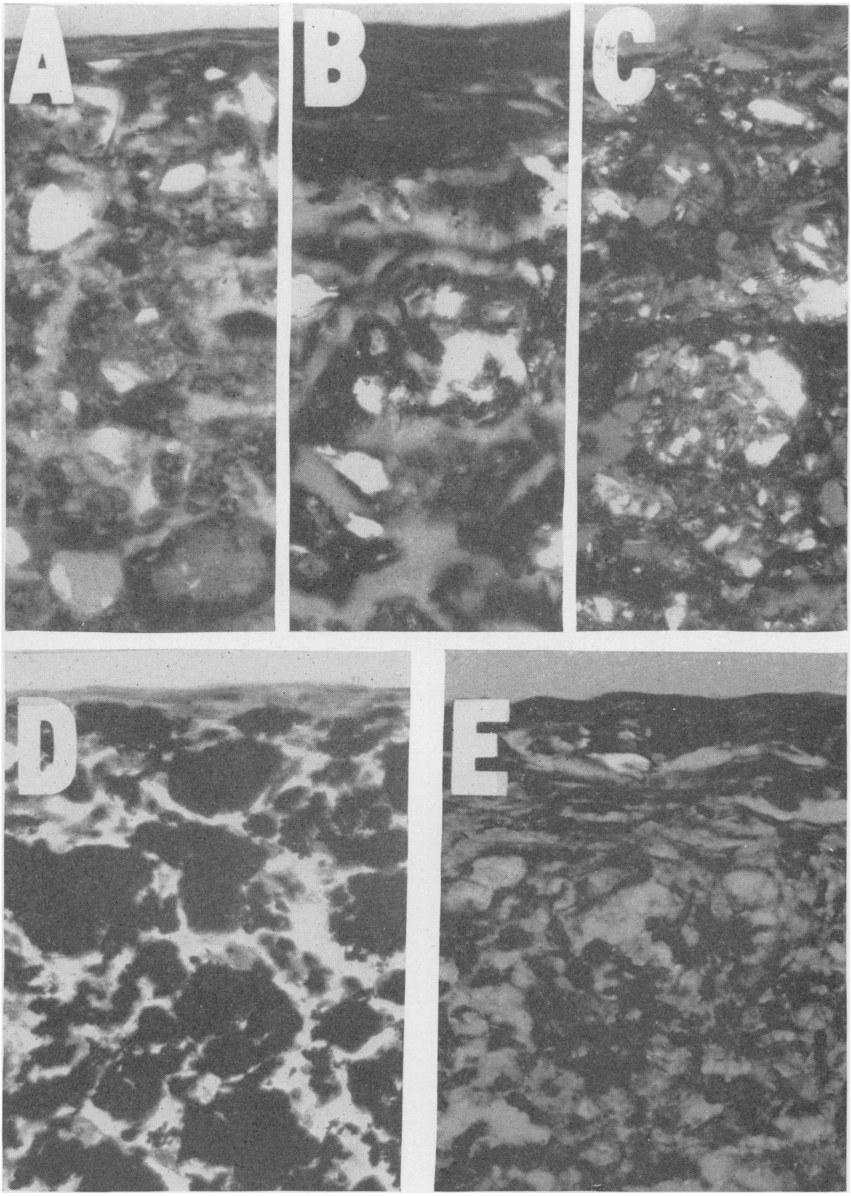


Figure 2. Same nodules as in figure 1 (× 400). All except 2D photographed with polarized light. Anisotropic particles appear white. A. Quartz. B. Slag No. 5. C. Lyon Mountain ore tailings. D. Anthracite. E. Calcite.

Gross Pathology

Autopsies were made on all guinea pigs that died or were killed for study. The gross findings were essentially similar to those described

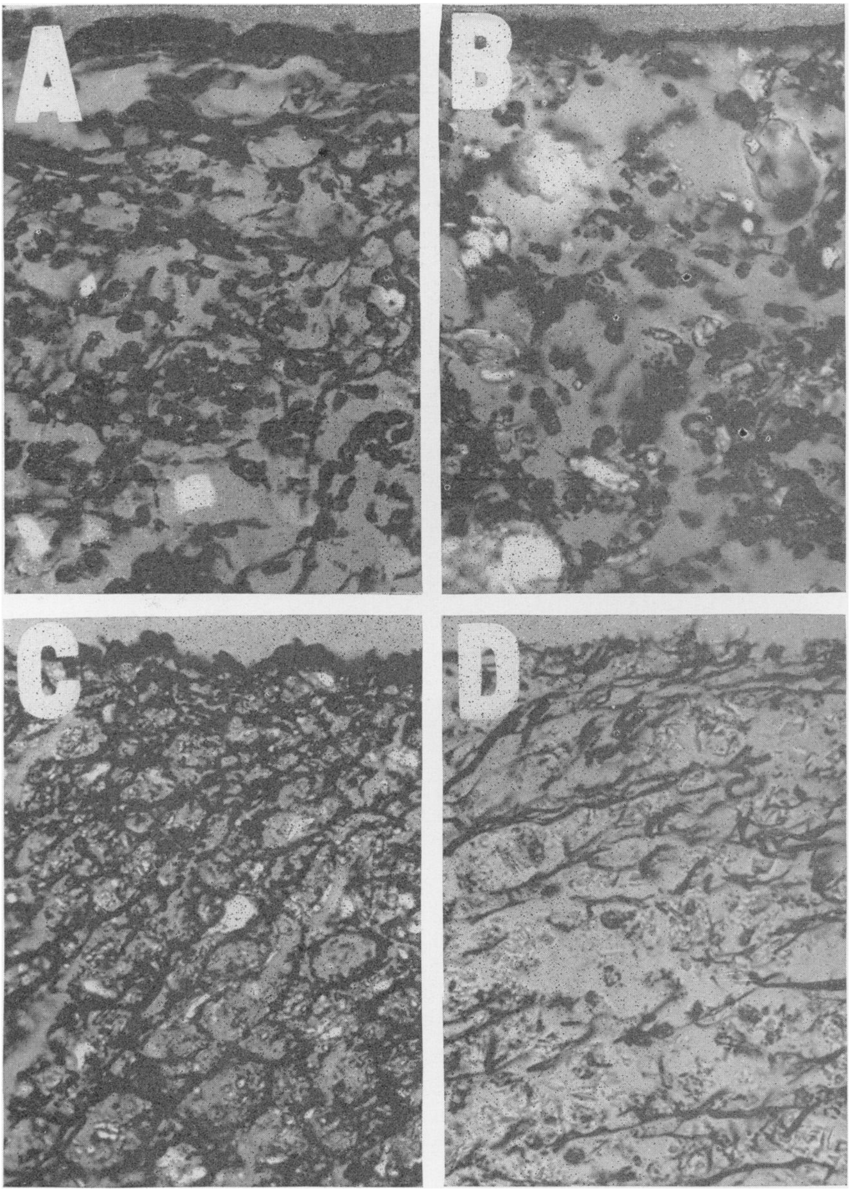


Figure 3. Peritoneal nodules at 105 days after injection stained for reticulum by Wilder's method (× 400). A. Quartz. B. Slag No. 6. C. Trap rock No. 3088. D. Obsidian. (All except 3D photographed with polarized light.)

by Miller and Sayers (*2*, *3*, *4*). Nodules, varying in color with the material injected, were often found throughout the peritoneal cavity, but the site of the largest collection was generally in the peritoneum of the anterior abdominal wall, the most dependent portion of the

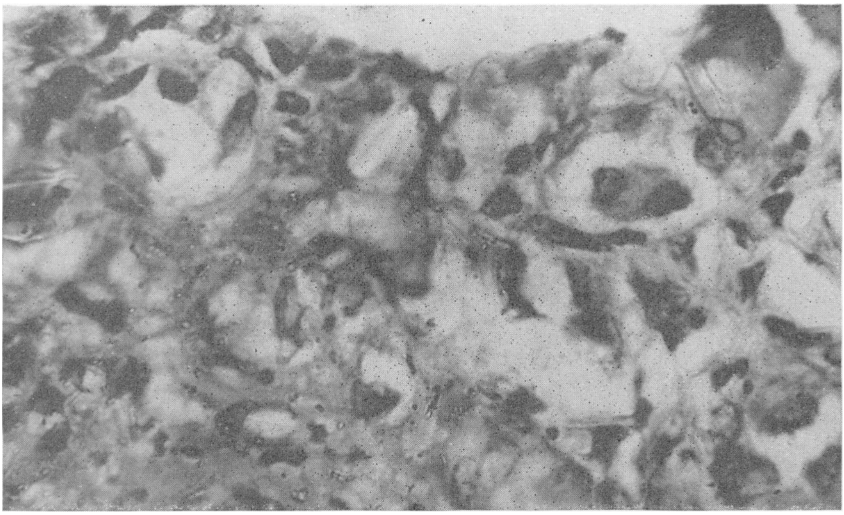


Figure 4. Quartz at 105 days. Note necrotic area in lower left portion of figure. The particles appear translucent and less prominent than in figure 2A because nonpolarized light was used. (Azure eosinate; × 667.)

peritoneal cavity. The severity of the reaction to the dust was graded grossly on the basis of the number, size, elevation, and degree of coalescence of the nodules noted on the peritoneal surface of the anterior abdominal wall.

The most severe gross peritoneal nodular lesions were produced by silica sand, followed in decreasing order of severity by quartz, vitreous silica, trap rock No. 3088, obsidian, anthracite, slag No. 3, Lyon Mountain ore tailings, slag No. 1, slag No. 2, slag No. 5, slag No. 4, bituminous coal, lodestone, magnetite, hematite, and calcite. Because the severity of the lesions often varied considerably in animals given the same treatment, this order cannot be considered exact. Miller and Sayers (*2*, *3*, *4*) have classified the reaction caused by quartz as proliferative. Since the nodular lesions produced by silica sand and vitreous silica were similar in severity to those produced by quartz, they may be similarly classified with quartz as dusts producing a proliferative reaction. However, the reaction was somewhat atypical in that it was more severe in some animals killed at 35 days than in other animals, receiving the same dust (including quartz), killed at 70 or 105 days after the injection. Using the criteria of Miller and Sayers, we considered calcite as causing an absorptive reaction and the other dusts as producing either an inert or a modified proliferative reaction.

It must be emphasized that the classification of the reactions and the order of severity listed are tentative and based on gross findings only; they must be considered in conjunction with the character and

894706—50——2

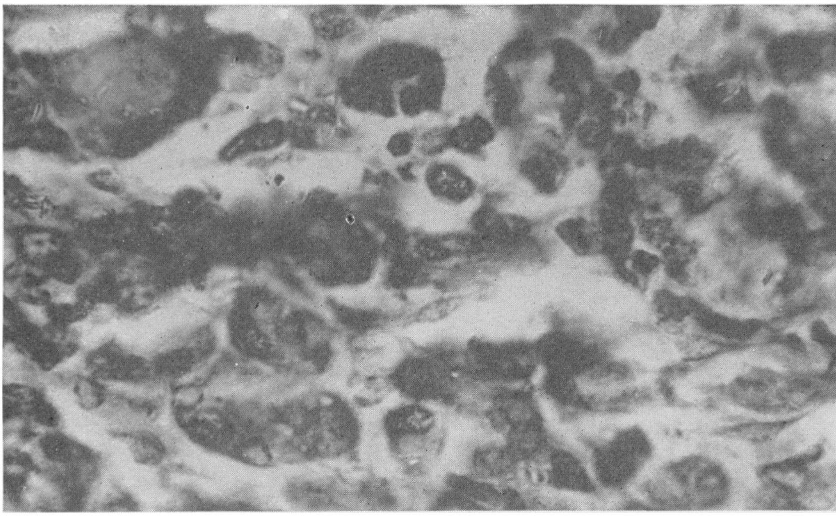


Figure 5. Silica sand at 105 days. Note similarity of reaction (giant cells and macrophages) to that of quartz shown in figures 2A and 3A. The particles are transparent and difficult to detect. (Azure eosinate; × 667.)

severity of the tissue changes produced by each powdered mineral dust as described below.

Microscopic Pathology

The tissues were fixed in formaldehyde. Whenever feasible, the histologic sections of the abdominal wall were made so as to include the central portion of the largest nodules. Routine paraffin sections were studied after staining with azure eosinate and Masson's trichrome stain, and after treatment with acidulated ferrocyanide for iron and frequently with silver impregnation methods for reticulum (*5*). In general, there was no consistent striking difference between the lesions at 35 and 105 days after inoculation with the dust. Nearly all the nodules were completely organized and traversed by a network of slender vascularized fibrous septa. A few of the larger nodules, particularly at 35 days, presented in the central portion one or more large masses of unorganized (not traversed by vascularized fibrous septa) dust particles often marginated by or admixed with some necrotic fibrinocellular exudate. Such unorganized dust aggregates were found occasionally even in nodules produced by relatively inert dusts, such as anthracite and bituminous coal. The fibrous septa were formed chiefly of mature connective tissue cells with a few lymphocytes and large mononuclear cells and a little collagen. Collagen tended to be somewhat more abundant at 105 days than at 35 days.

There were several types of reaction. The nodules produced by

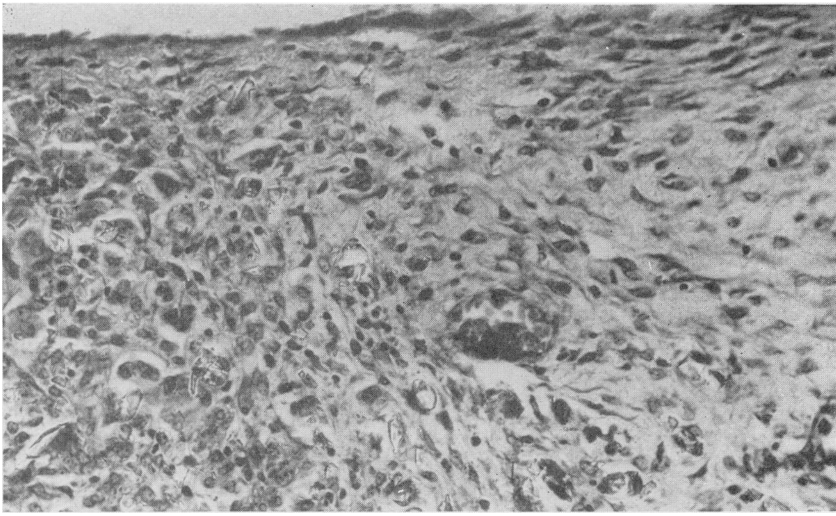


Figure 6. Vitreous silica at 35 days. Note fibrosis on the right and macrophages and giant cells on the left. The peritoneal surface is shown above. (Azure eosinate; × 267.)

anthracite, bituminous coal, lodestone, and hematite showed little other than a network of fibrous septa, the meshes of which were occupied by amorphous, dark masses and clumps of dust. Smaller dust masses occurred also in the cytoplasm of some of the septal cells. The dust in nodules evoked by lodestone gave the Prussian blue reaction for iron.

Other dusts produced a more severe cellular reaction with an outpouring of cells between the fibrous septa (interseptal spaces). There were variable numbers and proportions of lymphocytes, large mononuclear cells, macrophages, fibroblasts, and multinucleated foreign body giant cells. All of these as well as intermediary types were often present, but usually one or two types of cells predominated. The term "macrophage" is used here to denote a cell with a large round pale nucleus and relatively abundant cytoplasm often laden with dust particles, and "large mononuclear cell" is a term used for a somewhat smaller cell with a darker nucleus. Lymphocytes, mononuclear cells, and fibroblasts tended to be most numerous in the outer portion of the nodules and along the septa. Giant cells tended to vary with the number of large particles exceeding 10 microns in length. Reticulum or intercellular fine collagenous fibers were infrequent except in the outer interseptal spaces of some nodules showing numerous macrophages. Many nodules had a thin fibrous layer, chiefly along the peritoneal surface, but there was usually no marked fibrous encapsulation except in some nodules showing extensive central necrosis or suppuration.

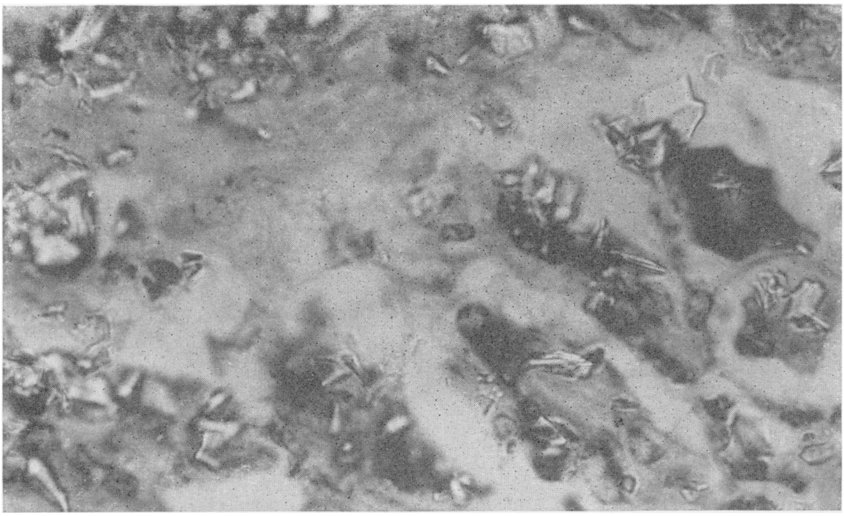


Figure 7. Vitreous silica at 105 days. Note necrosis in left upper portion of figure. (Azure eosinate; × 667.)

The most severe interseptal cellular reaction was induced by quartz. There was a predominance of macrophages and of large multinucleated giant cells, many containing large particles. The bulk of the dust consisted of scattered, irregularly shaped, anisotropic particles ranging chiefly from 10 to 25 microns, with some smaller and larger particles. Fibroblasts were numerous in some nodules, and intercellular collagen and reticulum were scanty to abundant. Three of the nine animals presented nodules showing widespread necrosis of cells and intense eosinophilic degeneration of septal collagen. Silica sand evoked a somewhat similar reaction with a predominance of macrophages.

The other dusts provoked an interseptal cellular reaction less than that of quartz but greater than that of the anthracite group mentioned above. In nodules induced by Lyon Mountain ore tailings, the interseptal spaces generally presented dense clusters of dust particles marginated by and occasionally admixed with relatively few cells, chiefly small and large mononuclear cells. Obsidian and slag No. 4 often showed a somewhat similar reaction. With magnetite, and slags Nos. 1, 2, 3, and 5, the dust clusters were relatively fewer, smaller, and less compact; the interseptal cellular reaction was moderate to marked, with giant cells, macrophages, mononuclear cells and lymphocytes occurring in variable proportions. Mononuclear cells tended to predominate in nodules produced by magnetite and slag No. 5; and macrophages, in those by other slags.

With trap rock, the particles were more dispersed in the interseptal spaces, and cellular reaction was moderate with a predominance of macrophages, many of which contained particles. A somewhat

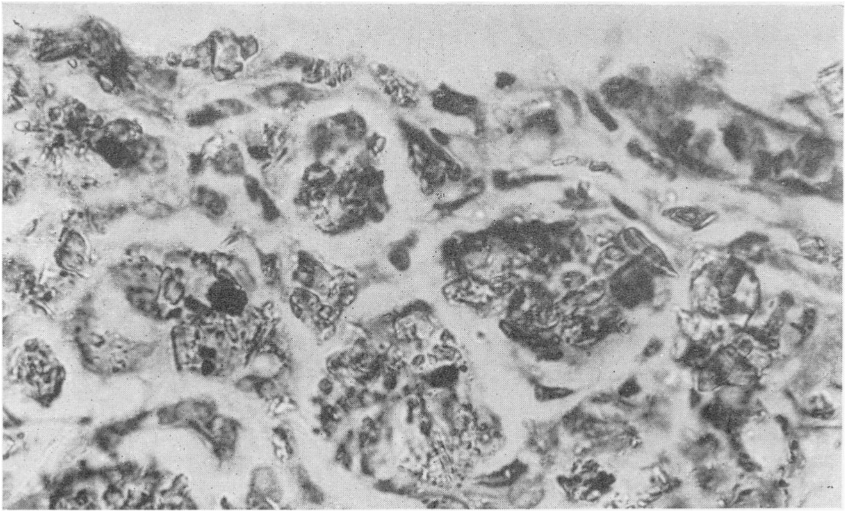


Figure 8. Trap rock No. 3088 at 105 days. Note abundance of particles and cells in the interseptal spaces. The septal network is fairly distinct due to shrinkage of the cells entailed in the process of preparing paraffin sections. (Azure eosinate; × 667.)

similar reaction was induced by vitreous silica and occasionally by obsidian and other dusts. The fibrous septa of the nodules showed a variable amount of dust and cellular infiltration and were not clearly distinguishable in some nodules showing a marked interseptal cellular reaction.

The severity of the reaction was graded by estimating the percentage of dust by volume in the nodules. This was done by Chalkley's method for the quantitative morphologic analysis of tissues (*6*). The percentage of dust often varied moderately in different nodules and in different animals and intervals after inoculation, but it generally fell within a certain range for a given dust, as shown in table 2.

It is interesting to note that dusts such as anthracite, bituminous coal, and hematite, which are relatively harmless to man, produced

Table 2

(A) Mild reaction*	(B) Moderate reaction*	(C) Marked reaction*	(D) Severe reaction*
Anthracite	Lyon Mountain ore tailings**	Slag No. 1	Quartz.
Bituminous coal	Magnetite	Slag No. 2	Silica sand.
Hematite	Obsidian	Slag No. 3	
Lodestone	Slag No. 4**	Slag No. 5	
	Trap rock No. 3088	Vitreous silica	

*The reaction was classified as mild if more than 40 percent of the nodule was occupied by dust, moderate if the percentage was between 25 and 40, marked if between 10 and 24, and severe if under 10 percent.

**After this study was completed, it was found that Brown and Schrenk (*1*) had suggested as a health measure the use of substances of a similar composition as traction material. The recommendation was based on the low silica content of these materials as well as on practical experience.

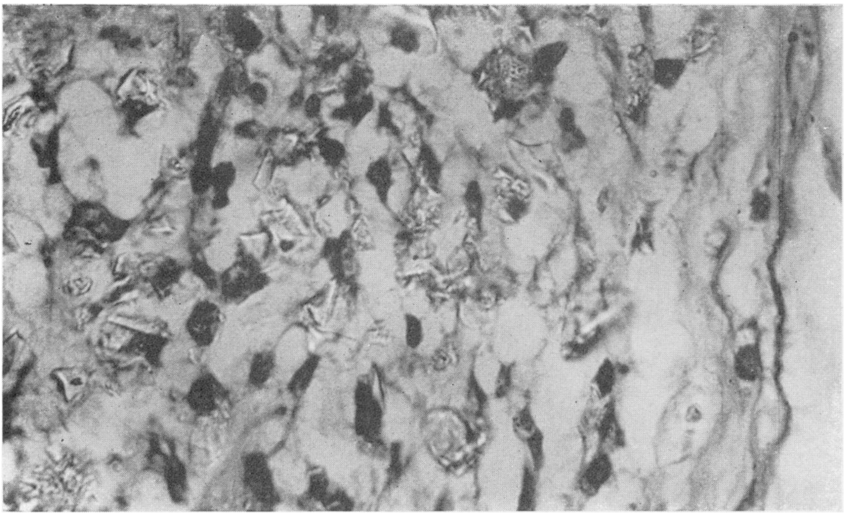


Figure 9. Obsidian at 105 days. Note particle-laden macrophages on the left and beginning subperitoneal fibrosis on the right. (Azure eosinate; × 667.)

in this study only a mild peritoneal reaction in guinea pigs, and that quartz, which can produce severe silicosis in man, produced a severe peritoneal reaction in guinea pigs. These findings suggest that the pulmonary reaction in man (like the peritoneal reaction in the guinea pigs) may be greater to dusts in groups B and C than dusts in group A, but less than to those in group D. The sample of magnetite, which

Figure 10. Slag No. 1 at 105 days. Note lymphocytes with small, dark, round nuclei in outer portion of nodule below; macrophages with larger, paler nuclei tend to predominate elsewhere. (Azure eosinate; × 667.)

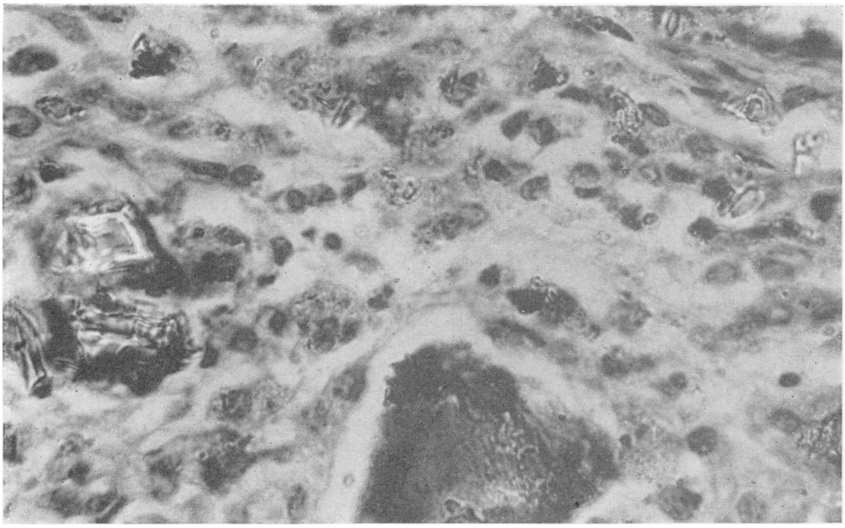


Figure 11. Slag No. 2 at 105 days. Note marked cellular reaction with lymphocytes, macrophages, and large multinucleated giant cells. (Azure eosinate; × 667.)

produced a moderate peritoneal reaction, contained relatively many more doubly-refractile particles (free silica) than the sample of lodestone (selected masses of magnetite), which produced only a mild reaction. Slag No. 6 is not included in the table because nodules satisfactory for gradings were found in only four animals; the average dust concentration was 23 percent. Calcite is not included because it produced an absorptive reaction.

The microscopic appearance of the nodules produced by anthracite, bituminous coal, hematite, lodestone, and quartz have been described in some detail. Following are more detailed histologic descriptions of nodules produced by some of the other dusts.

Calcite Crystals. Only one guinea pig, killed at 35 days, showed a definite peritoneal lesion. This consisted of two coalescent nodules, each about 1.5 mm. in width and 0.4 mm. thick. Lying chiefly in the outer portion of the nodules were some iron-positive pigment masses and a few scattered transparent birefringent particles measuring 5 to 25 microns. One nodule showed slight, and the other extensive, central necrosis and peripheral fibrous encapsulation. Cellular reaction was marked with a predominance of large mononuclear cells and fibroblasts and occasional multinucleated giant cells. Intercellular collagen was moderately abundant.

Lyon Mountain Ore Tailings. The peritoneal nodules showed a coarse network of slender fibrous septa and large interseptal clusters of irregularly shaped transparent and light brown particles predominantly from 2 to 10 microns in diameter. Many of the particles were doubly refractile, and some gave the Prussian blue reaction for

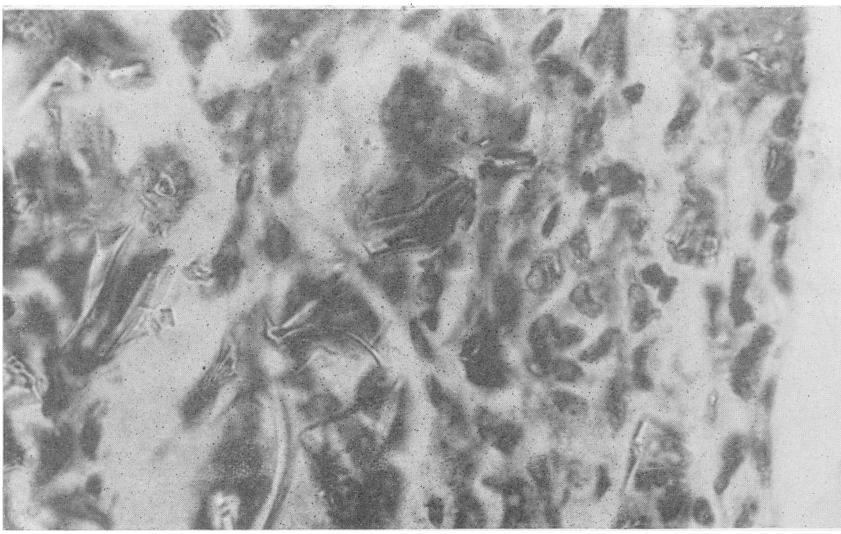


Figure 12. Slag No. 3 at 105 days. Peritoneal surface is on the right. (Azure eosinate; × 667.)

iron. The clusters were marginated by and occasionally admixed with relatively few cells, chiefly mononuclear cells. There was little or no interseptal reticulum.

Magnetite. The dust in the nodules was rather abundant, lying chiefly in the meshes of a network of vascular fibrous septa. There were many small, dark brown, amorphous masses and clumps giving the Prussian blue reaction for iron and many scattered, transparent to light brown, irregularly shaped particles, 2 to 75 microns long, some of which were doubly refractile and did not react like iron. Interseptal cellular reaction was moderate; large mononuclear cells often predominated, but there were also numerous macrophages and multinucleated giant cells. Interseptal collagen was scanty or absent.

Obsidian. The dust in the nodules was moderately abundant and fairly homogeneous. It was composed chiefly of irregularly shaped, translucent or light brown, isotropic particles predominantly between 2 and 10 microns in length. In most nodules, the particles lay chiefly in the interseptal spaces in dense clusters marginated by and occasionally admixed with relatively few cells, chiefly small mononuclear cells. In one nodule from an animal killed at 105 days, the particles were dispersed and often engulfed by macrophages. Reticulum was fairly abundant in the interseptal spaces. The nodules from several other animals showed a similar macrophage reaction in their peripheral portions.

Silica sand. The peritoneal nodules contained a relatively small amount of dust consisting chiefly of scattered, irregularly shaped, transparent and light brown, anisotropic particles ranging principally

Figure 13. Slag No. 5 at 105 days. Peritoneal surface is below. (Azure eosinate; × 667.)

between 10 and 100 microns in maximum diameter. Clusters were uncommon. Cellular reaction was severe with a predominance of macrophages and fewer large multinucleated giant cells, some of which contained particles. One nodule showed a small area of oxyphilic necrosis. Intercellular reticulum and collagen were moderately abundant.

Silica, vitreous. The nodules showed a moderate abundance of dust composed chiefly of irregularly shaped, translucent, isotropic particles predominantly from 2 to 15 microns in diameter. Some nodules had a distinct network of vascular, fibrous septa, in the meshes of which were large clusters of particles admixed with relatively few cells. In one such nodule from an animal killed at 105 days, the fibrous septa showed marked thickening with extensive hyalinization and oxyphilic degeneration. In most nodules, the network of fibrous septa was less distinct, and the dust was disposed in the interseptal meshes as small clumps or individual particles admixed with and often engulfed by numerous cells, chiefly macrophages. Intercellular collagen or reticulum was scanty except near the periphery of the nodules, where the macrophages often seemed to grade into fibroblasts and connective tissue cells.

Slags Nos. 1, 2, and 3. The peritoneal nodules produced by slags Nos. 1, 2, and 3 were essentially similar histologically, though the composition of the dust differed somewhat. The dust was moderately abundant and consisted chiefly of irregularly shaped, translucent particles, predominantly from 5 to 50 microns which occurred singly and in small clumps. There were also some brown and black particles

894706—50——3

Figure 14. Lyon Mountain ore tailings at 105 days. The interseptal spaces contain large compact masses of particles with relatively few cells, their nuclei appearing black. (Azure eosinate; × 667.)

and amorphous masses. Only a few particles were doubly refractile or gave the Prussian blue reaction for iron. There was a moderate to marked interseptal cellular reaction with a predominance of macrophages, many of which contained dust particles. There were also a moderate number of lymphoid cells and multinucleated foreign body giant cells. Intercellular reticulum appeared in moderate amount in some nodules and scanty in others. Several nodules contained unorganized large dust masses.

Slag No. 4. The nodules contained moderately abundant dust consisting chiefly of interseptal clusters of fine, brown particles giving the Prussian blue reaction for iron. There were also occasional isotropic and anisotropic larger particles (5 to 25 microns) of variable size, shape, and color. There was little or no interseptal cellular reaction except in several nodules showing some large mononuclear cells and macrophages in occasional interseptal spaces, chiefly peripherally. Reticulum was scanty or absent.

Slag No. 5. The nodules were traversed by an irregular network of slender, vascular, fibrous septa. There was a moderate amount of dust lying chiefly in the interseptal spaces. The particles appeared transparent, brown, or occasionally black. Many were doubly refractile, and some gave the Prussian blue reaction for iron. Coarse particles (5 to 25 microns) predominated, but there were also many fine particles often loosely arranged in small clusters. Many particles were intracellular. Interseptal cellular reaction was marked with a predominance of multinucleated giant cells and large mononuclear

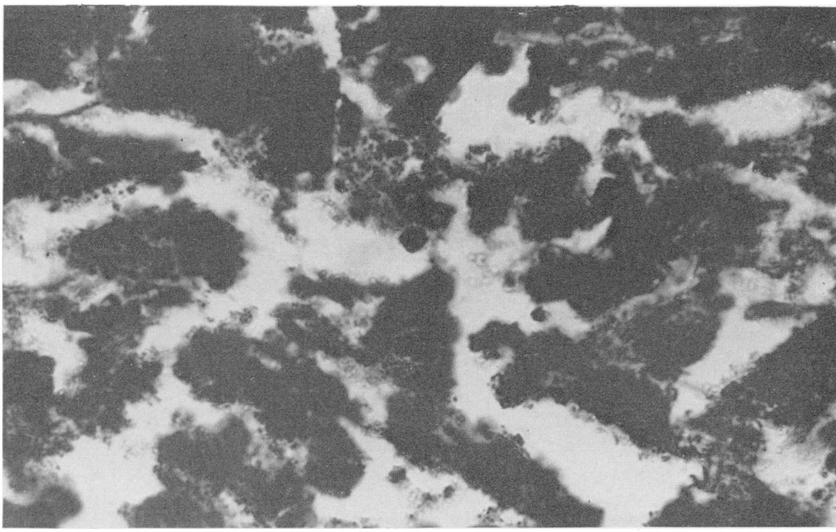


Figure 15. Slag No. 4 at 105 days. Note scant cellular reaction and similarity to anthracite (fig. 2D). (Azure eosinate; × 667.)

cells grading into macrophages. Interseptal reticulum was scanty to moderate in amount.

Slag No. 6. The peritoneal nodules showed a moderate to marked cellular reaction with a predominance of macrophages. Particles were generally light brown or translucent, often anisotropic, and varied markedly in si e and shape, but particles over 10 microns predominated. Large clusters were uncommon. Interseptal reticulum was scanty or absent.

Trap Rock No. 3088. The dust in the peritoneal nodules was moderately abundant. The dust particles varied markedly in size and shape. Many were doubly refractile, and some gave the Prussian blue reaction for iron. Most of the particles were translucent, but some were brown or black. They occurred singly and in small clumps. Interseptal cellular reaction was marked with a predominance of macrophages, many of which contained dust particles. There were also many lymphoid cells and a few multinucleated giant cells. Reticulum was variable in amount. There was often some fibroblast proliferation, particularly along the periphery, with the formation of a capsule.

Summary and Conclusions

The use of sand as traction material for mine locomotives has been considered a potential health hazard. The purpose of this study was to determine the relative safety of possible substitute materials. Guinea pigs were injected intraperitoneally, according to the method of Miller and Sayers, with suspensions of the various powdered materials or dusts. The dusts caused a cellular reaction with the formation of peritoneal nodules. An attempt was made to grade the severity of the reaction objectively by estimating the percentage of dust by volume in the nodules, using Chalkley's method for the quantitative morphologic analysis of tissues. The severity of the reaction was considered to vary inversely with the percent of dust in the nodules.

With this method of grading, it was found that quartz and silica sand produced a severe cellular reaction. A marked cellular reaction was induced by vitreous silica and slags Nos. 1, 2, 3, and 5. A moderate cellular reaction was induced by Lyon Mountain ore tailings, magnetite, obsidian, slag No. 4, and traprock No. 3088. A mild cellular reaction was evoked by anthracite, bituminous coal, hematite, and lodestone.

Miller and Sayers have noted, at least in some instances, a correlation between the severity of the peritoneal reaction in guinea pigs and the pulmonary response in man. In this study, it was noted that anthracite, bituminous coal, and hematite, which are relatively harmless to man, produced only a mild peritoneal reaction in guinea pigs, and that quartz, which can produce severe silicosis in man, produced a severe peritoneal reaction in guinea pigs. These findings suggest that the materials which produced a mild or moderate peritoneal reaction in guinea pigs are likely to be less harmful to man than those, such as quartz and silica sand, which produced a marked or severe peritoneal reaction. Among the materials which fulfilled this condition were iron ore tailings corresponding to the composition indicated, slag No. 4, U. S. Bureau of Mines No. 49–303(3), and traprock conforming to the type described. These materials also appear to have the requisite hardness, commercial availability, and other properties suitable for use as traction material.

REFERENCES

(*1*) Brown, C. E. and Schrenk, H. H.: Control of silicosis by substitution of quartz-free or low-quartz material for sand used under mine locomotives. Bureau of Mines Information Circular 7297, October 1944.

(*2*) Miller, J. W. and Sayers, R. R.: The response of peritoneal tissue to dusts introduced as foreign bodies. Pub. Health Rep. **49:** 80–89 (1934) Reprint No. 1608; J. Am. Med. Assoc. **103:** 907–12 (1934); Am. J. Pub. Health **25:** 452–56 (1935); Pub. Health Rep. **51:** 1677–88 (1936) Reprint No. 1787.

(*3*) Miller, J. W. and Sayers, R. R.: Microscopic appearance of experimentally produced dust nodules in the peritoneum. Pub. Health Rep. **50:** 1619–28 (1935). Reprint No. 1717.

(*4*) Miller, J. W. and Sayers, R. R.: The response of peritoneal tissue to industrial dusts. Pub. Health Rep. **56:** 264–72 (1941).

(*5*) Lillie, R. D.: Histopathologic Technic. Blakiston Co., Philadelphia, 1948.

(*6*) Chalkley, H. W.: Method for the quantitative morphologic analysis of tissues. J. Nat. Cancer Inst. **4:** 47–53 (1943).

1080 (Sodium Fluoroacetate) Poisoning of Rats on Ships

By JOHN H. HUGHES, Ph. D.*

Poison compound 1080 (sodium fluoroacetate) is in its fifth year of use by the Public Health Service for shipboard rat control. Following the successful initial use of this poison on ships by the Division of Foreign Quarantine, the program was expanded. Ten-eighty poisoning has replaced the standard hydrocyanic acid gas fumigation on approximately one-half of the ships on which rat control measures are required.

This report gives results obtained by shipboard use of 1080 at quarantine stations during a period of nearly 4 years.

Ten-eighty, unfortunately, is highly toxic to man as well as other animals; it should be used only by carefully trained persons under conditions which offer a minimum of hazard. THERE IS NO KNOWN ANTIDOTE FOR 1080 POISONING.

General instructions and information on the value and hazards of the use of 1080 are presented in a National Research Council brochure (*2*), which should be studied carefully by persons interested in using 1080. This writer's earlier report on the poison gave details for handling it and precautions to be observed in its use, particularly on shipboard (*1*).

Procedures

Using 1080 on Ships

For the control of rats on ships the usual method of using 1080 is to place it in water. The recommended concentration is one-half ounce or 14 grams of the poison dissolved in one gallon of water. Solid baits are sometimes used.

Water containing 1080 is readily accepted by rats, but some effort was made to enhance it by adding attractants. Vanilla extract and anise oil were used in the poison solution on a number of ships, but without conclusive results. It is doubtful that attractants used in conjunction with 1080 would be of any significant value in shipboard rat control.

A warning color, produced by adding nigrosine black dye to 1080, has been recommended as an added precaution (*3*).

*Scientist, Entomology Branch, Division of Foreign Quarantine, Public Health Service.

A paper container, shown in figure 1, designed specifically for 1080-poisoning operations (*2*), has largely replaced the type of container used earlier in the program and shown in figure 2. This new squat-type container, with a capacity of three-fourths fluid ounce, is practically tip-proof; it is colored light brown, and it is appropriately labeled.

Occasionally, pint-size chicken watering fountains have been used in making large quantities of 1080 solution available for rats.

Flea Control

An important reason for destroying rats on ships is obviously to eliminate their flea parasites, some of which are responsible for transmission of the plague organism to man. A measure of flea control is achieved indirectly by destruction of rat hosts. However, since 1080 poisoning does not directly accomplish flea control, an insecticide was employed in conjunction with the rat poisoning program. This was done with the hope that many of the fleas which might be present on dead or dying rats, or which might escape from them, would be killed. A thin layer of 10 percent DDT (dichloro-diphenyl-trichloroethane) dust was sprinkled around each 1080 station for a distance of about 2 feet as shown in figure 2; it was also applied along rat runways and around suspected harborages.

Later, laboratory studies were conducted to determine the effectiveness of DDT in flea control when employed in this manner on ships. This work (*4*), which was preliminary, showed a high rate of flea control when infested rats walked through a 24-inch-long box with a 2½- by 3-inch passageway in which folds of cheesecloth impregnated with 10 percent DDT dust were fastened at the top, the floor being covered with DDT dust. In other tests, when infested rats were required only to walk in 10 percent DDT dust for a brief period, the flea mortality was much lower.

The laboratory results were not conclusive, but suggest that if flea control is desired a rat must be more thoroughly subjected to DDT than it is when it walks only through a thin layer of the insecticide.

In effectiveness, the flea-control method employed on ships would seem to approach the more effective of the two laboratory methods reported. Many rats poisoned by 1080 on ships were found dead within the area of DDT near poison cups (fig. 2). Fleas escaping from these rats would undoubtedly come in contact with the DDT. Rats that did not die in the DDT-treated area sometimes spent several minutes in the insecticide while consuming poisoned water, or made several trips through the insecticide while traveling to and from the poison stations, thus increasing the probability of exposure of the fleas to the DDT.

Figure 1. Ten-eighty poison station and plastic bottle used to pour 1080 solution. White powder is 10 percent DDT.

The rats shown in figure 2 were photographed as found on a ship by quarantine inspectors approximately 19 hours following distribution of 1080.

Figure 2. Rats killed by 1080 in ship's hold. White powder is 10 percent DDT (photograph by U. S. Army).

Results

Since the inception of the 1080-poisoning program in 1945, this poison has been used on 379 ships at eight quarantine stations, located at Baltimore, Boston, Los Angeles, Mobile, New Orleans, New York, San Francisco, and Seattle. These stations presently conduct approximately 75 percent of all Public Health Service shipboard rat-control activities, including 1080 poisonings and HCN (hydrocyanic acid gas) fumigations. The number of ships recorded includes 96 reported in 1947 (*1*) and 283 on which 1080 has been used since that time. Table 1 gives detailed data showing results during the two phases of the work and for the over-all study. The efficiency, or ratio of rats killed by 1080 to the rats estimated to be aboard, was 91.8 percent for the last 283 ships, a slight increase over the efficiency for the first 96 ships. The efficiency for all 379 ships reported for the entire period 1946–49 at the eight stations was 89.9 percent, which is also favorable.

Table 1. *Comparison of 1080 data*

Period	Number of ships	Dispensers		Solution 1080 (ounces)	Number of rats		Percent of estimate killed
		Cups	Fountains		Estimated	Killed	
1946–47 [1]	96	7,893	132	7,516	1,475	1,262	85.5
Average per ship		82.2	1.37	78.3	15.36	13.1	
1947–49 [2]	283	21,633	66	18,334	3,550	3,259	91.8
Average per ship		76.4	0.23	64.8	12.54	11.5	
1946–49 [2]	379	29,526	198	25,850	5,025	4,521	89.9
Average per ship		77.9	0.52	68.2	13.3	11.9	

[1] For Boston, New Orleans, New York, and Seattle.
[2] For Baltimore, Boston, Los Angeles, Mobile, New Orleans, New York, San Francisco, and Seattle.

During the program a large number of rats (4,521) were killed by 1080 on ships and found by quarantine inspectors; this represents an average of 11.9 per ship. There was also evidence of many additional dead rats that were not found.

In the distribution of 1080 solution, the average number of paper cups used per ship was 77.9; the average amount of poison solution used per ship was 68.2 ounces. All remaining poison solution was collected and disposed of at the end of the exposure period for a ship. The poisoned water was not ordinarily reused, since the concentration would be increased as a result of evaporation of water. An increase in concentration of the solution would probably make it less desirable as a rodenticide and would present a greater hazard to animals other than rats.

Dead rats were destroyed by incineration after being identified and studied. Compound 1080 decomposes at approximately 200° C. or 392° F. (*2*), losing its poisonous quality.

Table 2. *1080-poisoned rats found dead per ship* [1]

Number of rats killed per ship	Number of ships	Percent of all ships on which rats were found
0	42	
1-10	221	58.3
11-20	55	14.5
21-35	36	9.5
36-75	20	5.3
76-106	4	1.1
435	1	0.3
Total	379	

[1] At Baltimore, Boston, Los Angeles, Mobile, New Orleans, New York, San Francisco, and Seattle.

The number of rats found dead from 1080 poisoning ranged from 0 to 435 per ship (table 2). One to 10 dead rats per ship were found on 221 (58.3 percent) of the 379 ships reported; 11 to 20 were found on 55 (14.5 percent) of the ships; 21 to 35, on 36 (9.5 percent); and 36 to 75, on 20 (5.3 percent). Four ships had 76 to 106 dead rats each. One ship that had been hauling cattle and horses aboard had the exceedingly large number of 435 rats dead from 1080 poisoning.

Table 2 also shows that no rats were found on 42 (11.1 percent) of the 379 ships reported. There was evidence of comparatively few rats on many of these ships prior to using the poison; hence, the significance of this seeming inefficiency of 1080 on the 42 ships is not

Table 3. *Deratization activities by individual compartments of 197 ships* [1]

Compartment	Number of times		Percent of estimated times rats found	Number of rats		Percent of estimated number killed
	Rats estimated	Rats found		Estimated	Killed	
Holds No.:						
1	92	67	72.8	314	234	74.5
2	91	67	73.6	297	283	95.3
3	90	74	82.2	350	339	96.9
4	81	55	67.9	285	285	100.0
5	73	41	56.2	219	148	67.6
6	4	2	50.0	9	4	44.4
				[2] (1,474)	[2] (1,293)	
Shelter deck space	17	15	88.2	90	76	84.4
Bunker space	2	2	100.0	12	9	75.0
Engine room, shaft alley	3	1	33.3	5	2	40.0
Forepeak and storeroom	29	7	24.1	68	25	36.8
Afterpeak and storeroom	9	3	33.3	16	4	25.0
Other storerooms	26	17	65.4	56	51	91.1
Lifeboats and boat decks	48	33	68.8	113	84	74.3
Chart and wireless room	2	1	50.0	4	1	25.0
Galley and bakery	16	13	81.3	41	25	61.0
Pantry	6	2	33.3	21	4	19.0
Saloon	1	0	0.0	1	0	0.0
Messrooms	5	5	100.0	7	6	85.7
Quarters	19	12	63.2	44	21	47.7
Toilets	4	1	25.0	6	2	33.3
Lockers	2	2	100.0	2	2	100.0
Workshops	2	2	100.0	2	2	100.0
Miscellaneous spaces	14	10	71.4	28	26	92.9
All	636	432	67.9	1,990	1,633	82.1

[1] At Baltimore, Boston, Mobile, New Orleans, New York, San Francisco, and Seattle.
[2] Total for holds.

great. Actually, not more than 5 rats were estimated on each of 25 ships, and not more than 2 rats were estimated on each of 19 of these.

Relative Distribution of Rats on Ships

The relative distribution or occurrence of rats on ships is indicated in table 3, which considers estimates and actual findings in individual compartments and in groups of compartments or areas on 197 ships. These estimates and findings of dead rats, made by well-trained inspectors, are reasonably accurate for many ships, but are sometimes very difficult or impossible to make, depending primarily on the nature and quantity of cargo present.

The presence of rats in 636 aggregate compartments and areas on the 197 ships was suggested by quarantine inspectors. Rats killed by 1080 were found in 432, or 67.9 percent, of the times they were thought to be present. The greatest number of dead rats, 1,293, or 79.2 percent of the total rats killed by 1080, was found in the ships' holds. This should not be considered unusual in view of the extensive area involved and the various types of cargo, including food products, stored in these spaces. The percent of estimated rats killed by 1080 in all compartments on the 197 ships was 82.1.

Inspection of Ships for Poisoned Rats

Inspection of ships for dead rats following distribution of 1080 is made usually after an overnight shipboard exposure of the poison. Ordinarily the exposure period is approximately 18 hours, but it is sometimes much longer. Inspections for dead rats are made daily while 1080 is present on ships, and they are often continued following its removal. The number of inspections is determined by the degree of infestation, nature and quantity of cargo, and duration of the ship's stay in port. Most often only one or two inspections per ship are made for the purpose of finding dead rats, but as many as nine have been made on a ship during its unloading.

Table 4 gives inspectional data for 376 of the ships included in the total study. As may be seen, first inspections were by far the most important. Of 4,394 dead rats found, 68.8 percent were accounted for during first inspections; 18.3 percent of the dead rats were found during second inspections, and only 13.0 percent were found during the remaining inspections.

The average length of time from placement of 1080 on the ships till the end of the respective inspection periods ranged from 22.3 hours for the first inspections to 165.9 hours, or almost 7 days, for the sixth and other inspections included therewith; this represents an average of 53.9 hours per ship.

Table 4. *Inspections made and rat mortality for 376 ships*

All stations[1]	Inspections						
	First	Second	Third	Fourth	Fifth	Sixth [2]	All
Number of inspections made	376	227	127	66	29	22	847
Average duration of study (hrs.)[3]	22.3	55.1	89.5	124.2	149.4	165.9	53.9
Total dead rats found	3,024	803	271	175	83	38	4,394
Average number of rats found	8.0	3.5	2.1	2.7	2.9	1.7	5.2
Percent of all rats found	68.8	18.3	6.2	4.0	1.9	.9	----------
Percent of total inspections	44.4	26.8	15.0	7.8	3.4	2.6	----------

[1] At Baltimore, Boston, Los Angeles, Mobile, New Orleans, New York, San Francisco, and Seattle.
[2] Four records for inspections 7, 8, and 9 included.
[3] From beginning of 1080 exposure to end of inspection period.

Species and Sex of Rats Found

The kind and sex of rats found were noted for 3,924 (86.8 percent) of the 4,521 rats killed by 1080 at the eight stations named in table 5. Three species recovered from ships were: the black rat, *Rattus rattus rattus* (Linnaeus); the Alexander, gray, or roof rat, *Rattus rattus alexandrinus* (Geoffroy); and the Norway, brown, or sewer rat, *Rattus norvegicus* (Berkenhout). The black rat was reported most often, comprising 47.7 percent of the rats found; the Alexander rat was second in abundance with 30.9 percent, and the Norway rat was last with 21.4 percent. There were more females than males reported for each species.

Although the number of dead rats differed with species and with sex, there was no apparent difference in the susceptibility to 1080 poisoning. The time required to produce death from poisoning was reported to have varied from less than 30 minutes for some rats to several hours for others, presumably depending largely on the quantity of poison consumed.

Table 5. *Species and sex of rats killed by 1080*

Station	(Black rat) *Rattus rattus rattus*		(Alexander rat) *Rattus rattus alexandrinus*		(Norway rat) *Rattus norvegicus*		All species		Total determinations made
	Male	Female	Male	Female	Male	Female	Male	Female	
Baltimore	1	0	0	0	3	4	4	4	8
Boston	63	106	168	220	51	56	282	382	664
Los Angeles	0	0	0	0	6	1	6	1	7
Mobile	0	0	9	15	73	74	82	89	171
New Orleans	103	300	155	293	0	1	258	594	852
New York	407	452	40	47	259	274	706	773	1,479
San Francisco	5	1	1	2	0	0	6	3	9
Seattle	230	204	128	135	22	15	380	354	734
Total	809	1,063	501	712	414	425	1,724	2,200	3,924
	1,872		1,213		839		3,924		-------
Percent of all determinations	47.7		30.9		21.4		43.9	56.1	-------

Summary

Poison compound 1080 (sodium fluoroacetate) has been used successfully on ships as a rat control measure for more than 4 years.

To kill fleas, DDT dust is employed as a supplement to the 1080 poisoning procedure.

As many as 435 rats were found dead from 1080 poisoning on one ship. However, on most ships not more than 10 dead rats were found, and on 42 none. Very few rats were estimated for the 42 ships. Rats were found most often and in the greatest numbers in the ships' holds.

Usually one or two daily inspections are made for dead rats on ships following an approximate 18-hour exposure of the poison.

Three species of rats found on ships were: the black rat, *Rattus r. rattus*; the Alexander rat, *Rattus r. alexandrinus*; and the Norway rat, *Rattus norvegicus*. The black rat was found most often. Female rats were predominant in all species found.

ACKNOWLEDGMENT

Grateful acknowledgment is made to the medical officers in charge of the quarantine stations, to sanitary inspectors, and to others who were responsible for conducting the 1080-poisoning program on ships, and who made available the data used in this report.

REFERENCES

(*1*) Hughes, J. H.: Studies in deratization of surface vessels by means of 1080 (sodium fluoroacetate). Pub. Health Rep. **62**:933 (1947).

(*2*) National Research Council: Instructions for using sodium fluoroacetate (compound 1080) as a rodent poison. Revised October 1948, 11 pp., mimeographed.

(*3*) National Research Council: Addendum to instructions for using sodium fluoroacetate (compound 1080) as a rodent poison. Revised October 1948. January 1949, 1 p., mimeographed.

(*4*) Joyce, C. R.: Unpublished report.

WHO Publishes New Boundaries for Yellow Fever Danger Zones

A revised delineation of the two zones of prevalence of the yellow fever virus in the tropical belts of the Americas and of Africa was published in the World Health Organization's Weekly Epidemiological Record June 28, 1950.

The delineation, a revision of that made by UNRRA in 1945–46, was drawn up by a WHO panel of experts last December, and finally accepted by all WHO Member States attending the Third World Health Assembly in May. According to international sanitary agreements, countries are required to take special quarantine measures (inoculation, disinfection, etc.) against persons and transports coming from or going to the zones concerned.

The endemic yellow fever area in Africa is limited in the north by a line from the mouth of the Senegal River in French West Africa to Eritrea (excluding the port of Massawa) and extends southward to the 18th degree of latitude enclosing part of Angola in the west, the major part of the Belgian Congo, and all of Kenya in the east. Djibuti and the rest of French Somaliland were excluded from the endemic area by the December 1949 revision, while parts of Bechuanaland and all of Nyasaland were added to it. Modifications result partly from surveys on the occurrence of the disease, and partly from the results of anti-*aegypti* measures in urban communities.

In America the endemic zone comprises Venezuela, Colombia, the British, Dutch and French Guianas, and parts of Brazil, Peru, Bolivia and Ecuador, but excludes certain northern ports. In December, the experts also decided to exclude the port of Manaos, Brazil, which was reported free of *Aedes aegypti*.

Further revision will take place as the situation warrants. In Africa plans are being made for a further study of the occurrence of yellow fever, particularly around the southern border of the endemic zone. In Brazil, favorable reports of the *Aedes aegypti* eradication program with DDT indicate that the mosquito will have been wiped out of the country before the end of the present year. It has already disappeared completely from all ports and cities and is found only in a small rural area in the northeastern part.

—ANNOUNCEMENTS—

Seminar on Plumbing Problems

The University of Michigan School of Public Health will give its second in-service, noncredit training course in plumbing problems September 15 and 16 at Ann Arbor.

Applications for enrollment in the course should be submitted to H. E. Miller of the School of Public Health, 109 South Observatory Street. The enrollment fee is $5.00.

The course is designed especially for the benefit of plumbers, architects, engineers, and sanitarians, but any interested persons will be accepted.

The first day will be given to the theory and practice of hydraulic principles, to safety devices and safety precautions, and to protective equipment for the water system. The second day, in addition to plumbing problems involved in the disposal of wastes and to the fundamentals governing septic tank design and installation, a national plumbing code will be discussed and a movie based on the code will be shown.

Course in Diseases of the Endocrines

Michael Reese Hospital Postgraduate School offers a course in Diseases of the Endocrines, Physiology and Diagnostic Methods. The class will meet from September 18 through September 29, 1950, and will be under the direction of Dr. Rachmiel Levine, Director of the Department of Metabolic and Endocrine Research. The course will consist of a balanced program of lectures and case demonstrations. Tuition is $100. For further information and a detailed schedule, address: Dr. Samuel Soskin, Dean, Michael Reese Hospital Postgraduate School, 29th St. & Ellis Ave., Chicago 16, Illinois.

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 22, 1950

New cases of acute poliomyelitis reported in the Nation for the current week numbered 827; an increase over the 664 cases reported for the preceding week. However, the number was lower than the 1,440 cases reported for the corresponding period last year. The cumulative total (4,017) for the current "disease" year was below the corresponding total (5,408) for last year, the highest year on record. The "disease" year for acute poliomyelitis begins with the twelfth week of the calendar year.

For the current week, all geographic divisions except two showed increases over the preceding week. These increases ranged from 11 (11 to 22) cases reported in the Mountain States to 44 (117 to 161) cases in the South Atlantic States. Texas reported the largest num-

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 1945–49	Seasonal low week	Cumulative total since seasonal low week		5-year median 1944–45 through 1948–49	Cumulative total for calendar year		5-year median 1945–49
	July 22, 1950	July 23, 1949			1949–50	1948–49		1950	1949	
Anthrax (062)	1		(1)	(1)	(1)	(1)	(1)	27	33	(1)
Diphtheria (055)	63	100	113	27th	123	184	251	3,251	3,952	6,548
Acute infectious encephalitis (082)	23	10	12	(1)	(1)	(1)	(1)	421	299	264
Influenza (480–483)	518	356	492	30th	276,275	111,739	181,682	245,745	75,469	138,124
Measles (085)	3,418	2,941	2,941	35th	299,082	634,264	574,526	279,952	581,871	539,597
Meningococcal meningitis (057.0)	50	49	54	37th	[2] 3,363	2,990	3,248	[2] 2,450	2,146	2,276
Pneumonia (490–493)	662	736		(1)	(1)	(1)		57,772	52,495	
Acute poliomyelitis (080)	827	1,440	666	11th	[3] 4,017	5,408	2,789	[3] 5,151	6,323	3,256
Rocky Mountain spotted fever (104)	21	32	32	(1)	(1)	(1)	(1)	236	307	260
Scarlet fever (050)	316	238	555	32d	55,818	79,517	87,417	39,379	56,973	60,731
Smallpox (084)			1	35th	43	49	195	23	39	141
Tularemia (059)	22	27	24	(1)	(1)	(1)	(1)	568	703	592
Typhoid and paratyphoid fever (040, 041) [4]	100	112	109	11th	1,186	1,199	1,280	1,696	1,687	1,753
Whooping cough (056)	2,468	1,650	2,245	39th	98,106	41,851	84,652	76,570	31,818	55,284

[1] Not computed. [2] Arkansas: deduction week ended July 15, 1 case. [3] New Mexico: deductions weeks ended May 27, June 3 and 24, 1 case each. North Carolina: week ended July 15, 1 case. [4] Including cases reported as salmonellosis.

ber of cases (111); Virginia, the second highest (76); and New York, the third (64).

The total number of cases of influenza reported for the current week was 518, compared with 356 for the corresponding period last year. The cumulative total for the "disease" year (beginning with the 31st week, 1949) was 276,275 reported cases of influenza. The 5-year median was 181,682.

The number of cases of acute infectious encephalitis reported for the week was 23, an increase from the 17 cases reported for the preceding week. For the corresponding week last year 10 cases were reported. The cumulative total for the current calendar year was 421 which may be compared with the corresponding figure of 299 for 1949 and 264 for the 5-year median.

The total number of cases of whooping cough reported in the Nation for the current week was 2,468 compared with 2,363 cases last week. For the corresponding week last year, 1,650 cases were reported. The cumulative total for the "disease" year to date was 98,106 compared with 41,851 cases reported for the corresponding period last year and 84,652 cases, the 5-year median. The "disease" year for whooping cough begins with the 40th week of the calendar year.

The total number of cases of diphtheria reported for the current week was 63, the lowest total for the corresponding week in the past 5 years. The cumulative total for the current calendar year is 3,251 cases, the lowest total number reported for the corresponding period during the past 5 years.

One case of anthrax was reported in Pennsylvania. One case of psittacosis was reported in Louisiana. No cases of smallpox were reported in the United States.

Deaths During Week Ended July 22, 1950

	Week ended July 22, 1950	*Corresponding week, 1949*
Data for 93 large cities of the United States:		
Total deaths	8, 116	8, 184
Median for 3 prior years	8, 086	----------
Total deaths, first 29 weeks of year	272, 383	270, 704
Deaths under 1 year of age	649	575
Median for 3 prior years	625	----------
Deaths under 1 year of age, first 29 weeks of year	17, 953	18, 602
Data from industrial insurance companies:		
Policies in force	69, 683, 374	70, 320, 074
Number of death claims	11, 673	12, 188
Death claims per 1,000 policies in force, annual rate	8. 7	9. 0
Death claims per 1,000 policies, first 29 weeks of year, annual rate	9. 6	9. 4

Reported Cases of Selected Communicable Diseases: United States, Week Ended July 22, 1950

[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	**63**	**23**	**518**	**3,418**	**50**	**662**	**827**
New England	**2**	**1**		**334**	**2**	**22**	**14**
Maine				4		3	1
New Hampshire				4			
Vermont				7			2
Massachusetts	1	1		255			7
Rhode Island	1			1			
Connecticut				63	2	19	4
Middle Atlantic	**1**	**6**		**1,065**	**6**	**195**	**93**
New York	1	3	(1)	514	2	104	64
New Jersey		3		350	1	35	12
Pennsylvania				201	3	56	17
East North Central	**9**	**5**	**9**	**1,025**	**8**	**68**	**113**
Ohio	3	1	1	170	1	20	30
Indiana				35	1	7	10
Illinois	2	1	1	288	2	27	45
Michigan	3	3	1	154	1	11	18
Wisconsin	1		6	378	3	3	10
West North Central	**4**	**3**	**1**	**113**	**6**	**24**	**91**
Minnesota	1			32		10	8
Iowa				24	1		42
Missouri				31	1	6	7
North Dakota		3			1	3	
South Dakota				2			4
Nebraska				17	1	3	11
Kansas	3		1	7	2	2	19
South Atlantic	**19**		**111**	**183**	**5**	**61**	**161**
Delaware				10			
Maryland	1		2	18	1	12	3
District of Columbia				5		12	8
Virginia			77	47		19	76
West Virginia	5		23	58	2	1	11
North Carolina	9			16	1		22
South Carolina			6			3	22
Georgia	3		2	16		7	14
Florida	1		1	13	1	7	5
East South Central	**7**	**1**	**5**	**65**	**8**	**50**	**105**
Kentucky	2		1	24	1	14	40
Tennessee	1		1	26	5		21
Alabama	1	1	2	11	2	18	16
Mississippi	3		1	4		18	28
West South Central	**16**		**350**	**145**	**11**	**184**	**163**
Arkansas			18	11		6	18
Louisiana	3			3	2	22	21
Oklahoma	3		10	5		4	13
Texas	10		322	126	9	152	111
Mountain	**4**	**1**	**39**	**203**	**1**	**17**	**22**
Montana			5	9		1	1
Idaho			5	70			
Wyoming				2			7
Colorado	2	1	5	63		5	7
New Mexico			1	9		2	7
Arizona	2		23	15	1	6	
Utah				35		3	
Nevada							
Pacific	**1**	**6**	**3**	**285**	**3**	**41**	**65**
Washington				16		2	8
Oregon	1		2	15		4	3
California		6	1	254	3	35	54
Alaska							
Hawaii				5			

[1] New York City only. Anthrax: Pennsylvania, 1 case.

Reported Cases of Selected Communicable Diseases: United States, Week Ended July 22, 1950—Continued

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

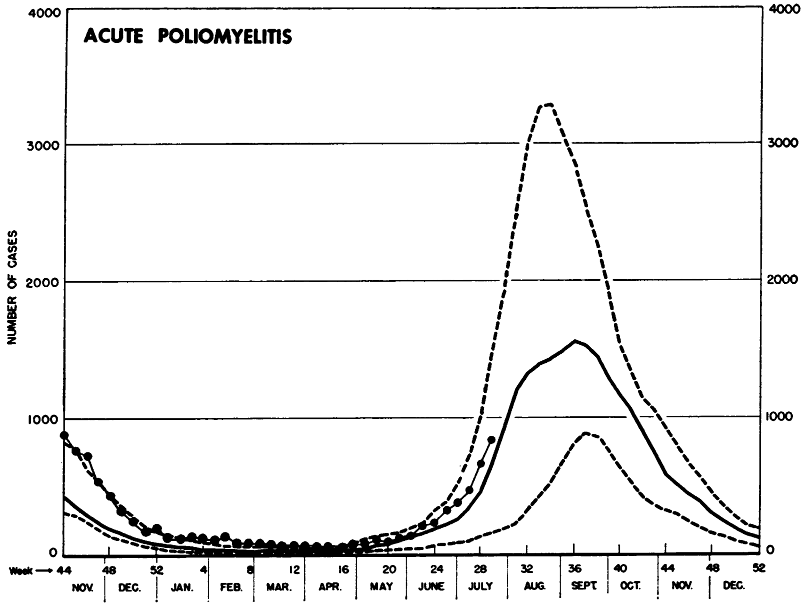
Area	Rocky Mountain spotted fever (104)	Scarlet fever (050)	Smallpox (084)	Tularemia (059)	Typhoid and paratyphoid fever (040,041) [1]	Whooping cough (056)	Rabies in animals
United States	**21**	**316**		**22**	**100**	**2,468**	**114**
New England		**41**			**3**	**266**	
Maine						46	
New Hampshire		1				3	
Vermont		2				16	
Massachusetts		33			3	112	
Rhode Island						26	
Connecticut		5				63	
Middle Atlantic	**2**	**56**			**11**	**294**	**24**
New York	1	[2] 37			3	119	23
New Jersey		7			4	94	
Pennsylvania	1	12			4	81	1
East North Central	**1**	**83**		**1**	**8**	**562**	**20**
Ohio		33			3	140	6
Indiana		5			1	29	9
Illinois	1	7		1	1	111	
Michigan		25			1	158	4
Wisconsin		13			2	124	1
West North Central	**1**	**14**		**2**	**2**	**172**	**12**
Minnesota		2		1		34	
Iowa		3				54	12
Missouri	1	1			2	37	
North Dakota		2		1		9	
South Dakota						2	
Nebraska		5				4	
Kansas		1				32	
South Atlantic	**11**	**19**		**2**	**15**	**354**	**11**
Delaware						2	
Maryland	2	2			1	29	
District of Columbia					1	5	
Virginia	5	4		1	3	133	1
West Virginia		2			2	51	
North Carolina	4	10			4	90	
South Carolina					4	12	3
Georgia						17	7
Florida		1		1		15	
East South Central	**2**	**36**		**1**	**21**	**124**	**26**
Kentucky		15			11	24	15
Tennessee	1	16			4	67	5
Alabama	1	2			5	28	3
Mississippi		3		1	1	5	3
West South Central	**1**	**15**		**14**	**29**	**393**	**18**
Arkansas		2		13	5	33	1
Louisiana	1				2	4	
Oklahoma		4		1	3	22	1
Texas		9			19	334	16
Mountain	**3**	**6**		**1**	**1**	**90**	**1**
Montana						8	
Idaho	2	3				6	
Wyoming						1	
Colorado		2				20	1
New Mexico							
Arizona		1			1	41	
Utah	1			1		14	
Nevada							
Pacific		**46**		**1**	**10**	**213**	**2**
Washington		2				64	
Oregon		1		1	1	35	
California		43			9	114	2
Alaska		1			1		
Hawaii							

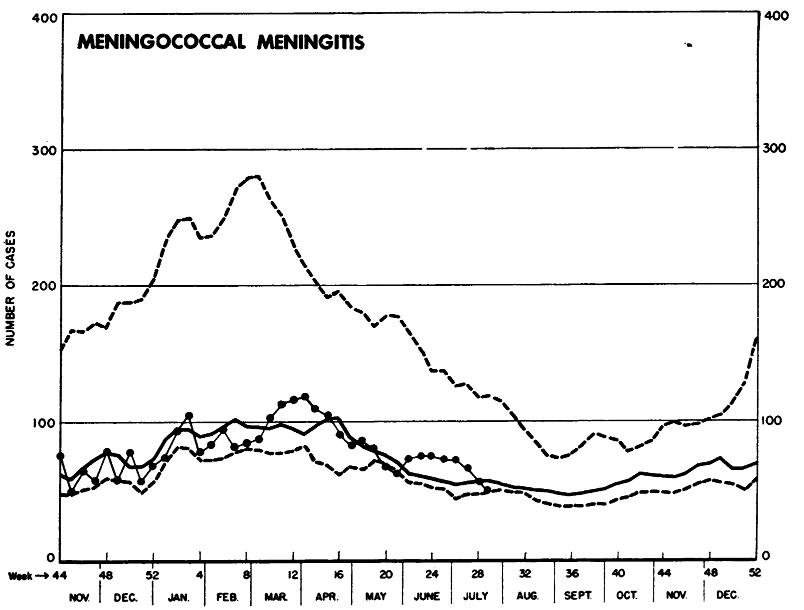
[1] Including cases reported as salmonellosis.
[2] Including cases reported as streptococcal sore throat.

Psittacosis: Louisiana, 1 case.

Communicable Disease Charts

All reporting States, November 1949 through July 22, 1950





The upper and lower broken lines represent the highest and lowest figures recorded for the corresponding weeks in the 5 preceding years. The solid line is a median figure for the 5 preceding years. All three lines have been smoothed by a 3-week moving average. The dots represent numbers of cases reported for the weeks 1949–50

FOREIGN REPORTS

CANADA

Reported Cases of Certain Diseases—Week Ended July 1, 1950

Disease	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Brucellosis					2	5				1	8
Chickenpox			15	1	65	197	19	18	79	98	492
Diphtheria					5	2			1		8
Dysentery:											
Amebic						1					1
Bacillary					4	1	2			3	10
Encephalitis, infectious									1		1
German measles			11		1	498		80	117	224	931
Influenza			4			6	1				11
Measles			3		125	501	26	16	12	110	793
Meningitis, meningococcal						3		1			4
Mumps			18		48	270	10	56	101	88	591
Poliomyelitis						4				2	6
Scarlet fever	4		1	1	33	18	1	7	40	4	109
Tuberculosis (all forms)	13		2	27	126	38	11	17		26	260
Typhoid and paratyphoid fever					12	1	2		1	3	19
Venereal diseases:											
Gonorrhea	5		13	6	109	53	25	26	32	57	326
Syphilis	3		12	6	49	17	8	5	3	7	110
Other forms								1			1
Whooping cough	2		4		57	56		3	3	54	179

CUBA

Reported Cases of Certain Diseases—4 Weeks Ended June 24, 1950

Disease	Pinar del Rio	Habana		Matanzas	Santa Clara	Camaguey	Oriente	Total
		Habana City	Total					
Cancer	7		14	17	19	2	21	71
Chickenpox		15	16	4	1	3	2	26
Diphtheria		4	6	1	1		1	9
Leprosy	2		2			3	1	8
Malaria		4	4				7	11
Measles				2	1		4	7
Poliomyelitis		2	2				1	3
Tuberculosis	5		9	5	8	14	21	62
Typhoid fever	3	9	16	3	13	3	33	71
Whooping cough			8					8

NORWAY

Reported Cases of Certain Diseases—April 1950

Disease	Cases	Disease	Cases
Diphtheria	39	Pneumonia (all forms)	2,949
Erysipelas	296	Poliomyelitis	6
Gastroenteritis	2,401	Rheumatic fever	127
Hepatitis, infectious	67	Scabies	937
Impetigo contagiosa	1,478	Scarlet fever	149
Influenza	2,681	Tuberculosis (all forms)	303
Malaria	1	Typhoid fever	1
Measles	732	Venereal diseases:	
Meningitis, meningococcal	12	Gonorrhea	201
Mumps	235	Syphilis	59
Paratyphoid fever	4	Whooping cough	2,829

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. A table showing the accumulated figures for these diseases for the year to date is published in the PUBLIC HEALTH REPORTS for the last Friday in each month.

Cholera

Burma. During the week ended July 8, 1950, 66 cases of cholera, with 53 deaths, were reported in Burma.

India. In Calcutta, 197 cases of cholera were reported for the week ended July 8, 1950, and 180 cases for the week ended July 15. New Delhi reported 20 cases for the week ended July 8, and 7 cases for the week ended July 15.

Plague

Belgian Congo. During the week ended July 8, 1950, one fatal case of plague was reported in Goto, a village in Stanleyville Province, northeast of Blukwa.

Ecuador. During the month of May 1950, four cases of plague (one fatal) were reported in Chimborazo Province, as follows: In Malobog, Licto Parish, Riobamba County, two cases, one death; and in Shio, Chambo Parish, two cases.

Indochina (French). During the week ended July 8, 1950, three cases of plague were reported in the port town of Phanthiet, Viet Nam.

Peru. During the month of March 1950, plague was reported in Peru as follows: In Aija Province, Ancash Department, three cases; in Chancay Province, Lima Department, two cases, one fatal.

Smallpox

Gold Coast. On July 8, 1950, 61 cases of smallpox were reported in Gold Coast. The period for which the report was made was not stated.

India. During the week ended July 8, 1950, 78 cases of smallpox were reported in Calcutta and 95 in Madrid.

Indonesia. For the week ended July 8, 1950, 184 cases of smallpox were reported in Surabaya, Java.

Typhus Fever

Spain. Typhus fever has been reported in Spain as follows: Week ended June 3, 1950, one case in Granada Province; week ended June 10, two cases in Malaga Province.

Yellow Fever

Brazil. On April 3, 1950, one death from yellow fever was reported in Colinas, Maranhao State.