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U. S. GOVERNMENT PRINTING OFFICE: 1945

TB MED 146

WAR DEPARTMENT TECHNICAL BULLETIN

MEDICAL AND SANITARY DATA ON PRATAS ISLAND

War Department, Washington 25, D. C. • • • March 1945

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Section I

INTRODUCTION

1. GENERAL. Pratas Island lies between 20°41′41″ and 20°42′35″ north latitude and 116°42′00″ and 116°43′28″ east longitude. It occupies the sunken or western part of the great Pratas Reef, which has the form of a crescent about 12 miles in breadth and incloses a lagoon, roughly 10 miles in diameter (area approximately 65 square miles), that is dotted with numerous coral patches and shoals. The southeastern side of the reef often is concealed by dense fogs which occur during the winter months when the northeastern monsoon prevails. Pratas Island is about 1⅜ miles long and ½ mile wide; it has an elevation of 25 to 30 feet above sea level and its surface is composed of coral sand. The island belongs to China and is under the administration of the government of Kwangtung Province. Since 1926 the Chinese Government has maintained a naval weather observatory in the island. The meteorological staff was removed by the Japanese when they occupied the island in September 1937 and established a garrison there.

Section II

PUBLIC HEALTH AND ENVIRONMENTAL FACTORS INFLUENCING HEALTH AND SANITATION

2. PUBLIC HEALTH DEPARTMENT. There is no organized public health department functioning in this island, which has no permanent population.

RESTRICTED

3. WATER. There is one shallow dug well (about 30 feet deep) the water of which has a high phosphate content. Water from this well and sea water are distilled to furnish fresh water supplies for the personnel of the naval meteorological station. Rain water is collected, but the amount is small because the island's climate is drier than normally might be expected in tropical latitudes. It is said that brackish water may be obtained in the northeastern part of the island by digging a few feet into the sand.

4. WASTE DISPOSAL. Human excreta are deposited in pit latrines or are dumped untreated into the sea. Garbage and other wastes are cast into the sea.

5. ANIMALS IMPORTANT TO MAN. Mosquitoes are said to be few; their species is unknown. Houseflies (species not reported) are exceedingly numerous. White ants (species not stated), beetles of the genera Dermestes and Corynaetes, spiders of the genus Acrosoma, small scorpions (species not stated), Ocypoda crabs, and hermit crabs of the genera Cenobitae and Paguri have been recorded from the island. Harmless snakes are said to be plentiful but there are no venomous species reported. A visitor to the island in 1933 states that no rats were observed at that time, although rodents were reported to be present about 80 years ago. No information is available regarding the presence of lice, fleas, other insects, ticks, mites, or centipedes. There are no domestic animals in the island.

It is not unlikely that the waters about Pratas Island may contain harmful species of marine life known to be present in the South China Sea, such as the puff-toadfish (genus Tetrodon), the sting ray (genus Trygon), poisonous jellyfish, and sharks. In the puff-toadfish, the toxic principle (a thermostable alkaloid resembling muscarine) apparently exists chiefly in the ovaries and testes. Eating the roe of this species is followed by serious illness (ciguatera) in a few minutes and death may ensue in a few hours. The easily recognizable features of the species include a large head, the absence of scales, and the presence of numerous small spines on the body. It is a good rule to abstain from eating any fish which has no scales. The sting ray possesses a barbed spine in its whip-like tail which is capable of inflicting serious wounds that are slow to heal. Contact with some species of jellyfish produces a painful dermatitis.

6. PLANTS. The vegetation of the island consists mainly of shrubs. There are said to be no poisonous plants. The shrubbery is very thick and only a few low trees are reported. A variety of "long, rank grass" is stated to thrive in the island. Seaweeds of the genera Padina, Sargassum, Ulva, and Zostera are plentiful. For many years the Japanese have gathered the seaweed, *Ulva reticulata*, from Pratas and have taken it to Taiwan (Formosa) for the manufacture of iodine.

7. FOOD IN RELATION TO HEALTH. There is no soil in the island and therefore no agriculture or other cultivation. All attempts to cultivate vegetables have failed, partly because of numerous plant insects. Fish are abundant in the waters about Pratas and wild birds are numerous. The birds recorded from the island include the frigate bird, gannet, kingfisher, plover, sandpiper, shrike, and swallow. An occasional buzzard has been seen. The gannet predominates in numbers. Except for fish and birds, all food supplies have to be imported. The most serious aspect of the food situation in the island is a lack of green vegetables which might be alleviated by soilless (hydroponic) cultivation.

Section III

MEDICAL FACILITIES

8. GENERAL. The naval meteorological station personnel lived in barracks, one room of which was set aside for care of those who became ill or injured. A physician usually was included among the various specialists assigned to the station. There were no hospital facilities, other medical personnel, laboratories, or welfare organizations in the island. It was reported in 1934 that 100 men probably could be quartered in the buildings then present. The main building was a single story, U-shaped, concrete structure, with the base about 60 feet in length and each wing about 40 feet long. The base served as working quarters and the wings as living quarters. Another concrete building about 60 by 30 feet was used for storage purposes. The radio transmitter was powered (in 1934) by a Mannheim crude-oil engine driving a 10-kw generator, the sole source of electric power in the island. The present status of buildings and equipment is unknown.

Section IV

VITAL STATISTICS

9. GENERAL. Prior to the Japanese occupation of Pratas Island, it had no permanent population. Fishermen occasionally took refuge in the island. The normal complement of personnel assigned to the meteorological observatory was 30 men who served for a period of 6 months and were replaced by another similar group. There are no women living in the island. In 1940, the Japanese garrison was reported to number some 400 men, and a cruiser was said to be stationed at the island. It is not known whether or not the Japanese garrison is billeted ashore. No information is available regarding such facts as the present size of the garrison or the importation of women.

Section V

DISEASE INFORMATION

10. GENERAL. Since Pratas Island has no permanent population the only human diseases encountered are those brought in by such people as visit the island. The weather station personnel had minor upper respiratory infections and occasional intestinal disorders. Reports are lacking concerning the occurrence of heat reactions among Chinese and Japanese who have spent the summer months in Pratas. The heat is said to be oppressive and it is not unlikely that occidentals will exhibit heat reactions during the summer months in this island, unless adequate precautions are taken to prevent them. Abrasions and lacerations may result from more or less violent contact with the rough coral sands. One of the problems which the Chinese meteorological staff found difficult to overcome was that of loneliness induced by the sense of isolation. The authorities found the problem sufficiently serious to warrant limiting the tour of duty on the island to a period of 6 months.

Section VI

SUMMARY AND RECOMMENDATIONS

11. SUMMARY. Prior to the Japanese occupation of Pratas Island in September 1937, there was no permanent population in the island. There were no organized public health department, hospitals, medical facilities, or medical personnel other than the physician usually included among the specialists assigned to the weather observatory. Well water having a high phosphate content, and sea water are distilled to furnish fresh water. Rain water is collected. Human excreta are deposited in pit latrines or dumped untreated into the sea. Mosquitoes are few but houseflies are abundant. Ants, beetles, spiders, scorpions, and crabs are reported. Nonvenomous snakes are present. Rodents were reported many years ago but were not observed in recent years. The island has no domestic animals. The island vegetation consists mainly of shrubs. There are no poisonous plants. There is no soil in the island and therefore no agriculture or other cultivation. All foodstuffs must be imported. The only human diseases encountered are those brought in by visitors.

The chief medical problems which will confront a military force operating in the island will be concerned with water supply, sewage disposal, prevention of heat reactions, and the amelioration of loneliness.

12. RECOMMENDATIONS. The following recommendations are for personnel operating in Pratas Island and are intended to supplement the general sanitary precautions ordinarily in force in all areas.

a. Water. The only source of fresh water in the island, other than rain water, is a small well the water of which has such a high phosphate content that it is unfit to drink. Ground water, which usually is brackish, can be obtained by digging shallow wells. Water from the well and sea water must be distilled to furnish drinking water, or a supply must be brought in by boat from time to time. In the latter case, adequate storage facilities must be provided.

b. Sewage. Provision must be made for sanitary disposal of sewage, garbage, and other wastes.

c. Food supply. All foods must be imported. The storage, handling, and preparation of food should be done in such a way as to protect it from contamination by flies.

d. Control of flies. Because of the importance of flies in the spread of intestinal diseases, comprehensive fly-control measures must be instituted upon arrival and unremittingly carried out.

e. Control of heat reactions. Control meassures should include:

(1) Clothing should be loose, and shoes should not fit too tightly. Sun helmets should be worn by troops when exposed to direct sunlight for any length of time.

(2) Frequent rest periods of adequate length should be provided, when practicable, for troops who must work in the sun, especially during the heat of the day.

(3) Diet should include liberal amounts of cooked fruits and vegetables, if possible. Only light meals should be eaten during the heat of the day.

(4) Liberal amounts of water should be provided so that water will be available to satisfy maximum requirements. Troops should be encouraged to drink water as often as dictated by thirst. The daily amount required per individual varies from ½ gallon for the resting individual up to 3 gallons for one doing manual labor throughout the day.

(5) Additional salt will be required to provide for that lost in perspiration. A 0.1-percent solution is suitable for drinking purposes and can be prepared by adding 1 pound of table salt to 100 gallons of water, by adding 0.3 pound to a 36-gallon Lyster bag, or by adding ¼ teaspoonful of table salt or two 10-grain salt tablets to each canteen of water.

(6) A water station and heatstroke center should be established to give aid and emergency care for threatened heatstroke cases.

(7) Troops should be instructed concerning the early warning signs of heatstroke and heat exhaustion (headache, giddiness, dry skin, nausea, fever or a subnormal temperature, abdominal cramps, or muscular cramps), and the necessity for complete rest and medical care in the event these signs and symptoms appear.

f. First-aid treatment of wounds. Serious infections may result from minor wounds in a tropical climate. All personnel should be made aware of the necessity for giving prompt first-aid treatment to all wounds, burns, abrasions, and the like, no matter how trivial they may appear. Any skin infection must be given prompt attention.

g. Mental hygiene. Adequate recreational facilities to suit the varied interests of troops should be provided. Consideration should be given to limiting the length of time any given troops will have to serve in the island without relief.

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G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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TB MED 144

WAR DEPARTMENT TECHNICAL BULLETIN

RODENT CONTROL

WAR DEPARTMENT • *APRIL 1945*

WAR DEPARTMENT
Washington 25, D. C., 7 April 1945

TB MED 144, Rodent Control, is published for the information and guidance of all concerned. This bulletin follows TB MED 143, subject, "Cutaneous Diphtheria." Distribution given TB MED 143 was identical to that given TB MED 142.

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G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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RODENT CONTROL

1. Purpose

This bulletin is a guide to effective rodent control for Army personnel.

2. Why rodents must be controlled

The Army is concerned with rodents primarily because these animals are reservoirs of some of the most serious diseases affecting man and domestic animals. In the United States, public health safeguards and high living standards have relegated these diseases to the position of a potential hazard. In other parts of the world where American troops are now operating, they are an actual and serious threat. The geographical distribution of some of the important diseases transmitted through rodents is shown on the maps in appendix VIII.

a. Rodent-borne diseases of primary importance. (1) Plague ranks first in importance among rodent-borne diseases. Primarily a disease of rats and other wild rodents, it may be transmitted to man by the bite or feces of a flea which has previously fed on an infected rodent. Cases originating in this way are termed bubonic plague. Cases or epidemics of pneumonic plague transmitted from man to man by contact may develop from a bubonic case and spread without relation to rodents. Between 1900 and 1925 there were several outbreaks of plague in humans in United States ports along the west coast and Gulf of Mexico. Since 1925 there have been only a few sporadic cases in far western States, principally California, with none in ports. Rodents and fleas infected with the disease are found each year in many parts of the country. In Central and South America, Africa, and Asia, many human cases occur annually.

Sixty thousand cases of pneumonic plague, with 100 percent deaths, have been reported in Manchuria, 10,000 cases and 10,000 deaths occurring there in 1920–21. These cases were associated with the Siberian tarbagan, a rodent closely related to the North American ground squirrel and woodchuck.

(2) Endemic or murine typhus also is transmitted to man by the bite or feces of the rat flea. This disease is reported frequently in various portions of the United States. It has been reported also from Hawaii, Mexico, Australia, Africa, and the Federated Malay States. It must be distinguished from epidemic typhus carried from man to man by the body louse.

(3) The causative organisms of various types of bacterial food poisoning infect rats and mice and may be transmitted to man by the contamination of his food with their feces and urine. Intestinal parasites, such as the tapeworm, may be similarly transmitted.

(4) Infectious jaundice (Weil's disease) is caused by contact with the urine or feces of an infected rat. It may be contracted through the skin or by consumption of food contaminated by rats. It is of general distribution, but probably occurs with greatest frequency in the Netherlands.

(5) Rat-bite fever may occur occasionally in various parts of the world.

(6) Tularemia is a highly contagious disease which may be contracted from handling infected rodents or by the bite of an infected tick or deerfly. It is distributed widely in the United States and has been reported from Russia, Japan, Central Europe, Scandanavia, and Canada.

(7) Rocky Mountain spotted fever and tick-borne relapsing fever are transmitted through infected ticks, rodents and other animals as their normal hosts. They will also bite man.

(8) Scrub typhus (Tsutsugamushi fever, Japanese river fever) is transmitted by a larval mite which is normally parasitic on rodents, marsupials, and ground birds. It has been a problem among troops principally in the Southwest Pacific.

(9) Trichinosis is ordinarily a disease affecting rats and pigs. Man becomes infected by the consumption of infested pork which has not been sufficiently cooked. It has been claimed pigs may contract the disease by eating infected rats.

b. The destruction of food and property, for which rodents are responsible, is estimated at many millions of dollars annually. Rodents may destroy or contaminate food supplies; damage manufactured articles and goods; kill trees and seriously damage agricultural crops; impair reservoirs and other water-impounding structures; destroy domestic fowl and eggs; and cause fire damage due to removal of insulation from electric wires.

3. Responsibility for rodent control

a. MEDICAL DEPARTMENT. The responsibility for the initiation and supervision of rodent control measures to protect personnel against rodent-borne disease is vested in the Medical Department by AR 40–210, AR 40–205.

b. CORPS OF ENGINEERS. The execution of the work on real properties to control rodents is a responsibility of the Corps of Engineers, which does the work in accordance with the recommendations of the Medical Department (AR 100–80).

c. COMMANDING OFFICERS. Commanders of all grades are charged with the responsibility of putting into effect the provisions for the protection of personnel from rodents.

4. Commensal or domestic rodents

a. COMMON TYPES OF RATS. (1) *Norway rat* (brown, sewer, wharf, or barn rat), *Rattus norvegicus.* This large rat usually weighs from 10 to 17 ounces (284 to 480 grams) with some individuals weighing much more. Its color ranges from reddish brown to brownish gray. The body is broad, the muzzle blunt, and the ears are small and densely covered with short, fine hair. The female has 12 mammae.

The Norway rat is a burrowing animal and usually confines its activities to the lower parts of buildings. It is found frequently in or near buildings rather than away from them. It is only a fair climber, and is often found in basements, around barns and chicken houses, drains, warehouses, and similar places. At times it may live in the fields in the manner of native rodents, particularly in the vicinity of dumps and sources of food supply. It is an expert swimmer, and often occurs in great numbers along the banks of canals and other waterways. It nests in burrows, under floors or concrete slabs, in rubbish piles, and in or adjacent to refuse dumps. The Norway rat is distributed throughout the world.

Figure 1. An adult common or Norway rat. (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

(2) *Black or ship rat* (*Rattus rattus rattus*), *and Alexandrine or roof rat* (*Rattus rattus alexandrinus*). These are closely related subspecies or races with generally similar habits. See appendix III for key to identification of each.

These rats are distributed throughout the warmer portions of the world. They have been introduced into the United States, and are found mainly in the south, particularly in the gulf coast seaports.

These two rats are smaller than the Norway rat, ranging in weight from 4 to 8 ounces (114 to 230 grams). They have slender bodies and pointed muzzles. The thin tail is usually appreciably longer than the combined length of head and body. The ears are noticeably larger than on the Norway rat, and lack the hairy coating found on the latter. The female has 10 mammae.

The feeding and scouting range of these rats is more extensive than that of the Norway rat. They are excellent climbers, and commonly frequent the upper parts of buildings. They seldom live in burrows, preferring to build their nests in attics, trees, and shrubbery.

In the absence of Norway rats, however, their nests may be found beneath the floors of barns, feed houses, and similar buildings. They are not fond of entering water as is the Norway.

Various other species of "domestic" rats have been described in many parts of the world which differ slightly from those discussed above. It is believed, however, that their habits will resemble those of either *Rattus norvegicus* or *Rattus rattus rattus*, and that control methods suggested for these will therefore be of general application.

A key to the various species of domestic rats is included in appendix III.

b. HABITS OF RATS. Rats are active principally at night. They make their homes in dark, well protected, and preferably warm places, just as close as possible to an easily accessible supply of food and water. They travel in narrow concealed paths or runs whenever practicable, and use the same routes so habitually that accumulations of oil and dirt from their bodies soon create the characteristic dark and greasy trails described below.

Rats will eat any food they can chew. The failure of a food supply has been known to cause them to make mass migrations. In some regions they live out of doors in summer and move into buildings and human habitations only in the winter. They are adaptable to almost all climates and are distributed over most parts of the world, frequently traveling from place to place by ship, train, and truck. They aggressively seek food and shelter and will travel miles when their food supply fails, or their shelters are destroyed.

Favorable conditions of abundant food supply and protection from weather and natural enemies are conducive to rapid breeding and large litters of young. Breeding may take place at all seasons and one female may raise four to seven litters per year. Litters consist of from 6 to 22 young, which reach sexual maturity 100 to 120 days after birth. One pair of captive adult rats has produced (with their descendents) more than 1,500 young in a single year.

c. EVIDENCE OF RAT INFESTATION. The following signs made by rats will be of assistance in determining the extent of infestation. These signs may persist indefinitely, and it must be determined whether they are indications of an existing or a past infestation.

(1) *Droppings.* Rat droppings are rod-shaped, with rounded ends, and from 1/4 to 3/4 inch in length, by 1/16 to 1/4 inch in diameter. They usually are dark in color and, when fresh, have a moist, glistening appearance and putty-like consistency. Old droppings are hard, discolored, and covered with dust or mold. Examination of this material may show three things:

(*a*) From the condition, whether the infestation is new or old.

(*b*) From the quantity and distribution, the extent of infestation and areas most frequented by rats.

(*c*) From the sizes, whether families of rats are being reared.

(2) *Runways.* Rats repeatedly travel over customary routes, soon producing well-defined runways. Footprints may be visible. The fur of the rat is covered with oil and dust, and whenever they rub their bodies against a wall, climb a pipe, or pass through a hole or barrier, they leave a dark greasy mark. These marks are built up until a runway with characteristic black markings results. Old rat runs may be distinguished from new ones by washing off some of the marks or covering a portion of the run with white paint and observing for a few days to determine if new markings occur. Active runways usually have a shiny, dust-free appearance.

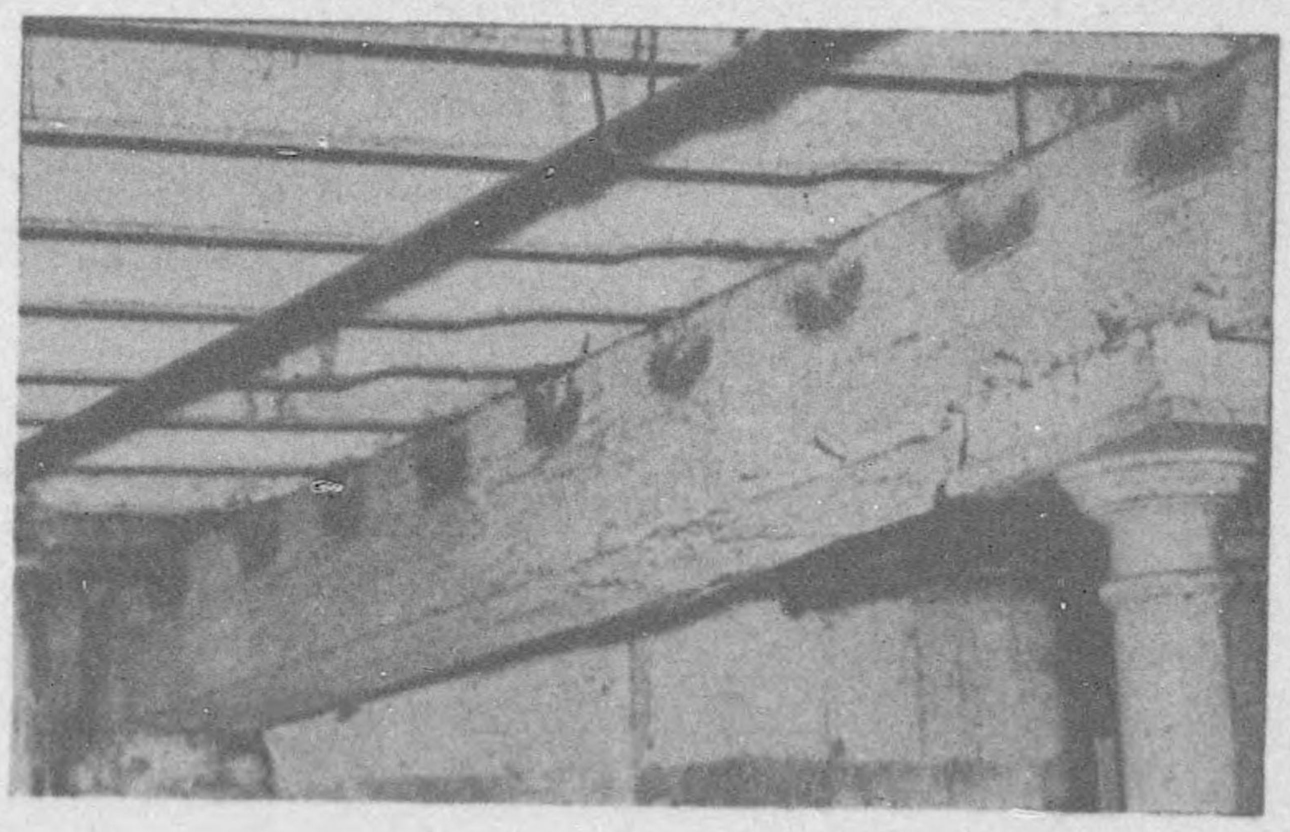


Figure 2. Rat run along beam.

(3) *Tracks.* In light dust, flour, and smooth earth, the four-toed marks of the paws and the broken, wavy line made by the dragging tail are quite distinctive. The tracks may be rubbed out and the site observed for a period to determine if the animals are still present.

(4) *Burrows.* Burrows may be used as nesting or hiding places, or as a means of

ingress to buildings. In the former case they are usually 12 to 18 inches deep, but may extend several feet in a horizontal direction and connect with other burrows and entrances. Rats have been known to burrow almost 4 feet vertically to pass under a foundation wall. Active burrows frequently have a pile of newly excavated soil at the entrance; abandoned holes often are covered with cobwebs.

(5) *Nests.* These may be found in waste lands, cultivated fields, trees, and buildings. The appearance of the material from which the nest is constructed and the age of the droppings and food nearby are of some assistance in determining the age of the nest.

(6) *Gnawings.* Gnawings may denote past as well as present infestation. Young rats can pass through a ¾-inch opening, and can easily enlarge the space beneath wooden doors and windows to permit their passage, unless these are made to fit tightly.

(7) *Damage.* Damage to foodstuffs or other goods may constitute the only visible evidence of rat infestation in some cases. Rats will often carry small pieces of food into inaccessible places, such as those beneath stoves and refrigerators, and leave scraps which are a good indication of their presence.

(8) *Rat odor.* The characteristic musty odor of rats may linger a considerable time in closed spaces which they have frequented.

(9) *Live or dead rats.* The occasional observation of a single rat is not enough to indicate the need for a control program. Inspection of a suspected area, such as a dump, at night with a spot light may disclose feeding rats. Finding the bodies of rats which may have died of disease always demands thorough investigation. Such dead rats should not be handled with the bare hands and should be placed in paper or cloth bags immediately to prevent the escape of fleas.

d. SURVEYS OF INFESTED AREAS. (1) A survey should be made of any area where a rodent problem is suspected to exist, to determine—

(*a*) The particular locations infested and the relative numbers and species of rodents involved.

(*b*) The sources of food and water available to them and possible means of denying them these supplies.

(*c*) Harborages or shelters actually in use or which may be used by rats.

(*d*) Proper control methods to use in each area.

(2) While the evidences of infestation enumerated above are an excellent guide in this regard, it is also desirable to set a number of traps in suspected areas to collect specimens and confirm the results of inspection. In city work, one man servicing 200 traps each day over an area of about 10 blocks should be able to obtain a satisfactory sample in 1 week. He should inspect all premises and set traps in those where evidence of active rat infestation exists. Traps should be removed in 3 days if there is no catch. More than 10 rats caught per 100 traps set and visited each day will indicate heavy infestation. Whenever possible, the animals caught and their ectoparasites (fleas, lice, mites, etc.) should be examined for disease by a qualified laboratory, as described in paragraph 6. Inquiries should be made among the civilian population near military camps and stations to determine local experience with the rodents concerned. Questioning may bring reports of large concentrations of rodents adjacent to the control area, such as at a city dump. Control on a military post is not likely to be successful if such opportunities for reinfestation occur.

(3) During the survey, particular attention must be given to all potential sources of rat food in the area, such as mess halls, commissaries, grain storage warehouses, garbage cans, and garbage and refuse disposal areas. The large concentrations of rats at these points frequently make them centers of infection when rodent diseases occur. Control measures directed at these spots will therefore be most effective in reducing the rodent population and retarding the spread of such disease.

(4) Conditions favorable to rodent propagation noted during the survey should be tabulated together with recommendations for their correction.

(5) During any rodent control campaign, regular inspections for new signs of rat activity should be made.

e. CONTROL PROGRAM. So far as practicable, control work should be regarded as a continuous program with a sustained effort to eliminate the causes of infestation, rather than one of recurrent intensive campaigns.

(1) *Removal of food supply.* Rat infestations can usually be traced to conditions of

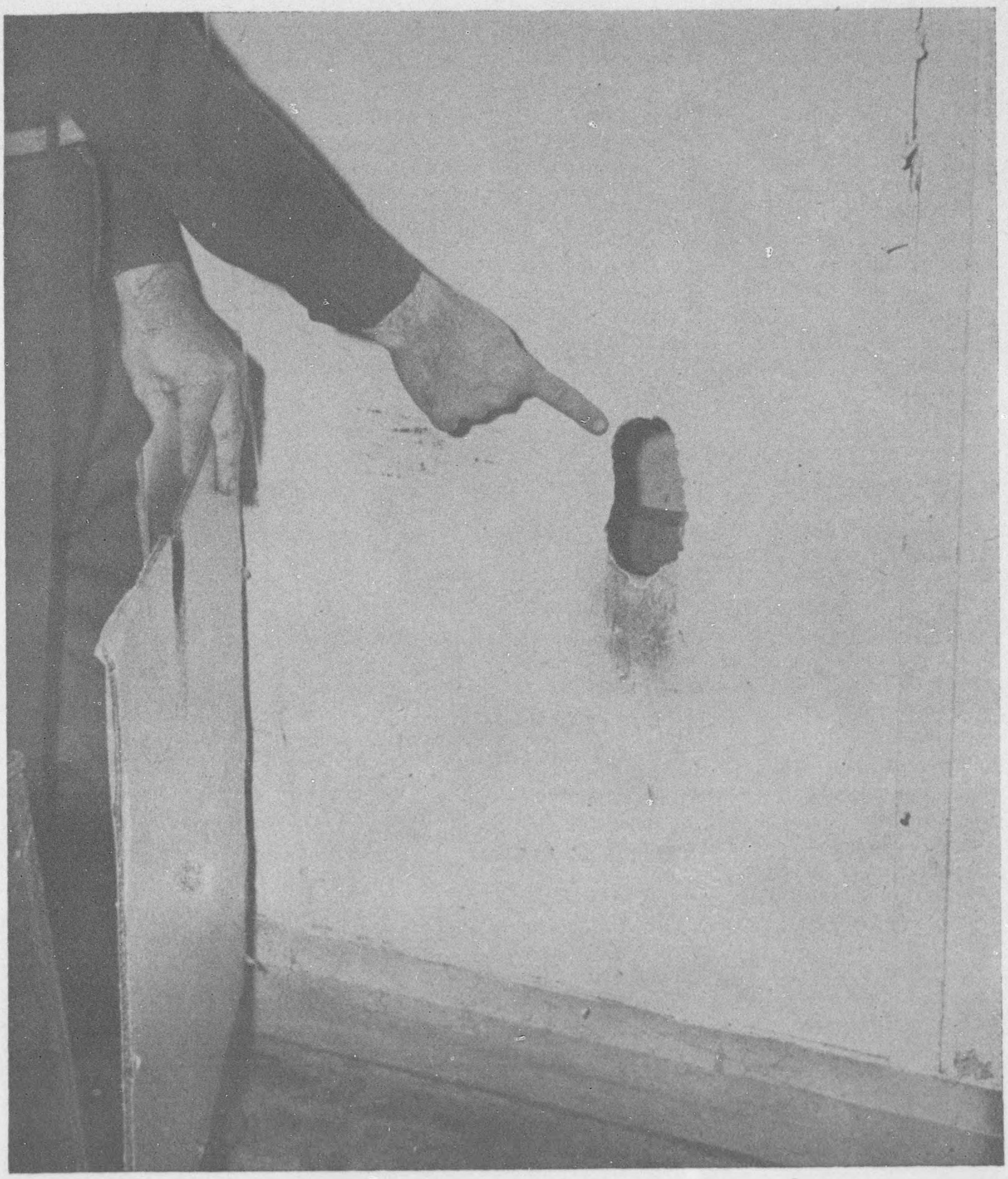


Figure 3. Rat shelter in double wall.

food and shelter favorable to the animals. Remove these factors, and rats cannot long exist. The proper storage and disposal of garbage, the storage of food supplies in ratproof containers and buildings, the elimination of food scraps around mess halls, Army exchanges, service clubs, theaters, field kitchens, markets, and bivouacs will help keep down rat populations. Ratproof storage rooms may be constructed even for small quantities of food.

A War Department publication (TB ENG 1) describing the proper operation of sanitary landfills for the disposal of garbage and mixed refuse as an aid in keeping down rat populations is listed in appendix IX. Where open dumps exist, rodents infesting them must be eliminated as far as possible with poison or gas before instituting sanitary landfill operation to prevent migration of the animals to other areas. Sanitary landfills may be maintained rodent-free only if the refuse and garbage are well compacted and entirely covered with 2 feet of compacted earth at the close of each day's operation. It has occasionally been necessary also to eliminate rodents living in burrows along waterways in the vicinity of landfills.

The destruction caused by war favors rat infestations. In consolidating a new position, the burial of bodies and the disposal of spoiled and damaged food supplies as soon as possible will assist in preventing gross increases in the rat population.

(2) *Elimination of shelter, and ratproofing.* Ratproofing consists of constructing buildings or changing their construction in such a manner as to prevent the entrance of rats, and to eliminate potential shelter for them within the building.

Each building presents individual problems depending upon its construction, method of use, and condition, as well as on the species of rats present. Where only the Norway rat is found, attention must be given mainly to the lower portions of the building; when the black or other climbing rats are present, it is necessary to close all openings in the upper stories, or to install devices to prevent these rats from entering the upper stories by ascending pipes, electric wires, or trees.

In general, ratproofing will necessitate closure of all openings in outer walls large enough to admit rats. This will include metal stripping or flashing of doors to prevent entrance being gained by gnawing or through openings due to poor fit; and screening of windows, ventilators, pipes, drains, skylights, and all openings around pipes and wires. Materials used for closing openings or screening should be 16-gauge galvanized wire cloth of 3/8-inch mesh, bricks, cinder blocks, or 1–2–4 mix concrete at least 3 inches thick. Outer wall doors may be protected if necessary by flashing the lower 8 inches of the door, frame, jamb, and sill with 28-gauge sheet metal.

Close openings in outer walls to exclude rats. Buildings with floors set directly on the ground may be protected by construction of a curtain wall. Recent studies show the most effective type of wall to be L-shaped, extending

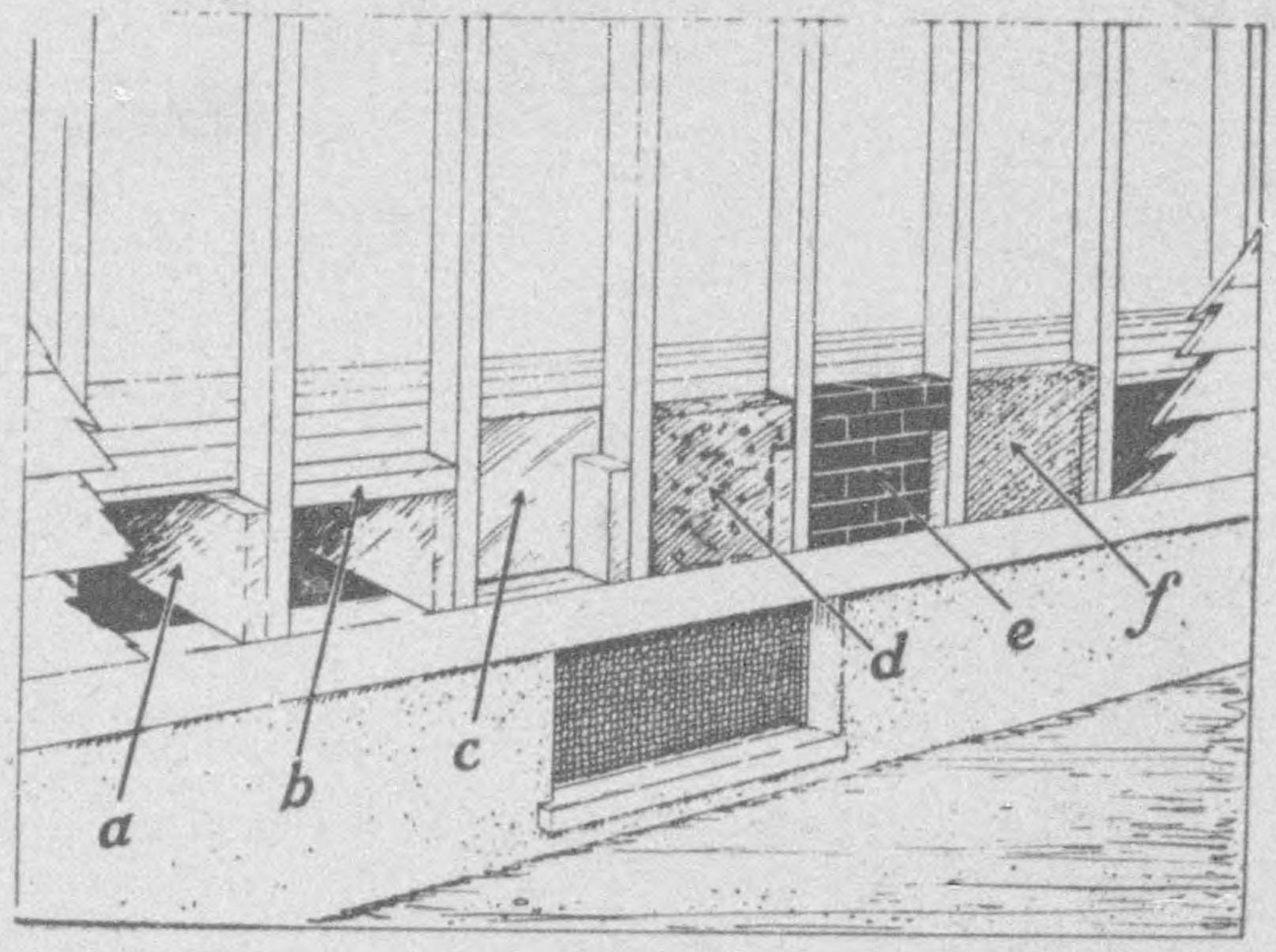


Figure 4. Methods of excluding rats from double walls. (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

A common type of building construction (a) with open space between floor joists, giving rats free access to double walls; wooden 2 by 4 stops (b) are sometimes employed but as these have an important function in fire control, noncombustible material should be used (wood is permissible, however, in upper floors); in old buildings galvanized sheet metal (c) may be cut to fit and be nailed into place between studs, joist, floor, and sill; in buildings under construction, noncombustible stops of cement and cinders (d) or broken bricks (e) are inadvisable, but preferably a good grade of rich cement (f) is recommended.

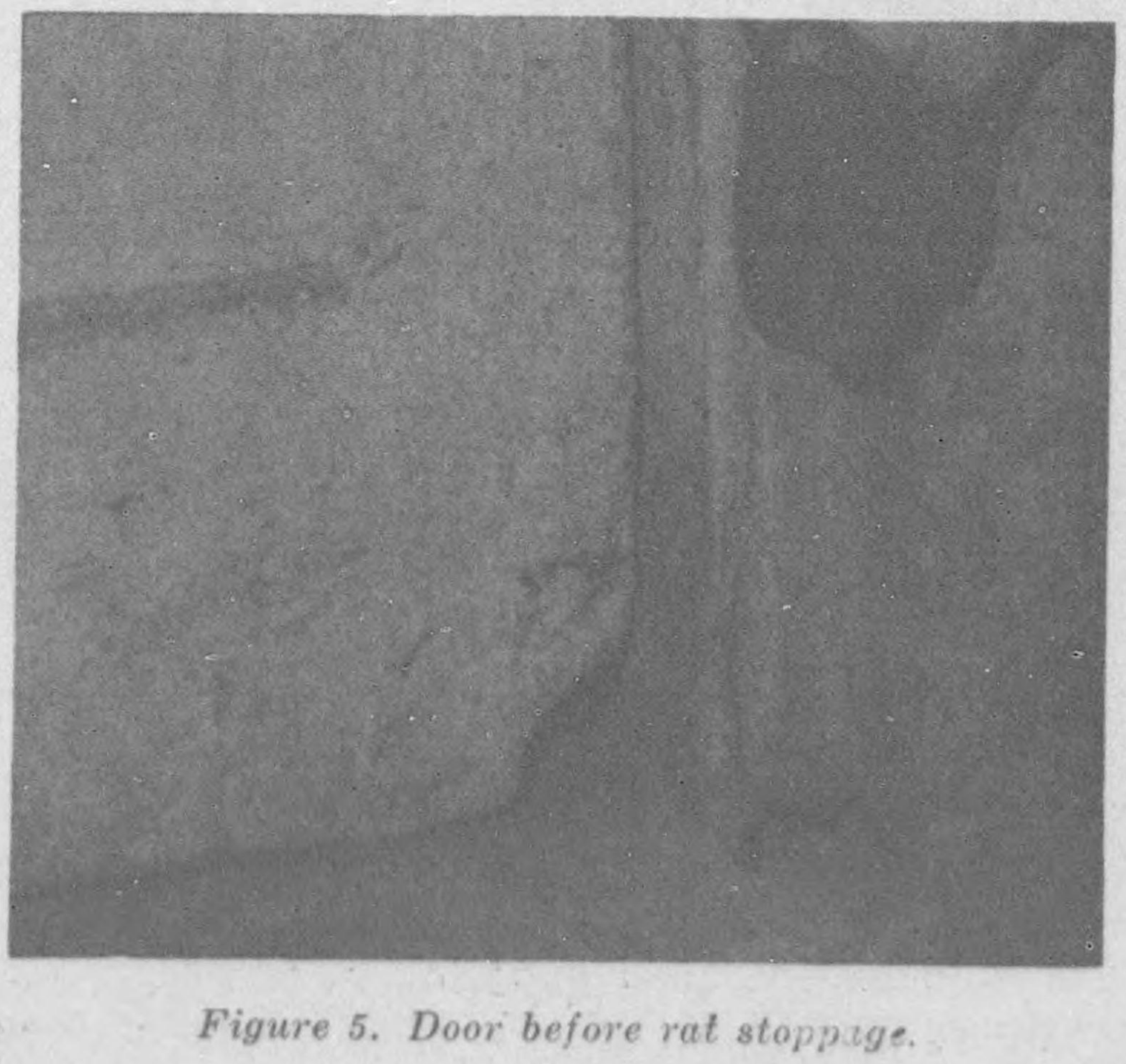


Figure 5. Door before rat stoppage.

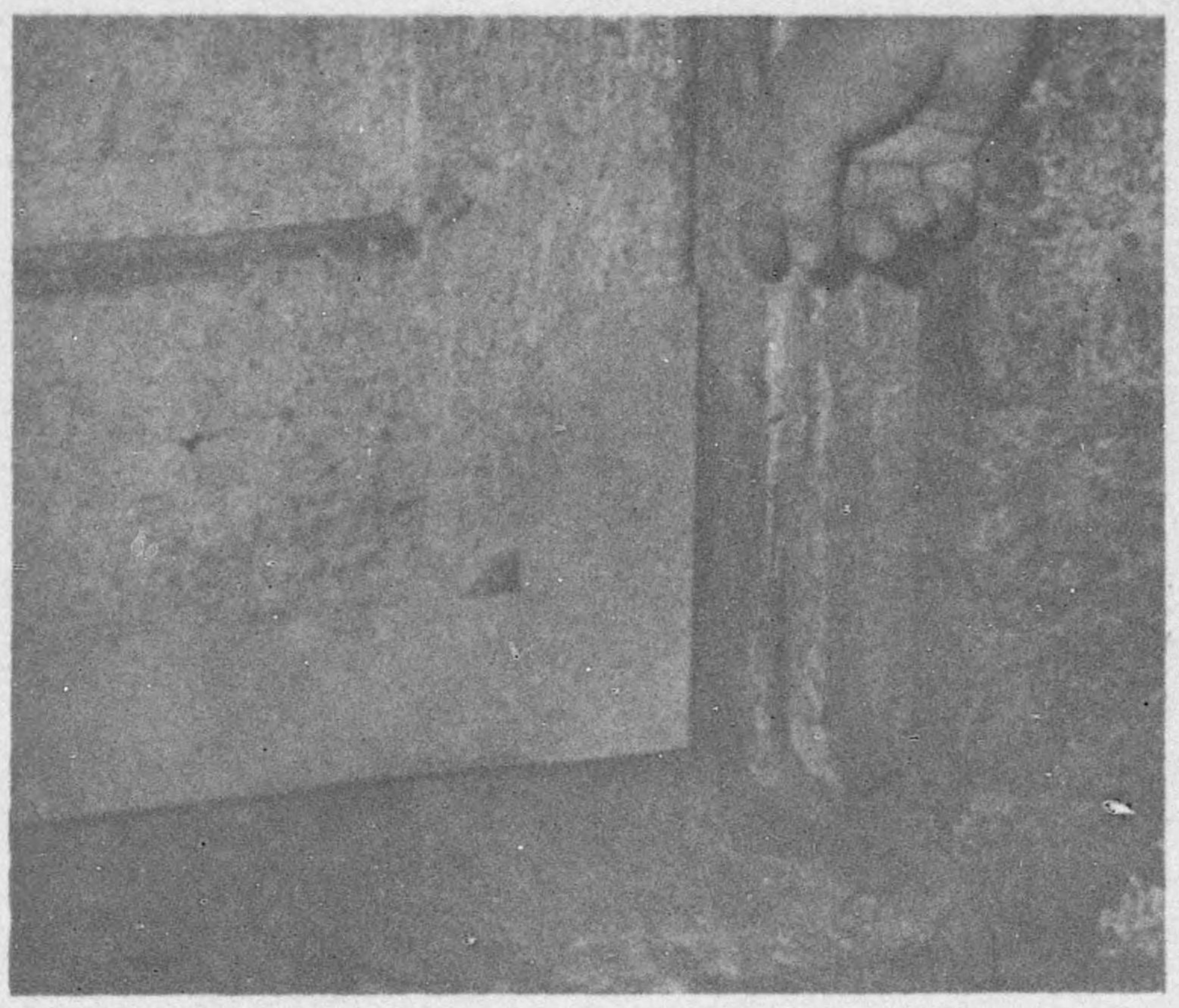


Figure 6. Door after rat stoppage.

24 inches below ground and 12 inches above, with an 8-inch bottom flange extending outward from the building.

Accumulations of trash and waste materials must be eliminated to prevent their use as rat shelters. Likewise, salvage lumber and similar

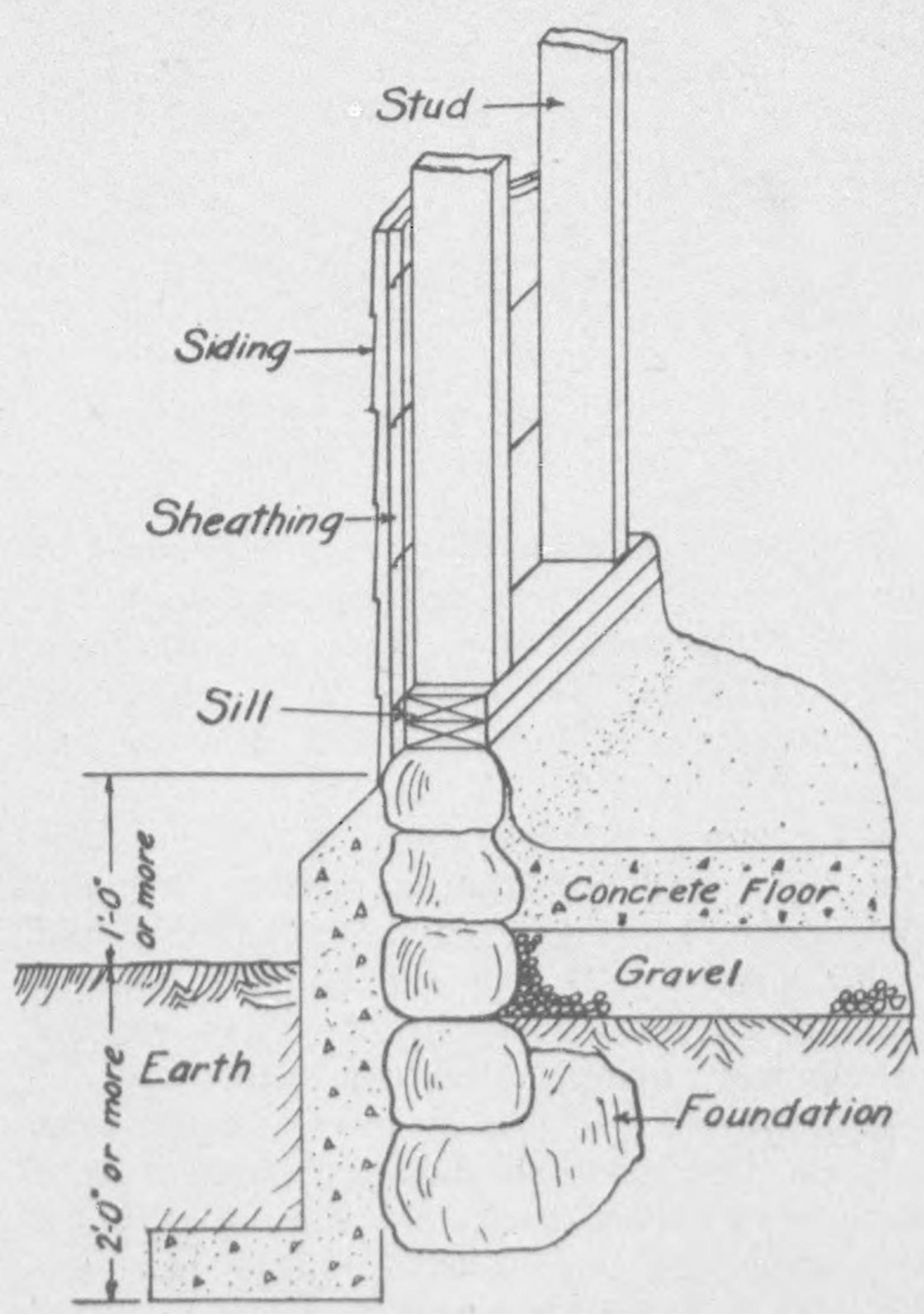


Figure 7. Curtain wall and concrete floor to exclude rats.

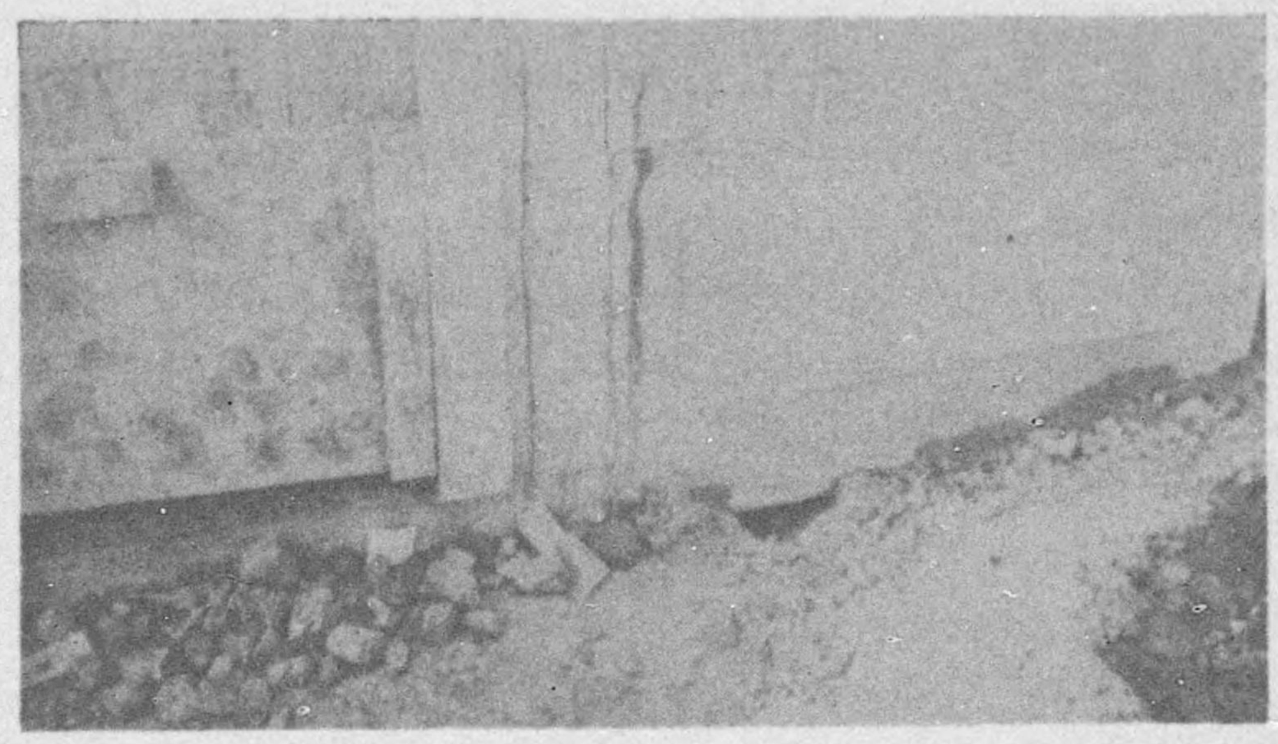


Figure 8. Rat burrow under coal box on ground. (Courtesy of Capt. Carl O. Mohr, SnC.)

Figure 9. Same box elevated on concrete blocks. (Courtesy of Capt. Carl O. Mohr, SnC.)

materials should be stacked on platforms 18 inches above the ground and clear of building walls.

The removal of vegetation along canal banks and near buildings will aid in eliminating rat shelters in these places. Limbs of trees overhanging a building should be trimmed to not less than 4 feet from the building, unless this interferes with camouflage.

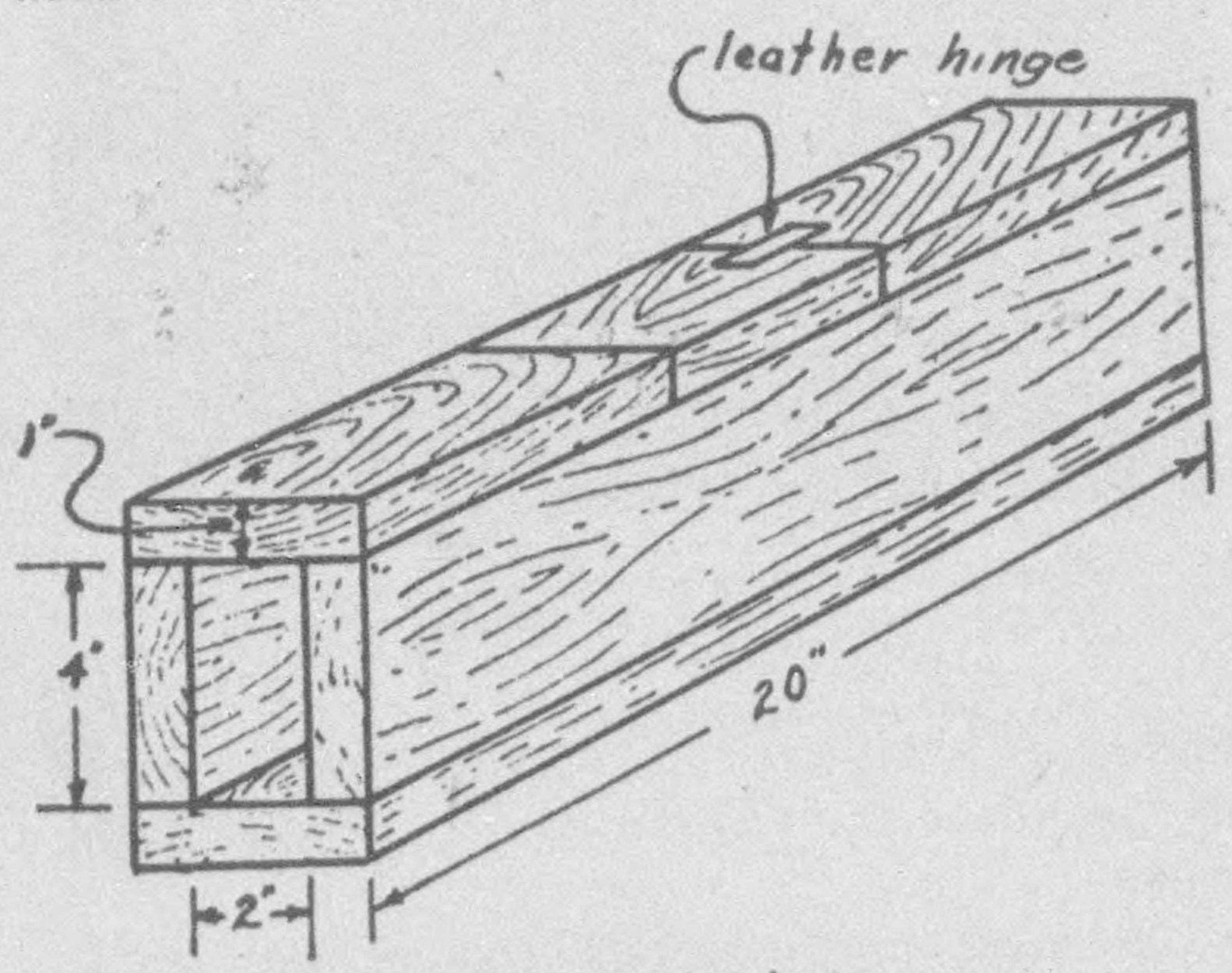
Harborages within buildings are of three types: structural, incidental, and temporary. Structural harborages include double walls, spaces between floors and ceiling, and boxed-in pipes and beams. The incidental types result from installation of nonratproof furniture, fixtures, and equipment, including shelves, counters, refrigerators, etc. Temporary shelters are those found in accumulations of rubbish, old lumber, and rocks, mass storage of materials and supplies, and litter in cellars, closets, attics, and in the space beneath buildings.

Always eliminate rat harborages during a control campaign to prevent them from being used by new rodents entering the area after temporary control measures have ceased. This will also prevent ectoparasites (fleas, mites, lice, etc.), which remain in the old shelters, from infesting new occupants. This is important from the disease control standpoint.

In ratproofing, remember that rats can jump 2 feet vertically, dig 4 or more feet in the earth to get under foundations, climb smooth pipes up to 3 inches in diameter, and travel telephone or other wires.

(3) *Poisoning.* This is a rapid and effective control measure where there are large numbers of rats, but it will not kill all the rats and results are temporary, unless accompanied by elimination of food supplies and harborages.

Caution: *Rat poisons are also poisonous to humans and domestic animals and must be used with caution.*



Construction of bait box.

Figure 10. Bait box or feeding station.

(*a*) The following procedure in poisoning should be followed where practicable:

1. Test baiting. The foods preferred by rats vary with the species and geographical area concerned. Samples from each of the following classes should be placed in the locations frequented by the animals for one or two nights to determine which are accepted most readily:

- *Cereals*—bread, oatmeal, corn meal, and grains.
- *Meats*—hamburger, liver, and fish.
- *Fruits* and *vegetables*—coconuts, tomatoes, melons, peanut butter, sweet potatoes, and bananas.

Most rats are omnivorous, but in general it is believed that Norway rats prefer baits higher in protein content while black rats react favorably to fruits and vegetables of rather high moisture content. The bait used will be determined by local conditions and materials available.

2. Prebaiting. The most acceptable bait having been determined, unpoisoned portions are placed in protected spots where the rats can find them, for several successive nights. To accustom the rats to feeding at these points, a final effort is made to remove all other possible food. If all prebaits are consumed in one night, the amount placed should be increased to insure that all rats desiring to feed may do so. It is well to use a large number of small baits rather than a few large ones. They should be placed along runways and places frequented by rats but out of reach of domestic animals and children. When infestation is heavy or when bait must be exposed to the weather, the use of feeding stations is desirable. These may be constructed in the form of small boxes large enough to accommodate several rats and having 2-inch openings at either end.

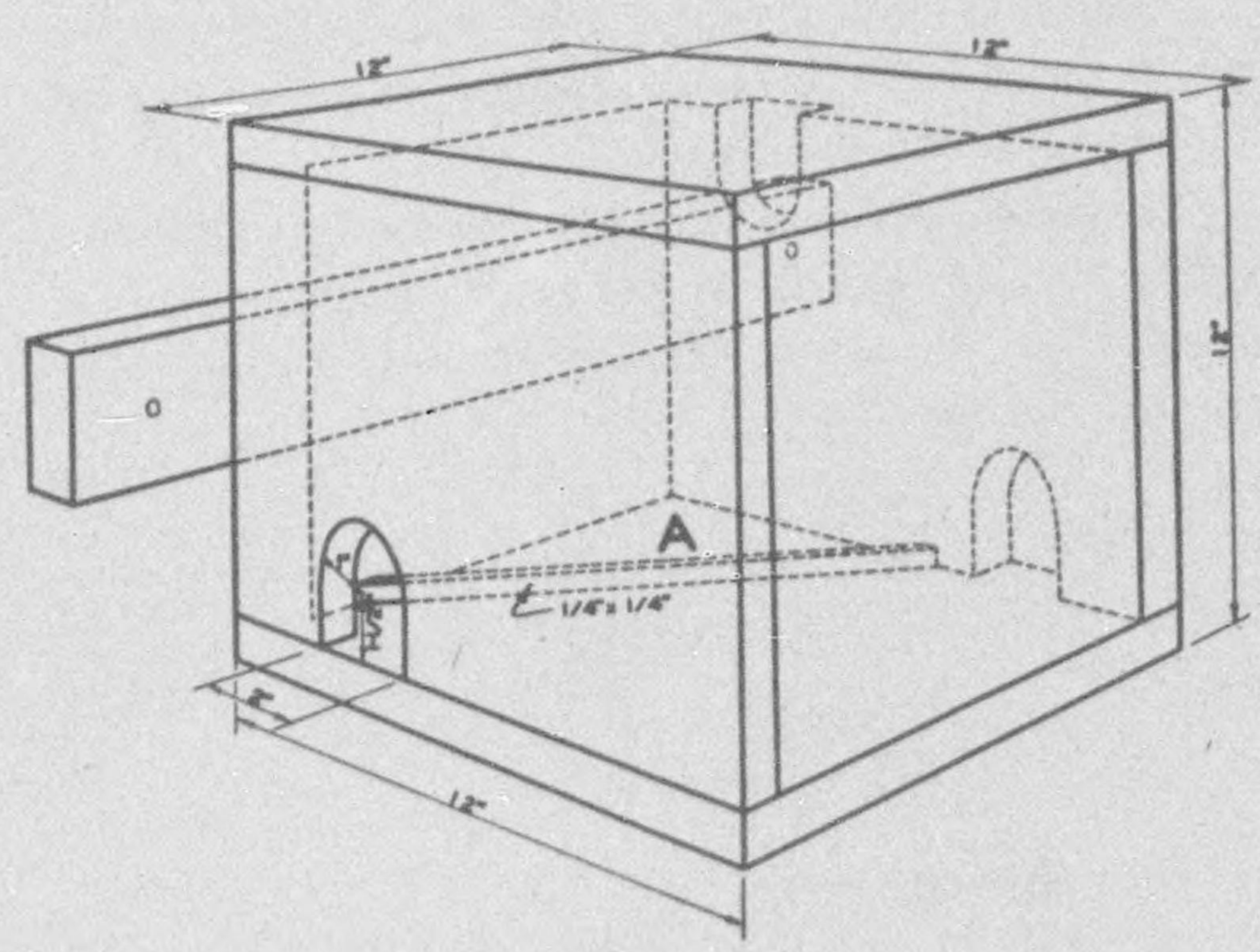


Figure 11. Bait box. (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

Four ounces (115 grams) or more of bait should be used per feeding station. Feeding stations will prevent domestic animals and children from reaching the baits. Baits or feeding stations should be placed in narrow passageways along natural rat runways.

3. Poisoning. When it is established that rats are feeding to the maximum extent on a material, poisoned baits of the same kind are distributed after all prebait material has been removed. An effort should be made to select a clear, still night if baits are exposed to the weather, since rain and wind may interfere with normal rat activity and may destroy the baits.

(*b*) One of the most important points to remember in planning rat control is that rats surviving a poisoning have a tendency to avoid the type of poisoned bait previously used. Every effort should therefore be made to get a high percentage of kill with the first treatment. The procedure outlined above will usually accomplish this objective. Remember to use ample bait. It is far better to overbait than to underbait. In treating extensive areas, however, prebaiting is frequently omitted, but may then be used in follow-up operations.

(*c*) Multiple type baits (cereal, meat, vegetables) have been found superior to single type baits. Changing of the bait material often has more bearing on acceptance than changing poisons. The same bait material and poison should not be used twice within 2 months in follow-up treatments on the same area.

(*d*) It has been determined experimentally that a hungry rat will eat enough food at one time to equal 1 percent of its body weight. A 14-ounce (397-gram) rat will consume about 4 grams of bait. However, only about 1 gram (0.035 ounce) of a 1-percent zinc phosphide bait is required to kill a rat of this size. It is recommended that where individual baits are used they be prepared in portions weighing about 5 grams each (approximately 90 baits per pound). One level teaspoonful may be used for each bait if scales are not available.

(*e*) Baits should be placed in groups of two to five pieces throughout the infested area in order that every rat may be exposed to one or more. They should be freshly prepared and distributed in the late afternoon where practical. Poisoning is most effective when plenty of baits are used.

(*f*) Often it is desirable to expose poison baits in the form of torpedoes wrapped in light oiled or waxed paper. The use of torpedoes provides a convenient means of determining acceptance. Their use simplifies placing baits in burrows or other shelters. Rats will frequently carry individual baits a considerable listance. A level teaspoonful (5 grams) of ɔait should be used in each torpedo.

(*g*) Contrary to popular belief it is not necessary to avoid getting human odors on rat baits.

(*h*) Tartar emetic (antimony potassium tartrate) may be added to poison previous to mixing in the following proportions by weight, to prevent the accidental poisoning of pets: thallium sulfate 7 parts, tartar emetic 4 parts; zinc phosphide 8 parts, tartar emetic 3 parts.

(*i*) Rodent poisons programmed for distribution through The Quartermaster General are zinc phosphide (Rodenticide, general control) QM Stock No. (51–E–465) and thallium sulfate (Rodenticide, plague control) QM Item No. (51–R–470). Limited supplies of thallium sulfate necessitate that it be used only where plague or other rodent-borne diseases create an emergency. It will be issued by The Quartermaster General only on approval of the Office of The Surgeon General. (Stocks on barium carbonate may be available at some stations, but this item will be deleted from revised Quartermaster lists.)

(*j*) Zinc phosphide has been selected and made an item of Quartermaster issue as the rodenticide for general use for the following reasons.

1. It is effective against all types of rodents.

2. The toxicity is high and a very low percent (1 percent) of poison can be used in the baits.

3. When properly packaged and stored it retains its toxicity over long periods of time.

4. It is low in cost compared to other poisons of equal toxicity.

5. When properly handled and distributed it is not dangerous to persons using it although it must be kept out of reach of children and domestic animals.

6. Its characteristic odor acts as a repellent to humans who may accidentally come in contact with the poisoned bait.

Zinc phosphide is a heavy, gray-black powder which depends upon its phosphorus content for its poisonous qualities. The powder is stable when kept sealed and dry, but will break down slowly in the presence of moisture, with the release of phosphine. This is an extremely poisonous gas with a disagreeable garliclike odor. It can usually be detected by the odor before hazardous concentrations have developed. Zinc phosphide will kill rats in most cases in 6 to 12 hours, although a few animals may survive for several days. The material should be handled carefully at all times. Gloves should be worn when mixing and distributing baits. Do not handle poisoned bait with bare hands.

In rat bait formulas use zinc phosphide in the proportion of 1 ounce (28 grams) to 6 pounds of bait (1.0 percent by weight).

(*k*) Thallium sulfate is a very toxic, heavy, white, crystalline salt which is water soluble, and has no distinctive warning taste or odor. It is a very effective rodent poison, although it may take several days to kill.

Thallium has the disadvantage of being dangerous to handle. It is a cumulative poison which may be absorbed through the unbroken skin. Baits should be mixed in enamelware or glass containers and distributed with spoons. *It must not be handled with the bare hands.*

It should be used in proportion of 1½ pounds to 98.5 pounds of bait (1.5 percent by weight).

(*l*) If zinc phosphide is not available, any of the poisons listed below may be procured locally by the post engineer. However, before purchase, tests should be made to determine if the poison is toxic to the rodent to be poisoned. The poisons should be mixed with bait in the proportions indicated:

	Percent by weight
Red squill (fortified)	10.0
Micronized arsenic trioxide	3.0
Barium carbonate	20.0
Strychnine alkaloid	0.6
2 percent yellow phosphorus paste	33.0

Water with 2 percent thallium sulfate has proved an effective poison against rats.

Suggested bait formulas which have proved successful are given in appendix I.

(*m*) The day after poisoning the area should be searched for poisoned rats. These should be picked up and disposed of as stated in (5) below. Additional baits should be put out at the same time unless an ample number of original baits remain. All baits remaining should be picked up after 4 days.

(*n*) If infestation persists the poisoning process may be repeated using different bait; or other methods of control such as fumigation and trapping should be tried.

(*o*) Baits should be mixed in clean containers by use of paddles or shovels. Care should be taken to insure complete mixing of poison with bait. For the protection of the operator, rubber gloves should be worn when handling poisons, and all utensils used in mixing bait should be thoroughly washed and labeled. Poisons should be kept locked and labeled in a safe place separate from other materials.

(*p*) Poisoning has the disadvantage of failing to destroy the ectoparasites of rats. Fleas, lice, and mites from the dead rats may stay in burrows and shelters to infest any new rodent population which develops or may be forced to use man as a substitute host. As indicated in paragraph 6, insect control should accompany rat destruction to eliminate ectoparasites.

(*q*) In general, experienced crews and competent supervision are necessary to carry out an effective poisoning campaign. The size of the crew will vary with the urgency of the work and the size of the area to be covered. In case of an outbreak of plague in a large city, several hundred men might be employed in a short, intensive poisoning campaign. After termination of the campaign a small number of trained men would carry out successive poisoning in heavily infested locations, augmented by trapping for the collection of specimens, and gassing of active burrows. A list of personnel, equipment, and supplies necessary for such a program in a city of 100,000 population is given in appendix IV.

(4) *Fumigation and gassing.* Rat infestations in ships, or in buildings, such as grain mills and warehouses used for the processing and storage of foodstuffs, can be more effectively eliminated by fumigation if it is possible to render the ships or buildings relatively gastight. Instructions for the use of fumigation with HCN gas are contained in WD Pamphlet No. 5-1, *Control of Insects, Rodents, and other Vermin.*

Fumigation is a hazardous process and should be carried out only by properly trained and equipped personnel. The building to be gassed should be sealed as tightly as possible. It may also be necessary to evacuate adjoining structures. Guards must be posted to prevent persons from entering the buildings until adequate ventilation has been completed and occupancy has been approved by the surgeon.

Five ounces of HCN gas per 1,000 cubic feet will kill rodents and their ectoparasites with an exposure of 4 to 6 hours. Two ounces per 1,000 cubic feet with an exposure of 2 hours will kill rodents only.

For the destruction of rats in burrows located in dumps, around buildings, or beneath concrete slabs, the QM Item No. 51-R-460 Rodenticide, fumigant dust, which gives off hydrocyanic gas when acted on by the moisture in the air, is recommended. The fumigant dust may be forced into burrows or other inclosed places by fumigant dust pumps equipped with flexible hose. The open space around the hose when it is placed in the burrow should be sealed with earth. If dust escapes from cracks in the ground or other openings in the burrow system, these must be sealed also to render gassing effective. The process should not be used at temperatures below 40°F. A moderate amount of moisture in the atmosphere or in the soil is necessary.

Figure 12. Box trap.

The most satisfactory dust pump is QM Item No. 41-P-2975 Pump, foot, rodenticide fumigant. In practice, the pump is first operated with the cut-off device in the DUST position for about 5 full strokes; the lever is then switched to AIR and the plunger operated for approximately 10 strokes, thus insuring thorough diffusion of the dust-air mixture throughout the entire system. See instructions for operation on pump label. It is well to be prepared to club rats, which may be driven from burrows by the gas.

Both the dust and the gas are very poisonous in small quantities, and containers of dust should be opened and the pump filled or operated out of doors. *The dust should not be used to fumigate the interior of a building.*

Fumigation with hydrocyanic gas or dust has the advantage of killing ectoparasites as well as rats. It is advisable to excavate burrows occasionally to determine if an actual kill is being obtained.

Carbon monoxide from the exhaust of a motor vehicle may be used to eradicate rats in burrows, etc. The carburetor should be adjusted for a rich mixture.

Carbon disulphide, if obtainable locally, can be applied to the burrows with a special spray pump (Demon Rodent Gun or similar type), or on "waste" balls soaked with one or more ounces of the liquid and pushed into the burrow. After the carbon disulphide is applied, the opening of the burrow should be sealed with earth. It is not recommended that the gas be ignited. It is important that the fire hazard be recognized. Crews using carbon disulfide should not be permitted to smoke. Carbon disulphide is heavier than air and settles in the lowest portion of the burrow.

(5) *Trapping.* Trapping is recommended

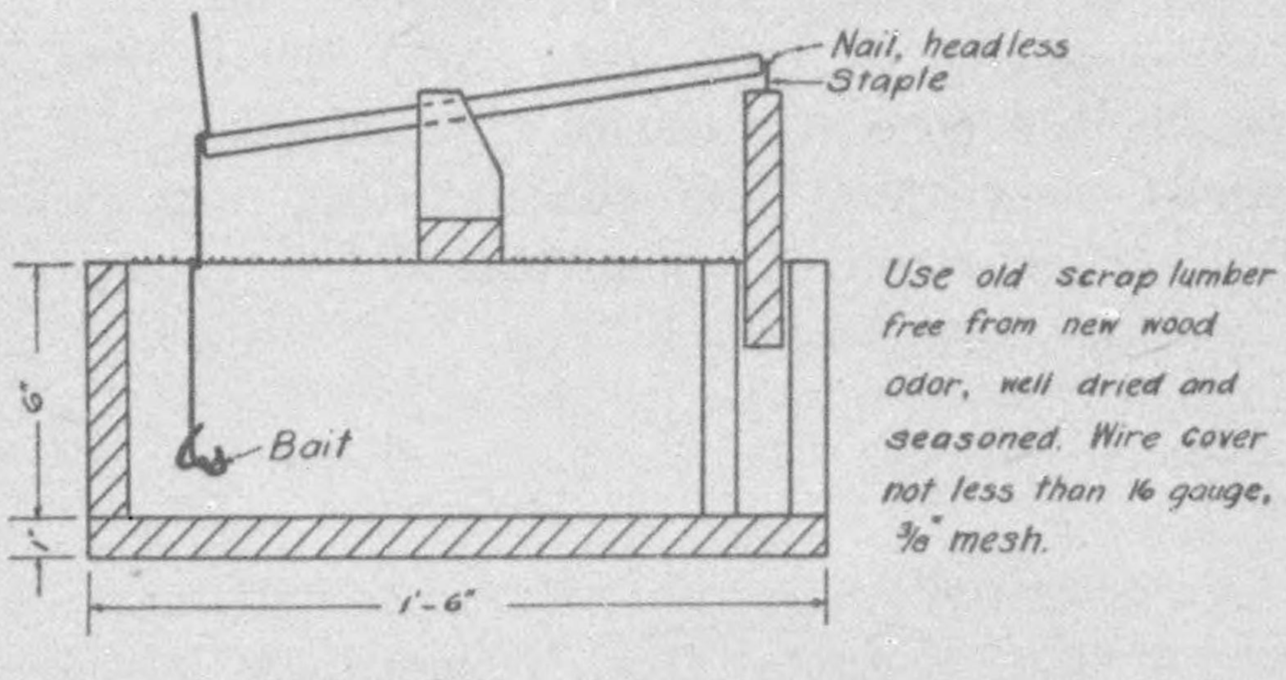


Figure 13. Longitudinal section of box trap.

to ascertain the density of the rat population; as a clean-up method for rats that survive poisoning and gassing; as a method of collecting rat specimens (see par. 5); or for use in those places where it is not advisable to use poison bait or gas. It is a slow method of reducing populations, since as a rule less than 10 percent of the traps set are successful each night. The need of using a large number of traps in all promising locations is therefore evident.

Trapping to secure specimens of infected animals where plague exists should begin at the center of the infested area and move outward in a radical direction as far as infected animals are found. During the control program, sampling and examination of rodents should continue until no additional sick animals can be found.

It is not necessary to avoid handling traps on the assumption that rats are repelled by the odor of man since experience has shown this is not the case.

The snap trap is usually the one of choice (QM Item 42–T–12900) for obtaining specimens and for control. In humid climates, the wooden base traps may be soaked in linseed oil to prevent warping and splitting. All metal parts and the spring should be kept well oiled at all times, and traps should be set to trip at the slightest touch. Box traps are useful also. Snap traps may be used either with or without bait. They should be set in rat trails or runways at right angles to the wall, with the trigger ends against the walls, in such a manner that the rats must pass over the trigger in using the runways. If the trap is not baited, it is advisable to enlarge the trigger surface by slipping a 2½-inch square of corrugated cardboard over it.

Considerable ingenuity is required for effective selecting of trap locations. Since rats usually move close to walls, traps should be placed near them and so that they can be approached from either direction. It is well to protect traps by leaning boards or boxes over them. They should be moved to new locations whenever rats are not caught at the points chosen.

A variety of foods may be used to bait traps. Bacon rind, walnuts, fresh coconut, or bread dipped in bacon grease have been particularly successful. Traps should be inspected daily. All food, other than that on the traps, should be eliminated.

In city work, one man should be able to service approximately 200 traps each day, over an area of about 10 square blocks. He should set traps where evidence of infestation exists, and remove them in 3 to 4 days if there is no catch. With this procedure the maximum practicable reduction of rats obtainable by trapping will be secured in about 3 weeks. Dead rats should be placed in fleaproof bags immediately and taken to the laboratory for examination, or should be burned or buried. (See par. 6.)

(6) *Ships and ports.* Because rats migrate extensively, and because the opportunity for them to travel is increased by the large numbers of ships using the seas at the present time, there is danger that diseased rats may be imported into new areas where they may infect the native rodent population. Prevention of ship-to-shore and shore-to-ship movements of rats is a disease control measure of the greatest importance. Governing port authorities should require observance of the following:

(*a*) Inspection of ships to determine the presence of rats. Infested ships should be fumigated before docking. Special care should be taken to determine whether or not the vessel has visited ports where plague is known to exist. Fumigation of ships should be attempted only by experienced crews.

(*b*) Rat guards at least 3 feet in diameter to be maintained at all times on lines between ships and docks, such lines to be illuminated at night.

(*c*) All landing ramps, gangways, and cargo nets to be removed when not in use. All those in use to be illuminated—military security permitting—and guarded at night.

f. HOUSE MICE. House mice are distributed widely and are found generally in and around human habitations. In some places they live in the fields much like native rodents.

Figure 14. House mouse. (Courtesy of Fish and Wildlife Service, U. S. Department of the Interior.)

The house mouse is suspected of carrying human diseases, and is known to spread pathogenic organisms mechanically. It makes itself felt as a pest in a variety of ways: by direct consumption of human food, by damaging food containers so that the contents are spilled, soiled, or wasted, and by destruction of goods to obtain nesting materials.

Formulas for the preparation of poison baits for mice are given in appendix I. These baits should be put out in small amounts in places frequented by mice, such as cupboards, storerooms, on shelves, etc. It is well to expose the baits in small containers to prevent them becoming mixed accidentally with foodstuffs. As in the case of rats, removing other food supplies and eliminating shelter is necessary before poisoning will be effective.

Trapping is a recommended procedure for controlling mice. Small snap traps similar to Trap, mouse, spring type, QM Item 42-T-12500, set to go off at the slightest touch are needed, since mice can remove bait from ordinary rat traps without springing them. Large numbers of traps should be used and located as recommended for rats. The traps should be baited by spreading rolled oats or other cereals over the front end, or by attaching cheese, bacon, nut meats, or other suitable bait to the trigger.

5. Field rodents

a. GENERAL. One or more of the field (native) rodents sometimes constitute a problem to civilian and military authorities. This is particularly true in the western portion of the United States, the Mediterranean, the near East, and the Pacific Ocean area and Asia where bubonic plague, scrub typhus, and other diseases are present in these rodents. Such rodents frequently destroy crops, and their burrows have sometimes created hazards to airport runways.

There are numerous genera and species of field rodents, and the methods for their control vary according to the type of animal and the conditions under which it lives.

In the western United States, the Office of Plague Suppressive Measures, U. S. Public Health Service, the Division of Predator and Rodent Control, U. S. Fish and Wildlife Service, and several State health and agricultural departments have had extensive experience with the problems. They have frequently carried out control programs on military reservations, and their assistance should be sought when extensive field rodent problems arise in the United States. In Hawaii, health authorities and sugar planters have done a great deal with the control of native rats. See references in appendix IX.

Control methods for field rodents will often vary within an area due to elevation, climate, type of vegetation, and land use. For each kind of field rodent there is usually an optimum season of the year at which to attempt control, and it cannot be carried out at other times without loss of effectiveness.

Several of the rodents important from a plague standpoint in the United States spend a considerable part of the year in a dormant state, either hibernation, or estivation induced by heat and dryness of summer, which limits the period during which attack may be made upon them.

It is usually not economically feasible to interfere with the natural food and shelter of field rodents. In some cases, however, the removal of vegetative cover to reduce the food supply and to expose the location of burrows has proved a valuable preliminary to poisoning. This may sometimes be accomplished by the burning off of ranges surrounding military areas.

b. EXAMPLES OF FIELD RODENTS. (1) *Malay and Pacific Island or native rats.* There are many kinds of small field rats, and one or more of the closely related species are found on the island groups from Burma and the Malay Peninsula across the Pacific to the Hawaiian Islands where they have frequently been found infected with plague. The Hawaiian rat (*Rattus hawaiiensis*) may be described as an example. Over a period of years, considerable research on the control of this rat has been conducted in the Hawaiian Islands. The suggestions for control given below are based on these studies.

Rattus hawaiiensis is a small rat weighing from 2 to 3 ounces (57 to 85 grams). The average body length is 4 to 5 inches and the tail measures an additional 4 to 5 inches. It resembles and is sometimes mistaken for a mouse. It is cinnamon brown with black hairs on the back and sides; its belly is buff or buff white. The females have eight mammae. It is distinctly a field rat, only rarely found in proximity to buildings. It burrows and nests in gulches, fields, and embankments.

Other species of native rats of similar habits are found in South China Indo-China, Burma, Formosa, and Java. These are larger rats, and the females have 10 mammae.

If the vegetation on the area will permit access to all parts of the field, the use of torpedo type baits is recommended. About 150 to 175 torpedoes each containing 2 to 3 grams of bait are used per acre. When the entire area is not accessible it is necessary to establish feeding stations at 50 to 100 feet intervals around the outside of the area and along trails leading through it. As instructed previously in this bulletin, the stations should be prebaited with unpoisoned material until the rats become accustomed to feeding at them. Poison bait should then be substituted. It has sometimes been found that clearing vegetation from an area is almost an essential preliminary to poisoning operations. When using the feeding station method with native rats, satisfactory results have sometimes been obtained, using 1 pound of poison to 200 pounds of bait in place of the amounts shown in the formula in the appendix.

(2) *Ground squirrels.* The ground squirrels of North America (*genus Citellus*) comprise a group of rodents which are distributed from Alaska to Mexico, and from the Mississippi Valley to the Pacific Ocean. Ground squirrels similar to those found in North America occur in Europe and Asia. There are some 25 species of *Citellus* and many subspecies found in the United States.

These animals differ from tree squirrels in their habit of living in burrows and in appearance by having shorter and less bushy tails. Most of them become dormant for periods of varying extent during the year. Their food consists of seeds, grains, green vegetation, eggs, insects, and occasionally birds and small mammals. They prefer open flat country, hillsides, or artificial embankments, and are seldom found in heavy growth of forest or brush. They are known to migrate one or more miles and therefore it is desirable to establish buffer strips through poisoning operations two or more miles wide around areas to be protected to prevent reinfestation.

The control of ground squirrels is important because of the part they play in the dissemination of bubonic plague and other diseases; their burrows constitute definite hazards on airfields and training areas and cause damage to water-impounding structures. They also destroy vast quantities of agricultural products.

Where fruit and nut orchards are being damaged by squirrels, the trees can be protected by fastening smooth metal cylinders or disklike shields around the trunks.

In trapping ground squirrels, "blind" sets near burrows or along runways will be most successful. These are made by scraping small depressions in which the traps may be laid. A piece of paper or cloth is then placed over the pan and under the jaws, and the whole trap and chain is covered by sifting fine dirt

Figure 15. Meadow mouse (Microtus). (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

over it. The trap should be anchored with a stake or drag. No. O single spring steel traps may be used. An open set may be made for some species, as the Columbian ground squirrel, by placing the trap in the mouth of the burrow.

(3) *Meadow mice.* Meadow mice, sometimes referred to as meadow voles, field mice, or voles, are distributed widely in North America, Europe, and Asia. They are blocky animals with coarse brown fur, small furry ears and short, slender tails. Their presence in an area is revealed by numerous shallow burrows and tunnels which are connected by a network of tiny roadways or trails under the old grass and fallen vegetation. Meadow mice are prolific breeders, having five to six litters annually with an average of five young per litter. The young are able to shift for themselves when 2 weeks old. These animals are most active in early morning and late afternoon. They usually feed above ground and eat vegetable matter. It was demonstrated in 1942 on military areas in California that these mice and their ectoparasites were carriers of plague.

(4) *Prairie dogs.* Prairie dogs are found in the great plains region of the western United States where they live on open grasslands, parks, or in farming areas. Occasionally individuals will be found in rough, brush-covered spots. As a general rule they form colonies or towns, and their presence is readily determined by the large burrows which, in some species, often have well-built rims about the entrances. Their food consists principally of stems, roots, seeds of native vegetation, and agricultural crops. They are active only during daylight. In colder regions they hibernate.

These animals are destructive to crops, their burrows create hazards on airfields, and they serve as one of the known reservoirs of plague.

(5) *Pocket gophers.* The pocket gopher derives its name from the large cheek pouches which are wholly outside the mouth.

Figure 16. Pocket gopher. (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

Its range is west of the Mississippi River, except for portions of Illinois, Wisconsin, Indiana, Alabama, Georgia, and Florida. It is a burrowing animal which is seldom seen above ground. Evidence of its presence is furnished by the fan-shaped mounds of fresh dirt which are pushed up when the rodent is active. Its burrow system consists of a main runway with short laterals which lead to the ground surface. It is possible for one pocket gopher to cover an acre of ground with its mounds; hence the number of mounds on an area is not a true indication of gophers present.

The food of the pocket gopher consists chiefly of the roots, tubers, bulbs, and stems of plants. The animals obtain most of this food underground, but sometimes feed on the surface. Ordinarily a burrow system will be occupied by only one animal, except during the breeding season or when young are being reared.

The need for control of these animals arises from the hazards their mounds cause on airfields and training areas, their destructive burrowing in lawns, gardens, and water impounding areas, and the damage they cause to soil conservation plantings.

When infestations are heavy and extend over a large area, poisoning is usually the quickest and cheapest method of control. Baits are prepared from cut sections of vegetables, such as sweet potatoes or carrots, or from grains such as oats, wheat, or milo maize, or from fresh clover or alfalfa leaves. It is necessary to place the baits in the main runway after locating it by probing near a fresh mound. The main runway may be distinguished from short lateral tunnels by the relation of the various mounds to each other, and from the fan shape of the mound, since the main runway is usually on the narrow side. If all baits are placed in runways 18 inches from the mound, they are likely to be in the main one, since laterals are seldom more than 18 inches long. Two bait spots in each burrow system are sufficient. Poison formulas are given in appendix I. The best time to conduct control, in most sections, is in late summer and fall when the animals are active and evidence of their workings is conspicuous. Gassing is not recommended.

After a burrow system is poisoned, it is a good plan to close the holes and level off the mounds, care being taken to see that earth does not cover the bait or obstruct the main runway. It is then possible to determine by the appearance of new mounds whether additional treatment is necessary.

The Macabee gopher trap has been proved to be satisfactory. To use it, the main runway is opened with a spade and two traps are set facing in opposite directions to intercept an animal moving from either direction. Single traps may be set in laterals but should be 12 inches from the entrance and should not extend into the main runway. It is not necessary to bait the traps.

Young trees may be protected by sinking cylinders of 1-inch wire netting 12-inches in diameter and 18 inches deep around the trees when they are planted.

c. CONTROL METHODS FOR FIELD RODENTS. (1) *Poisoning.* Poisoning is the most widely used method of attack against field rodents. It will frequently need to be repeated each season, since there will usually be enough survivors to produce a reinfestation. Operations should be carried out when each season's young have matured sufficiently to eat the material. Operations should be preceded by an inspection to determine the extent of infestation and the rodent concerned.

Test baiting with various types of grains available in the vicinity should be carried out to determine the one most acceptable as bait. In instances where the rodents do not readily take poisoned bait, prebaiting with unpoisoned grain is necessary. If the prebait is not cleaned up in 24 hours, poisoned bait should not be put out. Prebaiting is usually not feasible on large areas; it can generally be avoided by careful test baiting. Poisoning

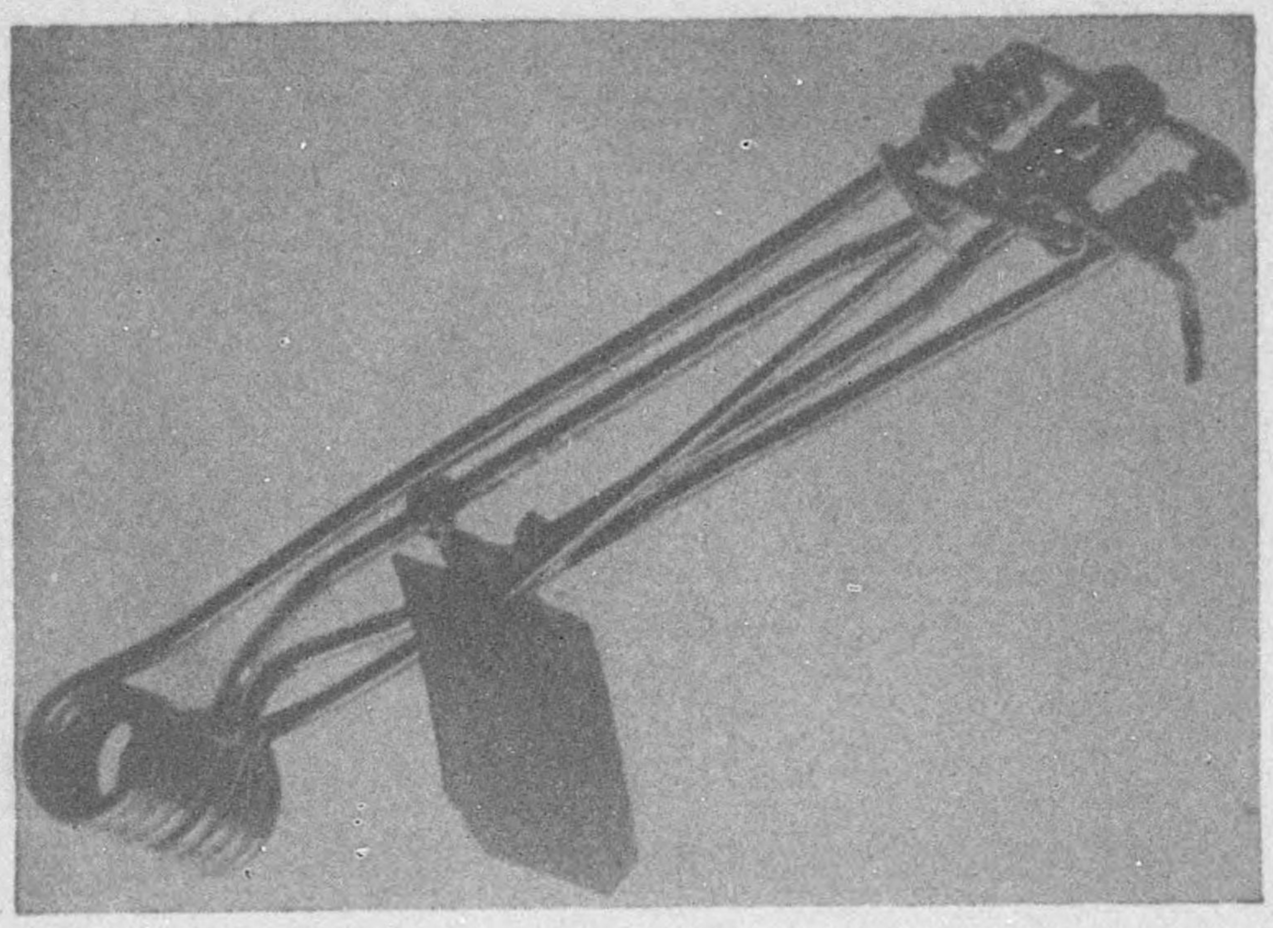


Figure 17. Macabee gopher trap. (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

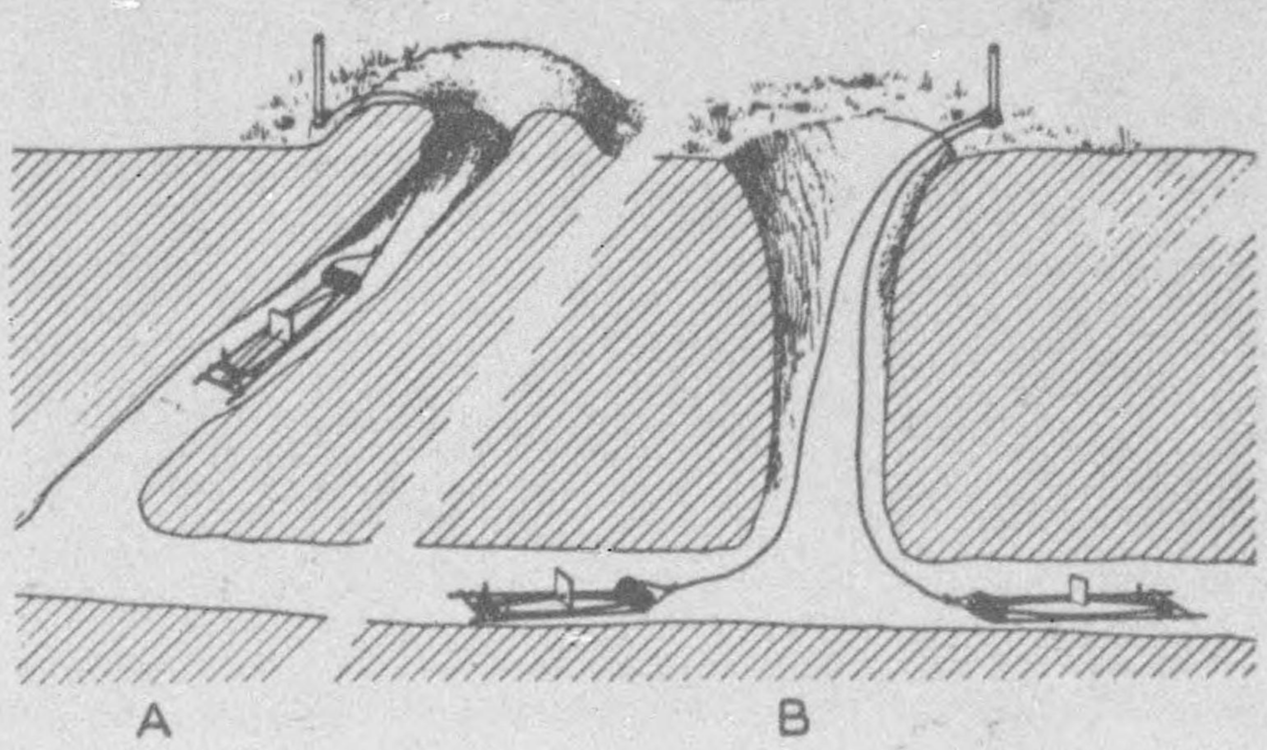


Figure 18. Arrangement of traps in gopher runway. (Courtesy of Fish and Wildlife Service, U. S. Department of The Interior.)

operations should be conducted on bright, warm days when the rodents are likely to be more active. Baits exposed immediately prior to or during rainstorms lose their effectiveness. Areas poisoned previously with strychnine bait may be more successfully retreated with zinc phosphide or thallium sulfate.

Oats, barley, and in some areas milo maize, treated with strychnine, thallium sulfate, or zinc phosphide have been the most effective baits in the United States. Wheat is not recommended for general use, as it is dangerous to birds. Other strychnine treated grain, when properly prepared and used, presents little danger to quail, pheasants, and grouse.

When grain is well scattered, there is little danger to domestic stock. It is suggested that, in foreign countries, native cereals, fruits, and other agricultural produce may prove to be better accepted bait materials than those shown in the formulas in appendix I.

In the control of field rodents by poisoning, it is frequently necessary to treat a number of square miles of infested land. In such cases large crews of men working either on foot or on horseback are employed. The crew, preferably not over 10 men, lines up abreast, and works systematically back and forth across the infested areas. The interval between men will vary with topography and with the kind of rodent being controlled, but ranges from 15 to 50 feet. The men place small quantities of bait (about a level tablespoonful) on bare ground near each burrow and on runways which they observe; and also at intervals of about 15 steps, even if they see no direct evidence of infestation when the area is generally infested. The grain should be thrown so that it will scatter over an area about 18 inches in diameter. Bait should not be placed down the burrow or in dense vegetation. Each man carries a canvas shoulder bag with capacity of about 20 pounds of bait. A spoon should be used to distribute bait when zinc phosphide or thallium sulfate is being used.

The foreman should follow a short distance behind the crew, at least during the training period, in order to watch for missed holes, carelessly placed baits, and to correct, if necessary, the size of the bait spots, or any other faulty practices.

The amounts of bait used will vary widely, depending on the kind and number of animals. With light vegetation and infestation, from 0.5 to 1.0 pound of grain will usually be required per acre (or per 35 burrows). One man can treat from 25 to 50 acres in an 8-hour day. One man on horseback can treat 100 acres. Daily inspections should be made following poisoning to determine if a kill is being secured.

(2) *Trapping*. Trapping is not a satisfactory method of controlling field rodents other than pocket gophers unless the infestation is confined to a very small area and there are few animals. In making a survey of animals which are chiefly nocturnal in their habits, trapping is useful. For example, about 100 of the small museum traps should be set per acre to procure a fair sample of meadow mice and other small rodents present. The victor No. 0 and No. 1 and No. 91 Oneida jump traps should be used for ground squirrels and prairie dogs. Various baits may be used. Rolled oat paste has proved successful in many instances.

Traps should be placed in runways near burrows, or where animals have been eating. They should not be put in burrow entrances except in the case of the Columbian ground squirrel. Traps should be set in the late afternoon and should be visited morning and evening for 3 or 4 days.

(3) *Fumigation and gassing.* Gassing is an effective method of destroying some of the larger field rodents. It should be used when the ground is moist and there are few cracks through which the gas can escape. All interconnecting entrances to the burrow system must be sealed. Any of the gases described under paragraph 4 may be used. The use of gas in individual burrows is an expensive and time-consuming process, and with field rodents its use should be limited ordinarily to small areas or in follow-up work. Carbon disulphide, methyl bromide, and calcium cyanide, a dust, have been widely used in the control of California ground squirrels.

(4) *Shooting.* The few rodents surviving a poisoning campaign can usually be shot by a good marksman. It is also desirable to shoot such field rodents as can be seen, early in the spring before the young are born.

It is emphasized again that the advice and assistance of local representatives of governmental agencies engaged in rodent control, such as the Fish and Wild Life Service, should be solicited.

6. Rodent disease survey and control

In localities where rodent-borne diseases may constitute a problem, it is recommended that specimens of the animals and the ectoparasites infesting them be collected and examined for disease. A rodent survey to detect the presence of plague and other diseases should include the following:

a. Locate centers of high rodent infestation. Disease spreads most rapidly among rodents when large numbers of them are living in close contact and are each infested with large numbers of fleas and other ectoparasites. It has been shown that plague is less likely to develop in rodents when the number of fleas per animal is less than two. For this reason the average number of rat fleas found on rodents collected is often used as an indication of the likelihood of plague outbreak, or of its probable duration.

b. Collect specimens of rodents by trapping, shooting, or poisoning. The tendency of sick rodents to remain in shelter reduces the number of infected animals taken when collections are made. To find infected animals it is usually necessary to examine a large number of specimens. Burrows and other shelters should also be opened, to discover sick and dead rodents if possible.

Rodent diseases, particularly plague, are highly contagious. They may be contracted by handling infected animals or through the ectoparasites infesting them. All personnel handling rats or other rodents should be carefully instructed regarding the danger of handling them. In areas where rodent diseases exist or are suspected, personnel should wear gloves and use insect repellents. As a protection against infected fleas, leggings treated with repellent should be worn. Rodents should be placed immediately in fleatight paper or cloth bags. These are placed unopened in a gastight container with several tablespoonfuls of Rodenticide, fumigant dust (Calcium Cyanide, A dust) and held for a minimum of 20 minutes to kill fleas and other ectoparasites. This procedure does not destroy the virulence of the plague bacillus and other disease organisms and all material from the bags must subsequently be handled with the greatest care, using aseptic procedures.

c. Collect all ticks, lice, mites, and other ectoparasites from the bags and from the animals by combing and striking them over a vessel with a white background. Insects from each animal, or from several animals taken at the same spot, are placed in ¼-ounce vials of 2 percent saline solution.

d. Immerse animals in a bath of 5 percent cresol solution.

e. Dissect each animal to find abnormalities suggestive of plague or other diseases. Abnormalities particularly suggestive of plague may include:

Skin: Animals with acute plague usually show increased redness and wetness of the inside of the skin.

Lymph nodes: The lymph nodes may be enlarged, red or white. They may be firm cheesy, or hemorrhagic on section, with or without gelatinous material around them. (Cervical, axillary, inguinal, sacral, mesenteric, thoracic.)

Spleen: An enlarged, soft, or spotted spleen (spots may be grayish white, pin point in size or larger, and many or few) suggests plague. There may be scars in the spleen or it may be adherent to the intestines.

Liver: It may be dark or yellowish red. Spotted or scarred spots may be pin point in size or larger.

Lungs: Chest may contain fluid, clear or reddish. Red or white spots (varying in size or number) may be present in lungs. There may be brown portions which will sink if placed in water. The red spots usually have a very small, grayish white center. Lungs may be adherent to chest wall.

Intestines: Red spots may be present on the wall of either, or both, small and large gut; or generally increased redness or injection. There may be adhesions to wall of abdomen or other organs.

Operators should wear rubber gloves and aprons while carrying out dissections, and should take full aseptic precautions. Special care should be taken to examine liver, spleen, and lung in a good light for pin point spots.

The definite identification of plague from the above findings is not possible, but samples of tissue from suspicious lesions together with ectoparasites collected should be submitted to the laboratory for further examination. All tissue samples should be iced. Specimens of tissue and ectoparasites should be labeled with the exact location where taken and also when, by whom, and from what species of rodent collection. In handling plague specimens there must be strict compliance with AR 40-225 and War Department Circular No. 453, 1944, titled "Foreign Quarantine." Plague specimens may not be transported across international boundaries without permission of the civil health authorities. The remains of animals dissected must be immediately burned or buried.

Laboratory examination should include inoculation of the ectoparasites and tissue into guinea pigs or other suitable experimental animals and culture of material from the animals at autopsy.

All human cases of plague must be isolated and contacts of cases of pneumonic plague must be quarantined for 7 days. (See TB MED 124.)

Control of plague and other rodent-borne diseases involves the destruction of rodents and preventing their fleas from attacking man. In some cases it will be necessary to attack ectoparasites directly by the use of insect repellents by individuals and the disinfestation of premises.

Fleas in buildings should be destroyed by spraying the floors and the lower 18 inches of walls with 5 percent DDT in kerosene or 10 percent DDT dust or with a mixture containing 1 pound of soap, 2 gallons of water, and 4 gallons of kerosene. Individuals infested with fleas or lice should be dusted with 10 percent DDT in pyrophyllite, QM Item No. 51-I-180 or Item No. 51-1-173.

Clothing and other items may be disinfested with 10 percent DDT dust, by steam or with Rodenticide, fumigant dust, HCN, or methyl bromide in closed containers.

Because it is important that fleas as well as rodents should be destroyed, control methods which accomplish both purposes, such as fumigation, elimination of shelters, and ratproofing, are recommended for use wherever possible in areas where plague and other rodent-borne diseases exist. When a sick rodent dies in a shelter, its fleas may infect other rodents which subsequently use the same shelter. It is therefore essential to eliminate such shelters as a part of plague control.

Elimination of shelters, poisoning, and other control measures should begin at the periphery of the infestation and work toward its center to prevent migration of rodents from the heavily infested zone into new areas.

APPENDIX I

POISON FORMULAS

(Alternative formulas are given letter designations)

Norway rats

	Large batch	Small batch
Rolled oats or bread crumbs.	46½ lb	3 lb
Ground fish or meat	50 lb	3 lb
Corn oil	2½ lb	2½ oz
Zinc phosphide	1 lb	1 oz

Suspend poison in oil. Mix fish or meat with rolled oats. Add the oil-poison mixture and mix thoroughly. (See notes 1, 2, 3, 4, and 5.)

Black and Alexandrine rats

A.

	Large batch	Small batch
Raw sweet potatoes (½-inch cubes) or raw coconut meat.	99 lb	6 lb
Dust with: zinc phosphide	1 lb	1 oz

See notes 1 and 3.

B.

	Large batch	Small batch
Rolled oats or bread crumbs	67 lb	4¼ lb
Ground fish or meat	27 lb	1½ lb
Corn oil	5 lb	5 oz
Zinc phosphide	1 lb	1 lb

See notes 1, 3, 4, and 5.

House mice

A.

	Small batch
Bread crumbs	5¼ lb
Powdered corn sugar	8 oz
Corn oil	4 oz
Zinc phosphide	1 oz

Blend the poison and corn sugar. Add this to bread crumbs and stir thoroughly. Then stir in the corn oil until mixture is moist. (See notes 1, 3, and 4.)

B.

	Small batch
Rolled oats or bread crumbs	5½ lb
Ground fresh pork	8 oz
Zinc phosphide	1 oz

Mix poison and oatmeal. Add ground pork fat and mix thoroughly. (See notes 1, 2, 3, and 5.)

C.

	Small batch
Diced apples or sweet potatoes	6 lb
Zinc phosphide	1 oz

Dust apples with poison. (See notes 1 and 3.)

Malay and Pacific Island or native rats

A.

	Large batch	Small batch
Rolled oats	95 lb	6 lb
Corn oil	5 lb	5 oz
Zinc phosphide	1 lb	1 oz

Suspend poison in corn oil and pour over oats; work thoroughly. (See notes 1, 2, 3, and 4.)

B.

	Large batch	Small batch
Rolled oats	73 lb	4½ lb
Ground salt pork	25 lb	1½ lb
Zinc phosphide	1 lb	1 lb

Mix poison into pork and add oats. Mix thoroughly. (See notes 1, 2, 3, and 5.)

Ground squirrels

A.

	Large batch	Small batch
Barley (recleaned, whole grain) (or steam rolled oats, depending on species of squirrel to be controlled).	100 lb	14 lb
Strychnine alkaloid	7 oz	1 oz
Gloss starch	4 oz	½ oz
Bicarbonate of soda	5 oz	1 oz
Glycerin	2 oz	¼ oz
Heavy corn syrup	1 pt	2 oz
Water	4 pt	14 oz

Mix starch with ¼ pint cold water, stir into remainder of water while it is boiling. Mix strychnine with soda, add to the starch paste, and stir until free of lumps. Add syrup and glycerin. Pour mixture over the barley or oats and turn until all kernels are uniformly coated. Allow to dry before sacking and turn occasionally to prevent mold. (See note 6.)

B.

	Large batch	Small batch
Steam rolled oats	100 lb	10 lb
Zinc phosphide	10 oz	1 oz
Petroleum jelly	8 oz	1 oz
Mineral oil	3 oz	½ oz

Blend jelly and oil by heating over a low flame. Add poison and pour over the grain. If rolled oat groats are used in this formula, amounts of jelly and oil are increased, to 10 ounces of each. (See note 6.)

Meadow mice

A.

	Large batch	Small batch
Steam rolled oats	98 lb	6 lb
Petroleum jelly	10 oz	1 oz
Mineral oil	10 oz	1 oz
Zinc phosphide	1 lb	1 oz

Warm oil and petroleum jelly together until they are just fluid. Add poison and stir until suspended. Pour over grain and mix thoroughly. (See notes 1 and 6.)

B.
Formula (Ground Squirrels, A) given above, also is acceptable, when mixed on steam rolled oats. (See note 6.)

C.

	Small batch
Fresh apples in ½-inch cubes	6 lb
Zinc phosphide	1 oz

Sift poison over apples in enamel pan.

Prairie dogs

A.
Formula (Ground Squirrels, A) given above, is acceptable with the addition of 8 ounces each of borax and common salt, except that steam rolled oats must be used instead of barley. (See note 6.)

B.
Formula (Ground Squirrels, B), given above, also is good. (See note 6.)

C.

	Large batch	Small batch
Steam rolled oats	100 lb	6 lb
Thallium sulphate	24 oz	1½ oz
Yellow dextrin	16 oz	1 oz
Glycerin	1 pt	1 oz
Water	2½ gal	1¼ pt

Paste dextrin with small amount of cold water. Add thallium to remainder of water and dissolve by bringing to a boil. Add dextrin paste and glycerin and boil 10 minutes. Pour over grain while hot and mix thoroughly. Use only granite kettle for boiling mixture. (This formula is not suitable for use with zinc phosphide.) (See note 6.)

Pocket gophers

A.
Formula (Ground Squirrels, A) given above, is satisfactory, when mixed on steam rolled oats.

B.

	Large batch
Sweet potatoes, carrots, or parsnips	2 qt
(Or fresh clover or alfalka	1¼ lb)
Strychnine alkaloid	⅛ oz

Cut vegetables in pieces 1½ inches long and ¼ inch square. Dust strychnine on the baits and mix thoroughly.

NOTES

1. Where outbreaks of plague occur, thallium sulfate may be substituted for zinc phosphide in the above formulas in the proportion of 1½ parts thallium sulfate to 1 part zinc phosphide. Other poisons, if obtainable, may be substituted in the percentages given in paragraph 4*e*(3).

2. Other grains may be substituted where oats and barley are shown in the formulas. Test baiting should be used, to determine acceptability to the animal concerned, before poisoning is attempted.

3. To prevent accidental poisoning of pets, tartar emetic (antimony potassium tartrate) may be added to poisons, previous to mixing, in the following proporitions by weight: thallium sulfate 7 parts, tartar emetic 4 parts, zinc phosphide 8 parts, tartar emetic 3 parts.

4. Cottonseed oil, vegetable cooking fat, lard, or similar materials may be substituted for corn oil in the formulas. The use of animal fats should be avoided if possible since they cause baits to turn rancid in a short time.

5. If desired, sodium sulphite may be added to baits in a ratio of 1 percent to retard spoiling.

6. Ready mixed bait may be purchased from the Pocatello, Idaho, depot of the U. S. Fish and Wildlife Service.

APPENDIX II

FIRST AID FOR POISON CASES IN HUMANS

1. In rodent control operations there is danger, through carelessness, of accidental poisoning of humans and domestic pets. When a poisoning program is to be conducted the surgeon should be contacted and advised as to the poison being used. *In all cases involving humans, a medical officer should be called immediately.*

2. The following suggestions are offered to the field operator in cases of emergency:

a. ZINC PHOSPHIDE. (1) Call medical officer.

(2) For use by a layman:

(*a*) Give 1/4 teaspoonful of copper sulphate crystals dissolved in 1/2 pint of water, or give 1 teaspoonful of powdered mustard dissolved in 1/2 pint of water, or tickle the throat to force vomiting. Repeat in 10 minutes if necessary.

(*b*) Give an oxidizing solution, potassium permanganate 1/4 teaspoonful in a quart of water, or hydrogen peroxide 1/4 cup of the 1 percent solution.

(*c*) After 1 hour give 2 teaspoonfuls of Epsom salts in a cup of warm water.

Caution: Do not give any milk, lard or other oils as these will increase the absorption of phosphorus.

b. THALLIUM SULFATE. Thallium sulfate is a slow poison which is dangerous when eaten or handled carelessly. It may be absorbed through the intact skin. Symptoms rarely appear until several hours have elapsed after the poison has been eaten. Signs of gastric irritation and polyneuritis indicate heavy metal poisoning. Treatment should be started as soon as the victim is found, even though some time may have elapsed. The antidote to be used will depend upon the training of the person giving aid.

(1) Call medical officer.

(2) For use by a layman:

(*a*) Give 1 teaspoonful of powdered mustard in a cupful of warm water to cause vomiting; or tickle the throat.

(*b*) After a few minutes, give 1/4 teaspoonful of sodium iodide dissolved in glass full of water.

(*c*) Give 1/2 teaspoonful of bismuth subcarbonate suspended in 1/2 cupful of water.

(*d*) Give 2 or 3 glassfuls of whole milk.

(3) For use by medical officer:

(*a*) Empty the stomach by use of a stomach pump.

(*b*) Wash the stomach by repeated lavage with 2.3 percent sodium iodide solution.

(*c*) Give high enema with a thin suspension of bismuth subcarbonate.

(*d*) Administer 15 to 30 cc of a 2.3 percent solution of sodium iodide daily intravenously.

(*e*) Give 2,500 cc of 5 percent glucose solution daily intravenously.

(*f*) Prescribe a diet which includes a high proportion of milk, barley, or oat gruel, to protect against corrosive ulceration.

(*g*) Give 10 cc of calcium gluconate by mouth every second day.

(*h*) Prescribe indicated symptomatic treatment to relieve suffering.

(*i*) Have the clinical laboratory conduct daily urinalysis, including test for thallium, and regulate degree of treatment to the speed of thallium elimination.

c. BARIUM CARBONATE. (1) Call medical officer.

(2) For use by a layman:

(*a*) Force vomiting by giving 1 teaspoonful of powdered mustard in a cup of warm water or by tickling the throat.

(*b*) Give 1 teaspoonful of Epsom salts in 1/2 cup of warm water.

(*c*) Give a high enema to aid elimination if medical aid is not secured at once.

d. RED SQUILL POWDER. (1) Call medical officer.

(2) There has never been a proved case

of human poisoning report from squill, but in known instances this raticide has killed animals.

(3) If vomiting has not started, induce it by giving 1 teaspoonful of powdered mustard in a cup of water, or by tickling the throat. If slowing of the heart develops call a physician.

e. ARSENIC. (1) Call medical officer.

(2) For use by a layman:

(*a*) Force vomiting by giving 1 teaspoonful of powdered mustard in a cup of warm water, or by tickling the throat.

(*b*) Give the whites of two eggs in a glass of warm milk.

(*c*) If elimination has not started, give a high enema if medical attention cannot be secured at once.

f. STRYCHNINE. (1) Call medical officer.

(2) For use by a layman only when the patient has just taken the poison and there is no sign of a spasm or increased nervous irritability:

(*a*) Force vomiting by giving a teaspoonful of powdered mustard in a cup of warm water or by tickling the throat.

(*b*) Keep the patient warm, and in the dark, and as quiet as possible.

Caution: *Do not do this if the patient is getting stiff or convulsions seem imminent.* The vomiting might start a fatal spasm before any other treatment could be undertaken.

(3) For use by medical officer—

(*a*) *When patient is not in spasms.*

1. As soon as the patient can retain medicine after vomiting, give 5 to 7 amytal tablets (1½ grains each).

2. After 5 minutes give a teaspoonful of tannic acid in a cup of water.

3. Then give 3 to 5 charcoal tablets, or a cup of cream or warm lard.

(*b*) *When patient is in convulsions, or near them when discovered.*

1. Pour one teaspoonful of ether on a pad made from absorbent cotton or a folded cloth and allow the patient to breathe the fumes. Keep pad from touching the face.

2. As soon as the spasm is controlled and the patient can swallow, give 5 to 7 amytal tablets. Amytal should be administered by medical officers only.

3. If spasms return before the amytal has caused sleep, use a little more ether as described above.

4. To avoid giving too much ether, use only enough to control the convulsion, and not enough to completely anesthetize the patient.

(4) For use in animal cases:

(*a*) *Dog cases when animal has just taken poison and is not nervous.* Give one teaspoonful of table salt by force feeding. After the animal has vomited, give 2 to 4 amytal tablets. After a few minutes, give a quart of water in which has been dissolved ½ teaspoonful of potassium permanganate. Then give a cup of cream, warm lard, or other animal fat.

(*b*) *When dog is in spasms or is highly nervous.* Give 2 to 4 amytal tablets if possible, and then control the spasms with ether as described for humans. Keep the animal warm, quiet, and in the dark. Call a veterinarian.

(*c*) Horse cases. In case the animal is caught eating strychnine poisoned grain, seize the tongue and clean out the mouth and throat thoroughly. Then drench the animal with 2 to 4 quarts of potassium permanganate solution (½ teaspoonful to the quart). Repeat in a few minutes. Then give a drench of 1 quart of warm lard. Keep the animal warm, quiet, and in the dark. Call a veterinarian.

APPENDIX III

KEY TO IDENTIFICATION OF RATS

A. Total length (including tail) less than 300 mm. (Oceanic Islands of Pacific.)
   b. Back tawny or brownish; total length, adults, 230–290 mm; length of tail, 120–150 mm; length of hind foot, 25–30 mm; length of ear from notch, 14–20 mm. (Small Polynesian rat) *Rattus hawaiiensis subsp.*

AA. Total length (including tail) more than 300 mm.
   B. No distinct outer cusp (style) on first row of cusps on first molar (cheek) tooth.
   C. Tail more or less bicolored; head and body robust; length of tail usually less than length of head and body; ear short, normally does not extend more than half way to eye when laid forward. Total length, adults, 325–460 mm; length of tail, 150–215 mm; length of hind foot, 38–46 mm; length of ear from notch, 16–20 mm. (Norway Rat) *Rattus norvegicus.*

BB. A distinct outer cusp (style) on first row of cusps on first molar (cheek) tooth; tail unicolored; head and body more slender; length of tail usually greater (at least equal to) length of head and body; ear long, reaching half way to eye when laid forward; hind foot, 36–42 mm.

d. Back slaty or slaty black; color above and below similar. Total length, adults, 390–450 mm; length of tail, 185–250 mm; length of hind foot, 36–40 mm; length of ear from notch, 24–26 mm. (Black or Ship Rat) *Rattus rattus rattus.*

dd. Back tawny; underparts not slaty or slaty black (except in worn pelage when tips of hair are worn off).

e. Belly never clear white or lemon-colored, and hairs always slaty at base on underparts (except occasionally on throat and chest); belly may appear grayish in worn pelage. Total length, adults, 350–450 mm; length of tail, 190–250 mm; length of hind foot, 34–42 mm; length of ear from notch, 20–27 mm. (Roof Rat) *Rattus rattus alexandrinus.*

ee. Belly white or creamy (lemon), and hairs white to base; ground color of back tawny; no gray margin at line of demarcation between ground color of back and the whitish belly. Total length, adults, 345–455 mm; length of tail, 190–255 mm; length of hind foot, 34–40 mm; length of ear from notch, 20–24 mm. (White bellied Rat) *Rattus rattus frugivorus.*

APPENDIX IV

PROPOSED INFECTIOUS RODENT SURVEY AND CONTROL TEAM

1. The following is a suggested organization with the necessary equipment to carry out an effective infectious rodent survey and control program. This organization and equipment may be assembled in the theater. It should serve in a consulting and supervisory capacity. Labor to mix and distribute baits, gas burrows, and set and collect traps should be procured from local civilian or prisoner of war sources. This organization can carry out an effective program for an urban area of approximately 100,000 population, or a rural area with scattered centers of population of approximately 200 square miles. From 100 to 200 civilian employees can be utilized.

T/O INFECTIOUS RODENT SURVEY AND CONTROL TEAM

1	2	3	4	5	6	7	8
Unit	Specification Serial No.	Technician Grade	Headquarters	Survey unit	Control unit	Total	Remarks
Major			1			1	
Rodent control	(a)		(b1)			(1)	
Captain				1	1	2	
Entomologist	3315			(b1)		(1)	
Sanitary engineer	7960				(b1)	(1)	
Total commissioned			1	1	1	3	
Technical sergeant				1	1	2	
Sanitary	196			(1)	(1)	(2)	
Staff sergeant				1	1	2	
Sanitary	196			(1)	(1)	(2)	
Corporal			1			1	
Clerk-typist	405		(c1)			(1)	
Technician, grade 4 } Including						3	
Technician, grade 5 } Including				2	5	3	
Private, first class } Including						1	
Sanitary	196	4		(1)	(2)	(3)	
Sanitary	196	5			(2)	(2)	
Truck driver, light	345	5		(1)		(1)	
Truck driver, light	345				(1)	(1)	
Total enlisted			1	4	7	12	
Aggregate			2	5	8	15	
O Truck, ¼-ton			1			1	
O Truck, ¾-ton weapons carrier				1	1	2	

Remarks:

[a] See appendix VII for qualifications of rodent control officers.
[b] Sanitary Corps.
[c] Also drives truck, ¼-ton.

Function: Infectious rodent survey and control team conducts rodent-borne disease and rodent surveys; organizes and conducts rodent control programs; acts as consultant on rodent control problems; supervises natives or prisoners of war employed in the control of rodents; and trains army or other personnel in correct rodent control methods.

Assignment: As required.

For specification serial numbers for officers see TM 12-406 and 12-407; for enlisted men see TM 12-427.

This team has not been approved by Hq., ASF as of 1 March 1945. Approval will depend on theater demand.

2. The following is a suggested list of equipment and supplies which the infectious rodent survey and control team may need in case of an infectious rodent disease outbreak or in preventive work. All items will not be required in all cases; only those required should be procured. The quantities are based on a civilian or native crew of 100 men.

Note. This Table of Equipment list has not been approved by higher authority but is submitted as a guide.

CHEMICAL

1 Item		2 Allowances	3 Basis of distribution and remarks
Apparatus, decontaminating, 1½ qt. capacity, M2.	ea	3	1 per fuel consuming mtr vehicle outside continental US when auth by theater of opr comdr.
Kit:			
Chemical agent detector, M9	ea	1	Outside continental US when auth by theater of opr comdr.
Repair, gas mask, universal, M8	ea	1	
Mask, gas, service, combat, M5-11-7	ea	15	1 per indiv (mask, gas, sv, lightweight, M310A1-6 or M3A1-10A1-6, or mask, gas, sv, will be issued in lieu of mask, gas, combat, M5-11-7, as dir by WD).
Respirator, dust, M2	ea	6	2 per wheeled, fuel consuming mtr vehicle (respirator, dust, M1 will be issued in lieu of respirator, dust, M2 until exhausted).

ENGINEER

Compass, lensatic, luminous dial, w/case	ea	1	
Duster, insect, hand, rotary blower type, Paris green or powder, 5 to 10-lb capacity.	ea	40	
Extinguisher, fire, water, 4-gal, demountable nestable pump type.	ea	1	1 per 6 sqd tents.
Hose, solvent, resistant, w/coupling, ⅜-in. diameter, 25 ft. long.	ea	6	
Net, camouflage, cotton, twine, fabric garnished:			Outside continental US when auth by theater of opr comdr.
22 x 22 ft	ea	3	1 per trk, ¼-ton; tlr ¼-ton.
29 x 29 ft	ea	2	1 per trk, ¾-ton.
Sprayer, insect, knapsack type, plunger type, cylindrical shape, 3-gal. capacity.	ea	40	
Sprayer, insect, portable, piston pump type, gasoline engine driven, skid mounted, 4 GPM, at 300 PSI., EST 2118.	ea	3	

MEDICAL

Brassard, Geneva Convention	ea	15	1 per indiv (med sv).
Chest, Infectious Rodent Control	ea	1	See app V.
Chest, Infectious Rodent Survey	ea	1	See app VI.
Chopper, meat, hand	ea	2	
Funnel	ea	1	
Kit, first-aid:			
Gas casualty, complete	ea	1	1 per 25 indiv or maj fraction thereof outside continental US when auth by theater of opr comdr.
Motor vehicle, 12-unit, complete	ea	1	1 per 4 fuel consuming mtr vehicles or fraction thereof.

ORDNANCE

Weapons and miscellaneous

Rifle, U.S. cal. .22, M2	ea	3	SNL B-17.
Shotgun, 12-gauge, automatic	ea	3	SNL B-9.
Watch, wrist, 7 or 15 or more jewel	ea	7	1 per off; NCO 1st 3 gr.

Vehicles

Trailer, 2-wheel, ¼-ton, cargo	ea	2	1 per ¾-ton trk.
Truck:			
¼-ton, 4 x 4	ea	1	1 per hqs.
¾-ton, 4 x 4, weapons carrier	ea	2	1 per surv unit; control unit.

Motor transport equipment

Axe, handled, chopping, single bit, standard grade, 4-lb.	ea	3	1 per fuel consuming mtr vehicle (SNL M-3).
Mattock, handled, pick, Type II, Class 5, 5-lb.	ea	2	1 per fuel consuming mtr vehicle except ¼-ton trk (SNL M-3).
Rope, tow, 20′ long, 1″ dia	ea	3	1 per fuel consuming mtr vehicle under 1½-ton capacity.
Shovel, general purpose, D-handled, strapback, round point, No. 2.	ea	3	1 per fuel consuming mtr vehicle.

QUARTERMASTER

Individual equipment

1 Item		2 Allowances	3 Basis of distribution and remarks
Bag, canvas, field, od, M-1936	ea	3	1 per off.
Belt, pistol or revolver, M-1936	ea	15	1 per indiv not otherwise issued cartridge belt.
Cover, canteen, dismounted, M-1910	ea	15	1 per indiv.
Pack, field, cargo and combat:			
Pack, field, cargo	ea	12	1 per EM (haversack, M1928 and carr, pk, M1928, or pk, fld, will be issued in lieu thereof until exhausted).
Pack, field, combat	ea	12	
Suspenders, pack, cargo and combat	ea	12	
Strap, carrying, general purpose	ea	3	1 per bag, canvas, fld, od, M1936.
Suspenders, belt, M-1936	ea	3	1 per off.

Organizational equipment

Axe:			
Camp	ea	4	
Handled, chopping, single bit, standard grade, weight 4-lb.	ea	2	
Intrenching, M-1910, with handle	ea	2	1 per 10 EM.
Bag:			
Canvas, field, od, M-1936	ea	60	
Canvas, water-sterilizing, porous, complete with cover and hanger.	ea	1	
Delousing	ea	1	1 per 20 indiv or maj fraction in areas where louse-borne typhus is high when auth by WD.
Bar, wrecking, gooseneck, dia. of stock ¾-in., length 24-in.	ea	2	
Bucket, general-purpose, galvanized, heavy-weight, without lip, 14-quart capacity.	ea	60	
Burner, oil stove, tent, M-1941	ea	12	1 per tent, stove, M1941 when auth by WD.
Can:			
Corrugated, nesting, galvanized, with cover:			
10-gallon	ea	4	
16-gallon	ea	4	
Water, 5-gallon	ea	3	1 per 5 indiv or fraction thereof.
Carrier:			
Axe, intrenching, M-1910	ea	2	1 per axe, intrenching, M-1910.
Pick-mattock, intrenching, M-1910	ea	2	1 per pick-mattock, intrenching, M-1910.
Shovel, intrenching, M-1943	ea	8	1 per shovel, intrenching, M1943 (carr, shovel, intrenching, M1910 will be issued when shovel, intrenching M1910 is issued).
Case, canvas, dispatch	ea	3	1 per off.
Clipper, hair	ea	1	1 per 40 indiv or maj fraction thereof operating in extremely cold areas outside continental US when auth by theater of opr comdr.
Desk, field, empty, fiber, company	ea	1	
Drum, gasoline, 5 gallon	ea	3 or 15	1 per trk. 1 add per burner, oil stove, tent M1941 when auth by WD.
Goggles, M-1944	ea	6	2 per wheeled fuel consuming mtr vehicle.
Hammer, carpenter's claw, bell-faced, weight 1-lb.	ea	3	
Lantern, gasoline, 2-mantle commercial	ea	5	
Mattock, handled, cutter, type II, class D, 5-lb.	ea	2	
Opener, can, mechanical, table type	ea	2	
Outfit, cooking, 2 burner	ea	1	
Pan, dish, capacity, 12-quart	ea	2	
Paulin, canvas, small	ea	2	
Pick, handled, railroad, 6-7 lb	ea	4	
Pick-mattock, intrenching, M-1910 with handle.	ea	2	2 per 10 EM outside continental US when auth by theater of opr comdr.
Pump, foot, rodenticide fumigant	ea	12	
Rake, garden, steel, 14-teeth	ea	10	
Screen, latrine, complete (with pins and poles).	ea	1	
Shovel:			
General purpose, D-handled, strapback:			
Round point, No. 2	ea	12	
Square point, No. 2	ea	3	
Intrenching, M-1943	ea	8	7 per 10 EM outside continental US when auth by theater of opr comdr (shovel, intrenching. M1910, to be substituted until exhausted).

1 Item		2 Allowances	3 Basis of distribution and remarks
Spoon, basting, 21-inch	ea	60	
Stove, tent, M-1941, complete	ea	12	2 per tent, sqd, when auth by CO.
Strap, carrying, general purpose	ea	60	
Tent, squad, M-1942	ea	6	6 per team for adm storage and sup.
Tool Set (Complete with tools), carpenter's, No. 2.	ea.	1	
Tube, flexible, nozzle	ea	3	1 per fuel consuming mtr vehicle.
Typewriter, portable, with carrying case	ea	1	1 per desk, fld, empty, fiber, co.

SIGNAL

Flashlight TL-122-( )	ea	18	1 per off; EM; fuel consuming mtr vehicle.

3. The following is a list of expendable items which should be made available to an Infectious Rodent Survey and Control Team.

ENGINEER

1 Item	2 Allowances	3 Basis of distribution and remarks
HCN Discoids	1,000 lb	For use only by sp crews (see WD Pamphlet No. 5-1).

ORDNANCE

Cartridge, Rifle (22 long)	500	For shooting rodents.
Oil, guns	4-oz can	For oiling guns.
Shells, Shotgun, 12-gauge	500	For shooting rodents.

QUARTERMASTER

Insecticide, powder, louse (DDT)	4,000 lb	For flea control.
Larvicide, DDT powder dissolving	1,000 lb	For flea control.
Rodenticide, fumigant dust	200 lb	For gassing rodents.
Rodenticide, general	60 lb	For poisoning rodents.
Rodenticide, plague control	30 lb	For poisoning rodents only in case of rodent disease outbreak.
Traps, mouse	100	For trapping mice.
Traps, rat	2,000	For trapping rats.
Duster, powder, insecticide	50	For dusting indivs for flea control.
Paper, sulphite, substance 18 white, 8 x 10½"	2,000 sheets	For making poison bait torpedoes.

SIGNAL

Flashlight bulbs	18	
Flashlight batteries	48	

APPENDIX V

PROPOSED INFECTIOUS RODENT CONTROL CHEST

At certain times it will be desirable for a rodent control officer to have a chest readily available to him which easily could be transported as a unit to the site where control measures are to be initiated. This chest should be furnished separately or as part of a Table of Equipment. The following is a suggested list of equipment and supplies for such a chest. Additional supplies such as bait, poisons, etc., should be procured locally. This chest at present is not a standard item but is submitted as a guide.

M. D. item No.	Nomenclature and description	Unit	Number	Remarks
	Kit, poison antidote	Each	6	To be in small bottles with two tablespoon capacity. Screw caps which can be used as ¼-teaspoon measures. Bottles and paper cups to be packaged in kit similar to Kit, jungle medical, individual. M-2-9710900.
	Powdered mustard			
	Copper sulphate crystals			
	Bismuth subcarbonate			
	Potassium permanganate			
	Magnesium sulphate			
	Amytal, 1½ gr. tablets			
	Cups, paper folding, 12			
	List of Instructions.			
	Note. Above items may be obtained in larger units from standard supply catalog.			
3705500	Kit, Suction, Snake kit	Each	2	
7306000	Knife, boning	Each	1	
7312000	Knife, paring	Each	4	
7323000	Measure, liquid, 1 qt.	Each	1	
7385000	Scale, grocer's 10 lb. capacity	Each	1	
7401000	Spoons, basting, long-handled	Each	30	
7865000	Padlock	Each	1	
9753500	Chest, field, plain	Each	(*)	

* Chests should be of sufficient number to hold the above contents and 30 bags, canvas, field, 100 traps, mouse, and 200 traps, rat, which will be authorized under Table of Equipment (see app. IV).

APPENDIX VI

PROPOSED INFECTIOUS RODENT SURVEY CHEST

When a rodent control officer is called upon to make an infectious rodent survey he will require special equipment and supplies. At such times it will be desirable to have a survey chest readily available to him. The chest should be available as a special unit of equipment or as part of a Table of Equipment (see app. IV). The following is a suggested list of equipment and supplies for such a chest. This chest at present is not a standard item but is submitted as a guide.

MD item No.	Nomenclature and description	Unit	Number
1470000	Talc, purified	Lb.	1
2014000	Cotton, absorbent, 1 lb roll	Carton	1
2025400	Mask, face, surgical	Each	12
2035000	Plaster, adhesive, 3 in. by 5 yds.	Spool	1
3270000	Forceps, tissue, spring, 5½ in. straight	Each	4
3335900	Knife, operating, 1½ in. blade	Each	2
3475000	Scissors, operating, 5½ in. straight	Each	2
3674000	Gloves, autopsy, size 9, rubber	Pair	8
3734000	Ruler, metric scale, 15 cm.	Each	1
3864000	Tape measure, steel 60", spring winding pocket type	Each	1
4056200	Bottle, screw neck, vial type, round 9cc. with cap	Each	250
4127000	Case, mailing, water	Each	25
4187400	Counter, hand (tally register)	Each	1
6127500	Ruler, X-ray, transparent, 18", graduated in inches and millimeters.	Each	1
7456000	Brush, hand	Each	1
7493000	Soap, white, floating, 6 oz.	Bar	2
7507000	Band, rubber, No. 32	Carton	1
7515500	Book, blank, memo	Each	2
7557000	File board with clip	Each	1
7576000	Label, large, 75 gummed	Box	2
7579005	Label, vial, large 750	Book	2
7597000	Pad, memo, 8 x 10½ in.	Each	1
7604000	Paper, carbon, 8 x 10½ in.	Box	1
7624000	Pencil, lead	Dozen	1
7630000	Pencil, wax, red	Each	12
7660000	Tags, shipping, paper, 50	Bundle	2
7663000	Twine, cotton	Ball	1
7701000	Apron, rubberized	Each	6
7737000	Can, oil, 2 oz.	Each	1
7794500	Divider, 8 in.	Each	1
7799000	File, 5 in., triangular	Each	1
7862000	Needle, common, 25 assorted	Pkg.	1
7865000	Padlock	Each	1
7876000	Pin, straight, common	Paper	1
7883000	Pliers, side cutting	Each	1
7934010	Thread, cotton, black, 500 yards	Spool	1
7934040	Thread, cotton, white, 500 yards	Spool	1
7950000	Vial, prescription bottle, 16 oz.	Each	2
8112100	Stone, carborundum	Each	1
9433000	Magnifier, folding	Each	1
9753500	Chest, field, plain	Each	(*)
9777100	Kit, first aid, motor vehicle, 24 units, complete	Each	1
9904500	Bag, patient's effects (for rodent specimens)	Each	25

MD item No.	Nomenclature and description	Unit	Number
9913000	Box, soap	Each	1
9914000	Bucket, canvas, collapsible	Each	2
1051000	Alcohol, ethyl, denatured 1 qt.	Bottle	1
1159000	Cresol, saponated sol., 1 qt.	Bottle	1
1419000	Sodium borate, 1 lb.	Bottle	1
B-205130	Field Collectors Manual in Natural History, Smithsonian Institute, Washington, D. C.	Each	3
F-006950	Brush, water color, small	Each	2
TB MED 144	Rodent Control	Each	3
AR 40-130	Collection and Shipment of Specimens to Laboratories	Each	2
	MISCELLANEOUS NONSTANDARD ITEMS		
	Alum, ammonium, powdered	Lb.	1
	Arsenic, powdered, white (arsenic trioxide)	Lb.	1
	Comb, fine toothed	Each	4
	Tags, specimen } Procure from The Smithsonian Institute, Washington, D. C.	Each	200
	Tags, skull } Procure from The Smithsonian Institute, Washington, D. C.	Each	200
	Wire:		
	Monel BWG No. 15, 0.072 dia.	Lb.	1
	Monel BWG No. 17, 0.085 dia.	Lb.	1
	Monel BWG No. 20, 0.035 dia.	Lb.	1
	Rodent examination set consisting of:		
	Pans, combing, aluminum, approximately 16" x 12" x 4½"	Each	6
	Tray, examination, aluminum, approximately 16½ x 12¼" x 1".	Each	1

* Field chests should be of sufficient number to contain all the items listed above and to provide space for 2 flashlights, 6 flashlight batteries and 4 flashlight bulbs which will be authorized under Table of Equipment (see app IV).

APPENDIX VII

QUALIFICATIONS AND DUTIES OF RODENT CONTROL OFFICER (SANITARY CORPS)

1. Qualifications and duties

a. Serves as technical consultant in matters pertaining to rodent control; makes rodent surveys; identifies rodents of medical and economic importance; recommends control measures; supervises the execution of control and survey programs; prepares museum specimens and collects ectoparasites.

b. Must have at least 2 years' actual experience in rodent control, including rat control. Must be a graduate of an approved college or university with major subjects in zoology. Practical knowledge of entomology is desirable.

2. Source jobs

Fish & Wildlife Service, U. S. Dept. of Interior.

United States Public Health Service.

State or Country Agricultural Commission.

Commercial Rodent Exterminators.

APPENDIX VIII

GEOGRAPHICAL DISTRIBUTION OF CERTAIN DISEASES ASSOCIATED WITH RODENTS

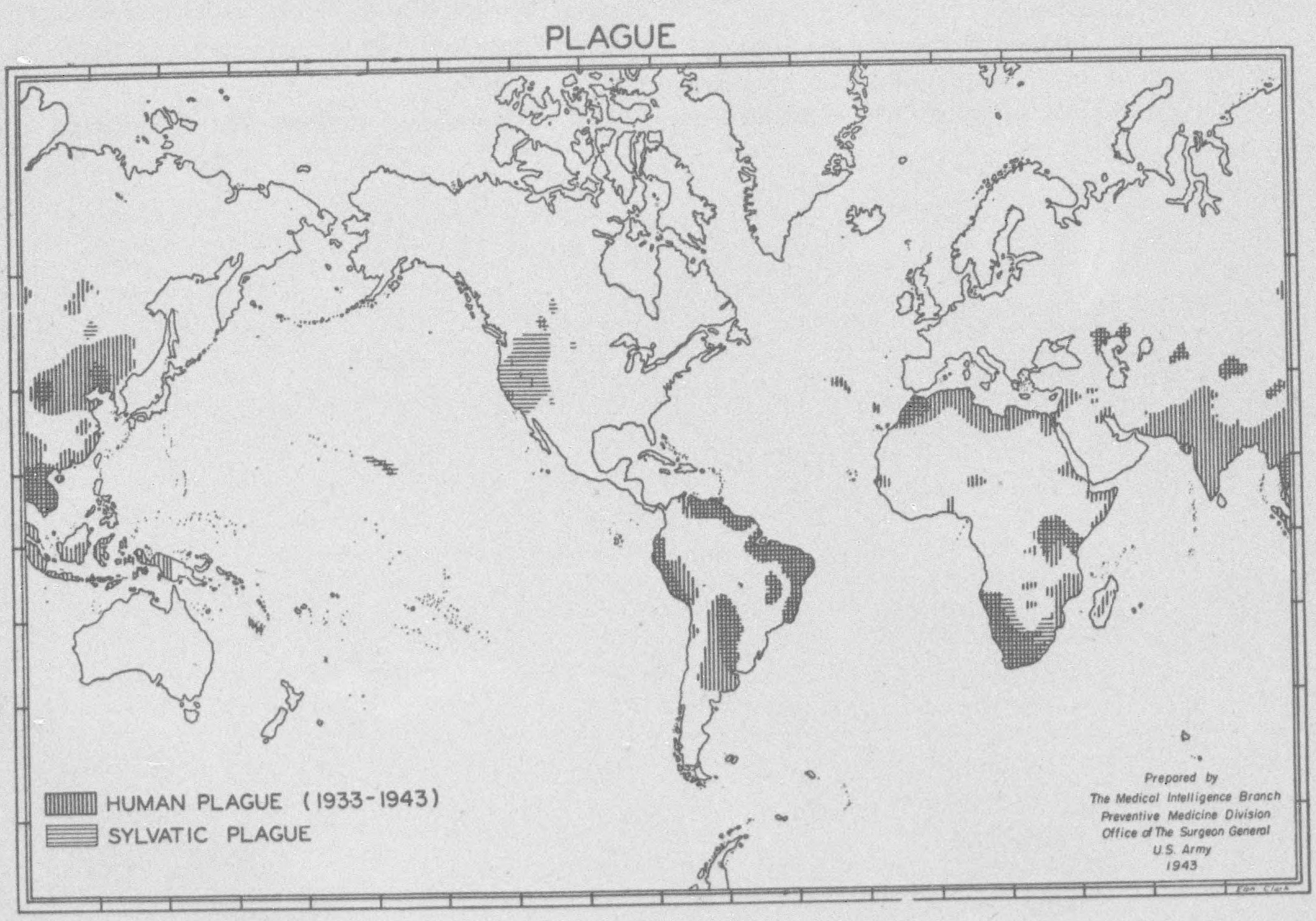


Figure 19. Map showing distribution of plague.

TYPHUS FEVER

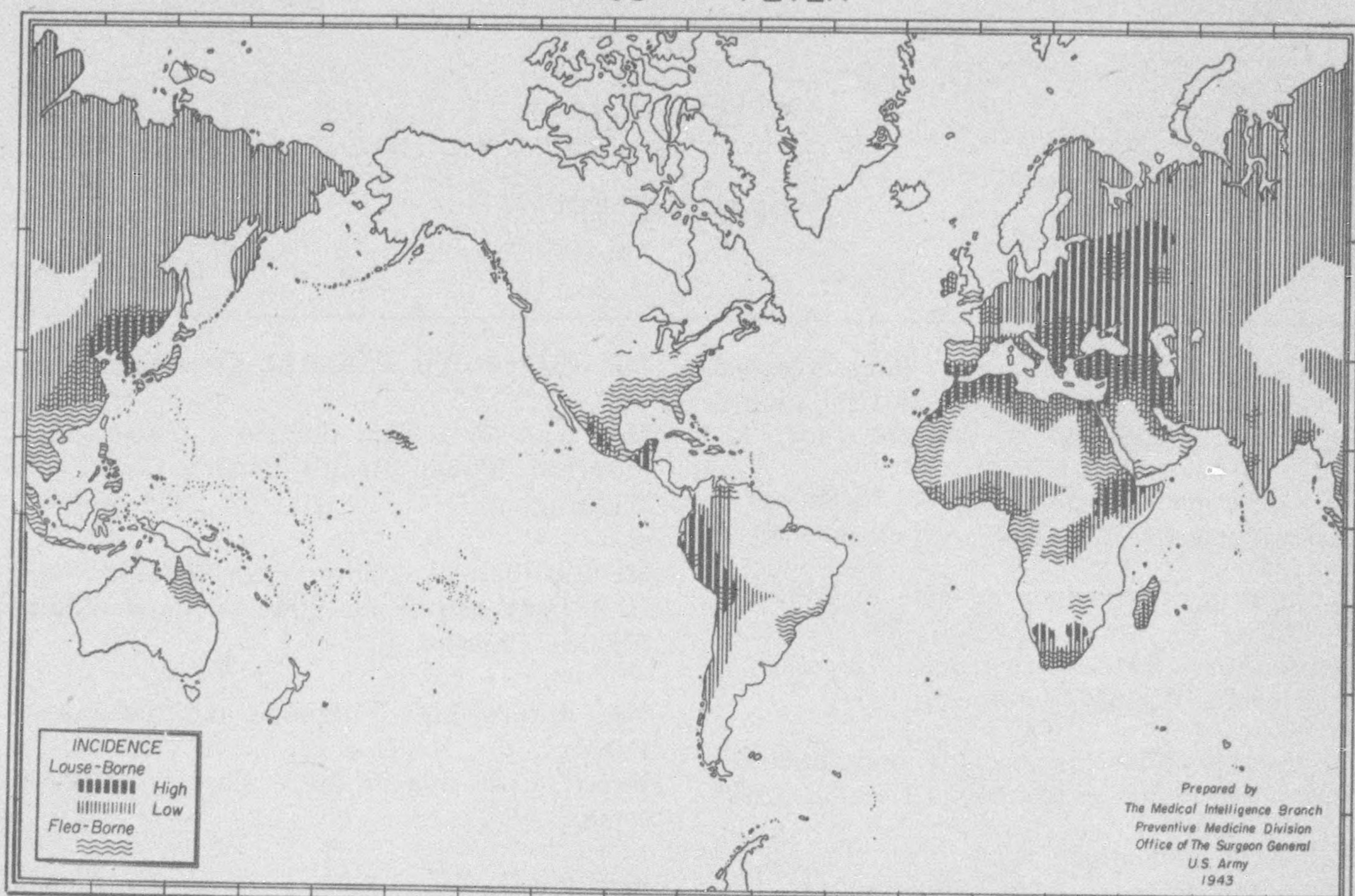


Figure 20. Map showing distribution of typhus fever.

MITE TYPHUS

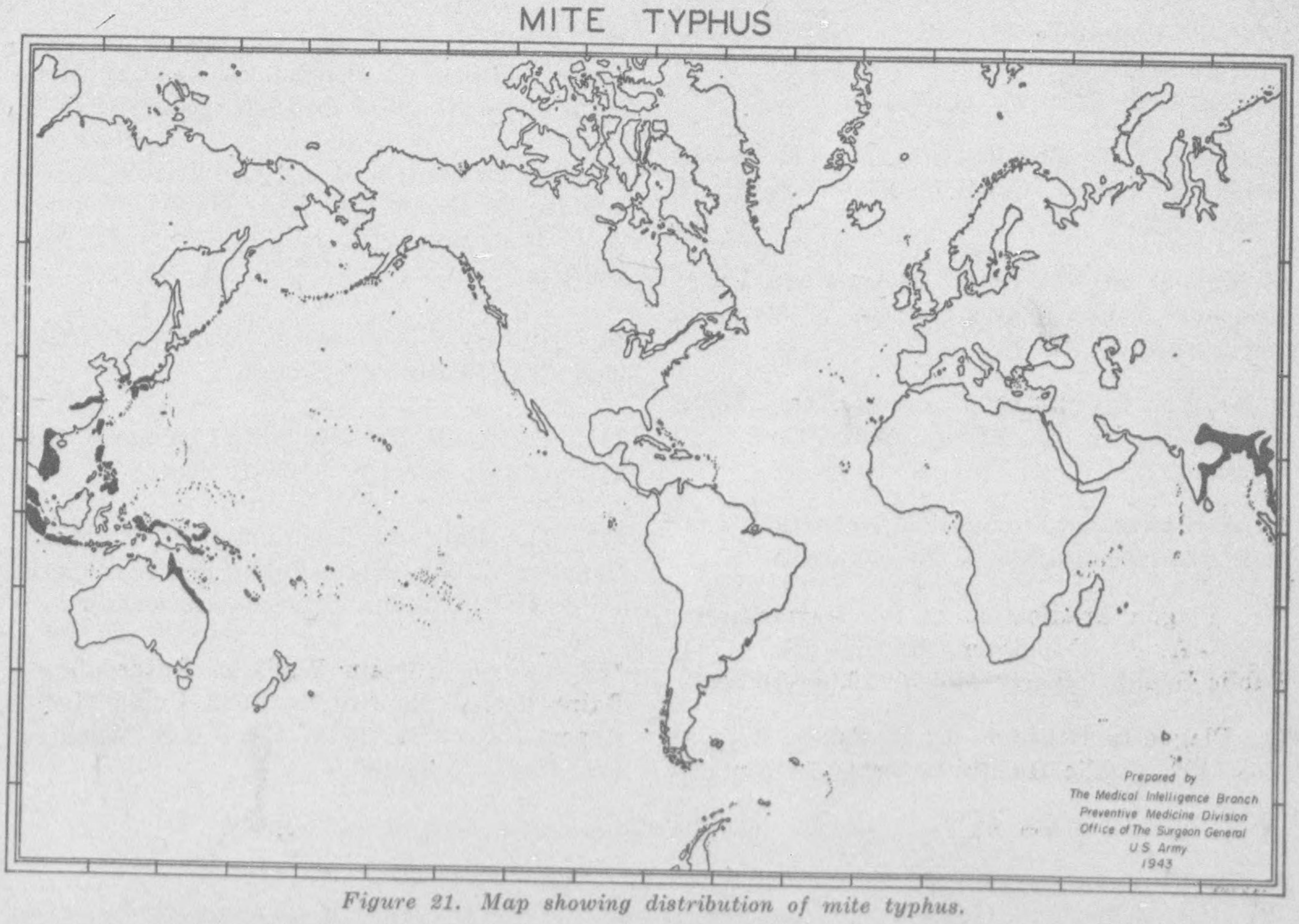


Figure 21. Map showing distribution of mite typhus.

APPENDIX IX

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* May be purchased from the Superintendent of Documents, Washington, D. C. at the prices indicated.

file – 1
One to ea med & mac off as far as they go.

TB MED 143

WAR DEPARTMENT TECHNICAL BULLETIN

CUTANEOUS DIPHTHERIA

War Department, Washington 25, D. C. • • • February 1945

This bulletin supplements, but does not replace, paragraph 5, TB MED 47, 23 May 1944.

This bulletin follows TB MED 142, subject, "Filariasis (Wuchereria) with Special Reference to Early Stages." Distribution given TB MED 142 was as follows: AAF (5); AGF (5); ASF (2); T of Opns (25); S Div ASF (1); Dept (5); Base Comd (5); Is Comd (5); AAF Comds (55); Arm & Sv Bd (2); Def Comd (5); Tech Sv (2); Sv C (10); Named & Numbered GH (60); Numbered GH (NP) CZ (45); Named SH (Including RH & Numbered SH) (40); M Conc C (55); Gen Disp (ZI) (10); Fld Hosp (15); Hosp Tn (2); Hosp Ship Plat (5); Hosp Ship Complements (15); Conv Ctr (15); Conv Camp (10); Vet Gen Hosp (10); Vet Sta Hosp (10); Vet Evac Hosp (5); Vet Conv Hosp (5); Portable Surg Hosp (5); Evac Hosp (750 bed) (40); Evac Hosp (SM-400 bed) (30); Conv Hosp (20); Gen & Sp Sv Sch (5); Enlisted Techn Sch 8 (1); USMA (2); ASTPU (3); ROTC (2); Army Med Tng C (60); Ind Sta (10); Sv C Lab (5); A (5); CHQ (5); D (55); AF (55); One copy to each of the following: T/O & E 3-25; 4-45; 4-145; 4-232; 5-35; 5-72; 5-95; 5-275; 6-35; 6-55; 6-65; 6-75; 6-95; 6-175; 6-325; 6-355; 6-365; 6-395; 7-85; 9-12; 11-25; 17-55; 17-125; 18-25; 19-35; 20-42. Two copies to each of the following: T/O & E 2-22; 4-152; 4-260-1; 5-386: 5-535S; 6-12; 6-45; 8-22; 8-26; 8-520; 9-35; 9-76; 10-22; 10-165; 10-217; 11-15; 17-15; 18-10-1; 18-35; 19-55; 20-46; 44-15; 44-25; 44-75; 44-115; 44-125; 44-225S; 44-315; 55-120-1. Three copies to each of the following: T/O & E 5-192; 7-95; 8-27; 10-45; 10-175; 17-115 44-135; 44-320; 55-110-1; T/O & E 5-21 (5); 5-251 (6); 5-510S (35); 8-28 (10); 8-510 (15); 8-534 (5); 8-537T (15); 8-550 (60); 8-550S (45); 8-560 (40); 8-572S (5); 8-580 (40); 8-581 (30); 8-590 (20); 8-591T (15); 8-595T (10); 8-650 (10); 8-750 (10); 8-760 (10); 8-780 (5); 8-790 (5); 10-95 (7); 10-125 (6).

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1. GENERAL. Although in the present war diphtheria has not been conspicuous among the diseases disabling military personnel, still it is a constant threat. Diphtheria occurs frequently in the Tropics, and outbreaks of considerable size have been reported during this war. Application of the Schick test to large groups has demonstrated that from 30 to 50 percent of adults of military age are Schick positive and, hence, presumably susceptible. Therefore, should the infection be introduced, the soil is ready, and an epidemic might occur, were diphtheria not recognized and preventive measures promptly instituted. It is a matter of first importance that medical officers be aware of this danger and be alert to recognize the first case of diphtheria that comes under their care. Failure to diagnose nasopharyngeal diphtheria occurs because local symptoms which are severe are attributed entirely to concomitant streptococcal infection or those which are mild are disregarded. Furthermore, medical officers are frequently unfamiliar with the well-established fact that virulent diphtheria organisms may infect both wounds and skin lesions. As medical officers become aware of the possibility, more and more instances of cutaneous diphtheria are being recognized. The diagnosis requires adequate and experienced laboratory aid. In some quarters, the importance of cutaneous diphtheria is viewed with skepticism which is probably best explained by inadequate laboratory diagnosis. Moreover, there is evi-

dence to support the belief that some cases of neuritis of undetermined cause may be a sequel to unrecognized diphtheria, particularly of the cutaneous variety. For these reasons, it is considered important to emphasize the subject and to furnish medical officers with a more comprehensive discussion of cutaneous diphtheria than has appeared previously in official publications.

2. DEFINITION. As a working definition, the term "cutaneous diphtheria" should be used to designate any lesion of the skin from which *Corynebacterium diphtheriae* of proved virulence is recovered. This definition includes dermatological conditions which may be looked upon as representing carrier states, as well as instances in which the presence of diphtheria organisms results in harm to the individual. Such an inclusive definition is necessary because of epidemiologic, diagnostic, and therapeutic considerations.

3. EPIDEMIOLOGY. The fact that cutaneous and pharyngeal diphtheria are known to coexist in certain military populations strongly suggests that they are epidemiologically related. Whenever opportunity has been taken to follow contacts carefully, instances of the various possible contact infections have been observed. On more than one occasion, the diagnosis of cutaneous diphtheria has been suspected only after an outbreak of nasopharyngeal diphtheria has involved patients or attendants on a dermatological ward. The observation that in one series 38 percent of the cases of cutaneous diphtheria were still Schick positive indicates the possibility of infection of the patient's pharynx from his own skin lesion. That the reverse may also occur is suggested by the peculiar location on the arms and about the axilla and neck of diphtheritic ulcers in some cases. For example, a diphtheritic ulcer of the right axilla has been observed in a patient with pharyngeal diphtheria who habitually slept on the right side with the arm abducted in such fashion as to allow drooling of saliva into the axilla.

4. CLINICAL FEATURES. *a. Systemic reaction.* This is usually absent. As a rule, patients complain only of such discomfort as may be caused by the skin lesion. When symptoms such as fever and prostration occur, in all probability they are due to infection of the skin lesion with other bacteria, rather than to diphtheria organisms.

b. Types of skin lesions. (1) No type of skin lesions is pathognomonic of cutaneous diphtheria, since the growth of this organism in the skin is not limited to a single variety of lesion. In general, the occurrence of cutaneous diphtheria depends upon the accidental introduction of the organisms into an existing lesion. Virulent diphtheria bacilli have been isolated from a variety of skin conditions which are mentioned in (3) below. It has been isolated most frequently, however, from the type described in (2) below. Attention is also directed to the occurrence of diphtheritic infections of the region of the anal mucocutaneous junction, which are reputed to be especially dangerous.

(2) The skin lesion most commonly infected with diphtheria bacilli is an ulcer which is rounded, deep, and "punched out." The margin is sharply defined, declivitous, indurated, often rolled, and occasionally undermined. The base is usually relatively clean, but sometimes has adherent soft fibrinopurulent material or a dry, fibrinous crust over it. Beneath the crust there may be exudate which is gray or gray green, rather than yellow. Usually, there is a zone of induration, erythema, and violaceous pigmentation about the lesion. These ulcers vary in diameter from 2 or 3 millimeters to several centimeters. They are usually multiple, but may occur singly. The extremities are most often affected, though any part of the body may be involved. Some observers believe that the ultimate morphology of these ulcers, which often begin as minute traumatic lesions, is determined by the presence of the diphtheria bacillus and its toxin. The lesions here described conform to the general description of tropical or desert ulcer. They are not confined to individuals in the Tropics, although they are very common in combat troops serving in the jungle or desert. Insect and leech bites and minor abrasions are the usual antecedents. Repeated traumata, scratching, infrequent bathing, chance contact with pathogenic organisms, and overzealous treatment are all factors which may contribute to the subsequent course.

(3) Although virulent diphtheria bacilli are most frequently isolated from the type of lesion

described in (2) above, they have been recovered from a variety of other skin conditions, including epidermophytosis, impetiginous dermatitis with shallow ulceration, moist eczematoid dermatitis, exfoliative dermatitis, acne, and paronychia. In a few instances, cutaneous diphtheria in preexisting fungus infections of the toes produces a deeply penetrating narrow tract with thick everted lips resembling those of the ulcers described in (2) above. In addition to the infection of relatively superficial lesions which have been described above, virulent diphtheria bacilli are among the occasional secondary invaders of deeper wounds.

c. Neuritis. Study by independent groups of investigators during this war indicates that the role of diphtheria as a cause of neuritis in troops has been underestimated. It is well known that the development of neuritis is not necessarily related to the clinical severity of the preceding diphtheria. Hence, it is reasonable to assume that cutaneous or wound diphtheria as an antecedent to diphtheritic neuritis will be even less frequently recognized than diphtheria of the upper air passages. Approximately a fifth of a recently studied group of cases of diphtheria of the skin were found to have peripheral neuritis. Manifestations such as blurring of vision, loss of taste, paresthesias about the face, dysphagia, and hoarseness have been observed as transient phenomena in some patients who subsequently developed neuritis of the extremities. The symptoms and signs of neuritis of the extremities may include paresthesias, hyperthesia, and loss of deep reflexes and of motor function. The lower extremities are most often involved.

d. Myocarditis. In a group of well studied general hospital cases of cutaneous diphtheria, approximately 5 percent showed significant electrocardiagraphic changes and there was one death from myrocarditis.

5. DIAGNOSIS. *a. General.* The diagnosis of cutaneous diphtheria depends first upon thinking of it as a possibility. Suspicion of diphtheria cannot be confirmed and a final diagnosis of diphtheria is not justified unless virulent diphtheria organisms are recovered or the patients develop characteristic neuritis or myocarditis. Diphtheria-like organisms are ubiquitous saprophytes, usually without clinical significance. Hence their presence in the bacterial flora of a skin lesion will not attract attention, unless diphtheria is suspected. Consequently, keen alertness on the part of both clinician and laboratory officer and close cooperation between them are essential, if suitable bacteriological procedures are to be employed in the study of skin lesions which may be diphtheritic.

b. Clinical. (1) The actual presence of infection with diphtheria organisms can be established only by laboratory proof (see *a* above). Nevertheless, the medical officer must often act promptly on his clinical impression and epidemiologic information with respect to the institution of isolation and treatment.

(2) It has been stated in paragraph 4*b*(1) and (3) that many unrelated skin lesions may harbor virulent diphtheria bacilli. On the other hand, experience indicates that the ulcers described in paragraph 4*b*(2) are the lesions most likely to be so infected. In one group of patients carefully studied for cutaneous diphtheria, the incidence of positive cultures was significantly higher for lesions which had existed for less than 8 weeks as compared with those which were older than 8 weeks.

(3) The degree of suspicion that one is dealing with cutaneous diphtheria may be increased in the following steps:

(*a*) A single patient with ulcers such as those described in paragraph 4*b*(2).

(*b*) A group of patients with suspected ulcers, originating in a common area.

(*c*) Proof of diphtheria in one or more patients with skin disease or in individuals associated with such patients by development of clinical evidence of pharyngeal or nasal diphtheria or appearance of characteristic complications of diphtheria. Attention is called to the fact that the time of appearance of characteristic complications varies. Manifestations of myocarditis are likely to appear suddenly and early (electrocardiograms may be helpful). On the other hand, those of neuritis develop insidiously and may appear only after very long intervals, such as 2 to 4 months. The amount of protein in the spinal fluid may be increased (instances of a content as high as 125 mg per 100 cc have been reported).

(4) A knowledge of the endemicity or epidemicity of diphtheria is the most important guide to action. When diphtheria is known to be endemic, patients with ulcers such as those described in paragraph 4*b*(2) should be regarded as potentially having diphtheria and isolated until they are proved to be nondiphtheritic. When diphtheria is epidemic, not only such patients but also patients with eczematoid and exfoliative lesions should be managed in this way.

c. Laboratory study (see par. 306, TM 8-227). (1) The *Corynebacterium diphtheriae* is a Gram-positive, nonmotile rod which may manifest marked plenomorphism, determined in part by the age of the culture and the constituents of the medium. The most typical morphology is seen in films made from Loeffler slant cultures stained with Loeffler's methylene blue. The rods may be straight or curved and occur in aggregates of peculiarly angled clusters. There may be central or terminal swelling and the frequent irregular staining occasionally produces a granular or beaded appearance. The longer rods generally have this appearance, whereas the shorter rods stain deeply and uniformly. When the characteristic morphological structure is noted in a film from an initial Loeffler slant or a suspected lesion, it may be considered as presumptive evidence for the presence of *C. diphtheriae.*

(2) *Direct smears.* The heavy contamination of most skin lesions, and especially those of field soldiers, by numerous bacteria makes this method of examination rarely of value. Nevertheless, it should be employed in suspected cases, since large numbers of organisms with all the morphological characteristics of *C. diphtheriae* are found occasionally.

(3) *Cultural procedure.* Loeffler's medium is the most widely employed preparation for the cultivation of *Corynebacteria*, though Pai's egg medium is a moderately suitable sugstitute. Adequate growth is usual in 12 to 18 hours, in the form of small, moist, grayish, shiny colonies. After such incubation, the entire growth should be emulsified on the slant. A methylene blue stained film is prepared and examined for *C. diphtheriae* and a plated medium (in order of preference: cystine—tellurite blood agar of Frobisher, tellurite blood agar, or whole blood agar) is streaked. Transfers are made from suspicious colonies on the plate to Loeffler's slants. Such slant cultures are used for further study of the morphology of the suspected organisms, and for fermentation and animal virulence studies.

(4) *Fermentation of carbohydrates. C. diphtheriae* will generally ferment dextrose and not sucrose in 5 days at 37° C. Cultures of organisms with such properties are used for animal virulence tests.

(5) *Virulence determination.* The reaction of experimental animals to the inoculation of suspected diphtheria organisms is the only certain method of determination. The single animal method of Fraser using the rabbit or guinea pig is recommended. Animal virulence is not directly related to any specific colony morphology or biochemical reaction.

6. TREATMENT. *a. Isolation.* See paragraph 7*b*.

b. General. Skin lesions which contain diphtheria organisms should be managed in accordance with generally accepted therapeutic principles for dermatological diseases. Care should be taken to avoid overtreatment. Diphtheria organisms usually disappear rapidly from skin lesions once bed rest and general and local care are instituted. Patients with diphtheria of the skin are subject to all the complications that may develop in the nasopharyngeal form of the disease. Accordingly, these complications should be guarded against and treated promptly in case they appear.

c. Local. The lesion should be thoroughly cleaned in an appropriate manner. The application of sterile warm saline compresses is recommended. Such treatment, combined with general care, usually suffices to clear the lesion of diphtheria organisms, but compresses soaked in penicillin solution (250-500 Oxford units per cc) give a quicker effect. The parenteral administration of penicillin has also been suggested, but the value and necessity of such treatment are not yet clear. Applications of various ointments, dyes, and sulfonamides are of no value and may be harmful. Sulfonamides are also ineffectual when given by mouth.

d. Specific. When it is decided after careful epidemiologic and clinical consideration that a patient probably has cutaneous diphtheria, antitoxin should be given without delay. If a clinical diagnosis is not justified, the results of laboratory studies should be awaited. In cases in which only cutaneous lesions are infected and no complication is present, the recommended amount is 20,000 units, administered intramuscularly in a single dose. The usual precautions to prevent anaphylactic reactions to foreign proteins must be rigidly employed. Further administration of antitoxin in such cases must depend upon the clinical findings and course. It is to be noted that there is no evidence that antitoxin hastens the healing of skin lesions. Patients with nasopharyngeal diphtheria as well as cutaneous diphtheria should be treated according to the usual principles for the management of nasopharyngeal diphtheria.

7. CONTROL. *a. General.* The administrative procedures prescribed in AR 40-210 for the control of diphtheria are applicable to the cutaneous form of the disease. In applying these procedures, the following considerations should be borne in mind:

(1) Individuals known to harbor or strongly suspected of harboring *C. diphtheriae* in cutaneous lesions, even though not exhibiting symptoms or signs of clinical diphtheria, should be considered to be carriers and isolated accordingly.

(2) Contacts to cases of cutaneous diphtheria should be subjected to the same inspections and administrative control as contacts to nasopharyngeal diphtheria.

(3) Stations receiving troops, who may have been exposed to cutaneous diphtheria, should be alert to the possibility of faucial or cutaneous diphtheria developing among such troops.

b. Isolation. Strict isolation technique should be employed in the same manner for cutaneous diphtheria as for the nasopharyngeal type. This isolation should be continued until three cultures from the lesion and from the nose and throat, taken at least 24 hours apart, are negative for diphtheria bacilli except that the isolation may be terminated if, by appropriate tests, the organisms are found to be avirulent.

(1) Particular attention should be given to the disinfection of dressings and other articles contaminated with discharges from the lesions. Since virulent *C. diphtheriae* have been recovered from the floor of a cutaneous diphtheria ward, special care must be taken in the proper cleansing and disinfection of the floors in rooms or wards in which these patients are being treated. Under no conditions should dry sweeping be allowed.

(2) No person should be permitted to act as attendants for cases of cutaneous diphtheria unless known to be Schick negative.

c. Immunization (see TB MED 114). (1) Immunization of large groups of military personnel to diphtheria is not a routine procedure. It should be undertaken only under special circumstances. While it is apparent that immunity to diphtheria toxin does not prevent the multiplication of diphtheria organisms in skin lesions, such immunity should prevent systemic damage from the toxin elaborated by these organisms. In addition, since cutaneous diphtheria may be a source of nasopharyngeal infection, immunization may be indicated for the prevention of an outbreak of the latter type of disease. It is considered that the incidence of susceptibility in United States troops is such that, with extensive exposure, considerable numbers of diphtheria cases may develop. Therefore, under some conditions, active immunization may be indicated. The decision for or against the application of this measure is one requiring sound medical judgment and must, in each instance, be based on a careful evaluation of the problem at hand. The following are offered as tentative indications for such immunization. They are intended as guides only since they may not be applicable to all situations.

(*a*) Admission rates for diphtheria (either or both forms) above 100 per thousand per annum when averaged over a period of several weeks except that

(*b*) When the disease is limited to small organizations or units, that is, 1,000 strength or less, the critical rate might well be considered to be 200 per thousand per annum and

(*c*) In large organizations, that is, 20,000 or more, the critical rate might be considered to be

50 per thousand per annum or less in the presence of persistently occurring cases, scattered throughout the organization.

(*d*) Situations in which admission rates are not considered reliable but in which there is definite indication of the spread of diphtheria in the organization or command concerned.

(2) The recommended method for immunization of adults to diphtheria is as follows:

(*a*) The material used for immunization is diphtheria toxoid, plain (medical item No. 1604100). Since reactions to this agent are not uncommon in adults, the following technique of administration is recommended:

1. Administer subcutaneously a "test dose" of 0.1 cc of toxoid to all individuals in the group concerned. Those who have severe reactions to the test dose should not receive further doses.

2. Forty-eight hours after the "test dose," begin the regular series of three doses of the toxoid (0.5, 1.0, and 1.0 cc, respectively). These injections should be made subcutaneously at intervals of approximately 3 weeks.

(*b*) Individuals experiencing severe reactions after any dose should be excused from further injections. This practice will not achieve active immunization of the entire group, but it will serve to raise the immunity level of the group and thereby reduce markedly the danger of an outbreak of nasopharyngeal diphtheria.

d. Schick testing. The conduct of Schick test surveys of large groups of military personnel is not considered to be a practical procedure, particularly under field conditions. Accordingly, this procedure should not be used as a control measure unless it is possible to carry it out very carefully, using materials that are known to have been stored under proper conditions, and there is opportunity for reading of reactions at 48 and 96 hours. For details concerning this procedure, see TB MED 47.

[AG 300.5 (15 Feb 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
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The Adjutant General

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For explanation of symbols, see FM 21-6.

AGO 496A
U. S. GOVERNMENT PRINTING OFFICE: 1945

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TB MED 142

WAR DEPARTMENT TECHNICAL BULLETIN

FILARIASIS (WUCHERERIA) WITH SPECIAL REFERENCE TO EARLY STAGES

War Department, Washington 25, D. C. • • • February 1945

This bulletin supersedes paragraph 9 of SGO Circular Letter No. 33, 1943

This bulletin follows TB MED 141, subject, "Nutritional Value and Characteristics of Certain Expedionary and Packaged Rations." Distribution given TB MED 141 was as follows: AAF (5); AGF (5); ASF (2); T of Opns (25); S Div ASF (1); Dept (5); Base Comd (5); Is Comd (5); AAF Comds (55); Arm & Sv Bd (2); Def Comd (5); Tech Sv (2); SvC (10); Named & Numbered GH (60); Numbered GH (NP) CZ (45); Named SH (Including RH & Numbered SH) (40); M Conc C (55); Gen Disp (ZI) (10); Fld Hosp (15); Hosp Tn (2); Hosp Ship Plat (5); Hosp Ship Complements (15); Conv Ctr (15); Conv Camp (10); Vet Gen Hosp (10); Vet Sta Hosp (10); Vet Evac Hosp (5); Vet Conv Hosp (5); Portable Surg Hosp (5); Evac Hosp (750 bed) (40); Evac Hosp (SM-400 bed) (30); Conv Hosp (20); Gen & Sp Sv Sch (5); Enlisted Techn Sch 8 (1); USMA (2); ASTPU (3); ROTC (2); Army Med Tng C (60); Ind Sta (10); Sv C Lab (5); A (5); CHQ (5); D (55); AF (55); One copy to each of the following: T/O & E 3-25; 4-45; 4-145; 4-232; 5-35; 5-72; 5-95; 5-275; 6-35; 6-55; 6-65; 6-75; 6-95; 6-175; 6-325; 6-355; 6-365; 6-395; 7-85; 9-12; 11-25; 17-55; 17-125; 18-25; 19-35; 20-42. Two copies to each of the following: T/O & E 2-22; 4-152; 4-260-1; 5-386; 5-535S; 6-12; 6-45; 8-22; 8-26; 8-520; 9-35; 9-76; 10-22; 10-165; 10-217; 11-15; 17-15; 18-10-1; 18-35; 19-55; 20-46; 44-15; 44-25; 44-75; 44-115; 44-125; 44-225S; 44-315; 55-120-1. Three copies to each of the following: T/O & E 5-192; 7-95; 8-27; 10-45; 10-175; 17-115; 44-135; 44-320; 55-110-1; T/O & E 5-21 (5); 5-251 (6); 5-510S (35); 8-28 (10); 8-510 (15); 8-534 (5); 8-537T (15); 8-550 (60); 8-550S (45); 8-560 (40); 8-572S (5); 8-580 (40); 8-581 (30); 8-590 (20); 8-591T (15); 8-595T (10); 8-650 (10); 8-750 (10); 8-760 (10); 8-780 (5); 8-790 (5); 10-95 (7); 10-125 (6).

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1. GENERAL. This bulletin refers to filariasis which is due to infection of the lymphatic system with nematode worms of the genus *Wuchereria*. The best known and most widely distributed species is *W. brancrofti*. The only other known species is *W. malayi*. In general, except where otherwise noted, the statements in this bulletin may be considered to apply to infections with either worm.

2. EPIDEMIOLOGY. *a. Geographic distribution.* Although filariasis is widespread among natives of practically all tropical regions, a high incidence of infection is usually found only in limited areas. The exact distribution of filariasis is known for only a relatively small portion of the extensive regions in which the disease occurs.

(1) Infection due to *W. bancrofti* is endemic in a wide belt around the world, between latitudes 30° north and 20° south. (See fig. 1.) In most places its distribution is "spotty," large variations in incidence often being noted in adjacent villages. Also, it is not found in some tropical regions where conditions for spread are apparently favorable. For example, *W. bancrofti* has not established itself in Panama,

although it is common on many of the West Indian islands, and large numbers of natives with filariasis have migrated from these islands to the Isthmus. In the United States an endemic area of *W. bancrofti* formerly existed in the vicinity of Charleston, South Carolina, but no new cases have been reported in recent years.

(2) The distribution of *W. malayi* is limited to the Far East, where it is found in India, Ceylon, the Netherlands East Indies, Malaya, Indo-China, and South China. (See fig. 2.) It has not been reported from New Guinea or the Philippines.

b. Transmission. (1) The adult worms live in the lymphatic system of man. Female worms release large numbers of sheathed microfilariae (which are prelarval forms) into the lymph and blood streams. Microfilariae are incapable of development in man, and unless they are taken up by a mosquito of an appropriate species, eventually die. In most endemic areas microfilariae of *W. bancrofti* or *W. malayi* are present in the peripheral blood of

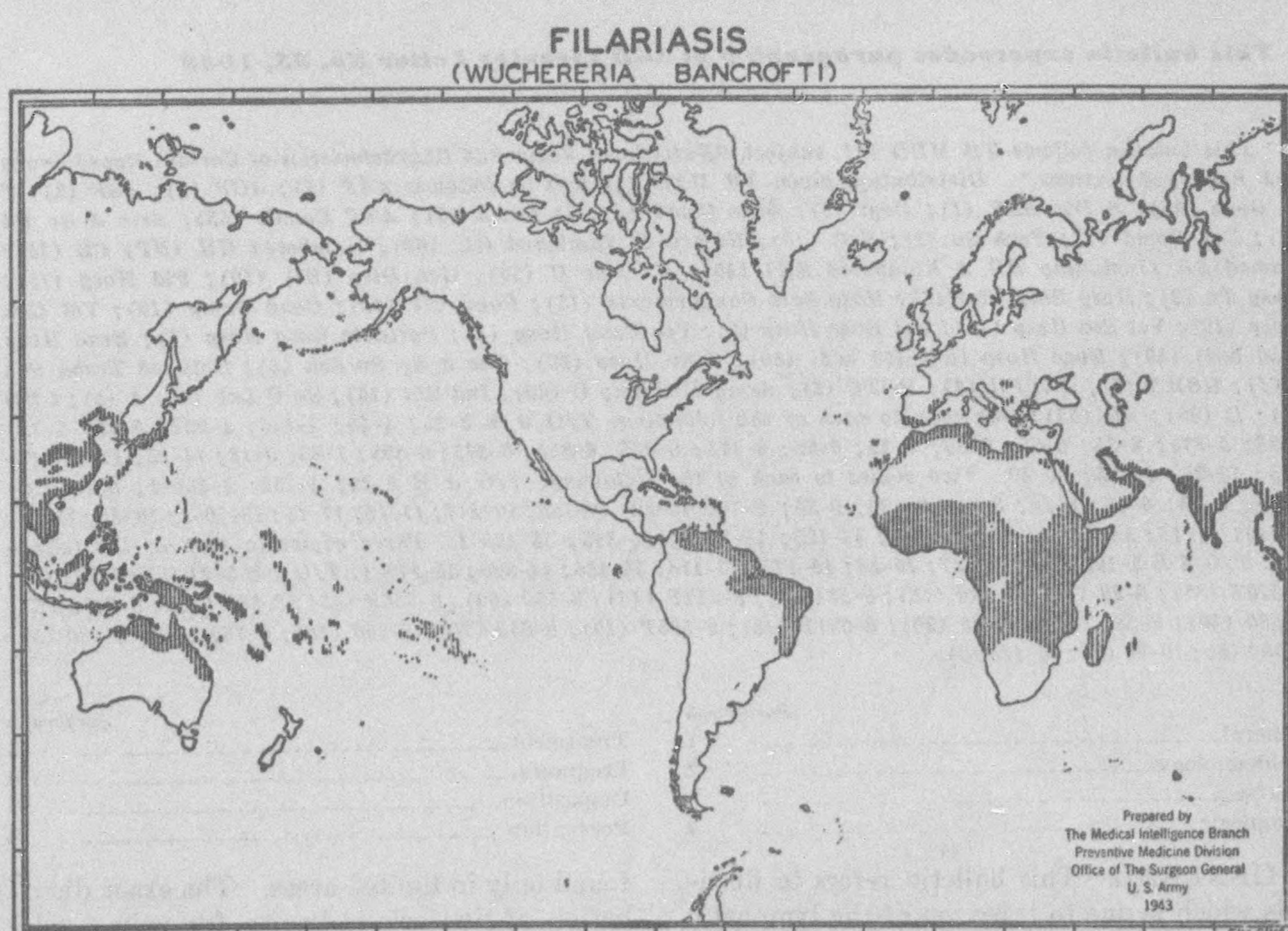

Figure 1.—Geographical distribution of the incidence of filariasis (Wuchereria bancrofti).

infected individuals in greatly increased numbers at night and the mosquitoes which act as intermediate hosts are commonly night-biters. Noctural periodicity in the appearance of microfilariae is not shown, however, by the type of *W. bancrofti* which occurs in many of the South Pacific islands (east of the New Hebrides and Solomons), and in these places the mosquito vectors are day or twilight biters (see *c* below).

(2) In the mosquito, the microfilariae taken up with the blood develop during a period of 10 days or more into infective larvae, which migrate into the mouth parts of the mosquito. When the mosquito then bites again, these larvae are liberated and penetrate the human skin to start a new infection. The interval which is required for the worms to become sexually mature in man and to release a new generation of microfilariae is not known with

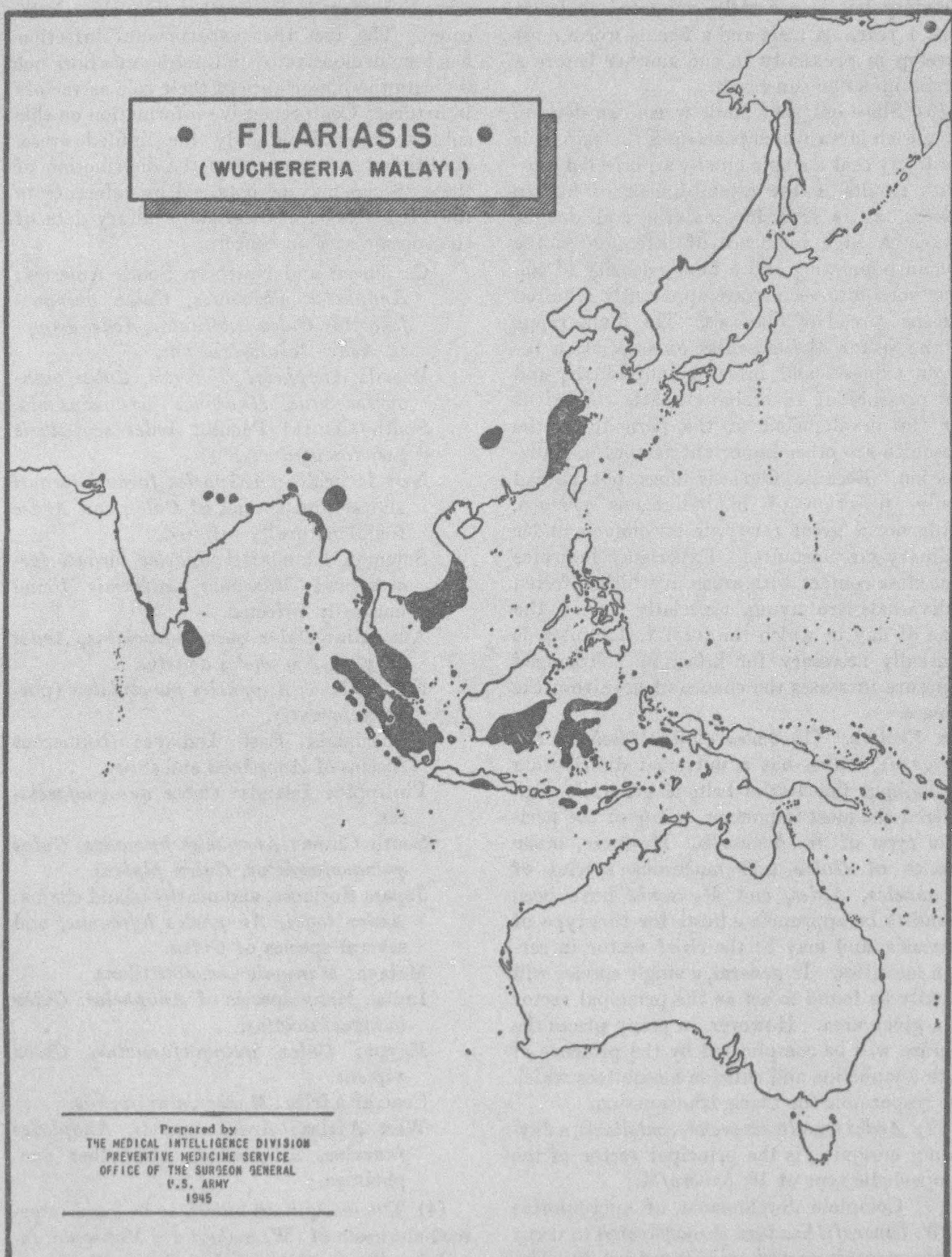

Figure 2.—Geographical distribution of the incidence of filariasis (Wuchereria malayi).

certainty but is generally estimated to be at least 1 year. A male and a female worm must develop in proximity to one another before a fertile infection can result.

(3) Since only one adult worm can develop from each larva which penetrates the skin, it is not likely that a single bite by an infected mosquito results in the establishment of human disease, as is true for malaria and dengue fever. A high incidence of infection in the human population and a heavy density of efficient mosquito vectors are apparently required for the spread of filariasis. The flight range of the vector, the closeness of association between exposed and infected individuals, and the presence of favorable climatic conditions for the development of the parasite in the mosquito are other important factors in transmission. Because filariasis does not spread easily, infection of nonindigenous persons, while not a great rarity, is uncommon under ordinary circumstances. Experience indicates that close contact with areas in which infected individuals are living, especially during the time of day in which the local vector bites, is generally necessary for infection. Prolonged exposure increases the chance of acquiring the disease.

c. Vectors. (1) *Culex quinquefasciatus* (*C. fatigans*), which has a universal distribution throughout the filarial belt, is generally considered the most important vector of the periodic type of *W. bancrofti.* However, other species of *Culex* and numerous species of *Anopheles*, *Aedes*, and *Mansonia* have been found to be appropriate hosts for this type of filariasis, and may be the chief vector in certain localities. In general, a single species will usually be found to act as the principal vector in a given area. However, in many places the picture will be complicated by the presence of both anopheline and culicine mosquitoes which are responsible for filaria transmission.

(2) *Aedes scutellaris pseudoscutellaris*, a day-biting mosquito, is the principal vector of the nonperiodic type of *W. bancrofti.*

(3) Complete development of microfilariae of *W. bancrofti* has been demonstrated to occur in the mosquitoes and areas listed below. Undoubtedly numerous additional species are appropriate hosts and the species listed probably serve as vectors in areas other than those indicated. The fact that experimental infection has been demonstrated in these species does not indicate the importance of their role as vectors in nature. Comprehensive information on this subject is available only for limited areas. Additional information on the distribution of these species may be obtained by reference to the TB MED on medical and sanitary data of the specific area in concern.

Caribbean and Northern South America: *Anopheles albimanus, Culex quinquefasciatus, Culex habilitator, Aedes aegypti, Aedes taeniorhynchus.*

Brazil: *Anopheles albitarsis, Culex quinquefasciatus, Mansonia juxtamansonia.*

South Central Pacific: *Aedes scutellaris pseudoscutellaris.*

New Hebrides: *Anopheles farauti farauti* and several species of *Culex* and *Aedes* found naturally infected.

Solomon Islands: *Anopheles farauti farauti* and *Mansonia uniformis* found naturally infected.

Australia: *Culex quinquefasciatus, Aedes aegypti, Anopheles amictus.*

New Guinea: *Anopheles punctulatus* (possibly *farauti*).

Netherlands East Indians: Numerous species of *Anopheles* and *Culex.*

Philippine Islands: *Culex quinquefasciatus.*

South China: *Anopheles hyrcanus, Culex quinquefasciatus, Culex pipiens.*

Japan, Formosa, and nearby island chains: *Aedes togoi, Anopheles hyrcanus,* and several species of *Culex.*

Malaya: *Mansonia pseudotittilans.*

India: Many species of *Anopheles; Culex quinquefasciatus.*

Egypt: *Culex quinquefasciatus, Culex pipiens.*

Central Africa: *Mansonia uniformis.*

West Africa: *Aedes aegypti, Anopheles funestus, A. gambiae,* and other anophelines.

(4) The mosquitoes known to be good intermediate hosts of *W. malayi* are *Mansonia annulata, M. annulifera, M. indiana, M. longipalpis, M. uniformis, Anopheles hyrcanus sinensis, A. Hyrcanus X,* and *A. barbirostris*

barbirostris. The larvae of these species of *Mansonia*, all of the subgenus *Mansonoides*, develop under water in association with certain aquatic plants, such as *Pistia* (water lettuce), *Eichhornia* (water hyacinth), and *Lemna.* The adults are generally night feeders.

3. COURSE. In all probability, many infections remain asymptomatic for years, or even for their duration. The interval from infection to the appearance of symptoms (when they occur) is not well known. In some recent cases, the period from first exposure to the development of symptoms has been as short as 3½ months. It is commonly believed, however, that a period of a year or more frequently elapses. The symptoms and signs may be divided into two general groups, one of which is predominantly early and usually transient, and the other predominantly late and often persistent.

a. Early symptoms and signs. The account which follows relates particularly to early events in the course of filariasis acquired on the islands of the southern part of the Central Pacific region where the nonperiodic variety of *W. bancrofti* occurs. There is some doubt that the same clinical picture occurs as frequently in the early stages of filariasis acquired in other areas. The Samoan native name "Mumu" is often used to designate the clinical picture in question.

(1) The manifestations occur in a series of acute attacks which last from 5 to 6 days or for several weeks. Recurrences are not periodic. It has been observed that strenuous exercise or hard work may precipitate attacks. In the intervals, patients may appear to be in normal health. Acute attacks vary greatly in severity, being sometimes very mild or hardly noticeable and sometimes incapacitating. Among the symptoms are lack of energy and stamina, constant fatigue, anorexia, nausea, headache, vertigo, drowsiness, blurring of vision, photophobia, and muscle spasm. Pain is common, but rarely severe. It occurs in the chest, lower abdomen, muscles, and in association with local swellings and lymphangitis. Fever, chills, and prostration are unusual, except in mild degree. Neurotic symptoms are frequent and mental depression may be severe.

(2) The physical signs are largely those of enlarged lymph nodes, other localized swellings, and lymphangitis. Involvement of the genitalia is especially frequent, with retrograde funiculitis, epididymitis, orchitis, varicocele, and edema of the scrotal skin. There is no evidence that early filariasis has any deleterious effect upon the sexual functions. Swollen lymph nodes, which are rubbery in consistency and remain discrete, appear in the inguinal, cervical, axillary, or epitrochlear regions. Lymphangitis may develop in the arms, neck, or thighs. It proceeds in a retrograde or centrifugal direction, in association with a red streak, under which the enlarged vessel may be palpable. In some instances, circumscribed, localized areas of swelling occur in the arms or legs, which are dull red, tense, and edematous. Urticaria is occasionally seen. Other changes in the skin are rare. Conjunctivitis may be present. Pleural friction rubs have been heard. Anemia does not develop, unless other causes are operative. A moderate leucocytosis is present in about one-third of the cases. Since intestinal parasites are often present, they must be taken into account in estimating the significance of eosinophilia which occurs in about two-thirds of cases. The urine shows no significant changes.

(3) The swellings which have meen mentioned usually involve the genitalia and one or more extremities. They show only moderate tenderness and rarely suppurate. All of the changes described may develop rapidly and may regress just as quickly, so that the picture changes greatly in 12 to 24 hours. Repeated or prolonged attacks occasionally leave behind them enlargements or thickenings, usually of lymph nodes or genitalia (especially the spermatic cord), which are rarely marked, but may be detectable in the intervals between acute attacks.

(4) It has been demonstrated in many acute attacks that there is no concomitant bacterial infection. Such infections, therefore, are not necessarily an essential part of this picture. The clinical manifestations have no relation to the presence of microfilariae in the blood. Furthermore, the early swellings are clearly not due to mechanical blockage of lymph channels by

worms. The theory that an allergic mechanism underlies the early attacks has been suggested by many observers and has much to commend it. Available information is inadequate, however, to justify the acceptance of any theory at present.

b. Late symptoms and signs. As a rule, the manifestations which characterize the later stages of filariasis are associated with permanent changes in the tissues. The characteristic developments include lymph node enlargement and the condition known as elephantiasis. Since this condition is sometimes caused by other infections, the term "elephantiasis" should not be used as an equivalent of "filariasis." Elephantiasis consists of permanent, extensive thickening and swelling of the soft tissues, with enlargement of the part affected. Any portion of the body may be affected, but the genitalia and the extremities, especially the legs, are most often involved. At least in part, the change is a consequence of more or less complete occlusion of the local lymphatic drainage. Some investigators believe that bacterial infection plays an important etiological role. The development of late manifestations has no relation to the presence of microfilariae in the blood. It is generally believed that many years of repeated infection with filariasis are required for the development of elephantiasis. Among natives of endemic areas who are exposed to the disease from birth, the condition is rarely seen before the age of 20. It is by no means a necessary consequence of infection, since heavily infected populations may show it in only 5 percent or less of their numbers. Chylous effusions in the chest and, especially, the abdomen and chyluria are occasional late manifestations. Extensive abscesses may develop in the soft parts of the extremities or the wall of the trunk. Acute attacks, similar to those described in *a* above, but more often associated with chills and fever, may occur. So far as is known, no case has appeared to date in Army personnel in which elephantiasis has developed following filarial infection acquired during the present war.

4. DIAGNOSIS. The diagnosis of filariasis should be made not only when the presence of the disease is proved by the demonstration of microfilariae or adult worms, but also when the history and clinical findings provide sufficient evidence thereof. It is important that Medical Department records show this diagnosis in all cases in which a reasonable basis for it exists.

a. History and clinical findings. (1) The most important considerations are outlined below. Exposure to the disease in an area where it is known to be endemic is essential. (According to experience during the war to date, filariasis in Army personnel has been acquired only by troops stationed on islands in the South Pacific.) Prolonged close association with natives known to have filariasis should be noted. The interval between first exposure and first symptoms is characteristically long (3 or 4 months to 1 year or more). Recurrent attacks should be given great weight, when manifestations of the group described in paragraph 3*a* substantially repeat themselves.

(2) The most significant signs are characteristic lymph node enlargement, involvement of the genitalia and, especially, retrograde lymphangitis. The diseases which most frequently need to be excluded are malaria and various bacterial infections. Among the latter, streptococcal and gonococcal infections, syphilis, and tuberculosis should receive special consideration. Appendicitis, hydrocele, and hernia should not be overlooked. In many cases, the diagnosis is difficult or impossible when acute manifestations are absent. Experience furnishes the only reliable guides. Exercise tests, particularly marching, are helpful, if they participate acute attacks, as often happens.

b. Laboratory studies. The demonstration of microfilariae or of the adult worm is the only proof of the presence of filariasis.

(1) Microfilariae have been found unquestionably in only a few instances among soldiers infected in the Pacific during this war. Nevertheless, the search for them should always be made and repeated at intervals. Microfilariae may be discovered in preparations of the blood or aspirated contents of a lymph node or hydrocele. In general, they are present in the circulating blood in greatly increased numbers at night (2200 to 0200 hours), but in infections

acquired on Pacific islands east of the New Hebrides, there is no periodicity. Whenever worms are found, the species should be identified, preferably by a trained parasitologist. In any case, a full description should be recorded immediately, the preparation should be preserved, and the finding should be eventually confirmed. In well-established infections, such as those often found in natives, microfilariae are readily demonstrable in thick-blood films. In cases showing early manifestations of the disease, the concentration method of Knott should be used. A brief description follows: Withdraw 1 cc of blood from a vein and discharge into 10 cc of 2 percent formalin solution in a 15-cc conical tip centrifuge tube. Thoroughly mix and set aside to sediment for 12 to 24 hours. Decant the supernatant fluid and with a capillary pipette containing a small amount of water remove the sediment and make an even, fairly thin smear on a glass slide. When dry, stain with Loeffler's methylene blue for 2 or more minutes, rinse free of excess stain, and when dry, counterstain for 1 to 2 minutes with 1/3 percent aqueous solution of eosin. Giemsa stain may also be used. In the formalized sediment the microfilariae lie stretched out and not in the graceful curves seen in thin and thick blood smears. Since the microfilariae measure about 300 micra in length, they are easily visible under the low power of the microscope.

(2) Adult worms have been demonstrated in about 30 percent of the recent Pacific cases in which biopsies of lymph nodes have been studied. Substantial verification has thus been secured of the general reliability of these diagnoses. Excision of lymph nodes or other tissue while acute symptoms are present is sometimes followed by severe exacerbations and might lead to more serious consequences. It should not be performed at such times. In the complete absence of acute manifestations and under expert guidance, a lymph node may be removed for study. The removal of other tissue is undesirable at any time. The selected node should be at least moderately enlarged, firm, and free from adhesions. The operative technique and post-operative dressing should be unimpeachable. Patients should be kept in bed for at least 5 days. The preparation and study of sections should be done by a trained pathologist. The findings should be fully recorded and the slides should be carefully labeled and preserved. Sometimes in long-established infections, the presence of adult worms may be inferred from wirelike calcifications in the lymphatic system as demonstrated in roentgenograms.

(3) Other laboratory studies are helpful only in connection with clinical findings. Leucocytosis and eosinophilia, which may be present, are not specific. Skin tests and complement fixation tests have been used, which usually employ an antigen derived from *Dirofilaria immitis*, a related species which occurs in dogs. They are not strictly specific and the technique has not been thoroughly standardized. For the skin test, it is important that such antigens be used in very dilute form (1 to 8,000 is recommended) and that adequate controls be conducted. The possibility of infection with intestinal nematodes should be investigated. The results of these tests may be helpful in conjunction with other findings, especially in groups of patients, but they require critical evaluation. Further information about such tests may be secured from The Surgeon General by any Army hospital or medical laboratory having to do with a sizable group of patients suspected of filariasis. To a certain extent, the microscopic pathology of tissues acutely involved in the early stages of the disease is suggestive, but this fact cannot be applied in routine diagnostic studies.

5. **TREATMENT.** *a. General measures.* During acute attacks, patients should be kept in bed. Compresses, either hot or cold, should be applied over local inflamed areas. When swellings appear, the part should be elevated. A specially devised scrotal support is necessary, if the scrotum is enlarged. X-ray treatment of acute filarial lymphangitis or adenitis is of doubtful value and may be harmful. In the presence of acute manifestations, all surgical operations are considered undesirable, except such as may be clearly indicated as emergency measures. The treatment of elephantiasis is not discussed in this bulletin.

b. Drugs. No efficacious specific chemotherapeutic agent is known. If trials of drugs as antifilarials are undertaken, approval of The Surgeon General should be obtained, or in oversea areas, that of the theater surgeon. Although sulfonamides have no known effect on filariasis itself, sulfadiazine may be given in cases in which evidence exists of secondary infection with susceptible bacteria. The usual precautions should be taken, including care to insure an adequate urinary output. Sedatives should be given as necessary for the relief of serious discomfort or restlessness.

c. Psychological management. Patients with filariasis may suffer greatly from worry over the possible outcome of the disease and fear of transmitting it to their families and others. These worries and fears are due especially to lack of knowledge of the disease, abseration of cases of elephantiasis among natives, and involvement of the genitalia. Throughout the treatment, the medical officer should bear in mind the great importance of gaining the patient's confidence, of explaining to him in ordinary language the elementary facts about the transmission, nature, and course of filariasis. In the light of present knowledge of the disease, it is justifiable and desirable to reassure patients and to explain to them that, although they may have further transient attacks, the chance of serious permanent damage is negligible.

d. Convalescence and reconditioning. Following acute attacks, patients should slowly resume normal activities. They should not be kept in bed or in a regular hospital ward any longer than is necessitated by the occurrence of symptoms. As soon as possible, they should enter a reconditioning program which should be modified, if necessary, to suit their needs. Careful supervision and proper psychological management, with due attention to morale building, are essential.

6. PROGNOSIS. Filariasis itself presents no significant threat to life. In the great majority of instances, the signs which develop during the early stages are entirely transient. Experience indicates that as time goes on the remissions lengthen and the recurrences become milder. Many soldiers with the diagnosis of filariasis, in the absence of symptoms, have demonstrated their ability to perform military duties satisfactorily. The risk of the development of permanent lesions, including elephantiasis, is not known in statistical terms. In view of the low incidence among heavily infected natives of endemic areas, this risk is believed to be very small for individuals who have not had long exposure to repeated heavy infections and are removed from further exposure.

7. DISPOSITION. In regard to the diagnosis of filariasis, see paragraph 4. Patients with a diagnosis of filariasis should be—

a. Evacuated to the United States, if they are in an area where filariasis is endemic.

b. Hospitalized until they are free from symptoms and clinical signs or eligible for separation from the service as described in *d* below.

c. Returned to duty after a reasonable period of freedom from clinical manifestations and suitable reconditioning. This period is estimated to average about 3 months. The presence of microfilariae in the blood alone is not a basis for prolongation of hospitalization or other restriction. Such patients should be classified for service limited to the United States.

d. Separated from military service for filariasis only if permanently incapacitating residuals or sequelae of the disease are present after maximum benefit of hospitalization is obtained.

8. PREVENTION. *a. General.* The prevention of filariasis depends primarily upon segregation of troops at a safe distance from infected native populations, control of mosquito vectors, and individual protection from bites of mosquitoes.

b. Segregation of troops from natives. Since infected natives serve as the reservoir of filariasis and thus are the source of infection for troops, the maintenance of a safe distance between the two groups and a restriction of their association to a minimum is of the utmost importance for the prevention of the disease in military personnel. Camp sites should be located at least 1 mile from native habitations. If for military reasons it is necessary to make permanent camp sites in proximity to native villages, the latter should be moved to other locations. In areas where filariasis is prevalent, native laborers should be examined for microfilariae and only individuals who are negative should be permitted to work in contact with troops. All other natives should be excluded from troop areas. The practice of permitting natives to attend camp movies is particularly condemned. Native villages should be declared out of bounds at all times and the regulations enforced.

c. Control of mosquito vectors. (1) Numerous species of mosquitoes with varied feeding habits and biology transmit filariasis. In areas where the parasite is of the nonperiodic type, day-biting species have been found to be the important transmitters. In other regions, night-feeding anophelines and culicines are the common vectors. Every effort should be made to ascertain the type of filaria involved and the important mosquito vectors. Where the same mosquito transmits both malaria and filariasis, the malaria control program should amply provide the needed protection against filariasis. In the absence of specific information, methods directed at the control of all species of mosquitoes should be employed.

(2) All feasible and practical larvicidal measures including those employed in malaria control (see FM 21-10 and TB MED 14) should be instituted. In addition to the anopheline habitats emphasized by malaria control, careful attention must be given to the numerous types of natural and artificial water collections which serve as breeding places for *Culex* and *Aedes* mosquitoes. Thorough policing of camp areas for tin cans, coconut husks, oil drums, tire casings, and other sources of mosquito breeding should be practiced routinely. Breeding of *Mansonia* mosquitoes cannot readily be controlled by surface larvicides, since the larvae live in association with aquatic plants, obtaining air through the roots. When drainage is not practicable, their numbers may be reduced by clearing of all water lettuce and water hyacinth plants from breeding areas near camps.

(3) Particular emphasis should be placed upon measures directed against adult mosquitoes, including: the application of DDT residual spray to troop quarters and to native huts (see TB MED 110); barrier treatment of camp sites with DDT; screening; clearing area of vegetation when the tactical situation permits; and routine insecticidal spraying of all buildings and quarters both during the day and in the evening, depending upon the habits of the mosquito vector. The treatment of native habitations with DDT residual spray is especially important because this procedure has long-lasting effects and will kill many mosquitoes soon after they become infected. Destruction of infected mosquitoes breaks an essential link in the chain of transmission of the disease.

d. Individual protective measures. Personal antimosquito measures, as applied against malaria mosquitoes, will also afford protection against the common vectors of nocturnal filariasis. Insect repellent and mosquito bars should be used routinely. Long-sleeved shirts and full-length trousers should be worn at all times during the day, and in the evening until retiring under the protection of bed nets. In areas where troops are exposed to the nonperiodic type of *W. bancrofti*, transmitted by day-biting culicine mosquitos, the application of repellent repeatedly during the day is recommended.

[AG 300.5 (12 Feb 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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For explanation of symbols see FM 21-6.

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TB MED 141

WAR DEPARTMENT TECHNICAL BULLETIN

NUTRITIONAL VALUE AND CHARACTERISTICS OF CERTAIN EXPEDITIONARY AND PACKAGED RATIONS

War Department, Washington 25, D. C. • • • February 1945

This bulletin follows TB MED 140, subject, "Medical and Sanitary Data on Hungary." Distribution given TB MED 140 was as follows: AAF (5); AGF (5); ASF (2); Dept (Med Lab) (1); Def Comd (3); S Div ASF (1); Tech Sv (Tng D) (1); SvC (Surg) (3); SvC (Tng D) (1); SvC (Med Lab) (1); AAF Sta (Continental U. S.) (1); PE (1); PE (Surg) (1); PE (Intell O) (1); GH (Continental U. S.) (1); RH (Continental U. S.) (1); SH (Continental U. S.) (1); Med Sv Sch for O (1); Med Techn Sch (1); ASF Unit Tng C (3); Med Lab (1); A (3); A (Med Lab) (1); CHQ (3); D (3); AF (3).

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1. PURPOSE. The purpose of this bulletin is to inform Medical Department personnel of the characteristics, components, and nutritive content of the various field rations. In order that comments, data, and criticism received from the field through Sanitary and Essential Technical Medical Data reports may be of greatest usefulness in improving the rations, these comments and criticisms must be based on an accurate knowledge of the designation, the components, and the nutritional values of the various field, packaged, and emergency rations in use overseas.

2. B RATION AND MODIFICATION THEREOF. This ration, known also as Expeditionary Force Ration No. 1, is used overseas where organized messing operations are possible. It is composed mainly of canned or otherwise preserved items and will vary somewhat depending on the availability of transportation and local supply. The Quartermaster Corps is attempting to supplement this ration with fresh, frozen meat and fresh fruit in all theaters whenever possible. Issue charts and menus for tropical, temperate, and cold climates have been prepared by the Office of The Quartermaster General and published as War Department Circulars for the information and guidance of all concerned in the various theaters of operations. It is as much like the field ration A served in camps in the United States as possible, except that most of the food is canned or otherwise preserved, as by dehydration. The average nutritional composition of this B ration is shown in table I.

3. 10-IN-1 RATION. This is a ration designed for use in support areas or by mobile forces in combat areas where cooking and messing in small groups is feasible. It is specially packaged in a fiberboard box capable of being carried on a packboard and with sufficient food for 10 men for 1 day or for 5 men for 2 days. Variety is afforded by five different menus and by the inclusion of a large number of components within menus.

a. The components of this ration have been and are being changed and improved frequently. In general, the menus have the following components as packaged at the present time:

(1) *Breakfast.* Premixed, ready-to-eat cereal, breakfast meat, jam, coffee, milk, and sugar.

(2) *Dinner.* Meat or cheese, biscuits, candy and fruit drink and desserts.

(3) *Supper.* Meat, vegetables, biscuits, Army spread, candy, fruit bar or peanuts, cocoa or coffee.

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b. In addition to the food there is a supply of cigarettes, water purification tablets, matches, salt, can opener, toilet paper, paper towels, and salt water soap.

c. The ration is packaged so that breakfast and supper can be prepared for groups of troops, whereas the dinner is individually packed in two or three small containers in order to allow separation of members of the group during the day.

d. The average nutritional value of the 10-in-1 ration (current production with 5 menus) is shown in table I.

4. C RATION. *a.* This is a combat ration packed in typical 3½- by 3-inch cans—six per man per day—and designed for use when no messing facilities are available. Three of the cans contain meat items designated as "M" units, while the other three—designated "B" units—contain biscuits, various confections, and beverages (coffee, lemon or orange drink, or cocoa). Until very recently the "M" units were of only three types: meat and beans, meat and vegetable stew, and meat and vegetable hash. Experience has shown that troops may be required to subsist on this ration for longer periods than was originally foreseen and, as a consequence, a much more varied ration is now being procured. The number of "M" units has been expanded to 10; the biscuits have been improved and three types are now present; the variety of confections has been increased, and jam and a disk of premixed, ready-to-eat cereal have been included. The "M" units which are now in production are: frankfurters and beans; ham, eggs, and potato; pork and beans; meat and rice; ground meat and spaghetti; improved meat and beans; meat and vegetable stew; meat and noodles; chicken and vegetables; and ham and lima beans. Packing schedules have been devised to insure that the total variety reaches the troops.

b. The ration is packed in wooden cases each containing 8 rations with a total weight of 40 pounds. With the new ration there is an accessory packet containing cigarettes, matches, water purification tablets, toilet tissue, can opener, and chewing gum.

c. The nutritional values of the original and the recently modified C rations are given in table I.

5. K RATION. The original K ration was developed for paratroopers, but the resulting light weight and durable ration has found an important place as a combat ration for ground forces. It is used as an alternate to C ration.

a. The ration is packaged in three units, each 7 by 2⅝ by 1⅝ inches, with a total weight of about 2 pounds 10 ounces. Twelve rations are packaged in one case.

b. The present components of the K ration are:

(1) *Breakfast.* K biscuits, egg and meat product, fruit bar, coffee, sugar, cigarettes, and chewing gum.

(2) *Dinner.* K biscuits, cheese product, caramels, lemon juice powder, sugar, candy, chewing gum, matches, and cigarettes.

(3) *Supper.* K biscuits, meat product, bouillon, chocolate bar, cigarettes, chewing gum, and toilet tissue.

c. The egg and meat products of the breakfast unit are:

(1) Chopped pork and egg yolk.

(2) Chopped ham and egg.

d. The cheese products for dinner are:

(1) Cheese, processed American.

(2) Cheese, processed American with bacon.

(3) Cheese, processed American and Swiss.

e. The meat products for supper are:

(1) Canned pork with carrot and apple.

(2) Beef and pork loaf.

f. Within the past few months improved biscuits have been included.

g. It should be emphasized that the synthetic fruit beverage powders in the K ration as well as in the 10-in-1 and C rations are included for the very important purpose of providing vitamin C in which these rations are otherwise poor. Each packet of this item contains 60 milligrams of ascorbic acid in stable form.

h. The nutritional value of the K ration (current product) is given in table I.

6. D RATION. This is a ration for emergency survival conditions, to be used only when all other food supply is lacking. It consists of three 4-ounce bars of high-melting-point chocolate fortified with vitamin B_1 and contains about 1,800 calories. This highly concentrated product should be eaten slowly. It can be made into a chocolate drink.

HEADQUARTERS 32d INFANTRY DIVISION

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	1 ea Med Dept officer and 1 ea to the Portables —	

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TOP

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(Write nothing below this line)

7. NUTRITIONAL COMPOSITION OF RATIONS. For the purposes of information and comparison the Recommended Daily Allowances of the Food and Nutrition Board of the National Research Council and Minimum Allowances of Dietary Essentials for limited periods are included in table I with the nutritional composition of the various rations described above. It will be noted that with the exception of the D bar, the rations in nearly every particular contain amounts of the various nutrients equal to those of the Recommended Allowances.

Table I.—Nutritional composition of rations

Ration	Calories	Protein (gm)	Fat (gm)	Carbohydrate (gm)	Calcium (gm)	Iron (mg)	Vitamin A (i. u.)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic acid (mg)
Field ration B	3, 915	122	141	532	0. 996	27	9, 430	1. 98	2. 42	26. 7	103
C ration:											
Up to July 1944	2, 775	121	78	379	. 818	33	18, 370	1. 0	1. 8	28	87
July to October 1944	3, 240	143	114	410	. 800	24	9, 450	2. 5	3. 0	28	80
October through December 1944	3, 396	143	122	436	. 800	22	5, 410	2. 8	3. 0	29	72
1 January 1945 forward	3, 709	148	132	482	. 925	23	5, 430	2. 7	3. 0	28	112
10-in-1 ration:											
April to December 1944	3, 927	124	171	473	1. 310	22	5, 220	2. 3	2. 7	24	80
1 January 1945 forward	4, 150	130	170	525	1. 150	25	3, 100	2. 7	3. 6	26	75
K ration:											
June to December 1944	2, 786	89	129	317	1. 282	14	4, 674	2. 1	2. 4	15	65
1 January 1945 forward	2, 860	93	122	343	1. 350	17	4, 695	1. 8	2. 5	17	70
D ration	1, 770	32	95	200	. 700	10. 8	-------	1. 50	0. 50	1. 2	------
Recommended daily allowances [1]	[2] 3, 000	70	------	------	. 800	12	5, 000	1. 80	2. 70	18	75
Minimum daily allowances [1]	[2] 3, 000	50	------	------	. 600	6	3, 000	1. 00	1. 50	10. 0	50

[1] Food and Nutrition Board, National Research Council.
[2] For a man of 70 kilos, moderate activity. Calorie need will of course depend on energy expenditure.

[AG 300.5 (7 Feb 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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For explanation of symbols, see FM 21-6.

AGO 285A

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TB MED 138

WAR DEPARTMENT TECHNICAL BULLETIN

CHOLERA

War Department, Washington 25, D. C. • • • February 1945

This bulletin supersedes par. 2 of SGO Circular Letter No. 33, 2 February 1943.

This bulletin follows TB MED 137, subject, "Physical Reconditioning for Bed and Ward Ambulant Patients." Distribution given TB MED 137 was as follows: AGF (5); ASF (2); T of Opns (25); S Div ASF (1); Dept (5); Base Comd (5); Is Comd (5); Arm & Sv Bd (2); Def Comd (5); Tech Sv (2); SvC (10); Named & Numbered GH (60); Numbered GH (NP) CZ (45); Named SH (Including RH & Numbered SH) (40) except AAF (0); M Conc C (55); Gen Disp (ZI) (10); Fld Hosp (15); Hosp Tn (2); Hosp Ship Plat (5); Hosp Ship Complements (15); Conv. Ctr (15); Conv. Camp (10); Vet Gen Hosp (10); Vet Sta Hosp (10); Vet Evac Hosp (5); Vet Conv Hosp (5); Portable Surg Hosp (5); Evac Hosp (750 bed) (40); Evac Hosp (SH–400 bed) (30); Conv Hosp (20) except AAF (0); Gen & Sp Sv Sch (5); Enlisted Techn Sch 8 (1); USMA (2); ASTPU (3); ROTC (2); Army Med Tng C (60); Ind Sta (10); Sv C Lab (5); A (5); CHQ (5); D (55); AF (55); One copy to each of the following: T/O & E 3–25; 4–45; 4–145; 4–232; 5–35; 5–72; 5–95; 5–275; 6–35; 6–55; 6–65; 6–75; 6–95; 6–175; 6–325; 6–355; 6–365; 6–395; 7–85; 9–12; 11–25; 17–55; 17–125; 18–25; 19–35; 20–42. Two copies to each of the following: T/O & E 2–22; 4–152; 4–260–1; 5–386; 5–535S; 6–12; 6–45; 8–22; 8–26; 8–520; 9–35; 9–76; 10–22; 10–165; 10–217; 11–15; 17–15; 18–10–1; 18–35; 19–55; 20–46; 44–15; 44–25; 44–75; 44–115; 44–125; 44–225S; 44–315; 55–120–1. Three copies to each of the following: T/O & E 5–192; 7–95; 8–27; 10–45; 10–175; 17–115; 44–135; 44–320; 55–110–1; T/O & E 5–21 (5); 5–251 (6); 5–510S (35); 8–28 (10); 8–510 (15); 8–534 (5); 8–537T (15); 8–550 (60); 8–550S (45); 8–560 (40); 8–572S (5); 8–580 (40); 8–581 (30); 8–590 (20); 8–591T (15); 8–595T (10); 8–650 (10); 8–750 (10); 8–760 (10); 8–780 (5); 8–790 (5); 10–95 (7); 10–125 (6).

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Treatment	5
Prevention	6

1. GENERAL. Cholera is an acute enteric infection in which the *Vibrio comma* is the specific etiologic agent. Although the organism may persist in nature under favorable circumstances for at least a few days, infection is usually traceable to patients in the immediate neighborhood. Patients in the incubation stage and those with mild symptoms or subclinical infections are important potential sources. Convalescent patients may remain carriers of virulent organisms for a short period of time. Recent studies have cast doubt upon the existence of true carriers. Susceptible individuals acquire the disease through the ingestion of food, drink, or other material contaminated by feces which contain the specific organism. Attacks of cholera in an exposed group of individuals often appear to be distributed capriciously, probably because of the occurrence of subclinical attacks in the community. It is widely believed that any preexisting intestinal disturbance predisposes to the disease. Contamination of water is one of the most important means of spreading cholera. Flies may play an important role. Epidemics are seasonal, since their development is favored by climatic conditions, such as high temperature, high relative humidity, and intermittent heavy rainfall. In some areas, epidemics are associated with floods. Once a cholera epidemic gets under way, unless effective control is exercised, it rapidly sweeps

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through an unprotected population and spreads along lines of communication with a speed proportional to that of the available means of transportation.

2. GEOGRAPHIC DISTRIBUTION. The best known endemic center of cholera is in the region of the lower Ganges River in Bengal, eastern India. The disease is said to be always present in this area. Other endemic areas may exist in Burma, southern China, and elsewhere, but their continuous existence is uncertain. Cholera often spreads throughout India and Burma. In recent years relatively few cases have appeared in Ceylon or to the west of India. During the summer in many years, cholera spreads extensively to the eastward. For some years before the war, British Malaya and the Netherlands East Indies (except for a small, somewhat questionable, epidemic in Celebes in 1937–39) were practically free of the disease. The same was true of the Philippines, except for the years 1930–34. Cholera often appears in Thailand, French Indo-China, Hong Kong, and Canton. It spreads northward through the ports of the China coast (such as Swatow, Amoy, Foochow, Wenchow, Shanghai, Tsingtao, and Tientsin). From these ports, the disease invades neighboring inland areas, especially the valley of the Yangtse River through which it reaches far into the interior. Formosa, the Ryukyu Islands, and Japan proper for many years before the war were kept relatively free of cholera, although the tendency for it to reach these islands from China is great. Very few, if any, cases of cholera have ever been reported from the Japanese Mandated Islands or Guam. In the years 1930–34 an extensive epidemic occurred in many parts of the Far East, reaching as far north as Peiping, China. Cholera was also widespread in 1938–39. The great epidemics of the nineteenth century reached all but the coldest parts of the world. The potential distribution of cholera, therefore, is nearly universal. In all parts of the Far East especially, the danger of epidemics is ever present.

3. COURSE. *a. Symptoms and signs.* The incubation period is usually from 1 to 3 days. Premonitory symptoms of depression, lack of energy, and simple diarrhea sometimes occur. In epidemics, mild cases may be seen which show only malaise and diarrhea throughout. In ordinary cases, the onset is sudden, with profuse, watery stools which quickly lose all fecal characteristics. The stools are voluminous and frequent; they are of a light grayish color and contain small mucous flocculi. Tenesmus is uncommon. Vomiting, which is copious, is often precipitate and free of nausea and retching. Prostration rapidly becomes severe. Dehydration may reach an extreme degree in a very short time, so that it is obvious in the thickening of the blood (the specific gravity may rise nearly to 1.070) and in the shrinking of all the tissues. There is great thirst. Patients are apathetic but clear in mind. In addition to huge quantities of fluids, large amounts of mineral metabolites are lost, especially chlorine, sodium, and calcium. There is a strong tendency toward acidosis, and a marked shift may occur in the acid-base balance of the blood (pH as low as 7.07 and bicarbonate reserve as low as 18 vols. per 100 cc, with total base reduced by 10 percent, have been reported). Muscular cramps may be widespread and severe. The circulation is profoundly affected, with peripheral collapse and low blood pressure rapidly developing to marked degree. The secretion of urine often fails and uremia often appears in severe cases. The skin temperature may be subnormal, though the rectal temperature remains elevated. In severe cases, the rectal temperature also falls. In some instances, a stage of "reaction" develops, with high temperature and the appearance of complications, such as pneumonia.

b. Duration and outcome. The course is usually run in a few days (average, 3 to 5). In fatal cases, death may occur in a few hours or after several days. Even in recent years, epidemics among neglected patients show a fatality rate of 50 to 70 percent. When proper treatment is promptly applied, the case fatality rate should not be over 8 to 10 percent.

4. DIAGNOSIS. *a. General.* The possibility of cholera should be brought to mind by epidemiologic considerations. In and near endemic areas, it is essential to be informed of cases suspected of being cholera among native populations. The recognition of the first few cases of cholera in an area is a matter of vital importance. At the start of an epidemic, rela-

tively mild ambulatory cases which are exceedingly dangerous as potential source of spread may be mistakenly diagnosed as food poisoning or dysentery. In the presence of an epidemic, every person having diarrhea or gastrointestinal disturbance should be regarded as a cholera suspect until proved otherwise. Cholera must be separated from: acute bacillary dysentery, in which the stool content is different and tenesmus is present (except in mild cases), and in which collapse is rare in adults; food poisoning, in which distressing vomiting with nausea and retching, and headache are common; clinical froms of malaria (chiefly falciparum malaria), in which intestinal symptoms and collapse occur; heat exhaustion and other conditions in which a state of shock develops.

b. Specific. (1) Cholera is diagnosed specifically by the identification of *Vibrio comma* in stool cultures. Fecal smears stained with carbolfuchsin diluted 1 to 10, showing the comma forms with the "fish in stream" appearance, are suggestive. The final diagnosis, however, requires culture of the organism from stool specimens and identification by agglutination.

(2) Specimens of feces from cases or suspected carriers should be planted (two or more loopfuls of liquid feces or mucus) without delay in several tubes of alkaline (pH 8.0 to 8.4) peptone water (peptone 1 percent, NaCl 0.5 percent) and incubated at 37° C. for 6 to 8 hours. Other intestinal organisms are inhibited somewhat at this alkalinity, and the vibrio if present will become concentrated at the surface. Examine the surface growth microscopically for typical gram-negative, slightly curved, motile rods. Streak onto nutrient or infusion agar. Typical 24-hour colonies resemble those of the other enteric gram-negative bacilli. Suspected colonies may be tested with specific *V. comma* agglutinating serum using a slide technique and a 1:20 antiserum dilution.

(3) Colonies giving a positive slide agglutination should be isolated and their identity confirmed by macroscopic tube agglutination and biochemical studies. *V. comma* produces acid without gas in glucose, maltose, mannite, and sucrose. Lactose may become acid in 14 days. Nitrites are produced from nitrates; indol is positive and gelatin is liquefied. Macroscopic tube agglutinations should be done at 37° C. for 2 hours rather than at 56° C., since rapid lysis of the vibrio occurs at the higher temperature. It should be noted that *V. comma* is sometimes strongly or completely inhibited on the selective media such as EMB agar or SS agar used for the isolation of other enteric pathogens.

(4) To isolate the cholera vibrio from suspected water, 100 cc samples are inoculated into 10 cc of 10 percent peptone water and incubated for 6 to 12 hours at 37° C. The surface growth is examined as outlined in (2) above.

5. TREATMENT. *a. General.* A patient with cholera represents a therapeutic emergency. The prompt institution and intelligent management of therapy are essential. Since it usually happens that a group of patients (often a very large number) must be treated at the same time, some general plan of action should be prepared and adhered to unless cogent reasons for deviations appear. An outline of the essential part of the treatment is given in *f* below. As in all severe infections, good general medical and nursing care are important. Patients with subnormal temperatures should be kept warm. During the early stages of the disease, little or no attempt should be made to give the patient food, except such as he may be able to take in liquid form.

b. Isolation. See paragraph 6*a*.

c. Replacement of fluids and electrolytes. At present this is without doubt the most important form of treatment, far outranking any available drug or serum therapy. Those who are familiar with the urgency of this form of treatment in young children with dysentery will recognize the similarity of the situations. However, even in moderately severe cases of cholera the problem is much more difficult and persistent. During the acute stage, patients usually can retain only very little of the fluid taken by mouth (advantage should be taken, however, of any possibility that they can retain fluid taken by this route). Reliance must be placed, therefore, upon intravenous injections. Subcutaneous injections are not recommended.

d. Types of solutions. If sufficient supplies of standard solutions and standard sterile distilled water for intravenous administration are not available, solutions should be freshly prepared with distilled water and freshly sterilized. Many "reactions" described in cholera are due to pyrogenic impurities in water. However, in grave emergencies when large groups of patients must be treated, the administration of fluid should not be withheld because of inability to use ideal technique. Plasma and whole blood generally are not necessary in cholera and *may be very harmful.* The state of shock which accompanies cholera is not in itself an indication for plasma. Plasma and blood should be given only when specific reasons for giving them are known to exist. The three solutions described below, with or without dextrose and thiamin, are given intravenously to meet various needs which develop in the course of cholera (see *e* below).

(1) Isotonic saline: sodium chloride 9 gm per liter.

(2) Hypertonic saline: sodium chloride 14 gm per liter. This solution should be prepared by adding sodium chloride (ACS) 14 gm to about 1,100 cc of freshly distilled water and boiling to the point where the volume is 1,000 cc.

(3) Alkaline saline: sodium bicarbonate 18 gm and sodium chloride 6 gm per liter. This solution should not be sterilized by heat because of the attendant loss of carbon dioxide. The following technique may be employed: Dissolve sodium chloride (ACS) 6 gm in about 1,100 cc of freshly distilled water and sterilize by boiling to the point where the volume is 1,000 cc. Add immediately sodium bicarbonate (USP) 18 gm which has been taken directly from the original container and weighed in a sterile vessel. Cool the solution to body temperature and use it at once.

(4) Dextrose to make 5 percent solution should be added to physiologic or hypertonic saline, but not more than 50 gm of glucose should be given in 1 hour or 400 gm in 24 hours. It is desirable, but not essential, to add thiamin chloride 1 mgm for every 25 gm of glucose.

e. Determination of amount, frequency, and type of fluid. (1) The inexperienced physician needs first to learn that patients with cholera usually require relatively huge amounts of fluid and that such treatment may have to be continued over a surprisingly long period. Secondly, he must learn that too much fluid is dangerous, particularly if given after the blood has approached its normal specific gravity. The criterion which has been most used in an effort to be exact is the specific gravity of the blood which is normally from 1.056 to 1.058. As the normal value is closely approached, the rate of fluid administration should be slowed, but the patient must be watched to see that further large losses of fluid are not occurring and do not begin again. The specific gravity of the blood may be determined by the copper sulfate method (see the *Bulletin of the United States Army Medical Department*, number 71, December 1943, page 66), if circumstances permit. Such determinations are by no means necessary for thoroughly satisfactory treatment of patients. In general, judgment must be based especially on the blood pressure; but color and consistency of the blood, rate of the pulse, and amount of urine are also helpful. The development of palpitation, restlessness, pain in the chest, coughing, or edema indicates that too much fluid has already been given. Most patients should have 2 liters of fluid in the first 2 hours. For some time, more fluid is necessary every 3 to 4 hours. The usual rate of continuous infusions (50 to 60 drops per minute) is quite inadequate. It may be necessary to give as much as 6 to 8 liters in the first 24 hours, although 4 or 5 liters are often sufficient. Intravenous fluid may have to be given well into or through the second 24 hours.

(2) In general, physiological saline is the fluid to be used. In regard to the use of glucose, see *d* (4) above. Some observers believe that hypertonic saline in limited amounts gives better results, especially in early cases (before dehydration is severe). As has been pointed out above, the tendency to acidosis is strong. Most patients have an alkali deficit when they come under treatment, and all may develop this condition later if a favorable response is not secured. Hence, it is advised that treatment begin with a limited amount (500 cc) of alkaline saline solution. The further administration of this solution must depend upon observation of the patient. The rate and depth of respiration are not good guides to the presence of acidosis in the acute stage of cholera, though they may be in the later stages. Ketone bodies are not necessarily present in the urine in acidosis due to cholera. Determination of the pH, the carbon dioxide combining power, or the urea content of the blood would be helpful, but such

studies are often impossible. If measurement of urine volume is possible, it is helpful. Continued lack of urine formation is associated with the development of acidosis. The reaction of the urine may be used, within limits, as a guide to the further need for alkali. In the past, many patients have been overdosed with the result that clinical alkalosis appeared.

f. General routine. The following plan is recommended as an initial procedure: Isolate the patient and make certain that all members of the staff understand the system of isolation and disinfection and the need for continuous close observation of the patient and his treatment. Begin at once to administer fluid by vein and give 2,000 cc in the first 2 hours. Of this amount, 1,500 cc should be physiological saline solution with 75 gm glucose and 3 mgm thiamin hydrochloride. The remainder of this amount of 2,000 cc should consist of 500 cc of alkaline saline solution; if available, it is convenient to give the alkaline solution at the start. This amount of saline solution is almost never sufficient to cover the needs of a patient, although it is often not necessary to supply more alkaline solution. Further physiological saline solution, often in the amount of 1,000 cc, will be needed every 3 or 4 hours in many cases. The amount and type of such fluid must be determined in accordance with the principles outlined in *e* above.

g. Chemotherapy. Under no circumstances should the prompt institution of parenteral treatment with liberal amounts of fluid be neglected because of the use of chemotherapy. The value of the sulfonamides and penicillin in the treatment of cholera is uncertain. Because of the frequent failure of renal secretion, it is believed that sulfadiazine and other well absorbed sulfonamides should not be given by any route. Reports of the results of giving sulfaguanidine are difficult to evaluate. The use of sulfaguanidine is suggested; if it is given, full doses should be administered: 5 gm four times a day or 3.5 gm six times a day for 4 or 5 days. The clinical value of penincillin has not been determined. Although the vibrio is gram-negative, the drug has been shown to exert an effect *in vitro.* Penicillin in large dosage therefore should be tried in a suitable series of patients, with adequate controls. Full accounts of the results of chemotherapy in cholera are desired.

h. Various drugs. Numerous drugs of a great variety have been used in the past, most of which rest on no rational basis and have not been shown to be efficacious. Their use is considered to interfere with the proper treatment of the patient, especially during the acute stage. Included in this group are digitalis, epinephrin, hypnotics, sedatives, and laxatives. In some cases with collapse, the injection of caffeine sodium benzoate may be helpful.

i. Special forms of treatment. No bactericidal or antitoxic serum which is known to be efficacious is available. Claims have been advanced for cholera bacteriophage, but clear evidence of its value is lacking. Its use is not recommended.

j. Convalescence. Once convalescence is established, it usually proceeds rapidly. Patients should be allowed to resume normal activity only gradually. Suitable restrictions must be imposed for the first 2 weeks. The diet should soon be liberal. Most patients can be expected to return to duty in about 30 days.

6. PREVENTION. *a. Isolation.* Patients and proved carriers should be strictly isolated. Special care must be taken in the disposal of excreta and vomitus and all articles which are contaminated by them. Patients' clothing, bedding, and eating utensils should be disinfected by boiling. All attendants should soak their hands in an antiseptic solution and wash them with soap and water *immediately* after handling patients or any article contaminated by them. A cholera ward should be screened and remote from any general source of water and from any mess or kitchen.

b. Foreign quarantine. Cholera is a quarantinable disease as defined in intenational sanitary codes. Military personnel found or suspected to be infected with cholera are subject to the provisions of such international sanitary regulations except, of course, as their application may be modified by martial law or by the necessity of the military situation. Traditional practice provides for detention of cases and suspects traveling internationally by boat or aircraft until the individual is determined to be uninfected. Decisions are ordinarily based upon physical inspection, evaluation of contact history, epidemiology of the disease in areas departed, and stool examinations when indicated. Freedom of the stool from cholera vibrios is usually required for release from detention. U. S. Army policy considers that effective immunizations, conditions of sanitation in military carriers and stations, and the constant medical surveillance maintained over personnel traveling in military traffic are adequate guarantees, and that evidence of valid immunization and freedom from symptoms of cholera at the time of travel may be taken to fulfill quarantine requirements without further ado, in order to avoid delay en route.

c. Immunizations. (1) Although cholera vaccination is of proved value, reliance must not be placed upon vaccination as the sole means of preventing cholera. Vaccination is definitely secondary in value to sanitary measures for protection of water and food. These measures must be applied vigorously, even though all personnel are immunized against cholera.

(2) Cholera vaccination is required for personnel stationed in or traveling to or through Asia, including the area around the Persian Gulf, the Philippines, the islands of the East Indies and far western Pacific. It may be required in other areas at the direction of The Surgeon General, or at the discretion of the local surgeon when danger from cholera exists. Initial vaccinations consists of two subcutaneous injections of cholera vaccine at a 7- to 10-day interval. The first dose is 0.5 cc and the second dose 1.0 cc; stimulating doses of 1.0 cc should be administered every 4 to 6 months during danger of infection. Additional doses of 1.0 cc each will be given whenever in the opinion of the surgeon stimulation of immunity is indicated (see par. 4*g*, TB MED 114).

d. Water supply. When the danger of cholera exists, particular care should be exercised to safeguard water supplies. In the case of fixed installations, a special sanitary survey of the water system should be made by a qualified sanitary engineer, as provided in paragraph 11*a*(3), AR 40-205, unless such a survey has been made within 6 months previously. A chlorine residual of not less than four-tenths part per million (0.4 ppm) will be maintained in the active part of the distribution system at all times, and daily or more frequent tests of the residual will be made. In the case of field supplies, water will be checked to insure maintenance of required chlorine residuals until consumed. Drinking water that, due to its organic or mineral content, can not be effectively chlorinated should be boiled and then chlorinated to protect from subsequent contamination. Whenever possible, water should be coagulated, settled, and filtered prior to use, either in fixed filter plants or by portable or mobile purification units. All personnel should be specifically directed not to consume water except from sources approved by the surgeon.

e. Food and food handlers. Food should be eaten only in authorized places, and other establishments should be declared "out of bounds." Native help should be excluded as food handlers at military installations. Personal hygiene, especially the proper cleansing of hands, should be rigidly enforced for all personnel handling food. Fresh fruits and vegetables must be cooked before being eaten, or else soaked for 30 minutes in a concentrated solution of Compound Germicidal Rinse (1 unit dissolved in 8 gallons of water). Compound Germicidal Rinse is QM Stock No. 51-C-1606. Stool cultures on all food handlers should be made at regular intervals. The importance of reporting any symptoms or signs of an intestinal upset, even one loose stool, should be impressed on all food handlers. Individuals known to have been infected should not be permitted to handle food for a period of 3 months after return to duty and then only after three negative stool cultures have been obtained. Careful attention should be paid to the washing and disinfection of eating and cooking utensils, in accordance with AR 40-205 and changes thereto. If boiling water is not available for disinfection, then after washing and rinsing, the dishes and cooking utensils should be immersed in a solution of Compound Germicidal Rinse (1 unit in 25 gallons of water) for a period of at least 1 minute. After cleansing, dishes and cooking utensils should be air dried. During the drying and storage periods they should be protected from insects and dust.

f. Fly control. The control of flies is especially important in areas where cholera is present. Adequate screening of kitchens, messes, isolation wards, and latrines should be provided and maintained in good repair. Proper disposal of organic waste materials should be enforced to prevent breeding of flies. In the field it is essential that flies be denied access to human feces by flyproof construction of latrines. When native labor is employed, proper latrine facilities should be provided and their use enforced. Destruction of adult flies by the use of insecticides, traps, and swatting should receive close attention, especially in sick wards, kitchens, mess halls, and latrines. DDT may be used to kill adult flies by applying as a residual spray and to kill fly larvae in organic wastes by applying as a spray or powder. Residual spray (5 percent DDT in kerosene, QM Stock No. 51-I-305) applied to surfaces on which flies commonly rest will remain lethal to flies alighting on such surfaces for 2 or more months. The recommended rate of application is 200 mg per square foot (1 quart per 250 square feet). Screens, walls, ceilings, light fixtures, garbage racks, and latrines should be treated. To kill fly larvae in pit latrines, it is recommended that DDT residual spray be applied evenly over the fecal contents at the rate of 2 ounces per latrine box hole (½ ounce per square foot). Or, 1 ounce of 10-percent DDT powder (Larvicide, DDT powder, dusting, QM Stock No. 51-L-122) may be used (¼ ounce per square foot). This treatment should be repeated twice a week unless local experience indicates that less frequent application will suffice.

[AG 300.5 (31 Jan 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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For explanation of symbols, see FM 21-6.

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TB MED 137

WAR DEPARTMENT TECHNICAL BULLETIN

PHYSICAL RECONDITIONING FOR BED AND WARD PATIENTS

War Department, Washington 25, D. C. • • • January 1945

This bulletin follows TB MED 136, subject, "Avoidance of Relapses of Vivax Malaria by Use of Suppressive Medication." Distribution given TB MED 136 was as follows: AAF (5); AGF (5); ASF (2); T of Opns (25); S Div ASF (1); Dept (5); Base Comd (5); Is Comd (5); AAF Comds (55); Arm & Sv Bd (2); Def Comd (5); Tech Sv (2); Sv C (10); Named & Numbered GH (60); Numbered GH (NP) CZ (45); Named SH (Including RH & Numbered SH) (40); M Conc C (55); Gen Disp (ZI) (10); Fld H (15); H Tn (2); H Ship Plat (5); H Ship Complements (15); Conv Ctr (15); Conv Camp (10); Vet Gen H (10); Vet Sta H (10); Vet Evac H (5); Vet Conv H (5); Portable Surg H (5); Evac H (750 bed) (40); Evac H (SH-400 bed) (30); Conv H (20); Gen & Sp Sv Sch (5); Enlisted Techn Sch 8 (1); USMA (2); ASTPU (3); ROTC (2); Army Med Tng C (60); Ind Stat (10); Sv C Lab (5); A (5); GHQ (5); D (55); AF (55); One copy to each of the following: T/O & E 3-25; 4-45; 4-145; 4-232; 5-35; 5-72; 5-95; 5-275; 6-35; 6-55; 6-65; 6-75; 6-95; 6-175; 6-325; 6-355; 6-365; 6-395; 7-85; 9-12; 11-25; 17-55; 17-125; 18-25; 19-35; 20-42. Two copies to each of the following: T/O & E 2-22; 4-152; 4-260-1; 5-386; 5-535S; 6-12; 6-45; 8-22; 8-26; 8-520; 9-35; 9-76; 10-22; 10-165; 10-217; 11-15; 17-15; 18-10-1; 18-35; 19-55; 20-46; 44-15; 44-25; 44-75; 44-115; 44-125; 44-225S; 44-315; 55-120-1. Three copies to each of the following: T/O & E 5-192; 7-95; 8-27; 10-45; 10-175; 17-115; 44-135; 44-320; 55-110-1; T/O & E 5-21 (5); 5-251 (6); 5-510S (35); 8-28 (10); 8-510 (15); 8-534 (5); 8-537T (15); 8-550 (60); 8-550S (45); 8-560 (40); 8-572S (5); 8-580 (40); 8-581 (30); 8-590 (20); 8-591T (15); 8-595 T (10); 8-650 (10); 8-750 (10); 8-760 (10); 8-780 (5); 8-790 (5); 10-95 (7); 10-125 (6).

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1. PURPOSE. This bulletin has been prepared for the guidance of all medical officers who are responsible for prescribing and supervising physical reconditioning activities for convalescent patients in Army Service Forces hospitals. Because the application of an exercise program to bed and ambulatory patients (classes 4 and 3) is new and because most medical officers have in the past paid little attention to the therapeutic value of remedial and conditioning exercises to speed recovery, this bulletin is provided.

2. MEDICAL OFFICERS' RESPONSIBILITY. *a.* Physical reconditioning is part of the convalescent treatment of patients. It is the responsibility of the medical officers charged with the professional care of these patients to prescribe appropriate physical reconditioning activities as early in convalescence as sound medical judgment permits. Constant attention

should be directed to advance the convalescent patient in physical activities as rapidly as the clinical progress of each case permits, for progressive increase in the amount of physical activity of patients is essential if convalescence is to be shortened.

b. The responsibility of medical officers for patient reconditioning makes essential their understanding of the purposes and scope of this program. Each ward officer is responsible for the operation of the prescribed reconditioning program on his wards. Patients must be made to feel that physical exercise is an essential part of their medical care. The ward officer must therefore prescribe each inidvidual patient's participation and provide continuous professional supervision of this activity.

c. To assist medical officers, a scientifically developed program of physical reconditioning activities has been prepared by The Surgeon General. Qualified officers and enlisted men specifically trained in the techniques of physical reconditioning are being assigned to all Army Service Force hospitals to implement the program. The utilization of this program and personnel by all medical officers is essential.

3. ADMINISTRATION OF BED AND WARD AMBULANT EXERCISES. *a*. Bed exercises should be started as soon as each patient has recovered from the acute stages of illness, injury, or operative procedure. Surgical and orthopedic patients should participate in exercises which do not involve the region of disability. Medical cases rarely show such limitations. The first objective of the bed exercises is to *maintain*, to the largest extent possible, the level of physical condition which was present when the disability was incurred. It is frequently possible to improve this initial status. The earlier the exercises commence the lesser is the effect of the atonic and atrophic processes accompanying recumbent bed rest on the normal physiological balance of the skeletal, muscular, and the cardiovascular systems.

b. All patients should start with exercises which are within their physiological tolerance. From that point the dosage should be gradually and progressively increased. The chief precaution which must be exercised is not to increase the dosage suddenly. By small increments of physical activity each day, the patients can be brought to a point in 2 weeks where they are taking a reasonable dosage with complete safety.

c. (1) For most reconditioning exercises, the *length of time* an activity is performed provides an adequate index of dosage if the *intensity of participation* is maintained at approximately the same level from day to day. For conditioning exercises, however, another method of measuring the amount of exercise is available. To utilize this method it is necessary to employ the *same set of exercises* for the period of time a patient is in each class or grouping. No one can measure the dosage of activity with accuracy when new exercises are utilized every day.

(2) When the same group of exercises is employed over a period of time, the amount of activity is easily measured by the *cumulative count*. The cumulative count is a method of indicating the number of repetitions of an exercise on the last numeral of an exercise. Thus: 1–2–3–1; 1–2–3–2; 1–2–3–3; etc. All four-count exercises in the set are repeated the same number of times. Thus, the first day's dosage for bed patients will be four repetitions of each exercise. After 2 or 3 days the number of repetitions is increased to five. Thus the amount of activity can be steadily and progressively increased.

d. The amount of muscular development resulting from exercise is in direct proportion to the demand made upon the organism. The nearer the exercise approaches the limit of a patient's tolerance the more rapid will be his development. Unless the patient takes a progressively greater dosage of activity, his physical condition will not improve. The increase in dosage is accomplished by increasing the cadence or the load borne, or both. For example, in conditioning exercises the exercises should be performed at a more rapid cadence, or more repetitions of each exercise should be executed, or both.

e. There are great individual variations in physical condition among convalescent patients. Some soldiers will have been in very good condition before they were hospitalized, others will not have attained satisfactory condition. Some will have been injured very severely, others will have experienced relatively minor injuries or illnesses. All such types may be located in the same hospital ward and may have to be exercised at the same time. To adapt to these varying conditions, the reconditioning personnel will individualize the exercise program in accordance with the prescription of the medical officer.

4. TIME ALLOTMENT. *a.* Bed patients require a minimum of 30 minutes per day of physical reconditioning activities. The recommended time allotment is 45 minutes per day divided into two periods. Unless contra-indicated, patients should be encouraged to spend additional time in exercise. Wherever possible, the time devoted to physical activity should be spread over two periods per day. The time required for remedial exercises should be in addition to that indicated above.

b. Ward ambulant patients require a minimum of 60 minutes per day of physical activities. They should be given every opportunity and encouragement to spend additional time in exercise. Where facilities are available they should go to the gymnasium or outdoors for physical activity.

5. NATURE OF PROGRAM. The over-all physical reconditioning program has two aspects, the *general* and the *remedial*. The purpose of the general exercise program is to build up the general physical condition of patients by means of conditioning exercises, guerrilla and log exercises, grass drills, running, games, athletics, and various gymnastic activities. The remedial exercise program consists of individual exercises with and without apparatus, designed to promote recovery and to restore functions of injured or diseased tissues.

6. CONTENT OF BED AND WARD AMBULANT PATIENT PROGRAMS. *a. Program for bed patients.* The activities available for bed patients are limited largely to conditioning exercises and resistance and spring exercises. The use of resistance exercises and exercises on spring exercisers to supplement the bed calisthenics is strongly recommended.

b. Program for ward ambulant patients. A wider variety of activities is available for hospital ambulatory patients. In addition to the activities used for bed patients which are available, various exercises with apparatus, such as the rowing machine, bicycle, pulley weights, Indian clubs, punching bags, medicine balls, dumbbells, bar bells, and the like may be used. A wide variety of the milder sports and games, such as horseshoes, shuffleboard, table tennis, archery, croquet, golf putting, volleyball, softball, and the like, may be employed to advantage. Where facilities are available, swimming is an excellent activity for many of this group.

7. CONDITIONING EXERCISES FOR BED AND WARD AMBULANT PATIENTS. *a.* Conditioning exercises (calisthenics) are excellent activities for developing strength and they are adaptable to the varying levels of condition and the different disabilities encountered, they can be regulated for dosage and progression, and they are readily adaptable to the hospital situation.

b. The conditioning exercises are arranged in "set" drills. A "set" drill is one which exercises all important muscle groups of the body and is to be repeated many times. The use of such drills eliminates the great waste of time associated with the necessity for teaching new exercises. It greatly facilitates the work of the medical officer in prescribing exercises, the nature and dosage with which he is familiar. The use of set drills also simplifies the problem of leadership, particularly when patients and ward attendants are used in this capacity. Unless a set drill is used, it is virtually impossible to increase the dosage of activity in a gradual and progressive manner.

c. The drills recommended for bed and ward ambulant patients have been scientifically selected and evaluated. Each drill consists of seven exercises. After having been executed once *all 7 are to be repeated immediately*, making a drill of 14 exercises. The exercises selected cover the principal muscle groups of the body and unless the exercises are repeated, the dosage of activity is insufficient.

d. Because of the fact that patients with specific surgical disabilities will frequently be prevented from engaging in certain of these exercises, alternative exercises are provided. One or the other of the two exercises can be executed unless the patient suffers multiple injuries. The patient should not be permitted to be inactive because of a local disability; he should perform the alternate exercise.

e. Each exercise of the set drills has a short name. After the exercises have been learned they will follow one another in sequence. The instructor calls out the next exercise by its name, puts the group in the proper starting position, and proceeds. If necessary, the instructor may demonstrate each exercise quickly to refresh the memory of the patients. The cadence should be counted, preferably by the ward attendant, a patient, or an assistant if one is available. The instructor should move about among the patients, give suggestions, and exercise supervision.

f. Patients in subclassification classes in *4C* or *3C* should stop on each exercise after *four* repetitions (of four counts each). Patients in classes *4B* or *3B* should stop after *8* repetitions. Patients in classes *4A* or *3A* should do *12* repetitions. (Subclass C is minimum, A is maximum.)

g. Exercises that are alternative to the regular exercises are given under the same number, with the addition of "A" (for alternate). Thus, exercise 4A is the alternate for exercise 4 when the latter cannot be done because of some disability.

h. Exercises will be executed in good form and with vigor. The instructor will set a good example and will insist upon enthusiastic and accurate participation upon the part of the patients.

8. CONDITIONING DRILL FOR BED PATIENTS.

1. RAISE AND PUSH.

a. Starting position: Lying on back, hands grasping the sides of the head of the bed about 8 inches above the level of the mattress.

b. Cadence: Slow.

c. Movement:

(1) Push down toward the floor with the hands, pushing hard enough to lift head and shoulders slightly from the bed, but without assisting this movement with the abdominal or thigh flexor muscles.

(2) Recover to starting position.

(3) Push with both hands overhead in a direction away from the feet, and at the same time pull the hands together inward toward the middle line of the bed.

(4) Recover to starting position.

The principal muscles used in this exercise are the shoulder muscles and those of the upper back which adduct the upper part of the shoulder blades (upper and middle trapezius and rhomboids). The other muscles of the arms and forearms are used secondarily.

1A. ALTERNATE LEG RAISER. *a. Starting position:* On back, feet together.

b. Cadence: Moderate.

c. Movement:

(1) Raise left leg upward to the vertical.

(2) Lower left leg and at the same time raise right leg to the vertical. Knees should not be bent.

(3) Lower right leg and raise left leg to vertical.

(4) Lower left leg and raise right leg to vertical. (On last *repetition* finish with both legs on bed.)

The principal muscles used in this exercise are those of the thigh flexors (ilio-psoas, rectus-femoris, and tensor fascia femoris). Secondarily, the abdominal muscles are used to fix the pelvis.

2. LEG STRETCHER.

a. Starting position: On back with pillow doubled and placed under the knees, arms by sides, feet together.

b. Cadence: Moderate to slow.

c. Movement:

(1) Straighten knees and point toes downward forcibly resting knees on pillow, and grip hands hard.

(2) Recover to starting position, stretching fingers hard.

(3) Straighten knees hard and raise toes, pushing forward hard with heels, and grip hands hard.

(4) Recover to starting position, stretching fingers hard.

The principal muscles used in this exercise are those which extend the knees, and which extend and flex the foot and the muscles of the forearms and fingers. If there is disability to one foot or leg, this exercise will not be executed on that side.

3. SHOULDER BLADE SQUEEZER.

a. Starting position: On back, arms forward (towards ceiling).

b. Movement:

(1) Swing arms sideward and backward, and press arms hard against the bed.

(2) Relax slightly, and press again.

(3) Press back again.

(4) Return to original position.

3A. CHEST RAISER.

a. Starting position: On back, fingers interlaced behind head.

b. Cadence: Moderate.

c. Movement:

(1) Patient raises chest forcibly and inhales deeply, and presses backward against bed with head and arms. At the same time, he contracts all of his back muscles and extends toes downward hard.

(2) Recover to original position.

(3) Repeat count one.

(4) Recover to starting position.

4. CURL AND TWIST.

a. Starting position: On back, arms by side, feet separated about 2 feet.

b. Cadence: Moderate.

c. Movement:

(1) Raise head and shoulders from floor, raising right shoulder the higher, touching left knee with right hand, and at the same time raising left leg off ground about 6 inches.

(2) Recover to starting position.

(3) Repeat first count to other side.

(4) Recover to starting position.

The principal muscles used in this exercise are those of the abdomen and those which flex the thigh. If it is impracticable to lie on the ground to do the curl and twiht, the following exercise may be substituted for it:

4A. FOOT SUPINATOR.

a. Starting position: Lying on back, fingers laced behind head, toes pointed downward.

b. Cadence: Slow.

c. Movement:

(1) Bend ankles inward until soles of feet are together, knees very slightly bent, and press soles together hard.

(2) Recover to starting position.

(3) Repeat first movement.

(4) Repeat second movement.

The principal muscles used in this exercise are those that supinate the feet, the muscles of the soles of the feet, and the adductors of the thighs. If the patient has recently undergone an abdominal operation, he should press the heels against the bed hard.

5. BRIDGE RAISER.

a. Starting position: On back, knees drawn up, feet about 2 feet apart, fists pressed on pillow on either side of head, elbows elevated, forearms alongside of head.

b. Cadence: Moderate to slow.

c. Movement:

(1) Raise trunk from bed, resting weight solely on head, fists, and feet. Hips should be raised until the body is approximately straight from shoulders to knees.

(2) Recover to starting position.

(3) Repeat count one.

(4) Recover to starting position.

The principal muscles used in this exercise are the extensors of the whole body, neck, back, hips, and hamstrings. The extensor muscles of the back of the shoulders are also exercised vigorously. If properly executed, this exercise does not contract the muscles of the abdomen.

5A. SPLIT AND CROSS.

a. Starting position: On back, legs raised slightly from the bed and separated widely, knees straight.

b. Cadence: Moderate to slow.

c. Movement:

(1) Swing legs together and cross them as far as possible, left leg above right leg.

(2) Recover to starting position, with legs widely separated.

(3) Swing legs together and cross them, right leg over left leg.

(4) Recover to starting position. On last movement of last repetition, recover to position with legs extended on the bed.

The principal muscles used in this exercise are the flexors of the thighs, the abdominal muscles, and the abductors and adductors of the thighs.

6. HIP SHRUGGER.

a. Starting position: On back, hands behind head, knees fully bent, and feet apart about 18 inches.

b. Cadence: Slow.

c. Movement:

(1) Raise left hip from the bed and "shrug" it up toward the armpit on that side as though trying to bring top of hip bone under the armpit. (The hip movement is like raising one foot from the ground while standing *with both knees straight*).

(2) Recover to starting position.

(3) "Shrug" the right hip upwards toward the right armpit in a similar manner.

(4) Recover to starting position.

The principal muscles used in this exercise are the muscles of the sides of the abdomen (quadratus lumborum, external and internal obliques, and the erector spinae muscles on the side upon which the shrugging movement is made).

6A. KNEE DIP.

a. Starting position: Prone on bed, arms at thrust with fists resting on bed on either side of chest just below the line of the shoulders, knees flexed.

b. Cadence: Moderate to slow.

c. Movement:

(1) Push downward with fists, raising the body in the ordinary push-up movement, but resting on knees rather than on feet. Body is straight from shoulders to knees.

(2) Recover to starting position.

(3) Repeat count one.

(4) Recover to starting position.

The principal muscles used in this exercise are those of the abdomen and the thigh flexors, the muscles on the backs of the arms (triceps), the muscles on the anterior shoulders (anterior deltoid), the muscles on the anterior chest (pectoralis major), and the muscles which pull the scapulae forward (serratus anterior).

7. FOUR-COUNT BREATHER.

a. Starting position: On back, hands on hips.

b. Cadence: Slow.

c. Movement:

Inhale on four counts, taking a deeper breath on each count. Usually the patient will have inhaled fully by the third count, but he should try to inhale further on the fourth count. He then exhales in four counts, again exhaling in "waves" attempting on the third and fourth count to blow all of the air out.

9. CONDITIONING DRILL FOR WARD AMBULANT PATIENTS. These exercises are to be repeated in the same fashion as the class 4 exercises with the exception that the sixth exercise is different when given the second time.

1. NECK FIRM AND ON TOES.

a. Starting position: Standing, fingers laced behind head.

b. Cadence: Slow.

c. Movement:

(1) Pull head and neck backward, raising chest high, and straightening upper back, resisting forcibly with hands. Pull elbows backward, and rise high on toes.

(2) Recover to starting position.

(3) Repeat count one.

(4) Recover to starting position.

The principal muscles used are those of the arms and shoulders, of neck and upper back, and the calf muscles. Individuals with arm or shoulder disabilities will use the good arm; or if both arms are incapacitated, will execute the head, back, and on-toes movement without use of hands. Individuals with a neck disability will do as much of the movement as is prescribed.

2. SQUAT AND UP.

a. Starting position: Hands on hips.

b. Cadence: Moderate.

c. Movement:

(1) Squat fully, placing hands on ground.

(2) Recover to starting position.

(3) Repeat count one.

(4) Recover to starting position.

The principal muscles used are those of the extensors of the knees, the muscles of the buttocks, and secondarily, the extensors of the back. Individuals with any disabilities of knee or hip will modify the movement as much as necessary by separating the feet and squatting principally on one leg, or by going only to a half squat position.

3. SHOULDER BLADE SQUEEZER. (The same exercise as described for class 4, exercise 3, par. 50. This exercise, however, is done in the erect position.)

4. CURL AND TWIST. (The same exercise as described for class 4, exercise 4.)

4. (Substitute) FRONT KICK.

a. Starting position: Erect, arms sideward, palms up, feet together.

b. Cadence: Moderate.

c. Movement:

(1) Raise left leg forward with knee straight until foot is approximately the height of the shoulder, and at the same time swing arms forward, touching foot with hands. The right knee may be somewhat bent.

(2) Recover to starting position.

(3) Repeat count one with right foot.

(4) Recover to starting position.

The muscles used in this exercise are primarily those of the abdomen, the thigh flexors, the abdominal muscles, and the muscles of the shoulders. The muscles of the standing leg are also exercised. For those unable to perform this exercise, the following should be substituted:

4A. STAIR CLIMBER.

a. Starting position: Erect.

b. Cadence: Moderate.

c. Movement: Execute a stationary walk lifting the knees to the height of the hips and swinging the arms normally. Breathe deeply in cadence with the steps, two steps while inhaling, two steps while exhaling. The muscles used in this exercise are about the same as those used in exercise 11 except that they are not used as vigorously. The exercise is designed to permit the respiration and circulation to return to normal gradually at the conclusion of the drill.

5. HIP RAISER.

a. Starting position: Back leaning rest, with buttocks on the ground.

b. Cadence: Moderate.

c. Movement:

(1) Raise hips with knees straight until hips are slightly above a line drawn from shoulders to heels.

(2) Recover to starting position.

(3) Repeat count one.

(4) Recover to starting position.

The principal muscles used in this exercise are the extensors of the back, the hips, and the hamstring muscles on the back of the legs.

5A. BOBBER. (This exercise is used when individuals have an arm or shoulder disability which prevents them resting on their hands in the position of the back leaning rest.)

a. Starting position: Side straddle.

b. Cadence: Moderate.

c. Movement:

(1) Bend forward with knees straight and touch ground between feet.

(2) Relax slightly and "bob" downward again, touching ground from 6 to 8 inches farther forward.

(3) Repeat second count, touching ground still farther forward.

(4) Recover to starting position.

The muscles used in this exercise are principally those of the back and the backs of the hips, and the hamstrings of the legs. In addition to strengthening these muscles, this exercise tends to stretch and thereby slightly lengthen the hamstrings and to make the individual more flexible. *Patients with back disabilities will restrict the amplitude of the movements.*

6. SIDE BEND.

a. Starting position: Side straddle, fingers laced behind the head, chest high.

b. Cadence: Moderate.

c. Movement:

(1) Bend sideward left, keeping knees straight.

(2) Recover to starting position.

(3) Repeat count one to opposite side.

(4) Recover to starting position.

The muscles used in this exercise are primarily those on the sides of the waist (oblique muscles of the abdomen, quadratus lumborum) and the back muscles on the convex side. The thigh abductor muscles on the sides of the hips are also exercised strenuously. (On the second administration, the STATIONARY RUN will be substituted.) If impracticable to do the stationary run because of a leg disability, substitute, for this exercise, hopping on the leg which is unaffected. The principal muscles used will be the same as used in the stationary run, except that they will be confined to the active leg.

7. FOUR COUNT BREATHER. Same as that given under 7 in class 4, except that patient is standing at attention.

10. ADAPTATION OF CLASS 3 AND 4 DRILLS TO DIFFERENT DISABILITIES.

The class 3 and 4 exercises are, with their alternates, adapted to varying physical conditions. The exercises indicated for each condition are given in table I. An asterisk indicates that the exercise is contra-indicated and should *not* be *done* by this class of patient. A dash indicates that the exercise may be done but should not be substituted for the original exercise which is more beneficial.

Table I. Exercises for varying physical conditions

Exercises	Disability					
	Upper extremity	Lower extremity	Abdominal	Back	Intervert. disc.	Pilonidal cyst
CLASS 4 EXERCISES						
1. Raise and Push 1A. Alternate Leg Raiser	(*) 1a	1 (*)	1 (*)	1 or 1a	1 –	1 –
2. Leg Stretcher	2	2	2	2	2	2
3. Shoulder Blade Squeezer 3A. Chest Raiser	(*) 3a	3 or 3a	3 or 3a	3 or 3a	3 or 3a	3 (*)
4. Curl and Twist 4A. Foot Supinator	4 or 4a	4 (*)	(*) 4a	(*) 4a	(*) 4a	(*) 4a
5. Bridge Raiser 5A. Split and Cross	(*) 5a	(*) 5a	5 (*)	5 or 5a	(*) 5a	Elbow ext. Press up [2]
6. Hip Shrugger 6A. Knee Dip	6 (*)	6 (*)	6 (*)	6 or 6a	(*) (*)	(*) (*)
7. Four Count Breather	7	7	7	7	7	7
CLASS 3 EXERCISES						
1. Neck Firm and On Toes	1	1	1	1	1	1
2. Squat and Up	2	Modified 2	2	2	2	(*) Repeat 1
3. Shoulder Blade Squeezer	One arm 3	3	3	3	3	3
4. Curl and Twist 4A. Front Kick 4B. Stair Climber	4 or 4a –	4 or 4a (*)	(*) (*) 4b	4 or 4a 4b	(*) (*) 4b	(*) (*) 4b
5. Hip Raiser 5A. The Bobber	(*) 5a	5 or 5a	5 or 5a	5 –	5 (*)	(*) Repeat (*) 4b
6. (1) Side Bend (2) Stationary Run	6 (1) 6 (2)	6 (1) (*)	6 (1) 6 (2)	6 (1) 6 (2)	(*) 6 (2)	6 (1) 6 (2)
7. Four Count Breather	7	7	7	7	7	7

[1] Pilonidal cyst cases do all class 4 exercises in *prone* position.
[2] Elbow Extension Press Up: Patient lies prone, arms folded and elbows on bed beneath shoulders. Feet are apart about 1½ feet. Patient raises body upward, resting only on forearms and toes. Exercise may be made more severe by moving arms farther forward.

[AG 300.5 (22 Jan 45)]

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For explanation of symbols see FM 21–6.

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TB MED 136

WAR DEPARTMENT TECHNICAL BULLETIN

AVOIDANCE OF RELAPSES OF VIVAX MALARIA BY USE OF SUPPRESSIVE MEDICATION

War Department, Washington 25, D. C. . . . . January 1945

This Bulletin Supersedes Paragraph 8, TB MED 72, 10 July 1944

This bulletin follows TB MED 135, subject, "Function and Scope of Medical Department Laboratories." Distribution given TB MED 135 was as follows: AAF (3); AGF (3); ASF (2); T of Opns (10); T of Opns (Surg) (3); Dept (3); Dept (Surg) (3); Def Comd (3); Island Comd (3); Base Comd (3); S Div ASF (1); Tech Sv (2); Sv C (5); Sv C (Surg) (3); GH (3); Named GH (3); RH (3); SH (3); Conv Hosp (3); Med Techn Sch (1); USMA (2); ASTU (1); Med Lab (3); Sv C Med Lab (5); A (3); CHQ (3); Three (3) copies to each of the following: T/O & E 8-550; 5-550S; 8-560; 8-580; 8-590; 8-591T; 8-595T

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1. GENERAL. Many individuals infected with vivax malaria who are not taking suppressive medication have relapses of the disease from time to time. The purpose of this bulletin is to expand and clarify current procedures on the management of relapses of vivax malaria. The subject matter is concerned with the use of suppressive medication in individuals who have had attacks of vivax malaria within 6 months and who are not in an area where suppressive medication is in general use. It is not concerned with the use of suppressive medication in organizations which are required by competent authority to take such treatment as a general measure (see TB MED 65, Drug Suppressive Treatment of Malaria).

2. AVOIDANCE OF RELAPSES. In most instances, general health does not suffer from recurrent attacks, which tend to become shorter and milder. Relapses are considered to be unusual after 2 years from the date of infection and rare after 3 years. However, recurrent attacks often interfere with military efficiency, interrupt leave or furlough, or hinder necessary medical or surgical treatment. If relapses are frequent and numerous, they may impair morale. Proper administration of suppressive medication is highly effective in preventing acute attacks. It is impracticable, however, to use this procedure in an endeavor to prevent all relapses in the United States and other well sanitated areas.* Suppressive medication should be used, however, in numerous individual instances in which the avoidance of relapses is particularly desirable. It is recognized that administrative arrangements designed to insure the regular taking of suppressive medication for this purpose cannot be made in many instances. Nevertheless, the probable gain from

* War Department Circular No. 449, 1944, requires that personnel who are still taking suppressive medication upon return to this country from oversea areas continue to take such treatment for a period of 28 days after arrival in the United States.

this use of suppressive medication is considered to justify its recommendation. It should be understood that this treatment is not regarded as curing or tending to cure vivax malaria. No treatment is known which will eliminate the infection with certainty. The following paragraphs describe the usage which is advised for the avoidance of relapses of vivax malaria in individuals who are not in an area where suppressive medication is in general use.

3. INDICATIONS. *a. Prolongation of interval between attacks.* Following completion of regular treatment for an acute attack of vivax malaria (as described in pars. 4 and 5, TB MED 72), it is often desirable to insure an intermission of sufficient length to permit individuals fully to regain their health and, if they are otherwise fit, to resume military duties. Clinical treatment of vivax malaria, therefore, in many cases should be followed immediately by suppressive medication which should be continued for 3 months, unless contra-indications arise. Patients whose sole diagnosis is malaria should be disposed of by return to a duty status as soon as their condition warrants such action (without reference to the completion of suppressive medication). Commanding officers should be notified of the instructions regarding suppressive medication which have been given to patients.

b. Presence of conditions other than malaria. Patients who have not recently had an attack of vivax malaria, but who are known to have had an attack within 6 months and who are under treatment for injuries or other diseases than malaria, should receive suppressive medication for 1, 2, or 3 months, according to the circumstances of the individual case, unless contra-indications exist.

c. Assignment to oversea service (see par. 10*a*, TB MED 72). Commissioned officers and warrant officers who are selected for oversea assignments and who are known to have had an attack of vivax malaria within 6 months should be given suppressive medication to enable them to carry out such assignments. This treatment should be continued for at least 3 months. (Enlisted personnel are disqualified for oversea service until a date 6 months subsequent to that of recovery from an attack of malaria or of disappearance of malarial parasites from the blood.)

4. PRECAUTIONS. Care should be taken not to prescribe as a suppressive a drug to which an individual is known to be sensitive. Personnel given suppressive medication should receive thorough indoctrination in the need for regularity in taking the drug. They should understand the potential danger of overdosage. They should be instructed to report at once to a medical officer or, if necessary, to a civilian physician, in case they develop any illness or unusual symptoms. However, they should be informed that yellow discoloration of the skin frequently occurs when atabrine is taken and that this in itself is no cause for alarm. In order that they may not develop a false sense of security, they should know that further attacks of malaria may occur after they cease taking the drug (although attacks will not necessarily develop).

5. DRUGS AND DOSAGES. *a.* Atabrine is the drug of choice, but in cases of intolerance to atabrine, quinine may be substituted for it (see par. 2, TB MED 72).

b. Atabrine dosage. If no atabrine has been taken for 3 weeks or more, "loading doses" of 0.1 gm (1½ grains) 3 times a day for 3 days should be given at the start. This should be followed by a daily dose of 0.1 gm (1½ grains). Each dose should be taken with a full glass of water, after a meal.

c. Quinine sulfate dosage. Daily doses of 0.6 gm (10 grains), taken with a full glass of water, after a meal.

[AG 300.5 (20 Jan 45)]

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For explanation of symbols, see FM 21-6.

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TB MED 134

WAR DEPARTMENT TECHNICAL BULLETIN

DATA ON MALARIA CONTROL

War Department, Washington 25, D. C. • • • January 1945

This bulletin follows TB MED 133, subject, "Suspension-Traction Treatment of Fractures." Distribution given TB MED 133 was as follows: AAF (5); AGF (5); ASF (2); T of Opns (25); S Div ASF (1); Dept (5); Base Comd (5); Is Comd (5); AAF Comds (55); Arm & Sv Bd (2); Def Comd (5); Tech Sv (2); Sv C (10); Named & Numbered GH (60); Numbered GH (NP) CZ (45); Named SH (Including RH & Numbered SH) (40); M Conc C (55); Gen Disp (ZI) (10); Fld H (15); H Tn (2); H Ship Plat (5); H Ship Complements (15); Conv Ctr (15); Conv Camp (10); Vet Gen H (10); Vet Sta H (10); Vet Evac H (5); Vet Conv H (5); Portable Surg H (5); Evac H (750 bed) (40); Evac H (SH-400 bed) (30); Conv H (20); Gen & Sp Sv Sch (5); Enlisted Techn Sch 8 (1); USMA (2); ASTPU (3); ROTC (2); Army Med Tng C (60); Ind Sta (10); Sv C Lab (5); A (5); GHQ (5); D (55); AF (55); One copy to each of the following: T/O & E 3-25; 4-45; 4-145; 4-232; 5-35; 5-72; 5-95; 5-275; 6-35; 6-55; 6-65; 6-75; 6-95; 6-175; 6-325; 6-355; 6-365; 6-395; 7-85; 9-12; 11-25; 17-55; 17-125; 18-25; 19-35; 20-42. Two copies to each of the following: T/O & E 2-22; 4-152; 4-260-1; 5-386; 5-535S; 6-12; 6-45; 8-22; 8-26; 8-520; 9-35; 9-76; 10-22; 10-165; 10-217; 11-15; 17-15; 18-10-1; 18-35; 19-55; 20-46; 44-15; 44-25; 44-75; 44-115; 44-125; 44-225S; 44-315; 55-120-1. Three copies to each of the following: T/O & E 5-192; 7-95; 8-27; 10-45; 10-175; 17-115; 44-135; 44-320; 55-110-1; T/O & E 5-21 (5); 5-251 (6); 5-510S (35); 8-28 (10); 8-510 (15); 8-534 (5); 8-537T (15); 8-550 (60); 8-550S (45); 8-560 (40); 8-572S (5); 8-580 (40); 8-581 (30); 8-590 (20); 8-591T (15); 8-595T (10); 8-650 (10); 8-750 (10); 8-760 (10); 8-780 (5); 8-790 (5); 10-95 (7); 10-125 (6).

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1. INTRODUCTION. The purpose of this bulletin is to inform malaria control personnel in the field of current observations and data which are of particular interest and value. It must be emphasized that this information is not to be construed in any way as directive.

2. CONTROL METHODS. *a. DDT residual spray.* (1) A large-scale practical test was made at Stuttgart, Arkansas, by U. S. Department of Agriculture and U. S. Public Health Service investigators to determine the duration of effectiveness of a single application of DDT residual spray to the interior of buildings and under bridges and culverts against the general population of *Anopheles quadrimaculatus* in the vicinity. Buildings and out-of-doors anopheline resting places in two areas, each 3 miles square, were sprayed with 5-percent DDT solution, one at the rate of 56 mgm per square foot and the other at the rate of 208 mgm per square foot. The anopheline population in these areas was compared with that in two similar nearby untreated areas. Results obtained showed definitely that the treatment greatly reduced the number of adult mosquitoes remaining indoors during the daytime. Most of the mosquitoes which were collected at closed windows or on screens as they attempted to leave treated resting sites died within 24 hours. The treatment remained effective against adults over 2½ months with either dosage. Extremely significant was the observation that dipping records showed a 60-percent reduction of anopheline larvae in the treated areas. Counts of adults resting in untreated nail kegs scattered throughout both the treated and untreated areas showed little or no reduction in the treated areas, but this may have been due to migration.

(2) A report from the Mediterranean theater provides data on the persistence of toxicity to mosquitoes of a single application of DDT in buildings. Effective control of adult mosquitoes entering human and animal quarters was obtained for a period of 80 days after treatment of the inside surfaces with 5-percent DDT in kerosene at the rate of 60 mgm of DDT per square foot of surface sprayed. For 105 days after treatment with the above dosage, the kill of 100 adult *Anopheles labranchiae* released in treated rooms was complete in those remaining closed and fluctuated around 90 percent in a room with the windows left open. Treatment with 5-percent DDT in kerosene at the rate of 60 mgm of DDT per square foot gave more effective control of adult anophelines in human and animal quarters than treatment with 10-percent powder in which only 20 mgm of DDT per square foot adhered to treated surfaces. From extensive trials at an African base it was found that DDT in solution with kerosene, when applied at the rate of approximately 150 mgm per square foot to interior surfaces of grass and reed type of native dwellings, will maintain a residual killing effect on anopheline adult mosquitoes, namely, *A. gambiae* and *A. funestus*, for a period of at least 9 weeks.

(3) A striking residual effect of DDT on *Anopheles gambiae* adults has been demonstrated in controlled field tests performed in West Africa. Huts located on one side of a road dividing a native village were treated with a 5-percent solution of DDT in kerosene at a dosage of approximately 100 mgm of DDT per square foot. Dwellings located on the opposite side of the road were left as untreated controls. Comparison of anopheline collections in the huts prior and subsequent to application of DDT showed an almost complete reduction in the treated huts which persisted for the 10-week period during which checks of the village were made, while counts in the control group remained high. Similar reduction of *A. gambiae* adults was demonstrated in studies of several other native villages treated with DDT residual spray.

(4) The following is abstracted from a report of tests with DDT residual sprays applied to jungle-like areas in Florida against adults of *Aedes taeniorhynchus* and *A. sollicitans* which were carried out by the U. S. Department of Agriculture at its Orlando, Florida, laboratory.

(*a*) In tests with residual type sprays for long-term mosquito reduction 5-percent DDT in No. 2 fuel oil was applied to the ground and foliage with hand equipment at the rate of 3, 5, and 10 gallons per acre. These treatments were equally effective for more than 17 days after application, giving 91, 87, and 88 percent reduction, respectively, as compared with the mosquito population outside the plots. After this time, however, the 3-gallon-per-acre dosage began to lose its effectiveness quite rapidly. There appears to be no difference between applying the spray to the foliage or to the ground alone. Results obtained within a ½-acre plot protected by a surrounding 100-foot barrier treated at the rate of 10 gallons per acre indicate that this method may be effective in protecting an inner untreated area, particularly against species of anophelines which have a short flight range.

(*b*) In tests to determine the amount of temporary reduction of adult mosquitoes following application of finely atomized sprays, it was found that over 90 percent reduction in 1 hour was obtained with a solution containing 5 to 10 percent DDT or 0.75 percent pyrethrins applied at the rate of 240 milliliters per acre with a hand-operated DeVilbiss paint sprayer. Ninety-three percent reduction was obtained with as little as 67 ml of 20-percent DDT solution, but it is difficult to obtain complete coverage of an acre with such small dosage. Although the above results were obtained against salt marsh mosquitoes, it was felt that similar results may be expected against anophelines and other mosquitoes that rest in vegetation.

b. Larvicidal methods. (1) A South Pacific base reports a significant economy of labor and Diesel oil by the use of DDT. A sanitary company, equipped with flit guns, found that its monthly output of DDT-oil solution over a stipulated area was 150 gallons. This amount was 10 percent of the volume of plain Diesel oil formerly required to cover the same area with knapsack sprayers. Other advantages were the decreased weight carried by each field man and the less frequent filling of sprayers and replenishing of oil depots.

(2) Two malaria control units report the formation of a DDT flit gun squad to treat ground pools and the use of M-20 smoke tanks adapted for the ground application of Diesel oil (see par 4*d*, TB MED 87). The crews using flit guns devote their attention to areas with numerous isolated breeding sites, supplementing the work of knapsack sprayer oiling crews. The M-20 smoke tank was used by a hand-spraying crew to expedite coverage of easily accessible pools. The M-20 smoke tank with an air pressure of 65 to 70 pounds will dispense 40 gallons of oil. Ordinarily this was sufficient for a half day's operations.

(3) Bags of burlap filled with sawdust and soaked in a 5-percent solution of DDT in Diesel oil were used at a Pacific island base for control of small pools which could not otherwise be eliminated economically. These were placed in the pool of water and left for as long as the water remained. One bag per 200 square feet of water surface was found to be adequate to control larval breeding for many weeks without additional oiling. In another area, oil-soaked coconut husks were placed in coral rock crevices and water impounded in tire ruts, borrow pits, and other natural or artificial water collections. The husks, which are first dried out and then soaked in malariol with a small amount of castor oil to increase its spreading power, release sufficient larvicide to produce a complete film on the water surface. The husks absorb four times their weight of oil and acts as a reservoir to renew the surface film when it is removed by heavy rainfall.

(4) In studies carried out at Guadalcanal, the most practicable and efficient dispenser for DDT larvicidal mixtures was found to be the "flit-gun" type of hand sprayer equipped with an atomizing nozzle (QM Item 41-S-4106, Sprayer, liquid, insect, continuous spray). The knapsack and decontamination sprayers fitted with garden spray nozzles were less suitable. The following statements are taken from a report of the studies:

The effectiveness of a DDT oil mixture is dependent upon two things, namely (1) the type of dispenser used and (2) the manner in which the dispenser is operated. Assuming that the "flit-gun" type of atomizing hand sprayer is the most practicable for use by malaria control personnel, it is of utmost importance that they be instructed in its proper use. This is best accomplished by the demonstration method of instruction. The spray applied in the absence of a breeze will cover a swath of approximately 12 feet; with a slight breeze (about 3 mph) a swath of about 30 feet. This area will have a film sufficiently toxic to kill all of the larvae present. Therefore, it is obvious that good judgment must be exercised by the operator in using a sprayer of this type. In some cases it is possible to stand at one spot, operate the sprayer for a few seconds and watch the drift of the material, then walk to the point where the vapor was last observed and commence spraying again. This film is often perceptible on the surface of the water by the "rainbow-like" effect; however, it is not necessary to see this in order to have a toxic film present. Another method is to walk rapidly along the breeding area operating the sprayer continuously, spraying with the wind. This method, of course, gives very complete coverage and also an overdosage of the area, resulting in a waste of material.

(5) Studies conducted on the larvicidal effect of ground spraying with 5-percent DDT in malariol on malaria vectors in India indicated that this method of control gives excellent results. The tests covered typical *Anopheles minimus* habitats, as well as those of *A. philippinensis*, *A. sundaicus* and *A. subpictus*. By applying an even distribution of the larvicide at the rate of 1 quart to an acre, an average kill of 98.5 percent of anophelines was obtained for all experiments except those done on running water. A kill of 100 percent was obtained on all still water habitats where atmospheric conditions did not interfere with the experiments. Heavy rains after the spraying reduced the rate of kill by dilution of the strength of DDT or by washing it away. A dosage of 1 quart to an acre was not effective against *A. minimus* in streams. Control of such habitats required application at the rate of 4 to 6 quarts to the acre. The killing time of the larvicide was longer for culicines than for anophelines. This was particularly true of *Culex fatigans*.

(6) The following note on vertical drainage is taken from a South Pacific news letter:

The elimination of road ruts has been aided by a unique type of vertical drainage that has been called "the divining rod in reverse action." The ruts average 6 inches in depth and are waterfilled much of the time. Elimination is done by crews of hand laborers. Two men head the crew, with a drill-like rod about the diameter and weight of a crowbar but 8 to 9 feet in length. The rod is forcefully driven down through the water and thin layer of soil into the soft coral beneath. A single strong blow will often sink the rod to a depth of 6 feet or more, and as much as 20 gallons of water will drain away in a few minutes. Large pools holding several hundred gallons of water have been rapidly drained by multiple holes. The space thus freed of water is filled in by other members of the crew and the road is closed to further traffic.

c. Airplane spraying. (1) During a epidemic of dengue fever among troops on Saipan, airplane spraying of DDT was employed and played a significant role as an adjunct to other sanitary measures which reduced the mosquito population and resulted in a rapid decrease in the incidence of the disease. A C-47 type plane was used and the spray disseminated by an improvised arrangement of a series of oil drums connected to an M-10 smoke tank, the outlet of which served as a spray nozzle. A pay load of over 300 gallons of spray was obtained with this equipment. Seven 55-gallon oil drums lying horizontally were secured in the plane and connected in parallel by a 2-inch pipe which passed through the floor of the plane, then through an inspection plate being reduced in size to 1½ inches, and into an M-10 smoke tank which was attached beneath the fuselage of the plane by a para-rack. A valve was inserted in the line to control the flow of spray. The leading edge of the para-rack was removed to permit air to enter the M-10 tank through an airway. A modified tailpiece designed by the U. S. Department of Agriculture was prefabricated for the M-10 smoke tank. Glass shields, blast caps, or similar accessories for the smoke tank were not needed. Air vents were placed in each oil drum and a power oil pump was used to fill the drums with 5-percent DDT in kerosene. Flights were made at a speed of 140 mph and at an elevation of 100 feet. With the valve completely open and with little or no wind, the spray was distributed in a swath of 100 yards width at the rate of ¾ quart per acre and the load expended in 20 minutes. A dosage of ¾ quart per acre appeared quite effective. Surveys revealed 75 to 85 percent reduction of adult and larval mosquitoes for 3 to 5 days. Some areas were obviously missed by the plane. Ninety-five percent of caged mosquitoes set out died within 5 hours after spraying. Similarly, evaluation studies showed larval kills of 66 percent in 5 hours to 97 percent in 28 hours after spraying by plane. Heavier dosage was used on other areas and, in all, over 15,000 acres were treated with 8,600 gallons of spray. It was suggested that placing the barrels on end rather than on their side would permit a total of two rows of eight tanks connected in parallel and would increase the pay load to 800 gallons of spray. An increase in the diameter of the pipe leading into the M-10 tank from 1½ to 2 inches would permit greater dosage per acre on a single application.

(2) In a report from the Far East Air Forces, the use of a B-25 plane with a 195-gallon CWS smoke tank (E-1B) is described as follows:

> A new CWS smoke tank, called E-1B, was designed and manufactured in the Southwest Pacific. This tank holds 195 gallons and is mounted in the bomb bay of a low-level bombing B-25-D aircraft. This new type of tank does not have any of the disadvantages of the M-10 smoke tank. It holds almost six times more solution and the spray may be opened up or closed as the terrain demands. A lever at the navigator's seat controls the valve at the outlet. In case of emergency the tank can be released like a bomb. This tank is unquestionably more desirable than the modified M-10 smoke tank insofar as DDT spraying is concerned.
>
> At a speed of 200 air-miles per hour, 100 feet altitude, and about 5 mph wind in the direction of the flight, the E-1B smoke tank mounted in the B-25 will spray effectively an area 4.4 miles long and about 200 yards wide. This coverage may be increased by varying the speed and/or altitude to suit the purposes. A number of B-25's fitted with these tanks may fly in prearranged formation and cover vast territories in one mission. Frequently, the new area to be sprayed with DDT is about a hundred miles or more from the base of operations. With the new E-1B tank it would take only one mission, whereas three or four missions would be required with the A-20 mounting M-10 tanks.

A survey made 1 to 3 days after the DDT aircraft spraying, using B-25's and E-1B tanks, during beachhead operations revealed numerous dead larvae in water collections. Whereas numerous adult mosquitoes were observed by task force personnel prior to spraying, none could be found 3 days after spraying.

(3) A trial was carried out by British investigators on the effects of DDT sprayed by plane on adult and larval *Ades aegypti.* A 5-percent DDT solution sprayed from an M-10 tank carried on a Mustang plane flying at 280 mph at a height of 100 feet and in a wind of 17 mph, covered an area of 165,000 square yards. A sufficient contamination density was obtained to give 100 percent kills of *A. aegypti* adults and larvae. The minimum contamination density of solution sprayed by this method to insure 100 percent kills was 0.1 gm per square meter, equivalent to 0.005 gm per square meter of pure DDT. The spray could not be relied upon to penetrate thick overhead cover.

(4) A report on spraying of a mixture of 5-percent DDT in equal amounts of No. 2 Diesel oil and lubricating oil (SAE No. 10) from an

L4–B Piper Cub airplane equipped with a Husman-Longcoy sprayer at a Pacific island base is of general interest. The mixture was applied at the rate of approximately 1½ quarts per acre, and with the equipment employed about 150 acres could be sprayed in an hour. Three areas were selected, each about 150 acres in size. One area was densely wooded; the second was an open grassy field very much cut up with road ruts; and the third area was composed of both jungle and grassy field terrain. Careful survey was made of each of these areas and flags set up to indicate small pools and ruts breeding mosquitoes. Record was made as to whether they were breeding anophelines, culicines, or both. The three areas were then sprayed by plane and resurveyed within 24 hours. Anopheline larvae were found at only one site and culicine larvae at two others previously marked as breeding places. While this represented almost 100 percent kill, observers at the time of application noted that these sites were missed by the airplane as a result of the pilot deviating from the course. It was believed that with a little more practice by the pilot 100 percent larval kill could be obtained in open grassy land, coconut groves, or in the densely wooded areas. Over the open field the pilot flew at a height of 15 to 25 feet; over the jungle at about 100 to 150 feet. The average width of a single swath was about 40 feet. There were numerous occasions to observe that the spray could effectively penetrate through very narrow openings to produce complete larval kill. Small breeding sites were noted under a heavy canopy of vegetation, yet there was sufficient spray reaching the water surface to kill anopheline and culicine larvae. The plane in these instances had flown over the location at an altitude of 150 to 175 feet.

(5) The following is an abstract of the Second Report on Air Spraying of DDT by a Board of Officers in charge of experimental field trials in Panama of the Husman-Longcoy sprayer mounted in a Cub (L–4) plane:

An area in the lower Chagres Valley along the Chagres River was selected. The experimental plot contained 137 acres and for the most part was covered by second-growth jungle with fairly thick underbrush. Capture stations were located in moderately heavy cover in the experimental area and in a control area about 800 yards up the river. Counts of mosquitoes were made after nightfall for a period preceding and following the test. DDT was applied by spray from a slow low-flying plane in dosages ranging from approximately 0.5 to 0.78 pounds per acre. Spraying was done on two occasions four days apart as early in the morning as light and weather would permit. The formula of the spray used was as follows: DDT, 67.5 lbs.; acetone, 45 lbs.; diesel oil #2, 42 gal.; lubricating oil, SAE 30, 27 gallons. Good penetration of the spray following both applications was evidenced by a 100 percent kill of larvae set out in pans in the test area, whereas no larvae set out in a control area died. Complete kill of larvae was also obtained in natural breeding places in the treated area. A markedly significant reduction in the adult population which averaged from 60 to 90 percent was demonstrated in the treated areas up to one week following the last spraying.

(6) A British experimental unit in West Africa found that by using 3.2 percent DDT solution in M–10 tanks with a 2½-inch vent and flying at 200 to 250 feet elevation with a speed of 200 to 220 mph, 90 percent of the spray fell within a swath 200 yards wide and 1,100 yards long. The penetration of spray through tropical vegetation varied inversely with cover density: 1 percent reached the ground through thick arboreal cover 50 feet high; 25 percent reached the ground through dense 10-foot secondary growth; and 50 percent passed through growing cassava and similar native crops. A dosage of 50 pounds of pure DDT per square mile in an area of heavy arboreal coverage produced an 80-percent reduction of the adult mosquito population but gave erratic control of *A. funestus* larval breeding. Similarly, with a dosage of 250 pounds of DDT per square mile the larval kill was unsatisfactory in breeding places screened by any form of vegetation. With the latter dosage there was a significant reduction for about 1 week in the number of adult *A. funestus* collected in native huts in the area sprayed. To replace the glass, a plastic (Bakelite) rear closure plate was developed for the M–10 tank. This is grooved concentrically near its outer edge, causing it to break cleanly on detonation. It has a hook on the rear side so that the detonator is held against the plate. This eliminates the need for a rear detonator clip, shortens and simplifies assembly procedure, and reduces the probability of incomplete shattering of the rear closure plates. Restriction in the diameter of the discharge orifice of the M–10 tank from 5½ to 2½ inches, obtained by the use of a sheet metal thimble which slips over the standard tail pipe, results in increasing the dis-

charge time from a plane flying about 200 mph from 6 to 9 seconds and distributes the tank load over a strip approximately ½ mile long.

(7) A British report from Italy describes the use of a single 250-pound SCI (smoke curtain installation) tank filled with 3-percent DDT in Diesel oil containing 0.5 percent oleic acid, carried on a Hurricane aircraft. In a flight made at 200 mph and at an elevation of 360 feet in a mean wind of 7 to 10 mph, an area 700 yards long by an indefinite width was sprayed with DDT. In this area a band about 115 yards wide showed a 100 percent kill of *A. maculipennis* larvae. The minimum concentration of this band was 0.5 grams of spray fluid, or 15 mgm of DDT per square meter. Approximately 95 percent kill of larvae was obtained in a band 210 yards wide, situated 100 to 310 yards from the spraying track in which the minimum concentration was 0.15 grams of spray fluid or 4.5 mgm of DDT per square meter. It is probable that significant results were achieved even further downwind, but conditions made dipping impossible. Drop counts at 170 yards downwind of the spraying track gave an average of 6.5 drops per square inch; drop size 0.6 mm, and density 0.9 gram per square meter. There appeared to be little residual effect of DDT in the water, as extensive breeding was observed in all areas 4 days after spraying. It was believed that this was largely due to wind and drift dispersing any residue of DDT left in the water.

(8) Trials were carried out in Southeast Asia to determine the effectiveness of mosquito control provided by DDT aerial spray under field conditions during the monsoon season. Sites selected for the studies were typical areas and camp sites where this method of control would be employed. Breeding places of a number of anopheline species, such as *A. annularis*, *A. subpictus*, *A. sundaicus*, and others were included. It was demonstrated that a substantial reduction of the adult and larval population could be effected for 4 to 14 or more days with a dosage of 2 to 4 quarts per acre of 5 percent (wt/vol) commercial DDT in kerosene, and that the population remained low for a period which, under monsoon conditions, appeared to depend primarily on the rainfall. The fact that the reduction in adult population was maintained for as long as 2 weeks was attributed to the residual effect of the DDT deposited on vegetation. Aircraft fitted with 250-pound SCI tanks (2½-inch orifice) flying low at 185 mph were employed. Since the downwind carry of the spray depends both on the wind speed and the elevation of the plane, it was found that a constant ground distribution could be obtained by choosing a height inversely proportional to the wind speed. With a height-wind product of 1000, an average concentration of solution of 2 U. S. quarts per acre was obtained in a belt 200 yards wide and of a length equal to the distance traveled by the plane while emitting. The majority of the droplets had diameters of from 1 to 0.5 mm and about 75 percent of the spray was recovered in the target area.

(9) (*a*) Reports of field studies on airplane spraying in the Burma-India theater indicate that convection currents, particularly during the intense heat of the day, interfere with obtaining dispersion in proper quantity of DDT-oil solution. Using a P-40 with a CWS M-10 tank fitted under each wing and a third tank in a central position, it was found that the quantities of oil reaching the ground in direct line with the flight varied greatly. Due to the patchy distribution of the spray the adult and larval kills of *A. minimus* and other mosquitoes, although significantly high, were erratic. At 1100 on a sunny day oil was observed in the air at 1,000 feet by the pilot a few minutes after completing the spray run which was accomplished at approximately 150 feet altitude. Convection currents appeared to prevent proper lateral distribution of the spray, but were not believed to be entirely responsible for the very large quantities of oil thrown down at some sites. It has been noted that various types of aircraft have a tendency to throw down oil in different manners due in part to placing the tanks in a position where air flow around the aircraft is a complicated system of eddies. To reduce the effect upon the distribution of spray occasioned by vertical convection currents, it was necessary that spraying be done in the early morn or at dusk when advantageous weather conditions prevailed.

(*b*) A 585-gallon tank was installed in the bomb bay of a B-25 and an emission tube from an M-33 CWS tank fitted with an adjustment valve was attached below the tank for dispersal of the spray. Preliminary tests gave an even dispersal of spray over an area approximately 300 yards wide at a speed of 180 mph and 150 feet elevation. Results obtained from the studies of the distribution of droplets and effect on adult and larval mosquitoes appeared to indicate that the B-25 was a more suitable plane than the P-40 for the dispersion of DDT-oil solution. It was found impossible to gauge the distance between runs from the air, confirming the view that smoke bombs, radio contact, or other systems of communicating information from the ground to the pilot are necessary for efficient operation.

d. Toxicology of DDT and its solvents. (1) *Toxicity of DDT.* The following statement on the toxicity of DDT to humans is taken from a manuscript being prepared for publication:

> The DDT insecticides adopted for use can be safely employed, but it must not be overlooked that DDT is a toxic material. In general, inhalation of dusts, sprays or mists containing DDT should be reduced to a minimum. Whereas dry DDT as used in inert powders is not absorbed through the skin, solutions of DDT in oils and organic solvents can be absorbed through the skin and therefore, unnecessary skin contact should be avoided. For this reason, use of repellents in conjunction with DDT louse powder is not advised; and garments, including DDT dusted or impregnated underwear, accidentally contaminated with oils in the presence of DDT should be changed as soon as practicable, the individual washing himself thoroughly with soap and water. Contamination of food with DDT must be prevented. This is especially important because DDT is a white, odorless and tasteless powder and offers no warning upon ingestion. Storage with food should be strictly prohibited to prevent mistaken identity. Symptoms of DDT toxicity in animals are anorexia, weight loss, hyperexcitability, tremor and convulsions. Signs of liver and kidney disfunction may precede nervous manifestations. Pathological findings in fatal poisoning induced in animals consist in evidence of degeneration of the anterior motor neurons, and may include toxic necrosis of the liver and kidneys.

(2) *Toxicity to humans of certain solvents for DDT.* It has been noted that certain solvents, particularly the halogenated hydrocarbons, have been suggested or employed in the field to increase the solubility of DDT in oil. With some of the solvents in question, such as tetrachlorethylene, carbon tetrachloride, acetylene tetrachloride, benzene, trichlorethylene, and ethylene dichloride, systemic poisoning will occur through inhalation of their vapors and skin contact. Dermatitis may also result from skin contact with these materials (see TB MED 35). In view of their toxicity and the extreme caution required for their handling, they must *not* be used as auxiliary solvents for DDT. Poisoning due to the use of toxic solvents might erroneously be attributed to DDT and excite unfounded apprehension regarding its use.

3. ENTOMOLOGY. *a.* A technique for mounting mosquito larvae which appeared in SCIENCE 99, *206*, 1944, entitled "A Rapid Method for Making Permanent Mounts of Mosquito Larvae," has given very satisfactory results in the field. Larvae are killed in hot water to fix the protein in the body. They are placed in 70 percent alcohol for 10 to 15 minutes, transferred to 95 percent alcohol for 3 to 5 minutes, and then to absolute alcohol for about 5 seconds. After dehydration, the specimens are placed in cresote USP for clearing. Delicate specimens should be treated with 50 percent creosote in absolute alcohol before final treatment with undiluted creosote. Clearing requires only a few minutes. Larvae are then mounted in canada balsam.

b. A new anopheline species, *A. lungae*, has been described by Belkin and Schlosser from the Solomon Islands. The adult female is a medium-sized, yellowish, speckled anopheline with the apical third of the labium yellow. This species can be separated easily from forms of *A. punctulatus punctulatus* and *A. farauti farauti* (syn. *A. punctulatus moluccensis*) in both the male and female and in the larval stages. Seventy individual rearings of larvae established the identity of this form. The larvae of this species are normally found in the jungle in seepage areas, along the margins of streams, potholes in stream beds, dense jungle swamps, and temporary pools. There is a decided preference for shade in its breeding places. Adults are usually found resting in partial shade on tree trunks in the jungle, under logs, and inside boxes, oil drums, nail kegs, and fox holes. Males and females were observed leaving their daytime resting places between 1830 and 1900. The anopheline is apparently not strongly anthropophilic and its normal blood supply is believed to be birds and possibly bats. Seventy percent of blooded females collected in the jungle near troops showed nucleated red blood cells. Of 246 females collected in the immediate vicinity of troop quarters, eight (3.27 percent) were positive for oocysts; sporozoites were demonstrated in only four (1.63 percent) of the salivary glands.

c. Dissections of anophelines collected on a military reservation in the Caribbean area have revealed nine naturally infected stomachs in 1,193 dissections of *Anopheles neomaculipalpus* and one in *A. oswaldoi.* There are believed to be the first reported natural infections in these two species of mospuitoes.

d. Since the value of DDT treatment of huts and tents depends largely upon the habits of anophelines before and after feeding, particular attention was given to this subject by Australian investigators in one area of New Guinea. In a series of night catches in huts in which the insects were given some opportunity to feed, 728 adults were captured. Of these, 431 were resting, 53 being engorged and 378 unfed. The resting adults included both *A. punctulatus punctulatus* and *A. farauti farauti* as well as intergrade forms. The findings indicated that, on occasions, at least half of the population visiting huts at night rested before biting, and also that engorged mosquitoes may also rest before moving out. Fifteen of 20 unfed females were observed to rest for periods varying from 6 to 30 minutes. Unfed and fed anophelines were observed resting on the walls of huts and tents and on ceilings of huts as well as on almost any article of furniture present. Fed mosquitoes usually rested very close to the site where they had engorged and, when disturbed, were not inclined to fly very far.

e. A. farauti farauti (syn. *A. punctulatus moluccensis*) was observed to bite through several types of regulation issue clothing when it is stretched tightly against the skin. GI wool socks possibly increase the number of bites. The mosquitoes are disturbed by the cloth and puncture the skin repeatedly before finding a satisfactory location to feed. Almost every mosquito attempting to feed through the socks was successful in engorging. Herringbone twill allowed numerous bites. Cotton twill trousers were tested several times and only rarely were bites observed. It was pointed out that when men pull their socks up over the trouser legs, little protection is given to the ankle between the shoe-top and the trouser bottom, which is a favorite biting location.

4. ANTIMALARIAL DRUGS. *a.* The following information is extracted from a summary of large-scale studies on malaria conducted by an Australian Research unit:

The results of the research show conclusively if troops have taken the correct dosage of atabrine that,

(1) Malignant tertian malaria will be suppressed and finally cured by the concentration of atabrine in the blood.

(2) Benign tertian malaria will be 100 percent suppressed in all cases where the soldier can absorb atabrine. The proportion of individuals who cannot absorb atabrine is negligible.

(3) Malaria carriers will not be found in the Force, since the atabrine concentration prevents sexual parasites from appearing in the blood.

(4) The death rate will be practically nil and no blackwater fever will develop.

(5) These results are *not* adversely affected by such factors as exertion, heat, cold (−9° C), emotions like anger or fear, diet, blood loss anoxia as in high altitude flying (15,000–18,000 ft. at 28° F), and any other demonstrable factor.

b. Similarly, other British investigators report from studies on the action of mepacrine (atabrine) as a prophylactic on malignant tertian malaria that in proper dosage—

(1) The drug will give complete protection against infection with malignant tertian malaria;

(2) It acts in some cases by first suppressing the trophozoites and then sterilizing the infection; and

(3) If a frank attack of malignant tertian malaria does not occur within 30 days of infection in an individual taking suppressive mediciation, the infection has almost certainly been eliminated and no future relapse need be feared.

c. It has been assumed by some individuals that patients with diarrhea fail to absorb oral quinine or atabrine because of increased intestinal motility. Failure of atabrine suppression in soldiers with diarrhea has been ascribed to this supposed poor absorption. The problem was investigated by members of a malaria research unit in the Pacific. A series of severe or moderately severe cases of bacillary dysentery or nonspecific diarrhea were treated with either atabrine or quinine and blood levels measured to determine whether absorption took place. Determinations of the plasma concentration of the drugs indicated that both quinine and atabrine are well absorbed by patients with diarrhea or dysentery.

d. Attention of malaria control personnel is directed to War Department Circular No. 449, 1944, which concerns the regulation governing the discontinuance of malaria suppressive therapy among troops returned to the United States from overseas. In order that personnel who are still taking suppressive medication upon arrival in this country may be protected from malarial attacks during travel and furlough, and also to insure that at least 4 weeks of medication is taken after last exposure in the oversea malarious area, suppressive treatment will be given to such personnel for a period of 28 days following their arrival. The policy established by this circular is that appropriate reception agencies at points of entry will provide such personnel with the proper amount of drug and instructions for taking it.

5. EDUCATION. *a. Attitude toward malaria control.* (1) A survey of the attitudes of American troops toward malaria control as reported in a War Department publication titled, "What the Soldier Thinks" revealed some significant points. The study was made of infantry combat veterans in two Pacific divisions, and additional data were obtained from a cross section of the enlisted personnel in malarial zones, most of whom had not seen combat. The following information is abstracted from the above report:

(2) To test their knowledge of malaria control, the men were given a malaria information quiz. While a majority gave the correct answers to each of the questions asked, many revealed that they have been either poorly informed or misinformed on the subject. For example, 9 percent of those who had had malaria and 8 percent of those who had not acquired the infection said that protective clothing, nets, sprays, and repellents were of little help, and that getting malaria was mostly a matter of luck.

(3) A greater degree of misinformation was evident in answers to questions regarding atabrine. Twenty-two percent said that when atabrine is used, it is less necessary to use other preventive measures. Fifty percent also answered incorrectly that taking atabrine regularly for more than a few weeks is likely to have bad effect on a man's health. It appeared that many men were obviously in need of more information to correct the above misconceptions. This need was echoed in answers to other questions about malaria. When asked the main reason for the failure of some individual to take proper precations against malaria, the men's replies included: "They don't know enough about what they should do" . . . 15 percent. "They think they may get malaria anyway" . . . 25 percent. "They don't really care whether they get malaria or not" . . . 21 percent. "It is just too much bother to take proper precautions" . . . 22 percent. Miscellaneous or no answer . . . 17 percent.

b. Training aid. War Department Graphic Training Aid 8-4, titled "Graphic Portfolio on Malaria," has been released for distribution. The portfolio, which measures 30 by 40 inches, consists of 24 illustrated pages with suggested texts for the instructor, and an attached display stand. It is designed as a visual aid to assist unit instructors in presenting the subject of malaria in such a manner that it will be readily understood. Requests for this training aid should be directed to the local adjutant general depot.

c. Films. The following list of films is presented for the information of personnel concerned with malaria control education.

(1) TF 8-953, "Malaria, Cause and Control." Running time, 25 minutes. A basic and comprehensive film for training in malaria prevention and control.

(2) TF 8-1378, "Clinical Malaria." Running time, 26 minutes. This film concerns the clinical aspects of the disease, and is intended primarily for training of Medical Department personnel.

(3) TF 1-3343, "Malaria Discipline." Running time, 27 minutes. Demonstrates mode of infection and emphasizes malaria discipline and command responsibility. Illustrates control procedures, both individual and collective.

(4) Miscellaneous Film No. 157, "The Mosquito." Running time, 20 minutes. A Disney film animated and in color.

(5) Miscellaneous Film No. 1035, "Private Snafu vs. Malaria Mike." Running time, 4 minutes. Animated cartoon designed to induce military personnel to practice individual malaria control. Stresses use of mosquito netting, clothing, atabrine, repellent, and common sense.

(6) Miscellaneous Film No. 1046, "Silent Battle." Running time, 30 minutes. The Australian equivalent of TF 8-953. Comprehensive coverage of malaria control, with emphasis on personal protective measures.

(7) Film Bulletin 147, "Medical Service in the Jungle." Running time, 12 minutes. Illustrates the medical chain of evacuation under jungle conditions. The subjects of field sanitation and malaria control are covered.

(8) Army-Navy Screen Magazine No. 28, part of GI Movie Weekly Release No. 61, "Target Snafu." Running time, 5 minutes. Animated cartoon in which Snafu, in typical fashion, ignores the proper precautions and is attacked by "squadrons" of trained malaria-carrying mosquitoes. Running time for entire magazine, 17 minutes.

6. OVERSEA MALARIA RATES. Figure 1 shows malaria rates for the South Pacific area, based on official data compiled in the Surgeon General's Office from WD MD Form 86ab reports. Rates for other oversea theaters were presented in TB MED 87. At the time that TB MED 87 was written, a compilation of the data for the South Pacific had not been completed.

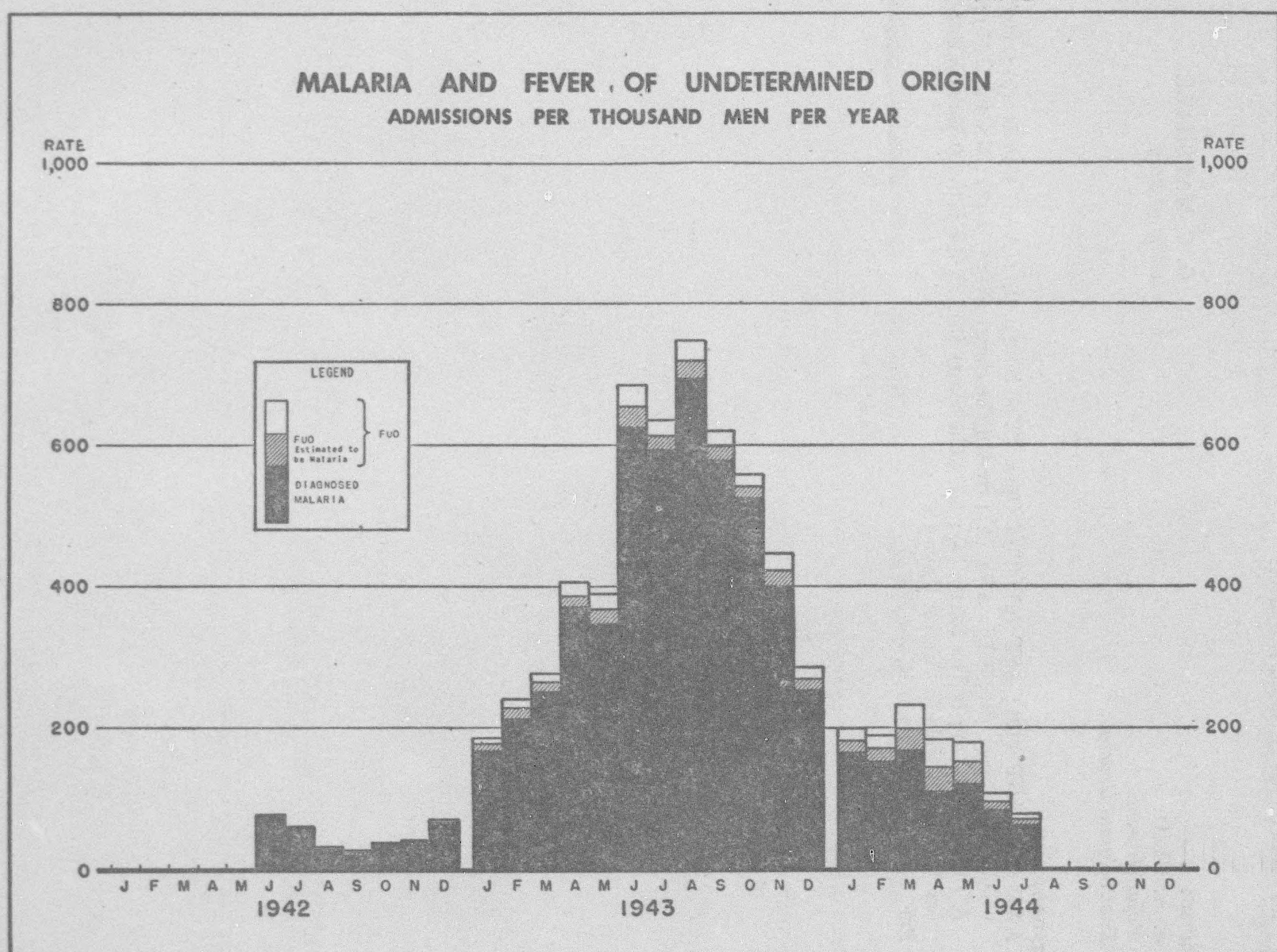

Figure 1.—South Pacific theater.

[AG 300.5 (12 Jan. 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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For explanation of symbols, see FM 21-6.

AGO 366A

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TB MED 133

WAR DEPARTMENT TECHNICAL BULLETIN

SUSPENSION-TRACTION TREATMENT OF FRACTURES

War Department, Washington 25, D. C. • • • January 1945

This bulletin follows TB MED 132, subject, "Medical and Sanitary Data on Italian Somaliland," Distribution given TB MED 132 was as follows: Dept (Med Lab) (1); Def Comd (3); S Div ASF (1); Tech Sv (Tng D) (1); SvC (Surg) (3); SvC (Tng D) (1); SvC (Med Lab) (1); AAF Sta (Continental U. S.) (1); PE (1); PE (Surg) (1); PE (Intell O) (1); GH (Continental U. S.) (1); RH (Continental U. S.) (1); SH (Continental U. S.) (1); Med Sv Sch for O (1); Med Techn Sch (1); ASF Unit Tng C (3); Med Lab (1); A (3); A (Med Lab) (1); CHQ (3); D (3); AF (3).

1. The purpose of this Technical Bulletin is to discuss the application of suspension traction in the treatment of fractures with particular reference to femoral fractures, and to outline the standard equipment available. It is desirable that a simple method of application using standard items be adopted. Particular attention is invited to the value of this form of treatment of fracture of the femur during the late as well as during the early stages of bed care. Fractures of the femur are evacuated from field units to forward hospitals in the Army leg splint, using the litter bar, ankle strap, and five triangular bandages. These fractures are evacuated from forward hospitals to fixed hospitals in the communications zone either in skin or skeletal traction suspended and fixed in an Army leg splint or in a plaster hip spica. (The application of multiple pins or wires through fracture fragments incorporated in plaster in order to maintain reduction is not recommended.) In fixed hospitals overseas, fractures of the femur should be treated by suspension traction until sufficient union has been obtained to permit safe transportation in a plaster hip spica, preferably of double type, to the zone of interior. After arrival in the hospital in the zone of interior in which the patient will remain, the spica cast should be removed and the suspension traction treatment again instituted if further immobilization is indicated. Plaster immobilization is desirable only for transportation of fractures of the femur. The suspension method will not only lead to the earlier return of joint motion and muscle strength than any other method but it also is the best means of preventing angulation and overriding.

2. In the definitive treatment of fractures of the femur it is important that, in the early stages, traction be sufficient to overcome the pull of the strong thigh muscles and to maintain the reduction of the fracture but that this traction not be so great that distraction or separation of the fracture fragments occurs. This method of treatment requires daily attention to details in order that the fracture reduction be maintained, that it be neat in appearance, and that it be comfortable at all times.

3. Skin traction, because of its simplicity and safety, is preferred whenever possible. Adhesive tape and gauze bandage are commonly used, but the use of flannel bandage with a skin adherent is preferred because it is more com-

fortable and durable. The latter two are standard medical supply items:

2001000 Bandage, canton flannel, 3-inch by 5 yards.

1045000 Adherent, 4 oz for skin traction.

After application of the skin adherent to the unshaven skin, the strips of flannel are cut to proper length and applied with the flannel side to the skin, followed by firm, smooth bandaging. The success of skin traction depends on the care with which it is applied.

4. Skeletal traction is indicated where skin traction cannot be used, or where it will not be effective because of the amount and duration of traction required. Kirschner wire is preferred to a Steinman pin because of ease of application and minimum trauma, but it is imperative that a bow be used which keeps the wire under tension. Rotary and lateral motion of the bow must be prevented. Solid Steinman pins are also effective. These do not require a bow and are preferred where the patient is of necessity to be transported in a splint with skeletal traction or with the pin incorporated in a cast. Jointed Steinman pins are dangerous and obsolete and should not be used. Ice tongs for skeletal traction on long bones are not approved because of the difficulty in satisfactory application and the subsequent danger of slipping and the causing of soft tissue trauma. The insertion of the pins or wires for skeletal traction or fixation should be done under rigid asceptic precautions and preferably in the operating room. As far as possible, these pins or wires should not be inserted in the vicinity of traumatized skin or in the vicinity of a future operative incision, since even a healed pin tract must be considered a site of potential infection. Nerves, vessels, and joints should be scrupulously avoided. Pins which completely transfix the extremity should not be inserted in the humerus or proximal two-thirds of the femur. Obviously, a wire or pin inserted into bone for skeletal traction should engage sufficient bone so it will not cut through and pull on the soft tissues.

5. In suspension traction treatment, the injured extremity should be so suspended in the splint or hammock, and so balanced by weights, that it can move with the movement of the body and still furnish effective immobilization of the fracture. Rigid fixation of the extremity to the bed or fracture frame is not desirable. Supporting slings should be smooth and well padded and rope knots should be secure. Special attention must be given to the position and resulting pressure of the ring where a ring splint is used. So far as possible, by position of the patient and the bed, the body weight is used for countertraction and a minimum weight is applied to hold the splint in position. If a wound is present in the ischial region, the half ring of the splint may be reversed to the front of the thigh.

A trapeze bar hung on the Balkan frame at the right height to be used by the patient in pulling himself up is indispensable as an aid for changing position in bed and nursing care.

The standard Balkan frame is both adjustable and adaptable. It allows the application of any form of traction on from one to four extremities in any position desired.

During the early stage of fracture treatment, active motion must be avoided. However, it is desirable that static muscle contraction, such as quadriceps exercise, be instituted early in order to prevent atrophy and stiffness. After the fracture of a femur has partially united, support and traction are still required, but knee motion can be started. This is best accomplished with the use of a Pierson attachment to the Army leg splint which allows both active and passive motion of the knee. Traction is to be maintained until all support is discarded and free recumbent exercise can be practiced. As soon as the degree of union permits, knee motion should be practiced at regular and frequent intervals. It is urgent that knee motion be restored by regular exercise as soon as possible.

Since the ischial caliper adopted by the Army to be worn after the suspension traction treatment is discontinued has no knee joint, it must be removed regularly for exercise of the knee after the patient becomes ambulatory.

6. The following illustrations represent the approved methods of suspension traction in the treatment of fractures in fixed hospitals. Particular attention will be paid to the use of this form of treatment in order to improve circulation and to effect early function of joints and muscles.

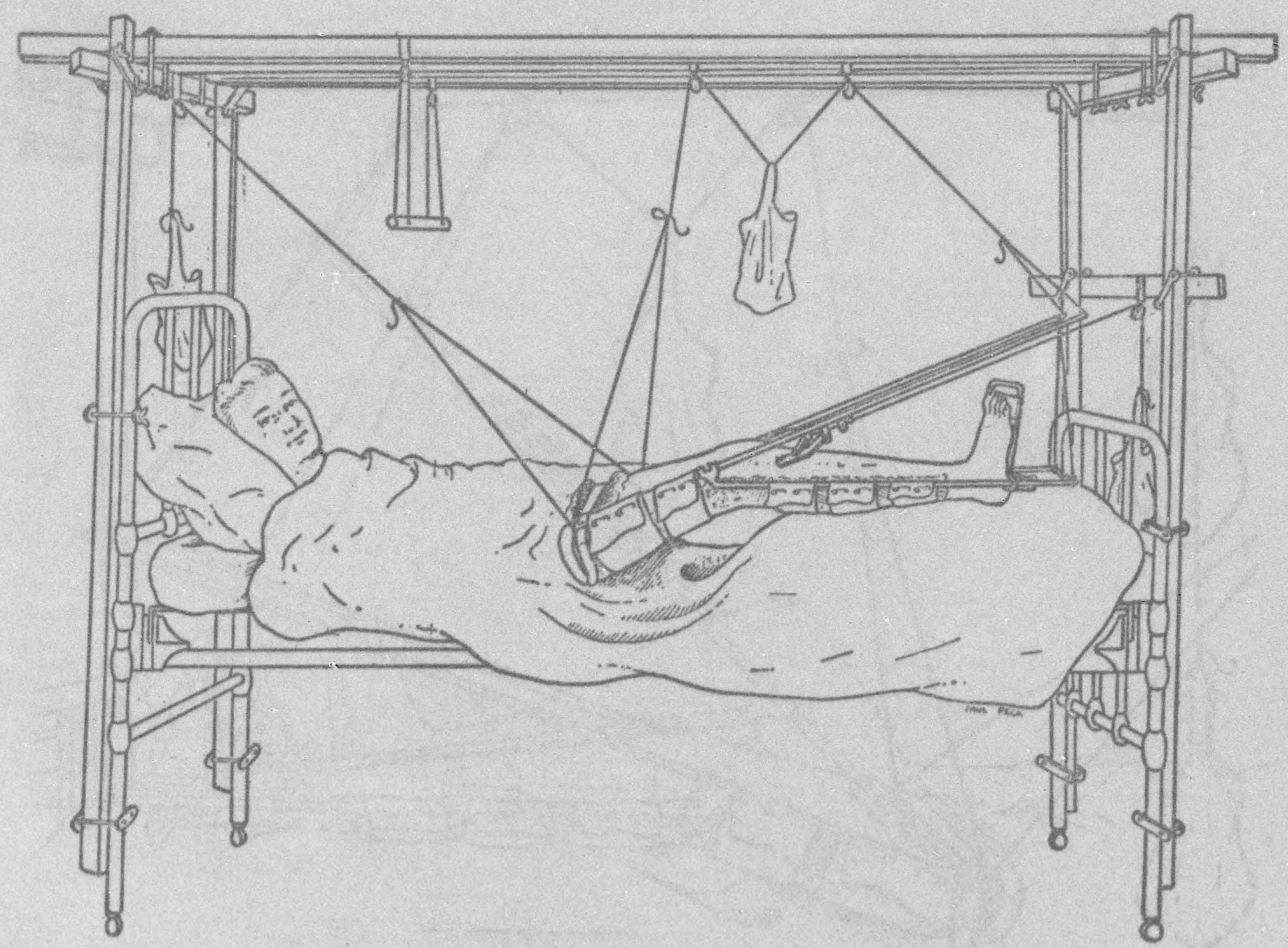

Figure 1. Skin traction and suspension for lower extremity (illustrating the standard Balkan frame).

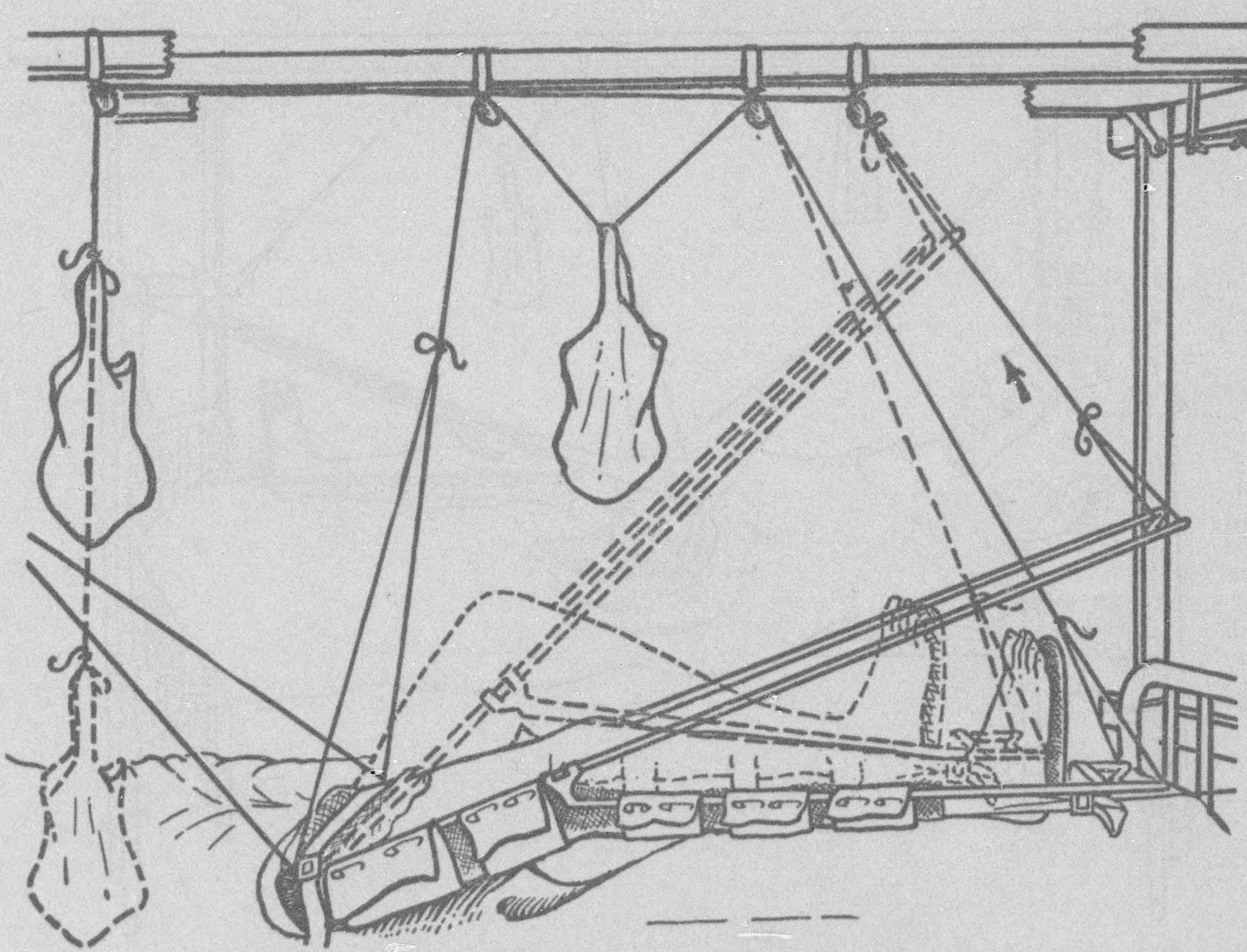

Figure 2. The Pierson attachment hooked up for knee motion.