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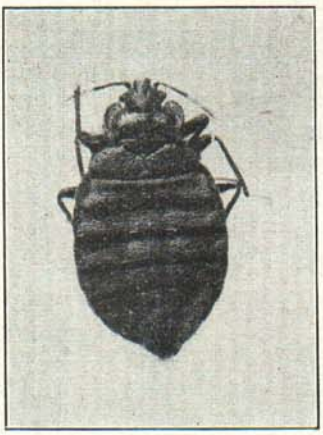
Fleas, Bedbugs, and Human Lice

By E. I. McDANIEL



Bedbug

MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science
EXTENSION DIVISION
R. J. Baldwin, Director

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FOREWORD

Verminous insects, in the struggle for existence, have developed remarkable adaptations, and as a result may become a nuisance whenever conditions are altered slightly in their favor. As disease vectors, they constitute an ever present threat to public health.

This bulletin undertakes to present the simplest and safest control measures effective against these pests.

Ray Hutson

FLEAS, BEDBUGS, AND HUMAN LICE

E. I. McDANIEL

Fleas, bedbugs, and human lice are among the most objectionable of all insects that attack man. The effective control of any insect depends upon knowledge of the life-history and the habits of the individual species under consideration. It is hoped, therefore, that the following discussion will aid those attempting to eradicate any of these three pests. The facts as given are limited to conditions as they exist in Michigan. Several control measures are suggested for each insect because, under different conditions, different remedial measures are required.

FLEAS

There are several species of fleas found in Michigan, but the cat flea, *Ctenocephalus felis,* and the dog flea, *Ctenocephalus canis,* are the predominating species. They were formerly considered to be the same species and were known as *Ctenocephalus serraticeps.* In addition to the cat flea and the dog flea, several other species of fleas are occasionally found. Of these, the human flea, *Pulex irritans;* the hen flea, *Ceratophyllus gibsoni;* and the rat flea, *Ceratophyllus fasciatus,* are the best known. All these species will attack man.

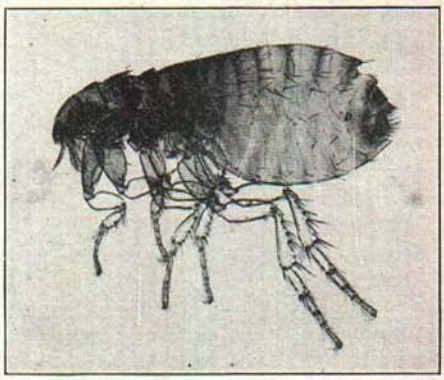

Fig. 1. Cat flea, greatly enlarged.

Fleas differ from other parasites in that they do not remain continuously on their host animals, but may drop off for a time. When ready to resume feeding, they may or may not return to their original host animal, or they may establish themselves on any available warm-blooded animal.

Description—Adult fleas of different species have a general resemblance, but can be distinguished by microscopic characteristics. Fleas are dark, reddish-brown in color with flat, compact bodies made up of chitinous segments ornamented with stiff spines or bristles which project backward. These spines assist the insect in moving about in the hair of the host animal and undoubtedly often save the fleas from being dislodged by their irritated host. Clubbed antennae rest in grooves on the side of the heads; the eyes, when present, are simple. The mouthparts are for piercing and sucking. The legs are long and well-developed with the hind thighs abnormally thickened and fitted for jumping.

Life-history*—The life-history and habits of the cat flea and the dog flea are practically identical. Both species are equally at home on cat or dog and both species attack man. Fleas have complete metamorphosis, that is, they go through four stages, egg, larva, pupa, and adult, in the course of their development. The mother flea may lay her eggs on the floor, in an animal's nest, or in some protected place, or she may lay her eggs on the animal. If this occurs, the eggs drop off as the animal moves about and many find suitable quarters in which they develop into the adult flea.

Fig. 2. Eggs of cat flea, greatly enlarged.

Naturally, eggs accumulate where animals sleep. These eggs hatch in a few days and the tiny larvae find lodging in cracks or crevices where they feed on accumulations of dried animal matter. A meal seems to be necessary between each of their two molts and the larvae eat their own cast skins. When mature, the larvae spin silken cocoons, within which they pupate. Winter is passed in the pupal stage. The amount of time required to complete a life-cycle and the length of time that elapses before the adult flea starts laying eggs is governed by humidity, temperature, and food supply. Apparently, the adults require a meal of warm blood before egg-laying begins.

During the summer, the length of time required to complete a life-cycle under Michigan conditions is from two to four weeks. The eggs hatch in from two to four days, the larvae require from eight to 24 days to complete their development, and from five to seven days are required in the pupal stage.

The human flea, *Pulex irritans,* is worldwide in its distribution, and has a number of different host animals. It is particularly troublesome on hogs, skunks, cats, dogs, rats, and squirrels. The life-history is similar to that of either the cat or the dog flea, from two to 10 weeks being required to complete a generation during the summer. The immature stages of the human flea are passed in places similar to those frequented by the young of the cat and dog flea. The eggs hatch in from two to nine days and the larvae complete their development in from eight to 32 days. The pupal stage usually requires from five to 34 days.

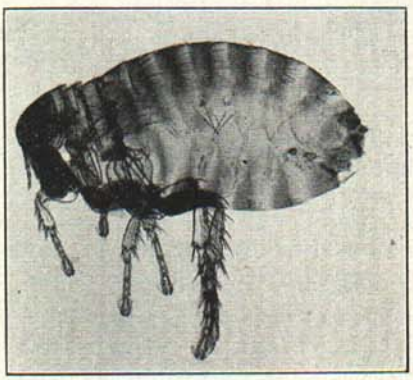

Fig. 3. Human flea, greatly enlarged.

Gibson's hen flea, *Ceratophyllus gibsoni,* infests poultry. The foci of infestation are usually the nests. When disturbed in any way the fleas swarm

*The facts concerning the life-history of fleas are based on the life-history of the cat and dog flea, since they are the predominating species in this part of the world.

out and collect in numbers on the offender. Caretakers object because they swarm over the hands and arms and clothing. Fortunately, this species is still rare in Michigan. It can be readily controlled by dusting the nest with fresh pyrethrum powder, flora grade, or by spraying the hen-house with either a contact insecticide or a miscible oil, taking precautions to thoroughly soak the floor and to get the insecticide into every nook and corner.

The rat flea, *Ceratophyllus fasciatus,* is the species common on rats in Michigan. This is one of the largest species of fleas found in the country, and will attack man as readily as rats.

Importance—There are at least three ways in which fleas affect man and higher animals, they set up an irritation as they feed or move about over the body of the host, some species are intermediate hosts for certain parasitic worms, and in some parts of the world fleas are carriers of bubonic plague.

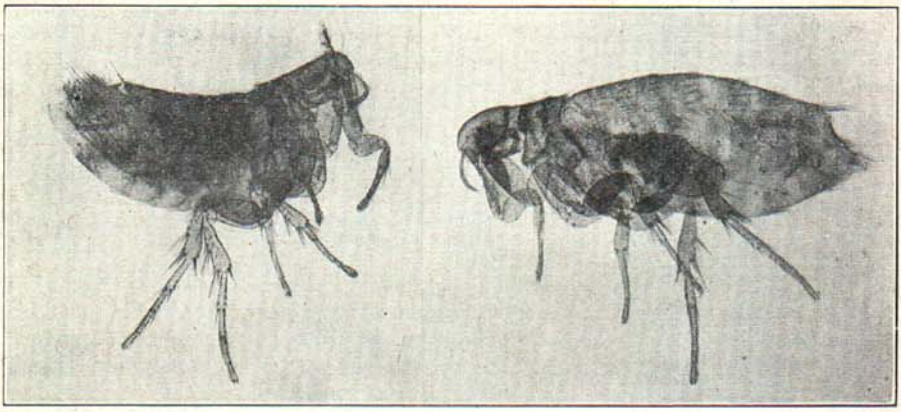

Fig. 4. Left, male Gibson's hen flea, greatly enlarged; right, female.

Many people are immune to fleas, while others suffer only passing discomfort, but there are people who are particularly susceptible to fleas; and, on such individuals, flea-bites often develop into red, angry welts that remain irritated for days, or even weeks.

The study of fleas took on a serious aspect during the last part of the 19th century, when it was found that they were vectors of *Bacillus pestis,* the causative organism of bubonic plague to and between man and certain rodents. Of all rodents, the rat is most dreaded on this account because it invariably lives in houses or on board ship where it is more or less associated with man. Rats seem to be particularly fond of ocean travel, and there is scarcely an ocean-going vessel that does not carry a number of rats. Ships taking cargo from ports where bubonic plague is present may get an infested rat on board. The disease then spreads from one rat to another, being transmitted by fleas roaming about in search of food. When a ship carrying diseased rats arrives in port, if any of the infested rats escape, other rodents are infested by fleas from the imported rats, and an epidemic usually follows. Human beings attacked by infested fleas are very likely to

contract the plague. It has been noted in the past that outbreaks of bubonic plague have been preceded by a high mortality among rats in the community.

Bubonic plague for centuries overran Europe and Asia, and during that time it claimed millions of victims. There have been several severe outbreaks in the United States, but so far these have been confined to seaport towns of the Pacific and Gulf Coast.

Besides carrying the organism causing bubonic plague, fleas are known to carry a number of other diseases as well as several tapeworms. The dog flea is the intermediate host for the dog tapeworm, *Dipylidium caninum*. As many as fifty cysticercoids (this stage corresponds to the embryo of the insect) have been found in the body cavity of a single flea. These cystercoids return as parasites to the dog whenever it crushes the body of an infested flea with its teeth. This tapeworm sometimes occurs in human beings, usually children.

Habits—Fleas are attracted to light colors and to moving objects. Usually, they are more numerous during late summer or early fall. Once established in houses, especially houses that are to be closed for a time, they breed freely and may literally overrun the place. Unused rooms or rooms where the floors are covered with stationary carpets or straw matting furnish ideal breeding places, but these insects are not able to sustain themselves in rooms where the floors are gone over weekly with soap and water or in rooms that are in constant use. Once established in a vacant house, the adults feed on rats, mice, or other rodents and the larvae subsist on dried blood or other animal matter. Fleas are able to survive several months as adults before feeding. An infestation of fleas usually starts in the basement, but sometimes they overflow the first and second floors, particularly when cats and dogs have the run of the house.

Infestation—Animals acquire fleas when they associate with infested animals, or they may collect a few adults when they visit infested houses, kennels, or lawns. Houses and lawns become infested with fleas when visited by infested animals. The source of infestation may be dogs or cats with so few fleas that they do not come under suspicion, or stray animals may gain entrance into the basement or take up quarters under the porch for a long enough time to infest the place with fleas.

Houses without basements and built on the ground with openings at intervals for ventilation often serve as a rendezvous for cats, dogs, chickens, and various other animals. Under such conditions, an infestation of fleas may overflow both house and lawn. Enormous numbers of fleas breed in neglected dog and fox kennels, rabbit hutches, and hog-pens. Of the domesticated animals, cats, dogs, hogs, and rabbits are commonly infested with fleas; while, among wild animals, the infestation is usually limited to gregarious rodents and carnivores that have more or less permanent sleeping quarters or lairs.

Control—The first step in the eradication of fleas is to treat the infested animals. Non-infested animals may then be excluded from premises. The animals which have been treated should not be permitted to wander about and collect new batches of fleas but if permitted to visit infested premises, it is essential that they be treated regularly; otherwise they will only reinfest the home premises.

There are a number of ways to kill fleas on animals. Where a powder is preferred, the use of a dust containing either pyrethrum or derris may be

used, or a combination of pyrethrum and derris is sometimes recommended. It is essential that either powder be fresh to insure best results. Where fresh pyrethrum powder, flora grade, diluted with some inert carrier such as bran, oatmeal, or talc is worked into the fur, many stunned fleas drop of their own accord, and it is possible to brush a number of others from the fur.

For this reason, place the animal to be treated on a large piece of paper in order that the accumulation of dust and stunned fleas may be collected and burned. With cats, especially long-haired cats, brush the powder out of the hair because they are continually licking themselves, and if they are permitted to swallow a quantity of insecticidal material and hair, digestive disturbances take place. There is an advantage in placing the animal to be treated on a large piece of absorbent cotton, since many of the fleas will drop off and become entangled in the cotton and be prevented from escaping.

There are a number of commercial insecticides on the market, the killing agents of which are mostly rotenone or pyrethrum. Soaps containing derris are particularly recommended for the control of fleas on household pets because they do not have an unpleasant odor, they are non-poisonous to warm blooded animals, and they leave the hair in good condition. Besides the derris and pyrethrum preparations, there are a number of saponified coal tar dips on the market recommended for the destruction of fleas. Since there is a wide range in the strength of these different commercial preparations, it is necessary to follow the directions of the maker. With most of these preparations it is advisable to rinse the animal in warm water after treating in order to remove the excess dip from the fur. *In washing an animal with any insecticide, wash the head first to prevent the insects from collecting around the eyes and nose.*

After the animal has been treated, clean the kennel before the animal is allowed to return. Shake the bedding over a paper and burn the refuse, air the carpets or cushions, destroy any old straw, and give the animal a clean bed. Either whitewash the kennel on the inside or treat it with a contact spray containing derris or pyrethrum. Treat the floor or the soil with any of the contact insecticides mentioned or with kerosene and pyrethrum (p. 11). Where fleas are established, it is imperative to make this treatment weekly until the infestation is checked.

To control fleas in houses: If circumstances are such as to permit either hydrocyanic acid fumigation (p. 12) or sulphur fumigation (p. 12), the results are usually satisfactory. Where sulphur fumigation is used, the fire hazard must be taken into consideration, together with the effect of the fumes on drapes, rugs, wallpaper, and finishing; for either fumigation it will be necessary to vacate the house, for at least 24 hours during the fumigation.

Since fleas breed in cracks in the floor or in any protected place, remove and clean all rugs and carpets. Scrub the infested floors with strong soapsuds and treat with a pyrethrum preparation. Kerosene fortified with pryethrum gives excellent results where it is possible to use kerosene without injury to the finish or where the odor is not objectionable. Where it is not desirable to use kerosene, there are a number of commercial preparations on the market that can be used in place of the homemade product. Take precautions that not a crack remains untreated. The use of stationary carpets and straw matting are to be discouraged where fleas are a problem.

Fleas in basements can be controlled by using kerosene fortified with either pyrethrum or creosote (p. 11). It is necessary to use enough of this insecticide to insure the flooding of all cracks, crevices and corners in

the basement. From three to five gallons of the material is usually required to thoroughly treat an average-sized basement.

Fleas are attracted to lighted lamps and white objects. It is possible to trap them by placing a candle or a lamp over a shallow pan of soapsuds setting in the middle of the floor. Where the edges of the pan are vertical or nearly vertical, the fleas find it difficult to escape. Kerosene is better than soapsuds if the odor is not objectionable.

Where forced to sleep in rooms infested with fleas, it is possible to get some relief by using either pryrethrum or derris powder. This may be somewhat unpleasant, but it is not to be compared with suffering from the bites of fleas.

Powdered alum* has been found useful in exterminating and repelling fleas. Where the powder is worked into the rugs and curtains, fleas are said to disappear. Under some conditions, this would be worthwhile, because powdered alum does not injure rugs and is not particularly objectionable.

Fleas are capable of maintaining themselves on rats, mice, and other rodents. It is, therefore, essential that these animals be destroyed where a flea eradication campaign is under way.

Where the ground under houses without basements becomes infested with fleas, treat the soil with any of the contact insecticides recommended for the control of fleas on animals or use a 2 per cent summer oil of the type commonly used in orchard spraying, fortified with nicotine. Whatever insecticide is used, see that a thorough application is made.

Fleas are fond of dried blood, and epidemics of fleas can be checked by using a bait made by combining equal parts of lead arsenate and dried blood at the rate of 10 to 15 pounds per acre. This bait is poison and, where it is used, take precautions against accidents. It can be used freely under houses or porches if the openings are screened to prevent animals from getting to it.

To eradicate fleas on lawns: Occasionally, fleas become established on lawns or in the soil about buildings. Where the ground is bare, air-slaked lime or hydrated lime discourages the insects. Grass or plants in the yard may be freed from the pest by an application of any of the contact sprays, such as pyrethrum, derris, or summer oil combined with nicotine (p. 11). Many an epidemic of fleas originates about hog-pens. It is not unusual for them to literally swarm in the hog-house or to congregate in numbers about hog wallows. Hogs may be relieved from fleas by putting crude oil on the surface of their wallows or by supplying rubbing posts that are occasionally treated with cylinder oil.

*(1926) Herrick, Glenn W., "Household Insects," p. 160.

BEDBUGS

Cimex lectularius

Bedbugs are now found practically everywhere that man has established permanent settlements. Infestations are usually confined to sleeping quarters, but, where bedbugs breed unchecked, they may distribute themselves throughout the entire building. All types of buildings are infested, particularly quarters where the in habitants are transients, such as boarding houses, barracks, dormitories, cars, or ships. There are several species of bedbugs recorded from different parts of the world as feeding on man, but in the United States the infestations are confined to one species, *Cimex lectularius*. There are also some closely-related species that infest poultry, bats, and chimney swallows, but these species are not capable of maintaining themselves on man.

Fig. 5. Common bedbug, (Enlarged).

Habits—Bedbugs are nocturnal. They feed at night and secrete themselves away in protected places during the day. Often, the hiding place is remote from the common feeding ground. In cities when an infested house is vacated, it is not unusual for bedbugs to migrate from one house to another. In districts where houses are widely separated, bedbugs often maintain themselves on rodents and other warm-blooded animals. They are cannibalistic in the absence of warm blooded animals and may survive for long periods without any food. Their presence about beds is often indicated by small black spots on the sheets, pillowslips, or mattresses, as well as by their characteristic odor.

Life-history—There are several generations each year. The minimum period required to complete a generation is about 45 days. During cold weather, the length of time required to complete a generation is considerably longer.

Each female is capable of laying about 100 eggs during her lifetime. These are laid a few at a time. The small, white, elongated eggs are laid singly in cracks and crevices about the bed, behind picture moldings, or under loose wallpaper. The eggs usually hatch in a little over a week into pale, transparent young that resemble their parents except for size and color. They molt, or shed their skins, at least five times during development, and from necessity feed on blood from warm-blooded animals at least once during periods between molts. The eggs are always more abundant in the spring and early summer.

Infestations—Bedbugs may become established in houses in a number of different ways. There is always a possibility that they may be carried in infested merchandise, furniture, or other house furnishings. However, many reputable dealers, realizing this possibility, now take precautions to prevent or to eradicate bedbugs. Traveling bags infested enroute or laundry done in private houses may serve as a source of infestation. Bedbugs may migrate from one apartment to another or from one building to another, providing the buildings are not too far apart, or the insects may sometimes be carried on clothing into houses. The control for bedbugs has been simp-

lified where brass beds or iron bedsteads have taken the place of wooden bedsteads, where tints or paints have taken the place of wallpaper, and where hardwood floors and rugs have replaced the old-fashioned floors and carpets.

Importance—Bedbugs attack their victims at night, disturbing their rest, and in many instances, poisoning the system to such an extent that each feeding puncture swells up into an angry welt. Bedbugs also are under suspicion of carrying infectious diseases from one individual to another.

Fig. 6. Flat-bug (Aradid) greatly enlarged,—often mistaken for the bedbug.

Flat bugs are sometimes confused with bedbugs. However, they are always found in the open under bark or in rotten wood and feed upon fungi or upon the juices of plants.

Control—Kerosene-pyrethrum: It is possible to control a light infestation of bedbugs with kerosene impregnated with pyrethum, p. 11. It is necessary to inject a liberal quantity of the fortified kerosene back of the woodwork and into crevices of furniture. Thoroughly brush the tufts of mattresses as well as the seams and folds, and treat with some preparation that will not injure the covering. Usually, one of the commercial extracts of pyrethrum is recommended for this purpose.

Corrosive sublimate (mercuric chloride): Many people still use a solution of corrosive sublimate painted into the crevices of the furniture with a stiff feather for the control of bedbugs. The advantage of this material is that it is more or less odorless. However, since corrosive sublimate is such a violent poison and the fumes emulating from the dried chemicals are dangerous even when present in small quantities, this treatment is not recommended.

Either sulphur fumigation, p. 12, or hydrocyanic acid gas fumigation, p. 12, will control bedbugs where the infested room or buildings can be made tight. Frequently, it is necessary to repeat the fumigation once or even twice because the fumes do not always penetrate into all crevices where the eggs are hidden. There are conditions under which fumigation is not advisable, and before deciding to use either treatment the arguments for and against fumigation should be carefully weighed.

Bedbugs, along with other household pests, succumb to super-heating when it is possible to raise the temperature of a room or building from 120 to 130 degrees Fahrenheit, still heat, and maintain this temperature for six or eight hours. Make the building as tight as possible to prevent the heat from escaping. When the treatment is made in warm weather, less effort is required to maintain the desired temperature.

CONTROL METHOD

Kerosene Fortified with Creosote or Pyrethrum—Where kerosene is impregnated with creosote, use one part creosote to three parts kerosene. Where kerosene is impregnated with pyrethrum, use one-half pound fresh pyrethrum, flora grade, to each gallon of kerosene. Stir the powder into the kerosene and allow the mixture to stand for from 12 to 24 hours and decant. Use the clear liquid for an insecticide and dispose of the sludge.

Contact Spraying—The following contact sprays are recommended for the control of fleas in the soil. Where a 2 per cent summer oil emulsion is desired, use 14 fluid ounces of any of the commercial summer oils on the market to five gallons of water and add about five ounces of 40 per cent nicotine sulphate. The summer oils recommended are those now on the market for the control of insects in orchards. Another very satisfactory spray is made by using one ounce of nicotine sulphate to five gallons of warm soapsuds. Apply this combination immediately after it has been mixed.

FUMIGATION

At times, it is desirable to fumigate for bedbugs or fleas with sulphur or hydrocyanic acid gas. Under ordinary conditions, no fumigant will give 100 per cent control when used at the strengths commonly recommended. The fumes seldom penetrate all infested areas in sufficient strength to kill the more resistant stages of insect life, and, usually for this reason, two and even three fumigations spaced 10 days or two weeks apart are required. A building cannot be successfully fumigated during cold weather, during a high wind, or unless it can be made perfectly tight.

To insure the best results raise the temperature to 70 degrees Fahrenheit or above for four or five hours before fumigating, and if the treatment is applied during cool weather, heat the building for a week or 10 days prior to the fumigation. Determine the exact cubical contents of the room or building to be treated and use a dosage strong enough for the particular case. The best results are obtained when the fumigation is started late in the afternoon.

For any fumigation to be a success, certain factors must be taken into consideration:

1. The temperature should be 70 degrees or above.
2. Calk the building to make it as tight as possible.
3. Determine the correct cubical contents of the rooms to be fumigated.
4. Make the dosage strong enough.
5. Where the infestation is severe or where conditions are adverse, two or even three fumigations may be necessary.
6. Permit 2 or 3 weeks to elapse between fumigations.
7. All fumigations are dangerous in one way or another.
8. It is too much to expect that any fumigation will give 100 per cent control under conditions as they exist in dwellings.

Sulphur Fumigation*—For sulphur fumigation to be effective, arrangements must be made to keep the buildings closed for at least 24 hours after the fumigation has started. First, make the buildings as tight as possible, calking all openings about doors, windows, ventilators, and registers. Determine the exact cubical contents of these rooms and burn at least three pounds of sulphur for each thousand cubic feet of air space. More sulphur will be necessary if it is impossible to make the building tight. To insure that all sulphur will burn, stir a handful of charcoal into the sulphur. Where no charcoal is used, the sulphur is very likely to burn for a short time and then the fire will go out.

Precautions to be Observed When Using Sulphur Fumigation—There are several objections to sulphur fumigation. First, there is the danger from fire; second, sulphur has a tendency to fade colors and to rot fabrics; third, metals, especially those unprotected by lacquer, are usually tarnished or corroded. To insure protection against fire, burn the sulphur in an iron kettle suspended over a pail or tub. The pail should have three or four inches of dry ashes or sand in the bottom. Cover the kettle with a coarse wire screen to prevent the burning sulphur from boiling over and setting fire to the floor. The flame from the kettle of burning sulphur may be two or three feet in height; bear this in mind when placing the container.

When surphur fumigation is used against insects, moisture in the air is not desirable. The fumes of sulphur are more active as a bleaching agent in the presence of moisture and cause fabrics to rot more rapidly, so it is wise to have the air as dry as possible. Protect metal surfaces, especially where unprotected by lacquer, by painting them with vaseline to aid in the prevention of corrosion.

Remove pianos or other instruments with metal strings before fumigating with sulphur, because corrosion of the strings usually follows such fumigation. Sulphur fumigation also destroys the germination of seeds and spoils some food stuffs.

Hydrocyanic Acid Gas—Hydrocyanic acid gas is one of the most deadly poisons known, and, whenever possible, this fumigation should be directed by experienced operators or, in any case, by individuals who realize the dangers involved, familiarize themselves with the details for successful fumigation, and follow them explicitly. While the poisonous gas is liberated only when cyanide comes in contact with sulphuric acid, take precautions to prevent getting any of it in the mouth, eyes, or open wounds.

What to Use—For each 100 cubic feet of space to be fumigated:

1 ounce .....sodium cyanide† (98% to 99%)
1½ fluid ounces .....sulphuric acid
3 fluid ounces .....water

Sodium cyanide is on the market in several forms. The egg cyanide is preferable because each egg weighs an ounce and it is possible to measure the correct dosage with the minimum amount of handling. Where bulk cyanide is used, it is necessary to break the large, irregular chunks into a convenient

*Sulphur candles are worthless when fumigating for insects, because it is impossible to burn enough candles to have an effect. Formaldehyde is useless when used as a fumigant or a contact spray against insects.

†When potassium cyanide is used in place of sodium cyanide, increase the amount by one-fourth.

size to fit in the paper sacks and the amount has to be carefully weighed out. Protect the hands with gloves when handling cyanide and where a quantity of large chunks must be broken up do the work in the open or in a well-ventilated room.

Use 3-gallon, or larger, earthen crocks for generators and take precautions to see that the containers are not more than half full of water and acid. Considerable heat is developed when the gas is generated, and, where the generators are more than half full the liquid often spatters over and injures the floor. A 3-gallon crock is large enough for 15 to 25 ounces of cyanide, a 4-gallon crock for 20 to 30 ounces, and where more than 30 ounces are required it is better to use two containers. Place the right amount of water in each generator and slowly add the required amount of acid. *Never pour water into acid,* since intense heat is generated and an explosion invariably follows.

Place the required amount of cyanide in double paper sacks of heavy paper, marking the amount contained on the outside of each package. Use a No. 8 sack inside a No. 10 sack and set each sack alongside each generator. The double sacks make for the safety of the operators, since it slows up the generation of gas enough to enable them to get out before the fumes are generated. Where sacks are not available, the cyanide may be wrapped in several thicknesses of newspaper.

To Prepare a Building for Fumigation—To prepare a building for hydrocyanic acid gas fumigation, first determine the exact cubical contents of the room or building to be fumigated and divide the number of cubic feet by 100 to get the number of ounces of cyanide necessary. Calk doors, windows, fireplaces, registers, and ventilating shafts, to make the place as nearly air-tight as possible, before starting the fumigation. See that the house is completely vacated and make it possible to open the doors and windows from the outside and and from a distance. Do not attempt to seal off a room in an occupied house and fumigate it with hydrocyanic acid gas, and do not fumigate a house in close proximity to other houses unless they are also vacated.

Remove plants and all liquid or greasy food supplies. Open up all bedding and arrange clothing and furniture in such a way that the fumes can penetrate with the least possible obstruction. Put out all fires before starting, for while hydrocyanic acid gas is not considered inflammable at the strength recommended, once a fumigation is under way it is impossible to enter a building until it has been thoroughly aired.

To Fumigate—When all preparations have been made, start with the top floor and carefully set the sack of cyanide into the generator containing water and acid. Work rapidly toward the lower floors and toward the exit. Always start with the top floor, because the fumes of hydrocyanic acid gas are lighter than air and tend to rise. It is safe when two people work together, each taking different rooms, and the more rapidly they can move from room to room the less danger there is of being over come by the fumes.

Finally, close and bar the outside entrances. Either post guards around the building from the time the fumigation starts till the place has been thoroughly aired or, where conditions warrant it, post conspicuous warning signs at each barred entrance. Leave the building closed for from 12 to 24 hours and when the fumigation is over open the building from the outside and do not enter until it has thoroughly aired.

Hydrocyanic acid gas is colorless and has a rather pleasant odor that re-

minds one of peach kernels. For further information on the use of hydrocyanic acid gas consult:

L. O. Howard, "Hydrocyanic Acid Gas Against Household Insects". U.S.D.A. Farmers' Bull. No. 699, 1916.

Riley, Wm. A., and Johannsen, O. A., "Medical Entomology", pp. 423-426, 1932.

Calcium Cyanide—The use of calcium cyanide for household fumigation is increasing in popularity. It is less dangerous to handle and more readily applied than the sodium cyanide-sulphuric acid-water fumigation just discussed. Calcium cyanide is made by combining cyanide with lime. It is on the market both as a powder and in the granular form. The powder is usually used in household fumigation. When exposed in a thin layer to the air, a chemical reaction takes place between the cyanide and the moisture in the air, liberating hydrocyanic acid gas.

The dosage depends upon the tightness of the room or building to be fumigated and on the amount of available hydrocyanic acid gas in the calcium cyanide. Where the amount of available cyanide if from 50 per cent to 55 per cent, 1 pound to each 1000 cubic feet is usually considered the standard strength for household fumigation. Where 88 per cent is available, ¼ of a pound per 1000 cubic feet is recommended. Under some conditions, it is wise to increase the dosage; for example, if there is a strong wind blowing at the time of fumigation or if there is a question as to how readily the fumes will be able to penetrate bedding, rugs, or clothing.

Place a strip of paper the full length of the room and spread a thin layer of calcium cyanide on the paper. Start on the opposite side of the room and work toward the door. Leave the place closed for 24 hours and air out thoroughly before entering. The grayish residue remaining on the paper after the fumigation is harmless and can be disposed of by burning.

Black and Cotton* advocate the use of porous discs containing a known amount of hydrocyanic acid gas. The discs are distributed about the room and the method of fumigation is similar to that of calcium cyanide.

LICE

There are three species of lice that infest man—the head louse, *Pediculus capitis;* the body louse, *Pediculus corporis;* and the crab louse, *Phthirius pubis.* Some authorities believe the head louse and the body louse to be one and the same species, designated as *Pediculus humanus.* However, there is some difference in the activities of lice on the head and those on the body. Head lice apparently confine their activities to the head and the body lice to the body. Of the two lice, the head louse is somewhat the smaller, slightly darker and a great deal more active.

Both head lice and body lice are known to be carriers of several diseases of which relapsing fever, typhus fever, and trench fever are among those most dreaded. Where lice are permitted to feed continuously, the skin becomes pitted, hardened, and pigmented. This condition is commonly known as Vagabond's disease.

Head Lice—Head lice measure less than an eighth of an inch in length; the males are smaller than the females and there is considerable variation in

*1932. Back, E. A., and Cotton, R. F. "Hydrocyanic acid gas as a fumigant for destroying household insects." U. S. Agr. Dept. Farmers' Bull. 1670: 1-20.

color. Infestations usually start on the back of the head or back of the ears, although the entire scalp is affected in a heavy infestation. Each female lays from 50 to 150 eggs, called nits, glueing each egg individually to a hair. About a week is required for the eggs to hatch, and from 12 to 24 days are required to complete a life-cycle. Where head lice are numerous, the hair next the scalp is often stiff with eggs and there is an objectionable exudation from the seeping punctures of the insect. Where an infested head is neglected, the fetid mass forms a trichome in which fungus often becomes established, and beneath this scab myriads of lice collect and feed.

Body Lice—During the Civil War and the period immediately following, body lice were known as "greybacks", but since the World War they have been familiarly known as "cooties". They infest all parts of the body, but are most numerous in the areas protected by hair.

Body lice do not necessarily remain on the body all the time, and they may distribute themselves through the clothing or even infest bedding. The eggs are usually laid on the seams of outer garments where they come in close contact with the body, very few being laid on the body itself. Each mother louse lays between 150 and 300 eggs, and only about two weeks are required to complete a life cycle. The length of time adults may live is governed by temperature and food supply. Under favorable conditions, an adult may live from 30 to 40 days. According to Nuttal, unfed lice may survive for 10 days at 40 degrees Fahrenheit, but only two or three days at a temperature of 80 degrees Fahrenheit. It is generally conceded that infested clothing stored in a dry place will be automatically freed from lice and their eggs after a period of three weeks.

Crab Lice—The crab louse is thus called because it resembles a tiny crab in appearance. It measures about one-fifth of an inch or less in length and its legs are large in proportion to the rest of the body. This species lives on the hairy portions of the body and its presence is usually indicated by the irritation set up by its feeding activity. Often an individual louse will bury its head into the skin and remain feeding in the same place for several days at a time. The infested areas often take on a bluish cast.

Control—Lice often become a problem wherever people are confined in close quarters under insanitary conditions. Head lice or body lice may migrate from one garment to another or from infested furniture to an individual or from one individual to another.

Personal cleanliness is one of the first prerequisites in the control of human lice. A thorough bath with warm water and soap at least once a week is essential, and either a complete change of clothing or some method of eradicating lice on the clothing removed before the bath is necessary. Where possible, avoid overcrowded conditions and places likely to be infested. Lice on the body or head can be killed by bathing in kerosene. Usually, a kerosene emulsion is recommended. A satisfactory emulsion can be made by mixing together equal parts of kerosene and soft soap or kerosene and olive oil. The latter combination is preferred because it is less irritating. Shampoo the hair carefully with kerosene emulsion and wrap the head with a towel. After about an hour, remove the towel and shampoo with soap and water in the usual way, then rinse the hair carefully in water containing enough vinegar to loosen the nits. Rub the hair dry and comb with a fine-tooth comb.

Derris soaps have proven very satisfactory in the control of both body lice and head lice. They have the advantage over other preparations in that they are practically non-irritating; they are less difficult to apply and it is not necessary to rinse them from the hair. Any nits that may be present can be loosened with vinegar and removed with a fine-toothed comb.

Where a shampoo is not advisable, it is possible to kill lice with either derris or pyrethrum powder. Both of these powders are on the market under commercial brands, and, where a commercial brand is used, it is necessary to follow directions of the manufacturer. Where pyrethrum is used, get fresh powder, flora grade, and dilute half and half with bran, oatmeal, talc, or some other non-irritating carrier. Cover the treated head for 15 to 30 minutes with a cloth and then brush all powder carefully out of the hair and remove the nits in the usual way. Where social conditions are such that reinfestation cannot be prevented, remember that short hair is easier to treat than long hair.

With any of the above treatments recommended it may be necessary to repeat the application in a week or 10 days to get any lice that may have escaped the previous treatment or to check any new infestation. Treat hats, caps, and other head coverings to prevent reinfestation.

The control of body lice is practically the same as control of head lice. Disrobe completely and treat the infested parts of the body with a 2 per cent Lysol or creosote solution, pure kerosene, kerosene emulsion, or use a derris or pyrethrum preparation and take a hot bath. Since body lice and crab lice commonly collect on the hairy parts of the body, shaving off the infested hair not only materially aids in cleaning up the infestation but also serves to prevent reinfestation. Place infested clothing in a container for treatment and put on non-infested clothing.

It is possible to free clothing from lice and nits by boiling all material that will not be harmed by laundering in this way. To avoid shrinkage in woolen garments soak them in 2 per cent Lysol or creolin solution for one-half to three-quarters of an hour and then wash carefully in the prescribed way for handling woolen.

Where infested clothing is subjected to heat at 140 degrees Fahrenheit for 20 minutes, lice in all stages of development will be killed. Coats, suits, and other garments that would be injured by any of the above treatments may be sent to the dry cleaners or pressed with a hot iron taking care to treat especially all seams and folds.