INSECTS INJURIOUS TO THE HOUSEHOLD

BY

GLENN W. HERRICK

The Rural Science Series

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HOUSEHOLD INSECTS

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INSECTS INJURIOUS TO THE HOUSEHOLD AND ANNOYING TO MAN

BY

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INTRODUCTION

SOME one has remarked in a rather facetious vein that, from a zoölogical standpoint, the present age may be called the age of insects. On second thought, the remark holds more reason than might appear at first sight. We are especially impressed with the importance of the relation to man of these tiny, but multitudinous, forms of life when we recall that the species of insects outnumber the species of all other animals combined; that the insect pests in this country alone cause a loss of over a billion dollars annually; that several hundred trained men in the United States are giving their entire time to a study of these pests; and that thousands of letters are sent each year to our government agencies, requesting information regarding insects and means of fighting them. Until within the last few years the economic importance of insects has been attributed to their indirect injuries to man through attacks on the things that he produces. Suddenly, almost within the last decade, insects have assumed an entirely new and exceedingly important significance through knowledge of their direct injuries to man himself.

Since the epoch-making discoveries were made that mosquitoes carry malaria and yellow fever, insects, especially those frequenting the household, have assumed a most unexpected importance. The hum of the mosquito and the buzz of the house-fly have become fraught with an entirely new significance. Even the dog and the cat, with their burdens of fleas, have taken on a new aspect and appeal to us from an entirely new viewpoint. The kitchen drain, the open cesspool and closet, the barnyard manure pile, the horse stable, and the hog pen present entirely new problems to the occupants of the farm home through the insects that originate in them. One neglected manure pile can furnish enough house-flies to overrun several households all the summer through. An open kitchen drain can afford breeding-places for enough mosquitoes to change pleasant summer evenings into hours of torment and displeasure.

The present work is not intended as a treatise on the relation of insects to disease. The author's colleagues are now at work on a thorough and extended discussion of that phase of the subject. In the following pages, the writer devotes the principal part of the discussion to the habits, injuries, and control of insects simply as pests of the household and of man, contenting himself with a brief summary of the relation of insects to disease. It is hardly to be expected that so brief a work will include all of the insect pests that may invade the household; but an attempt has been made to discuss, at least, the most important ones with which our present knowledge makes us more or less familiar.

The erroneous ideas and unnecessary fears prevalent regarding the poisonous nature of certain insects and their near relatives and the interest evinced in this matter have seemed to warrant the addition of a chapter on this subject. In this discussion, the author has attempted to state the simple truth and to clear away, as far as existing knowledge makes it possible, the hazy and almost superstitious notions regarding the venomous qualities of these small animals.

The book has been written particularly for the housekeeper and for those who desire to obtain information regarding household pests and practical methods of controlling them. As few technical terms as possible have been used. Nevertheless, painstaking efforts have been made toward accuracy of statement. To make the work of value to the student, references to literature have been given and the lack of knowledge regarding the life histories and habits of many of these common pests has been pointed out with the hope of stimulating investigation. The author has drawn freely on all available sources of information and has often quoted extensively from various writers.

Most of the illustrations are original. They have been drawn from actual specimens principally by Miss Anna C. Stryke, Miss Catherine Kephart, and Mr. John Eyer. To these the author is greatly indebted for their careful and accurate delineation. Whenever it has seemed more advantageous, figures have been copied from various sources but full credit has always been given. The writer is also under deep obligation to his wife, Nannie B. Herrick, who has read the manuscript and proof and has made many helpful suggestions and constructive criticisms.

GLENN W. HERRICK.

ITHACA, NEW YORK.

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CHAPTER I

THE HOUSE-FLY

Musca domestica

There are no household insect pests more annoying, on the whole, than house-flies. They are present from early spring to late fall, even remaining far into the winter. They are troublesome in kitchens and dining-rooms because of their abundance, their proneness to get into food, and their generally filthy habits. Until within comparatively recent years the house-fly (Fig. 1) has been generally regarded as somewhat of a scavenger and has been considered of value to humanity because of its aid in the removal of wastes that are a menace to human welfare. The eggs of the house-fly are often deposited on decaying vegetable

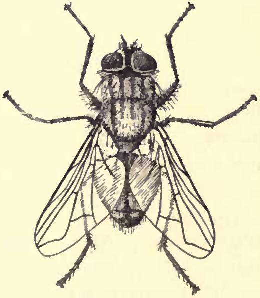

Fig. 1. — The adult house-fly. (× 5.)

matters that are allowed to accumulate in the vicinity of human habitations and the maggots that hatch from the eggs live on this decaying matter and aid in destroying it. Thus it must be conceded, perhaps, that house-flies do assist somewhat in the removal of foul and dangerous waste matters and, to this extent, are of benefit. On the other hand, it has been conclusively shown that this modicum of benefit is greatly overbalanced by their rôle in disseminating dangerous diseases. It has been shown that house-flies carry the germs of cholera, typhoid fever, cholera infantum, and tropical dysentery, on their feet, legs, and bodies and in their digestive tracts. There can be no doubt of the responsibility of the house-fly for much sickness and many deaths.

A COMMON SOURCE OF HOUSE-FLIES

In the summer of 1910, two large piles of horse manure were drawn and placed in a field about twenty rods south of the building in which the office of the author is located and on the same side. During the months of July and August the flies were so abundant in the building and especially in my office that screens had to be used as a protection against the dreadful annoyance of these pests. On investigation, the piles were found to be teeming with maggots of the house-fly. In seven ounces of the manure, taken from the smaller pile, 458 maggots of various sizes were actually counted. Many of the smaller ones must have escaped notice. The seven ounces of manure was a seething mass of maggots, showing what a tremendous number of flies the two piles of manure could have furnished if they had been equally infested all through the surface layers. Fortunately they were not. It was only in the moist, warm portions of the piles near the surface that maggots were present. But with these conditions enough flies were bred in the two piles of manure to stock the rooms of a very large building.

Apropos of the possibilities of manure in the production of house-flies, L. O. Howard gives even more surprising figures. He took a quarter of a pound of horse manure, well infested, and found within it 160 maggots and 146 puparia which would produce about 1200 flies to a pound of manure.

Again, during September, the manure that had been allowed to accumulate for several months was removed from a certain large cowshed at the old University barns. The wagons were backed under the shed and loaded. When drawn out they had to pass over a plank twelve inches wide that served as a threshold of the double doors. After the work had been going on some time, W. A. Riley gathered the puparia that had accumulated on one square foot of this plank. By weighing the whole mass and a known number of the puparia, he was able to determine that the square foot of surface had yielded 7000 puparia. In a subsequent examination, the plank was found, for its whole length, black with them, and the remaining manure on the floor of the shed was full of the dark brown puparia.

THE LIFE HISTORY OF THE HOUSE-FLY

The house-fly, like its remote cousin, the mosquito, has four distinct stages in its life history, egg, larva or "maggot," pupa, and adult. The house-fly, in all of its phases and instincts, seems to be a lover of filth. Its eggs are usually laid in manure, preferably in horse manure, at least whenever this medium can be found. Sometimes they are laid on cow manure and often on human excrement, especially in open closets, and on other decaying animal and vegetable material. A female fly may deposit 120 to 150 eggs at a time and as she has been observed to make four deposits we must conclude that a single fly is capable of laying at least 600 eggs. This will account, in a measure, for the enormous number of these insects.

The egg is a small, white object about one-twentieth of an inch long and resembles in shape a grain of wheat, except that it is more pointed. They are laid more or less in clusters (Plate I) and hatch in from eight to twenty-four hours or longer, depending on the temperature.

FIG. 2. — Maggot of house-fly. (× 3½.)

The maggot is whitish in color, pointed at the head end, blunt at the opposite end and about one-third of an inch in length when mature (Fig. 2). It is quite active and can crawl with considerable facility. It grows rapidly, molts three times,[1] and reaches maturity in five to seven days under favorable conditions. With the third and last molt the larva transforms to a pupa.

The pupa is inclosed in the last cast skin of the maggot. This skin soon turns dark brown and becomes hard and dry, thus affording a protective case for the pupa, known as a *puparium* (Fig. 3). The pupa rests quietly for five to seven days or longer, at the end of which time its enveloping case breaks open and the adult fly comes forth.

[1] If the casting of the last skin that serves as a puparium is counted.

Our observations indicate that house-flies frequently pass the winter in the pupal stage. We are also of the opinion that adult flies are able to survive the winter.

The length of time required for a generation of flies to mature varies and will depend upon the temperature, amount of food available, and other factors. For example, in Massachusetts, it may take about fourteen days for a generation of flies to mature, while in the latitude of Washington, D.C., ten days may be sufficient. But it takes the flies several days after they issue to become sexually mature and ready to lay eggs. In Massachusetts, then, there might be time, during a favorable season, for seven or eight complete generations, while in the latitude of Washington there would be time for ten or twelve generations. One can hardly realize the enormous numbers that such rapid development is capable of producing. Inside of two months, one female fly can give rise to many millions of progeny. For the purpose of illustration, we will assume that a female fly lays 100 eggs. If these hatch and all the larvæ come to maturity, about one-half will probably be males and the other half females. Then at the end of the first generation there will be fifty egg-laying females. At this rate, at the end of the eighth generation there would be produced about 1,875,000,000,000 adults. Of course, in nature, a very large part of these would die and never reach maturity, so that actually one female would probably never produce such an enormous number of individuals. However, under normal conditions tremendous numbers are produced.

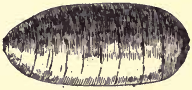

Fig. 3. — Puparium of house-fly. (× 5.)

BREEDING PLACES FOR FLIES

Without doubt, house-flies prefer piles of horse manure whenever these can be found. This has been shown by many observers. Next to horse manure, flies apparently prefer human excrement. At least, open closets in the back streets of cities have been shown to be one of the main sources of house-flies in such localities, especially in those regions in which there are few or no horse stables. Moreover, Howard has shown that the larvæ of house-flies are often found in chance droppings of human feces in back allies, yards, and so on. We would emphasize the fact that the most dangerous breeding places for flies are in open closets; for in these places the germs of typhoid fever, dysentery, and other enteric diseases are present in great abundance.

House-flies will also breed in cow manure especially when moist enough. Piles of stable manure containing rotting straw or barnyard refuse are favorable breeding places. Manure, bedding, and filth of pig-pens breed large numbers of flies; even the refuse of poultry houses, if composed in considerable part of rotting bedding, may contain maggots. The decaying and fermenting garbage from kitchens, if allowed to stand long enough in barrels or cans, may become breeding places for flies, although it would seem that the stable fly, *Muscina stabulans*, is the more common fly in such situations.

Forbes' assistants bred 267 house-flies from carrion in the streets, which runs contrary to former ideas concerning carrion and house-flies. It is probably safe to say that house-flies will breed in almost any vegetable matter that lies long enough to ferment and decay.

THE ADULT FLY

The adult fly is about one-fourth of an inch in length and has two thin membranous wings, the fifth longitudinal veins of which turn abruptly upward near the ends (Fig. 1). The dorsal side of the thorax is dusty gray in color and has four dark, longitudinal stripes. The legs and the body are covered with many hairs and bristles, among which great quantities of germs are easily entangled and carried from place to place. Moreover, each one of the six feet is furnished with two sticky pads called *pulvilli* (Fig. 4). Each pad, or pulvillus, is thickly beset with tiny hairs, which secrete minute drops of a sticky liquid that literally sticks the fly to the ceiling upon which it is walking. Unfortunately, these sticky hairs, in addition to enabling the fly to walk upside down, form ideal organs for picking up all sorts of bacteria from the filthy materials upon which the fly walks. Thus we see the house-fly is fitted in many ways for gathering and carrying germs. In fact, it cannot help but gather bacteria from the various things upon which it alights and then distribute them far and wide, for it wipes its feet upon everything it touches. The relation of the fly to the germs that it carries is purely a mechanical one. It has been shown repeatedly that house-flies do carry multitudes of bacteria. In Fig. 5 is shown a plate of gelatine

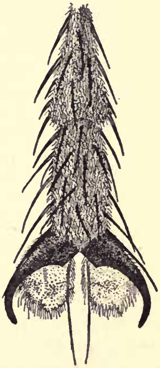

FIG. 4. — Foot of house-fly, showing pulvilli, enlarged.

over which a fly was allowed to walk. In every footprint there is a white colony of bacteria with millions of individuals.

Esten and Mason examined 414 flies from different sources and found that the number of bacteria carried by each one varied from 550 to 6,600,000, with an average

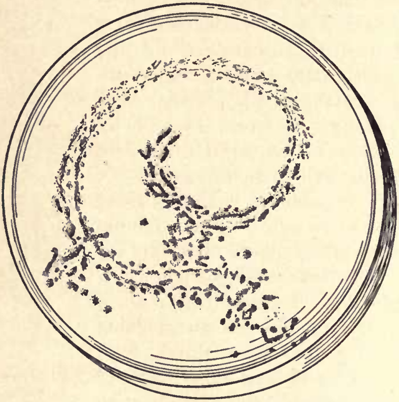

Fig. 5. — Plate of gelatine, showing colonies of bacteria in footprints of fly. (× 1.)

for each fly of nearly one and one-fourth millions. They also found that those flies caught in swill-barrels, pig-pens, and similar places carried the most bacteria and the most objectionable kinds of bacteria.

The mouth-parts of the house-fly are very complicated but, in general, they constitute a short proboscis fitted for sucking but not for piercing. The house-fly cannot "bite." The proboscis (Fig. 6) can be protruded and retracted to a certain extent. Roughly, the proboscis consists of two parts, a part nearest the head that bears two short curved appendages, and a longer part farthest from the head that bears two lobe-like appendages called the oral lobes. Each lobe bears on its under surface many transverse ridges called false tracheæ (pseudotracheæ). These lobes are rasping organs. Each lobe reminds one of an old-fashioned shoe float formerly seen in stores and used for removing the ends of wooden pegs that projected through the soles in the inside of a shoe. When feeding on fluid substances the fly simply applies the oral lobes to the material and sucks it up. When feeding upon solid substances the action is quite different. If such a substance as sugar is eaten, for example, it is first moistened and dissolved by saliva from the mouth of the fly before it is sucked up. The oral lobes also serve to rasp the material and break it down.

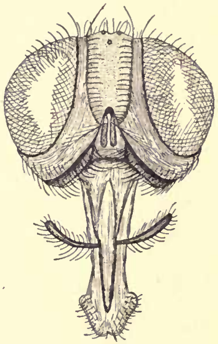

Fig. 6. — Head and proboscis of house-fly. (× 20.)

Graham-Smith watched a fly sucking a mass of sputum that had apparently dried and hardened. The insect seemed to moisten the layer of sputum by sending out saliva through its proboscis and sucking the fluid in and out until the layer was liquefied and could be drawn up into the mouth.

HOW FAR CAN THE ADULT FLY?

The question of how far this insect will fly from its breeding place has an important bearing upon methods of fighting it. Moreover, the area that it can cover in a neighborhood has an important bearing upon its dangers as a disease-germ-carrying instrument. It is held by observers, in general, that house-flies, under normal conditions, do not fly far. However, when aided by winds they may go considerable distances. Arnold, of the Monsall Fever Hospital in Manchester, captured 300 flies and marked them with a spot of white enamel on the back so that he could identify them. He liberated these in fine weather and during the next five days captured 5 out of the 300 in traps, all within 30 to 190 yards from the point of liberation. Hewitt says he has seen them flying at a height of 80 feet and remarks that this would greatly facilitate their carriage by winds.

In an experiment by Copeman, Howlett, and Merriman, three English investigators, on the range of flight of flies, they recovered marked specimens at distances varying from 400 to 1408 yards and, in one case at least, at a distance of 1700 yards. This indicates a flight of nearly a mile. It shows that the breeding places within a mile of a given building must be abolished if the flies are exterminated.

C. F. Hodge has found house-flies very numerous on the cribs of the Cleveland waterworks six miles out in Lake Erie. These flies could not possibly have bred on the cribs and the only conclusion is "that the flies are blown at least six miles off shore."

ENEMIES OF THE HOUSE-FLY

The house-fly has a goodly number of enemies, some of them members of the plant world, but most of them belonging to the animal kingdom. These enemies, however, do not seem to succeed in reducing the numbers of the house-fly to any great extent. Of course, it is impossible to say how many house-flies there might be if none of its enemies existed.

It is a common thing to find dead house-flies on window panes in the fall surrounded by a whitish ring. This ring is caused by the minute white spores of a fungus that lived within the body of the fly, finally causing its death. There are, at least, three species of these minute low plants or fungi that have been found to attack the house-fly.

Certain mites are often found attached to the bodies of house-flies. It is certain that some of these, at least, are simply clinging to the fly as a method of transportation from one place to another. They undoubtedly lie in wait for the fly and when opportunity offers seize hold and are carried to a supply of food, where they drop off. It is possible that other species of these mites feed upon their host, but very little of definite information is at hand concerning this point.

Of course, spiders, when allowed to build their webs and establish themselves in rooms, will catch and kill many flies.

Hornets are more or less effective fly catchers. The English Entomologist, Westwood, writing in 1840, quotes from St. John's "Letters to an American Farmer" to the effect that "The Americans, aware of their [hornets] service in destroying flies, sometimes suspend a hornet's nest in their parlors." Again, in 1869, Benjamin D. Walsh, an American Entomologist, writes that "some persons in America have turned this insect devouring propensity of the hornets to good purpose by suspending one of their nests in a house much infested by the common house-fly. In such a situation we have been told that they soon make a clearance of the obnoxious flies; and so long as you do not meddle with them they will not meddle with you." It has never been the author's good fortune to know any one personally who has used this unique method of destroying house-flies. Under ordinary circumstances we believe the good housekeeper would rather take her chances of happiness among the house-flies than with a good big nest of hornets as a kitchen companion.

There are several minute hymenopterous parasites of the house-fly. Some of these are parasitic on the larvæ and some upon the puparia. It is probable that in certain instances some of these parasites are numerous enough to destroy many flies. However, much more remains to be learned regarding the habits and destructiveness of these enemies of the fly.

A. A. Girault and G. E. Sanders of the University of Illinois have given a good deal of attention to the parasites of the house-fly. Many of their observations have been published in the entomological magazine, *Psyché*, within the last two or three years. In one instance, at least, they found a certain parasite so abundant that it destroyed as high as ninety per cent of its host. One could wish that this enemy of the house-fly occurred more frequently and were more widely distributed.

THE RELATION OF THE HOUSE-FLY TO DISEASE

Notes of suspicion have been sounded against the house-fly by far-seeing physicians for many years, but nothing definite was proven against this insect until comparatively recent times. It has now been definitely proven that house-flies can and do carry, both externally and internally, certain disease producing germs. For example, it has been shown by several observers that the bacilli of typhoid fever may be carried on the feet, legs, bodies, and in the alimentary canals of flies. Moreover, the bacilli pass through the alimentary tract and are voided in the "specks" in a virulent condition. The typhoid bacillus has been recovered from flies caught in undrained privies.

The bacillus of cholera has also been found in great numbers on the bodies of flies and has been found in fly "specks" within 17 hours after the insects have been fed upon cholera infected material and the bacilli have persisted in the "specks" for several days. Moreover, flies infested with these germs have been shown to carry them to milk.

It is also held that the house-fly may carry the tuberculosis bacillus and deposit it on food. Several experimenters have found the bacillus in the intestines and excrement of flies that have been fed on the sputum of tuberculous patients. There is evidently grave danger of infection through the agency of house-flies. Every one has noted the avidity with which flies seem to feed on expectorated saliva.

House-flies are charged with the conveyance and distribution of the germs of infantile diarrheal diseases. Jackson showed that the mortality of bottle-fed infants in proportion to those feeding at the breasts was as 25 to 1 in New York City. He feels sure that the house-fly is responsible for a large part of this mortality among bottle-fed infants, due to the infection of the milk by the flies with the germs of infantile diarrhea, and the like.

There seems a possibility that the house-fly may convey the plague bacillus from infected rats or human beings to other individuals. The bacilli of leprosy have been found in the alimentary canals and feces of flies after they have been allowed to feed on leprous sores. Whether these bacilli, if lodged by the fly on the person of an uninfected individual, would enter the system of that individual and produce the disease is not known. At all events, one would not care to have a fly carrying these bacilli alight on one's food or person.

Anthrax bacilli are also carried about by flies, and Howe, according to Howard, has shown that the purulent conjunctivitis of the Egyptians is spread by the house-fly. House-flies are especially dangerous as agents of the dissemination of disease germs because they are fond of all kinds of human foods, both liquid and solid, and, moreover, are very restless, active insects, traveling quite extensively and flitting from place to place with considerable rapidity. "In the course of a few moments a single fly may crawl over human or other excrement, sip from a glass of milk or water, and merrily chase across a dish of mashed potatoes, or other human food. It may visit a dead and decaying animal, or sport about the mouth of a reeking sewer, and in the next five or ten minutes sip from the edge of a glass of jelly or alight in the sugar bowl." As an English author wrote many years ago, the house-flies become a great nuisance "both from their numbers and the pertinacious curiosity with which every individual of the race seems resolved, for its own satisfaction, to taste, see, and touch every object around it."

As a result of this restless characteristic of the house-fly, it often plays a prominent part in the contamination of milk. Unfortunately, milk is a favorable medium for the growth and multiplication of bacteria and it is, therefore, easily contaminated. We have already pointed out that the body and feet of the fly are admirably fitted for carrying bacilli; and that the bodies of flies are usually teeming with myriads of these microscopic plants. Moreover, it is easy, in fact almost inevitable, for flies to fall into open pails and cans of milk whenever the latter are accessible to these roving insects. If a fly bearing typhoid fever bacilli should fall into a pail of milk, the contagion might easily be spread all along the route of the milkman. Undoubtedly, such instances have occurred, as shown by the following case quoted by Hewitt from Taylor (Colorado State Board of Health). "In the city of Denver we had a very sad as well as a plain demonstration of the transmission of typhoid fever by flies and milk. Early in August of this year the wife of a dairyman was taken with typhoid fever, remaining at home about three weeks before the removal to the hospital, August 28. During the first two weeks of September we received reports of numerous cases of typhoid fever in the northern portion of Denver, and upon investigation found that all these cases had been securing their milk from this dairy. An inspection of the dairy was then made, and in addition to learning of the illness of the dairyman's wife, we also found the dairyman himself suffering with a mild case of typhoid fever, but still up and delivering milk. The water supply of the dairy was fairly good. However, we found that the stools of both the wife and husband had been deposited in an open privy vault located 35 feet from the milk-house, which was unscreened and open to flies. The gelatine cultures exposed for 30 minutes in the rear of the privy vault and in the milk-house among the milk-cans gave numerous colonies of typhoid bacilli, as well as colon bacilli and the ordinary germ-life. The source of infection in the dairyman's wife's case is unknown, but I am positive that in all the cases that occurred on this milk route the infection was due to bacilli carried from this vault by flies and deposited upon the milk-cans, separator, and utensils in the milk-house, thereby contaminating the milk. The dairyman supplied milk to 143 customers. Fifty-five cases of typhoid fever occurred and three deaths resulted therefrom."

THE NATURE OF TYPHOID FEVER AND ITS RELATION TO THE HOUSE-FLY

The relation of the house-fly to typhoid fever is considered the most important phase of the disease-germ-carrying powers of this insect. In order to understand and appreciate this relation clearly, something of the nature of the fever and of the typhoid bacillus should be known.

Typhoid fever is a so-called enteric disease. That is, it is caused by a bacillus or germ that enters and lives within the intestines of the affected individual, causing ulcerations of these organs. The bacillus affects other organs than the intestines, for example, the spleen, and is often found in the kidneys, liver, lungs, and even in the brain. Its presence, together with a poison that it excretes, produces the conditions that give rise to the characteristic symptoms of typhoid fever, namely, an increasing and fluctuating temperature, rose rash over the abdomen, diarrhea or constipation, and occasionally hemorrhages of the intestines. The peculiar and vitally important thing about the bacillus causing the disease is, that it may be present in the alimentary canal of a human being some time before the individual becomes ill and may remain long after the patient has entirely recovered. Moreover, the bacilli, when present in an individual, may be given off in the feces and in the urine. Thus, an individual may be giving off these bacilli of typhoid fever days before taking to the bed, and weeks or months or even years, in the case of a "walking typhoid" patient, after recovery. If the excreta or urine containing these bacilli are deposited where they are accessible to flies, for instance in open privies, the chances are high that the bacilli will be carried on the bodies of these insects back to our kitchens and dining-rooms and be deposited on our food. During the Spanish-American War, flies were traced by their whitened feet, from the lime-sprinkled, open latrines, or privies, to the dining tables of the soldiers in camp.

It makes one shudder to think of the thousands of open closets in the towns of the United States to which flies have access and in which they breed and from which they may come direct to our kitchens and dining-rooms.

CHRONIC CARRIERS

As stated in the foregoing, it has been known for some time that the bacilli of typhoid might be given off before the patient was brought to bed and several days, perhaps, after apparent recovery. But it is only within comparatively recent years that the "chronic carrier" has become recognized.

Howard gives many instances of this type of affected individual, among the more notable of which are the two following:

"The first case here to receive general notice was that of 'Typhoid Mary,' an Irish cook, who was discovered by Dr. George A. Soper of New York. She had been cook with a family on Long Island and during the summer of 1906 several cases of typhoid occurred. The writer was consulted, and advised that Doctor Soper be called in to make a thorough investigation. The results of Doctor Soper's search were most interesting. After studying every possible source with absolutely negative results, the proper examinations were begun, and it was discovered that Mary, the cook, was a chronic carrier. Her past history was looked into, and it was found that for several years there had been typhoid cases in nearly every family who had engaged her. She was immediately isolated and kept in custody three years. Then she was released, promising never again to engage as cook and to report at frequent intervals. She returned after four months, saying that she could get no work and was placed by the New York City Department of Health in one of the laundries of a public institution, where she still remains."

"In another instance an epidemic of typhoid in the Tenth German Army Corps in the summer of 1909 was traced to a chronic carrier in the case of a woman who prepared vegetables and who had assisted in the preparation of vegetable salads. The typhoid bacillus grows on the surface of potatoes readily, and this accounted for the outbreak, on the necessary supposition that the woman was of uncleanly habits. The curious point in this case was that she had had typhoid thirty-six years previously for the only time."

It is difficult to detect these chronic carriers, and often a serious problem to know what to do with them when found. It is evident that they are dangerous and undoubtedly many, of whose presence we are unaware, are in existence. It is important that all possible efforts should be made to detect them and it is equally important that none of them should be allowed to take any part in the production or sale of milk or its products and no part in preparing and handling food.

FLIES THAT BREED IN HUMAN EXCREMENT

Since flies take up bacilli on their feet, from places where they breed and over which they walk and carry them into our dwellings, it becomes pertinent to ascertain what flies breed in human excrement and whether such flies enter our houses. L. O. Howard, in an investigation of this subject, found that 36 species of flies actually breed in human feces and 41 species were found visiting this substance or feeding upon it. Of these 77 species, he found that six were in the habit of visiting houses and were actually caught in dwellings. At the head of these stood the common house-fly, which was, by far, the most abundant fly in houses, but not, be it said, the most numerous one on the excrement.

It is almost superfluous to point out and emphasize the great desirability of protection from these filth-carrying and quite possibly disease-carrying insects.

METHODS OF PREVENTION

The ideal method of fighting house-flies would be to destroy the eggs and maggots, just as we fight mosquitoes, but the problem is a difficult one, especially in the country, where open closets exist and horse and cow stables are always present. The opportunities for flies to breed are really very great, and waste material in the form of decaying animal and vegetable matter is an invariable accompaniment of life. There is much that can be done, however, to lessen the dangers from this insect.

Treatment of manure piles. — Domestic animals are absolutely necessary, but it is not necessary to throw the manure from horse and cow stables and from pig-pen and poultry house out into piles in the open yard to lie there for weeks and become ideal breeding grounds for flies.

The treatment of manure piles with a substance to kill the maggots has been tried by Howard, Forbes, Herms, and others. Howard found that chloride of lime was an effective maggot-killer and that one pound of it mixed with eight quarts of horse manure killed 90 per cent of the maggots in less than twenty-four hours. Unfortunately, chloride of lime costs at least three and one-half cents a pound and, in addition, the chlorin fumes from treated manure piles act as an irritant to the eyes of live stock. If the manure is piled away from the stable and one does not mind the expense, chloride of lime may prove satisfactory. Otherwise it is probably impracticable.

Howard's experiments with kerosene seem to indicate that this material is also impracticable. It does not penetrate a large pile of manure with sufficient ease to reach all of the maggots unless so large quantities are used that the cost becomes prohibitive. Ordinary slaked lime has not proved an efficient destroyer of the maggots.

J. J. Davis of the University of Illinois, under the direction of S. A. Forbes, carried out some interesting experiments in the treatment of manure piles with iron sulphate. This treatment proved so successful in killing the maggots that it seemed possible to make certain recommendations, namely, that a solution of iron sulfate, two pounds in a gallon of water, or two and one-half pounds of dry sulfate would be sufficient for one horse each day. Iron sulfate is so cheap that it would not cost over two cents a horse a day and, in addition, it completely deodorizes the manure. As a basis for this recommendation, it was estimated that the average driving horse produces about fifteen pounds of manure a day, while a working horse might produce twice that amount. But a large part of the manure of the working horse is dropped out-of-doors, so that, perhaps, no more would accumulate for treatment than for a driving horse.

The storage and removal of manure. — It has been shown that flies prefer light, open places in which to breed and that they rarely enter dark rooms to deposit their eggs. It therefore becomes an inexpensive and simple matter to build a dark, well screened room or a tight cement pit in which the manure can be stored for a long time or, if preferred, can be removed once or twice a week.

Herms describes and illustrates several forms of receptacles for the storage of manure in use in Berkeley, California. He says, "Where only one horse is stabled a simple galvanized iron garbage can has been found very useful and convenient, or even a tight barrel covered over with a tightly fitting lid. The contents of these cans or barrels are removed once or twice per week, either by the city scavengers or by gardeners for fertilizing purposes. Where many horses are stabled, as in a livery stable, a larger receptacle must be provided. In such cases, a closet or bin can be constructed at a small cost, which is satisfactorily offset by the absence of the fly nuisance. Such a closet may be built in one corner of the stable, with a small screened door through which the manure is thrown when cleaning the stalls (providing for ventilation), and an outer door giving access to clean out the closet once or twice per week. Or a closet of about the same construction may be built in the form of a shed or lean-to, connecting with the stable by means of a small screened door, as above. Where it is not convenient to construct a lean-to of this type because of sliding doors or other obstruction, a bin may be substituted as shown in the figure (Fig. 7). The illustration shows the bin ready to receive the manure; the bolted door shown in front swings up to allow access in the removal of the manure. The use of a concrete floor built directly upon the earth is strongly recommended, and the wood inside should be well provided with a heavy coat of tar." Of course, con-

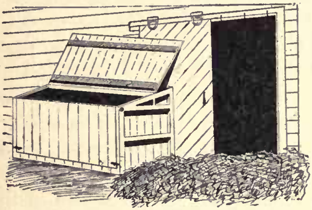

FIG. 7. — Bin for holding manure.

crete bins and pits are preferable to wooden ones, but they are more expensive.

In the country, where it is preferred to remove the manure once or twice a week rather than to store it, it should be drawn to the fields and scattered thinly over the surface. If the manure is left in piles or in large lumps, there is still danger of its serving as a breeding place for flies. But if scattered thinly, it will soon dry out and become unsuitable for the maggots. A manure spreader would be an admirable machine for this purpose, for it cuts the manure up fine and scatters it evenly and thinly.

Open box privies. — These are more dangerous in a direct way than barnyard manure piles. The flies that breed in these privies and those that breed in the manure piles and afterward visit the privies are a constant source of danger. The feet of such flies are sure to be loaded with whatever germs there may be in such filth and where they eventually visit the kitchen and dining-rooms the food they touch just as surely becomes contaminated with the germs the flies are carrying. Moreover, on farms these flies are apt to contaminate the milk and thus endanger the lives of people consuming it. City health authorities are becoming alive to the dangers of unsanitary conditions on the farms from which milk supplies come. It, therefore, behooves a farmer to pay special attention to these conditions, not only to safeguard the lives of his own family, but to insure the disposal of his milk products to the best financial advantage. There is no longer any excuse for the old open, box privy, cleaned out once a year. It is a positive menace to every house in the near vicinity as well as to individuals living, perhaps, hundreds of miles away because of its possibilities in contaminating milk supplies. Some form of sanitary closet must be substituted and the question is so important that it seems worth while to discuss it at some length.

Undoubtedly some form of closet by which the waste matter falls in water to be disposed of later or to be carried away immediately through underground pipes to a safe place of disposal is the most satisfactory. In the country, and in a multitude of small country towns probably some form of dry closet will be most used for years to come.

A type of closet that serves much better than the open, box privy should, first of all, be built as nearly fly tight as possible. It should have a vault built underneath it of brick and cement or other water-tight material. The vault should be wide enough so that it extends as far back outside of the closet as it extends underneath and should be high enough to prevent surface water from entering it. Of course the part extending outside of the closet must be cloesd with a tight fitting cover. In addition, an abundant supply of wood ashes, sifted coal ashes, or fine soil, or lime, should be kept inside and sprinkled freely over the material in the vault by each one using the closet. A liberal use of kerosene oil by pouring it over the material in the vault once every week will aid greatly in destroying the eggs and maggots of the fly. When the part of the vault beneath the seat becomes full, the material may be drawn backward into the outer half of the closet. This may be repeated several times during the year. The material may remain there, but it is best to soak it well with oil occasionally. When it is removed, it should not be used as fertilizer, but should be burned if possible, and if not, it should be buried far from any buildings.

A much better form of closet is described and figured in detail by Stiles and Lumsden in Farmers' Bulletin 463 of the United States Department of Agriculture. This bulletin may be had by writing to the Secretary of Agriculture, Washington, D.C. The author would advise all who are interested in this subject to obtain a copy of this bulletin. Two simple types of sanitary privies are described in detail and fully illustrated. Each one is simple in construction, inexpensive, and sanitary. Explicit directions are given for building them, together with a detailed bill of lumber and materials needed.

FIG. 8. — Hodge's trap for garbage can.

Fly traps. — There are excellent wire traps for catching flies, that, when baited with some attractive substance, will catch hundreds of these insects.

C. F. Hodge is very enthusiastic over the use of traps placed out-of-doors, for instance, on garbage cans, to catch the flies before they enter the houses at all. With one of these traps affixed to a garbage can he caught 2500 flies in fifty-five minutes (Fig. 8). The cover of the can was held up so that there was a small open space all around through which the flies might enter. After they had once entered the can, they naturally migrated upward through the hole over which the trap was placed, being attracted by the light which entered only at this place.

Hodge argues that we should catch the first original pair of flies in the spring before they lay any eggs and thus escape the whole fly trouble. And he thinks it could be done in some such way if every one would coöperate.

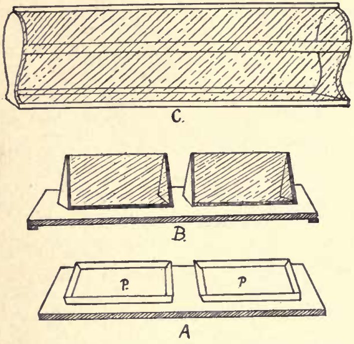

FIG. 9.—A large fly trap.

The ordinary fly traps are rather small and where flies are abundant have to be emptied too often. It is sometimes desirable to have a trap in which flies may be caught in large quantities without being frequently emptied. A. M. Bull of the engineering division of the University of Minnesota designed a large trap of this kind that has proved very successful (Fig. 9). The trap is twenty-four inches long, eight inches high, and twelve inches wide. It consists of three parts, a baseboard (*a*), a roof-like trap (*b*), and an oval part (*c*). On the baseboard are two shallow pans to contain the bait, usually milk and bread. The trap consists of two roof-like screens with several openings along the ridge for the flies to crawl through. These two traps are fastened to the board (*b*). The oval part (*c*) covered with wire screen is placed over the roof-like traps to receive and hold the flies. The three parts are held together by the hooks at the end (Fig. 10). In Fig. 11 is shown a cross section of the trap, which will aid in explaining the construction. The space between the baseboard and middle portion is about one-half an inch. The bait should be renewed occasionally and not allowed

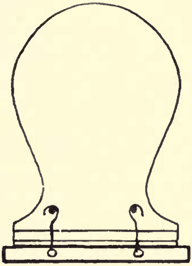

FIG. 10. — End of trap, showing hooks.

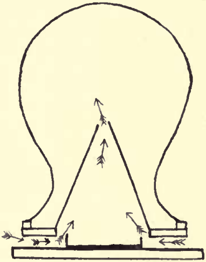

FIG. 11. — Cross section of trap.

to become dry and unattractive. The flies that gather in the upper, oval part of the trap may be killed by pouring boiling water on them. Probably galvanized wire screen will withstand the effects of water and general usage without rusting better than the ordinary painted wire.

With this trap, the Minnesota people caught in a dairy barn in one day, 1700 flies; dining hall, rear of building, two days, 3000 flies; same place, five days, 13,000 flies; on the back porch of a dwelling house not far from a stable containing a few horses, two days, 8700 flies; same place, one day, 12,000 flies; same place one and a half days, 18,800 flies. These instances suffice to show the effectiveness of such a trap in certain situations.

Insect powder. — There is a powder known as pyrethrum, Persian insect powder, or buhach, that is sold a great deal for killing all kinds of insects, especially household pests. When the pyrethrum can be obtained in a fresh condition it is an excellent insecticide. There is no more satisfactory way of ridding a kitchen of house-flies than by the use of this powder. Go into a kitchen at night, close all the doors and windows and then sprinkle fresh insect powder over the stove, on the window ledges, tables, in the air, everywhere. In the morning flies will be found lying around dead or stupefied. They may then be swept up and burned. It is often difficult to get fresh pyrethrum and for this reason its use is not always a success. The buhach is a California product made from the pulverized heads of a species of Chrysanthemum grown near Stockton, California. This powder costs a little more than the Persian powder, but it is apt to be fresher and stronger. It will pay to buy the buhach whenever possible.

Another method of using pyrethrum or buhach is to moisten the powder with water and mold it into small cones. These cones are then placed in an oven until they are thoroughly dry. Then they may be set on end in pans and lighted at the tips. The fumes, which are not unpleasant and are harmless to human beings, will kill the flies.

It is said that the vapor produced by placing 20 drops of carbolic acid on a hot shovel will also kill the flies. We have never tried this and have heard of reported failures. It would seem as though the amount to be used would depend upon the size of the room.

Mims culicide. — This is also useful in killing flies as well as mosquitoes. It should be used exactly as is described in the chapter on methods of protection from mosquitoes.

Bichromate of potash. — This is a substance often used to kill flies. It is not a virulent poison and, therefore, little danger is incurred in putting it about the room. It should be dissolved in water at the rate of one part of the potash to two of the latter and then set about in shallow dishes. If the room can be darkened except one window and the solution put on the ledge of this one, in the light, the results will be quicker. This substance has not always given good results.

Formaldehyde. — One of the best solutions for attracting and killing flies is a dilute mixture of formaldehyde (40 per cent) with water and milk. A tablespoonful in a pint of equal parts of water and milk will attract the flies and kill large numbers of them. The mixture should be poured into shallow dishes, soup plates for instance, and a crust of bread dropped into the middle of the dish for the flies to light upon and to facilitate their feeding. If the shades of all of the windows in a room but one are pulled down and a plate of this mixture set in the light, the flies will be attracted and killed. We have cleared a dining-room of every fly in an afternoon in this way.

Formaldehyde will not prove so effective in dining-rooms or kitchens where there is food, water, or milk to which the flies have access. It will be most successful where it is the only liquid they can get to drink. Formaldehyde is not a virulent poison and little risk is run in using it.

Fly papers. — Tanglefoot fly papers should be in use in a kitchen and in a dining-room too, if the latter has flies in it. This fly paper can be had anywhere now, costs little, and is very efficient. No fly should be allowed to live a minute longer in any kitchen than is absolutely necessary. Better, a great deal, that it should live in the parlor.

House-flies are very fond of gathering on a string or strip of paper or cloth hanging from the ceiling. This habit is noticeable in any room where flies are abundant and the strips are available. It may be taken advantage of in a very effective manner, namely, by suspending narrow strips of tanglefoot paper from the ceiling. The flies will alight on these narrow strips when they will not go near the sheets lying on a table or window sill. It is amazing how easily and in what numbers they may be caught by this simple device.

Disposal of wastes. — Decaying fruits, vegetables, scraps, and slops from the house ought always to be placed in tightly covered cans or barrels or in closely screened rooms until they can be removed and buried, burned, or otherwise disposed of. Scrupulous care and cleanliness should always be practiced around the house.

The excretions of patients suffering from typhoid fever, diarrhea, dysentery, and other intestinal diseases should be thoroughly sterilized by treating with a liberal quantity of carbolic acid before being thrown into closets or sewers, or should be burned.

Special effort should always be made to exclude flies from a sick room, particularly in the case of contagious

PLATE 1

Eggs of house-fly (×4), above; properly screened porch, below.

diseases. They not only annoy the patient, but they are liable to convey contagion to other members of the household. The faces of babies should be screened with mosquito netting.

Protection of food. — Food and confectionery exposed in public places, lunch counters, and restaurants should be protected from flies by screens, cases, or other contrivances. One ought to boycott lunch counters that expose their food to the dust, flies, and other insects always found in abundance about railway stations, and restaurants. The exposure of fruits in the ordinary street fruit stands in cities is dangerous to public health.

The use of screens. — After all is done that seems possible, still there will be some flies, but these may be largely kept out by a thorough screening of all doors and windows, as is fully described in the discussion of the mosquito. Especially will there be flies and filthy, germ-bearing ones, if the neighbors take no pains with their stables and closets.

Flies enter a house largely through the back door of the kitchen. They are attracted to this opening by the odor of the cooking and by the warm air pouring outward when the door stands open. This is especially noticeable on a wire gauze door toward night if the main door is left ajar. The wire screen is often literally black with flies and whenever it is opened some of them are almost sure to enter. Moreover, this door is opened, probably, more than any other in the house. The only efficient method of keeping flies out of the kitchen is to build a porch (Plate 1) over the back door and screen the three open sides. Of course a wire gauze door must be placed in one side wherever it is most desired. With this arrangement, the flies cannot gather on the screen door of the kitchen, and they do not gather on the porch screen door any more than anywhere else because there is no warm air or odor there.

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CHAPTER II

FLIES, OTHER THAN THE HOUSE-FLY, THAT FREQUENT HOUSES

AMONG the flies commonly found in houses, the house-fly constitutes the major number; but there are several other species of flies that frequent dwelling rooms, some of which are often mistaken for the house-fly. Perhaps the most common ones found in houses are the biting house-fly, the small house-fly, the cluster-fly, the stable-fly, the "blue-bottle" flies, and the fruit flies.

Although the foregoing and a few other species of flies are frequently found in dwelling-houses, the house-fly constitutes, by far, the greater portion of all the flies that may occur in living-rooms. Howard, aided by persons in different parts of the United States, made a collection of the flies found in rooms in which food-stuffs were exposed. Altogether, 23,087 flies were caught from various localities in this country. Of these, 98.8 per cent were the common house-fly. Of the remaining 1.2 per cent, the smaller or lesser house-fly was the commonest species. Hamer, in London, found that more than nine-tenths of the flies in kitchens, and living-rooms of houses near depots for horse-refuse, manure, etc., were the common house-fly.

The following table adapted from Johannsen will serve to distinguish some of the more common of these allied species. A hand lens will be needed to make out some of the characters: —

a. Wing with apical veins (M and R) parallel or diverging at tip (Fig. 12). *Homalomyia canicularis,* the lesser house-fly, breeds in waste vegetable substances, and also in excrement.

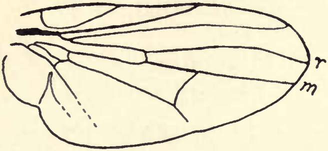

FIG. 12. — Wing of the lesser house-fly. (× 10.)

The male has 3 pairs of yellow translucent areas on its abdomen. Several related kinds (*Phorbia,* etc.) are also frequently seen in houses.

aa. Wing with apical veins (M and R) more or less convergent (Fig. 13).

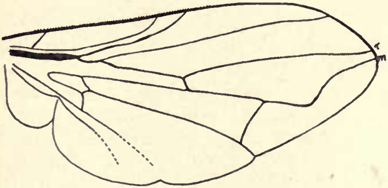

FIG. 13. — Wing of house-fly. (× 10.)

b. Flies with blue or green metallic coloring. Blue and green bottle flies. Common indoors, especially in spring and fall. They breed in fresh and decaying meat and vegetables, some in excrement.

bb. Flies with dull non-metallic coloring.

c. With mouth-parts produced and pointed, fitted for piercing (Fig. 16). *Stomoxys calcitrans,* the biting house-fly, is a trifle larger than the typhoid fly. Especially common in barns. It breeds in vegetable refuse, manure, and excrement. 3 *Hæmatobia serrata*, the horn fly, is similar, but much smaller. It is occasionally found in houses; common on cattle.

cc. With blunt mouth-parts (Fig. 6).

d. Last section of vein M of the wing with abrupt angle.

e. Thorax with four longitudinal lines and without golden hairs. House-fly, *Musca domestica*.

ee. A larger fly with no lines on thorax but with golden hairs. Cluster-fly, *Pollenia rudis*.

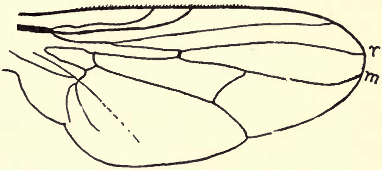

FIG. 14. — Wing of stable-fly (*M. stabulans*). (× 8.)

dd. Last section of vein M of the wing with a broad gentle curve (Fig. 14).

f. Eyes microscopically hairy; each abdominal segment with 2 spots. Larvæ are found in dung and excrement. *Myiospila meditabunda*.

ff. Eyes bare; abdomen gray and brown marbled. *Muscina assimilis* with black legs and feelers, and *Muscina stabulans* with legs more or less yellowish, and which breeds in decaying vegetable substances, dung, and excrement, are frequently found in houses.

THE CLUSTER-FLY

Pollenia rudis

The cluster-fly is well-known to most housekeepers because of its habit of entering houses in the autumn and hiding away in protected nooks in large groups or clusters. We have seen a handful of these flies in single clusters in the corners of rooms and beneath garments hung up in closets and beneath curtains at the windows of seldom used rooms. They are a nuisance and a source of considerable annoyance, not from the damage they do, for this is evidently slight, but because of their presence. They are not welcome guests at any time.

The cluster-fly is an European insect and it was known there at least a century ago. Just how or when it came to this country is not known. It could easily have come to this country on board ships, for it would as readily enter a ship lying in port on an autumn day as a dwelling house. From its habit of hibernating in clusters all winter it could take several rides back and forth across the ocean before spring. Loew mentions it in a list of flies published in 1864 as common to Europe and America so that it was here some years before that date, at least.

Appearance of the fly. — It is slightly larger than the house-fly and appears longer and narrower. This is because the wings, when in repose, overlap each other, thus bringing the outer edge of each almost parallel with the sides of the abdomen. This position of the wings gives the effect of narrowness when viewed from above (Fig. 15). The wings of the house-fly when in repose stand out at a considerable angle to the abdomen. Moreover, the thorax of the cluster-fly bears many short, golden hairs. The thorax is of a uniform coloration and lacks the light and dark lines on the thorax of the house-fly. The abdomen is grayish but inclined to be iridescent, and thickly set with hairs, especially at the posterior end and along the sides.

Its habits. — Normally the cluster-fly lives out-of-doors, frequenting the flowers and fruits of plants. In the autumn, however, it enters dwelling-houses in search of snug retreats in which to pass the winter. It gathers in clusters in the corners of unused, darkened rooms, under clothing in closets, beneath curtains at windows, and in other nooks. A correspondent writes, "Can you give me information concerning the house-fly which in late August and September gets into unused rooms where there is no food or odor and bunches in the angles of the wall and behind pictures and furniture? They do not fly much but crawl about in a lazy manner. Screens and every device which works perfectly in excluding the ordinary fly are useless in keeping these out." This letter describes the habits of the cluster-fly admirably.

Fig. 15. — The cluster-fly. ($\times 2\frac{1}{2}$.)

W. H. Dall quotes from a letter of a relative living at Geneva, New York, who had been much troubled with these flies. Evidently the flies had been troublesome in the neighborhood, for the letter says, "people soon learned to look everywhere; in beds, in pillow-slips, under table covers, behind pictures, in wardrobes, nestled in bonnets and hats, under the edges of carpets, etc." They were also said to be found in incredible numbers under buildings between the earth and the floor.

Lintner gives several instances of the occurrence of these cluster-flies in buildings in different localities in New York State.

The cluster-flies enter a building in the fall one by one through cracks and crevices and afterwards gather in clusters. In the spring they swarm on windows on warm sunny days. When crushed some say they emit an odor like honey, others say the odor is disagreeable.

Its life history. — Almost nothing is known of the life history of this fly, as common as it is. Riley states that he found the puparia of the cluster-fly in the roots of grass about three inches below the surface of the ground. Howard says that a single specimen of this fly was reared from cow-manure in the Insectary of the Bureau of Entomology at Washington. J. S. Hine of Columbus, Ohio, writes Howard that he reared a number of specimens of cluster-flies from cow droppings in the pasture.

Robineau Desvoidy remarks that the eggs of the members of the genus Pollenia are laid in manure and in decomposing animal and vegetable matter.

Methods of control. — We are probably partly safe, at least, in assuming that the cluster-flies lay their eggs on decaying vegetable matter and that the larvæ live in these substances. If correct, then the same methods used in the control of the house-fly will also be of benefit in controlling the cluster-fly. However, it is probable that the cluster-fly breeds over much wider areas, — away from buildings, out in the fields and possibly in the woods.

In this event, it would be impracticable to control it in the same way as we would the house-fly.

The clusters of flies found in the corners of rooms may be swept into boiling water and killed. Fresh pyrethrum or buhach dusted freely on them will kill or stupefy them so that they may be swept up and burned.

Screens afford little protection against cluster-flies. A correspondent writes that, "The only way I have found to keep them out of the room is to leave out screens, lower the window from the top, and have the room light." Fortunately, the cluster-flies are often subject to a fungus disease, which kills many of them. This fungus has been determined by Thaxter as *Empusa americana.*

THE BITING HOUSE-FLY

Stomoxys calcitrans

This fly is commonly known as the stable-fly, but as it frequents houses, bites severely, and is often mistaken for the house-fly, it may well be called the biting house-fly. Because of the mistaken identity between this fly and the common house-fly the popular fallacy that the latter can bite has arisen. The biting house-fly is slightly larger and more robust than the house-fly and has an awl-like proboscis (Fig. 16) with which it can pierce the flesh and cause severe irritation. It will bite through stockings, and is very annoying, sometimes, by biting one's ankles, especially when low shoes are worn.

Habits and life history. — This is normally an outdoor insect, but it frequently seeks the shelter of houses, especially just before storms and has, therefore, been called the "storm-fly." Other flies, however, have the

FIG. 16. — Head and proboscis of the biting house-fly. (× 8.)

same habits, and the name "storm-fly" is no more appropriate for this fly than for others. It loves the direct sunlight, and may be seen basking on walls and fences in the sun. When darkness begins they seek shelter in protected places, entering stables and other buildings. While camping one summer in the Adirondacks the author pitched his tent in a small wooded pasture near the shores of a lake. Every evening these flies (Fig. 17) would come into our tent in numbers and rest on the walls and roof until the sun appeared the following morning. They evidently bred in the droppings of two cows that frequented a moist shady retreat not over a score of yards from our tent.

Farm-yards and stables are evidently the usual haunts of this fly, but it is found in fields, about gardens, and in open woods where cattle are grazing.

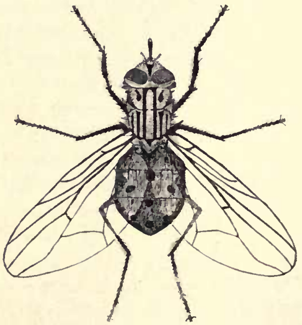

FIG. 17. — Biting house-fly, *Stomoxys calcitrans*. (× 3½.)

Newstead has traced its life history quite fully. He found that the creamy-white eggs were laid in irregular heaps in fresh horse manure and in the feces of other animals. He found the females actually depositing their eggs in numbers in piles of heated lawn grass alongside of a cucumber frame in a garden. Howard has reared the fly from horse and cow manure and remarks, "I judge from the fact that it is attracted to human excreta that it may become a carrier of intestinal disease."

The eggs hatch in two to three days under temperatures ranging from 65 degrees to 72 degrees F. The larvæ demand a good deal of moisture and an absence of light for their best development. Under these conditions they attain their growth in two to four weeks. Evidently where soil is available beneath the manure the larvæ bore down to it and pupate in the earth. The pupal stage lasts 6 to 26 days. The complete life cycle is, therefore, passed through in from 3 to 4 weeks under favorable conditions of light, heat, and moisture.

F. C. Bishopp records a very interesting outbreak of the biting house-fly in Texas. The flies, in this case, were found breeding in great numbers in straw stacks. From these situations they swarmed on the live stock, causing serious injury to horses and cattle. Moreover, investigation and inquiry disclosed the fact that previous outbreaks of this fly had occurred in former years.

Bishopp found the flies breeding in oat, rice, barley, and wheat straw, and in horse manure and cow manure. In the straw stacks, the maggots were found in the wet rotting straw. When the larvæ attained their growth they pupated in the straw. A single fly was seen to make three depositions of eggs, laying a total of 278 eggs. The total period from egg to adult varied from nineteen to forty-three days.

Howard, in his book on the house-fly, relates an interesting investigation of the biting house-fly made by Lucien Iches and reported in a paper to which we have not had access. Iches found the flies swarming in great numbers on a large estate in the province of Santa Fe', Argentina. The cattle were very greatly annoyed and driven almost frantic by the bites of the flies. Certain Durham bulls were particularly infested with the flies. The hair had disappeared in spots and the skin was cracking. A search for the breeding places showed that the larvæ and puparia existed by the millions in the lower portions of piles of straw left from threshing. Fermentation had begun in the straw, thus affording an attractive place for the deposition of eggs. The breeding places were destroyed by burning the straw.

The bite of this fly is severe, as any one can attest who has been a victim. Osborne says: "It causes a great amount of annoyance to cattle, horses, and other domestic animals, and it is frequently very troublesome to people working in places where it abounds. Its bite is not poisonous and aside from the pain given and the possibility of its disseminating disease, it is less injurious than some other members of the group. When abundant, however, this annoyance may be very great, and they all deserve attention."

Bold gives an interesting note regarding the severity of the bite on cattle. In this case fourteen cows under the treatment of a veterinary surgeon were generally bitten on the legs, shoulders, and rarely on the necks. "In some of the severe cases the joints were so much swollen that the poor animals could not bend their legs to lie down; and in them the inflammation rose so high as to cause the loss of the outer skin and hair. The flies appeared to prefer the knees and upper portion of the foot in the cow, frequently crawling from thence to the hands of the veterinary, but on him their bite had no injurious effect."

Relation to disease. — The biting house-fly has been suspected of transmitting disease, particularly among domestic animals. They have been charged with transmitting glanders from diseased to healthy animals and anthrax among cattle. Schuberg and Kuhn have lately shown, experimentally, that this fly is capable of transmitting certain trypanosomes in a mechanical manner to healthy animals. In 1912, Brues and Sheppard brought together certain evidence pointing toward this fly as a transmitter of infantile paralysis. Later, in September of that same year, Rosenau and Brues announced that they had experimentally transmitted infantile paralysis, through the agency of *Stomoxys calcitrans* to monkeys which were suspectible to the disease. In the month following, October, Anderson and Frost, of the Public Health and Marine Hospital Service, announced that they had repeated the experiments with similarly positive results. We therefore find that four scientists working in groups of two, independently of each other, have demonstrated that the biting house-fly is a transmitter of infantile paralysis among monkeys susceptible to the disease. Moreover, Brues and Sheppard have shown that the seasonal occurrence, distribution, and other facts connected with Stomoxys agree wonderfully well with the conditions of an epidemic of this disease. From all the evidence at hand we are justified in looking upon the biting house-fly with considerable suspicion, for it may be a transmitter of infantile paralysis among children. It must be said, however, that later experiments by different workers have given only negative results in the transmission of this disease.

It has been suggested, with some show of reason, that this fly may play a rôle in the transmission of pellagra.

THE STABLE-FLY

Muscina stabulans

The stable-fly resembles the house-fly considerably but it has a longer and more robust body. It is evidently not as abundant in houses as some of the other species. Hewitt says he usually finds it in the early summer before the house-fly has appeared in any numbers. It seems to be widely distributed in this country and in Europe and is often mistaken for the house-fly (Fig. 18). The dorsal side of the thorax is gray and bears four dark longitudinal lines quite similar to the thorax of the house-fly.

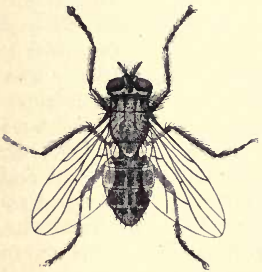

FIG. 18. — The stable-fly, *Muscina stabulans*. (× 3.)

The eggs of the stable-fly are laid on decaying vegetables, fruits, fungi, and in cow manure. Hewitt says that the larvæ sometimes attack growing vegetables, probably having been introduced about the plants in manure. Howard found the flies frequenting human excreta and the larvæ breeding in this material. It has been reared from the pupæ of the cotton-leaf worm, the gipsy moth, and from pupæ of certain Hymenoptera. It has also been reared from masses of the larvæ and pupæ of the imported elm leaf-beetle. The chances are that it was not parasitic on these insects, but that the pupæ were in a decaying condition, thus acting as food for the larvæ. The life history of this fly is not known in detail, but Taschenberg says that the life cycle occupies from five to six weeks. The larva of this fly has been known to pass through the alimentary tract of man. In this case access was probably gained to the stomach through vegetables eaten by the individual.

The relation of this fly to the dissemination of disease is not definitely known, but it is a species that should be considered with suspicion until proven guiltless, at least. It breeds in human excreta and is evidently attracted to this material, especially when it is deposited in open places. As it enters houses there is thus ample opportunity for it to pick up and convey disease-producing germs. Its scientific name, *stabulans*, was given to it before its habits were known; but in the light of what we now know of its breeding places there seems to be little appropriateness in the name stable-fly.

THE LESSER HOUSE-FLY

Homalomyia canicularis

In early spring, in May and June, before the house-fly appears, there are often numbers of small flies frequenting rooms and crawling on the window panes. Chief among these is the lesser house-fly. It is considerably smaller than the house-fly and by many is considered a young house-fly not full-grown. The Germans call it the "Kleine stübenfliege," which means little room-fly or house-fly. The lesser house-fly differs markedly from the house-fly not only in size, but in other characters. The fifth vein of the wings runs straight out to the edge without the sharp upward curve of the same vein in the wing of the house-fly. Indeed, the lesser house-fly belongs in the family *Anthomyiidæ,* a family considered, by some authors, distinct from the *Muscidæ,* which contains the house-fly. Although the lesser house-fly appears rather early in the season, it is soon lost among the greater numbers of the house-flies that come on in June and July.

The larvæ of the lesser house-fly differ very much from those of the house-fly. The body is compressed or flattened and along each side bears a double row of spiny processes very different from the perfectly smooth maggots of the house-fly. The dirt usually clings to the spines, thus giving the maggots a dirty appearance. The full-grown maggot measures from $\frac{1}{5}$ to $\frac{1}{4}$ of an inch in length.

The larvæ of the lesser house-fly live in waste vegetable matter, in the manure of different animals and especially in human excrement. Hewitt says he has found them very abundant in privies. This habit of breeding in excreta of various kinds makes the flies dangerous inhabitants of our rooms. They may act as conveyors of disease-germs quite as readily as the real house-fly. They are rapid breeders, for a generation may be produced in two weeks in hot weather.

It is interesting to know that some of the Anthomyiids are parasitic on other insects, while some are well-known pests of garden crops, for example, the cabbage-root maggot, the onion maggot, and the beet-leaf miner.

THE BLUE-BOTTLE OR BLOW-FLIES

Calliphora erythrocephala and *Lucilia cæsar*

There are certain large flies known as "blue-bottles," "green-bottles," or "blow-flies" that are found in houses, especially during June and early summer. They may be recognized by their large size, buzzing noise, and blue metallic colors.

FIG. 19. — The blow-fly. (× 2.)

The common blow-fly, *C. erythrocephala*, has a bluish-black thorax and a dark metallic blue abdomen (Fig. 19). The eggs of this fly are usually laid on fresh or decaying meat, although they may be deposited in sores or wounds of living animals. The female blow-fly seems capable of laying a large number of eggs. Portchinsky records finding 450 to 600 eggs from a single fly. Hewitt found that a generation of these flies was produced in twenty-two to twenty-three days.

Normally, this blow-fly lives out-of-doors, but it often enters houses in search of material upon which to deposit its eggs and evidently also for shelter. It has been found frequenting human feces and for this reason may be suspected of bearing intestinal bacteria, thus making it a fly to be dreaded.

The other "blue-bottle" (*L. cæsar*) is smaller than the one just discussed and is more brilliant in color, — sometimes bluish and sometimes greenish. It is common in this country and in Europe. It frequently enters houses, especially just before rain-storms. It breeds in carrion, in sores on living animals and in the excrement of man and other animals. The larvæ are very similar to those of the first blow-fly discussed except that they are smaller.

THE MOTH-FLIES

Psychoda minuta

There are often found upon window panes certain tiny flies with broad wings densely clothed with hairs. In appearance they resemble very small moths and are, therefore, known as moth-flies. They belong to the family Psychodidæ and may be distinguished from all other flies by their moth-like appearance. The larvæ of some of these flies live in cow-dung, others in decaying vegetation, while some live in water, especially sewage water or drain water from kitchens. We have seen hundreds of these moth-flies among the weeds overhanging a ditch carrying the drainage water from a kitchen. We have also seen them in abundance along ditches carrying sewage water from houses. In the first-mentioned instance they were always present on the window panes of the kitchen, readily passing through the ordinary wire screen. Judging them from the places in which they breed, we would consider them unwelcome guests in our houses.

Almost nothing is known of the life history of the North American species. Kellogg found the larvæ of one species of moth-fly, *Pericoma californica,* in a stream in California. He found the larvæ were slug-like, about one-tenth of an inch long and that they clung to stones in the stream by a row of eight suckers on the ventral side of the body. When ready to pupate the larvæ crawl higher up on stones where the spray dashes on them. The pupæ are small, flatish, and breathe by a pair of respiratory tubes on the thorax. After about three weeks the adults issue and fly to the overhanging weeds.

It is an interesting fact that one of the species of this family is a carrier of the disease known as phlebotomus fever. This disease occurs in the countries surrounding the Mediterranean Sea and the fly concerned in carrying the fever is *Phlebotomus papatasii.* The habits of this fly seem to be similar to those of the related species occurring in this country. The adult fly is said to be a vicious biter, although very small, and does its biting entirely at night. We have one species of *Phlebotomus* in the United States, but it is not known whether it will act as a carrier of this disease or not.

It seems also to have been demonstrated that a species of *Phlebotomus* in South America transmits the disease verruga.

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CHAPTER III

MOSQUITOES, THEIR HABITS AND DISEASE RELATIONS

MOSQUITOES are really a kind of small fly differing from house-flies in size and in their power to "bite." They are no more abundant to-day than they were a century ago; but much greater interest is shown in them nowadays than formerly because of their relations to certain diseases. Since the discoveries were made that mosquitoes carry certain diseases the hum of one of these insects has come to have an entirely new meaning for us. Before, our only thought was to kill the insect to prevent it from annoying us. Now, we see visions of sickbeds, feverish patients, suffering, and, in many cases, death. Naturally, a great deal of interest in mosquitoes has been aroused, and very properly so, because we should take an interest in anything that affects our health.

There are known to be nearly 400 different kinds of mosquitoes in North America alone, and over sixty species occur in the United States. Not over half a dozen of these are common about our houses and only three[1] of them are known to carry malaria and only one is concerned in disseminating yellow fever. The malarial species occur all over the United States in sufficient numbers

[1] The three species are *Anopheles quadrimaculatus* and *Anopheles crucians* with *Anopheles pseudopunctipennis* as a probable third host.

to carry malaria to thousands of people. It must be said, however, that our most common and abundant species of mosquitoes have no connection with human diseases, so far as we know, and are of importance only because of their extreme annoyance in biting.

Mosquitoes are found in both salt and fresh water. It would seem as though these insects bred in greatest numbers in saltwater, and we usually find areas of greatest infestation along the seacoasts. The greater number of our common species of mosquitoes belongs to the genus *Culex*. So far as known, none of these are disease-carrying. There are three species belonging to the genus *Anopheles* in the United States that have been shown to carry malaria in some one or more of its forms. Finally, there is one species of mosquito, *Aëdes calopus,* that has been proven to carry yellow fever. In order to control mosquitoes intelligently, one should understand something of their life histories and habits.

LIFE HISTORY OF A COMMON MOSQUITO (*Culex*)

Throughout the interior of the United States probably the house mosquito, *Culex pipiens,* is the most common. It is a so-called European species, but has now been determined as present quite generally over the country. So far as is known, it neither transmits malaria nor yellow fever to human beings. It is, therefore, of importance largely because it greatly annoys man. We portray its life history (Fig. 20) and habits here, because it is familiar to every one and thus serves as an example to show how mosquitoes live. It breeds in almost every place in which fresh water may be found, in quiet pools, roadside ditches, sewer ditches, hollow stumps, rain-barrels, cisterns, tin cans, watering-troughs, and other receptacles. Some instances of curious places in which the larvæ have been found will be given later.

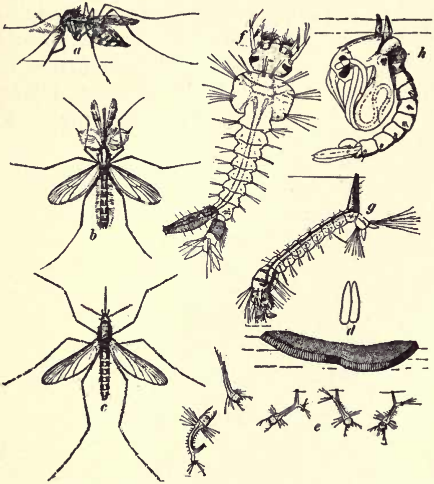

Fig. 20. — Life history of a house mosquito. (× 3.)

The adult mosquitoes, in the fall, hide away in cellars, barns, outhouses, or other suitable places and there pass the winter in a dormant condition. Probably the majority of these hibernating mosquitoes die before spring. Those females that survive the winter become active in the early spring, and after feeding or sometimes without obtaining food, seek a convenient pool of water on which to deposit their eggs.

Eggs. — The eggs of *Culex pipiens* are laid on the surface of the water in more or less boat-shaped masses, (Fig. 21). Each mass contains from 75 to 200 eggs, consequently they vary much in size. They measure from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in length and are plainly visible to the eye. The eggs stand on end in regular rows with the larger ends down. When first laid the masses appear yellowish white, but a little later they become dark brown in color and appear as small masses of soot floating on the water. Very often where there are many egg masses on the water, several of them will run together by capillary action and form a raft of eggs on the surface. We have seen as many as a dozen of these egg masses clinging to each other.

Fig. 21. — Egg mass of the house mosquito. (× 5.)

Each individual egg is long and cylindrical, larger at the lower end, and tapering to the upper end. As seen from the side, it resembles the blade of a knife (Fig. 20, *d*). These eggs float on the surface of the water from twenty-four hours to several days, depending upon the temperature, and then hatch.

Larva. — When the egg hatches, there issues from the lower end a larva, or "wriggler." Every one that has looked into rain-barrels that have stood for some time during hot weather has surely seen "wrigglers." These are the product of mosquito eggs. The larva of *Culex pipiens* rests for the greater part of the time with the tip of the abdomen at the surface of the water, and the head hanging downward at an angle of 40 degrees. At the tip of the eighth abdominal segment is a long tube known as the respiratory tube (Fig. 20, *g*). It is through this tube that the larva takes in its supply of air. This fact accounts for its position with the tail end up and the breathing tube just at the surface of the water, so that air may be drawn through it to sustain life. At the same time, two dark brushes of hairs about the mouth can be seen in constant vibration, by which currents of water are set up and food thus brought to the animal. In a jar containing many of the wrigglers, some may always be seen wriggling to and from the bottom in search of food. The larval stage lasts from five to ten days.

Pupa. — At the end of a week or ten days, in hot weather, the larva changes to another form that we call the pupa, one of which is shown in Fig. 22. The pupæ live in the water along with the larvæ and can wriggle about as actively as the larvæ. In fact, we suspect most people call them wrigglers, supposing them to be the same as the larvæ. But by looking carefully one can see a considerable difference between these two forms. The pupa is mostly head and thorax, with but a slender abdomen. The breathing apparatus now consists of two respiratory tubes instead of one, and, moreover, they are situated on the thorax instead of on the end of the abdomen, as in the larva. As a result of the change in position of the breathing tubes, the pupa floats in the water with

Fig. 22. — Pupa of Culex, enlarged.

the head up. It is as active as the larva when disturbed. After the pupa has lived five or six days it, in turn, transforms to the adult. The skin of the pupa splits open along the top of the thorax and the adult mosquito gradually works its way through the opening. Then, using the empty skin as a raft, it rests for a few minutes to dry its wings and then flies away. Ordinarily, the female lives until she finds a suitable place to deposit her eggs, which may take two or three weeks, during which interval she may bite several times.

Adult. — The full-grown *Culex pipiens* is a moderate-sized mosquito. In Fig. 20, *c*, the adult female is shown considerably enlarged. It is usually the female alone that bites and annoys us. The male mosquito is well behaved, and although he often enters the house, does not annoy us. He usually lives by sucking the nectar of flowers. We have seen him sipping the sirup from a jug on the table. The male can easily be distinguished from the female mosquito by the brushes of hairs on the head. The antennæ or "feelers" of the male mosquito, as shown in Fig. 23, are clothed with many long bristles, while the antennæ of the female have fewer and much shorter hairs. The difference is almost as noticeable to the unaided eye as Fig. 23 shows it to be. These house mosquitoes do not usually fly far, but in seeking for food

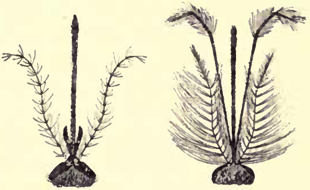

Fig. 23. — Head of female, left; male, right. (× 8.)

and breeding places they may wander several hundred yards from their birthplace.

From the foregoing description of the life history of *Culex pipiens* we see that three of the stages, egg, larva, and pupa, are passed on or in the water. The life histories of many other mosquitoes have been determined and in every case it has been found that two, at least, of these stages were passed in the water. We conclude, then, that water is necessary for the development and the very existence of mosquitoes. Conversely, we conclude that in an absence of water mosquitoes will not be able to exist. Mosquitoes will not breed in grass unless standing water is present.

MALARIAL MOSQUITOES (*Anopheles*)

There are several kinds or species of malarial mosquitoes in the United States. No one of these has been definitely proven to carry all of the different types of malaria. One of them, however (*Anopheles quadrimaculatus*, Fig. 24), seems to be the most general carrier, for it has been shown to carry at least two types of malaria, the tertian and the quartan. This species is evidently widely distributed in the United States and is probably responsible for the greater part of the dissemination of malaria. The life histories of the species of Anopheles seem to be similar. Like that of *Culex pipiens*, the life cycle of Anopheles consists of four stages.

Eggs. — The eggs of Anopheles are laid singly and at random on the surface of the water, but naturally run together and cohere in loose irregular groups or strings of from three to a score or more. This is totally different from the boat-shaped egg-masses of *Culex pipiens*. The individual eggs differ greatly in shape from those of

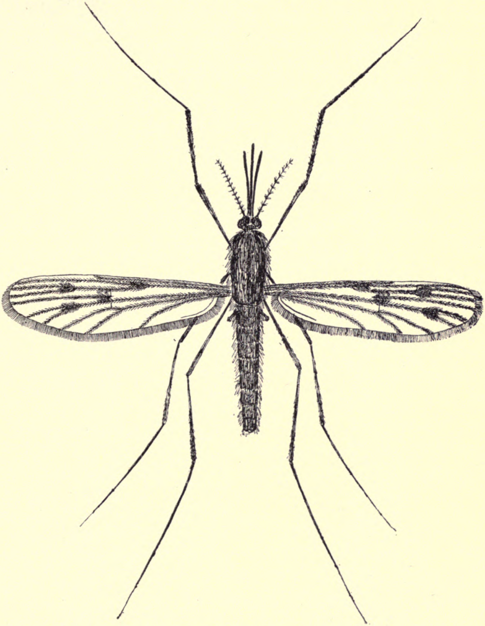

FIG. 24. — *Anopheles quadrimaculatus*. (× 7.)

Culex. The eggs of Anopheles are strongly convex below and slightly concave above. As seen from the side they are canoe-shaped.

Larvæ. — As we have already pointed out, the larvæ of Culex hang from the surface of the water, as it were, with the head downward. On the contrary, the larvæ (Fig. 25) of Anopheles lie in a horizontal position, apparently on the surface of the water. Really, they are just beneath the surface film. Their breathing tube is very short, and, consequently, they are obliged to lie close to the surface in order to get air. They can be readily recognized by this horizontal position. When disturbed they wriggle across the water in a horizontal direction, especially the younger larvæ. It will be recalled that the larvæ of Culex are constantly diving below in a vertical direction. As the larvæ of Anopheles become older they more readily wriggle downward.

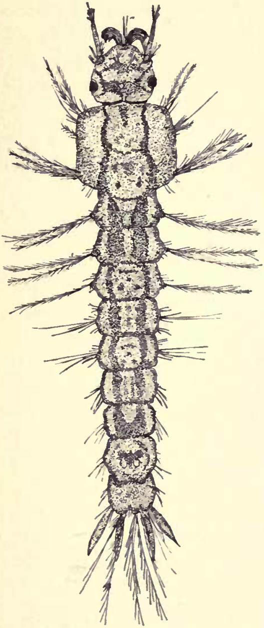

Fig. 25. — Larva of *Anopheles punctipennis*, enlarged.

The feeding habits of Anopheles larvæ are very interesting and remarkable. The head is joined to the rest of the body by a very slender neck, on which it readily and rapidly rotates, at least halfway round. When lying beneath the water film the body is in a normal position. That is, the upper side of the body is uppermost and the under side faces the bottom of the jar. The head, however, is turned just halfway round so that the under side is uppermost. This is its customary feeding position. If for any reason it attempts to swallow a piece of food too large and there is difficulty in getting it down, the head turns back with lightning-like rapidity. All the time the brushes of hairs about the mouth are in motion, bringing to it particles of food.

The duration of the larval stage, under normal conditions with plenty of food, varies from twelve to fourteen days.

Pupæ. — The pupæ of Anopheles are not strikingly different from those of Culex to the unaided eye.

The pupal stage of both males and females in the case of *A. punctipennis* which the writer has carefully observed lasts, with great regularity, just about two days. At least it could not have varied more than a few hours from this, as the adults were found in every case on the second morning subsequent to the morning on which the pupæ were found.

To sum up, then, the entire duration of the early stages of *Anopheles punctipennis* in Mississippi under normal conditions in July was sixteen to eighteen days. That is, the egg stage was two days; larval stage, twelve to fourteen days; pupal stage, two days. This indicates that in a pool where these mosquitoes breed there can be developed every sixteen to eighteen days a new lot of adult mosquitoes. It further indicates that if such a pool be treated with kerosene oil, it will need an applica-

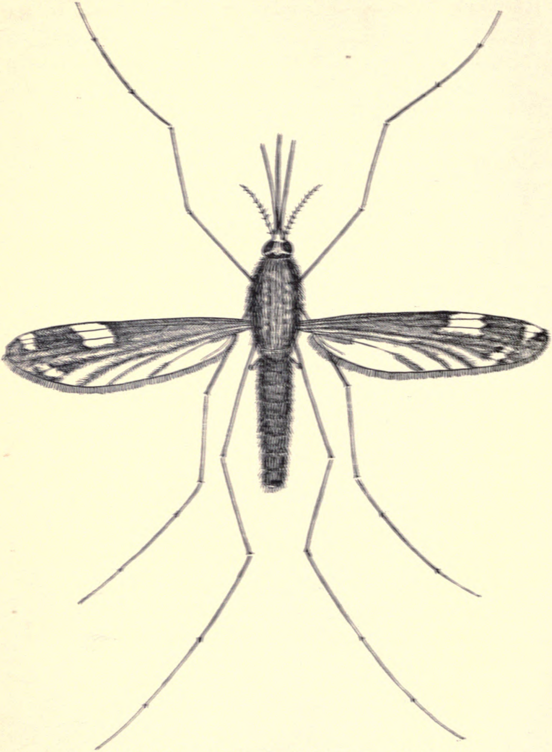

FIG. 26. — *Anopheles punctipennis.* (× 7.)

tion once in every sixteen days, or three weeks at the most, to be perfectly safe.

Adults. — The full-grown male and female *Anopheles punctipennis* (Fig. 26) are somewhat larger than those of *Culex pipiens*. The wings appear of a heavier texture and present a spotted appearance, owing to the well-defined spaces, covered with whitish scales. Situated on the front margin of each wing, three-fourths of the length of the wing from the body, is a yellowish white spot. These two spots together with the other smaller ones give the mosquito a very handsome and distinctive appearance.

DISTINCTIVE DIFFERENCES BETWEEN THE ADULT FEMALE ANOPHELES AND THE FEMALE MOSQUITOES OF CULEX

One can readily distinguish with the unaided eye, the malarial mosquitoes from the common mosquitoes provided one can see them close by and at rest. From the head of the female Anopheles there project three long, slender bodies of nearly the same length, while from the head of the female Culex there is only one projection. Figure 27 gives an idea of this difference, although the parts are much enlarged.

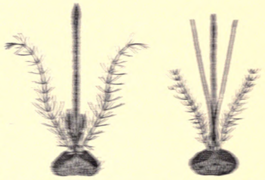

FIG. 27. — Head of female Culex, left; female Anopheles, right. (× 8.)

Another difference between the adult Anopheles and Culex is their resting positions. When the common mosquito, Culex, alights on a wall it rests with its body parallel to that wall like a house-fly; but an Anopheles mosquito usually rests with its body at a considerable angle to the surface. We have seen Anopheles clinging to the ceiling in a horse stall by their four front legs with their bodies hanging almost straight downward.

Moreover, the wings of all of the common Anopheles are more or less spotted, while those of Culex are plain and clear.

BREEDING PLACES OF ANOPHELES

It is quite as necessary to know the places in which these mosquitoes breed as to know their life history, if one wishes to destroy them before they become full-grown.

The common mosquito (*C. pipiens*) breeds in barrels, tubs, cisterns, and other receptacles about the house and is, therefore, known as the house mosquito; but Anopheles rarely breed in such situations. They choose a ditch, a pool, or the shallows of a spring brook, creek, or river for their breeding places.

It is important to note that all these breeding places are in water *standing or running on the ground* and only occasionally in barrels, buckets, or other receptacles about dwelling-houses. In this respect the malarial mosquitoes are quite different from the common Culex, which breeds in almost any situation where it can find water.

THE YELLOW FEVER MOSQUITO

Aëdes calopus = Stegomyia fasciata

The yellow fever mosquito is a small day-flying species with white banded legs and silver lines on the back of the thorax (Fig. 28). It is commonly known as the "day" mosquito, "tiger" mosquito, "gray" mosquito, and "calico" mosquito. It is undoubtedly not a native mosquito of the United States, but has been introduced through commercial intercourse from tropical countries. It is, however, widely distributed south of the Mason and Dixon line, and has been reported as far north as New York, where it was probably carried by boats. It is primarily a house mosquito in towns and cities and is seldom found around country homes.

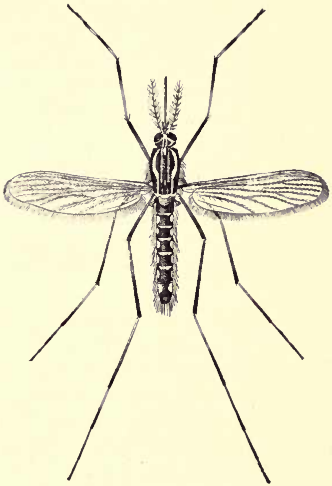

FIG. 28. — The yellow fever mosquito. (× 7.)

Its life history is similar to that of Culex. The eggs are black in color and covered with a shining membrane. They are cigar-shaped and are found singly or in groups near or on the surface of the water in rain-barrels, cisterns, tanks, or other receptacles for water about the house. The eggs are very resistant to cold and to drying, but under favorable circumstances hatch in ten hours to three days. The larvæ are very active, always searching and foraging for food. They attain their growth in from seven to eight or ten days. The pupal stage lasts about two days, so that the whole life cycle may be passed in two weeks or even less.

The yellow fever mosquito seems to be most active and to do most of its biting in the afternoon and early evening, although Miss Mitchell says that in Baton Rouge it troubled her most before 9 P.M. We have found them particularly active in the early afternoon on shady porches.

Yellow fever cannot become epidemic where this mosquito is not present. Any one can remain among cases of yellow fever with perfect safety if he avoids being bitten by an infested mosquito.

BREEDING PLACES OF THE MORE COMMON MOSQUITOES

In general, it may be said that almost any body of fresh water in almost any situation, if left standing long enough, will become infested with larvæ of mosquitoes. In the ditches that receive sewage, we have seen a black fringe of larvæ on both sides for nearly a mile.

It is ordinarily supposed that mosquitoes breed only in stagnant water, or in water that is changing very little. We have found them breeding in considerable numbers in troughs for watering stock, when the water ran in at one end and out at the other all the time. We have found an unused room swarming with mosquitoes that came from a bucket of slop water.

A friend of mine tells me of finding an abundance of wrigglers in a glass globe of water standing on a table in the parlor of a house at which he was visiting. Fish had been kept in the globe, among some water plants growing there. The fish had died some time before and had been thrown out and now the family were wondering where the mosquitoes were coming from.

HOW FAR DO MOSQUITOES FLY?

The answer to this question is an important one since upon it depends the success of certain methods of extermination. Owing to the careful observations of John B. Smith, and his corps of workers, we are able to answer the question with some degree of certainty. In the first place, it is held that Anopheles mosquitoes do not fly far — probably not more than half to three-quarters of a mile and usually not nearly so far. On the other hand, certain saltwater mosquitoes fly many miles, especially when aided by a strong wind. Fortunately, these do not carry disease so far as we know.

The domestic mosquitoes, Culex, under ordinary conditions, do not fly far from their breeding places. The yellow fever mosquito is essentially a domestic one and breeds near dwelling-houses.

Miss Mitchell says that "the mass of evidence by experts is to the effect that the greater number of species are not in the habit of flying more than two hundred yards to a quarter of a mile, and that most places, not situated near a salt marsh, will be found to be locally infested. . . . If mosquitoes, not the marsh species, are plentiful in a city, the chances are that the breeding place is near by."

THE BITE OF A MOSQUITO

The beak of a mosquito is made up of six bristle-like or lance-like organs inclosed in a sheath. This sheath constitutes the part of the beak that we see from the outside. The bristle-like organs inside are the real puncturing part of the beak, for the sheath does not enter the flesh when a mosquito bites. The sheath bends and the bristles project beyond the end and bore their way into the flesh. The whole apparatus serves as a carrier to conduct the blood to the mouth.

While the mosquito is puncturing the skin an irritating substance, the chemical nature of which is not known, is injected into the wound. It is thought by some authors that this poison comes from special glands situated between the salivary glands in the mouth of the insect. Others think it comes from the salivary glands themselves, while others think it is a liquid secreted in certain pouch-like organs connected with the esophagus and known as the *œsophageal diverticula*. At any rate a sensation of itching is produced by the bite. The immediate area turns red, becomes inflamed, and in some individuals much swelling follows.

The itching and irritation may be relieved by the application of dilute solutions of ammonia or a 5 per cent solution of carbolic acid or a 1 per cent alcoholic lotion of menthol.

RELATION OF MOSQUITOES TO MALARIA

It has been common knowledge, for nobody knows how long, that in some way malaria is connected with stagnant or standing water. Along with this we have also known that malaria is most prevalent in bottom lands, valleys, swamps, and in regions at the mouths of rivers because it is in such places that water collects and stands. It has been learned from experience that by moving to high, dry situations malarial fevers may be avoided. The disease has been attributed not so much to the water as to the so-called miasmatic airs that arise from the water and wet soil. In fact, malaria means bad air. Not long ago the writer heard a person object to building a house in a certain valley-like depression because the cold, damp air might cause malaria. It is a common precaution against malaria to go within doors at early dusk and remain until daylight, for the purpose, it is thought, of escaping the damp, fever-giving atmosphere.

It is true that there is a definite relation between malaria and low lands, swamps, stagnant water, marshes, and exposure out-of-doors at night in which people have believed so long. The relation, however, results from a very different agent than has been generally supposed heretofore. Within the last few years, it has been conclusively and repeatedly demonstrated that malaria is conveyed to human beings and communicated to the blood by mosquitoes and not by miasmatic airs arising from swamps and marshes. The question immediately arises, how does this accord with the relation of malaria to low lands, marshes, swamps, stagnant water, exposure at night, and the like? The facts as we now know them give the answer. We now know, by scores of investigations, that mosquitoes can exist only where there is water; that they are abundant in swamps, marshes, and low lands, and that they (malarial mosquitoes) fly and inflict their bites mainly at night and that they are not usually present in high, dry situations.

Our next great proof of the relation of mosquitoes to malaria is the fact that the germ causing malaria has been carefully and repeatedly traced through its life history, and it has certainly been found to pass a part of its existence in man and a part in the body of the mosquito. Moreover, the part of its life that is passed in man is not like that passed in the mosquito, but both are necessary to the ultimate existence of the germ. These facts have been independently worked out by some of the world's greatest scientists: Ross, Celli, Bignami, Daniels, Laveran, Shipley, Bastianelli, and others.

To those familiar with the lives and habits of the lower animals it is not at all difficult to believe that one of them can pass part of its life in the body of one animal and the rest of its life in the body of a second animal. Many cases of this kind are known and some of them commonly known. For example, a common tape worm which exists in the bowels of a human being spends a part of its life in the body of a hog. In fact, we get this particular tape worm only by eating what is known as *measly* pork. That is, pork containing young minute forms of the tape worm. The pork is eaten and the tiny, undeveloped tape worm set free, which soon grows into an adult worm within our own bodies. Again, there is the liver *fluke worm* that causes the liver rot of sheep. This parasite passes part of its life in a snail from which, after a time, it crawls up on the blades of grass growing about ponds and pools of water in which the snails live. In this situation the minute worm is swallowed by the sheep along with the grass and finally finds its way to the liver of the sheep. Then, there is that much dreaded parasite, *Trichinella spiralis* (Fig. 29). This is the little worm on which Uncle Sam spends so much money hiring men to look for it in the carcasses of animals in the great slaughtering and packing houses of the United States. If this worm is found in these carcasses, they are condemned and burned because it is by eating them that human beings get the Trichina in their bodies, which may cause death. Many more examples might be given of parasites that live in more than one host. So, after all, the fact that the malarial germ lives in both man and mosquitoes is not a new and anomalous discovery, having no parallel in animal life, for many similar examples have been long and well known. The nearest parallel we have is the germ causing what is known as Texas fever or tick fever, in the cattle of the Southern States. The parasite causing this disease is very similar to the human malarial parasite and acts on the blood of cattle in a similar way, namely, by destroying the red blood corpuscles. It causes fever and chills in the cattle quite similar to those caused in man by the malarial parasite. In fact, many writers call Texas fever *Cattle Malaria*. This germ spends one part of its existence in the common cattle tick and the other part in the blood of cattle. The germ is conveyed from one animal to another and injected into the blood by the bite of the tick very similar to the manner in which the malarial germ is carried to a person and injected into the blood by a mosquito. It has been demonstrated again and again that if cattle be kept free from ticks, they will not have Texas fever. On the other hand, it has been

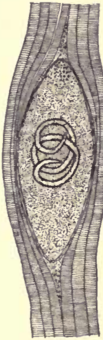

FIG. 29. — *Trichinella spiralis* embedded in human muscle, much enlarged.

repeatedly demonstrated that this fever can be given to cattle by putting ticks on them. Exactly similar facts have been demonstrated in regard to human malaria and mosquitoes. And these experiments constitute our last and final proof of the relation between malaria and mosquitoes.

The region known as the Campagna near the city of Rome, Italy, is a low, marshy, wet area, which is one of the most malarious regions in Italy, if not in the world. It is not at all a thickly settled region, because people will not and cannot live there on account of chills and fevers, especially in the autumn during the wet season. Here, if anywhere, was a good place in which to test the whole question of the relation of mosquitoes to malaria in a practical and convincing manner. Here was the water, the marsh, the bad air, the mosquitoes, and the malaria. If people could live in the midst of the Campagna, breathe the bad air, get wet, and undergo all the conditions of life there with one exception, namely, keep free from mosquitoes and their bites, and yet escape malaria, it would certainly convince the most skeptical. Exactly this has been done.

Two English physicians, Sambon and Low, in the summer of 1900 determined to satisfy themselves and the world in a practical way of the part that the mosquito plays in malaria. During the summer, they caused to be built in the worst part of the Campagna a small, one-story, five-room house, the windows and doors of which were tightly screened with wire netting so that no mosquitoes could possibly enter. Here both physicians lived and worked, for they had their instruments with them, during the late summer and autumn while the rainy and most malarial season was on. The house stood near the banks of a canal in which was an abundance of the larvæ of Anopheles. They went out during the day; at times allowed themselves to become wet to the skin; left the windows open at night so that the bad air could enter and circulate all through the house; in fact, they did everything that an ordinary inhabitant would do, with one exception; namely, they went into the house before six o'clock every day and so evaded being bitten by Anopheles mosquitoes. It must also be mentioned that they took no quinine or other preventive medicines against malaria. It was said that the critical test would come when the rainy season began in the autumn. At this time, the people living under ordinary conditions suffered much from chills and fever. *But through it all, these two physicians developed not the remotest trace of chills or fever.* It was certainly a remarkable and triumphant vindication of the labors and conclusions of Laveran, Ross, Celli, and many others. But this is not all. There yet lacked one more link in this chain of evidence. The chain had been surely forged link by link during all these years since 1880 through the persistent and brilliant researches of the men mentioned above and now came the forging of the last link that vindicated their wisdom.

A son of the renowned Manson, at that time living in London and who had not been in a malarious country since childhood and was therefore as free from the disease as one could well be, offered himself as a subject for the forging of this last link. Bastianelli, the famous Italian whom we have mentioned before, procured some Anopheles mosquitoes and turned them loose upon a man in Rome suffering from malaria. They, of course, bit the man many times, sucking his blood and thereby getting the malarial germ into their stomachs. These identical mosquitoes were then sent to London, England, and there allowed to bite Manson. In the regular course of time, he was taken with a well-marked case of malaria and, moreover, when his blood was examined the well-known germs were found in the red corpuscles. Finally, the thing was done. It had been actually proved that men could keep free from malaria by keeping free from mosquitoes and their bites, and lastly it had been proved that the bites of Anopheles mosquitoes would actually produce malaria in a man not previously suffering from it.

THE REAL NATURE OF MALARIA

Within the last generation tremendous strides have been made in the realms of both pure and applied science; and if more progress can be said to have been made in one domain of science than in another, it will have to be said of that of medicine. Moreover, with all the remarkable advances made in medicine perhaps no late discovery in that field has aroused more general interest than the discovery in 1880 of the causal germ of malaria by the French physician Laveran, together with the later demonstration by Ross that this germ is communicated to human beings through the agency of certain kinds of mosquitoes. When Laveran announced that he had discovered a minute organism living in the red cells of the blood and destroying them, thereby causing the disease, malaria, he was not believed. Later, however, his statements were corroborated by other reputable investigators, who had without doubt seen this same tiny parasite in the blood corpuscles. Since that time the work has been duplicated and verified by many reliable scientific workers here and in Europe. So that now we know malaria is caused by a very minute animal parasite living in the red cells of the blood and destroying them by the millions. The life history of the parasite has been carefully traced in the blood of man and in the body of the mosquito.

History of the parasite in man. — We will suppose that one of these tiny parasites (*sporozoit*) has found its way into a person's blood from the bite of a malarial mosquito. If conditions are favorable, it soon goes inside of a red blood cell, where it lives and grows, gradually destroying the contents of the red corpuscle, and finally taking up much of the space inside the cell. Finally, the parasite (now called a *schizont*) inside the blood cell has grown all it will, and it then divides into several distinct individuals (*merozoits*) commonly called *spores.*

The wall of the red blood corpuscle then bursts and these parasites are set free in the liquid part of the blood. Now if a person has a severe case of malaria, there may be several millions of these parasites in the blood, each one in its own red blood cell. Moreover, all the parasites become mature, form spores, and burst out of these red cells at just about the same time. It is just at the time that the multitudes of minute parasites burst forth into the liquid part of the blood that the chills and rigors begin. There are at least three kinds of malarial parasites: (1) the parasite that forms spores and causes chills every two days, thus producing *tertian fever;* (2) the parasite that forms spores and causes chills every three days, thus producing *quartan fever;* (3) the parasite that causes *malignant fever* which frequently becomes very serious.

The parasites set free in the blood may enter other red blood cells, grow, reach maturity, and burst forth again. These, in turn, may go through the same course again and again, producing chills and fevers incessantly unless destroyed by some agency. Finally, there appears in the serum of the blood the male and female individuals of the parasite, but these cannot develop farther until taken into the body of a mosquito.

History of the parasite in the body of a mosquito. — Suppose while the blood of a malarious person is full of the minute parasites he should be bitten by a mosquito. As the mosquito sucks up the blood some of the parasites would be sure to be taken up with it. After being sucked up into the beak of the mosquito they are carried to the stomach of the insect and there pass through a sexual process. They then enter into the cells of the stomach walls, undergo certain changes, and finally pass through the stomach walls of the mosquito, undergo complicated changes in the body cavity of the insect, and eventually find their way to the salivary glands, from which they are injected through the beak into the blood of the person who is being bitten by the mosquito. There they again enter the red blood cells, pursuing the course already described and causing chills and fevers.

Summary. — To sum up, then, malaria is caused by a minute animal parasite that lives within the red blood corpuscles of human beings. This parasite destroys millions of the red blood cells that are so necessary to life and, in addition, secretes certain poisonous substances known as toxins, which lodge in various parts of the body.

Its life history has been traced step by step by many careful observers.

It has been found that the parasite goes through certain stages in the blood of man, but that finally it is taken up by mosquitoes and in the bodies of these insects it goes through certain stages quite different from those gone through in man.

Finally, we know that the parasite is injected into the blood of a person by a certain kind of mosquito.

Since this parasite lives only in man and the mosquito, it can get from one person to another only through the agency of these insects. In other words, a person once free from the malarial parasite will remain free just so long as the bites of certain species of mosquitoes can be avoided.

Number of germs in the blood. — The number of malarial germs in the blood may vary at different times. The more germs there are, the harder will be the chills and fever as a rule. It is easy to see that the more infected mosquitoes there are to bite a person, the more germs there will be in the blood and the more severe will be the case of malaria. This is important to bear in mind because it is closely connected with what we shall have to say in regard to methods of prevention. Ross says he "computes that something like a quarter of a billion of them must be present to produce fever."

There is another fact that we should also bear in mind, namely, that the germs may actually be present in the body and yet not produce chills and fevers. They may lie dormant in the body, as it were, for a long time and then suddenly become active, increase and produce fever. Under such a condition of affairs circumstances might seem to prove that a person could have malaria without being bitten by mosquitoes. It must be remembered, however, that that person was bitten at some time by an Anopheles mosquito, else the germs could never have gained access to the blood.

RELATION OF MOSQUITOES TO YELLOW FEVER

That yellow fever is not a contagious disease, but one that, like malaria, is carried from one individual to another only through the agency of a mosquito, has been finally and authoritatively settled. It must be said, however, that no one has yet discovered the parasite that causes yellow fever. It is either too small to be seen with any lens now made or it inhabits some organs of the body not suspected or its habits are entirely different from any other parasite with which we are familiar. In any case the germ has eluded all efforts to locate it and scientists are ignorant regarding its real nature, habits, and appearance.

PROOFS THAT YELLOW FEVER IS CARRIED BY MOSQUITOES

Carlos Finlay, as early as 1881, promulgated the theory that mosquitoes transmit yellow fever and he carried on some experiments at that time in which he claimed to have conveyed the disease from yellow fever patients to non-immunes through the bites of mosquitoes. It was not, however, until the early part of 1900 that more serious experiments were undertaken to determine the actual agents in the transmission of yellow fever, and the relation of this disease to mosquitoes if any existed. During this year a medical commission from the United States Army, consisting of Walter C. Reed, James

Carroll, Jesse W. Lazear, and A. Agramonte, was sent to Cuba to investigate the whole question.

In a field near Quemados, Cuba, this commission of surgeons erected a small wooden building tightly ceiled and with the windows and doors closely screened so that no mosquitoes could enter. In this house, during a total of sixty-three days, seven non-immune men were kept. These men slept in beds furnished with the unwashed pillow-slips, sheets, and blankets that had previously been used on the beds of genuine yellow fever patients in Havana and elsewhere. This bedding was actually stained with the excretions of the fever patients. Neither during that time nor subsequently did one of these seven men develop a case of yellow fever. This indicated to the surgeons, beyond much question, that yellow fever is not carried in clothing, as had always been held. This experiment concluded the first phase of the work.

Another house was built in this same field and divided by wire screen from floor to ceiling, into two rooms. The doors and windows of each room were closely screened with fine wire netting so that no mosquitoes could enter. All bedding and material carried into the rooms were disinfected by steam, which precluded any possibility of the yellow fever germ being present in the bedding or clothing.

In one of the rooms, mosquitoes of a certain kind that had previously bitten patients sick with yellow fever were placed. In the other room none were allowed. Non-immune men were placed in both rooms. Of those in the room containing no mosquitoes, not one had yellow fever. Of those in the other room that were bitten by the infected mosquitoes, six out of seven developed cases of genuine yellow fever. This indicated beyond much question that mosquitoes were transmitters of this disease.

These experiments have been extended and duplicated many times with the same results, so that we are justified in believing that a certain mosquito known as *Aëdes calopus* is the sole and only agent in the transmission of yellow fever.

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CHAPTER IV

METHODS OF DESTROYING AND REPELLING MOSQUITOES

THE best way to escape annoyance from these insects and to prevent the carriage of disease by them is to destroy them.

No one has yet devised practical methods of destroying the adult mosquitoes, hence all of our efforts are best directed against the immature stages of these pests; namely, egg, larval, and pupal stages.

The methods taken to destroy mosquitoes fall into three distinct classes; namely, the drainage of bodies of water liable to contain eggs and wrigglers, the application of oil to bodies of water that cannot be drained, and the introduction of fish into pools that cannot be drained or oiled.

At the very start one should find out, if possible, what kind of mosquito is causing trouble and then find something about its habits and breeding places. If it is a far-flying species coming from far distant saltwater pools, make up your mind to endure it until it disappears. If it is a local, fresh-water species, then hunt out its breeding places, and use some of the methods outlined in the following paragraphs.

DRAINAGE

This remedy hardly needs discussion. It is obvious that if a pool be drained or a bucket or barrel be emptied, no mosquitoes can breed there. Tanks not especially needed should be taken down. This should always be done whenever possible, because a tank down and out of the way will be sure to give no trouble. All receptacles like buckets, and barrels, should be looked after and emptied at least once a week, and permanently if possible. Permanent ditches that trouble us most should be tiled and the water conducted a long distance from the house. In many cases, it is much easier to draw a wagon load of earth or even more to fill up a small shallow pool than to dig an outlet. Draining is the most desirable means of fighting mosquitoes because if once well done, it is always done and needs no attention afterward. There are hundreds of swamps and marshes near habitations that could be drained with comparatively little expense. When we come to realize fully the discomfort, sickness, and deaths that occur from malaria because of the presence, in the vicinity, of a small swamp in which malarial mosquitoes develop, the small matter of the expenditure of a little money will hardly be taken into consideration. The only question seriously considered will be the one concerning the best method of drainage.

FISH VERSUS MOSQUITOES

There are often pools or bodies of water that cannot, for one reason or another, be drained. There are also pools and ponds of water used for ornamental purposes that add greatly to the beauty and enjoyment of a landscape but that serve as prolific breeding grounds for mosquitoes. It is not desirable to drain such pools nor is it feasible to treat them with oils or other substances on account of the deleterious effect that may result to the plants growing in the water.

Much of the drinking water for stock in many of the states in this country is caught and stored in surface pools. The stock is allowed access to these pools at any and all times. These drinking pools often become breeding places for mosquitoes. The water cannot be drained away because it is absolutely essential for the stock. Neither is it desirable to pour oil on the surface because the water is thereby rendered unpalatable and obnoxious to the animals. In such cases, the best way of controlling the mosquitoes is the introduction of certain kinds of fishes into the pools.

In order for a species of fish to be effective in the control of mosquitoes it must possess certain characteristics. In general, it should be a small fish so that it can reach the shallower parts of the pool. It should also be a top-feeder, a voracious feeder on mosquito larvæ, and a prolific breeder. Finally, it should have a wide geographical range in order to make it available for as many localities as possible. It is evident that but few species of fishes possess the foregoing combination of qualities.

It would appear from a knowledge of the habits of the larvæ of Anopheles that they are much less easily held in check or destroyed than the larvæ of Culex. The larvæ of Anopheles are found especially in quiet waters, and in ornamental pools among the lily pads, duckweed, and other plants. They simulate remarkably well their surroundings and are thus screened from observation. Moreover, they live upon the surface, lying and moving in a horizontal plane. It is evident that only those fishes that are small and can penetrate to the spaces of water among the lily leaves and duckweed will ever be able to give relief from Anopheles mosquitoes. Moreover, the fishes must be top-feeders in order to find the larvæ lying on top of the water.

The goldfish is a good species for introduction into pools, especially ornamental plant pools. This fish is used in Japan for this purpose. In fact, goldfishes, when grown commercially in that country, are fed largely on the larvæ of mosquitoes. W. L. Underwood describes the work of goldfish in devouring mosquito larvæ as follows: "I took from the pond a small goldfish about three inches long and placed it in an aquarium where it could, if it would, feed upon mosquito larvæ and still be under careful observation. The result was as I had anticipated. On the first day, owing perhaps to the change of environment, and to being rather easily disturbed in its new quarters, this goldfish ate eleven larvæ only in three hours; but the next day twenty were devou.ed in one hour; and as the fish became more at home the 'wrigglers' disappeared in short order whenever they were dropped into the water. On one occasion twenty were eaten in one minute, and forty-eight within five minutes." Unfortunately goldfish grow rather large and tend to become cannibalistic.

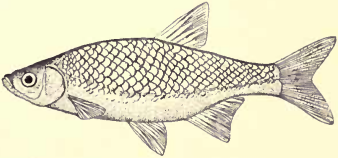


FIG. 30. — Roach or golden shiner.

The roach, or golden shiner (Fig. 30), is also an admirable fish for pools and ponds. It is widely distributed and is very abundant. Moreover, it is a very active fish, always scouting the waters in search of food. It is always found in large numbers in muddy pools, grassy ponds, and weedy bayous.

A species of fish that perhaps meets the requirements most nearly with the possible exception of a wide distribution is the top-minnow, *Gambusia affinis* (Fig. 31). This minnow does not become more than one and one-half to two inches in length. It is active and voracious and feeds near the top, penetrating to the shallowest parts

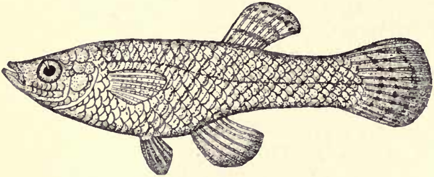


Fig. 31. — Top-minnow. (× 1½.)

of the pool about the edges. Here it is safe from its larger enemies and, at the same time, is in the presence of desirable food. It constitutes a most admirable fish for the destruction of mosquitoes in the Southern states. It occurs from the Potomac River and southern Illinois southward and west to Texas. Whether this minnow can be acclimated in northern waters is not yet known.

There are also two small species of sunfish, of the genus *Enneacanthus*, that seem well suited for this purpose. They are widely distributed, are active in pursuit of prey, and live among water plants.

In an admirable paper on "Fishes and their relation to the mosquito problem," W. P. Seal sums up the whole question as follows: "The writer has come to the conclusion, after many experiments in small ponds, that a combination of the goldfish, which is ornamental and useful in the open water, the roach or shiner, which is a very active species, two small species of sunfish, which live among plants, and the top-minnow would probably prove to be more effective in preventing mosquitoes breeding than any other fishes."

OIL AS A REMEDY FOR MOSQUITOES

The power that oil has to kill the larvæ and pupæ of mosquitoes has been known for some time. Its practical use against these insects has been of comparatively recent date.

How it kills. — If oil be poured upon water, it will sooner or later spread evenly over the surface in a thin film. This film has a comparatively strong tension, and speaking from the standpoint of an insect, is very difficult to break. The larvæ and pupæ of the mosquitoes, as we have already shown, breathe air direct by thrusting the ends of the respiratory tubes out of the water. As they come up beneath the oil film, to obtain air, they are unable to push their tubes through the oil, and thus are completely shut off from the air and in a short time drown from suffocation. It may also be said that the oil, as it comes in contact with the respiratory tubes, produces injury which hastens death. If any eggs are lying on the surface of the water and are touched by the oil, they are destroyed. Likewise the adult female mosquitoes are caught in the oil and killed when depositing eggs.

Kinds of oil to use. — In all my experiments ordinary kerosene oil, such as is used for illuminating purposes, was used. In the first place, ditches with their strong currents need a light oil that will spread as rapidly as possible. In the second place, petroleum has cost us just as much as the refined oil, even if bought by the barrel. For bodies of water that have no currents a heavy oil might be superior to ordinary kerosene because the former would not evaporate so quickly and thus need not be applied so often. On the other hand, an oil too heavy will not spread easily, but will gather in spots here and there over the surface, thus losing its effectiveness. Howard says, "so long as the oil flows readily and is cheap enough, the end is gained, provided it is not too light and does not evaporate too rapidly." Other investigators have found, that what is known as "light fuel oil" is the most satisfactory.

Amount of oil to use. — Careful experiments have shown that, in general, one ounce of kerosene is sufficient for every fifteen square feet of surface. One-half of a teacupful for a barrel is amply sufficient. If the oil is applied with a spray pump and fine nozzle, smaller quantities will be used.

How to apply oil. — For small pools, ditches, and tanks, a five-gallon knapsack spraying machine (Fig. 32) is almost ideal. The sprayer should have ten or twelve feet of hose attached and the hose should be furnished with a good nozzle tied to a pole about six feet long. With the pole the operator can reach both sides of a ditch and all sides of a tank without changing position.

In cases of barrels, cisterns, and cans, the oil may be poured on or thrown on from a cup, dipper, or other receptacle. In fact, it may be applied to the surface in many cases from a bucket sprinkler.

How often to apply the oil. — It has been shown in our study of the life history of *Culex pipiens* that the entire life cycle may be passed in ten or twelve days. In the case of Anopheles, the life cycle lasts from eighteen to twenty days. These facts alone indicate the necessity

FIG. 32. — Spraying a ditch for mosquitoes with a knapsack sprayer.

of frequent spraying. I have found that once in two weeks is often enough for sewage ditches. No doubt the oil is effective along the shallow edges of these ditches for some time after it is applied. That is to say, the oil along the edges does not run off immediately because of no current. On quiet pools oil is effective for several days after it is applied because it does not readily evaporate.

It is safe to say that an application of oil should be made at least twice a month to be surely effective. Possibly in certain cases oftener, especially in drains where the current is fairly strong.

Is the pouring of oil into water-closets effective in sewer ditches? — It has been asked of the writer so many times whether or not the same thing could be accomplished by pouring oil into the closets and allowing it to run down the sewer pipes, as by spraying, that it seemed worth while to give this point considerable attention. Accordingly, I poured two quarts of illuminating oil on the surface of the water in a main sewage ditch near the mouth of the tile to watch its effect below. A fairly quiet pool about two rods long and about fifteen rods below the outlet was selected as the first place of observation. Both sides of the pool were lined with multitudes of larvæ and pupæ lying in the shallows and in the miniature bays hollowed out of the sides of the bank. By the time the oil reached the pool it was well distributed. The result was, however, that the current was too strong to allow it time to spread into the quieter parts and bays of the pool. It was carried for the most part straight by. Many of the larvæ and pupæ, however, lying next to the current were so greatly disturbed that they blundered into the middle of the stream and were drowned beneath the film of oil. In a second and similar pool, about ten rods farther down, the effect was noted again. The oil had spread out even more by this time, but the effect was about the same. The majority of larvæ and pupæ escaped because the current gave the oil insufficient time to spread over them. Nevertheless, it is thought that several applications of oil, say one or two hours apart, would kill the larger part of larvæ and pupæ in such pools. A similar experiment repeated in another ditch gave precisely similar results with one additional point worthy of note. In one of the pools carefully observed, a thin mass of Algæ and scum rested over quite an area adjacent to one of the banks. In it were many larvæ and pupæ. Into this mass the oil never penetrated, and in my opinion with that current never would, no matter how many applications were made.

It would seem then, that the only sure and quick remedy for such places is to spray the oil on the surface. By this method many adults are killed at the same time. If poured into the sewer, several successive applications must be made to be in any degree effective, and even then in pools where there was algal slime it would have little effect. It is evident, that if the sewer pipes empty into pools or bodies of water with no current, the above conclusions would not apply.

FUMIGATING ROOMS TO KILL MOSQUITOES

It is often desired to free a house entirely of these insects. The best and most effective way to do this is to fumigate the rooms with some substance which will either stupefy or kill them. Many substances are used by campers and hunters to drive insects away, but for fumigating houses quite different materials are used. Probably sulfur is most universally used, while pyrethrum, culicide, and a few other substances are occasionally tried.

Pyrethrum. — Pyrethrum was originally produced in Asiatic countries only. Now the plant from which it is made is grown in California and the product is known as buhach. Buhach, pyrethrum, Persian insect powder, and Dalmatian powder are practically the same thing. They consist of the finely ground or powdered flower heads of certain species of chrysanthemum, *Pyrethrum cinerariæfolium* and *P. roseum*.[1]

It is difficult to secure pure pyrethrum from the drug stores. It is apt to be diluted with various substances that have no value as insecticides. However, the pyrethrum powders are used a great deal for fighting household insects, especially flies and mosquitoes. Usually the powder is blown into cracks and crevices frequented by the pests. The burning of the powder in rooms as a fumigant is also quite often practiced. The powder may be burned on coals or it may be heaped in little conical piles, which when lighted at the top will burn. The odor of the burning pyrethrum is inoffensive to most persons although with some individuals it may cause headache. When burned in a closed room, it will stupefy all of the mosquitoes. It does not actually kill all of them and they have to be swept up and burned. The odor of the burning powder will give relief from mosquitoes on open porches or in open rooms, but in order to receive the benefit one has to sit in the smoke. A pound of the powder to 1000 cubic feet of space has been recommended as necessary to accomplish the desired results. This makes such fumigation rather expensive, and because the powder does not actually kill the insects, sulfur is used more extensively.

Sulfur. — On account of its cheapness and effectiveness, sulfur is the most desirable fumigating substance for mosquitoes. The room in which the fumigation is to be done

[1] Now put in the genus *Chrysanthemum.*

should be made as tight as possible by stopping the cracks with strips of paper, as explained in a later chapter on bedbugs. The author has been able to burn sulfur very satisfactorily by putting the required amount, 2 pounds to 1000 cubic feet of space, in an iron dish and pouring on top half a teacupful of wood alcohol. The dish containing the burning sulfur is liable to become very hot and should be placed on bricks set in a tub containing a little water. The sulfur is liable to boil over and set fire to the floor. The gas kills all of the mosquitoes and is thus very effective. It, however, tarnishes brass, nickel, and gilt, and articles made of these materials should either be removed from the room or covered with paper or cloth.

Culicide. — In the great fight against yellow fever in New Orleans a compound of equal parts, by weight, of carbolic acid crystals and gum camphor was found efficient in killing mosquitoes in rooms. It is known as Mims "Culicide." Take one pound of carbolic acid crystals and liquefy by placing the bottle in hot water; take one pound of gum camphor, break into small pieces, place in a one-quart jar, and as the acid liquefies, pour it over the gum camphor, which will be gradually dissolved. When all the acid has been poured over the camphor and the latter has dissolved, there will be one full quart of a slightly reddish, heavy liquid. This is the Culicide, which will remain in this condition indefinitely, if kept covered. Three ounces evaporated in a closed room will suffice to kill all flies, mosquitoes, and other insects in one thousand cubic feet of space.

To evaporate, it is necessary to use heat, and an arrangement to do this is easily improvised by a section of stove pipe from which triangular pieces are cut at the bottom to leave three legs. A series of six holes, near the top, provides for a draft, and a tin pan or dish is set on top of the pipe and holds the Culicide, which is heated by the flame of an alcohol lamp placed at the bottom of the pipe. It will require an ounce of alcohol to completely evaporate three ounces of Culicide in twenty minutes. The Culicide is inflammable, but not explosive. As a matter of safety it will be better to place the apparatus in a tub of water on two or three bricks, so that in case of carelessness there will be no danger of fire. The room to be fumigated should be closed tightly, as recommended above, and should be kept closed for two hours at least. This material will not affect fabrics nor metals, nor are the fumes dangerous to human life. It is not recommended that anybody remain within the room while fumigation is going on, but the room can be safely entered immediately after opening, and it is quite possible to remain in the room with comfort until the evaporation or fumigation is thoroughly under way. It will be well to use only enough alcohol in the lamp to evaporate the material, so that it will go out when its work is done. The flame should be sufficiently high to reach well up toward the tin dish used, so that evaporation may be rapid. It should not be used so high as to come out through the holes and so run the risk of setting fire to the material.

THE USE OF BED NETS

In spite of our best efforts there are always a few mosquitoes in certain regions, but there is one good method of escape from them, and that is by the careful use of a good bed net. If a net is arranged so that it does not hang in folds and is not too low and close to the sleeper, there is little air excluded. The prejudice against bed nets and window screens, because they are thought to exclude a great deal of air, is unfortunate and unfounded. Nets and screens are coming into common use everywhere, especially in the South. The author has slept under a net nine months in the year and the feeling of security it gives is most satisfactory.

There are several essentials to success in the use of a good bed net. First it must be free from rents, small as well as large, and long enough to reach the floor on all sides of the bed. Some prefer a short net tucked under the mattress. This is good if the tucking is well done, but too often the net is carelessly arranged and then serves only as a trap. Do not have a net that opens up and down the side. Such a net cannot be made tight enough (except with *very great pains*) to keep out mosquitoes.

Really, a bobbinet bar reaching the floor on all sides of the bed is the only satisfactory net. Care should be taken not to allow mosquitoes to enter the net with the sleeper. The edge of the net must not catch on the bed rail or cover and remain off the floor during the night.

A net is not only useful and necessary at home, but it is indispensable when traveling. Hotels, especially those in country towns, often have no mosquito bars on their beds. Hotels are to be dreaded because the very room occupied to-night may have been occupied a few nights previous by a malarious person. If so, the malarial mosquitoes present in the room are liable to be teeming with the malarial germ and the unsuspecting sleeper will inevitably become infected by them before morning. It is advisable, in traveling, to carry needle and thread to mend the rents in bed nets; or, better still, to carry a small light net in one's bag for use where nets are absent or where they are too badly torn to mend.

I can do no better than to quote the words of Ross. He says "perhaps our first and best defense against malaria lies in the habitual and scrupulous use of mosquito nets at night. . . . The first care of the resident in the tropics, of the traveler, the sportsman, the soldier, the miner, the clerk, should be for his mosquito net. Wherever he lives, wherever he goes, he should see that his mosquito net is with him, that it is in good order, and that it is properly arranged at bed time."

WIRE GAUZE SCREENS AT WINDOWS

From his own experience, the author considers wire gauze screens at doors and windows next to bed nets in the prevention of malaria. It is true that the bite of one infected Anopheles will not, as a rule, give as severe a case of malaria as the bites of two or more. Hence, any measure capable of lessening the number of these insects that can gain access to an individual lessens the chances of contracting malaria, and also lessens the severity of the disease if contracted. It is not claimed that wire gauze can be fitted tightly enough to keep out all mosquitoes, but any one who has lived in a well-screened house in mosquito regions knows well the difference between the buzzing swarms of these pests found in outhouses after dark and the occasional ones in dwelling houses.

A word should be said regarding the kind of screens to use. In the first place, the wire should be galvanized and should have at least fourteen meshes to the inch, and better sixteen. For protection against the yellow fever mosquito, eighteen meshes to the inch are necessary.

The most efficient window screens are those that cover the whole window (Fig. 33). Such a screen is fitted inside

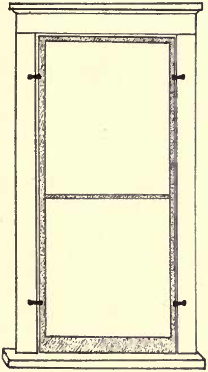


Fig. 33. — Screen covering whole window.

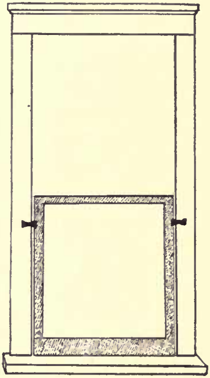


Fig. 34. — Screen over lower half of window.

the casing on the outside of the window and is held on by buttons, as shown in the illustration. The screen can be quickly removed in the autumn and easily replaced in the spring. Of course, this type of screen is suitable only where there are no shutters. The next best type of screen is one covering the lower half of the window and fitted inside of the casing (Fig. 34). This screen has a strip nailed along its upper edge on the inside to close the opening between the frame of the screen and the lower edge of the upper sash. It is fastened by two buttons near the top and a hook on the inside at the bottom which catches in a screw eye in the window sill. This arrangement enables one to put the screen on and fasten it from the inside of the house, which is of considerable advantage, especially in the case of windows in the upper stories. With this type of screen the upper sash of the window should not be lowered, but the lower sash can be raised or lowered at pleasure.

In case of those houses that have shutters the screen is sometimes made to fit the casing on the inside of the window. In this case, the screen fits in front of the lower sash only. The stops on the inside are usually removed and the screen put in place of them. These screens are arranged to slide up and down in order to gain access to the lower sash and to close or open the shutters. With one of these screens the lower sash should always be raised to its full height when opened, else there will be a space between it and the wire, and also between the two sashes through which insects could easily crawl.

So-called adjustable screens fitted beneath the lower sash are practically worthless. They never fit tightly enough to exclude mosquitoes, and with most of them house-flies can easily enter.

Every window and outside door in the house should be screened. In the Southern states the screens should remain on the year round. The same precaution is also necessary to exclude house-flies. Front doors are often screened while the back door is left unprotected, thus forming a fine place of entrance for mosquitoes. Cellar doors and windows should receive special attention because it is in warm cellars that the adult mosquitoes like best of all to pass the winter.

GOING INDOORS EARLY AT NIGHT

There has heretofore been a prevailing idea that night air caused malaria. We now know that night air is as pure and health-giving as any air, and that chills and fevers are contracted from the bites of Anopheles mosquitoes that fly at night, and not from any "miasma" in the air. It is therefore just as important that we remain in the house at night as it ever was. Moreover, it is important that we either go within doors early, before dusk, or very carefully screen our porches. It should be said, however, that Anopheles do bite in the daytime. Nevertheless, they are most numerous at night and do most of their biting about dusk. In hot climates, houses are built with as much porch room as possible, and people are much in the habit of sitting on these unprotected verandas. If malaria is to be escaped, such porches must be screened.

COOL SLEEPING ROOMS

In many of the Southern states mosquitoes breed and remain active very late in the fall. If sleeping rooms are kept warm, these insects will remain active and virulent for some time. To avoid this, one should not have fires in the sleeping room, except, possibly, for a little while in the early morning at rising time. In other words, mosquitoes should be made to lie dormant by low temperatures if possible.

REPELLENTS FOR ADULT MOSQUITOES

Various mixtures, oils, and ingredients are used to repel adult mosquitoes. Oil of citronella is said to be a very efficient protection against adult mosquitoes, but it will not last long, at most, and is not to be relied on for protection during a night of sleep. It is mainly useful while one is sitting on porches or in rooms where mosquitoes are troublesome.

Chickens and fowls are often pestered by mosquitoes and the author has seen one instance, at least, where he feels sure that mosquitoes were the cause of sore heads among a flock of chickens. It would seem advisable to use fish oil containing a little crude carbolic acid in such cases.

Miss Mitchell gives the following mixture as the best for general use by human beings; cedar oil, one ounce; oil of citronella, two ounces; spirits of camphor, two ounces. She says "a few drops of this on a cloth hung on the bed will keep mosquitoes at a distance, and the efficiency continues for a long time."

REPELLING MOSQUITOES BY THE USE OF TREES AND PLANTS

Many persons hold that where certain trees or plants grow no mosquitoes will be found. Eucalyptus trees and the castor-oil plant are thought to have peculiar efficacy in repelling mosquitoes. The eucalyptus tree, especially, is recommended for planting in mosquito-ridden localities. This tree is widely grown in California and there, if anywhere, it should demonstrate its use in repelling mosquitoes. Quayle who has observed this tree in California and its relation to mosquitoes says: "In the

Burlingame section all of the numerous winding avenues are lined with eucalyptus; there are eucalyptus along the highways, and there are groves of eucalyptus; yet, where these trees are most abundant it might be said that the mosquitoes are most numerous. . . . During the summer of 1904 we captured in five minutes' sweeping, immediately under eucalyptus trees, a pint cup of mosquitoes." Coyote Point, Cal., is covered with these trees, yet the construction of a hotel there was abandoned because of the mosquitoes. Other observers, who have lived where the eucalyptus grows and have had an opportunity of actually observing its relation to mosquitoes, declare that it does not repel these insects. All the authentic evidence we have on the subject proves that the eucalyptus tree is of no avail in repelling mosquitoes.

The castor-oil plant has also been heralded as repugnant to mosquitoes. Howard says this idea was based largely upon the report of Capt. E. H. Plumacher, United States Consul at Maracaibo, Venezuela. He reported that his house in Venezuela, surrounded by plantain and banana trees, had been greatly troubled by mosquitoes. But following the advice of neighbors he planted the seeds of the castor-oil plant among the trees, and the mosquitoes disappeared with the development of the plants. Some of these Venezuelan seeds were planted in New Jersey by Brakeley, but the plants proved of no efficacy in repelling the Jersey mosquitoes. J. B. Smith, also of New Jersey, says, "I put out several groups of them (castor bean plants) in 1902 in my front lawn and next to the porch. They were faithfully tested; but under the very plants themselves the mosquitoes were a little worse than anywhere else."

Chinaberry trees, which have also a reported charm against mosquitoes, have been shown to be worthless as repellents for these insects.

RULES FOR THE PREVENTION OF MOSQUITOES

The following measures against mosquitoes for the prevention of yellow fever published in 1906 by the Public Health and Marine Hospital Service are so authoritative and so much to the point that it seems eminently worth while to publish them here: —

HOW TO PREVENT YELLOW FEVER — NO MOSQUITOES, NO YELLOW FEVER

Treasury Department,
Bureau of
Public Health and Marine Hospital Service,
Washington, July 31, 1905.

Note. — The measures herein mentioned were recommended by the Army medical board of 1900, and have been indorsed by the American Public Health Association and by the First International Sanitary Convention of American Republics. They have also been justified by the experiences and observations of the two working parties of the Yellow Fever Institute of this Bureau in Vera Cruz, Mexico, and by the commission of the Pasteur Institute of Paris, France, operating in Rio Janeiro, Brazil. The measures have been tested successfully on a large scale in Havana, Cuba, and during the yellow fever epidemic at Laredo, Texas, in 1903:

THE INFECTION OF YELLOW FEVER IS CARRIED BY MOSQUITOES, AND BY NO OTHER MEANS IS THE INFECTION SPREAD.

PERSONS TAKE THE DISEASE BY BEING BITTEN BY MOSQUITOES THAT HAVE PREVIOUSLY BITTEN A YELLOW-FEVER PATIENT.

THE MOSQUITOES TO BECOME INFECTED MUST BITE A YELLOW-FEVER PATIENT DURING THE FIRST THREE DAYS OF HIS ATTACK. THESE FIRST THREE DAYS, THEREFORE, ARE THE MOST IMPORTANT TIME FOR PREVENTING THE ACCESS OF MOSQUITOES TO A FEVER PATIENT.

IT IS OFTEN DIFFICULT TO DECIDE DURING THE FIRST THREE DAYS WHETHER A PATIENT HAS YELLOW FEVER: HENCE THE NECESSITY IN THREATENED COMMUNITIES OF PLACING A MOSQUITO BAR IMMEDIATELY AROUND EVERY PATIENT WHO HAS FEVER OF ANY KIND, AND FOR THREE DAYS AT LEAST.

Facts about Screening

1. The netting used should have meshes fine enough to prevent the passage of mosquitoes (at least 18–20 meshes to the inch).
2. It is important to screen the windows and doors of the house. It is doubly important to screen the beds of fever patients.
3. Mosquitoes can bite through mosquito nets when any part of the patient's body is in contact with the netting.
4. Frequent examinations should be made to see that there are no torn places in the netting or that no mosquitoes have found a lodgment inside.
5. The netting should be well tucked in to keep mosquitoes from entering.
6. If mosquitoes are found within the netting, they should be killed inside and not merely driven or shaken out.
7. All cases of fever should be promptly reported to the local health officer. Awaiting his arrival they should be covered with a mosquito bar.

Facts bearing on Mosquito Destruction

1. Often mosquitoes live in the vicinity in which they breed. They do not fly a long distance.
2. Mosquitoes breed only in water — usually in artificial collections of fresh water.
3. The young mosquito, or wriggler, lives in water at least seven to twelve days.
4. Although the wrigglers live in water, they must come frequently to the surface to breathe.

5. Coal oil on the surface of the water prevents the wrigglers from breathing.

6. Destroy the breeding places and you will destroy the mosquitoes.

7. Empty the water from all tubs, buckets, cans, flower pots, vases, once every forty-eight hours.

8. Fill or drain all pools, ditches, unfilled postholes, and the like.

9. Change regularly every day all water needed in chicken coops, kennels, etc.

10. Treat with coal oil all standing water which cannot be screened or drained (1 ounce of oil will cover 15 square feet of surface). The oil does not affect the water for use if the water is drawn from below.

11. Where oil is applied to standing water it must be distributed evenly over the surface.

12. Put fine wire screening over cisterns, wells, and tanks of water in everyday use.

13. Places in which it is undesirable to put oil, such as watering troughs for stock, lily ponds, etc., can be kept free from wrigglers by putting in goldfish or minnows.

14. Clean away all weeds, grass, and bushes about ditches, ponds, and other possible breeding places, since these afford a hiding place for the mosquitoes.

15. Clean up vacant lots and back yards of all cans, tins, bottles, and rubbish.

16. First do away with, or treat, all places where mosquitoes are known to breed, and then begin to work on places where they might breed.

17. Inspect and treat with coal oil, gutters, culverts, ditches, manholes, catching basins, etc., along the roadside. Manhole covers should be screened.

18. Houses should be cleared of mosquitoes by burning 1 pound of insect powder or two pounds of sulfur to 1000 cubic feet of space. The mosquitoes will fall to the floor and should be collected and burned.

19. Success in mosquito destruction depends upon the coöperation of the members of the entire community.

20. While the infection of yellow fever is carried by a single

species of mosquito (the Stegomyia), to insure its destruction it is necessary to destroy all mosquitoes.

In places liable to yellow fever both individuals and communities have an effective method of protecting themselves, as indicated above. Use the mosquito bar at once over all cases of fever until the danger from yellow fever has passed. Destroy all mosquitoes.

WALTER WYMAN,
Surgeon-General.

CHAPTER V

THE COMMON BEDBUG

Cimex lectularius

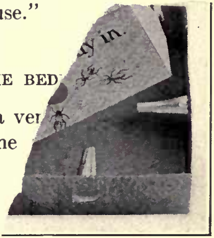
The bedbug is apparently as old as man himself, and records seem to show that this parasite has been man's bedfellow as long as human beings have slept in beds. Very likely the bedbug was a companion to the cave man long before such comparatively modern sleeping arrangements as beds were ever dreamed of. At any rate, the Romans knew it well and gave it the name Cimex, while Pliny wrote regarding its medicinal qualities and especially recommended it for snake bites.

Seven bedbugs mingled with water were a dose for a man while four were sufficient for children. Jame's Medical Dictionary tells us that the smell of them will relieve "hysterical suffocation." It is said that in certain portions of this country, inhabitants used to give bedbugs for fever and ague. Perhaps they had this as an excuse for allowing the pests in their houses.

It has gone with man wherever the latter's colonizing instincts have led him, and it came to America, very likely, with the early colonists. Kalm recorded this pest as abundant among the English colonies in 1748, but says it was unknown among the Indians.

NAMES BY WHICH IT IS KNOWN

The general name bedbug is given to this insect all over the United States and the name is a most appropriate and descriptive one. In the South, at least in Mississippi and parts of Texas, it is invariably called the "chinch." In New York they are often called "redcoats," while in Baltimore they are given the aristocratic and, at the same time, rather descriptive name "mahogany flat." An old English name for it was "wall louse."



DESCRIPTION OF THE BED

The bedbug is a member of a ver
sects known as Hemiptera. The
squash bugs are familiar members of this group and near relatives of the bedbug. The stink bugs, squash bugs, and bedbugs have certain glands in the body that secrete an oily, volatile, and ill-smelling fluid. No doubt, in the stink bugs, squash bugs, and others this fluid serves as a means of protection and oftentime
by their enemies, the b
the bedbug there is p
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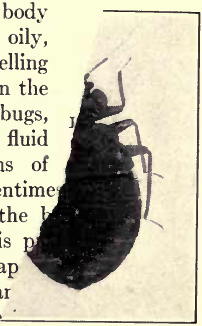


, with egg-case (× 1); trap for cockroaches; bedbug (× 8), below.

The bedbug h

(Fig. 35). The under lip has become greatly lengthened and the edges rolled upward until they nearly meet on top, thus forming almost a closed tube that constitutes the so-called beak. Inside this tube are four long, slender, thread-like organs that move over each other …ng, alternating motion that enables them to …ate the flesh and set the blood free. The … a tube to conduct the blood to the … bedbug is flat and wide (Plate II), a … wonderfully well to the places it has … The cracks and crevices of bed- …le protective retreats for an insect … Moreover, the bedbug has no large … and encumber its retreat. It is …rs of the bedbug had wings but … flightless life of so many ages … become lost through disuse. …f wings, for they have not … left of the wings are simply …nd it is fortunate that they … with which to fly, for then … control.

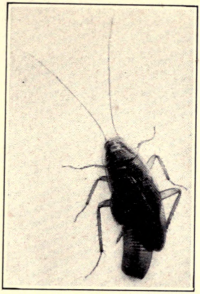
…THE BEDBUG

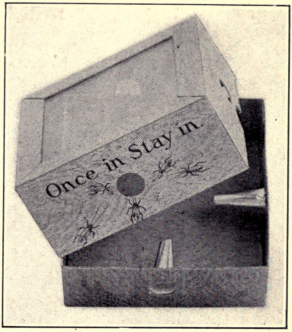
…eper, for good house- …sts on their beds, to …ished in her house. …hich bedbugs gain …t in by the washer- …en bedbugs come

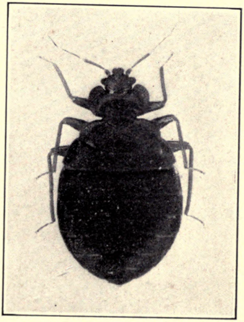
THE bedbug is ap…
records seem to show …
bedfellow as long as h…
Very likely the bedbug w…
long before such compar…
ments as beds were ever …
Romans knew it well and …
Pliny wrote regarding its me…
recommended it for snake bit…
Seven bedbugs mingled with …
while four were sufficient for …
Dictionary tells us that the s…
"hysterical suffocation." It is sa…
of this country, inhabitants used …
and ague. Perhaps they had this …
the pests in their houses.
It has gone with man wherever …
instincts have led him, and it came t…
with the early colonists. Kalm re…
abundant among the English colonies …
was unknown among the Indians.

NAMES BY WHICH IT IS KN…

The general name bedbug is given to th…
the United States and the name is a most …







Cockroach, croton-bug, with egg-case (× 1) ; trap for cockroaches; bedbug (× 8), below.

in on the weekly laundry and has seen them hiding away among the crevices of the clothes basket. In several instances, the writer has seen these insects on the white spread of a bed on which the clean clothes have been laid by the laundress. This is a source of infestation that has to be constantly watched.

If the members of a family travel a great deal they are liable to bring the pest home in their trunks and handbags. Guests that have been traveling and stopping at various hotels often unwittingly become the source of infestation by bringing the pest in their baggage.

In towns and cities, where houses are built close together, the bedbug will sometimes actually migrate from one house to another along walls and pipes. This is especially liable to happen where one house has been vacant for some time and the parasites have been deprived of food. Marlatt says the insect "will often continue to come from an adjoining house, sometimes for a period of several months, gaining entrance daily."

THE FOOD OF THE BEDBUG

Apparently the bedbug naturally chooses human blood in preference to all other food. In fact, the author is unable to find conclusive evidence that the bedbug will accept any other substance than *blood* as food. Some writers maintain, however, that this insect can subsist for a time upon the juices it may be able to extract from moist wood or from moist accumulations of dirt in cracks and crevices of floors and walls. Indeed, for that matter, DeGeer kept bedbugs alive and active for a year in a tight box without any food at all. Other investigators have kept them alve in vials and pill boxes without food for many months. This would indicate that they could live in unoccupied houses for several months, at least, even if they were unable to obtain blood. It is doubtful if bedbugs could exist more than one season, say an active summer and a dormant winter, in an uninhabited house where no sources of blood were available in all that time.

It is exceedingly interesting in this connection to note the experiments of Girault and Strauss on the host relations of the bedbug to mice. They found that bedbugs, under certain conditions, at least, would attack both recently killed mice and living mice and would gorge themselves with blood from these animals. It is not too much, in the light of these experiments, to suppose that these insects might eke out an existence in deserted dwellings for a considerable period of time if mice were present to serve as occasional hosts. It has also been shown that the bedbug will thrive upon domestic fowls as hosts and feed upon the cat, dog, rabbit, and other animals.

HABITS OF THE BEDBUG

These hardly need discussion they are so well known. Of course they frequent beds particularly, but are found, when abundant, in cracks of the floor, behind baseboards, window casings, and even in cracks of the ceiling. Wooden bedsteads, especially the large old-fashioned ones, are most apt to be infested. Iron beds do not afford many hiding places for them and are not universally infested. We have, however, seen them in iron bedsteads and in one case found a colony of 30 or 40 bugs living and increasing in the folds of a bed net along the seam up and down the back. Every now and then a bedbug was seen on the net and killed and then down came the bed for a treatment. Probably the bed had been treated half a dozen times when at last, in sheer desperation, the entomologist was called in. We were greatly puzzled at first because the bedstead was apparently free from the pests; but when told that the bugs were always seen on the outside of the net the search was begun there with the happy result just given above.

These insects procure their food at night, attacking the exposed parts of the body. During the day they remain hidden in the bedstead and in the mattress and about the room. Somewhat colored reports have been written regarding the sagacity and cunning of this insect to gain access to beds and remain hidden during the day.

THE BITE OF THE BEDBUG

To many persons it is very irritating and causes swelling and produces large red blotches on the skin. The writer remembers vividly his first and youthful experience with bedbugs in a city boarding house while attending school. In this instance they paid especial attention to his neck which was one mass of red blotches before he knew the cause of his restless and uneasy slumbers. Many people are not sensitive to the bite of this insect and seem never to be aware of its existence, even when present. So far as known, there is no poison secreted in the mouth of the bedbug and the inflammation seems to be due simply to the irritation caused by the puncture.

LIFE HISTORY

There are still several things to learn regarding points in the life history of so common and so widely distributed an insect as the bedbug.

C. L. Marlatt in 1896 was the first to give the true life history of the bedbug. Later, in 1905, A. A. Girault contributed considerable data to the life history of this insect. We are yet in the dark concerning the number of eggs desposited by a single female and we do not know positively how many generations there may be in a year.

The eggs are white and oval in outline with a rim around the free end and sculpturing over the shell. They are laid in batches of varying numbers in cracks and crevices in the bedsteads or other places in which the bedbugs happen to be. The number of eggs deposited by a single female is not known. Southall, Riley, and others have made the common statement, probably not based on actual observation, that each female lays about four batches of fifty each during the season. Girault actually succeeded in obtaining 111 eggs from one well-fed female between June 17 and August 19. How many she had deposited previous to confinement for the experiment he was, of course, unable to say. Girault's experience with this one bug indicates that the females may continue to lay eggs at different periods throughout the breeding season and that there is only one generation a year.

The eggs hatch in six to ten days and the young bugs or nymphs molt five times before they become adults. When first hatched the nymphs are whitish in color, but as soon as possible they feed, when the body becomes red or dark purplish, due to the engorgement of blood. As the nymphs molt and grow they become darker and darker in color. Marlatt pointed out that the periods between the molts vary greatly with the amount of blood the nymphs obtain. Girault showed that well-fed nymphs passed through their molts and became adults in 35 to 48 days, while those poorly fed took from 78 to 156 days for their development.

Marlatt says that under the most favorable conditions an average period of about eight days occurs between moltings and between the laying of the eggs and their hatching, thus giving about seven weeks as the period from egg to adult insect. It would seem that ordinarily a bug feeds but once between each molt. In this event, each one punctures its host at least five times before becoming an adult. The adult female probably punctures its host several times before the egg-laying period is finished.

DOES THE BEDBUG INFEST ANIMALS OTHER THAN MAN?

Many persons feel very sure that the bedbug is found on swallows and that houses may become infested with these pests from the nests of swallows and swifts. It is true that swallows and chimney swifts are infested with a bug very similar in appearance to a bedbug, but it is a species distinct from the latter. Occasionally, these swallow bugs get into dwellings and cause a great deal of worry to housekeepers. In one case, a correspondent writes that the bugs from swifts that had taken up their abode in the chimney of the house invaded a sleeping room in great numbers and severely attacked the occupant of the bed. In a careful search next day, however, none of the bugs could be found in the bed although they were abundant about the floors of the room. This is a very interesting note and if the observations and conclusions of the correspondent were correct, there is some ground for worry in connection with these bird "bedbugs."

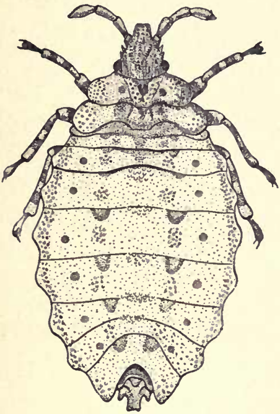


Fig. 36.—Nymph of a species of Aradus, much enlarged.

A bug very similar to the bedbug is also found in pigeon cotes and another in the nests of the English martin.

The true bedbug does, however, occur in poultry houses. It has been found that bedbugs breed in the houses and attack the chickens at night, causing considerable injury.

In certain parts of the West, the older inhabitants, at least, believe that the bedbug lives on dead or dying cottonwood trees beneath the bark and that they will surely be found in houses built of cottonwood logs. The early immature stages of another bug belonging to the genus *Aradus* (Fig. 36) are often found under the bark of cottonwood trees. In these immature stages this insect has no developed wings and greatly resembles a bedbug and is, therefore, mistaken for the latter. In this way, probably, the misconception has arisen that bedbugs live out-of-doors on trees.

THE RELATION OF THE BEDBUG TO DISEASE

Metschnikoff was probably the first to bring the bedbug under suspicion as a transmitter of disease. Since that time many writers and experimenters have labored hard to prove this insect guilty of graver offenses than that of simply stealing blood from human hosts. The most they have been able to do so far, however, is to show that in one case, at least, the *bite* of the bedbug formed a *starting point* for a case of bubonic plague. As a matter of fact, this is really a stronger indictment against the bedbug than, at first thought, might appear. The sores resulting from bedbug bites offer ideal points of entrance for disease-producing organisms and are a source of real danger. Actual and definite proofs of the transmission of disease by the bedbug are difficult to obtain, but suspicion points strongly in that direction. It is supposed that they spread the germ causing Obermeyer's relapsing fever, a disease occurring in Europe. Nuttall succeeded in transmitting this germ through the bite of a bedbug from one mouse to another. It is inferred that if the bedbug can transmit the germ from mouse to mouse, it can also transmit it from man to man.

Dutton has also shown, experimentally, that the bedbug may spread typhoid fever. The bugs were infected by feeding on the blood of a person in the acute stage of the fever. The bacilli were retained by the bug in a virulent condition for at least twenty-four hours.

In 1907 Patton discovered the parasites of a tropical disease of the Old World, known as Kala-azar, in bedbugs (*Cimex rotundatus*) that had fed on persons suffering from this disease. He did not demonstrate, however, that the bedbug actually inoculated other people with it.

It is extremely desirable to avoid the bites of this insect if possible, especially in hotels where beds are occupied by so many different people; but this is very hard to do, in fact, almost impossible if one travels much.

CONTROL OF THE BEDBUG

In the first place, iron or brass bedsteads are much more desirable than wooden beds in a fight against this pest. The former offer very few cracks and crevices and what there are may be easily reached.

There are several old-fashioned remedies for the bedbug that are efficient weapons in the hands of a persistent and thorough housekeeper. Kerosene oil, gasoline, or benzine will kill bedbugs if forced into cracks and crevices with a feather or with a hand syringe. The treatment must be thorough and should be made several times in succession, allowing intervals of three or four days between applications to give time for any untouched eggs to hatch.

A mixture of corrosive sublimate one ounce, alcohol one pint, and spirits of turpentine one-fourth pint, painted in the cracks of a bedstead with a feather, is an old fashioned remedy and an effective one. Since bedbugs are sucking insects and are killed by contact, it is hard to see how the corrosive sublimate adds anything to the effectiveness of the remedy. If these pests were biting and chewing insects and there was thus some probability of their eating some of the poison, there might be more reason for including it. It is possible that, as its name indicates, the mercuric chloride has more or less corrosive effect when it comes in actual contact with the insect.

Boiling water poured over the parts of a bedstead that have been carried where they may be liberally treated will kill both eggs and bugs. Of course, boiling water should not be used on highly polished and varnished furniture.

Sulfur has been used with success by some. Personally, the author has not found the burning of sulfur effective, but it seems now that not enough was used. Not less than two pounds to every thousand cubic feet of space should be burned and the room should be tightly closed for several hours. The most effective and, at the same time, most economical method of closing the cracks about windows, transoms, and doors, is to tear old newspapers into narrow strips and soak these thoroughly in water. When thoroughly soaked, these strips may be quickly applied over the cracks and will stick there closely for several hours. Fireplaces, chimney holes and other large openings should be closed with old quilts, sacks, or anything convenient.

The sulfur may be burned by putting it in an old kettle, baking pan, or similar dish that is not held together with solder, and setting it on brick or in a pan of cold ashes to keep it from burning the floor. A teacupful of wood alcohol poured directly into two pounds of sulfur and then lighted will serve to burn the sulfur completely and readily. The sulfur may be burned on live coals in an ash-pan.

It must be remembered that sulfur fumes bleach certain colors in wallpapers and fabrics and tarnish metals of various sorts. For these reasons, its use is objectionable.

Sulfur candles for fumigating are now made and are very convenient. They may be burned by setting them on bricks in a tub of water or in pans of wood or coal ashes.

Where swifts have taken possession of a chimney and bugs from them have overrun adjacent rooms it would be advisable to exclude the birds from their roosting place. This could be done by securely fastening heavy wire netting over the chimney opening. It would also probably be feasible to fumigate the chimney by burning sulfur in it after closing the top opening tightly.

Hydrocyanic acid gas. — This is the killing agent, par excellence, for bedbugs and household insects. It is a gas formed by the chemical reaction between potassium cyanide, water, and sulfuric acid, and is a deadly poison to human beings as well as to other animals. However, it can be generated and used in the fumigation of houses, without the least danger, if care and precaution are used in the work. The gas is not inflammable, does not bleach colors, does not injure fabrics in any way, and does not, in general, attack metals, although it will tarnish nickel fixtures. These should be covered with towels or similar articles. Dry food products are not affected, but milk and butter may absorb some of the gas and should be covered. See Chapter XVII for a discussion of the use of this gas.

Desiring to know the effect of hydrocyanic acid gas on bugs hidden away in mattresses, blankets, comfortables, and the like, the following experiments were tried: —

1. Three bugs were placed in a perforated pill box and then wrapped in excelsior, three inches all around, and this in turn in some domestic to imitate ticking.

2. Three bugs (one adult, one one-third grown, and one

very young) were placed in a similar box and then carefully wrapped in two folds of a thick comfortable.

3. Three bugs (two adults and one one-third grown) were placed in a similar box and carefully wrapped in cotton-batting to the depth of two inches.

4. Two bugs (one adult and one two-thirds grown) were placed in a similar box and wrapped in two folds of a thick woolen blanket.

5. Six bugs were put in a vial $3\frac{1}{2}$ inches deep and one inch in diameter, and the latter stopped with an inch cork which had been punched twice with a pair of dissecting-forceps with curved points. The holes thus made had apparently closed up, owing to the spongy nature of the cork, but it was found afterwards that air could be readily forced through them by placing the cork between one's lips.

6. To serve as checks several bugs in perforated boxes were placed about the room at different heights from the floor.

In every box of bugs wrapped in different materials several new-laid eggs were placed to determine the effect of the gas upon the hatching of the same.

The room in which the fumigation was done measured $14 \times 8 \times 8$, and contained 896 cubic feet. We used 10 ounces of cyanide, 300 cc. of acid and 600 cc. of water, allowing the room to remain closed 14 hours. We made a slight mistake in our computation, and used 1 ounce more of cyanide than our formula called for.

The result was surprising and very gratifying. Every bedbug in every case was killed.

The fumigation was done June 1st, and up to June 12th, none of the eggs showed any signs of hatching.

It is impossible to say whether they were fertile or not, but it is reasonable to suppose that they were. We obtained them by confining a dozen or more adult bugs in a large vial, and on the second day we found eggs in abundance. The eggs must have been formed in the females under natural conditions in the bedsteads from which they were taken, and very likely the bugs were fertilized there before we collected the females.

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CHAPTER VI

COCKROACHES

Ectobia germanica et al.

Cockroaches are exceedingly annoying from the mere fact of their presence and their disgusting proneness to get into things. Often they become of considerable economic importance because of their destructiveness. Several instances are recorded where they have defaced the bindings of books in libraries. The paste with which the bindings of books are put on is very attractive to these insects and in getting at the paste, the cloth and leather bindings are often scraped and defaced. In fact, cockroaches are almost omnivorous, eating cereals, bread, biscuits, and almost any dead animal matter. They occasionally injure leather covered furniture and are said to eat their own cast skins, and even living members of their own species, thus becoming cannibalistic.

It is really in large hotels and restaurants, about bakeries and on board ships that the cockroach becomes a serious and disgusting pest. Persons in private homes have no adequate notion of the cockroach as a pest. There are reliable accounts of these insects occurring in such numbers on board vessels that the whole supply of ship biscuits was either devoured or put in such a filthy condition that they could not be used as food.

R. H. Lewis, in writing of a voyage taken by him in 1835, gives an interesting account of the damages inflicted by cockroaches on board his ship in the following words: "The ravages they committed on everything edible was very extensive; not a biscuit but was more or less polluted by them, and among the cargo 300 cases of cheeses, which had holes in them to prevent their sweating, were considerably damaged, some of them being half devoured, and not one without some marks of their residence."

Another traveler, Sells, gives a graphic account of the work of these insects as he saw them in Jamaica. "This is the most annoying of the insect tribes in Jamaica, devouring leathern articles of all kinds which have been used, such as saddles, harness, gloves, boots, shoes, etc.; they devour the bindings of books after they have been handled, and any perspiration has adhered to them; they crawl over and eat fruit and vegetables, dropping their egg-cases and leaving their feces and an intolerable stench wherever they travel; they also eat the corks of bottled wine, cider, and porter, causing the liquid to escape. This may, however, be prevented by dipping the corks in a thick mixture of quicklime and water, the latter being occasionally impregnated with the bitter quassia. They harbor in empty bottles which are rendered not only difficult to clean, but almost impossible to sweeten again. They also eagerly devour parchment, which material is consequently never used for wills, deeds, conveyances, or other legal documents, which the insects would very quickly destroy. They have a great dislike to castor oil, which is accordingly rubbed over boots, shoes, and other leathern articles to protect them from their attack." Like the bedbug, cockroaches have a peculiar and disgusting odor wherever they have runways. This is familiarly known as the "roachy" odor. Dishes left standing on a shelf for some time where roaches are abundant are apt to become so impregnated with this odor that food afterwards cooked or served in them tastes unpleasant.

Cockroaches are among the oldest insects, geologically speaking, that we have. They existed in great numbers during the coal forming age when the prevailing temperature was warm and the atmosphere full of moisture. Under these conditions the cockroaches developed in numbers and species until, entomologically speaking, this period might be called the age of cockroaches. It will shed some light upon the habits of our present-day roaches if we remember the moist, warm environments under which their ancestors appeared and lived.

Most of our domestic cockroaches came originally from tropical regions, very likely from the warmer parts of Asia. They were carried to England and Holland during the sixteenth century in the ships that brought teas, spices, and perfumes from the East. For many years they were found only in seaport cities, but gradually spread among the inland towns. Probably, because of their tropical origin, these insects are not able to stand low degrees of temperature. Hubbard tells us that the cockroaches, even in dwellings, were nearly all destroyed in Florida during the severe freeze of 1894 when so many orange trees were killed. On the other hand, there is one species of cockroach that inhabits the huts of the Laplanders and occurs in such numbers at times that the stores of dried fish put away for the winter are greatly damaged and sometimes destroyed.

HABITS

Like the bedbug, the cockroach generally remains hidden during the daytime while the occupants of the buildings are actively about. When the kitchen and pantry are deserted and dark, these insects come forth to forage. If one comes into the kitchen suddenly and turns on the light, the roaches will be seen scampering away in every direction. So abundant do they sometimes become that they actually may be heard rustling over the floors as they scurry away. They prefer warm kitchens, bakeries, and pantries, where there are usually water pipes, warmth, and food. The croton-bug seems to come with the advent of waterworks. Many inhabitants of Southern towns never saw a croton-bug until within the last few years, during which so many of the progressive towns have installed systems of water supplies. Dozens of inquiries have come to us regarding the little roach which had never been seen until the bathroom fixtures had been installed and the kitchen fitted with water pipes.

The flat, thin bodies of roaches fit them admirably for crawling into cracks, behind baseboards, window casings, shelves, and other obstructions. It is in such places that they hide away during the day. Moreover, the protection afforded by these retreats is very effective, for it is exceedingly difficult to inject anything into these cracks and crannies with sufficient force or in sufficient quantity to actually hit and kill the roaches. The dark, sometimes almost black, color of roaches affords them protection on their nocturnal foraging expeditions. There are certain redeeming traits in the habits of cockroaches that atone a little for their offenses. They have biting mouth parts, and are primarily scavengers and may under certain conditions devour and thus remove certain offensive dead animal or vegetable matter.

They are also quite an enemy of bedbugs and will contribute towards the destruction of this annoying pest. However, the small benefit roaches may confer in both these directions will hardly compensate for their presence in dwellings.

Insect Life records a very interesting letter from Herbert Smith, who has traveled widely in the tropics, regarding the habits and numbers of cockroaches in Brazil. He says: —

"Cockroaches are so common in Brazilian country houses that nobody pays any attention to them. They have an unpleasant way of getting into provision boxes, and they deface books, shoes, and sometimes clothing. Where wall paper is used they soon eat it off in unsightly patches, no doubt seeking the paste beneath. But at Corumba, on the upper Paraguay, I came across the cockroach in a new rôle. In the house where we were staying there were nearly a dozen children, and every one of them had their eyelashes more or less eaten off by cockroaches, — a large brown species, one of the commonest kind throughout Brazil. The eyelashes were bitten off irregularly, in some places quite close to the lid. Like most Brazilians, these children had very long, black eyelashes, and their appearance thus defaced was odd enough. The trouble was confined to children, I suppose because they are heavy sleepers and do not disturb the insects at work. My wife and I sometimes brushed cockroaches from our faces at night, but thought nothing more of the matter. The roaches also bite off bits of the toenails.

Brazilians very properly encourage the large house spiders, because they tend to rid the house of other insect pests."

METHODS OF DISSEMINATION

The foreign species of roaches, the German roach, Australian roach, and Oriental roach were brought here on ships from the various countries in which these insects were native.

The German roach, now so well known by the name of croton-bug, is gradually spreading all over this country. It is called croton-bug because it was first associated with the water system of New York City supplied through the great Croton aqueduct. Very likely this cockroach had been in this country long before, but the water pipes gave opportunity for entrance to the houses and the accompanying dampness was much liked by the insects. It is a fact that these insects become numerous and greatly troublesome in dwellings as soon as a system of waterworks is installed. It is evident that these roaches demand a certain measure of dampness for their successful increase and continued existence. There is no reason to suppose they are brought to a town with the iron pipes; but the dampness attracts them and affords favorable conditions for their increase.

Roaches are often carried from town to town in shipments of grain, groceries, and other foods. The author once saw two cockroaches in a tight box containing groceries that had been shipped from Chicago to Mississippi. Undoubtedly roaches are carried from one house to another with furniture and supplies.

We have, at least, one recorded instance of the undoubted migration of cockroaches from one building to another. Howard records this migration in the city of Washington on a dark, drizzly day in September as follows:

"The army issued from the rear of an old restaurant fronting upon Pennsylvania Avenue and marched across the muddy street, undeterred by pools of water, ash heaps and other barriers, directly south to the front of the building opposite.

"This building was a machine shop and at the direction of the foreman several of the men took brooms and swept back the advancing horde. They swept until their arms were tired, but were unable to stem the advancing tide. The foreman then directed that a line of hot ashes from the furnace be laid along the brick sidewalk. This proved an effective barricade. The foremost cockroaches burned their antennæ and their front legs and the army divided to either side and scurried down into the area ways of adjoining buildings in which they disappeared. The march is said to have continued from two to three hours and many thousands of the insects crossed in this way. A moment's glance, after arriving at the spot, showed me that the insect was the croton bug and that nearly all of the individuals were females carrying egg-cases.

"I called at the restaurant and found to my surprise that no house cleaning had been going on and that no special effort had been made by the application of insecticides to rid the establishment of the roaches.

"It seems then to have been a true migration, a development of the true migrating habit in the croton-bug."

Perhaps it is in this way, under cover of darkness, probably, that dwellings become suddenly infested with these insects.

NUMBERS AND DISTRIBUTION OF COCKROACHES

The cockroaches belong to the family Blattidæ, which is rather closely related to the family of grasshoppers, or locusts. The family Blattidæ contains nearly a thousand known species and it is thought that eventually several thousand more species, now unknown, will be added to the list. Fortunately, most of these species occur in the woods and fields away from human habitations. In the United States only four or five species have become domestic. A few species are found in the fields and woods. In tropical countries, however, the domestic species are numerous, and the so-called wild species are abundant and many of them are striking in color and of large size, one species having a wing expanse of more than six inches. As we have already pointed out, at least one species occurs in the far North.

Of the four species in the United States that are considered pests, one of them, the "black-beetle" of Europe is commonly said to have come, originally, from Asia. One other, the so-called croton-bug, or German cockroach, is supposed to be of European origin. As a matter of fact, the origin of these two forms is very obscure and nothing absolutely definite is known about their native home. The third species, the Australian cockroach, is undoubtedly a native of Australia and came to this country in ships. The fourth one, the American cockroach, is a home species native to the tropical and sub-tropical parts of America. Thus it happens that three-fourths of the species of roaches common in our households have been introduced from foreign countries and have already become as injurious as in their original homes.

THE LIFE HISTORY OF COCKROACHES

It is almost an axiom that something unknown remains to be found out about almost any insect. This is certainly true of the life history of cockroaches. Many guesses and astonishing statements have been made regarding the time it takes young cockroaches to reach maturity. It has been said that four or five years are required for some species to pass through their life history from the egg to the adult. We cannot flatly dispute this statement, but with one or two species, at least, we know that the time for this development is much less.

Cockroaches have a peculiar and characteristic habit of depositing their eggs. Instead of laying their eggs one at a time, like other insects, they deposit them in batches. The eggs are held within the body of the insects and inclosed in a sort of capsule or egg-case, known as an *oötheca* (Fig. 37).

Fig. 37. — Egg-case of croton-bug. (× 3.)

While in the body of the female the egg-case apparently occupies most of the space within the abdomen. The capsule is more or less bean-shaped and, in case of the Oriental roach, contains just sixteen eggs arranged in two rows. The eggs are more or less outlined within the egg-case by line-like depressions between them. When the egg-case is first deposited it is creamy white in color, but within two or three days it turns to a dark brown nearly like the body of the parent. No very exact observations are known to the author which determine definitely the number of eggs laid by one female roach; but Seiss confined three females of the Oriental cockroach and observed them to deposit twenty-five cases, an average of about eight for each one, before they died. The twenty-five capsules were deposited between April 20th and September 6th of the same season.

Often the egg-case is not deposited free from the abdomen at once, but is carried about by the female with the end of the capsule projecting from the posterior end of the body (Plate II). C. V. Riley has said that "The female cockroach carries the egg-case about with her until the young are ready to emerge, when it is dropped." Other observers have found that the egg-cases are not carried by the female more than four or five days at the most. Butler says: "When full the case protrudes from the end of the abdomen of the female, and is carried about by her in this position for about a week, after which it is dropped into a suitable crevice in a warm situation."

The observer, Hummel, who watched the life history of the German cockroach, says that the young molted six times before becoming full-grown and that they spent from three to five months or even longer in completing their growth. When the nymphs first shed their skins they are soft and whitish in color, but soon harden and change to a darker color. He also states that the mother sometimes assists the young to escape from the egg-case by tearing it open with her jaws, thus providing a means of egress for the young.

Marlatt says that the common American roach (*Periplaneta americana*) has been carried from the egg to the adult state in the Insectary at Washington and that the young which hatched July 11 reached their full growth between March 14 and June 12 of the following year. In this case, then, nearly twelve months were needed to attain the adult stage.

It is evident, then, that in the cases which have been actually observed, the cockroach completed its growth in much less time than has commonly been reported. Undoubtedly the time consumed in the development of young cockroaches depends upon the temperature, amount of food available, and other surrounding conditions. Perhaps a scarcity of food, low temperature, and other unfavorable conditions might combine to retard the development of the nymphs and prolong it for years.

DOMESTIC SPECIES OF COCKROACHES

There are four principal species of cockroaches that frequent dwellings, other buildings, and ships, and cause the trouble that we have described in the foregoing pages.

Probably the best known and most disliked of the four is the German cockroach, or croton-bug, *Ectobia germanica,* as it is known in this country (Plate II). This species, so abundant in Germany and adjoining countries, is now widely distributed all over the eastern and southern parts of the United States and when it once enters a house it increases so steadily that it becomes exceedingly numerous. In a single fumigation of a small pantry and kitchen, the writer has killed over a gallon of these roaches by actual measure. Yet during the daytime they were not in special evidence, but their trails, odor, and general filth were everywhere and in everything.

It is the smallest one of the domestic species and the most difficult to get rid of or control. Moreover, it increases faster than the others because it lays more eggs at a time and the young complete their growth sooner than those of the other species. It is light brown in color with two characteristic dark brown lines on the thorax and is about five-eighths of an inch long.

Perhaps next to the croton-bug the American cockroach, *Periplaneta americana,* is the most common and most widely distributed in this country (Fig. 38). It is the largest one of the four and the wings are long and well developed. It is, perhaps, more common in the middle and western United States than anywhere else and formerly was the most troublesome species in these sections. In Texas it is abundant and in some localities, at least, is a great pest, especially in the southern parts of the state. This roach is supposed to be of semitropical or tropical origin, and very likely, the conditions in southern Texas are especially favorable to its existence.

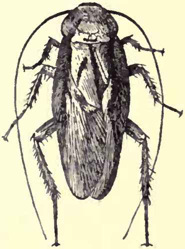

Fig. 38. — American cockroach. (× 1.)

This species is a well-known inhabitant of feed mills and becomes a nuisance and a costly occupant, because of the food-stuffs it not only eats but renders unfit for market. The basement of a corn mill in Cuero, Texas, was investigated in search of some specimens of the American roach. The basement of the mill was found to be literally alive with them and an abundance of specimens was obtained in a few minutes. They were a nuisance in the mill, but very difficult to get rid of.

Kellogg, in "American Insects," says that a friend of his in Mazatlan, Mexico, sent him "quarts of large native American roaches which he readily scooped up from his bedroom floor." He further says that ships come into

San Francisco with the sailors wearing gloves on their hands while asleep, to keep the hordes of roaches from gnawing off their finger-nails. These particular roaches are the most annoying ones on board ships. Moreover, they are responsible for serious injury to books because they like the starchy matter among the bindings. *Insect Life* records an instance of serious injury by this roach to the bindings of books in the National Treasurer's Department at Washington. Many of the books in the basement had their backs eaten off although they were up on the higher shelves and in dry situations. Many of the reports, bound in cloth, had been badly eaten both on the backs and covers, thus presenting a corroded appearance. It seemed that the American roach went no higher than one or two stories and few of them above the basement.

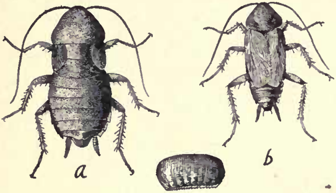

FIG. 39. — Oriental cockroach. (× $\frac{3}{4}$.)

The third species, *Blatta orientalis,* is known as the Oriental cockroach (Fig. 39) or "black-beetle," the latter name being applied to it in England especially. It is quite widely distributed in the United States, especially in the East and South. It is the most common roach in England and probably came to America with the early colonists. It came originally from the tropical parts of Asia, but has adapted itself to its changed environment with very great success. It is a dark brown roach, becoming almost black in the older female specimens, and is considerably larger and stouter than the croton-bug.

The males and females differ considerably from each other. The males are smaller and not so stout as the females and are furnished with two pairs of shortened wings. The females are wingless, or nearly so, very dark colored, and allow their abdomens to drag almost on the ground when in movement. This species is somewhat socialistic in its habits, many individuals living together in peaceable relations with one another.

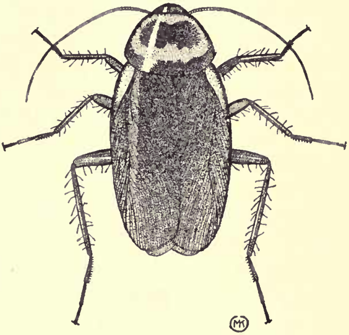

FIG. 40. — Australian roach. (× 1½.)

The last species, *Periplaneta australasiæ,* of importance as a domestic pest, is the Australian roach (Fig. 40), common especially in the Southern states. It resembles the American roach, although it is not so large. Moreover, it has one striking characteristic that serves to distinguish it from the American roach, namely, a bright, clearly defined yellow band on the thorax and a narrow yellow spot on each front wing. It is not so well and so widely known as a house pest as the croton-bug or the Oriental cockroach, but it is impossible to predict regarding its future development.

METHODS OF CONTROL

Cockroaches are among the most difficult to control of the household pests. They are difficult to reach because they are especially adapted with their flat, thin bodies for hiding away in inaccessible cracks, crevices, and crannies. Moreover, they are wary and shy of all baits and traps. The croton-bug is the most difficult one of all to get rid of. It seems to display more caution in avoiding traps and baits than most of the others, and as it increases faster, it becomes much more abundant.

Fumigation. — Here, again, as with the bedbug, fumigation with hydrocyanic acid gas is one of the most efficient methods we have of fighting roaches. It is used in the same manner and in the same proportions as set forth in the chapter on the bedbug. Unfortunately, the rooms in which roaches are generally found are usually less tightly built and have more openings than the other rooms of the house. Therefore, great care must be exercised in stopping the cracks and openings so that the gas will not dissipate itself. The author has used this gas in fumigating pantries and kitchens with fine success in most cases. In one or two instances, where the kitchen was very loosely built, as is often the case in warm regions, the roaches escaped through the cracks before the gas, which dissipated itself through the same openings, had time to do its work.

In small rooms that can be tightly closed and in which no fires or lights are present carbon bisulfide can be used to advantage. This is a clear, colorless liquid with a rather unpleasant odor that evaporates rapidly when exposed to the air. All animals succumb to the effects of the gas when confined with a sufficient amount of it in a closed space. It is especially suited for fumigating bathrooms and pantries and may be used in kitchens if there is no fire in the stove. The gas from carbon bisulfide is inflammable and explosive and great care must be exercised in its use. It should be used at the rate of two pounds to every 1000 cubic feet of space. The best way to apply it is to pour it into shallow vessels, tin pans or basins, close the room tightly, and allow it to remain closed from 36 to 48 hours. Time should be given for all of the liquid to evaporate and for the gas to do its work. After the fumigation is completed the doors and windows should be opened and the room thoroughly aired. While the fumigation is going on no light or fire, in any form, should be brought near the room.

Buhach. — Another substance used in fumigating for cockroaches is pyrethrum, or buhach. This is a powder obtained by pulverizing the flowers of a plant, pyrethrum, that is now grown in California. Our pyrethrum used to come from Persia and when it arrived here its strength was often greatly weakened, especially after it had stood on the shelves of a store awaiting a purchaser. Now, since it is produced in California, we are much more apt to get it fresh. The American product is sold more commonly under the name buhach. By moistening the powdered buhach it can be molded into cones which, when thoroughly dried in an oven, can be lighted at the tips and will burn slowly and steadily until consumed. The fumes are not poisonous to human beings and they are not explosive, but are often more effective against the cockroach than is the powder applied in the ordinary way.

Traps. — Westwood has described a simple trap for catching cockroaches as follows: "Various plans have been suggested for their destruction, but the most serviceable method is to use a small wooden box, having a circular hole at the top fitted with a glass rim, out of which it is impossible for them to escape. It should be nightly baited and the contents thrown the next morning into scalding water."

FIG. 41. — Cross-section of a roach trap.

In Fig. 41 a cross-section of such a trap is shown. A straight lamp chimney suspended firmly in a hole in the middle of the cover serves for the glass rim. The upper end of the chimney should be set just flush with the cover. Pieces of cake, cheese, or similar attractive bait may be placed in the bottom of the box to lure the roaches. Inclined strips of pasteboard or thin boards placed against the box as shown in the figure will afford easy access for the roaches to the traps. When once the insects have entered such a trap they cannot escape. Certain experimenters claim to have had fine success in catching roaches with this style of trap.

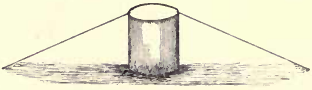

FIG. 42. — Tin box trap for roaches.

In Fig. 42 is shown a simple style of trap. It is simply a circular tin box baited with bits of material attractive to roaches and provided with inclined runways to make it easy for the insects to enter. A trap of this kind may be made from one of the ordinary cans in which coffee is often sold. One should select a deep can and use only those that are bright and smooth inside. The roaches after they have once entered the trap cannot climb up the sides of such boxes and escape.

Again, in Plate II is shown a somewhat more modern idea of a roach trap. The holes in the side of the box are fitted with cone-shaped tubes, the outer ends of which are just flush with the outer surfaces of the sides of the box. The roaches easily find their way into the box through the cones in search of the food inside, but cannot find their way out.

Roaches, in general, are very fond of stale beer and advantage is taken of this, especially in England, to trap them by drowning them in this liquid. Any deep jar will serve for the purpose. It is partially filled with the beer and sticks are then inclined against the jar on the outside and bent over until they project into the beer. The roaches climb up the sticks and slip down into the liquid in which they are drowned.

A rather unique way of killing roaches is described by Tepper of Australia. Plaster of Paris, one part, is mixed with flour, three or four parts, in a saucer, and placed where the roaches are abundant. Near by is placed a flat dish containing water, with bridges arranged so that the roaches can easily get to it. They eat of the flour and plaster of Paris and then drink the water. As a result, the plaster of Paris sets in the intestines and kills them. At any rate, they disappear.

Powders. — Buhach or pyrethrum is often used as a powder against cockroaches and when it can be procured in a fresh condition and is used persistently much good can be accomplished. It seems to be more effective against the three large species than against the croton-bug.

However, one application will accomplish little with any of them. It must be dusted over the floor, behind the boxes, on the shelves, and in every other place frequented by the roaches several nights in succession and subsequently should the roaches appear again.

A powder, known as Insectoline, manufactured by the Insectoline Company, Cincinnati, Ohio, has given good results in fighting these insects. The author has used it in kitchens and pantries with satisfactory effect. A large dwelling-house at Stonewall, Mississippi, that had become unbearably infested with the croton-bug was rid of them by the use of this powder. The owner was very enthusiastic in its praise. In order to get the best results with this powder it must be applied thoroughly and persistently.

Borax. — F. L. Washburn, after failures with several so-called remedies for cockroaches, tried powdered borax and has this to say concerning its value as an exterminator of roaches: "We then turned to powdered borax, using it freely in the kitchen, with marked success. This was sprinkled in cracks about the sink, along the top of baseboards, near the sink, and elsewhere wherever there were cracks which afforded the insects a hiding place. By a generous use of this substance, persisted in for two weeks, the room, in fact, we may say the premises, were entirely freed from this disgusting pest. Others to whom it has been recommended report the same success, and in conversation with other economic entomologists we hear unqualified praise for the '*borax method*.'"

Whatever powder or other substance is used it must be applied in large quantities over an extended period of time. Moreover, the material must be applied frequently and at short intervals. Persistence and thoroughness are absolutely essential to the successful control of cockroaches.

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CHAPTER VII

FLEAS

Pulex irritans, et al.

Perhaps by the time that this comes from the printer nearly a hundred and fifty species of fleas will have been found to exist in the world. Something over one hundred are now known and about fifty have been recorded from this country alone. It seems that we are very rich in species of fleas, and, at times, are richer in individuals than we desire. Fleas occur on a great variety of animals. These insects have been found on the dog, cat, rat, squirrel, woodchuck, opossum, grizzly bear, weasel, mole, mice, and other mammals and on birds. Two species, at least, are occasionally serious pests to the domestic fowl and two species attack man.

THE FORM AND STRUCTURE OF A FLEA

A flea has a body peculiarly well fashioned for the place in which it has chosen to live. In the first place, its body is compressed, that is, flattened from left to right. When we recall that a flea lives and moves about among hairs set close together we can readily see how much better a compressed body is suited for movement among such objects than a wide, flat body would be. In fact, so large an insect as a flea could move with difficulty through a thickly set coat of hair if its body were flat and thin like that of a bedbug. In the second place, many fleas have strong spine-like hairs projecting backward from the posterior edges of the body segments. Undoubtedly, these projecting spines catch around the bases of the hairs and serve to prevent the insect from slipping backward and enable it to push steadily forward. If a flea is caught between the thumb and forefinger, it will gradually work forward in spite of our best efforts and finally escape. Fleas do not have wings and are therefore unable to fly. On the other hand, their legs are very long and well fitted for jumping, especially the hind ones. So that the lack of wings does not seriously handicap them in getting around from room to room or from one animal to another. Moreover, each foot is furnished with two claws, which enable them to cling tenaciously to the hairs of their hosts. In some interesting experiments made to determine the jumping ability of the human flea, Mitzmain starved a female five days and then measured her jumps made on a smooth surface of wood. The four jumps recorded measured 10.5, 11, 12, and 13 inches, respectively, an average of $11\frac{5}{8}$ inches. He also determined that a human flea could jump at least $7\frac{3}{4}$ inches in a perpendicular direction.

The eyes of fleas are simple, and in some species, at least, are almost if not quite useless as organs of vision.

The mouth of a flea is constructed for piercing the flesh and sucking the blood. The mouth parts are composed of several long, slender organs, three of which serve for piercing and all of them together form the sucking tube. It is a very effective apparatus for obtaining blood from its host. The human flea is exceedingly bloodthirsty, and it is an interesting fact that blood is squirted from the anus while it is feeding.

KINDS OF FLEAS COMMONLY FOUND IN DWELLING-HOUSES

There are two species of fleas that become common in dwelling-houses in the United States and act as a source of irritation. These are the human flea, *Pulex irritans*, and the cat and dog flea, *Ctenocephalus canis*. Most of the fleas that we have found infesting dwelling-houses in the East and South have been the cat and dog flea. A pet dog or cat is very liable to become the source of infestation from this flea.

The author has seen dwelling-houses literally overrun with fleas that had originated from a pet cat. In one instance, in which a house had been closed only three or four weeks in the absence of the mistress, but which had remained accessible, in the meantime, to the pet cat, the fleas had become so abundant that one could not stay in the lower rooms with any degree of comfort.

That the cat and dog flea is the more common species infesting houses in the eastern United States is also confirmed by the records of the United States Bureau of Entomology, for Howard says: "Judging from the specimens of fleas sent to the Bureau of Entomology of recent years with complaints of houses being infested by them, the human flea, *Pulex irritans* (Fig. 43), is not the species most likely to occur in great numbers in dwelling-houses in this country, but rather the common cosmopolitan flea of the dog and cat, *Ctenocephalus canis* (Fig. 44). This holds especially for the eastern United States."

On the other hand, the human flea does occasionally seem to frequent houses in the East in large numbers, especially along the Atlantic Coast. For instance, a correspondent from Brooklyn writes that he finds his summer home on Long Island badly infested with fleas and sends some specimens for determination. These proved to be the human flea. In California and along the Pacific Coast the human flea is evidently by far the most abundant species found in the abodes of man. Doane gives a list of the fleas collected from human hosts and houses in San Francisco from February to June, 1908. In all, 916 fleas were taken, of which 913 were human fleas and 3 were the common rat flea, *C. fasciatus*. McCoy and Mitzmain record the fleas taken from 29 different individuals in California in one year as 337 human fleas and only 5 specimens of other species. This would indicate that *Pulex irritans* is the normal parasitic flea of man on the Pacific Coast.

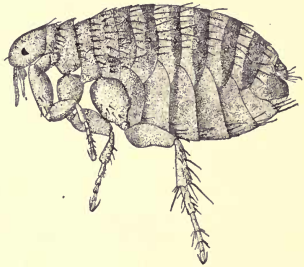

FIG. 43. — Human flea, much enlarged.

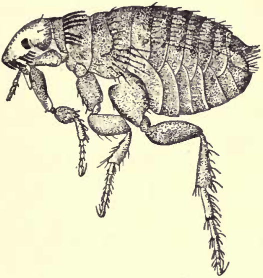

FIG. 44. — Cat and dog flea, much enlarged.

The human flea also occurs in large numbers, at times, on rats, cats, dogs, and in fewer numbers on mice. In fact, it seems quite certain that whenever a house becomes infested with human fleas, the rats in that house will also be found abundantly infested with them.

When dwellings are left vacant for a length of time they are often found, on the return of the occupants, abundantly infested with fleas. This has led to the popular opinion that these insects are sometimes spontaneously generated. Evidence seems to show that, under normal conditions, mammalian blood is necessary for the pairing and oviposition of adult fleas. On the other hand, it seems to have been fairly well established by different observers, that adult fleas can increase in deserted dwellings for some time without the necessity of the normal supply of food. Larvæ of fleas have been found in sweepings from the cracks of floors in deserted houses and adult fleas bred from them. In the light of these facts, it is not surprising that a vacant house often becomes badly infested with these insects.

OTHER FLEAS FOUND OCCASIONALLY ATTACKING MAN

In India and other countries where the plague occurs, the flea (*Lœmopsylla cheopis*) is the common flea on rats and it has come to be known as the plague flea. This flea now occurs in the San Francisco Bay region and occasionally attacks man. This is probably the principal flea concerned in carrying the plague.

The common rat flea in the United States is a much larger species, *Ceratophyllus fasciatus.* It is also frequently found on man.

There is another flea (*Rhynchoprion penetrans*) with peculiar habits and variously known as the "jigger," "jigger flea," "chigoe," and "chique," that occurs in tropical and subtropical America. It attacks man and causes much annoyance and serious injury. It is also found on the dog, cat, sheep, goat, cattle, horses, asses, mules, and even birds.

The adult female, after impregnation, burrows into the flesh of the host, especially under the toe nails. Here, the presence of the flea causes swelling and finally ulceration that sometimes becomes very serious in its final effects.

The hen flea, *Argopsylla gallinacea,* occasionally passes to man as a temporary host.

THE LIFE HISTORY OF FLEAS

The life history of a flea is similar to that of a house-fly in that there are four distinct stages during the full development of a flea, namely, egg, larva, pupa, and adult.

A flea does not pass its whole life history on the host which it infests. Only the mature stage or adult is found on the infested animal, the other stages being spent in quite different situations.

The eggs of the dog and cat flea are deposited, as a rule, while the insect is on the body of the host. It is probable that in many instances the eggs are deposited on floors, carpets, or cloths upon which the dog or cat may be walking or lying. If laid while the parent flea is on the host, they are not attached permanently to the hairs and do not remain on the body of the dog or cat, but quickly fall off. There are usually numbers of eggs around the spot where a flea-infested dog or cat has been lying. We recall a pet dog that came to the room and lay down a few minutes on a piece of dark blue cloth spread on the floor. After the dog had gone the writer noted many white specks on the cloth and on carrying it to the light and examining it carefully with a lens twelve beautiful pearly white flea eggs were found. These, of course, had fallen from the dog during the short time he had been lying on the cloth. The dog received a thorough bathing in a solution of creolin and his kennel, a barrel, was cleaned by burning a large handful of excelsior in it, while the matting upon which the dog had lain was burned.

The eggs are white and waxy, plainly visible to the eye, oval in shape, and it would take about forty of them, placed end to end, to reach an inch (Fig. 45).

FIG. 45. — Egg of dog flea. (× 38.)

The eggs that fall upon the carpets or floors in a house or on the sleeping cloths of the cats and dogs soon hatch into minute, white, worm-like larvæ. The body is composed of thirteen segments and the head bears biting mouth parts, but no eyes. The larvæ are active, wriggling creatures and they soon crawl away into cracks and crevices, where they feed upon whatever organic matter they can find. In these situations, they attain their growth in ten days to two weeks, under favorable circumstances, and then spin a fine, white, silken cocoon (Fig. 46), often covered with dust, inside of which they change to a quiet, inactive form, the pupa. After a week or ten days, the pupa transforms to the adult flea ready, after feeding, to deposit eggs for another generation. Under the most favorable conditions a generation of fleas may be produced in almost two weeks. It is probable, however, that a longer time is needed under most conditions.

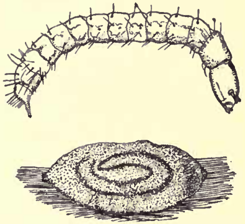

Fig. 46. — Larva of a flea, above; cocoon, below, much enlarged.

Simons, who reared some cat fleas from the eggs, found that the eggs hatched in a little over two days and that the larvæ became full grown in seven days. They then spun their cocoons, and after lying quietly in them for eight days more, during which time they changed to pupæ, came forth as adults. Thus it took seventeen days for the development of a full generation.

Howard relates that in Washington in several rearings of the cat and dog fleas the eggs hatched in from two to four days, the larvæ attained their growth in from seven to sixteen or twenty days, and the pupal state consumed from five to fourteen days. Here, again, we see that a single generation *may* be produced in a little more than fourteen days. Other observers give the period of development as 4 to 6 weeks and 9 to 10 weeks for the human flea. Evidently the period varies with the temperature and other environmental factors. For example, in the colder season, the pupal stage of the human flea may occupy as long as thirty-four days.

The following table compiled by Mitzmain shows the cycle of development of fleas in different countries.

Country and Species of Flea	Egg	Larva	Pupa	Complete Generation
India				
L. cheopis	2 days	1 week	7 to 14 days	21 to 22 days
Australia				
P. irritans	6 days	12 days	14 days	4 to 6 weeks
Europe				
P. irritans	4 to 6 days	11 days	12 days	4 to 6 weeks
Ct. canis	2 weeks	12 days	10 to 16 days	5 to 6 weeks
United States				
Atlantic coast				
P. irritans } *Ct. canis* }	2 to 4 days	8 to 24 days	5 to 7 days	2 to 4 weeks
Pacific coast				
P. irritans	7 to 9 days	28 to 32 days	30 to 34 days	9 to 10 weeks
L. cheopis	9 to 13 days	32 to 34 days	25 to 30 days	9 to 11 weeks
C. acutus	7 to 8 days	26 to 28 days	24 to 27 days	8 to 9 weeks
C. fasciatus	5 to 6 days	24 to 27 days	24 to 26 days	7 to 8 weeks

It has been found difficult to maintain just the right degree of moisture for the larvæ to thrive. The rearing cages are either too moist or too dry and many of the larvæ die before reaching maturity. In his own work with the larvæ of the hen flea, *Argopsylla gallinacea,* the author has had much difficulty in rearing them and was, in fact, unable to rear any to maturity from the few eggs he was fortunate enough to obtain. Mitzmain says that the human flea develops very satisfactorily in material composed of the sweepings taken from cracks in the floor. It is quite probable that the great majority of larvæ die under the conditions in which they find themselves.

It has long been a question regarding the food of the larvæ. Some authors have held that the adult human flea fed its young upon dried blood. This is now thought to be very improbable, for Laboulbene, a French investigator, and Mitzmain of the United States have found that the larvæ would thrive and reach full growth simply on the sweepings of rooms that contained no blood at all. Multitudes of fleas often develop in a house left empty during the summer. It is very probable that the only food found by the larvæ under such circumstances is the organic matter in the cracks and crevices of the floor, about the baseboards, in the corners, under the carpets, and in similar places.

THE RELATION OF FLEAS TO DISEASE

Fleas are now known to be active and menacing agents in the conveyance of disease, especially the bubonic plague.

In India, where the bubonic plague often decimates the native inhabitants, careful experiments have demonstrated that the rat flea found in tropical and subtropical countries readily takes this plague bacillus from infected rats and inoculates other rats with it; that the plague bacillus multiplies in the stomachs of fleas and that the bacilli are found in the feces of fleas taken from dead infected rats; that the bubonic plague does not persist in a locality apart from infected rats; that the rat flea will make use of man as a host and may be captured in large numbers on men in houses infested with rats; and, lastly, that evidence proves the rat flea as the transmitting agent of bubonic plague infection from rat to man.

Verjbitski, as a result of an important series of experiments that he made in 1902 and 1903, comes to the following conclusions, among others, concerning the relation of fleas to the bubonic plague: —

"All fleas and bugs which have sucked the blood of animals dying from plague contain plague microbes.

"The vitality and virulence of the plague microbes are preserved in these insects.

"The numbers of plague microbes in the infected fleas and bugs increase during the first few days.

"The feces of infected fleas and bugs contain virulent plague microbes as long as they persist in the alimentary canal of these insects.

"Infected fleas communicate the disease to healthy animals for three days after infection.

"The injury to the skin occasioned by the bite of bugs and fleas offers a channel through which the plague microbes can easily enter the body and occasion death from plague.

"Crushed infected bugs and fleas and their feces, like other plague material, can infect through the small punctures of the skin caused by the bites of bugs and fleas but only for a short time after the infliction of these bites.

"Human fleas do bite rats."

The many investigations that have been made of the relations of fleas to the bubonic plague by different plague commissions and individuals point to the definite conclusion that rats and fleas, are, at least, the most important factors in the spread of the disease. The bubonic plague is probably, primarily, a disease of rats and only secondarily a human disease. Epidemics of the plague seem to be usually preceded by this disease among the rats of that locality.

San Francisco, in her late fight with the plague, gave a great deal of attention to controlling the rats, basing her method of work upon the foregoing ideas of the relation of rats to the disease and the relation of fleas to rats and to man. The results of the fight were eminently successful and certainly serve to strengthen the soundness of the theory.

Fleas have also been suspected of bearing some relation to the dread disease, leprosy. The bacilli of leprosy have been found in the intestines of certain fleas, and it seems quite possible that the fleas might carry the bacillus to a human host. However, no definite proof of any relation between leprosy and these insects has yet been adduced.

Baker has pointed out that the rat fleas found by him in Cuba are quite closely related to the human flea and might, therefore, bite human beings quite readily. He also found that rats in a leper hospital in Cuba often had sores on them very similar to leprous sores, and argues that the fleas might convey the bacillus from rats to man.

It has also been found that the dog flea is the intermediate host of the dog tapeworm, *Tænia canina*. When fleas containing the immature stages of the tapeworm were fed to dogs the development of the tapeworm in the dog followed in all cases.

METHODS OF CONTROL

It follows from what has been said regarding the kinds of fleas found in houses and their rate of increase that pet dogs and cats must be gotten rid of or must be kept clean and free from these pests. These animals may be kept free from fleas by frequently bathing them in a solution of creolin and by paying special attention to their sleeping places. A dog or cat should be provided with a sleeping cloth or rug and this should be beaten or shaken at least once a week and hung in the sunlight, if possible, for a few hours. If infested, the dog kennel should be thoroughly washed inside and out with a 5 per cent solution of creolin. To keep it clean and free from eggs and larvæ of fleas it should be washed with strong soapsuds occasionally and once or twice a year carefully whitewashed.

To free a dog from fleas the animal should be bathed in a 3 per cent solution of creolin made by adding 4 teaspoonfuls to a quart of water or 4 tablespoonfuls to a gallon of water. For cats, a 2 per cent solution is strong enough, for their skin is a little more sensitive than that of a dog. The animal may be treated by putting the solution on with a brush or rag or by making enough of it for the submergence of the patient. After the application, no more attention is needed nor does the material need to be washed out of the hair. It softens the fur, destroys other vermin as well as fleas, heals scratches or sores in the skin, and will deodorize the animal and destroy obnoxious smells.

Pyrethrum, or buhach, if it can be obtained fresh, will kill or stupefy the fleas if it is thoroughly dusted among the hairs of the animal. Usually, the insects will fall from the animal, and they may then be swept up and burned if not already dead.

To clear a house of fleas when once infested is often a very strenuous task. In the first place, the source of infestation, if it be a cat or dog, must be removed or freed from the pests. In addition to this, the removal of carpets and a change to rugs are recommended. The larvæ of fleas cannot develop in rooms in which all parts of the floors are swept from time to time. Matting and carpets afford fine protection to the larvæ of fleas and offer splendid hiding places with plenty of dust containing organic matter for their development. No scheme of floor covering could be better for fleas. In severe infestations nothing but the removal of all floor coverings followed by a thorough washing of the floors with strong soapsuds will avail.

Sometimes the persistent use of buhach, in which it is sifted over the carpets, along the baseboards, and in all hiding places for fleas, becomes effectual. But, in some cases, it has utterly failed.

Again, sprinkling the carpets and floors with benzine is often successful. Great care should be exercised regarding fire while benzine is being applied.

Where only a few fleas are present in a room they may be caught by spreading a white cloth on the floor, and as they alight on the cloth, attracted by the white color, they may be caught by picking them up one by one on the end of the moistened finger and destroyed.

In one instance, a large room was greatly relieved of an infestation of fleas by having a man, with sticky fly paper tied around his legs, walk up and down the room. As the insects were disturbed by the walker they would jump on to the paper and stick fast. In this way hundreds of them were caught.

It is said that a thorough spraying of a room with oil of pennyroyal will drive the fleas out.

In work in the South the author has had many complaints of cases where the whole premises were overrun with an infestation of fleas. This will often happen in a warm country where houses are set up on foundations some distance from the ground and open beneath. Such conditions give opportunity for dogs and cats to range beneath the house unmolested and to become sources of wide infestation. Van Dine, entomologist in Hawaii, has had the same experience and his method of treatment is so good that it is quoted here.

"(1) If the lawn is infested, cut the grass as close to the ground as possible and burn the refuse. Exposure to the sun and air will be detrimental to the development of the larvæ. Keep the lawn well watered.

"(2) Clean out and burn all refuse from beneath the infested dwelling, leaving the surface of the ground as bare as possible, and apply an even dressing over the surface of lime, sulfur, and buhach at the rate of 20 pounds of air-slaked lime to 3 pounds of powdered sulphur and 1 pound of buhach, thoroughly mixed and dry. Spray the underpinnings of the house and the drives and walks (if the latter are sand, gravel, or dirt) with kerosene emulsion at the rate of 1 part of stock solution of the emulsion to 10 parts of water.

"(3) If dogs are owned, provide a room for them to sleep in and keep cats out of the house. Wash with strong soapsuds the floors of the room where the dogs are to sleep, and sprinkle afterwards, when dry, with a liberal amount of buhach. Use a liberal amount of buhach in places where the dogs have been in the habit of sleeping and remove and burn from such places all refuse, old sacks, matting, etc. Every week or so take the dogs to the room provided for them and brush them thoroughly with a strong, stiff brush. Afterwards collect the resulting hairs and the bedding and burn or immerse the sacks in hot soapsuds and hang in the sun to dry. Then wash the room out as before and sprinkle with buhach, and return the bedding. The dogs should be washed regularly, a little creolin being added to the water.

"(4) If the house is infested, sprinkle a liberal amount of buhach beneath all rugs and matting, and under all shelving and cabinets. The following day take all rugs, carpets, and matting out of doors and shake thoroughly and hang in the sun for several hours. Wash the floor with hot soapsuds. Sprinkle buhach beneath the rugs, carpets, and matting when returning them to the house."

Many people desire to keep a pet dog, and the following method of getting rid of fleas and still retaining the dogs is given by Henry Skinner of Philadelphia. He says: "In the latter part of May I moved into a new house that had not previously been occupied. No carpet was used and being summer only a few rugs were placed on the floors. A part of the household consisted of a collie dog and three Persian cats. Very soon the fleas appeared, the dog and cat flea, *Ctenocephalus canis*. . . . I tried mopping the floors with a rather strong solution of creolin, but it did little good. Previous experience with pyrethrum (buhach) was not very satisfactory. Knowing the volatility of naphthaline in warm weather and the irritating character of its vapor led me to try it. I took one room at a time, scattered on the floor five pounds of flake naphthaline and closed it for twenty-four hours. On entering such a room the naphthaline vapor will instantly bring tears to the eyes and cause coughing and irritation of the air passages. . . . It proved to be a perfect remedy and very inexpensive as the naphthaline could be swept up and transferred to other rooms. So far as I am concerned the flea question is solved and if I have further trouble I know the remedy. I intend to keep the dogs and cats."

The following method of ridding a cat of fleas as given in a New York paper is interesting and may be of a good deal of value: —

"An excellent way to get rid of fleas is used by a lady in Chicago, who owns some of the best cats in America. She has ready a square of cotton batting and a square of cotton cloth. Placing the cat in the center of the batting, which has been laid over the cloth, she rubs strong spirits of camphor quickly into the fur and then gathers the corners of the batting and cloth tight around the neck of the animal. She has the fine comb ready and a dish of hot water, for the pests, who detest the camphor, will run to the head of the cat, and must be combed out and plunged into the scalding water. Hundreds of them, however, will jump from the cat and lodge in the cotton batting, where their scaly feet stick in the cotton so that they cannot get away. When the fleas cease to run out into the head she judges that they have deserted the cat. The animal is then let out of the batting bag, and the latter carefully carried to the kitchen and deposited in the stove. The scent of the camphor clings to the cat for some time and acts as a preventive. A whole cattery may be cleaned out in this way."

L. O. Howard gives the substance of a letter from Miss Adele M. Fielde on a method of getting rid of flees as follows: She states that during a long residence in Southern China, where fleas swarm, even in clean houses, she made her own house immune through many years by dissolving alum in the whitewash or calcimine that covered the interior walls, putting sheets of thick paper that had been dipped in a solution of alum under the matting and scattering pulverized alum in all crevices where insects might lodge or breed. Powdered alum, she states, may be sprinkled upon carpets already laid and then brushed or swept into their meshes with no injury to the carpets and with the certainty of banishment to many insect pests, including both fleas and moths.

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CHAPTER VIII

ANTS, THEIR ACTIVITIES AND INVASIONS OF THE HOUSEHOLD

THE ants belong to the same great group of insects, *Hymenoptera,* that contains the wasps, bees, sawflies, and others; and, like the honey bee and common wasps, are social in their habits of living.

Every one is familiar with ants; they occur in all lands and all regions, from the dry deserts to the damp forests, from the timberline of mountains to the lowest valleys, and among the dwellings and habitations of man. They seem to thrive in all kinds of environment and multiply enormously, so that they outnumber all other terrestrial animals.

THE NATURE OF AN ANT COLONY

As we have said, ants are social, that is, they live in colonies or communities where every individual ant works for the good of the whole and not for itself alone. A colony of ants furnishes an illustration of a more perfect communistic society than any ever established by man and perhaps a more amicable one than any he will ever be able to organize.

In a typical colony of ants there are at least three kinds of individuals, the queen, the males, and the workers. The queen is not the ruler, but the mother of the colony. Her only business seems to be to lay eggs which hatch into workers and other forms to take the places of those that disappear or die, thus maintaining the full and continuous strength of the community. When the queen comes forth from the pupal stage she has wings which she retains until after the swarming period. After the swarming flight is over and the queen alights, her wings fall off or are torn off by herself or workers and from that time she remains wingless. In some species of ants there may be modified forms of the queen; for example, giant queens, dwarf queens, worker-like queens, and other forms.

The males, which have wings, exist only to mate with the queens, and after the swarming period is over they eventually die. The males are also often modified into giant males, dwarf males, worker-like males, and other forms.

The workers, which are undeveloped females, are wingless and constitute the great majority of individuals that we see running about in the vicinity of an ant nest. The workers are just what their title implies. They do the work of the community, build the nest, keep it clean, care for and procure food for the queen and larvæ, care for the eggs, fight the battles, and perform other functions. The workers may exist under several different forms. One especially interesting form has a very large head and strong jaws, thus fitting it for war-like functions. Workers thus modified are known as the soldiers.

THE STRUCTURE OF ANTS

Like other insects, the body of an ant is composed of three chief divisions, head, thorax, and abdomen. The abdomen of all of our common ants, at least, consists of two rather distinct parts; a slender anterior portion consisting of one or two segments that constitutes the *pedicel* or *peduncle* and a more robust posterior portion composed of several segments, called the *gaster*. Moreover, each segment of the pedicel is expanded on the top side and forms a lens or button-shaped knob, a character that distinguishes ants from all other insects.

The mouth of an ant is furnished with two pairs of jaws, one pair of which, the mandibles, are very large and strong. It is with these that the ants mine in the earth, wood, or living plant tissues, fight their battles, carry their eggs and young, cut leaves, obtain food, and do many other things. On the head are also borne the two antennæ, which are very important organs to the ant. The sense of touch is highly developed in the antennæ. Ants have one pair of compound eyes and three simple eyes.

The posterior end of the abdomen of the queen and the workers of many of our ants bears a sting, which, in some species, is a very effective weapon of defense.

THE NESTS AND ACTIVITIES OF ANTS

The nests of ants, in a general way, consist merely of a system of passageways or cavities communicating with each other and connected to the outside world with one or more openings. There are some species of ants that live below the surface of the earth and have no openings from their nests into the air except at the swarming period. The style of construction and the materials used by ants in making their nests vary with the different species and with the environment in which the ants live. Moreover, the nests are very irregular, especially when compared with those of wasps and bees.

The passageways of the nests are enlarged here and there into comparatively large cavities, or chambers (Fig. 47). It is in these different chambers that the activities of the

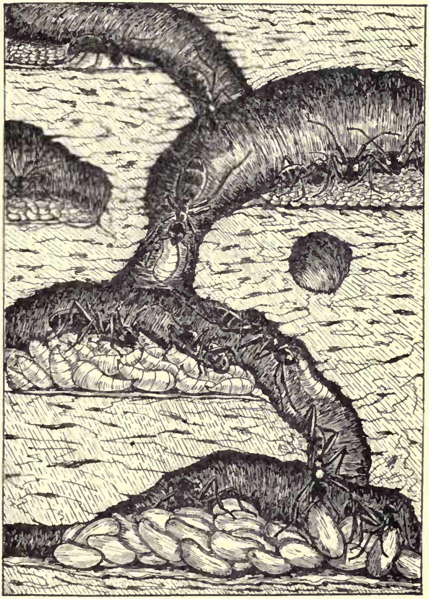

Fig. 47. — Interior of an ant's nest.

colony are carried on. The queen lies deep within the interior of the nest in a dry, dark chamber. Here she is carefully tended and fed by the workers, who bear the eggs as they are laid to other chambers and zealously care for them. Many insects never see their young; others may see them, but do not care for them; others, like the bees and wasps, put food into the gaping mouths of their young, but have no further association with them. The ants, however, stand alone among insects in their very intimate relations with their progeny from the egg to the adult. Some of the chambers in the nest are reserved for the eggs, some for the larvæ, and some for the pupæ. If, as often happens, the eggs, larvæ, and pupæ are all in one chamber, then they are each grouped by themselves in separate piles, reminding one, as Lubbock says, "of a school divided into five or six classes." In the simpler and more primitive ants this grouping and separation may not be so distinct. The ants are constantly transferring their young from one part of the nest to another in search of the right degree of moisture and temperature. In the warm part of the day the young will be transferred to near the surface, but at night will be carried down again away from the cool air. The ants are constantly cleaning the young, caring for the eggs to prevent mold from growing on them, helping the callow ants to emerge from their cocoons, bringing food, cleaning, enlarging, and reconstructing the nest, and doing thousands of things contributing to the comfort, growth, and happiness of the community.

RELATION OF ANTS TO OTHER INSECTS AND PLANTS

It has been argued, and many observations have been offered to show that there is a most intimate relation between ants and many kinds of plants. Certain authors claim that many plants not only offer special inducements to attract ants to them by affording favorable nesting places, but also offer the ants delectable food in the way of a sweet liquid, the floral and extrafloral nectar. In return for the domiciles and the food, the ants are supposed to protect their plant hosts from certain insect and other animal enemies. In other words, the relationship is one of mutual benefit or a symbiotic one. It is certainly true that many species of ants make their homes in the hollow stems of plants, in the thorns of acacias which the ants easily hollow out, in cavities in bulbs, leaves, and in the dried seed-pods of plants. It is also true that ants assiduously collect and carry to their nests the sweet nectar excreted by many plants. It is not so clear, however, that these favorable nesting places and the nectar are provided by the plants on purpose to attract the ants, nor is it clear that the ants afford the plants protection from the animal enemies. In other words, more definite proof is needed to show that the relations between ants and plants is a purposely mutual one.

On the other hand, the relation of ants to plant-lice, tree-hoppers, and certain scale insects is clearly, in many cases, a mutually helpful one. Especially is this true of the relations between ants and plant-lice. The aphids secrete a sweet liquid known as honey-dew, of which the ants are very fond and which they are active in collecting and carrying to their nests. It can hardly be supposed that the aphids excrete the honey-dew solely for the ants. The liquid is an excretion from the alimentary canal and is exuded whether ants are in attendance or not. On the other hand, ants are very solicitous in their care of aphids in return for the honey-dew. The ants sometimes build "sheds" over the lice for their protection and sometimes take the lice into their own nests to care for them. In the case of the corn-root louse the ants collect the eggs of the aphid in the fall, carry them into their own nests, and care for them all winter. In the spring, the newly-hatched aphids are carried out by the ants and placed in burrows dug beforehand among the roots of certain early food-plants. Later, the ants excavate burrows along the roots of the corn and transfer the aphids to these plants.

It is interesting to watch the ants collecting the honey-dew from the aphids. An ant approaches a louse and gently stroking the latter with its antennæ, the aphid exudes a drop of the sweet material which is quickly gathered up by the ant. This action may be repeated with three or four of the aphids until the ant has all it desires, when it hurries down the stem of the plant and away to its nest with its load of sweet provender.

THE LIFE HISTORY OF ANTS

Enough observations have now been made to enable us to say that most, if not all, colonies of ants are started by a solitary queen or occasionally by two queens working together. The queen, after the swarming period, alights, tears off her wings, and digs a burrow in the soil or in decayed wood, forms a small chamber, and then closes the opening. Here she remains until her eggs are laid, and have hatched into small larvæ that finally mature into normal but diminutive workers. All this time the queen has taken no food, but has lived and fed her brood on the reserve material in her body. The small workers now begin to enlarge the nest and soon other larger workers are reared and the community begins to multiply and increase.

The eggs laid by the queen are small and white and rarely seen by the ordinary observer. These are solicitously cared for by workers and finally hatch into white, footless, soft, grub-like larvæ. The larvæ are also tenderly cared for by the workers and changed from chamber to chamber in conformity with variations in temperature and moisture. The workers feed the larvæ either on food which has been predigested and which the workers now regurgitate or on bits of dead insects, leaves, or seeds that have been chewed fine. The larvæ, after attaining their growth, change to whitish pupæ which, in some species, are inclosed in cocoons, while in others they are not. These the workers treat with the same solicitude and care that they show toward their larvæ. Observers often mistake the pupæ for eggs. Often, on raising up a flat stone one will see the workers running this way and that with the larvæ and pupæ in their jaws, evidently seeking a place of safety for them. The pupæ finally transform to the adult ants of the various forms, workers, queens, and males.

ECONOMIC IMPORTANCE OF ANTS

Ants, as a whole, may probably be considered as agents in making the earth more habitable for man. Some of the species are neutral, perhaps, in relation to the economic status of mankind. A great many species are certainly beneficial through their action in stirring and aërating the soil. They are constantly burrowing deep into the earth and bringing up the particles which they distribute over the surface. Their action in this respect is similar to that of earthworms, the value of which was revealed to us by the classic investigations of Darwin. Ants are also important agents in aiding in the decomposition of organic substances. Their work in this respect is little appreciated or realized because it is invisible. It must be remembered, however, that this work of ants is gradual, incessant, and extends through tremendously long periods of time.

Again, ants are great insect destroyers. Their food consists, in great part, of the juices and tissues of dead insects or of insects that they kill. The interesting driver ants of the Old World and the legionary ants of tropical Africa pass through a territory killing and devouring multitudes of living insects, rats and mice. Hunter and Hinds tell us that there are 12 species of ants known to attack the immature stages of the Mexican cotton boll weevil. "In some cases more than half of the immature stages in fields have been found to be destroyed by ants alone. To find 25 per cent so destroyed is not a rare occurrence."

On the other hand, certain household species of ants are very annoying and troublesome. Moreover, the leaf-cutting ants of tropical America are very injurious to plants. They will strip a fruit tree of its foliage in a very short time. One species of these leaf-cutting forms (*Atta texana*) found in Texas attacks cotton, corn, fruit-trees, sorghum, and other plants, and has become of considerable economic importance. In some places land is not planted on account of fear of attack by these ants.

The mound-building prairie ant (*Pogonomyrmex occidentalis*), distributed over a large part of the western plains of the United States, has become a distinct pest since man has begun to occupy the prairies. Their large mound-nests in fields of alfalfa or grain become serious obstacles to harvesting the crops. Moreover, when the nests are disturbed the ants emerge in large numbers and attack man and beast, inflicting painful wounds with their stings. In dooryards and lawns and along paths they are liable to attack the passer-by, especially dawdling children.

The agricultural ant (*Pogonomyrmex barbatus molefaciens*) of Texas may build its mound-nests in fields of alfalfa, corn, or cotton, and since it allows no vegetation to grow over a considerable area around the nest, the injury may be quite serious. Moreover, they are pugnacious and sting intruders severely.

Perhaps the most injurious rôle assumed by ants is their protection and fostering of plant-lice, scale insects, and tree-hoppers. Aphids and scale insects are among our most injurious insect pests and anything that protects them or aids them in increasing may be considered an enemy to man.

As a pest, the Argentine ant (*Iridomyrmex humilis*) stands by itself. Newell says, "As a household pest I venture the opinion that this ant has no equal in the United States."

KINDS OF ANTS TROUBLESOME IN DWELLINGS

There are several species of ants that may become annoying in dwelling-houses in temperate regions, but perhaps the best-known species are the tiny red ant (*Monomorium pharaonis*) and the small black ant (*Monomorium*

Pharaoh ant
Common red ant

minimum). Occasionally the large carpenter ant (*Camponotus pennsylvanicus*) forages in houses, and the pavement ant (*Tetramorium cespitum*) becomes a troublesome intruder in cities along the Atlantic seaboard. The Argentine ant (*Iridomyrmex humilis*) wherever it occurs in the United States is probably the worst household pest of all. The little fiery ant (*Solenopsis molesta*) is also said to invade kitchens occasionally.

The red ant. — This ant (*Monomorium pharaonis*), which is really light yellow in color, is only about one-sixteenth of an inch long (Fig. 48) and, at times, literally swarms in houses, and because of its small size it gets into everything that is not almost hermetically sealed. Hardly any household food products come amiss to the red ants. They are especially fond of sugar, sirups, fruit juices, jellies, cakes, fruit pies, and the like. Whenever one of the tiny workers finds a pleasing morsel or supply of food it immediately informs the rest of the community and they all come quickly trooping to the source of supply. After the colony has found out the existence of a desired bit of food, they swarm over and through it in such numbers that it seems almost a hopeless task to get rid of them. The discouraging part of the problem is that no matter how many we may kill an equal number seems to come to take the places of those destroyed and so long as the queens are allowed to live on undisturbed the workers may continue to come. The French observer Bellevoye tells

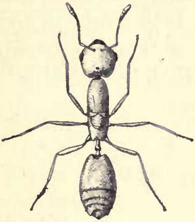

Fig. 48. — The red ant. (× 20.)

us that he gathered 349,500 workers in his rooms in six weeks besides a great many that he killed or threw into the fire without estimating their numbers. All of the workers evidently came from one nest located somewhere in the walls of the house.

There are a few redeeming features about the red ant that are worthy of note. Pergande, a careful entomologist and close observer, says that he saw an old building at Meridian, Mississippi, used as a barracks during the war, filled with bedbugs, but invaded by myriads of red ants. He said that several ants would attack a bedbug, pull off its legs, and carry the helpless body away. Every crack and crevice of the rough beds were sought out by the ants and the young and old bedbugs dragged forth and killed.

A correspondent of the *Florida Farmer and Fruit Grower* says that this habit of destroying bedbugs is well known and advises the introduction of red ants into houses for the purpose of exterminating these pests. If the ants would leave when the bugs were killed, all would be well; but if they should happen to remain as permanent inhabitants of the dwelling, it would be a question whether any gain had been made.

Another interesting rôle played by red ants is that of destroying the white grubs in soil, as related by G. H. Perkins, another observant entomologist. He says, "that a box in which a number of the larvæ were living having been discovered by the ants they at once took possession and promptly destroyed every one of them, and this leads to the conclusion that perhaps we are more deeply indebted than we have been aware to ants for destroying those larvæ which inhabit the ground."

The nests of the red ant may be formed in the walls of a house, under the floors, among trash in old trunks or boxes, or in the lawn or garden just outside the door.

The small black ant.—This ant (*Monomorium minimum*) is smaller, if anything, than the red ant, although there is little visible difference between them in size (Fig. 49). They differ decidedly in appearance, for this one is dark in color and easily distinguished from the red one. The nests of the little black ant are sometimes under stones in the yard, but are more often in the open. The nests have small craters about the entrances made of fine grains of soil. When the nests are opened there will usually be found, among the workers, one or more large females.

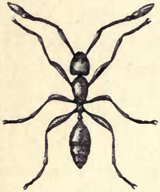

Fig. 49. — The small black ant. (× 14.)

The black ant is not strictly a house ant, at least not as much so as the red ant, yet it often invades dwellings in considerable numbers and becomes somewhat of a nuisance. The invasions are due to the workers who wander some distance from their nests on foraging expeditions.

The pavement ant. — The pavement ant (*Tetramorium cespitum*) is an introduced form. It seems to be widely distributed in Europe and constitutes one of the common meadow ants in that country. When introduced in this country it took up its abode in some of our Eastern cities along the Atlantic seaboard, New York, Philadelphia and Baltimore. Here it established itself by building its nests beneath the pavement or under flagging stones in the yards of dwellings. From these situations of vantage and nearness to dwellings, the pavement ant has acquired the habit of entering houses and becomes quite as much of a pest, in some instances, as the red ant.

Marlatt thinks the pavement ant was introduced into the United States many years ago and believes that it is the species referred to by Kalm in 1748 as often occurring in houses in Philadelphia at that early date. On the other hand, Wheeler points out some reasons for thinking this ant came into this country much more recently. The pavement ant is interesting in having several species of parasitic or slave-making ants associated with it and occurring in its nests in Europe. Evidently none of these parasitic species were introduced with their host into America.

Marlatt says the colonies of the pavement ant are often very large, for they may frequently be found in masses of a quart or more on turning over stones in yards or on lifting the flagging in paths.

The large black carpenter ant. — The large black carpenter ant (*Camponotus pennsylvanicus*) often becomes an annoying pest in dwelling-houses. It is one of those ants that have the habit of leaving their natural haunts at times and taking up their abode in dwelling-houses. This habit has evidently been assumed since the settlement of America and the erection of buildings here. The natural haunts of the black carpenter ant (Fig. 50) are in decaying stumps, fence posts, logs, and other pieces of wood. We have known them, however, to make their home in the decaying sill of a porch from which vantage ground they became a decided nuisance in the kitchen not far distant. Moreover, they occasionally do serious damage to rafters and beams in buildings.

Several observers have shown that the queen of this species founds a nest by herself. She selects a favorable place beneath the bark of an old log, for example, and there excavates a small cell. In this she may be found brooding over a few eggs, larvæ, cocoons, and small workers. Pricer has also determined that the number of inhabitants of a fully developed nest of the black carpenter ant may contain from 1943 to 2500 workers.

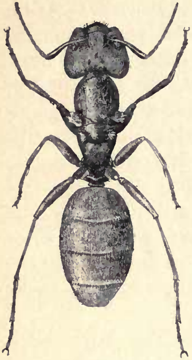

FIG. 50. — The large black carpenter ant, enlarged.

There are other species of ants that occasionally become household pests. The tiny thief-ant (*Solenopsis molesta*) is a native ant that occasionally leaves its natural haunts and builds its nest in houses, where the occupants become pests in kitchens and pantries. The workers of this ant are very small and yellow and nearly blind.

Finally, there is the Argentine ant that stands in a class by itself and is discussed later.

GENERAL METHODS OF FIGHTING ANTS

Perhaps the first thing to do as a method of prevention is to remove the substance attracting them if this can be done. It can often be placed on a support, the legs of which rest in water covered with a film of oil. Sometimes the simple removal of the attractive food to another room may be sufficient.

Another temporary expedient and one which may discourage the ants enough to finally stop them from coming is to soak small sponges in sweetened water and place them where the insects are most numerous. The ants will crawl into the pores of the sponges in great numbers and may be killed by dropping the sponge and all into boiling water. This process may be repeated over and over and thousands of the workers destroyed. In cases in which this has been given a thorough and persistent trial, the ants have become so discouraged and bewildered by the sudden loss of so many workers that they have finally abandoned the house entirely.

A sirup made by dissolving sugar and borax in boiling water will attract and kill many of the ants. It is said also that camphor, either free or wrapped loosely in paper, and placed around the foods attracting them will drive the ants away.

Often the ants may be traced, if carefully watched, and the crack or opening through which they enter discovered. When found, kerosene oil should be squirted into it or it should be tightly plugged with cotton soaked in kerosene. This is often an effective preventive.

Ordinary ants may be prevented from reaching tables by setting the legs in cups containing a little water with kerosene oil on the surface. This method does not seem to avail much with the Argentine ant. At least, these ants soon manage to cross the oil often on a causeway formed from the dead bodies of their sacrificed comrades. But against the red ant and the little black ant the film of oil is an effective barrier until it evaporates, when it must be renewed.

Cyanide of potassium has been used with marked effect against ants in the field. It is a deadly poison and should be handled with great care. If it is powdered fine and scattered over an ant hill, after the latter has been broken up or stirred on the surface, the ants will immediately begin to remove the pieces. In doing so, every one of them that touches the cyanide will be killed. Colonies have been almost exterminated in this way and whenever the colonies of the red ant can be located the cyanide may be used to advantage. It will be found more useful against the normally out-door species, such as the pavement ant, carpenter ant, and others.

It must be remembered that if fowls are allowed access to the poison and pick up the pieces, they will certainly be poisoned. To obviate this difficulty, it is best to use the cyanide in solution by dissolving it in water at the rate of one-half an ounce or an ounce to a gallon of water. It may then be sprayed over the nest or poured down the openings. This method seems to be quite as effective as scattering it in the powdered form. At least, experiments have shown that colonies of some species of ants may be nearly if not quite exterminated in this way. Another very effective method of application consists in placing a pint or more of the solution in hollows dug out at the exits of the burrows of the colony.

Ordinary cotton tape treated with corrosive sublimate acts as an effectual barrier to the red ant and other species. The tape is often wound about the legs of tables, tacked along the edges of shelves, and in other places to protect food. The ants will not cross these strips of tape. The prepared tape may be purchased in the larger cities of the South, but the author has never seen it for sale in cities in the North. But since one often gets an inferior article from the store it is best to prepare it at home.

Newell makes a solution of the corrosive sublimate by heating it in water in a granite ware vessel and dissolving all that the water will take up. After this solution has cooled it is filtered. The solution may be filtered, in the absence of filter paper, through a fine clean quality of cotton batting. Simply place a thick layer of the cotton in a funnel and pour the solution in, giving it time to filter through. The tape is then soaked in this filtered solution and pinned up on the wall to dry. Neither the solution nor the tape should be allowed to come in contact with iron, tin, or steel. When the tape is well made it will remain effective for many months, even a year.

Tartar emetic mixed with four or five times its volume of sirup and placed about in shallow dishes is an effective remedy against house ants. It is also mixed with sugar at the rate of 1 part tartar emetic, 10 parts sugar, and 100 parts of water. This mixture, poured into individual butter plates and set about in a refrigerator or pantry where ants are numerous, has proven very effective.

Naphthalene flakes have also proven an efficient repellent against ants. The material is simply scattered about on the shelves and in the corners frequented by the ants. A somewhat fuller discussion of naphthalene flakes and their use against fleas is given in the chapter on fleas.

The only method of getting rid of ants permanently is by locating their nests and treating them in such a way that the queen will finally be destroyed. Then no more eggs will be laid and the production of workers will cease. One of the best substances for treating nests to kill the queen and exterminate the workers is carbon bisulfide.

It is often difficult to locate the nest and sometimes, when found, it will be in an inaccessible situation, for example, in the foundation walls, or under the floor, or in some other equally secluded and protected place. One writer suggests that the black ants may be traced to their nests by baiting them with broken pieces of rice, farina, or cream of wheat. The ants will carry these pieces of white food to their nests and may be quite easily traced in this way. Perhaps the red ant may be followed to its home by this means. When the colony is located it may be treated with carbon bisulfide by pouring an ounce or two of the liquid into each of several holes made in the nest with a sharpened stick, after which the mouth of each hole should be quickly stopped with a clod of dirt. A heavy wet blanket thrown over the nest will aid in retaining the gas and tend to make the fumigation more effective. The liquid evaporates quickly and the gas permeates the whole nest, killing queens and workers and exterminating the colony. By attaching a torch to the end of a long pole and extending it out over the nest while the operator stands at a safe distance, the gas may be exploded and the fumes driven into all corners of the colony. If the colony is located in the foundation walls, the problem will be much more difficult and may be impossible of solution. The difficulty will be in reaching the nest with the liquid. If the nest is located under the floor, it may be necessary to remove a piece of the flooring in order to gain access to the colony.

In the use of carbon bisulfide, it must be remembered that the gas is inflammable and explosive and no form of fire or light should be brought near the place being fumigated.

C. W. Woodworth says that a very weak solution of arsenic poison such as he has used for the Argentine ant is effective in exterminating common species of ants. The proportions of arsenic and methods of using it are given under the discussion of the Argentine ant.

THE ARGENTINE ANT

As a pest, the Argentine ant (Fig. 51) stands in a class by itself. Newell, writing of this ant in 1908, says, "As a household pest, I venture the opinion that this ant has no equal in the United States." Unfortunately, it is not only a household pest, but it has come to be a serious menace to horticultural interests because it destroys the buds, blooms, and fruits of certain plants and because it protects and fosters some scale insects that are very injurious to certain plants, notably sugar cane. Again, in some instances it has actually shown itself to be dangerous to human life.

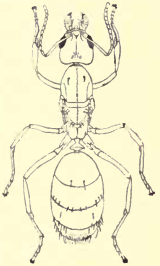

FIG. 51. — The queen Argentine ant, enlarged.

In all probability this ant was first introduced into the United States through the port of New Orleans by way of the coffee ships or other ships from South American points. The ant is a native of America in Brazil and the Argentine Republic and now infests the southern parts of Louisiana, Mississippi, parts of California and probably Texas.

This ant builds its nests everywhere, underneath houses, between the walls of houses, in hollow trees, in compost heaps, in dooryards under stones, and in many other places. They increase with great rapidity, destroy or drive out other ants with which they come in contact, and penetrate every room, closet, trunk, and corner of a dwelling. They are fond of all sugars, sirups, fruit juices, honey, cakes, fresh meat, blood, lard, cream, dead insects, and other substances. Like other ants, they are fond of the honey-dew secreted by aphids and, as a result, they foster aphids and certain scale insects greatly to the detriment of the infested plants. In Audubon Park, New Orleans, Newell says they destroyed the entire orange crop by eating into the fruit buds and that much of the fig crop in the vicinity of the city was also destroyed. What is more remarkable still, infants have been reported to have been killed by the hordes of these ants crawling into the mouth and nasal passages. Newell relates an instance falling under his personal observation of an infant's being found in great distress during the night from the thousands of these ants that were crawling into its mouth and nostrils. The child had to be submerged several times in water before the ants were driven from its body. It would seem that the possibilities of this ant for committing injuries of many kinds and against various interests are almost unlimited.

It seems that this ant is more persistent than any of our native species and the only permanent way to obtain relief is to destroy the whole colony, especially the queen.

Winter trapping.—These ants have a peculiar and rather striking habit regarding their method of passing the winter. In the autumn, there is a tendency for several small colonies to combine into one very large colony which then seeks a suitably protected location for the winter season. Newell says that he has taken advantage of this habit by providing a dry goods box and filling it with cotton seed and straw, leaving the top open so that the rains will moisten the material and cause decay with a consequent production of heat, especially in the center of the mass. By placing the box in the middle of a city lot or garden nearly all the ant colonies within thirty or forty yards will migrate to it and settle among the warm, decaying matter. By throwing a rubber cloth or waterproof canvas over the top of the box in January the whole collection may be killed with a pound of carbon bisulfide.

Summer destruction. — Whenever a colony is located in the ground about the lawn or garden, it can be exterminated with carbon bisulfide. Colonies occurring under boards or piles of rubbish may be destroyed by spraying them with kerosene, crude oil, or boiling water. When a colony is located in an inaccessible situation it may often be coaxed into a location in which it can be easily reached. For example, they are very fond of decaying wood as a nesting place, and if a piece of decayed log with a jar of honey or sugar is placed near the inaccessible situation, the colony will often desert their old nest and move bodily into the log. In this situation every individual may easily be destroyed.

Repellents. — The ant tape is effective in preventing the ants from reaching tables and other situations where the tape is so placed that the ants must cross it if they reach their desired goal.

Again, Newell says he has had success in driving the ants from a room which they persist in visiting by using a poisoned solution of sugar or molasses. The solution giving best satisfaction was made with white arsenic $\frac{1}{2}$ gram, sugar 20 grams, water 100 cubic centimeters. The arsenic is dissolved in a portion of the water by boiling and the sugar in the remainder. The two portions are then mixed and enough water added to make up for the loss by evaporation in boiling. When the solution was placed about in small dishes, as was described for the tartar emetic, the ants, in some cases at least, gradually left the vicinity.

C. W. Woodworth obtained the best results in killing the Argentine ant by the use of a very weak solution of arsenic and sirup. He found that by reducing the arsenic to between one-fourth and one-eighth of 1 per cent that the ants would take large quantities of the poisoned material to their nests and feed it to the young and the whole nest would be killed by slow poisoning. The most convenient way to feed the poison was by placing a sponge saturated with the solution in jars with perforated covers. The ants will enter the jars, fill themselves with the sirup, and carry it away.

In a later experiment Nickels used sodium arsenite which contains about $57\frac{1}{2}$ per cent of arsenic. To make a weak solution, he dissolves a trifle over one ounce of the arsenite in a little hot water. When dissolved it is added to a sweetened solution of 20 pounds of sugar dissolved in three quarts of water. It is necessary to heat the sirup mixture to thoroughly dissolve the sugar.

To make a small amount of the mixture, dissolve 3 grams of the arsenite in a little water and add it to a sweetened sirup of 2 pounds of sugar dissolved in $\frac{3}{4}$ of a pint of water. He says, "We have established that it is possible to exterminate the Argentine ant and to absolutely prevent its spread."

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CHAPTER IX

INSECTS INJURIOUS TO CLOTHES AND CARPETS

A RATHER large variety of insects attacks fabrics of different kinds, particularly those that contain much wool. Some, however, are impartial in their tastes, while others prefer starched cotton materials. Fabrics that remain undisturbed for some time are most likely to harbor the pests.

THE CASE-MAKING CLOTHES MOTH

Tinea pellionella et al.

Clothes moths have been the bugbears of all housekeepers probably since man began to live in houses and wear woolen and fur garments. The larvæ of clothes moths subsist on dried animal matter, such as the dead bodies of insects, dried skins, feathers, wool, and hair. It is quite possible, as Marlatt suggests, that these insects first came into association with man as scavengers living upon the waste animal matter about his rude and unsanitary habitations. Subsequently, when these convenient supplies of food were removed, the insects were driven to eat the hair and skin of the garments worn by man, later attacking the woolen fabrics as they came into use. Thus the moths have kept pace with man, improving their tastes as man progressed until now they apparently delight most in attacking the finest garments and costliest furs.

The clothes moths are all introduced species, having come to us from European countries along with our forefathers. It is certain that they have existed in this country for many years, for Peter Kalm, a professor in a Swedish university, in a quaint account written in 1771 (3d. ed.) of his travels in North America, tells us that "Moths, or *Tineæ*, which eat the clothes, are likewise abundant here. I have seen cloth, worsted gloves, and other woolen stuffs, which have hung all the summer locked up in a shrine, and had not been taken care of, quite cut through by these worms, so that whole pieces fell out." This description would fit conditions that are often found to-day quite as well as a century and a half ago.

Not only have clothes moths been long known and recognized in America, but they have been familiar insects to the human race for thousands of years. They are referred to in the Book of Job in the well-known passage, "And he, as a rotten thing, consumeth, as a garment, that is moth-eaten." The Romans were well acquainted with insects that destroyed clothing, and they applied the name *Tinea* to the caterpillar of any clothes moth, no matter what species, that was found injuring clothes. Pliny speaks of a Tinea with its case and relates how it changes to a chrysalis from which the moth finally issues. Scientists have, therefore, adopted the name, *Tineidæ*, for the family containing the clothes moths and many other closely related moths, all of which are very small, although the name of the family has no connection with our word tiny. The moths belonging to the family Tineidæ are all very small and have narrow wings fringed with very long, slender scales. Although small, some of them are really very beautiful, surpassing many of our larger moths in brilliancy and richness of coloring.

There was always a great deal of confusion concerning the species of clothes moths in this country until Fernald, in conjunction with Lord Walsingham of England, an authority on these insects, settled the question by a careful examination and comparison of the specimens found in America. It was determined that there were three species in the United States, evidently all European in origin. It seems that there are no native clothes moths in the United States. The three species are now known as the case-making clothes moth (*Tinea pellionella*), the webbing clothes moth (*Tineola bisselliella*), and the gallery-making or tapestry clothes moth (*Trichophaga tapetzella*).

There seems to be some difference of opinion as to which is the commoner species of moth in the northern sections of America. Fletcher maintained that he had found the webbing moth much more common in Canada, while Riley finds the webbing moth more common in the South, and the case-making species more abundant in the North. It is certain that in every case in which the work of these insects has been brought to the author's attention in New York many small whitish, silken cases have been found upon the material being eaten. Moreover, these cases have invariably been empty as though they were pupal cases rather than the cases of larvæ. The writer is inclined to believe that these were the pupal cases of the webbing clothes moth, *T. bisselliella* rather than the cases of *T. pellionella*. If so, then Fletcher seems to be correct regarding the more common species in southern Canada and New York. We have seen the work of these insects especially on fur caps and felt hats. Perhaps, on woolen clothing we should find the case-making species more abundant. A more detailed investigation of the life history, habits, and distribution of these moths is much needed.

The moths (Fig. 52) of the case-making species are small, measuring only about half an inch from tip to tip of the tiny wings when they are squarely expanded. The fore wings are of a shining yellowish-brown color with three distinct dark spots on each of them, while the hind wings are smaller and lighter in color and clothed with a fringe of long slender scales along the posterior margins.

FIG. 52. — Case-making clothes moth. (× 4.)

Normally, the moths appear in the spring and may be seen flitting about rooms most of the summer. They are apparently attracted more or less by lights and are frequently seen flying aimlessly about a lamp at night. The moths, of course, are innocent enough, so far as any actual direct damage to clothing is concerned. Nevertheless much energy is expended by the careful housekeeper in catching and killing them. This energy, however, is not wholly lost, for if the moths are allowed to live, they may deposit eggs for the production of larvæ, the real authors of the injury. Undoubtedly, many small, harmless moths are often mistakenly destroyed for the more injurious clothes moths.

The tiny eggs of this moth are tucked away among the folds of the garments upon which the larvæ are expected to feed. When they hatch, the minute white-bodied larva begins, at once, to make a case for itself. The case is a nearly cylindrical tube open at both ends. It is, however, slightly larger in the middle, thus resembling a cigar in shape (Fig. 53). The tube is made of silk and fragments of the material upon which the larva is feeding. When feeding, the larva thrusts out its head together with its thorax, which bears the three pairs of legs; and holding fast to its case with a pair of claspers on the posterior end of the body drags its house along with it wherever it goes. When disturbed, the larva retreats quickly within its case. The larvæ feed on woolens, clothing, carpets, furs, and feathers, and are exceedingly destructive. Fernald says that these moths "breed during the summer, but not in winter, even when kept in a room warmed by a furnace where the heat was uniform day and night. The moths emerge in June and July, and some even as late as August, yet there is but a single generation annually, so far as I have observed." In the South there are probably more generations a year.

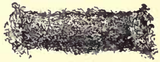

Fig. 53. — Case of the case-making clothes moth. (× 3.)

The young larva, of course, soon finds its case too small and, as it grows, it has to enlarge the case from time to time. This enlargement is done in a very interesting manner. Without emerging from its case, the larva cuts a slit halfway down one side, thus forming a triangular opening. Into this opening it inserts a triangular gore of the woolen material upon which it is feeding. This process is repeated on the opposite side of the case and without leaving its retreat it turns around and repeats the same thing on the other half of the case. Thus the case is enlarged in diameter, but it remains for the larva to lengthen its home. This is done by additions to each end of the case. On the outside the case appears to be composed of fibers of the material upon which the larva has been feeding, but inside the case is lined with a soft layer of fine silk. By transferring the larva to different colored materials a curiously parti-colored case may be obtained, for the insect will use the various materials for the enlargements.

The larva completes its growth by fall and seeks a secluded place in which to secrete itself and spend the winter in a torpid condition. The larvæ have been observed to leave the carpets upon which they were feeding and drag their cases up a wall fifteen feet high and fasten them to the ceiling. In the spring, the larvæ transform to pupæ in the cases within which they have lived during the winter. Apparently the pupal stage lasts about three weeks. The moths do not survive long after depositing their eggs. As a usual thing they shun daylight and remain hidden in dark corners.

The larva of the clothes moth, despite its secluded life, more or less protected in a case, is sought out by certain tiny but persistent parasites and killed. At least two of these parasites have been reared from the larval cases of this moth. They are *Hyperacmus tiniæ* Riley, Ms., and *Apanteles carpatus* Say.

THE WEBBING CLOTHES MOTH

Tineola bisselliella

By some authorities, this species is considered more common in the Southern states than in the North. It is certain that it exists in the South in abundance, for the writer has seen many of the naked larvæ of this moth on woolen materials. We recall to mind a college pennant of red felt that was stretched on the wall of a room in Mississippi. This banner was riddled and eaten by the larvæ of this species while it rested in that exposed position on the wall of the room. On the other hand, the webbing or naked clothes moth is certainly abundant in the vicinity of Ithaca, New York. The author has collected the larvæ in abundance from furs and rugs and has taken the moths in houses in April and May. In fact, this is the only species we have taken at Ithaca. Fletcher, as we have already pointed out, found this form more common in Canada than he did the case-making species. Washburn also states that he has come in contact with only this species in Minnesota. These observations certainly indicate the abundance of the webbing clothes moth in the North.

FIG. 54. — Webbing clothes moth. (× 4.)

This moth (Fig. 54) is usually a little larger than the case-making moth, although it varies a good deal in size. The fore wings are decidedly more yellowish in color — generally described as "shining ochreous" without spots or markings. The hind wings are paler, while the head is reddish.

The larvæ live upon a great variety of substances such as fur, feathers, wool, bodies of insects, and are occasionally found in the upholstering of furniture. The larvæ have been observed in England to eat cobwebs found in the corners of rooms and have, in fact, been reared to maturity on this rather filmy food. The larvæ are also, occasionally, somewhat injurious to specimens in museums and collections, especially to the bodies of insects. F. M. Webster experienced considerable trouble from the larvæ of this moth eating into and riddling the bodies of the larger moths in his collection of insects in Ohio. C. V. Riley records rearing the insect from grain infested with the grain moth, *Sitotroga cerealella.* Evidently the larvæ had fed upon the dead caterpillars of the grain moth. Riley and Howard report, in *Insect Life*, the interesting instance of the larvæ having been found in a can of beef meal which had been rejected as being "weevilly." The presence of the larvæ of this clothes moth in the beef meal demonstrated its fondness for animal products.

FIG. 55. — Egg of the webbing clothes moth. (× 25.)

The life history of this species has not been carefully followed, but we have had them under observation for some time. The egg is oval, pearly white, and very small (Fig. 55), yet visible to the eye. The eggs are desposited on the cloth or material on which the larvæ will feed. Eggs were easily obtained by putting moths in cages along with black cloth. One moth laid 44 eggs in a period of 9 days. These hatched uniformly in six days and the larvæ from these eggs, which hatched July 31st to August 8th, are only partly grown at this writing, March 22d. They have been kept in a cool room. From some overwintering larvæ we obtained pupæ from May 15th to May 18th. We obtained an adult moth on May 28th from a pupa formed on the 16th, thus giving a pupal stage of about

12 days. In another instance, the pupal period appeared to be about 16 days. It is said there are two generations of this clothes moth in the Northern states, "the first appearing in June from eggs deposited in May, and the second in August and September." It would appear, from our studies, that the first generation of moths is from eggs deposited in July and August of the previous year.

Fig. 56. — Larva of the webbing clothes moth. (× 6.)

The larva (Fig. 56) of this moth builds no case, but spins a path of silk wherever it goes. When the larva is full grown it builds a cocoon of silk intermixed with bits of food material. The cocoon is rather rougher and more irregular in outline than that of the case-making moth.

THE TAPESTRY MOTH

Trichophaga tapetzella

The tapestry moth (Fig. 57) is somewhat rare in this country, but apparently common in England. It is considerably larger than either of the other two species and much more striking in appearance, owing to the markings on its wings. The wings expand three-quarters of an inch and are black from the base to the middle, while the outer half is white, clouded with

Fig. 57. — Tapestry moth. (× 3.)

gray. There is a tiny dark spot about midway of the hind edge of each wing and two similar dots with a dark area at the apex of each wing. The hind wings are light gray in color, while the head bears a tuft of long white hairs.

The larvæ feed on a variety of materials, such as pelts, felts, carpets, horse blankets, and upholstering of carriages. In England the larvæ are met with more frequently in outhouses where carriages are kept than in the dwelling-houses. The larvæ burrow inside of the material upon which they feed when this is thick enough to enable them to do it. They, therefore, do not construct cases, but they do line their burrows with silk. On account of this borrowing habit these larvæ destroy much more material than they eat. Within these galleries it undergoes its transformations to the pupal stage.

One of the parasites (*Apanteles carpatus*) on the case-making moth has also been reared from the tapestry moth.

METHODS OF CONTROL

First of all, it should be definitely understood that odors emanating from small quantities of various substances like camphor balls, cedar, or naphthalene, have no killing effect on the moths or larvæ. Cedar chests or closets lined with cedar are of no avail if eggs are once deposited on clothes stored in them. Apparently, the odor of cedar has some effect in keeping the moths away. The odor of camphor balls also has a repelling effect on the moths. But a few moth-balls placed among clothes in a chest do not prevent injury if eggs are deposited on the garments before the latter are put away. The real function and value, then, of cedar chests or closets lies in repelling the moths and keeping them away from the garments. The garments, however, must be free from all eggs and larvæ of the moths before being put in chests. Great care must be taken to shake and brush the garments and to hang them in the sun and air until all of the larvæ and eggs have been shaken loose and destroyed.

In the second place, it should be plainly understood that garments which are often worn are not liable to be injured. It is the clothing and materials that are stored away in closets, trunks, and boxes, for a long time undisturbed, that are badly troubled. It is under such conditions that the moths get an opportunity to deposit their eggs and the eggs have a chance to lie undisturbed long enough to hatch and the larvæ have occasion to eat and grow toward maturity.

Sunlight and air are among our best available agents of protection from clothes moths. Garments should be hung in the air and sun and then thoroughly brushed and shaken to dislodge the eggs and larvæ that may be on them before being put away for the summer. In addition, they should be taken out occasionally (once a month) and brushed, shaken, and aired. The same treatment should be accorded woolen blankets and bedding that are to be stored. After they are once thoroughly cleaned, they may be packed away with a supply of camphor balls distributed among them to repel the moths. It is advisable to spray the cracks in closets and chests with benzine or gasoline before putting in the clothes in order to kill any eggs or larvæ of the moths that may be lurking there.

A few old woolen rags or pieces of old furs stored in attics but never used are prolific breeding places for these moths and should be taken out and burned.

Howard early suggested a method of putting away winter wraps and garments for storage during the summer which is practical and efficient, as we know from experience. He goes to the tailor shop and purchases a few common pasteboard suit boxes and in these the garments to be stored are neatly folded away. Then the cracks around the edges of the cover are sealed by pasting strips of paper over them. This makes a tight box that excludes all moths. The boxes, with care, last several years.

Another method of storing clothes is given by a resident of the city of Washington. He has a wooden chest to hold his clothes. In the cover of the chest he has bored a large hole and on the under side of the cover, directly under the hole, he has tied a large sponge. In the middle of the summer he pours a little carbon bisulfide on the sponge and closes the hole with a cork. In this way, he keeps the clothes free from injury.

Washburn uses a somewhat similar method. He has a large galvanized iron chest with a tight-fitting cover in which the garments are stored. During the summer he opens the chest occasionally and pours four tablespoonfuls of carbon bisulfide in a saucer on top of the clothes and shuts the cover. In this way he kills whatever larvæ may have hatched from eggs desposited on the clothes before they were stored away.

Finally, moth proof paper bags of large size are now offered for sale at many drug stores in the larger towns. The bags are large enough to receive skirts and coats without folding and they are so constructed that moths cannot gain entrance to the inside. These bags are safe receptacles for the storage of materials liable to be infested with moths and will last for years.

The upholstering on furniture and carriages is much harder to protect from the moths. Badly infested upholstered furniture should be placed in a small tight room and thoroughly fumigated with hydrocyanic acid gas.

Some good can undoubtedly be accomplished by spraying them several times during the summer with benzine or gasoline. These volatile liquids will not stain if they are reasonably clean. Care should be exercised regarding lights because gasoline and benzine are very inflammable.

COLD STORAGE

Cold storage plants for fruits and meats are common nowadays in all cities and in many small towns. These plants are available for various uses, among which is the storage of furs, rugs, and other valuable woolen goods during the summer season when the owners are out of town. In fact, this is fast becoming in cities a universal way of storing household goods.

L. O. Howard reports some careful experiments carried out mainly by Albert N. Read, manager of a cold storage warehouse in Washington, D.C. It was demonstrated in this series of experiments that a continuous temperature of 40 degrees F. is sufficient to maintain the larvæ of the case-making clothes moth in an inactive dormant condition. It was also shown that the larvæ could exist at a temperature as low as 18 degrees if it were continuous. If, however, the larvæ were taken out and revived by warmth and then returned to the low temperature they almost invariably died. These results are in accord with the general idea that the immature stages of insects are much more subject to the effects of varying degrees of temperature than of even and continuous temperatures.

In the light of these experiments, it is suggested that cold storage companies subject the goods in their care to low temperatures for a few days and then allow them to rest for a few days at higher temperatures, followed again by cold. Such variations of temperature would actually kill all the moths and larvæ that might be hiding among the goods, after which they could be stored at a uniform temperature of 40 degrees with perfect safety.

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Found in spirea flowers in spring.

THE "BUFFALO BUG" OR "BUFFALO MOTH"

Anthrenus scrophulariæ

There are two species of beetles in the United States that have come to be known as carpet beetles. Both of them are small insects and not familiar to most housekeepers. It is the larvæ or grubs of these beetles that really do the mischief and with these many housekeepers are only too well acquainted. The larvæ of one of these carpet beetles has come to be known as the "buffalo bug" or the "buffalo moth" and it is the more common and better known of the two. The other species is known simply as the black carpet beetle.

Again, we must make our acknowledgments to the Old World for a comparatively new pest in a new and serious rôle. It was first noted as a serious pest in this country about 1874, although Henshaw reports it at Cambridge, Massachusetts, as early as 1869. In Europe, however, no records are obtainable that show it is especially injurious to carpets, and it is not there considered a serious household pest. At least, it is of so little consequence in European households that it has never attracted any particular attention. It is known in Europe principally as a pest in museums, where it is often found eating the dead bodies of specimens and causing considerable injury. Indeed, it was imported into this country several times in insect collections brought from Europe and has played the rôle of a museum pest in Cambridge, Detroit, and San Francisco. About 1874 it was imported into this country into the cities of Boston and New York, probably simultaneously, in shipments of carpets. Since then it has spread westward through Ohio, Indiana, Michigan, Wisconsin, Illinois, and Kansas.

The nature of the pest. — In this country this pest is usually known as the "buffalo bug" or "buffalo moth" (Fig. 58). These names are both misnomers because the pest is not a bug, nor is it a moth. On the contrary, the adult insect is a small beetle about three-sixteenths of an inch long with a general background of black, spotted and speckled with white, and with a red line down the middle of its back. Near each end of the red line and at its middle there are side projections of red. Thus the beetle is rather handsome in its markings of black, red, and white.

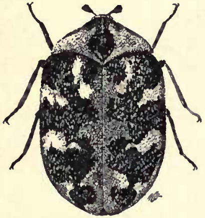

Fig. 58. — The "buffalo bug" (carpet beetle). (× 9.)

Most housewives are, however, not acquainted with the adult beetle, but rather with the active, brown, hairy larva. It is not the full-grown beetle that inflicts the injury to carpets, woolens, and furs, but, like the clothes moth, it is the larva that does the mischief. The beetles feed upon the pollen of flowers and are often found out-of-doors in the spring on spirea, wild cherry, and, later, on milfoil and other plants. When the beetles develop in the house they fly to the window panes in an effort to escape into the open air. Unfortunately, lady-birds (Fig. 59) are often found in the same situations and are many times mistaken for the carpet beetles and killed. The adult carpet beetles, when disturbed, fold up their legs and antennæ, feigning death and playing "'possum."

Life history of the beetle. — The curiously wrinkled, whitish eggs are laid by the mother beetle among the fibers of the cloth upon which the larvæ are feeding or will feed. Here, under favorable circumstances, they hatch in ten days to two weeks and the larvæ eat voraciously, grow rather rapidly if food is available, and cast their skins, under normal conditions, about six times. The growth of the larvæ is greatly retarded by cold weather or lack of food, but still they manage to exist and live on indefinitely, molting many times and devouring their cast skins.

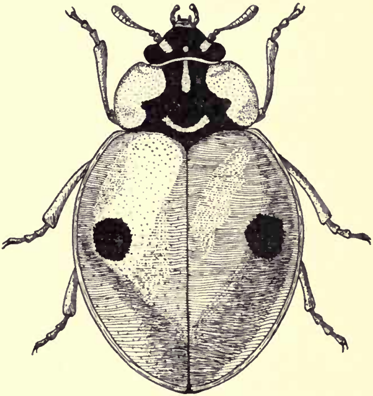

Fig. 59. — A common lady-bird. (× 13.)

The larva is quite characteristic in appearance. It is nearly a quarter of an inch in length and clothed with long brown hairs (Fig. 60). The hairs on the sides of the body are longer than those on the back, while the hairs at the anterior and posterior ends of the larva are longest of all. The larva is active and seems to be eating most of the time whenever food is to be had.

After the larva reaches full growth, it transforms, within its last skin, into the pupa. Finally, this old larval skin splits down the back, disclosing the pupa within. Eventually, the pupa transforms into the adult beetle, which often finds its way to the window panes in search of an exit to its out-door food plants. Some studies made here at Cornell indicate that there is only one generation a year in this latitude, although further observations are necessary to settle this point. L. O. Howard says, "there are, probably, in the North, not more than two annual generations." The earliest beetles appear in the fall, usually during October, and continue to appear all winter in well warmed houses and during the spring months. We have found the pupæ in houses in January together with freshly emerged beetles.

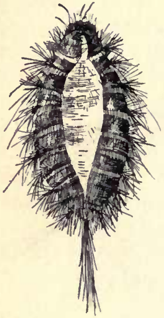

Fig. 60. — Cast skin of larva of "Buffalo moth." (× 6.)

Injuries and methods of control. — The larvæ when abundant may injure carpets rather seriously. They gnaw holes an inch or more in diameter in the borders where the latter are nailed to the floor. Sometimes the larvæ follow a crack in the floor and cut a slit in the carpet almost as neatly as though done with scissors. They are not only injurious to carpets, but attack woolen goods as well, and even wearing apparel in closets, drawers, and trunks.

This insect will always be difficult to control in houses having floors completely covered with carpets tightly tacked about the edges. A carpet placed permanently on a floor and allowed to remain there undisturbed for a year furnishes ideal conditions for this pest to thrive and increase. As was urged in the case of fleas, so here we would urge a change from carpets to rugs if possible. Where bare floors, covered more or less with rugs, are maintained, the carpet beetles will not find hiding places suited to their development. Moreover, the rugs can be examined without difficulty at any time and, in fact, are usually dusted and aired too often for the larvæ to gain a foothold. The tendency among modern homes is toward polished floors and rugs with a consequent diminution of the carpet beetles as a household pest.

Where the insect has become well established in a house, nothing but heroic measures and long-continued efforts will avail. Housecleaning should certainly occur twice a year instead of once and should be very thoroughly done, at least, so far as the carpets are concerned. The carpets should be removed, thoroughly dusted and beaten, sprayed with gasoline, and hung in the air and sunlight as long as possible.

The floors should be thoroughly washed and scrubbed with soap and water, especially along the baseboards and cracks. It would be of advantage to spray the cracks beneath the baseboards with benzine or gasoline and clean out all the dirt possible from the cracks in the floors and pour in benzine or kerosene oil. Before the carpet is replaced on old floors, the cracks should be filled with a crack-filler, thus eliminating the favorite hiding places for the larvæ. In badly infested houses, tarred building paper may be placed beneath the carpets, but the odor from such paper is not always pleasant.

The carpet may be very loosely tacked about the edges, thus affording an opportunity to examine it often to see if the pests have returned. The following is a good account of the manner in which one housekeeper finally got rid of these pests: "My own experience with them began last year. We moved to our present abode in April, and it was not until every carpet had been put down and the house settled that I was aware that we had such unwelcome guests. I was not long in observing their habit of running into any crack and crevice that presented itself, and also running along the joints of the floors, and our warfare against them was directed toward these joints. In the closets we stopped up every nook on the walls; every crevice under the baseboards, and filled up the joints of the floors; then we laid down oil-cloth, and kept a plentiful supply of camphor in the closets. I am happy to say that we have had no trouble with them since so doing.

"Fortunately, we had put paper under all the carpets, so we felt that they were in a measure, at least, protected, but I found them continually, just under the edges of the carpet. As far as possible, we filled up the crevices under the baseboards and I used benzine plentifully all the summer, saturating the borders of the carpets every two weeks and killing all I saw in the meantime. Last spring we varnished the cracks of the floors, and in some cases, where they were open, covered them with strips of thin muslin stuck down with the varnish; we again put paper under the carpets, as we had found it such protection the previous year. I have found the various insect powders of no use whatever when the insect is in the larval state: whether or not it has any effect on the beetle I cannot say; but this I can state, — that our unceasing warfare has not been in vain, for I have, during the past summer, seen only single ones where last year I found scores."

Hydrocyanic acid gas is quite as effectual for the carpet beetle as it is for the bedbug and may be used in exactly the same manner as was described in the chapter on the latter insect.

The fumes of sulfur are quite as effective if enough of the sulfur is burned at one time. Not less than two pounds to a thousand cubic feet should be used. The room should be tightly calked and closed as described in the chapter on the bedbugs. We would again call attention to the injury that may result from sulfur fumes to metals, wall paper, and gilt objects.

As we have pointed out the larvæ tend to congregate mostly about the edges of the carpets. It is said that a solution of sixty grains of corrosive sublimate dissolved in a pint of alcohol and applied to the edges and undersides of the carpets around the borders will poison the larvæ when they begin to eat the fabric. The alcohol quickly evaporates and leaves the corrosive sublimate among the fibers of the carpet where it will remain a long time. Since this material is such a virulent poison, great care must be exercised in regard to children when playing about the room lest they get hold of some of the material and become poisoned.

The larvæ may be trapped by placing woolen cloths, especially red ones, in closets. Among these, the larvæ will congregate and may be caught by shaking the cloths once a week over a piece of paper.

Furs and woolens may be stored in boxes in the same manner as recommended for protection against clothes moths. The box arranged for the application of carbon bisulfide serves as well in protecting materials from the carpet beetle as it does from clothes moths.

THE BLACK CARPET BEETLE

Attagenus piceus

In the case of this insect (Fig. 61) we have a pest with a varied menu and consequently one that is apt to be found committing a different kind of injury in different surroundings. For example, Hagen records it as a museum pest in the insect collection at Cambridge, Massachusetts, as early as 1878. The slender larva persists until it finds a crack or slit in the box of specimens and then enters to feed upon the dead bodies of the insects, thus causing much injury. Again, it has been caught doing damage in flour mills and is somewhat of a feeder on cereal products. Moreover, it is a frequent pest in feathers and sometimes causes what is known as "felting" in pillows. The short branches of the feathers which are stripped off by the larvæ in their feeding activities become firmly stuck into the cloth and form a close felting all over the inside of the ticking. Riley, in a case observed by him, says, "The felting was remarkably dense, evenly coating the whole surface of the ticking and greatly resembling in softness, smoothness, and color the fur of a mole." Finally, Lintner found the larvæ of this beetle in company with the

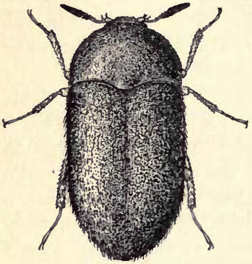

FIG. 61. — Black carpet beetle. (× 9.)

"buffalo moth" about the edges of carpets in a house at Schenectady, New York, in 1876. He, at first, supposed it was about the borders of the carpet in search of dead flies and the cast skins of the "buffalo moth," but, later, he found it a real enemy of the carpet itself. Since that time, this insect has become quite a noted carpet pest in this country. It has become more numerous in some houses than the "buffalo moth," and in the city of Washington, Howard says it has become very abundant and has taken the place of *Anthrenus scrophulariæ*. It is widespread in Europe and Asia and has been in the United States for many years.

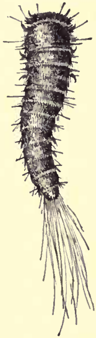

Fig. 62. — Larva of the black carpet beetle. (× 5.)

It has been said that this beetle is not so fond of working in cracks in floors as the "buffalo moth," but many of the larvæ of these beetles have been found in the floor cracks of a house in Ithaca, New York. They apparently bred in the cracks all the year round. The cast larval skins and living, mature larvæ were found in January.

Like the "buffalo moth," it is not the adult that commits the injury, but it is the larva that does the damage. The larva is long and slender and tapers toward the posterior end. It is reddish-brown in color, quite active, and clothed with hairs, while the posterior end of the body terminates in a pencil of long hairs. It is easily distinguishable from the "buffalo moth" and the illustrations should enable any one to tell the two apart (Fig. 62).

The adult is a small, blackish beetle only about one-sixteenth of an inch in length. It is about twice as long as wide and rather flattened (Fig. 61). It is very sober in coloring and can readily be distinguished from the much gayer colored "buffalo moth" beetle.

The life history of this insect is not well known. Its eggs are white, of a broad, oval shape, and are probably deposited about the edges of the carpets or upon the woolens or other materials it may be feeding upon. Chittenden has met with the larvæ in seeds and other vegetable matter and has shown that they will breed successfully from the egg in flour and meal. In his studies of the life history of this pest he found that two years were required for its development from egg to beetle. The pupal stage was shown to last from six to fifteen days.

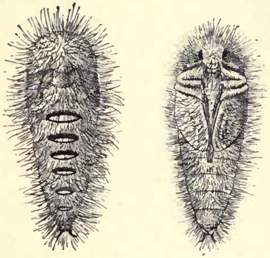

Fig. 63. — Pupa of the black carpet beetle, dorsal and ventral view. (× 9.)

We have had the adults appearing in May in our breeding jars and in dwellings. The pupæ (Fig. 63) are clothed with a coat of whitish hairs among which débris becomes entangled, the whole resembling a very thin, delicate cocoon. On the dorsal side of each of six segments of the abdomen there is a brownish eye-like spot. The inner edges of the spots are fringed with minute teeth. When the pupa is stroked with a needle along the back, these spots contract and close up. The larvæ of the black carpet beetle are certainly active throughout the winter in well-heated houses.

Methods of control. — Since the habits of this pest are so similar to those of the "buffalo moth," the same remedies may be applied to it.

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FISH-MOTHS

Lepisma saccharina

In taking from a shelf a book that has remained undisturbed for some time, we often catch a glimpse of a glistening or silver gray insect (Fig. 64) that glides quickly out of sight. In fact, this insect is an adept at dodging and when actually in contact with the fingers, the slick, shining body easily slips from the grasp. It is not a moth nor is it closely related to a moth nor does it remotely resemble a moth in general appearance or habits. Its body is clothed with shining scales like that of a fish and some person who had caught it injuring clothes in a manner similar to the larva of a clothes moth combined the character with the habit and thereupon dubbed it a fish-moth. It is quite common to call any insect found injuring household effects a moth, even though it is far removed from the group of insects containing the moths and butterflies. The glistening body of the fish-moth, its quick, gliding movements, and its ability to appear and as quickly and mysteriously disappear have resulted in its having received a number of names in different localities. It is variously known as the silver-fish, silver-witch, sugar-louse, sugar-fish, wood-fish, and bristle-tail.

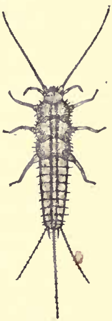

Fig. 64. — The fish-moth. (× 2.)

Food and injuries of the fish-moth. — It is still a question whether this insect lives mostly upon vegetable or animal products, or, at a pinch, upon both. It is commonly said that the fish-moth lives upon vegetable matter, mainly upon starch and sugar. In proof of this, the injuries to laundered clothes, bindings of books, wall paper, and similar materials are cited. It has been said that the insect attacks these objects to get at the starch or paste in them. Not long ago we received a letter from a careful housekeeper, accompanied by several specimens of this insect, saying that they were seriously injuring the curtains hung at the windows of a room very little used. These curtains had supposedly been starched, although the letter was not specific on this point. At any rate, something in the curtains other than the fiber, probably the starchy material, had proved attractive as a source of food to the fish-moths and the injuries followed. In this connection, M. de Rossi says that muslin curtains are sometimes perforated by fish-moths.

On the other hand, Garman says he has become convinced that these insects feed upon animal matter and cites an instance of some velox photographic prints from which the film had been removed by them in patches while the starch used in mounting the prints had remained untouched. In attempting to catch the depredators, baits of starch and sugar, both moist and dry, were set for them, but not the slightest attention was given to these food products by the insects. On the other hand, bits of white glue alone and dusted with Paris green, when placed about, were readily devoured by the pests. Moreover, the dead bodies of fish-moths were eagerly eaten by their living comrades. Taking these observations, as a whole, Garman is inclined to believe that these insects have a fondness for animal food and that they attack book bindings, gummed labels, and so on, mainly, for the animal matter contained in the glue on them. It must be stated, however, that the great majority of writers on these insects hold that they eat vegetable matter and they certainly do, at times.

Hagen brings together considerable evidence to prove that Lepisma shows a decided taste for starchy matter. He says, "If we tabulate all the facts, we find directly that all damage, except those to paper and its combinations, have been inflicted on silks, clothing, and muslin curtains which were invariably starched or finished with some stiffening size, making them more easily eaten or eroded. Secondly, the backs of books may have been more or less seriously injured. But just here paste had been used in quantity."

Book bindings are often badly scarred and scraped by these insects in their efforts to obtain the included glue or paste. Even the gold lettering on volumes has been eaten to get at the sizing beneath, and gummed labels used in museums and on books in libraries are often destroyed by them. Heavily glazed paper offers an attractive source of food to these insects and books made of such paper often have their leaves badly scraped and scarred. Wall paper is sometimes attacked by fish-moths and the starch so eaten up over a large area that the paper breaks loose from the walls. Starched collars, cuffs, and shirts, especially when laid away for a long time, are apt to suffer injury. Silk garments and silken tapestries have been injured occasionally, due, probably, to the material used in them for stiffening. In the Museum of Comparative Zoölogy at Cambridge, 700 labels on a collection of Paleontological specimens were all injured by fish-moths. Many of these were eaten enough to obliterate the writing and riddle the paper with holes. All of them had to be rewritten. The injury in this particular case, however, was ascribed to another species (*Lepisma domestica*). In such cases the loss is considerable and might be very serious if the labels on rare specimens became so defaced that the records could not be made out. Undoubtedly these insects do eat paper, when driven to it, for when S. Henshaw inclosed some of the fish-moths in a jar with only paper they readily ate holes in it. It is recorded that some books kept in a safe were attacked by a species of Lepisma. Occasionally vegetable drugs or similar materials are damaged by fish-moths.

Description of the insect. — The fish-moth is a member of the lowest and simplest group of insects. It has no wings and its body is about one-third of an inch in length, tapers gradually from the head to the posterior extremity, and is covered with minute silvery scales. On account of the covering of scales, it is almost impossible to catch an individual without crushing or greatly damaging it. As one correspondent said, "I have never been able to get one, as they are extremely quick in motion and when killed are crushed." Like all other insects it has six legs which, although not abnormally long, yet are powerful and enable it to run very swiftly for so small an animal. The two "feelers," or antennæ, are very long, slender, and conspicuous. Moreover, at the posterior end of the body are three, long, slender, bristle-shaped projections, the middle one extending straight backward and the other two extending to the right and left at considerable angles. It has biting mouth-parts consisting of two pairs of jaws.

One of the earliest notices of this insect occurs in a book called "Micrographia," written by R. Hooke, and published in London by the Royal Society in 1665. The following quaint description of the fish-moth is given: "It is a small white Silver-shining Worm or Moth, which I found much conversant among Books and Papers, and is suppos'd to be that which corrodes and eats holes through leaves and covers; it appears to the naked eye a small glittering Pearl-coloured Moth, which, upon the removing of Books and Papers in the Summer, is often observ'd very nimbly to scud, and pack away to some lurking cranney, where it may the better protect itself from any appearing dangers. Its head appears big and blunt and its body tapers from it towards the tail smaller and smaller, being shap'd almost like a carrot." Although we think of this as a rather crude description, yet it is sufficiently clear to enable us to recognize the insect under discussion and, at the same time, shows what a long standing pest it is. Nothing is known of its life history.

There is another species of fish-moth present in this country, but not so well known to housekeepers. It was described by Packard in 1873 in a paper on the Thysanura of Essex County, Massachusetts. He called it *Lepisma domestica* and said it was common in houses of Salem about hearths and fireplaces, in warm and dry situations, eating sugar, and other foods. He described it as having a broad body, pearly white, with a dense coat of scales and mottled with dark spots (Fig. 65). The same species, evidently, exists in England and it has since been named *Thermobia furnorum*. Both of these names refer to its heat-loving propensities. It seems to be abundant in bakeshops about the ovens where the heat would appear too great for any insect to withstand. It also occurs about fireplaces and ranges in dwellings and runs over hot bricks and metal with apparent impunity. In England, on account of its habits, it is called the "firebrat."

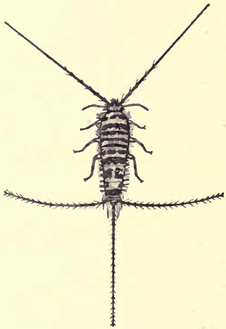

Fig. 65. — The domestic fish-moth. (× 1½).

A Dutch entomologist, Oudemans, who has given considerable attention to the group of insects to which the fish-moths belong, says that he finds this heat-loving species in all bakeshops in Amsterdam that he has investigated and adds, that it is well known to the bakers.

Marlatt says that it is very abundant in Washington City. Dean says that this species has often been observed in mills in Kansas.

This species resembles the more common fish-moth in general appearance. It is usually larger, the body being about one-half inch in length. As pointed out before, the back of the insect is mottled with dark spots, by which it may be readily told from the first species discussed. Then, again, its habits are quite distinct and characteristic.

Methods of control. — Usually books stored in moist basements or other damp rooms are most injured. This, of course, suggests airy, dry rooms for the storage of books or valuable papers if one wishes to preserve them free from injury by the fish-moth.

Another common method of preventing injury to books and papers by these insects is by the frequent use of buhach. The fresh buhach should be sprinkled freely on the shelves and about on the books themselves. Moreover, this treatment should be given frequently where these pests are abundant and persistent because the powder so soon loses its strength. In houses badly infested, starched clothes, stiffened silks, and similar fabrics should not be allowed to rest too long packed away in drawers or loose in chests or boxes.

It is customary among librarians to poison sweetened paste with white arsenic, spread the mixture on pieces of cardboard, and slip them about on shelves among the infested books as baits for the fish-moths. In the light of Garman's experiments, it would seem that a like method of procedure in which glue is substituted for the starchy matter might succeed better in killing the pests. These pieces of cardboard might be used to place about among garments or other stored fabrics if injury by the fish-moths is anticipated.

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CRICKETS

Gryllus domesticus et al.

The following interesting letters give the different phases of annoyance from crickets frequenting dwelling-houses. The first correspondent writes as follows: "I am writing to ask how to kill crickets. The house is built almost level with the ground and crickets have been able to get in the French windows, go up stairs on the rough plaster walls, and get into all the cracks in the woodwork. During August and September of last year I killed thirty or forty crickets a day as they bred in the walls and I feared they would eat clothing if left to themselves. Also they kept us awake at night."

The second correspondent gives another and more serious phase of annoyance from crickets. She says: "We will be very glad to have you tell us how we may rid our house of the common black crickets. They get into the closets in some unaccountable way and destroy the clothing, both linen and woolen. After destroying every one of them in the morning we go into the closets in the afternoon to find as many more as formerly. They seem to eat holes very similar to the moth."

To many householders, the presence of a "cricket on the hearth" is a source of pleasure, and in Spain it is said that crickets are sometimes kept in cages much as we keep canary birds. One might be quite ready to agree with the first correspondent, however, that a multitude of crickets with their peculiar chirpings could become anything but a delight, especially at night. Again, the common black cricket, as the second correspondent writes, often causes serious injury to clothing. Lintner records an interesting instance of this in the case of a common black cricket. He says, "Wm. B. Marshall of the New York State Museum at Albany, reports during a sojourn at Cape May, New Jersey, in the month of July last, that a suit of clothes belonging to a friend which had just been received from the tailor and was hanging over a chair was completely ruined in a single night by crickets that had entered through open windows and eaten large holes in the garments." Lintner identified the crickets as *Gryllus luctuosus*, a common black species.

Crickets hibernate as adults through the winter and, of course, seek warm protected places in which to hide. Very often in the fall, as the nights grow cold, they enter dwelling-houses, especially those that may be temporarily unoccupied. Here they often attack woolen clothing hanging in closets and cause serious injury by eating the garments full of holes. When the occupants return and start the fires they often find the house full of these noisy and rather unwelcome guests.

The crickets with which American residents are probably most familiar are individuals of the common blackish or brownish-black species present everywhere. These are not true house crickets, for they live in the fields and do not breed in houses so far as is known. The domestic cricket is a European insect, but it was probably introduced into this country very early in its history. It is evidently quite widely distributed in America, although it cannot be said to be common in the United States. It is much more common in Canada.

The house cricket (*Gryllus domesticus*) is of a pale brown color throughout (Fig. 66). It frequents more commonly the ground floors of houses and ensconces itself about the chimney, where there is sufficient warmth. Because of the warmth and food in bakeries it is often found in these shops. Like other crickets, it is mainly nocturnal in habits, waiting until the dusk of evening before beginning its activities in hunting food and chirping its love song.

Very little seems to be known regarding its actual life history, but as all sizes are found in houses it is inferred that the eggs are laid in dwellings and that the whole life history may be passed in the house. In summer, in Europe at least, it is often found out-of-doors about hedges and in gardens, but it returns to the houses for warmth in the fall.

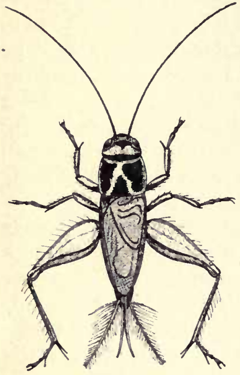
Fig. 66. — The domestic cricket. (× 1½.)

There are certain superstitions connected with crickets that cause them to become objects of considerable interest and to be looked upon by some as harbingers of good or evil. To many, their chirping is an omen of good cheer, while in others it induces sadness and melancholy. To many people the out-door crickets, in the autumn, seem to be voicing the dying of the year. There is also a curious superstition that if one kills a cricket, its relatives will hunt out the garments of the enemy and riddle them with holes.

Only the male crickets are musical, and it is interesting to watch them produce their song. If one of the males of the common field crickets is brought into the house in the fall and placed in a glass jar with a few pieces of bread crumbs for food, it will soon come to feel at home and will sing its song without fear or trepidation. The chirping noise of the cricket is produced by the upper pair of wings that bear special structures for the purpose and are put into rapid motion, as we shall see. The large vein that runs diagonally across each of the upper wings near their bases is crossed with many file-like ridges. Also, not far from the tip of each wing along the inner margin is a hardened membranous portion which may be called the scraper or drum. Thus each of the upper wings is furnished with a file and a scraper. When the cricket desires to make his chirping song, he elevates these wings at an angle of about forty-five degrees and holds them so that the scraper of one rests upon the file of the other. He then moves the wings very fast from side to side, rasping the scraper of each wing with the file of the other. This movement throws the wings into vibration and produces the chirping sound. Since the cricket can make sounds, we would have a right to infer that it is endowed with the sense of hearing. Curiously enough, there is an oval transparent disk on each of the fore legs that undoubtedly serves as an ear or organ for perceiving sound.

Methods of control. — Crickets are very fond of certain liquids like beer and sweetened vinegar. It is said that their extreme fondness for these liquids literally drives them to drink; for if deep glass vessels are half filled with a favorite liquid and placed where the insects can easily get into them, they can be trapped and drowned in great numbers. The author has never had an opportunity to try this method of catching crickets, but it is given on excellent authority.

They may also be killed by poisoning pieces of fresh carrots, parsnips, or potatoes with arsenic and placing them about where the crickets will easily find them. Of course great pains must be taken not to put the bait where children can get hold of it.

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CHAPTER X

INSECTS INJURIOUS TO CEREALS AND PRESERVED FRUITS

Cereals, like wheat, corn, oats, and rice and their products together with preserved fruits, both in the dried, and liquid form, are subject to the attacks of several species of insects. The principal offenders are the larvæ of beetles and moths, but the maggots of certain flies are often injurious to preserved fruits. Most of these pests are inhabitants, primarily, of granaries, storehouses, and mills from which they find their way into the household by being brought in with food-stuffs.

THE DARKER MEAL-WORM

Tenebrio obscurus

There are two species of beetle larvæ, called meal-worms, that work in meal, flour, and other cereals. They are very much alike in general appearance. The one under consideration has been called by many writers the American meal-worm. There is no valid reason for calling it an American insect because it is undoubtedly of European origin. We are, therefore, calling it the darker meal-worm, thus varying slightly from Chittenden, who has already written of it as the dark meal-worm.

Distribution and food. — The darker meal-worm is certainly widely distributed in this country and in Europe.

The larvæ and pupæ of both species of meal-worms are used for bird food and are grown in quantity by bird supply houses. The beetles will increase readily and rapidly when placed with a supply of bran or meal.

The larvæ are found in granaries, storehouses, bake-shops, barns, dwelling-houses, and grocery stores. The author has found them in numbers in oat bins. The larvæ eat meal, flour, bread, cake, and cereals.

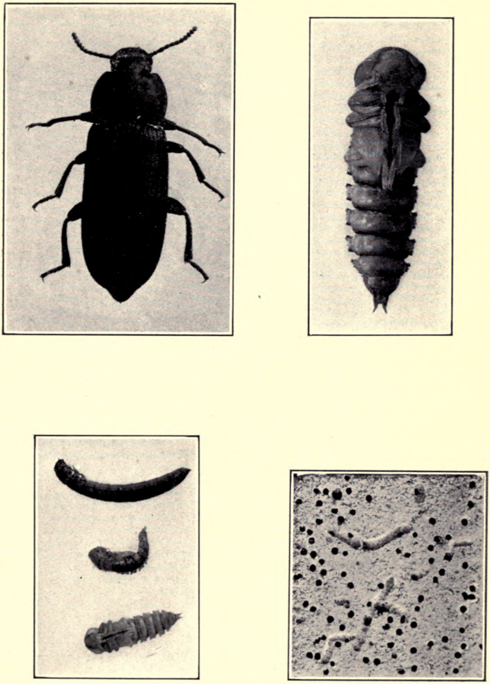
Since they so frequently occur in mills, they are undoubtedly ground up with meal and we probably eat the remains greatly diluted. However, none of us seem to be any worse for it and we trust that no one will be deterred from eating and enjoying all forms of corn-meal products.

Appearance of the beetle and "worms." — The beetle is dull black, often reddish-black and about one-half inch long. Running lengthwise of the wing-covers on the back are sixteen deep furrows plainly visible to the eye. The antennæ are conspicuous, although not long, and look like a string of black beads (Plate III). In this species the third segment of each antenna is noticeably longer than the corresponding segment in the beetle of the yellow meal-worm.

The larvæ of meal-worms are long, slender, and cylindrical. The skin is evidently heavily chitinized and therefore rather hard. The meal-worms are about one inch long, yellow in color, but shading off into yellowish-brown at either end and at the joining of the segments. The posterior segment of the abdomen ends in two minute dark-colored spines. They are furnished with three pairs of very serviceable legs, which enable them to travel quite fast unless they are on a polished surface.

When the larva attains its growth it changes to the pupa. The pupa is whitish in color and about five-eighths of an

PLATE III



Beetle of darker meal-worm (× 3) and pupa (× 2½); pupæ and larva of meal-worm (× 1); yeast cake injured by drug-store beetle.

inch long. The abdominal segments have curious fringed expansions on each edge and the last segment of the abdomen terminates in two spines, sharp and dark-colored at the tips (Plate III).

Methods of control. — The darker meal-worm may be controlled by the same methods as the yellow meal-worm.

THE YELLOW MEAL-WORM

Tenebrio molitor

The larva of this beetle is much like that of the darker one just described in size, shape, and general appearance except that it is lighter in color. The larva is about one inch in length, cylindrical in shape with hardened shining skin, much resembling a wireworm in appearance. It is yellowish in color, shading to a darker tinge at each end and at the joining of the segments. The last segment of the larva terminates in two small spines, although Westwood and Packard describe it as having but one spine.

The beetle closely resembles *Tenebrio obscurus* in shape and general appearance. The color, however, of this beetle is shining black, while *Tenebrio obscurus* is of a dead opaque black.

The white eggs of the beetle are deposited among the meal or cereal upon which the larvæ are expected to feed. The eggs are covered with a sticky material and the particles of meal adhere to them. Sometimes the eggs are laid singly and sometimes in bunches. In ten days to two weeks or more, depending upon the temperature, the eggs hatch and the tiny white meal-worms appear. They begin to feed at once and soon take on their yellowish, glossy appearance. The larvæ take a considerable period for their growth, three months or longer. The pupal stage lasts about two weeks. Under normal conditions the beetles appear in the spring of the year, but where the meal-worms are being reared in the house the adults are appearing at any and all times. Normally, there seems to be but one generation a year.

The yellow meal-worm is a common species in the Old World, but it has been widely distributed over the earth through the activities of commerce. It was purposely introduced into Chili to furnish food for domestic birds.

The larvæ of this beetle are found in corn-meal and flour the world over, where they can be made to breed almost indefinitely. There are on record several instances in which these larvæ have evidently been swallowed by people while eating corn-meal mush, or other materials in which the larvæ live. It is hard to see how the larvæ withstand the heat generated in cooking the food. In addition to this, the person eating the food must necessarily swallow it with very little mastication in order for the larvæ to enter the stomach whole, as without doubt they sometimes have.

An interesting case is related in *Insect Life* in which two of these larvæ were ejected from the stomach of a woman. Evidently the movements of the larvæ in the stomach had caused nausea and finally vomiting.

An interesting and rather humorous account of the occurrence of this beetle in a pincushion on the dresser of a hotel bedroom has come down to us also through *Insect Life*. A guest, who had occupied the bedroom, complained in the morning to his host that the room was haunted. The host, of course, pooh-poohed the idea, but the occupant persisted in his story and related how the bogies had plagued him. He said they were around the dresser and had kept him awake most of the night by the incessant scratching sounds produced somewhere about the furniture. Investigation showed that the scratching noises were present and were evidently issuing from a large pincushion lying on the dresser. When opened and the filling, composed of coarse shorts used as a food for horses, had been shaken out, several large black beetles of this species appeared among the grain. Evidently some of the larvæ or beetles had been inclosed with the shorts and had been breeding in the meantime within the cushion. The grain had served as food for them.

Methods of control. — The most practicable remedy is fumigation with carbon bisulfide, especially in granaries and meal bins. If meal or flour becomes infested in the house, it can be placed in a tight box or barrel and fumigated. After fumigation, the meal or flour should be carefully sifted in order to remove the dead bodies of the insects. As in other cases already recommended, the carbon bisulfide should be used at the rate of two pounds to 1000 cubic feet of space. Half a teacupful should be ample for 50 pounds of meal or flour if the fumigation is done in a small tight box or barrel.

It will be necessary to thoroughly clean the box or bin before putting in a new supply of flour.

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Tenebrio obscurus

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See Lintner's Ninth Rept. for further bibliography.

THE CADELLE

Tenebroides mauritanicus

The Cadelle is more particularly a stored-grain insect than a household pest. It and its larvæ are frequent occupants of granaries, mills, and storehouses and from these often find their way into households in cereals and other food products. Many years ago the French applied the name "Cadelle" to this beetle and it has been known under this name ever since. The Germans often term it the bread beetle. It is of world-wide distribution although Chittenden remarks that "there is every reason to believe that this insect is of American nativity."

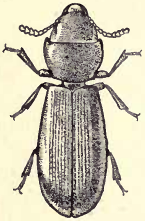

Fig. 67. — The Cadelle. (× 4.)

The adult insect is a dark, shining-brown beetle about $\frac{3}{8}$ of an inch in length (Fig. 67). It is therefore somewhat smaller than the meal-worm beetles, but much larger than the confused flour beetle. The head and thorax are finely punctate and the wing covers are longitudinally ridged. The prothorax and head are distinctly separated from the rest of the body, as shown in Fig. 67. The larva, shown in Fig. 68, is whitish or flesh-colored and about three-fourths of an inch long when full grown. The head, prothorax, and tip of the abdomen are dark reddish-brown. The last two segments of the thorax are also usually brownish. The end of the abdomen bears two dark corneous hooks. Altogether the larva is quite formidable in appearance, although it is perfectly harmless. The pupa is white and, as we describe later, is formed in a cell burrowed out in soft wood, at least when the wood is available.

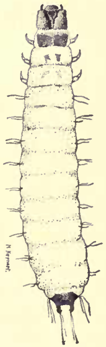

Fig. 68. — Larva of the Cadelle. (× 3.)

There has been considerable difference of opinion as to whether this insect lived upon plant food or upon other insects and small animals. There is no doubt about its being herbivorous, for it has been proven again and again that it feeds upon various grains. Chittenden says he has proven through experiments that it is also predaceous.

Some years ago several specimens of the adult beetles and larvæ were sent to this department by a correspondent in Ohio. They were infesting wheat in a granary and had injured the grain badly. Curiously enough, when the larvæ became nearly full-grown they burrowed into the pine boards forming the bins and changed to pupæ within the burrows. We show in Fig. 69 a section of the side of a bin showing the burrows made by the larvæ.

Slingerland made observations on the life history and habits of the beetles for a period of nearly a year in which he kept them in the insectary. He placed the beetles in tumblers containing wheat. Here the beetles freely laid their eggs, which hatched and the larvæ came to maturity, using the wheat grains as food. We have also found them in oatmeal and kept them under observation for a long interval in this cereal.

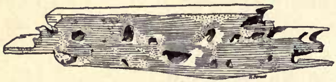

Fig. 69. — Section of bin showing holes in the wood made by the larva of the Cadelle.

The egg is a small, white object, much longer than wide and slightly curved. It would take nearly 20 of them, placed end to end, to reach one inch (1.3 mm. long and .3 mm. wide). Eggs laid about August 5th hatched August 15th, thus indicating an incubation period of about ten days. The newly hatched larvæ are very small and resemble the full-grown ones in color and general appearance. The larvæ that hatched from the eggs in August grew slowly and lived in the warm insectary among the wheat grains until the following April and May. In the latter part of April one larva was found in a burrow in a pine stick that had been placed in the tumbler. Later it pupated in its burrow. About the middle of May another larva was found in its burrow in a pine stick. A month later this larva had changed to a pupa and on July 10th one of these pupæ had changed to an adult beetle, while the other had dried up and died. Thus it evidently takes about one year for the insect to pass through its life cycle.

The beetles, themselves, are apparently long-lived insects, for Slingerland kept one of them alive and active for nearly a year in the tumbler. Another observer kept one alive for twenty-one months.

The larvæ of the Cadelle have been found in all sorts of unexpected places and among various kinds of food-stuffs. An instance is given in *Insect Life* in which a correspondent sent in a larva which had been found in a bottle of milk. Very likely, in this instance, the insect had crawled into the empty bottle from near-by grain and had remained there unnoticed when the bottle was filled. A far more interesting occurrence of the beetles is that related by Webster, in which he found two beetles that had tunneled through a cork and burrowed into a quantity of white hellebore. The beetles when found were dead, but they had channeled the material in all directions, showing that they had lived in the powder some time. The material, however, was old and had lost much of its strength, although later, when sifted upon gooseberry bushes, was found strong enough to kill the imported currant-worms. The larvæ of the Cadelle have also been found in one or two instances in sugar. Their presence there was probably accidental. The beetles and the larvæ were found by Johnson boring through the parchment paper of jars containing jams and jellies imported from Liverpool, England. After the insects had tunneled through the paper they fed upon the surface of the preserves.

Miss Ormerod found the larvæ feeding upon the larvæ of the rust-red flour-beetles. The injury done to cereals by the Cadelle is somewhat counterbalanced by its predaceous habits.

Methods of control. — The Cadelle can be controlled by taking the same measures recommended for the meal-worms.

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See also Reports of Ill. State Ents., IV, V, VI, XVI.

THE SAW-TOOTHED GRAIN-BEETLE

Silvanus surinamensis

Among the insects which are injurious to stored grains there is a small, narrow, chocolate-brown or reddish beetle. It is scarcely one-tenth of an inch long, but makes up in numbers for its small size (Fig. 70). It is one of the most abundant beetles in all kinds of stored grains, especially in the Southern states. Moreover, in the Southern states it undoubtedly causes more loss in many instances, than any other of the stored grain insects. This insect is commonly known among the farmers as the "grain-weevil" or the "saw-tooth weevil."

The beetle, itself, is a minute, flattened, reddish-brown beetle about one-tenth of an inch long. The thorax is the distinguishing feature of this insect. It is long and narrow and bears on each lateral margin a number, usually 6, of conspicuous tooth-like projections. It is this characteristic that gives the beetle the name of "saw-tooth weevil." There are three strong ridges on top of the thorax with two wide sunken areas, one each side of the central ridge. The wing covers are longitudinally ridged with the areas between finely punctate. The head is also densely covered with punctures.

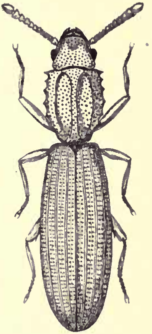

Fig. 70. — The saw-toothed grain-beetle. (× 20.)

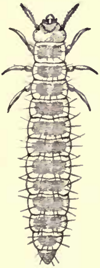

Fig. 71. — Larva of saw-toothed grain-beetle, enlarged.

The larva (Fig. 71) is somewhat flattened and has a transverse rectangular chitinized area on the dorsal side of each body segment. On the thoracic and anterior abdominal segments these rectangular areas may be divided in two by a whitish line through the middle. The larva, when living in granular material, like meal, usually builds a thin case out of the particles and the whitish pupa may be found within. When the insect is living in substances like fine flour it does not build a case.

The life history of this pest is not well known. It would seem that there may be several generations during a season, probably six or seven in warmer latitudes. During the summer months the life cycle occupies about twenty-four days, while in spring and fall during cooler temperatures a much longer time is required. The species apparently winters over in the adult condition.

The saw-toothed grain-beetle is fond of meal, flour, and grain of all kinds. It is nearly always present in granaries and has been reported in starch, tobacco, and dried meats, although Chittenden says, "it is doubtful if the insect will breed in such substances." It is often present in dried fruits. Our records show that the beetles get into macaroni, cornstarch, ginger, and mustard, and that they attack dried peaches. They are often brought into the house in the materials purchased at the store. Moreover, the beetles have the habit of gnawing holes through paper bags, thus finding their way into stores of cereals supposedly well protected from invasion by insects. Taschenberg, in discussing this beetle under the name of *Silvanus frumentarius*, mentions an instance where the adults invaded dwelling rooms adjacent to a brewery in which grains were stored. The invading beetles developed the curious habit of creeping into the beds and nipping the sleepers.

Evidently this grain beetle is widely distributed over this country and over the world. Taschenberg says that through commerce this species has spread over the whole earth.

Methods of control. — The insect is amenable to the same methods of control described for the control of the flour-beetles, meal moth, and others of similar habits. As in the case of the other species, so with the saw-tooth grain-beetle, the attempts at eradication must be thorough and persistent.

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THE ANGOUMOIS GRAIN MOTH

Sitotroga cerealella

The Angoumois grain moth (Fig. 72) is a European insect first reported as destructive at Luçon, France, in the province of La Vendée in 1736. Shortly afterwards it was found destroying grain in the adjacent province of Angoumois, from which it received the name that has always clung to it. Early in the history of the American colonies it was introduced somehow into

Fig. 72. — The Angoumois grain moth. (× 3.)

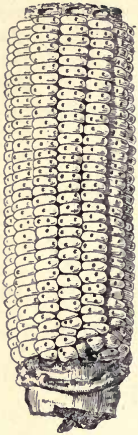

FIG. 73. — Ear of popcorn infested with larvæ of the Angoumois grain moth.

North Carolina and Virginia. From thence it has spread over the Southern states and as far north as Massachusetts, New York, and Michigan. It is more destructive in the South than elsewhere because of the warmer climate, and it is primarily a pest of stored grains rather than of household products, although it is often found in popcorn (Fig. 73), rice, and other cereals.

Life history and habits. — It is exceedingly destructive to stored grains, especially in the South. It has been known to reduce the weight of grain 50 per cent in a few months. It increases very rapidly and because of the secluded habits of the larva is difficult to control in any way except by heat and fumigation.

The moth is light grayish-brown or straw-colored with its wings lightly mottled and lined with black, especially near the tips. The wings are long and narrow and the hind pair is fringed with long, delicate hairs along the posterior margins. The moths resemble clothes moths in general appearance and habits of flying, but they are somewhat larger, for their wings expand a little more than one-half an inch.

FIG. 74. — Egg of Angoumois grain moth, enlarged.

The moths deposit their white eggs

(Fig. 74) on the kernels of corn or other grain. The eggs, which are elongated and regularly sculptured with

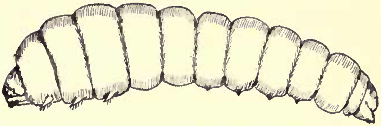

Fig. 75. — Larva of Angoumois grain moth, enlarged.

rectangular areas, soon turn to a pale reddish color. They hatch in five or six days and the tiny white larva (Fig. 75) burrows into the grain of corn, or wheat and lives on the substance in the interior. Like the grain-weevils, there may be two or more individuals in a grain of corn, but only one in a grain of wheat. In three weeks or more the larva becomes full-grown, gnaws a circular opening nearly through the skin of the kernel for the escape of the moth, and spins a cocoon about itself inside the grain, where it pupates (Fig. 76). The moth emerges a few days later.

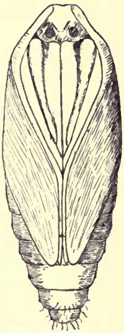

Fig. 76. — Pupa of the Angoumois grain moth, enlarged.

In the field there are at least four broods in a season in the Southern states, and in grain stored in a warm room the insects breed throughout the year. They pass the winter out-of-doors as larvæ in the kernels of grain.

The moth infests barley, corn, wheat, and other cereals. It is found in houses in popcorn, rice, and occasionally in other cereals.

Methods of control. — The same methods of control that were outlined for the grain-weevils will also hold the Angoumois grain moth in check.

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THE MEDITERRANEAN FLOUR MOTH

Ephestia kühniella

Some thirty-seven years ago this insect was discovered in a flour mill in Germany. Up to that time it had been comparatively unknown. In 1889 it appeared in destructive numbers in Canada and three years later was found in mills in California. In 1895 it was reported present in flour mills in New York and Pennsylvania and during subsequent years it has spread over a large part of the United States and has become one of the most serious pests found in flour mills and buildings where cereals are stored.

Naturally it has found its way into the kitchens, pantries, storerooms, and granaries of private households. The insect has been brought to these homes in sacks of flour, feed, and packages of cereals. Not long ago we received a complaint from a housekeeper in Ithaca, that a sack of bran in her storage bin was infested with many white "worms." A sample of the bran was obtained and the adults reared from the larvæ. They proved to be the Mediterranean flour moth.

Another instance of the same kind occurred in the house of an entomological colleague. In this case, the flour bin became badly infested with the larvæ and moths. They entered the cracks and crevices of the bin, webbing together the waste flour and dust. The whole bin had to be very carefully gone over with a stiff brush and the larvæ dislodged, swept up, and destroyed.

This moth will probably continue to increase as a household pest because it is now widely distributed among the larger flour mills of the country. It is bound to be brought into the homes of consumers in sacks of flour, feed, and cereals.

The eggs, which are very small (Plate IV), are often deposited on sacks containing flour and other products of the mill, in which situations they are easily transported long distances, especially into dwellings. The larvæ always conceal themselves by burrowing into the cereal infested and are thus easily overlooked and carried from place to place. It is not at all surprising in view of these habits that the insect has found its way into many pantries.

Appearance of the insect. — The larva of the Mediterranean flour moth is about one-half an inch in length and has a cylindrical, flesh-colored body with a pinkish cast. The body is sparsely clothed with long hairs and the head is reddish-brown in color. The larva has the three pairs of true legs on the thorax and four pairs of fleshy ones along the underside of the abdomen and a single pair at the hind end of the body.

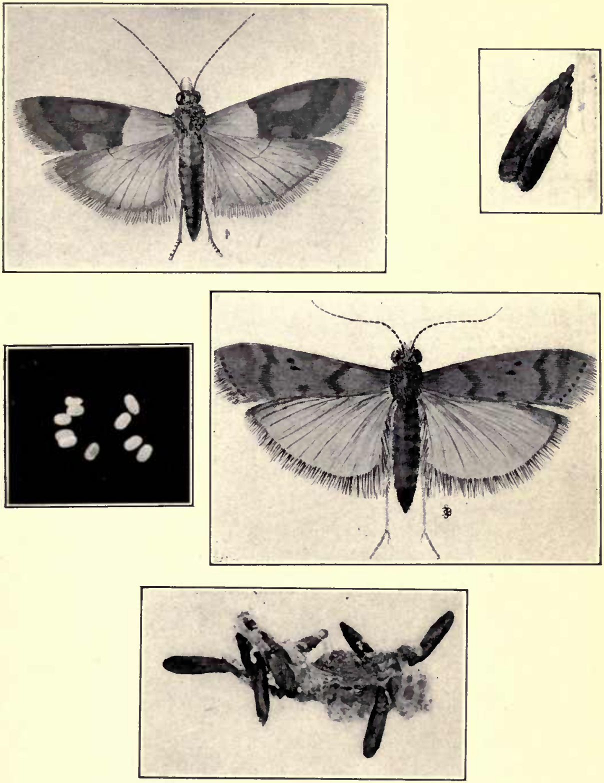
The adult is a dark-colored moth (Plate IV) varying from one-half an inch to three-quarters of an inch in length when at rest. When the wings are expanded they measure from three-fourths to an inch across. When at rest the wings are folded along each side of the body while the tip of the abdomen is often turned upward between the ends of the wings. The front wings are rather dark gray and crossed near the tips with dark, wavy lines and not far from the bases with a wavy, W-shaped line. The hind wings are silver gray. Both wings are heavily fringed with long hairs.

Habits, injuries, and food. — The larvæ have the very bad habit of spinning silken threads wherever they go. Moreover, they are constantly crawling here and there through the flour, bran, or other material upon which they are feeding. The result is that the material becomes webbed together with the silken threads. In mills, where the larvæ are present, the flour becomes webbed together in such masses that the spouts and machinery become clogged and unable to run.

When once the flour in a barrel or the bran in a sack becomes thoroughly infested with these larvæ the whole mass will be filled with their webs and so matted together that it becomes practically unfit for anything save to feed to stock. They are much more injurious in mills than in private dwellings.

It seems that these insects are more fond of rice flour and products than of anything else. Buckwheat flour is also very attractive to them. However, when driven

PLATE IV



Indian-meal moth above, enlarged; Mediterranean flour-moth (× 3) and eggs (× 5) in middle; pupæ of Mediterranean flour-moth, below.

to it they will eat almost anything. We have had a colony of them living on corn in the ear in the insectary for several years. The larvæ seem to thrive upon the corn and go on reproducing the whole year through.

Life history. — The egg is elongated, oval in shape, and when first laid almost white, but later it turns brown and becomes wrinkled. The egg is visible to the unaided eye, but so small that it takes forty to fifty of them, placed end to end, to reach an inch. In our cages the eggs were deposited on paper and cloth and on the sides of the glass tumblers in which the moths were confined. It takes the eggs from five to ten days to hatch after being deposited.

When the caterpillar first emerges from the egg it is only about one-twenty-fifth of an inch long. But it eats a great deal and grows rapidly, so that in midsummer it becomes full-grown in 25 to 40 days. In early spring and late fall, when the temperature is lower, it takes longer for the larva to mature. When the larva is full-grown, it spins a very fine thin cocoon of silk and within this changes to a pupa. The cocoon is usually fastened to some surface, and often particles of flour and meal are mixed with the silk. The pupa rests quietly for ten or fifteen days and then its skin splits open along the back and the moth crawls out, dries its wings, and perhaps flies to other parts of the house. The female moth is soon ready to deposit her eggs, which in our cages were laid mostly at night. Sometimes the eggs are laid singly and sometimes in chains of eight or ten. Johnson has shown that a single moth may lay as high as 271 eggs with an average of about 240.

Under natural conditions in the East there are probably four broods a season. In the South and in California there may be more. If infested material is stored in a warm pantry or kitchen, the insects will breed all through the year.

Methods of control. — In mills, where the work of extermination is done on a large scale, fumigation with hydrocyanic acid gas is often resorted to. In the case of a pantry this might also be done. First, however, all of the walls of the storage bin should be gone over with a stiff brush and just as many of the larvæ and pupæ dislodged, swept up, and burned as possible. Then the sacks of infested material should be separated so that the gas will have access to all sides of them. The same care to make the room as tight as possible should be exercised as was advised in the chapter on bedbugs.

It has been found that freezing will kill all forms of this insect, but the temperature must be zero or below and must continue for four or five days. It is also important to follow this freezing quickly with warm temperatures. It seems that the severe cold followed by high temperatures is more effective than prolonged, even, cold temperatures. Wherever conditions are such that this method can be used the insect may be exterminated.

Carbon bisulfide may be used if desired to spray the infested sacks and masses of flour or other cereal and to fumigate a storage bin or pantry. If used to fumigate, the room should be made tight, and two pounds of the liquid to each 1000 cubic feet of space should be used. The gas from carbon bisulfide is inflammable and no lights of any kind should be brought near the room which is being fumigated.

Probably the most economical way to follow in a private dwelling is to feed the infested flour, meal, or other cereal to stock and then to brush down all the larvæ and pupæ and burn them. Then spray the walls of the storage bins thoroughly with kerosene oil, being sure to force it into all the cracks and crevices of the walls and floors. This will kill eggs, larvæ, and pupæ. With care and persistence this moth can be exterminated from the house, but the pantry is liable to be reinfested with it at any time for, as we have said, it is present in most flour mills and there is little hope of its ever being exterminated.

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THE CONFUSED FLOUR-BEETLE

Tribolium confusum

Flour, meal, and prepared cereals of all kinds, are often infested with tiny reddish-brown beetles about one-eighth of an inch in length. In most cases one may be quite sure these are the confused flour beetles although in addition to their being confused with the rust-red flour-beetle one is liable to mistake the saw-toothed grain-beetles for them unless closely examined. The confused flour-beetle (Fig. 77) has a flattened, oval body with the head and thorax, on the top sides, densely covered with minute round punctures. The saw-toothed grain-beetle has a long, slender body, and the edges of the thorax are beset with tooth-like projections which distinguish it at once, when closely examined, from this flour-beetle.

FIG. 77. — The confused flour-beetle. (× 12.)

The confused flour-beetle occurs all over the United States, although it is an introduced species. Chittenden says that within two years from the time it was recognized in this country as a distinct species it was reported as injurious from almost every state and territory in the Union. We have received many complaints regarding this pest in various cereals. It was reported not long ago in oatmeal flour and has been breeding all winter in this material in our insectary. At this writing the flour is one mass of the tiny larvæ and adult beetles. They have evidently bred freely during the winter months in the warm room.

One of the large powdered food manufacturing companies sent us specimens of this beetle and the larvæ and said that they were found generally in their factories. The writer reported as follows on the habits of the insect; "They are found usually in cracks or under cover, seldom being seen in the open. The bugs eat wheat flour and unground wheat malt, while the worms eat the ground malt and our unfinished product. It seems that both are attracted by the sugar content of the material, as they are not found in a certain portion of it which does not contain sugar, with the exception of the wheat flour."

The larva of this flour-beetle resembles a miniature yellow meal-worm. Of course, it is very much smaller, being only about one-fourth of an inch in length. Its body is hard and of a shining brown color, except at the joining of the segments, where it is lighter in color. Where the larvæ are abundant they mat the flour together in hard masses and in these masses one will find the adults, larvæ, and pupæ.

The confused flour-beetle is a pest in mills as well as in houses. W. G. Johnson, in the different issues of the *American Miller*, gives considerable data regarding this beetle as a pest in mills. In the issue of this periodical for Jan. 1, 1896, he says that it was the most troublesome mill pest of the year 1895 and estimates that it had cost the millers of the United States over $100,000 in manufactured products during that one year.

The beetles and the larvæ are general feeders, for they are found in the cereals, in corn-meal, oatmeal, flour, and Chittenden says in ginger, cayenne pepper, baking powder, orris root, snuff, slippery elm flour, peanuts, peas, beans, and seeds of various kinds that are stored a long time. They are also pests in the museum, for they attack the bodies of insect specimens.

Chittenden cites an instance in which a whole consignment of baking powder was lost through an infestation by this insect. It seems that wheat flour had been used to adulterate the powder and probably it was this that attracted the insects. The boxes had all been wrapped tightly with paper so that they were practically air-tight. The beetles must have gained access to the powder in the factory before the boxes were closed.

The life history of this pest has not been completely worked out and it is not clearly understood. The small white eggs are laid in crevices of the receptacle or are attached to the sides of the bags or boxes or other convenient surface. It would appear, from our own observations, that they are laid among the cereal on which the beetle is working, especially on the hard lumps of which we have spoken. These hatch into the tiny white larvæ, which later become light brown in color. The larvæ probably attain their growth in about four weeks and then change to pupæ. Chittenden found that the insect passed through its whole life cycle in about thirty-six days. He estimated about six days as the period of incubation and about six days for the pupal period. There is evidently an opportunity for several generations during a season, and, as we have shown, they will breed in warm, evenly heated rooms all winter.

Methods of control. — Many times, when the beetles become abundant in a flour bin or in wooden compartments in which various cereals may be stored, they are hard to eradicate. In such cases, all of the flour and cereals will have to be removed and the receptacles thoroughly cleaned in some manner. The beetles may often hide in the cracks, and in that case boiling water will perhaps prove the best material with which to reach them. Whenever it is feasible to fumigate the bin or storage receptacles with carbon bisulfide this will prove effective if the flour containing the beetles is thrown away or fed out. They are so small and flour is so hard to penetrate with the gas that fumigation will not reach the insects when embedded in the food material. To make doubly sure, wooden barrels, buckets, or bins might well be given a good coating of white paint inside and out as a final touch to the efforts at eradication.

THE RUST-RED FLOUR-BEETLE

Tribolium ferrugineum

The rust-red flour-beetle is very similar to the confused flour-beetle and the two species have evidently been much confused. We have not found the rust-red species in New York, although it occurs in this latitude. It seems to be more generally confined to the Southern states, where it infests grain much as the confused flour-beetle. Its work and habits are similar to the species just discussed. J. B. Smith in his catalogue of the insects of New Jersey says that these two species occur in that state together and very often mixed with one another in the same food mass.

The two species may be distinguished by differences in the antennæ and in the margins of the heads.

The segments of the antennæ of the confused flour-beetle gradually enlarge from the base to the tip of the antenna, thus forming a gradually clavate organ. On the other hand, the last few segments of the antennæ of the rust-red beetle are much larger than the preceding ones, thus forming a suddenly clavate organ.

Again, the margins of the head of the confused flour-beetle are expanded and notched or angulated at the eyes, while the margins of the head of the rust-red beetle are nearly continuous at the eyes.

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THE INDIAN-MEAL MOTH

Plodia interpunctella

The writer first became acquainted with this insect, in a practical way, as a pest in packages of raisins in his own larder. As a matter of fact, it is a common household pest and the larvæ are found in all sorts of stored products. It probably finds its way commonly into houses by being brought in in supplies from grocery and feed stores. Not long ago the remains of a box of graham crackers were brought up from a grocery store for examination and determination of the kind of worms that were destroying this article of food. In a few days an adult moth appeared and proved to be the Indian-meal moth, as we had predicted from an examination of the larvæ.

Distribution and food. — The Indian-meal moth is widely distributed in the United States and Canada and is found in different countries in Europe.

As Holland says, this insect "has a propensity to feed upon almost anything edible that comes its way." In this country one of our earliest accounts of it was by Fitch, in 1856, who called it the Indian-meal moth because he found the larvæ feeding in corn-meal. The larvæ evidently are very fond of corn-meal, but they do not refuse grain of any kind, ground or whole. As we have already noted, we have found the larvæ feeding on oatmeal, graham crackers, and raisins. Our department records also show that the larvæ live upon and do much damage to stored peanuts. Popenoe records the same injury on a wide scale in Virginia and North and South Carolina. In addition, the insect has been recorded as feeding upon prunes, currants, dried apples, flour, beans, English walnuts, pecans, almonds, chocolate beans, dried peaches, plums, cherries, clover seed and other seeds.

Appearance of the different stages. — The moth is somewhat smaller than the Mediterranean flour moth and differs considerably in appearance when examined closely. The wings expand about five-eighths of an inch and the fore wings are dull white or cream-colored on their basal parts, while the outer parts of these wings are reddish-brown in color with irregular markings of blackish bands and patches. The hind wings are dusky gray with quite a long fringe of hairs (Plate IV).

The larva is whitish or flesh-colored and often with a rosy or yellowish tint (Fig. 78). The head of the larva is yellowish or reddish-brown and the thoracic shield is very pale brown with a distinct pale line through the middle dividing it in halves. The anal segment bears a pale brownish plate on the top side. Each larva has five pairs of prolegs along the abdomen, each of which is furnished with a circle of hooks at its extremity.

Life history and habits. — The eggs, which are small and white and look much like those of the Mediterranean flour moth, are deposited singly or in groups of half a dozen or more on the material upon which the insects happen to be living. It is said that a single female moth may lay as many as 350 eggs.

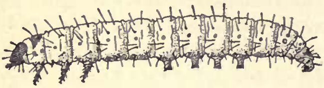

FIG. 78. — Larva of the Indian-meal moth, enlarged.

The eggs hatch in about four days if the room is warm and the larvæ in a warm room may mature in three weeks or possibly in less time. Some larvæ that we collected on September 19th, 1911, occupied over two months in reaching their full growth. Of course the temperature varied a great deal and probably averaged lower than in midsummer.

The larvæ are very active and can crawl backwards as well as forwards. While they are growing they crawl about a great deal and have the same pernicious habit of the Mediterranean flour moth of spinning a web wherever they go, which entangles the particles of food, binds them together in a webbed mass, and makes the material unfit for food.

When the larvæ become full-grown they crawl away in search of some fold in a bag, crack in a wall, or in the floor, or some other nook in which to ensconce themselves. Here they spin cylindrical white silken cocoons and change to pupæ. The pupæ lie quietly in their cocoons for a week or ten days, at the end of which time the moths emerge.

Under favorable conditions of an abundance of food and the right temperature the whole life cycle from egg to moth may be passed in four or five weeks. There is consequently time for four or even more generations in one year. In fact, in a warm room they may breed all the year through. In cold rooms, however, the larvæ remain quietly within their cocoons all winter, not changing to pupæ until warm weather of the following spring.

Natural enemies. — The Indian-meal moth seems to have a number of natural enemies. The two hymenopterous parasites, *Omorgus frumentarius*, and *Hadrobracon hebetor*, are considered the most important. Popenoe says that these two forms do a great deal toward holding the pest in check.

Methods of control. — The Indian-meal moth is so much like the Mediterranean flour moth in habits, injuries, and in the kind of food that it eats that the same methods used to control and exterminate the latter may be used for the former.

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THE MEAL SNOUT-MOTH

Pyralis farinalis

So far as the experience of the author goes, this insect is not as common a pest in households as the two which we have just discussed. However, it is often found in cereals, sometimes in flour, and meal, and often injures clover hay while stored in stack or barn. It is quite probable that its original sources of food consisted of dried grass or plant stems. It does not seem to be very fastidious regarding the kind of food it has, for it apparently relishes equally well straw, husks, bran, and seeds, whole or ground.

The moth. — The moth is much more striking and handsome in appearance than either the Indian-meal moth or the Mediterranean flour moth. Its wings expand about four-fifths of an inch, but they are wider than those of the two moths just mentioned, especially the hind ones. The front wings are rather conspicuously marked. They are light brown in color, but at the tip and base of each there is a chocolate-brown spot, each one edged with a curved white line that extends clear across the wing (Fig. 79).

The moth is usually found near the material infested by the larvæ, but very often it is seen clinging to the ceilings of rooms with the end of its abdomen curved over its back.

The larva and its habits. — The larva is somewhat similar in appearance to those of the other two cereal moths. It is whitish or flesh-colored, somewhat darker at either end, and its head is reddish.

It builds long tubes in the material on which it is feeding by binding the particles together with silk. In these tubes it lives and wholly conceals itself. When the larva has completed its growth it leaves the tube and finds a place in which to spin its cocoon, within which it transforms to a pupa.

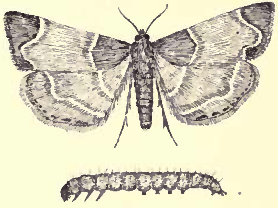

Fig. 79. — The meal snout-moth ($\times 2\frac{1}{3}$.) and larva.

It would seem that the life history of this insect has not been carefully worked out, and there remains considerable uncertainty regarding the length of time necessary for a generation or the number of generations in a year. Chittenden says that some experiments he was then conducting went to prove at least four generations a year. He had carried the species through all of its stages in the spring of the year in eight weeks.

Methods of control. — When this pest is found in stored grain it can be destroyed by the use of carbon bisulfide. The liquid should be poured in a shallow dish and set on top of the grain in the box or bin. The receptacle should then be covered tightly with old blankets and allowed to stand two or three days.

If flour, meal, or other cereals become badly infested and the larvæ build their tubes all through it, the material will probably have to be fed to stock or thrown away. In other cases the same methods of control will avail for this insect that were described as efficient for the control of the Mediterranean flour moth.

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THE GRANARY WEEVIL

Calandra granaria

Nearly every kind of small insect that is found in stored grains and cereals is commonly called a weevil. Really there are only two insects that frequent these food-stuffs that should properly be called weevils and these are the small snout beetles known as the granary weevil and the rice weevil.

Both of these beetles resemble each other very closely in size, shape, and general appearance. They are both widely distributed in this country, although the first one, *C. granaria*, is a more cosmopolitan species than the second.

The granary weevil is a very old offender, for it has been known as a grain weevil from the earliest times. It has been an inhabitant of houses, barns, and granaries so long that it has actually lost the use of its wings and is now strictly an indoor species. It is probably present in every state in the Union, for it has become widely distributed by being carried in the grains which it infests. It is undoubtedly more abundant in the warmer parts of the country, where it breeds the year round.

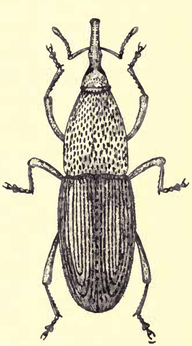

Fig. 80. — The granary weevil. (× 17.)

It is injurious to wheat, corn, barley, and other grains. We have found it in shredded wheat biscuits, even on Pullman dining cars, where one pays for the best quality of foods. It sometimes finds its way into households in pearl barley, which is used in soups.

The mature beetle is about one-eighth of an inch long and of a shining chestnut-brown color. It has a long slender snout, or proboscis, on the end of which is a pair of tiny but very efficient jaws. The thorax is marked with shallow oval punctures, while the wing covers are grooved and ridged lengthwise and are uniformly brown (Fig. 80).

The female weevil gnaws a tiny hole in a kernel of wheat or corn and then deposits an egg in it. The egg hatches and the small white grub lives inside the kernel, eating out the dry inner portions. In a kernel of corn there may be several individuals, but in a grain of wheat or barley there is room for but one. The larva is short, fleshy, and footless. When the larva becomes full-grown it changes to a white pupa with the proboscis, legs, wing pads, and antennæ plainly developed.

The whole life cycle may be passed under favorable conditions in about six weeks, but the period will vary with the temperature and time of year. In the fall and winter it is liable to be greatly prolonged. Under favorable conditions there may be three or four broods in New York in a season, but in the extreme South there may be six or more. If the infested grain is kept in a well-heated room, the weevils may breed all the season through. It is said that the granary weevil is very prolific, with the egg-laying extending over a long time and many eggs being deposited. It has been estimated that a single pair of weevils may, in a year, give rise to 6000 descendants. Thus a pair of these insects with their progeny may cause a good deal of damage in a comparatively short time.

The mature weevils have the habit of feeding on the grain, gnawing into the kernels for food and shelter, and since they are long-lived insects, they probably cause as much injury as the larvæ.

A curious, interesting, and perhaps important bit of knowledge concerning this insect is the fact that it has been used successfully as a substitute for the Spanish blister-beetle (*Cantharides*) with this added advantage, that it does not produce strangury. It was apparently used for this purpose in the South, perhaps during the war, when the Spanish beetles were not obtainable. So far as the author is aware, however, the granary weevils are not generally used for that purpose at present.

Cantharadin is a most dangerous and violent drug to take internally. It is quite possible that the finely ground bodies of the granary weevils, since they seem to possess much the same qualities as the Spanish flies, are also dangerous when taken into the alimentary canal. In that case, flour containing the pulverized bodies of these insects might prove seriously injurious to persons eating it. Undoubtedly flour is often made from wheat that is badly infested with these weevils.

THE RICE WEEVIL

Calandra oryzæ

The rice weevil seems to have originated in India, whence it has spread to all parts of the world. Because it was first found in rice it has always been known as the rice weevil. It is undoubtedly the more important and more injurious weevil of the two in this country, although it may not be as widely distributed as the first one. It occurs especially in warm countries and for that reason is very abundant and injurious in our Southern states.

Fig. 81. — The rice weevil. (× 7.)

The rice weevil is very similar in appearance to the granary weevil. It is just about the same size, with a similar proboscis, but varies in being dull brown in color in contrast to the shining brown of the granary weevil. Perhaps the most obvious difference by which the two weevils may be readily separated is the fact that the wing covers of the rice weevil have four red spots, one on each outer corner, as shown in the illustration (Fig. 81). The thorax of the rice weevil is closely pitted with round punctures in contrast to the oval, shallow punctures present on the thorax of the granary weevil. Moreover, the wings of the rice weevil are well developed and the insect can fly very readily.

The rice weevil is more apt to be found in households than the granary weevil, for it feeds upon the grains of rice and often invades boxes of crackers, cakes, and other breadstuffs, and is found in barrels of flour and sacks of meal.

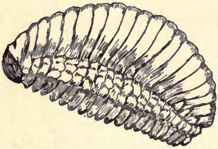

Fig. 82. — Larva of the rice weevil. (× 10.)

The eggs are laid within a kernel of corn or grain of wheat, where they hatch in about three days. The larva is short, fat, and whitish (Fig. 82) and lives within the grain for about sixteen days, when it transforms to a pupa (Fig. 83) which remains quietly within the grain from three to nine days. The adult beetle does not emerge from the grain as soon as it is formed, but remains within the kernel eating out the inside for several days. The life cycle is usually passed, under favorable conditions, in about thirty-five days. The adults are found in the fields during the summer, especially on the ears of corn. In the autumn they migrate to the barns and granaries where their food is stored.

Methods of controlling the grain weevils. — The most effective method of dealing with the grain weevils is by the use of carbon bisulfide. It has been shown, by recent experiments, that this liquid should be used at the rate of 2 or 3 pounds to every 1000 cubic feet of space.

One of the best methods of keeping seed corn, seed peas, beans, popcorn, and other seeds, is to store them in tight dry goods boxes. The boxes should be filled within 3 or 4 inches of the top. When infested with the weevils, the required amount of the carbon bisulfide may be poured into a shallow tin basin or pan and set on top of the grain. The top of the box should then be covered with two or three heavy blankets to keep in the fumes. The liquid will readily evaporate and the heavy gas will settle down through the grain killing everything in it.

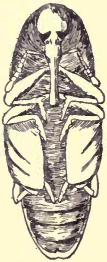

FIG. 83. — Pupa of the rice weevil. (× 10.)

The precaution should be taken of not going near the boxes with a lighted lantern or fire of any kind until after the blankets have been removed and the gas has dissipated itself in the surrounding atmosphere.

Of course, where a cereal or box of crackers is found to have become infested by the weevils it may be necessary to throw them away entirely. An infested pantry or storeroom should be carefully cleaned and all the remnants of material that may be attractive to the weevils thrown away. If a storeroom is so situated that a continuous heat of 130 degrees can be maintained for several hours, the weevils in all of their stages may be killed.

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FRUIT-FLIES

Drosophila sps.

Fifty-nine species of the genus *Drosophila* have been listed as occurring in North America. Over thirty of these have been recorded from the United States. Some of these species, as *D. funebris*, *D. graminum*, and *D. transversa*, are also common to Europe. *D. ampelophila* is also recorded from South Europe and North Africa. The flies of the genus *Drosophila*, for the most part, breed in decaying and fermenting fruit. The slender white maggots are found in pomace, about cider mills, and they are abundant about vinegar factories, often working into the barrels around the openings. The flies are always abundant in the fall about grapes, bananas, pears, and other fruits, especially if the fruit has begun to decay. If the fruit is left standing in the pantry or on the sideboard, it is almost sure to become infested with these tiny flies, and no amount of ordinary screening will keep them out because they go through the meshes of common wire screens. They are also abundant in decaying fruit in apple orchards and their larvæ are sometimes mistaken for those of the apple maggot, *Rhagoletis pomonella.*

It should be said that not all of the species of the genus *Drosophila* live in fruit. Some of the species mine in the leaves of plants, especially cabbages and radishes. These species have been separated from the genus by some authorities and placed in the genus *Scaptomyza.* Most authors, however, recognize this only as a subgenus.

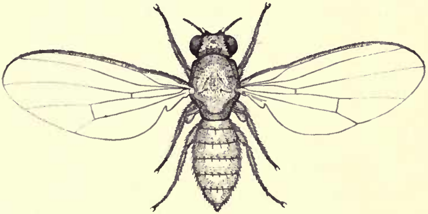

FIG. 84. — A fruit-fly (*D. ampelophila*). (× 10.)

Probably the most common species of fruit-flies in this country are *D. ampelophila* (Fig. 84) and *D. amœna.* These are about one-eighth of an inch in length, but their wings are rather large proportionately. Their bodies are reddish-brown in color and clothed with rather stiff hairs.

The tiny, white, elongated egg is deposited by the female in the soft pulp of the decaying fruit. During the month of October Comstock found the duration of the egg stage to be from three to five days.

The larva is a slender white maggot about $\frac{1}{5}$ of an inch in length. It takes from three to five days for it to mature. When full-grown it changes to a brownish pupa (Fig. 85) within or about the apple. It does not go into the ground like the larva of the apple maggot. The pupal stage lasts three to five days also, and the adult fly is ready to deposit eggs within two or three days. Thus a single generation of these fruit-flies may be produced in eleven days.

FIG. 85. — Pupa of a fruit-fly, enlarged.

The larvæ of the fruit-flies are sometimes injurious to grapes on the vines. W. L. Devereau of Clyde, New York, found that these maggots completely ate out the insides of grapes first injured by being pecked by birds while still hanging on the vines. Moreover, the maggots actually bore from one grape to another. Forbes relates the same habit of the larvæ at Moline, Illinois. He says they attack most frequently the grapes that have been injured by birds or rot, and after once having begun on a cluster they bore from one grape to another, while the adults are constantly depositing more eggs, thus finally destroying all of the berries in a cluster.

The maggots not only attack decaying fruit, but they are often found in canned and pickled fruits. Bowles says that he found the maggots in an earthen jar that had been nearly filled with raspberries and vinegar prepared for the purpose of making raspberry vinegar. On opening the jar ten days afterward it was found swarming with the larvæ and pupæ of the fruit-fly. Hundreds of the maggots were crawling about on the under side of the cover and on the sides of the jar. He further states that he has seen the flies hovering about the corks of wine jars, evidently trying to find an opportunity to deposit their eggs on the contents. In fact, he placed a few raspberries in a small quantity of vinegar in a jar with a loose cover. A fortnight afterward he found a number of larvæ inside the jar and several pupæ attached to its sides. Evidently these pests search for cracks and crevices through which to enter and find their way to their food. Probably the flies often deposit their eggs around the edges of covers to jars, and the maggots, when they hatch, manage to work their way through small openings into the fruit.

Lintner relates an instance of a species of *Drosophila* breeding in flour paste. A correspondent wrote him, saying: "I send a package containing larvæ of a fly very troublesome around my cellar and pantry. These I found in a little paste that I had set aside for a short time. I could not obtain the flies, but presume that they will be produced from the larvæ. They are very partial to anything in a state of fermentation, and if my pickled fruit or jam begins to sour, they find it before I do, and frequently the entire top of the fruit seems alive with the larvæ, although they never go deep into the jar." The flies emerged, but Lintner judged them to be a new species and not the *D. ampelophila,* which was probably the species referred to by the correspondent as infesting his pickled fruit.

Cockerell found the *Drosophila* flies prevalent in the Salt River Valley of Arizona in orange orchards and he concludes that it may be responsible for spreading the black rot of the navel orange. He argues that since the flies breed in the rotting oranges they no doubt become dusted with the spores of the fungus and carry them to the open ends of sound oranges, where infection might take place.

Methods of control. — It has been our experience that ordinary wire screen, say 12 or 14 meshes to the inch, does not prevent these flies from entering a house. Possibly wire screen with 16 meshes to the inch might keep them out. We doubt the practicability of effectually screening these flies from houses on account of their small size.

It is evident from their habits of entering crevices and cracks of fruit jars that, in order to exclude them, the jars must be hermetically sealed, or practically so. All fruit that is canned while hot and then hermetically sealed with rubber bands or otherwise will be safe from the attacks of these flies. Pickled fruits in stone jars with loose tops are subject to attack by these flies.

Jars of fruit that are opened now and then and left loosely covered must be placed inside of some tight receptacle for protection where these fruit flies are present. In case the maggots have gained access to a jar of fruit it is not necessary to throw away the whole jar since the larvæ occur only among the top layers. The infested portions may be thrown away when the remainder will be found free from the maggots and usually in perfectly good condition. Fruit, if left standing in the pantry, kitchen, or on the sideboard, must be kept free from all decayed specimens or must be tightly covered from the flies. It is not so much the destructiveness of the flies that we desire to avoid in these cases as it is the annoying presence of them in our pantries and dining rooms. They are always suggestive of overripe and decaying fruit.

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OCCASIONAL PESTS OF THE PANTRY

There are two weevils that occur in peas and beans that are liable to be found in the household among these edibles. One of them is often found in numbers in stored beans, for it breeds among the beans and badly injures them.

The pea weevil, *Bruchus pisorum*, is about one-fifth of an inch in length and the wing covers are marked with white and black spots. It is an old enemy to peas and does considerable injury farther South. The adult beetle deposits its eggs singly on the surface of the young pods in the field. The egg hatches and the young larva bores through the pod and enters one of the green peas. Many times every pea in a pod is infested. In these cases we certainly often eat one or more of the larvæ in the green peas, for each one remains practically invisible within the pea.

The bean weevil, *Bruchus obtectus* (Fig. 86), is somewhat smaller than the pea weevil and is not so conspicuously marked, although the wing covers are mottled with light and dark spots.

The bean weevil, besides laying its eggs in beans in the field and developing there, also breeds in beans after they are harvested and stored. In stored beans they cause an immense amount of damage, often destroying them for either food or seed purposes. It also breeds in dried peas, causing similar injury.

Stored beans may be protected from this weevil by the use of carbon bisulfide or heat, as already described in the case of the grain weevils.

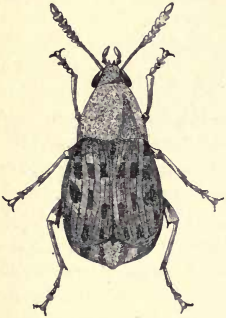

FIG. 86. — Bean weevil. (× 8.)

The broad-horned flour-beetle (*Echocerus cornutus*) is occasionally found in houses. In Europe it is reported as a pest in bakeries. It seems to get into the flour and into the dough that accumulates on the molds used in baking bread.

The species does not seem to be widely distributed in the United States, although it is fairly common on the Pacific Coast. In California it occurs both indoors and outside under bark. It is, therefore, firmly established and acclimatized in that region. It has been reported from the Pacific Coast in all stages of development in ground cereals of the stores.

The beetle itself, especially the female, resembles closely the confused and the rust-red flour-beetles. The male, however, possesses broad mandibular horns, that distinguishes it at once from the two flour-beetles mentioned. The habits and food of the broad-horned flour-beetles are similar to those of the confused flour-beetle. The beetles can be controlled in the same way as explained for the other flour-beetles.

The coffee bean-weevil (*Aræcerus fasciculatus*) is another insect that may probably be looked for as a household pest. It has a world-wide distribution, having been carried all over the world through the activities of commerce. It infests the raw berries of coffee, cacao beans, mace, and other tropical vegetable products. In this country, it has been found attacking cornstalks in the field, and breeding in cotton bolls, in the fruit of the chinaberry tree, in the pods of the coffee weed, and in the seeds of the wild indigo plant. Chittenden records an interesting outbreak of this weevil in a grocery store in Washington, D.C. The weevils had apparently been introduced into the store in bags of coffee. They had afterwards attacked dried apples, fig cakes, and other edibles in the store. It would be easy for them to be introduced into households purchasing supplies from the infested grocery.

There are several other insects that may occasionally be found in stored vegetable products and which may find their way, at times, into the household. It is quite likely that some of these occasional pests may become serious in some cases; and it is easily possible that some of them may become more or less habitual household pests. Insects are constantly changing their food habits and we may expect new pests at almost any time. Chittenden, in Bulletin 96, Part I, of the United States Bureau of Entomology, gives a list of 76 different species of insects that are found in stored cereals, any one of which is probably capable of becoming a household pest at any time.

CHAPTER XI

INSECTS INJURIOUS TO MEATS, CHEESE, AND CONDIMENTS

SMOKED and dry-cured meats of nearly all kinds are subject to injury from the larvæ of certain beetles, while cheese is often attacked by myriads of mites and the larvæ of certain flies. Condiments, like ginger, pepper, and other spices, together with various drugs stored in the pantry, are also seriously damaged by the larvæ of a few small beetles. Fortunately, most of these pests are not frequent visitors of the household.

THE LARDER BEETLE

Dermestes lardarius

Ham, bacon, and other kinds of meats that happen to be stored in the larder are sometimes attacked by small, brown, hairy larvæ, about one-half inch long when full-grown, that often cause considerable injury and become the source of a good deal of worry to the housekeeper. The larva may be recognized by its hairy body, and its meat-eating habits together with the fact that it bears two short, curved, stiff spines on the top of the last abdominal segment. These larvæ not only attack food products, but they feed upon horn, hoofs, skins, beeswax, feathers, and hair, and, moreover, become pests upon specimens in natural history museums, often seriously injuring valuable collections. The adult is a small beetle from one-fourth to one-third of an inch long, dark brown in color, and with a rounded back and front (Fig. 87). It has a pale yellowish-brown band across the anterior half of its wing covers. There are, on this band, six black dots, three on each side of the middle line. The first name of the beetle, *Dermestes*, is derived from *Derma*, skin, and is indicative of its habits, while its specific name, *lardarius*, shows its taste for the pantry or larder. Moreover, this beetle belongs to the same family to which the carpet beetles belong and, as we have seen, the larvæ have some of the same habits as the carpet beetles, namely, eating museum specimens, skins, and feathers.

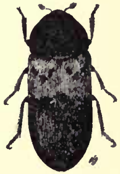

FIG. 87. — Larder beetle. (× 4.)

The larder beetle is widely distributed in this country and in Europe and Asia. Some years ago, a closely allied species, *D. vulpinus*, swarmed to such an extent in large skin warehouses in London and caused so much damage that a prize of £20,000 was offered for a practical and effectual remedy. Evidently the habits of the whole family of Dermestid beetles are much alike.

The adult beetles (Fig. 87) are often found out-doors, hiding away in nooks and crevices during the winter. We have found them hiding in crevices of the bark on trees. They enter the house in May and June and seek for food upon which to lay their eggs. If none can be found, they deposit their eggs in cracks and crevices about the pantry where the larvæ, when they hatch, can find food. The larvæ do not burrow into the hams they attack, at least not at first, but tend to confine themselves to the outside. Later, after casting their hairy skins several times, they burrow farther into the meat, where they change to pupæ. Moreover, they seem to prefer the fatty portions more than the lean muscular parts. It has been observed that the larvæ (Fig. 88) tend to infest hams that are beginning to spoil rather than fresh ones.

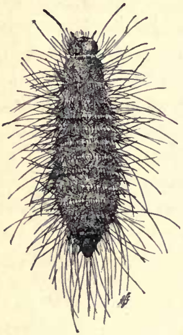

Fig. 88. — Larva of the larder beetle. (× 3.)

From the meager and fragmentary accounts of the life history of this insect that we have it may be inferred that the larder beetle may reproduce itself, under favorable conditions, quite fast and that there may be several generations during a season. Miss Heustis tells us that she placed four beetles, three males and one female, in a glass jar with a piece of meat on which she had found them feeding. She saw the female deposit eggs on the meat, but had to leave before they hatched. She was gone five weeks and on her return found a large and flourishing colony of larvæ, most of them full-grown. Horn found that the pupal stage lasted three or four days to a week or more, depending upon the temperature. Thus it is evident that a generation may be produced in the neighborhood of 45 to 50 days, and there may be four or five generations in a season.

Lintner quotes the following letter from a correspondent, which gives a good idea of the injuries caused by this insect: —

"Inclosed you will find several bugs and larvæ which I found destroying our bacon. Will you please tell me what they are, and if there is any way of preventing their ravages? Our meat was mostly put in heavy meat sacks; some was in muslin lined with paper, and a few pieces were without either. The meat was encased in sacks about the first of March and hung up in the garret. The sides were free from them although without sacks. If there is a remedy please let us have it."

Probably, in this instance, the eggs were laid on the meat before it was incased or the beetles found access to the bacon through openings or cracks in the wrapping.

Methods of control. — In the first place, the adult beetles are easily seen and they may be caught by hand. This is one way of dealing with them, and, in cases where they are not too abundant, it may be the most satisfactory and eventually the most effective. Cheese is very attractive to the beetles and by exposing pieces of it here and there they will congregate on them and may be caught and killed by hand in considerable numbers. If this method is followed up carefully for several days, it may often prove effectual.

If the beetles are abundant and there are many hiding places, the room in which they are present should be entirely cleared of food products and anything else that may interfere with the work of cleaning. The storeroom should then be thoroughly cleaned and finally sprayed with benzine or fumigated with carbon bisulfide or hydrocyanic acid gas.

Cheese ground up and poisoned with arsenic and then placed in the haunts of the beetles will often kill many of them. In putting away hams, and shoulders they should be bagged just as early as possible after being cured and should be wrapped with great care. The wrapping cannot be made too tight, for the least opening or crack will allow the entrance of the beetle to deposit its eggs.

If a ham or similar article of food should become infested with the grubs, the part containing them should be cut away and destroyed by burning or otherwise, and the remaining part of the meat treated with a dilute solution of carbolic acid.

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THE RED-LEGGED HAM BEETLE

Necrobia rufipes – Cleridae

This is a small steel-blue beetle (Fig. 89) scarcely more than one-fifth of an inch in length. Different individuals vary considerably in size and many of them are less than one-fifth of an inch in length. The legs of this beetle are reddish colored, hence its name red-legged ham beetle. Most of the beetles belonging to the family of this ham beetle live upon flowers or on living animal matter, but the ham beetle seems to prefer dead animal matter as food. The beetles are found about dead animal matter in fields or other situations.

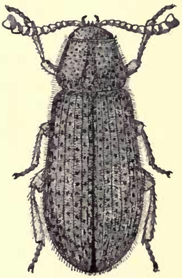

Fig. 89. — Red-legged ham beetle. (× 8.)

The larvæ of this beetle have been guilty and are still guilty of causing serious damage to stored hams, although they are not confined to this class of meat.

Life history. — The beetle normally feeds and spends its life history on dead animals in the field. However, in May or June the adults which emerge at this time probably often find their way into storerooms and pantries. Here the mother beetle deposits her tiny eggs upon ham if she can find this meat accessible. These small whitish eggs, twenty-five of which would not reach more than an inch, soon hatch into tiny white grubs, each with a brown head and two small hooks or tubercles at the tip of the body. The grubs burrow into the outside layers of fat just beneath the rind and grow rather rapidly, for they are ravenous eaters. As they multiply and grow they seem to have a great fondness for the hollow in the bone at the butt end of the ham, for they congregate here in numbers. When full-grown the grubs are darker in color, slightly over half an inch long, and have a number of brown patches on the upper sides of their bodies (Fig. 90).

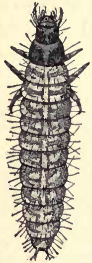

Fig. 90. — Larva of the red-legged ham beetle, enlarged.

When the larva gets ready to transform it makes a curious and interesting cocoon in a rather novel way. The larva leaves the fatty portions and gnaws its way either to the harder, more fibrous parts of the ham or maybe into a near-by beam. Here it makes a glistening white cocoon that looks much like paper. The cocoon is not made from silk like the cocoons of most insects, but is composed of small globules spit out of the mouth of the larva. These globules adhere to each other and when dry form the paper-like cocoon. Dealers in hams and other meats have given this insect the name of "paper worm" from the appearance of the cocoon. Riley says that there are probably several broods a year, but that it always passes the winter as a larva.

Distribution and injuries. — This ham beetle is widely distributed over this country and is also found in Europe, Australia, Africa, and the East Indies. Nearly all of the specimens in our University collection came from the Western states, for it seems to be more abundant in the western and southern portions of the United States.

Unlike many of the household pests, the ham beetle is not present and injurious the greater part of every season, but it appears occasionally in a ham or two and when destroyed may not be seen again for years. Its most serious injuries are caused to stored meats in warehouses. It occasionally becomes established unawares in large storehouses and the infested hams are shipped to retail dealers, who in turn deliver them to private households. Since these hams are tightly wrapped, the dealers may be wholly unconscious of the infestation.

C. V. Riley gives some interesting accounts of the work of this insect on hams in storehouses. He cites the case of S. S. Pierce & Co., of Boston, who ordered twenty tierces of hams from S. Davis, Jr., & Co., of Cincinnati during April and May, 1873. The hams were received and hung without examination in a dry, airy loft, where they remained until the following August. They were then examined and found full of worms. It seems probable, in view of the fact that the hams had been kept closely wrapped, that they were infested with the eggs of the beetle before leaving the packing house in Cincinnati. However, as this could not be definitely proven, Pierce & Co. were not able to collect damages from the packers.

He also cites the case of Francis Whittaker & Sons, St. Louis, who suffered severe loss through the injuries committed by this insect. The principal injury to the hams was done in this case around the end of the prominent shank bone. Here the canvas had become weak and worn through, giving the beetles access to the meat. Moreover, it seems that the Company had been in the habit of wrapping their hams a little too late in the spring.

Methods of control. — In the household this insect is not a serious pest. Moreover, the injury is not so great as it, at first sight, may seem. If a ham should become infested, the outer meat containing the worms could be cut off and thrown away. The inner meat usually remains sweet and unaffected and is perfectly good to use.

When a ham comes from the dealer infested, it can, of course, be returned at once.

In the case of packers and wholesale dealers the hams should be wrapped early in the season, before the first of May, with a strong canvas that will not break through or wear away. Great pains should be taken to close up all cracks in the wrapping so that no places will be left through which the beetles may gain access to the meat.

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THE CHEESE AND HAM MITES

Tyroglyphus longior, T. farinæ, T. americanus, et al.

Cheese, hams, and various other food products are often infested with enormous numbers of minute, pale-colored, eight-legged creatures, known as mites. These creatures are not true insects, for they have eight long legs (Fig. 91) and differ in other ways from their six-legged cousins. Near relatives of these mites are the common ticks that occur on dogs and cattle. These mites have a long list of food substances which they attack as opportunity affords. They often occur in sugar, especially raw sugar, in great numbers and are therefore sometimes called sugar mites. It is these tiny mites (Fig. 94), abundant at times in grocery stores, that cause the disease known as "grocer's itch." The malady is induced by the presence of the mites on the hands of those working among mite-infested food products. The materials attacked by these pests include flour, hams, dried meats, sugar, cheese, hair in furniture and mattresses, grains, cereal foods, drugs, dried fruits, seeds, bulbs, roots, and feathers. One species, at least, is a serious pest of mushrooms. We have seen mites exceedingly abundant in the manure about to be placed in spawn beds. Whether these mushroom mites originate in the manure used in the beds or not we dare not say. At any rate, manure is often infested with them and some mushroom growers have attempted to fumigate the manure with hydrocyanic acid gas before using it.

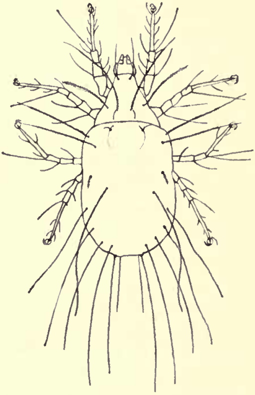

FIG. 91. — A common cheese mite (*T. longior*). (× 60.)

The life history and transformations of these mites are most remarkable and interesting. All of them lay eggs, which they scatter irregularly over the material upon which they are feeding. The young mites that hatch from the eggs have only six legs, but after molting they obtain two more. The young mites may gradually grow, by shedding their skins, into the adult forms, or they may pass through a curious stage, known as the *hypopus* (Fig. 92). The *hypopus* is very different in every way from the young mite from which it developed. The body of the *hypopus* is hard and chitinous and its legs are very short and inefficient for walking. The body on the ventral side near the tip is, however, provided with several sucking disks that serve a very useful purpose when the opportunity is presented. There is no mouth opening and there are no distinct mouthparts. Evidently the creature does not take food in this stage. In fact, the *hypopus* is a remarkable body and wonderfully adapted to a peculiar situation. The hard covering of the *hypopus* protects it from injury and from the influence of fluctuating temperatures, humidity and other influences. In this stage the mites can exist for long periods without food. When favorable conditions return, the *hypopus* will molt, when, behold ! it has changed to a young mite again which feeds normally and develops to an adult in the regular way. Just what influences induce a young mite to transform into a *hypopus* is not known. It is evidently not

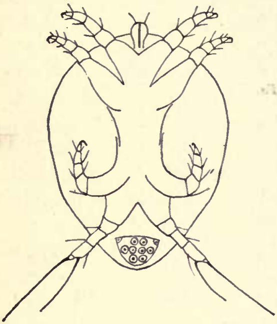

Fig. 92. — Hypopus of cheese mite, much enlarged.

a scarcity of food, for it has been shown that *hypopi* are developed when food is present.

It was formerly a source of wonder as to what became of the hordes of mites when they had completely devoured all of a given cheese, for example; or how an apparently clean storeroom became infested with these tiny creatures. We now know that some of the partly grown mites, either before or at the time the food disappears, transform to *hypopi* and remain in a half comatose condition awaiting events. As Howard says, "these fortunate survivors, possessing their souls with patience, retire into their shells and fast and wait, and as everything comes to him who waits, some lucky day a mouse or house-fly or some other insect comes that way, and the little mite clings to it and is carried away to some spot — where another cheese or food in some other form is at hand." It is under these circumstances that the sucking disks to which we have already referred perform their useful function, namely, that of fastening the *hypopus* to its agent of transportation, the mouse or the insect. This is undoubtedly the manner in which new food supplies and clean storerooms often become infested.

These mites are certainly widely distributed over this country and indeed over the world. Considerable confusion seems to exist, however, as to the identity of our species with the European forms. It seems certain that the common cheese mite (*Tyroglyphus longior*) and the flour mite (*Tyroglyphus* (*Aleurobius*) *farinæ*) (Fig. 93) both of which are European forms, occur here.

These mites increase with great rapidity and in a short time occur in enormous numbers. Flour, for example, may become literally *alive* with these tiny creatures. A correspondent writes to Lintner: "A few days since a neighbor sent us a pan of wheat flour with the request that we examine it. Setting the pan in a quiet place for twenty-four hours, the surface presented a strange appearance — only comparable to that of an ant hill — as though each grain was being separately moved. Slightly disturbing this surface and examining through a common sun-glass of low power it was found to be full of very minute life." Sugars, especially raw sugars, are often found infested to the same extent. Smoked meats, especially hams and shoulders, sometimes swarm with mites to such an extent as to resist all efforts at control and to render them totally unfit for sale. Packing houses and feed mills are occasionally very much troubled with them.

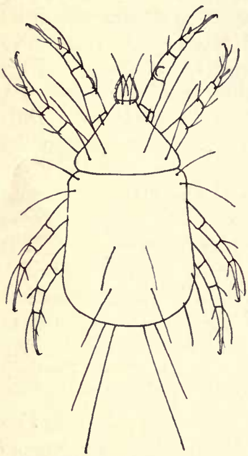

FIG. 93. — A cheese mite (*T. farinæ*). (× 80.)

It is interesting to know that these mites are sometimes checked and practically destroyed by some enemies of their own kind, one or more species of predaceous mites. The predaceous species seem to feed entirely upon their more troublesome brethren and eventually reduce the latter very greatly in numbers. Howard relates an interesting example of the work of these predaceous mites that came under his observation. A gentleman of Milwaukee sent him some thousands of the flour mites which were found in a bin of wheat in an old elevator. They were so numerous that a quart or more could be gathered every morning below the spout from which they had fallen. An examination showed that at least three species of predaceous mites were present among the flour mites, and were rapidly devouring the latter. In fact, one species was so abundant that there was no hesitation in writing the gentleman that the flour mites would soon be destroyed by the predaceous forms. A week or so later the correspondent wrote, "As you say, the parasitic mites have largely destroyed the smaller ones, and I suppose when their food is all gone they will die of starvation."

Methods of control. — When once these mites become established in a pantry or storeroom, heroic measures must be taken to exterminate them. The removal of all food-stuffs for a considerable length of time may not avail much when it is recalled that in the *hypopus* stage the mites can withstand a fast of months and that even the soft, pale, active mites may live for weeks without food. Neither is it any wonder that pantries and storerooms become infested, considering the ease with which the *hypopi* are carried about by mice and insects.

Infested parts of cheese and hams may be cut out and thrown away. It is often difficult, however, to get all of the mites, for they are so small and so easily escape the sight. Of course, where a few are left they soon reinfest the material. In the case of infested hams, all of the loose powdery material that accumulates on the surface of the meat should be brushed and scraped off as thoroughly as possible. To kill the eggs and any remaining mites that may have escaped the brushing the meat may be dipped for half a minute in a solution of one part of carbolic acid, ten parts of alcohol, and ninety parts of water. This solution should kill the eggs and mites and not injure the meat.

A storeroom or pantry once infested should be thoroughly cleaned and then may be fumigated with sulfur at the rate of 2 pounds to 1000 cubic feet or with hydrocyanic acid gas at the rate of 1 ounce to 100 cubic feet. If the room is not fumigated, it may be thoroughly sprayed or washed with kerosene oil. The oil should be forced into all of the cracks and crevices where the mites may be in hiding. Probably gasoline would be as effective in killing the mites and would be more pleasant to use than kerosene but more dangerous because of fire.

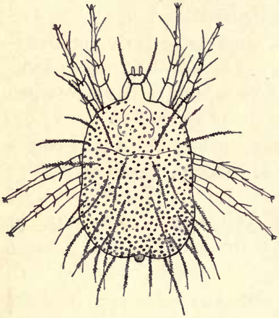

FIG. 94. — Sugar mite (*G. robustus*). (× 50.)

Remarks on the species. — Banks, from the material that he had at hand from the United States, found two species of the genus *Glyciphagus*. In this genus, the cuticle is more or less granular and the hairs of body plumose or scale-like. The name of the genus indicates that these mites are the true sugar mites and cause the disease of which we have spoken as "grocer's itch." We figure one species *G. robustus* after Banks (Fig. 94).

The species *Tyroglyphus farinæ* is the old *Aleurobius farinæ.* According to Banks it is not certain that *T. siro* occurs in this country. He believes that many of the references in literature to *T. siro* and *T. longior* refer to a new species *T. americanus* Banks, which he finds abundant in the collections of the Department of Agriculture at Washington, D.C., and recorded as occurring on rotten plums, in flaxseed, wheat, rice, cotton seed, and decaying oranges.

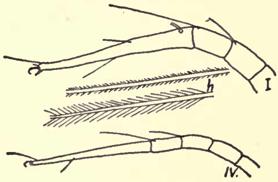

FIG. 95. — Tarsi *I*, *IV*, and hairs, *h*, from *T. longior*, enlarged.

The tarsi of *T. longior* are very long and the hairs of the body are plumose as shown in Fig. 95 after Banks.

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THE CHEESE AND MEAT SKIPPER

Piophila casei

It is rather disconcerting, not to say humiliating, for the lady of the house, at the last moment, to find the cheese ordered for a chafing-dish party, full of small, white, lively, and rather disgusting maggots. This is not an uncommon experience by any means. Grocers always

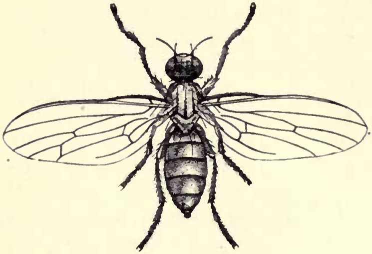

FIG. 96. — The parent fly of a cheese skipper. (× 9.)

keep their cheese beneath fine-meshed wire netting; but there are many opportunities for the small fly, parent of these skippers, to obtain entrance within and deposit her eggs.

The insect that lays these eggs is a small, shining-black fly scarcely one-half the size of a house-fly (Fig. 96). The eggs hatch into small white slender maggots that become about one-third of an inch in length. These maggots possess remarkable powers of leaping and on this account are called "skippers." They have no legs, yet by bringing the two ends of the body together and suddenly releasing them like a spring they are thrown considerable distances, four or five inches.

The cheese skipper was probably imported from Europe. It is now widely distributed over the United States. In fact, it is a cosmopolitan pest. C. V. Riley in 1880 showed that the same fly laid its eggs on cured meats, where they hatched and the "skippers" infested the meats. Thus it has also become known as the "meat skipper." In fact, it probably causes much more loss to the large meat packing establishments than it does to cheese making factories. Miss Murtfeldt quotes from a letter from a packing-house company regarding this insect as follows: "We wish to know what it is and especially at what period in its life it can best be fought. It entails an enormous loss upon all of our packing-house companies." The fly infests hams and shoulders, and other smoked parts of the carcass. Apparently, it is not much attracted to fresh meats or to those simply salted. Moreover, it seems attracted to pork more than to beef. Even when a ham of beef and of pork hang side by side, it prefers the pork. In cheese manufactories there is evidently less damage than formerly. The cheese storerooms are often darkened and the cheeses turned and rubbed every morning with grease. The skippers are notorious for their habit of infesting the better and richer cheeses. One can be sure that a "skippery" cheese is a good one but not good because of the presence of the skippers. It is not to be supposed that the skippers actually improve the cheese, although there is an old English custom of placing cheese under the drip of a beer keg to attract the insect and encourage its development.

Miss M. E. Murtfeldt made a series of observations on the life history of the cheese skipper in the summer of 1892. She found that the egg was pearly white, slightly curved, and one-twenty-fifth of an inch in length. The eggs may be deposited in more or less compact clusters of five to fifteen or they may be laid singly in folds of the wrapping cloth. The eggs hatch in thirty-six hours and the minute slender larvæ go at once in search of food. The larva, or "skipper," is cylindrical, tapers gradually toward the anterior end but is truncate at the posterior end (Fig. 97). Projecting from the posterior end are two horny stigmata and a pair of fleshy filaments.

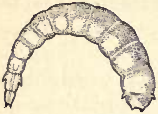

Fig. 97. — Cheese skipper, maggot of *P. casei.* (× 5.)

The maggots attain their full growth in seven to eight days, becoming about one-third of an inch long. While feeding, if there is an abundant supply of food, the larvæ do not move about much. When they become full-grown, however, each one crawls to a crack or crevice in the fold of the wrapper and there contracts and changes to a pupa (Fig. 98). The pupal stage occupies about ten days. Thus in August the life cycle would be passed in three weeks.

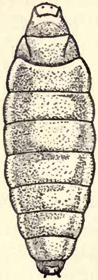

Fig. 98. — Pupa of cheese skipper, enlarged.

Kellogg also studied the life history of this insect during February and March of the same year. He found at this time of year that the egg stage occupied about four days and that the larvæ were about two weeks in completing their growth. The pupal stage occupied about one week. In this case then the life cycle occupied between three and four weeks. Probably the stages were prolonged by the lower temperature. The flies are certainly more active and more injurious during the hottest part of summer.

H. F. Kessler has also made careful observations on the life history of this insect in Europe. He found that the average time for the production of a generation of the flies was between four and five weeks and that there were two or three generations during the season. He found that the insect passed the winter as puparia and that the flies emerged the following spring in May. Other observers say that the adult flies hide in secluded nooks and live over the winter.

Methods of control. — Cheeses, when made at home, should be carefully examined every day, especially in the months of August and September. The checks and cracks should be kept filled with particles of cheese that have been crushed smooth in order to work into the crevices nicely. The bandages should be tight about the edges and should fit smoothly. By greasing the outsides of the cheeses and by turning them and examining them every day they can be kept free from skippers.

Infested portions of cheeses may be cut out and thrown away. When pieces of infested cheese are obtained from the grocer, they may be returned.

Hams are usually found to be infested only in certain portions and the remaining portions usually remain sweet and wholesome. Fortunately, the presence of the skippers does not induce decay and putrescence. The infested parts of the meat may then be cut out and thrown away while the remainder may be safely used for food.

Pantries or storerooms once infested should be thoroughly cleaned, fumigated with sulfur, and washed with ordinary kerosene oil. Special pains should be taken to clean out all the cracks and wash them with the oil because the puparia of the flies may often lurk in such places.

The flies may be kept out of rooms or receptacles by using wire screen having 24 meshes to the inch. If these pests are troublesome, the storeroom should be thoroughly screened so that the flies cannot gain entrance.

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See Lintner's Twelfth Report for further references.

THE CIGARETTE BEETLE

Lasioderma serricorne — ptinidae

The cigarette beetle is primarily a pest of tobacco in all forms. It attacks cigarettes and cigars by boring holes in them thus injuring them so that they will not draw. The insect is becoming abundant in many of the tobacco factories, warehouses, and stores in various parts of the

United States and is evidently on the increase. Probably many people would be inclined to look upon the cigarette beetle as a beneficial insect, provided it confined its injuries wholly to tobacco. Unfortunately, it is turning its attention to various household food-stuffs and is apparently gaining in importance as a household pest.

The adult beetle (Fig. 99) resembles the drug-store beetle in size and appearance and has very similar habits as a household pest. It infests a wide range of foods and condiments. It has been reported as infesting rice, figs, yeast cakes, cayenne pepper, ginger, rhubarb, and other similar materials. Two bottles of red pepper infested with either this insect or the drug-store beetle repose on the desk of the writer at this time, awaiting the appearance of the adult.

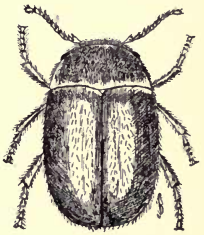

FIG. 99. — Cigarette beetle. (× 20.)

A more serious case of injury is reported in *Insect Life* in which the beetles and larvæ were found feeding upon silk with which certain furniture was upholstered.

The beetle is a little more than one-sixteenth of an inch in length. The head is bent under somewhat in front, yet it is more prominent than it is in the drug-store beetle. The wing covers are not striated and the segments of the antennæ are nearly of a uniform size. At least the last three are not enlarged like those of the drug-store beetle. The larva is rather thickly covered with long hairs (Fig. 100).

The insect multiplies rapidly and in the warmer climate of the South breeds most of the year, while in heated factories and rooms of the North it probably breeds continuously. There are evidently two generations a year, at least in the latitude of Washington. The eggs hatch in about eleven days and the larvæ may live two months or more before completing their growth. When full-grown the larva spins a silken cocoon covered with bits of the material on which it is feeding. The whole life cycle may be passed in forty-seven days under favorable conditions.

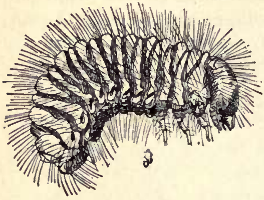

FIG. 100. — Larva of cigarette beetle. (× 20.)

It is interesting and of some satisfaction to know that the larvæ of the cigarette beetle are attacked by a tiny wasp-like parasite (*Catolaccus anthonomi* Ash). The parasite lays its eggs in the larvæ of the beetle, where they hatch, and the tiny grubs destroy their hosts. It is probable that this parasite would not exterminate the beetles, but it would undoubtedly hold them in check.

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THE DRUG-STORE BEETLE

Sitodrepa panicea

A box of yeast-foam cakes brought home from the grocer's was found to be swarming with small white larvæ or grubs. The larvæ had tunneled and mined through the cakes in various directions (Plate III). Wherever two of the cakes came in contact, the tunnels showed up nicely along their surfaces when they were pulled apart. The burrows of the larvæ were more or less filled with small white pellets of the undigested material that the grubs had deposited in them. The cakes were found infested on January 2d, and on March 3d an abundance of small reddish-brown beetles appeared. These proved to be the common drug-store beetle. Our experience was not at all an uncommon one. All sorts of substances bought at groceries and drug stores are apt to be infested with this insect.

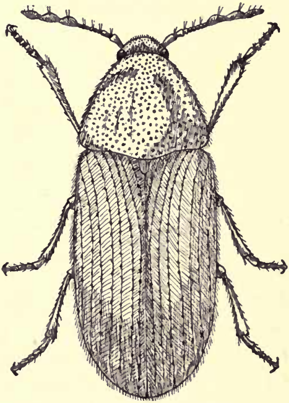

FIG. 101. — Drug-store beetle. (× 24.)

The adult beetle is very small, only a trifle over one-tenth of an inch in length, reddish-brown in color and covered with a fine silky pubescence (Fig. 101). The wing covers are plainly striated and the antennæ end in three large, long segments which form the so-called "club" of the antenna. When the beetle is at rest, the head is withdrawn into the peculiar hood-shaped thorax. The larvæ are white, cylindrical, and when working in their burrows assume a curved attitude like a miniature white grub of a May beetle. The mouth parts are dark colored and contrast plainly with the head. The pupæ which transform in the burrows made by the larvæ are white.

The yeast cakes referred to in the foregoing were kept in a steam-heated room. This was in March and the room often became quite cool at night so that the temperature was rather uneven. Under these conditions, the pupal stage lasted about two weeks (16 days). Very little, if any, attempt is made to form a cocoon. The larvæ seem to form more or less of a cell in their burrows and then transform without making a cocoon. The life history from egg to adult occupies about two months, and there may be four or five generations in a year in a heated building.

The larvæ (Fig. 102) of this beetle are almost omnivorous and they have been known to scientists as old offenders of many years' standing. The insect is widely distributed over the civilized world wherever commerce between countries has been carried on. It has been said of the larva that "it will eat anything except cast iron." It has been reported as boring through sheet lead and tin foil. It is particularly in evidence in drug stores, and apparently thrives upon all sorts of drugs, making no discrimination between those that are poisonous to human beings, at least, and those perfectly harmless. Indeed, in its drug menu, are such bitter and poisonous substances as aconite and belladonna. It also shows its liking for boneset, rhubarb, squill, orris root, dandelion, and ergot. In fact, Kellogg found this insect feeding on forty-five different drugs.

In addition to its depredations in drug stores it has occasionally caused serious injuries in wholesale boot and shoe houses by burrowing through the leather in all direc-

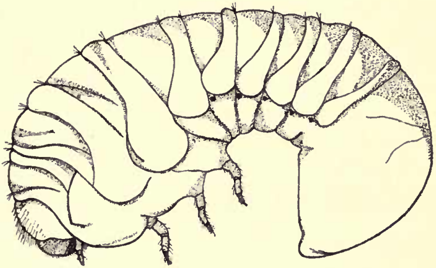

FIG. 102. — Larva of drug-store beetle. (× 20.)

tions, especially through the soles. The shoes attacked are left full of small round holes through which the adult beetles have emerged.

The beetles have occasionally shown their liking for books and the larvæ have, in some instances, caused considerable injury to books by boring through them. Comstock bred it in large numbers from the covers of an old copy of Dante's "Divine Comedy." They sometimes attack cork, especially sheet cork. As this kind of cork is often used to line insect boxes, the beetles are sometimes found among insect collections, and when the larvæ tire of the cork or desire a change of food, they have been known to attack the insect specimens in the box.

Among household materials, the larvæ are known to attack dried beans and peas and seeds of all kinds, together with flour, meal, breakfast foods, chocolate, black and red pepper, ginger, and other condiments. As we pointed out in case of the yeast cakes, the insects may be in the materials when they are purchased at the store. Very often one may find the contents of the packages of such foods totally worthless on account of the presence of so many larvæ throughout the whole mass.

Chittenden says that this small beetle has a most persistent enemy, a tiny chalcis fly (*Meraporus calandræ* How.). This parasite pursues the beetle relentlessly, even entering insect boxes in pursuit of its host. A small mite also preys upon the larvæ and pupæ of the drug-store beetle.

Methods of control. — When a small amount of material is brought from the store and is found to be badly infested, the simplest way of treating it is to return the package or destroy it, and buy new. Care should be exercised either to confine the beetles and return all of them with the package or be sure to destroy them all so that they do not escape into the house.

Where they occur in a sack or barrel of meal or flour, they will usually be found near the top. In this case, the top of the meal or flour may often be carefully removed and fed out to animals and all of the beetles and larvæ gotten rid of in this way. If the larvæ have found their way up and down the sides of the sack or barrel and have penetrated a pretty good portion of the material in this way, there is not much that can be done except to use it in feeding to animals. It would be best, however, to kill the larvæ and beetles by fumigating the cereal with carbon bisulfide, to make sure that none of them escape to infest other household materials. This may be done by setting a teacupful of the liquid on top of the flour in a tin dish and covering the barrel tightly. Allow it to stand two or three days in order that the gas may have time to penetrate into the flour as far as possible. In the meantime, do not go near the barrel with a light of any kind, for the gas of carbon bisulfide is inflammable and explosive.

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CHAPTER XII

SOME HUMAN PARASITES

THERE is probably neither bird nor beast that does not have as its foes certain minute forms of animal parasites. Sometimes these parasites are permanent and sometimes they are temporary. Some of them are external and some of them are internal. Man himself is no exception, for he is subject to the attacks of many internal parasites and is often greatly annoyed and seriously injured by the work of several external parasites.

We have already discussed, at some length, the temporary parasites, mosquitoes, fleas, bedbugs, and certain flies. There are, however, certain permanent parasites which attack man unless he is very careful in his personal habits and watchful of his contact with other less careful individuals. We refer to the itch mite, the head louse, body louse, and others. It is said that man is subject to the attacks of more than a score of external parasites.

THE ITCH MITE OF MAN

Sarcoptes scabiei, var. *hominis*

The itch mites are not true insects but are closely related to the ticks and belong to that large group of animals known as the Arachnida, the more familiar examples of which are the spiders. Like the spiders, the itch mites have four pairs of legs, but with this exception they resemble spiders very little. They are widely distributed over the earth wherever man has taken up his abode. They are very minute, increase exceedingly fast, and are most tenacious of life when once they have become established on the human skin. Unfortunately, not as much is known of the life history of these mites as is desirable — probably because no one cares to act as host for them as it would be necessary to do if one wished to study them thoroughly.

History of the itch disease. — This disease is very old, in fact, is probably as old as man himself. It seems quite probable that man contracted the disease, originally, from the lower animals with which he associated or came in intimate contact. The itch mite of the horse may be transmitted to man, but the infection is only temporary — three to eight weeks. On the other hand, the itch mite of the camel and goat, when transmitted to man, may cause severe and persistent cases of itch. The mite causing scabies on the hog and the dog may also thrive for a time on man. In view of the ease with which these itch mites from the lower animals thrive upon man, it is not too much to believe that primitive man originally contracted the disease from some animal with which he came in close contact. Indeed, it is held that the itch mites upon man and the lower animals are simply varieties of the same mites and not distinct species.

An Arabian physician, Avenzoar, in the twelfth century seems to have been the first man to point out the true cause of this malady. Other physicians in the fourteenth and seventeenth centuries pointed out the real cause of itch and in 1761 Linné very appropriately named the tiny animal responsible for the trouble *Acarus humanus subcutaneus*. Later, however, all of this knowledge concerning the cause of itch seems to have been overlooked and by many actually disputed and denied. During this period the disease was variously attributed to "thickened bile," "drying of the blood," "irritating salts," whatever that meant, and other fantastic causes. Now, however, we know the life history, appearance, and habits of the tiny mite responsible for the disease. In Figs. 103, 104 we show the male and female mites as they look under a microscope after they have been removed from the skin.

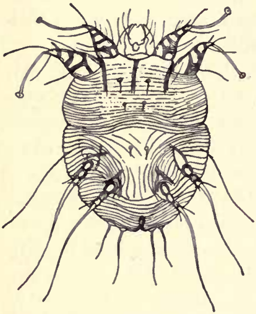

FIG. 103. — Itch mite, female. (× 85.)

Appearance of the mites. — The itch mites are very small — only just visible to the eye as minute white specks. It would take sixty or seventy of the females and eighty to one hundred of the males placed end to end to reach an inch. The body of each mite is oval and nearly circular when viewed from above. The body is whitish in color and when magnified is seen to be marked with many fine transverse folds of the skin. There are four pairs of legs situated in groups of two pairs, an anterior and a posterior group. The anterior legs are usually the larger and in both sexes each one terminates with a sucker borne on a long pedicel. Each leg of the posterior pairs in the female (Fig. 103) terminates in a long bristle, while in the male (Fig. 104) those of the third pair only terminate in bristles, and each one of the fourth pair ends in a sucker. On the anterior end of the body is a strong beak constituting the mouth parts which are formed for piercing and biting. The bodies of the itch mites bear slender bristles of various kinds and lengths.

It was formerly believed that there were as many kinds of itch mites as there were animals having the disease. Now, however, it is thought that there is only one species and that the itch mites on man, sheep, cattle, goats, and other animals are simply varieties of one and the same species.

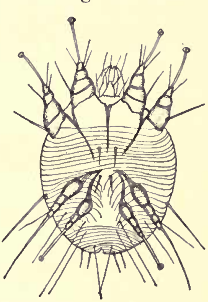
FIG. 104. — Itch mite, male. (× 125.)

Life history and habits of the mite. — The itch mite inhabits those parts of the body covered with thin skin, especially between the fingers, and in the bends of the elbows and knees, wrists, and a few other places. The mite excavates tunnels in the skin and lives within these burrows. The burrows usually extend through the outer skin down into the deeper layers of the true skin (Fig. 105). They are more or less tortuous and vary from one-fifth of an inch to over half an inch in length. The female mite may be found at the end of her burrow. Behind her in the tunnel will be found the tiny oval eggs which she deposited as she lengthened the burrow. She finally becomes exhausted, much shriveled, and eventually dies. Braun says, "The six-legged larvæ hatch out after four to eight days, and after about a fortnight, during which time they change their skins three times and undergo metamorphosis, they begin to burrow themselves." There may be generation after generation of the mites on the host, and they increase so fast that they soon number among the thousands. The irritation continues to increase with the increase in numbers.

Injury and contagiousness. — Wherever the mites are present they cause an intense irritation and the affected person scratches the parts incessantly. The irritation is much increased under the influence of heat and exercise, and always becomes especially intense when the patient goes to bed. The affected parts become covered more or less with grayish scales of skin and later papules and vesicles appear and the irritation increases. Often the galleries of the mites may be seen as tiny whitish or grayish streaks in the skin. The action of the parasite is both mechanical and chemical. The places on the body that are attacked by the parasite are so definite that one should have no difficulty in diagnosing the disease. If there is any doubt the mites can be found and examined.

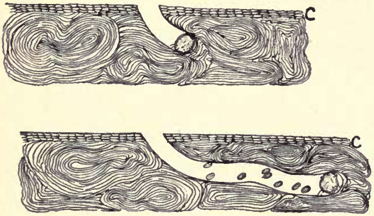

FIG. 105. — Burrows of the itch mite beneath the skin, diagrammatic.

Itch is highly contagious and is contracted through personal contact, especially through contact of the hands.

No one is exempt and it is especially liable to be contracted by school children, inmates of poor houses, jails, and by soldiers in camp life. During the Civil War there came into existence the army itch, which was the same old disease that had gained a firm foothold among the soldiers because they did not have facilities for bathing and for personal cleanliness and because they were in such intimate contact with one another. Before physicians knew so well how to treat the disease people were told that they had the seven years' itch and went on scratching for an indefinite length of time.

Methods of control. — The itch is easily eradicated if one is thorough and persistent. In order to succeed, the skin of the patient must be softened and the scurfy epidermis removed so that the preparation that is applied will reach the mites. A rigorous treatment consists in rubbing the patient all over with green soap and water and then putting the individual in a warm bath for half an hour. This process softens the skin and removes the outer crust of skin, thus exposing the mites to the action of any preparation that may be applied to the body. Ordinarily, common sulfur ointment is used to rub over the body and should be applied in liberal quantities. Sulfur ointment, however, will not kill the eggs and at least a second application should be made after an interval of two or three days. This is to give the eggs time to hatch. Some authorities also recommend that the underclothes, at least, should be immersed for some time in hot water.

It is always best, however, to apply to a physician for advice and then follow his directions. There is a large choice of remedies nowadays which are well known to physicians.

The Norway itch.—The so-called Norway itch is a curious form of itch disease first found in Norway but now known to occur in Austria, France, Denmark, Russia, Turkey, and the United States. It affects the palms of the hands, soles of the feet, knees and wrists especially, although in aggravated cases it may spread over the whole body.

At least one case has been found in this country and likely others will occur. Robert Hessler of Indianapolis gave a description of this case which occurred at the City Hospital. The body of the patient, who was a white man partly paralyzed, was covered with thick yellowish-white, leathery scales, the largest of which measured over an inch in diameter and over one-tenth of an inch in thickness. In and beneath these large scales there were multitudes of mites. The scales on the palms, soles, and knees, in extreme cases, may develop from a fourth of an inch to an inch in thickness. They may also form on the head, in which case the hair falls. Cases of this itch are of long standing, especially among slovenly people, where it has been known to run three to sixteen years.

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LICE PARASITIC ON MAN

Pediculus humanus et al.

There are three species of lice, the head louse, body louse, and crab louse, parasitic on the body of man. All of these species have been associated with man as long as we have any history of the human family. Some of the forms, at least, are referred to in the writings of Herodotus and Aristotle. Many of the oldest naturalists, Swammerdam, Linnæus, Redi, and others, have given lengthy dissertations on the head louse. The presence of these lice on the body of human beings did not seem to be a matter of so much consequence in the older days, for instance, in the days of the Stuarts, as it is nowadays. Cleanly people to-day would be very much horrified and disgusted to find one of these lice on their persons. In the olden times, however, these creatures were joked about and even tolerated on one's person. It is said that they were boasted of by some people.

In an old book entitled "Micrographia," published by R. Hooke of London in 1665, there is a description of the head louse which is introduced as follows: "This is a creature so officious that 'twill be known to every one at one time or other, so busie, and so impudent, that it will be intruding itself in every one's company, and so proud and aspiring withall that it fears not to trample on the best, and affects nothing so much as a crown; feeds and lives very high, and that makes it so saucy as to pull any one by the ears that comes its way, and will never be quiet till it has drawn blood."

These lice may pass directly from one person to another or they may be carried by flies. One is apt to become infested by sleeping in infested beds in hotels, sleeping-cars, and boarding houses.

These lice belong to the family of insects known as the *Pediculidae*, placed by some authors in the order *Hemiptera,* but by one author in the separate order *Siphunculata.* They are characterized, chiefly, by being entirely wingless, with not even a vestige of wings, by leading a parasitic life and by having sucking mouth parts. Among the older zoölogists there has been considerable dispute regarding the structure of the mouth parts, whether they were really sucking or biting. In fact, the structure of the sucking tube is not well understood yet. The mouth parts are exceedingly delicate, and always retracted within the head out of sight when not in use. For this reason they are very difficult to study. It is only when the louse is sucking up blood from its host that the rostrum or beak is extended and, of course, buried in the flesh of the animal attacked.

Schiödte, a Danish naturalist, has given us the most accurate description of the rostrum (*P. vestimenti*) and has given an account of his work in a very pleasing way. He obtained a supply of the lice and confined them in vials for several days without food to sharpen their appetites. At the end of the confinement he transferred one of them to the back of his hand where he could watch its movements with a hand lens. He describes the behavior of the louse as follows: "Scarcely does the abominable little monster feel the heat of the skin before it lays aside its former disheartened attitude, and begins to feel at ease, its antennæ oscillate for joy, and it stretches all six legs complacently out from the body. But though the pleasure and surprise at the sudden transportation into congenial surroundings for the first moment eclipse everything else, hunger soon asserts its claim, sharpened as it is by the long fast, which has rendered its stomach and intestines quite transparent. The animal raises itself on its legs, walks on a few steps, seeking and feeling its way with its antennæ, while we followed it with a magnifier. Presently it stops, draws in its legs a little, arches its back, bends the head down toward the skin at an oblique angle while it probes a small dark and narrow organ repeatedly forward, and draws it back through the fore end of the head; at last it stands still, with the point of the head firmly abutted against the skin." While in this position the rostrum was buried in the flesh, and the louse was pumping out the blood. Schiödte describes in detail the work of the louse in obtaining its supply of food. He made an attempt to dislodge the insect in such a way that its beak would still be extended. As soon, however, as the louse was dislodged from the flesh, it immediately withdrew the beak into the head so that it could not be seen. Finally, he quickly severed the head of the insect from its body, and succeeded in mounting it with the rostrum still extended. There was a long tube furnished with hooks near the base. Inside of the tube could be seen four slender thread-like projections. This structure evidently formed a very efficient pumping apparatus.

THE HEAD LOUSE

Pediculus humanus (capitis)

This species occurs chiefly among the hairs of the head although it is occasionally found on other parts of the body. It occurs, chiefly, on individuals of uncleanly habits and especially on children who may become infested from contact with their playmates at school or other places (Fig. 106).

The constant movements of the lice and the insertions of their beaks into the skin to suck blood set up an irritation which the victim tries to allay by scratching. Railliet says the irritation leads to the production of papules or even to vesicular pustules and that the excoriations due to the scratching with the exudations therefrom often form a crust that mats the hairs together. Such a condition exists only among very unclean people where the parasites are allowed to increase indefinitely.

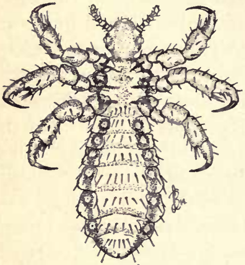

FIG. 106. — Head louse. (× 13.)

The sexes of this louse differ quite markedly from each other. The female is about one-twelfth of an inch in length and usually larger than the male, sometimes twice as large. They multiply rapidly, for the female is capable of laying (Railliet) at least fifty eggs in the space of six days and each egg will hatch in about six days, while the young lice may become adults in about eighteen days. Thus there may be, under the most favorable conditions, a complete generation within one month. At this rate the second generation would number 2500 individuals, while the third generation would furnish 125,000 of these obnoxious pests. Fortunately, such conditions probably never occur; probably the young lice do not ordinarily come to maturity in so short a period of time.

The eggs or "nits" are pear-shaped, whitish, and fastened by their smaller ends to the hairs, especially to those back of the ears, usually near the bases of the hairs. The eggs are glued to the hairs by a gelatinous substance that is secreted by the female louse when they are deposited.

The usual color of the head louse is light gray, but it varies according to the color of its host. For instance, according to Murray, it is nearly black on the West Africans, dark and smoky on the Hindoos, yellowish on the Chinese and Japanese, orange on the Hottentots, and dark brown on the South American Indians.

THE BODY LOUSE

Pediculus corporis (vestimenti)

This louse (Fig. 107) has been confused with the head louse, older authorities believing them to be the same species. More recent writers generally hold that they are distinct. The body louse is considerably larger than the head louse, with longer antennæ, and is of a dirty white color. As the common name indicates, this species frequents the body of man. They conceal themselves in the folds of the clothing where it is difficult to find them. Moreover, they lay their eggs along seams and wrinkles of the clothing and do not pass to the skin except to suck blood. Their existence and multiplication depend, therefore, upon the length of time their host retains the clothing without a change. In the case of soldiers on a long campaign, inmates of prisons, and other places where the individuals from necessity or neglect fail to wash and change their clothing at frequent intervals, this louse becomes very abundant and troublesome. Such was the case among the Russian soldiers in the Crimean War; and among our own soldiers in the Civil War, the body lice familiarly called "graybacks," because of the dark coloring on the back, became abundant and most annoying. In the campaigns of the Civil War the soldiers had little opportunity to change their clothing, and not much chance to wash it, other than in cold water, which does not kill these lice.

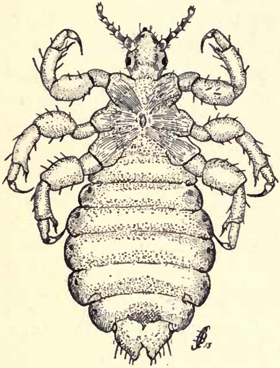

FIG. 107. — Body louse. (× 20.)

Leeuwenhoek, one of our very oldest zoölogists who worked about 200 years ago with great enthusiasm, made an attempt to find out something definite about the life history and rate of development of the body louse. He did not believe the popular saying that a louse could become a grandfather in twenty-four hours. At first he thought of hiring some person to act as a host for the lice. Later, he changed his mind, overcame his own natural aversion to these pests, and inclosed two large females within a fine black stocking, the top of which he fastened tightly around his leg above the knee. Here he allowed the two lice to live for six days and obtain their sustenance from his leg. At the end of this period he removed the stocking and found fifty eggs around one of the females and forty eggs in another part of the stocking, evidently laid by the second female which, however, had escaped. He wore the stocking for yet ten days, when on examination he found twenty-five young lice which so disgusted him and dampened his enthusiasm that he threw the whole thing into the street. Since Leeuwenhoek's time the author is not aware that any scientist has ever tried in the same way to study the life history of these lice.

Recently the body louse has come under suspicion as a carrier of typhus fever from one person to another. Typhus fever should not be confused with typhoid fever, for one is quite distinct from the other. Typhus is essentially a disease of temperate and cold climates and is therefore common in Europe and in some parts of America. It also occurs in the tropics but usually only at high altitudes and ceases at the advent of hot weather. It is usually associated with dirty and unsanitary surroundings and is especially prevalent among the inmates of prisons. It has been called a contagious disease but is now thought to be conveyed from one individual to another probably through the agency of insects.

Ricketts and Wilder have succeeded in transmitting the typhus fever of Mexico (tabardillo) to the monkey by the bite of the body louse in two experiments. The lice in one instance derived their infection from man and in another from monkey. We are not aware that the fever has been experimentally carried from man to man by the louse, or that it has been conclusively shown that such transmission actually occurs. The evidence obtained, however, points very strongly in that direction.

The disease may be carried by other blood-sucking insects.

THE CRAB LOUSE

Phthirius pubis (inguinalis)

The third louse infesting man is very distinct from the other two in general appearance. Its body is short and broad, in fact, nearly as wide as long. The legs are very stout, especially the two hind pairs, and are always spread out laterally, thus increasing the apparent width of the body. The body, as a whole, reminds one of a crab, hence its common name, "crab louse" (Fig. 108). This louse is whitish in color with a dusky patch on each shoulder and the legs are tinged with red.

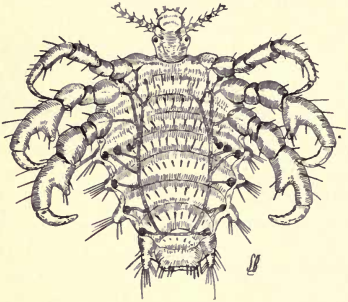

FIG. 108. — Crab louse. (× 20.)

It inhabits the pubic region particularly, but is found in the arm pits, and in the beard and occasionally among the hairs of the eyebrows, and has been reported on the head.

This louse is evidently more easily communicated from one individual to another than either of the other species.

Instances are not uncommon in which infestations of this insect have been contracted by using a public water-closet. The danger of unclean lodging houses and public bath tubs needs hardly be mentioned. Moreover, this species reproduces more rapidly than the others and sometimes causes serious affections, although older accounts of these have probably been greatly exaggerated. The eggs, which are pear-shaped, are attached to the hairs. They hatch in six or seven days and in fifteen days the young lice are ready for reproduction.

The presence of the lice causes a severe itching followed by reddish inflamed spots over the regions of the body infested. If allowed to go on undisturbed, more serious affections take place.

Stiles gives the following synonymy for these species of human lice: —

The head louse:	*P. humanus* Linnæus, 1758;
	P. capitis de Geer, 1778;
	P. cervicalis Latreille, 1803.
The body louse:	*P. corporis* de Geer, 1778;
	P. vestimenti Nitzsch, 1818;
	P. tabescentium Alt, 1824.
The crab louse:	*Pediculus pubis* Linnæus, 1758;
	P. inguinalis Reichard, 1759;
	Phthirius inguinalis (Reichard) Leach, 1815;
	Phthirius pubis (Linnæus, 1758) Küchenmeister, 1855.

Methods of controlling these lice. — First of all absolute cleanliness is a prime requisite in keeping free from these parasites. In case of the body louse, the clothes must be steamed or cleaned by immersing and soaking in gasoline. Two treatments of gasoline should kill the lice and eggs.

For the head louse, sulfur ointment and white precipitate are commonly used. If desired, the hair may be cut and the head subjected to an application of kerosene. This will kill the lice, but may not destroy all of the eggs. The kerosene should not be allowed to remain too long on the scalp.

A 2 per cent carbolic solution may be used and is said to be effective against the eggs ("nits"). Washing with a tincture of *Cocculus indicus* is advised by some writers, the principal recommendation being the absence of odor.

The crab louse will succumb to the persistent use of mercurial ointment.

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CHAPTER XIII

SOME ANNOYING PESTS OF MAN

THERE are some small insects and closely related animals, certain mites, that attack man and cause him much annoyance and sometimes serious discomfort. Some of these pests come no nearer the home than the lawns and fields adjacent to the house, while others come to the porches and often into the rooms where they exhibit wonderful persistence in biting and worrying the inmates. Chief among these are the redbugs, punkies, and black-flies.

HARVEST MITES, "REDBUGS," OR "CHIGGERS"
Trombidium sp.

During a residence of eleven years in the Southern states the writer has had ample opportunity to become acquainted in a very realistic way with redbugs or chiggers. It would, however, convey a wrong impression if we did not hasten to say that redbugs are not confined, by any means, to the southern part of the United States, but they occur as far north as Minnesota and east to the Atlantic as far up the coast as New Jersey. Harvest mites are also common in England and Scotland, where they are known as the harvest mite and "gooseberry bug." In France they are known as the "rouget" and "red flea" and are sometimes so abundant in grass-lands that they interfere seriously with the work of the peasants in gathering their hay and grain crops. The harvest mites occur also in Belgium, the Netherlands, and in parts of Germany, where a severe infection of the mites is called "stachelbeerkrankheit." Redbugs are abundant and troublesome in Mexico, where they are called "Tlalsahuate" and in the West Indies where they are often called "Bête rouge." In the United States they are also given the name "chiggers."

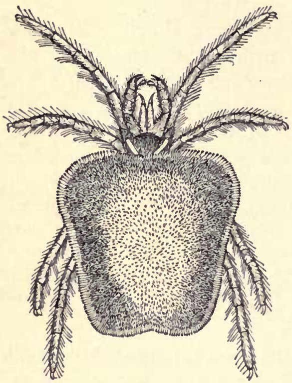

FIG. 109. — Adult of harvest mite (*T. holosericeum*). (× 20.)

What redbugs are. — Redbugs are the young or larval forms of different species of true mites that belong to the family *Trombidiidæ*. Probably all of the redbugs found in the United States belong to the one genus *Trombidium;* but there is yet much uncertainty regarding the actual species of which the redbugs are the immature forms. It is likely that more than one species is represented by the redbugs. The harvest mite has been variously referred to the species *Leptus autumnalis*, *Trombidium holosericeum* (Fig. 109), and to the genus *Tetranychus*, while the redbug commonest in this country has been called *Leptus irritans*. The adults of the harvest mites or redbugs are members of the class Arachnida, to which the spiders belong, and have four pairs of legs.

The bodies of redbugs are always red in color, although some are much darker than others. This color is not due to any food that they may have taken, for example, blood, as many suppose. Redbugs are very small, but still visible to the unaided eye. Their bodies, when they hatch from the eggs at least, are ovoid or nearly circular and more or less clothed with bristles. The mouth parts are formed for puncturing and sucking. Unlike their parents they have only three pairs of legs. Redbugs are parasitic, as a usual thing, upon insects. After the mite becomes attached to its host, its body becomes engorged and swollen with food. When full fed, the young mite loosens its hold and drops to the ground, where it seeks shelter in order to change to the next stage in its life history. When it finally becomes adult, it has four pairs of legs and in this stage does not trouble man, nor is it parasitic on any other animal. The adult harvest mite wanders around and feeds upon small insects, especially plant lice and caterpillars. One species has been found to destroy the eggs of grasshoppers, and another species in France has been found destroying the Phylloxera on the roots of grapevines.

The hosts of redbugs. — These small mites are called harvest mites because they are found in such great abundance toward the end of summer in fields of grass or grain, where they often attack the workers in the fields and cause much annoyance, even, in some instances, a cessation of work. In our own country they are found on grass and weeds in pastures and neglected places, on bushes, especially raspberry and blackberry bushes, on trees in hedgerows, and in damp locations along the banks of streams, edges of woodlands, and in other shaded situations. They usually avoid the sunlight and consequently are not often found on closely cropped lawns unless these are shaded by shrubs or trees.

Redbugs are often found attached to the bodies of insects, notably to grasshoppers and to house-flies underneath the wings. The author witnessed a rather unusual attack of redbugs on young chickens in Mississippi at one time. In this case they occurred in clusters and formed red nodules or tubercles on the flesh of the fowls. In one tubercle seventeen mites were counted and in another nineteen were seen all closely packed together like small red berries with their heads buried in the flesh like ticks. The mites affected their hosts seriously, for the chickens soon contracted diarrhea, grew weaker, and finally died.

In Europe, a closely related harvest mite, *Leptus autumnalis*, seems to prefer small mammals as hosts, such as moles, hares, dogs, and cats. It occasionally appears on cows and on cavalry horses, the latter of which have been seriously attacked during the autumn maneuvers of the army. In horses the mites cause an affection of the skin about the knees and hocks. If the harvest mites confined themselves to plants and the lower animals as hosts, we should have no cause of complaint against them here; but it is their habit of attacking man that gives us so much concern.

Their manner of attack on man and nature of the injury. — The redbugs (Fig. 110) are so small that when they have once gained access to the body of an individual they can easily pass through the meshes of the finest underclothing or stockings and reach the skin. Hamilton, in a rather humorous article, says that the mites wander around until they find the openings to the sweat tubes and then work their way down these tortuous canals until the blind ends are reached, when the mites die. Banks says that "they burrow beneath the skin and produce inflamed spots." Other observers say that the mites first injure the skin and then plunge their long piercing mouth parts into the wound. Sometimes this wound is located near the opening of a sweat pore and sometimes not. Evidently the mite does not enter these pores as a habitual practice. J. C. Bradley, who has observed redbugs rather carefully and who placed his notes at my disposal, says that they do not burrow underneath the skin but may enter the skin by a hair follicle or sweat pore, especially if disturbed. He concludes that the irritation is caused by some specific poison secreted by the mite rather than by any wounds that it makes.

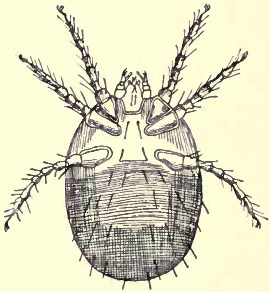

FIG. 110. — Young of harvest mite. (× 60.)

At any rate, the mites set up a severe irritation. On some persons this may take place within a short time, while on others it may not be felt until twelve to twenty-four hours after the infection of the mites. Red blotches, from the size of a nickel to that of a half-dollar, appear on the parts of the body affected. Along with the appearance of the blotches comes an intense itching sensation which, if allayed momentarily by scratching, returns with renewed intensity. Very often a slight fever accompanies the eruptions and the patient is liable to lose sleep and suffer almost unbearable torture.

Within twenty-four to thirty-six hours each red blotch is surmounted in the middle with a tiny water blister. This is succeeded by a small scab, and the irritation gradually subsides. The blisters and scabs may be taken as a pretty sure indication of redbug attack. The scab eventually falls off, but may leave a scar that does not disappear for weeks in some cases.

An affection by harvest mites is often diagnosed as "hives," nettlerash, bites of mosquitoes, or fleas. Young children and persons with delicate skin are most subject to attack. Laborers and other persons who are much in the fields where redbugs abound seem to become immune to their attacks. Perhaps the frequent inoculations finally work toward immunity. The mites attack those parts of the body first that are most exposed — nearest the ground. They work through the stockings and very often stop at the garters, if these are worn, and form a ring of red blotches around the legs at these places. If an abundance of the mites have gained access to the body, they will spread over the whole person, even to the neck and arms. Sometimes these affections result seriously. Hamilton says that erysipelas of the lower extremities often results from the bites of redbugs. It is said that death from blood poisoning has been known.

Life history of the mites. — Unfortunately, very little definite information is available regarding the life history of the harvest mites. Only a few forms have been reared and there is consequently much yet to learn regarding these creatures. Banks says that the mature forms hibernate over the winter in the soil or in other sheltered situations.

Blisters on leg caused by redbugs, enlarged.

Those that manage to survive until spring deposit their eggs, sometimes as many as 400, together in a bunch in or upon the ground. The eggs are usually brownish in color, very small, and spherical. By earlier workers they were considered minute forms of plants known as fungi. In time, the eggs hatch and the young larval mites are circular or ovoid in outline, very small, and with three pairs of legs, each ending in two or three prominent claws. The mites crawl to the stems of grasses and weeds and eventually gain access, if possible, to an insect. After feeding on the blood and juices of its host, the body of the mite becomes elongated and swollen. When full fed it loosens its hold and drops from its host to the ground, where it seeks some kind of shelter and gradually changes in shape but does not molt. "The new parts are formed under the larval skin, which in a few weeks cracks and discloses the adult Trombidium." As we have noted, the adults live upon aphids and small caterpillars. There appears to be but a single generation produced each year.

Methods of avoiding redbugs and remedies for the irritation. — One of the severest infestations the author ever knew was contracted by a person with delicate skin, subject to erysipelas, who sat down for a few minutes on the ground on the links of a golf club. The links had just been laid out in an old pasture which still contained much long grass and a good many plants of the horse bean, a legume quite common in Texas. The body of the individual was completely covered with the large inflamed spots, even to the neck, although none appeared on the face. The torture was intense for a week and the infection persisted for a much longer period. The thing that seemed to give the most relief was hot baths. No person subject to attack by redbugs should ever sit on the ground where there is the slightest chance of becoming infested. In fact, it is dangerous for such an individual even to walk among long grass, weeds, raspberry or blackberry bushes, or in other places where redbugs are liable to abound. If one does, ordinary flowers of sulfur should be sprinkled freely over the lower extremities and inside of the stockings. Bradley emphasizes this remedy very strongly, for he has had experience in using sulfur and in going without it in localities where redbugs abound.

If a hot bath, especially in water to which a liberal amount of salt or soap has been added, can be taken within an hour or two after infection, it will often give relief.

Redbugs seem to be most prevalent during the months of June, July, August, and the early part of September. In exceptionally warm seasons and far south they may be encountered both earlier and later than this.

To allay the irritation, a weak solution of ammonia applied to the affected areas is useful. Common baking soda dissolved in water until some remains in the bottom of the dish or until a supersaturated solution is obtained lessens the irritation and affords considerable relief. Alcohol, camphor, and Pond's Extract are used with good effect. Hamilton says that an effectual remedy, if taken in time, is a thorough sponging with a solution of carbolic acid, one ounce in a quart of water, after a good soap bath.

Lawns, closely cropped, will be free from redbugs, except in shaded areas near shrubbery. In such situations a piece of cloth may be saturated with kerosene and dragged over the grass. This may be followed by dusting flowers of sulfur in its wake with good results. Weeds, tall grasses, blackberry and raspberry bushes must be kept cut.

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WASPS

Vespa germanica and *Vespa maculata*

It often happens that the two species of wasps mentioned, namely, the common yellow-jacket and the bald-faced hornet, build their nests near a house and become unwelcome guests about the premises and in the rooms. The former, especially, are fond of the juice of broken or discarded fruit and of sweet liquids. They often swarm over fruit refuse and visit wells and other sources of water to obtain moisture. Usually they are the cause of more nervousness and fright than of actual injury, although they may occasionally sting horses and, what they consider, intruding humans.

Life history and habits of these wasps. — The yellow-jackets (Fig. 111) are small, somewhat slenderer than the

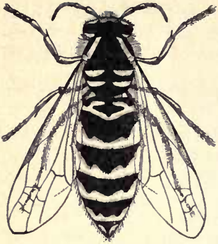

FIG. 111. — Yellow-jacket. (× 3.)

worker honey bee, and black with yellow stripes around the body. Each worker and queen is provided with a very efficient sting which they can use most effectively when they consider there is need for it. They are busy creatures and when treated with ordinary discretion will go peacefully about their business. The species of yellow-jacket under consideration is a European species and in its native home sometimes builds its nest in trees, but here in America it builds its nest in hollow logs and stumps, under boards, and occasionally underground. These underground nests are often very large, as big as a half-bushel basket, and communicate with the open air by a single (rarely two) small openings. The nest is enveloped with a covering of papery material and the number of inmates may reach the amazing total of fifteen to twenty thousand, the number varying with the season.

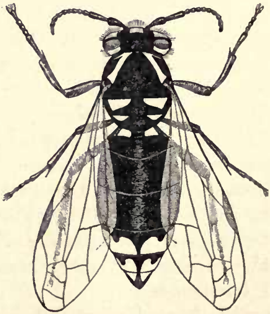

FIG. 112. — Bald-faced hornet. (× 2½.)

The bald-faced hornet (Fig. 112) is a much larger wasp, black marked with white, especially on the face, hence its common name. This wasp builds its nest among the branches of trees or attached to the projecting eaves of houses and barns. These nests are often very large and always more or less conical in shape with an opening at the bottom. They are always covered with a stout, thick gray papery material collected from old stumps, rails, and boards.

A community of wasps is very much unlike a colony of honey bees in that all of the wasps desert the nest in the fall and the males and workers all die, leaving only the queens who crawl away into protected nooks and crannies to pass the winter. In the spring, the queens come forth from their winter hiding places and start new homes. Each one begins by making a small nest in which she lays a few eggs. These hatch and produce only workers, which immediately relieve the queen of all her labors except that of laying eggs. The workers now begin to enlarge the nest, bring food, and look after the young. The activities and increase of the community go on during the summer season until fall, when the home is broken up, leaving only the queens to survive the winter season.

There are other wasps known as *Polistes*, that often build their nests in the attics of houses. These wasps are dark in color and have a spindle-shaped abdomen united with the thorax by a slender waist. They build a nest composed of a single comb suspended by a short stem from its support. The comb is not covered with an envelope of paper but is left perfectly bare. The *Polistes* wasps are not pugnacious and may be considered generally harmless, for they rarely sting.

Hornets as fly catchers. — The bald-faced hornet, especially, catches many house-flies as food for the young wasp larvæ. A correspondent of the *Rural New Yorker* writes: "Over the path leading to my stables, on the corner limb of a shade maple, hardly six feet from our heads, and within fifty feet of the house last summer was a large hornets' nest. The result was an absence of flies for days at a time. Over the doors of my horse stable was another large nest, with similar absence of flies. A neighbor, a physician, had four nests in his house grounds, and no flies. No one of his family, or mine, has ever been stung — hornets and children are the best of friends."

These observations are very interesting. The English entomologist, Westwood, writing in 1840, quotes from St. John's "Letters to an American Farmer" to the effect that "The Americans, aware of their (hornets') service in destroying flies, sometimes suspend a hornets' nest in their parlors." Again, in 1869, Benjamin D. Walsh, an American entomologist, writes that, "Some persons in America have turned this insect-devouring propensity of hornets to good purpose by suspending one of their nests in a house much infested by the common house-fly. In such a situation we have been told that they soon make a clearance of the obnoxious flies; and so long as you do not meddle with them, they will not meddle with you." The author has never had the good fortune to know any one personally who has used this unique method of destroying house-flies. Under ordinary circumstances we believe the good housewife had rather take her chances of happiness among the house-flies than with a good big nest of hornets as kitchen companions.

The young grubs in the nests of hornets are fed on the bodies of insects, cut and chewed into fine pieces by the workers of the colony. Whenever flies are available, they certainly furnish a considerable source of food supply, as any one can determine by watching a hornet catching the flies and carrying them to the nest. When one recalls that a large hornets' nest may contain several thousand cells and that each one of a large number of these may contain a hungry grub it would not be surprising to find the house-flies in close proximity to the nest kept well under control.

Methods of controlling wasps. — The colonies of yellow-jackets may be destroyed by pouring a goodly quantity of carbon bisulfide into the opening of the nest. This, of course, should be done after dusk and after all the inmates have entered for the night.

The entrance to the suspended nest of the hornets may be plugged after dark and the nest broken loose and burned or soaked with kerosene. It is said that these hornets may be destroyed by throwing kerosene on the nest when it will soak through and kill the inmates.

"PUNKIES"

Ceratopogon stellifer et al.

The local inhabitant, the summer visitor, the traveler, hunter, and camper in the forests of the northern United States are well acquainted with those tiny, almost invisible flies called "punkies." On account of their size the Indians of Maine have given them the very appropriate name of "no-see-um," while in certain parts of our country, notably in Texas, they are called sand flies. It is truly remarkable that such tiny creatures are capable of inflicting so much torment on human beings. There can be no doubt in the mind of any one who has felt the punctures of these tiny pests that their "bite" is out of all proportion to their size. As Lugger says, "it is difficult to understand how this small being can harbor the vast amount of 'cussedness' it is known to possess." When the writer first met with these flies in the Adirondacks it took him some time to find out what new disease had gotton hold of him. Finally, close observation of a burning spot on the hand disclosed one of these minute insects at work, and a pocket lens solved the mystery at once. Later we had opportunity to stow away several choice specimens in a vial of alcohol, which unfortunately got broken in transit so that we are awaiting another season to determine just what species is a frequenter of our camp.

Description and distribution of punkies. — A punkie is a minute fly belonging to the same great order of insects as the mosquito and the common house-fly. There are nearly one hundred species of these flies now represented in the U. S. National Museum but fortunately not all of them "bite." At least six species, however, are known to annoy man.

The legs of punkies are long in proportion to the size of the body and the mouth parts are formed for piercing and sucking. The wings of many forms are more or less clothed with hairs which often vary in color, thus imparting a spotted effect to these organs.

Punkies are apparently distributed all over the United States, for they have been collected from Maine to Florida and California. They are usually more abundant in the vicinity of streams or lakes or in the damp forests.

Habits of punkies. — Punkies will apparently attack any part of the body that is exposed, although in the case of the author, his hands have suffered most. Other observers have noted the inclination of the pests to attack more particularly the head in among the hair. Pratt, while among the mountains of Virginia, counted at one time twenty-five individuals among the hair on the head of his boy guide. It is astonishing how persistent the tiny rascals are in their attempts to obtain blood. They will bury their beaks in the flesh and suck the blood until

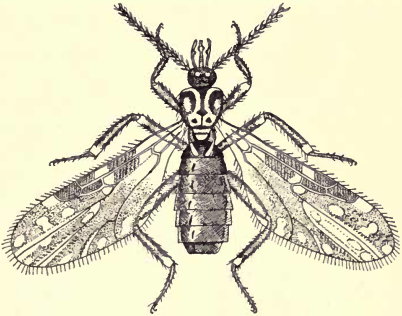

FIG. 113. — A punkie (*C. stellifer*), much enlarged.

their bodies are near to bursting. The effect of the bite varies on different persons. We have always found it to produce a burning, itching sensation very annoying and very uncomfortable. No serious consequences, however, have ever been experienced. Not so with others though, for in some cases pimple-like eruptions occur, looking much like the effect of posion ivy. A correspondent in Texas writes to the U. S. Bureau of Entomology concerning a punkie (Fig. 113) (*Ceratopogon stellifer*) that is abundant in his locality, especially in the vicinity of creeks choked with logs. He says when he first went to Texas that he was in the habit of pulling off his shoes and sitting down to read. Under these circumstances he was grievously tormented by the bites of the sand flies, especially around the ankles and wrists. His feet and hands would soon burn as though he had been wading through nettles.

Pratt says that the Virginia punkie is very troublesome to man and domestic animals. "If milking is put off later

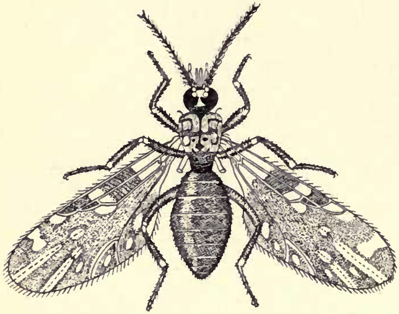

Fig. 114. — A punkie (*C. guttipennis*), much enlarged.

than usual in the morning, they drive the cows almost frantic by their persistence, and while that process is going on the operator, having both hands engaged, is at their mercy."

Life history. — Very little is known of the life histories of these flies. In fact, so far as we are able to find, almost nothing is known save what F. C. Pratt has observed regarding the life history of what he calls the Virginia punkie (Fig. 114) (*Ceratopogon guttipennis*). He found the larvæ in some dirty water holes in the hollows of poplar stumps in company with larvæ of mosquitoes. The eggs were not found. Evidently the larvæ live upon the material found in the dirty water and upon the dead wrigglers as well as on the cast skins of the larvæ and pupæ of the mosquitoes. He also found them apparently devouring a rat-tailed maggot, the larva of a fly that lives in filthy water.

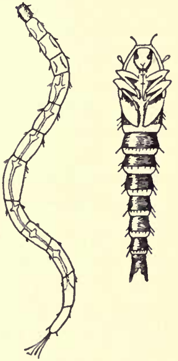

Fig. 115. — Larva and pupa of a punkie (*C. guttipennis*), enlarged.

The larva of this Virginia punkie, when full-grown, is not quite one-fifth of an inch long, and it is very slender, in fact, thread-like in appearance (Fig. 115). Moreover, it is white in color, with a brownish head and appears much like a very small worm. It has twelve segments in the body, besides the head, and moves with a sinuous motion like a snake. The larvæ frequently rise to the surface of the water and then descend and squirm along the bottom. Pratt kept some of the larvæ through the winter in a cold room where the water did not freeze. In the spring the larvæ transformed to pupæ from which adult flies issued from April 27th to May 8th. He remarks that it is possible that these larvæ freeze up in the water during the winter, then thaw out in the spring and complete the life history of the insect.

The pupa (Fig. 115) is about one-eighth of an inch long, of a brown color, and has eight abdominal segments. It remains in a perpendicular position just beneath the surface of the water, presumably with its two short breathing tubes in connection with the air.

Breeding places of punkies. — Comstock says the larvæ live under the bark of decaying branches, under leaves, and in the sap flowing from trees. Certain species of the genus *Ceratopogon* have been bred from horse and cow manure and the larvæ have been found on the underside of dry cow dung. The larvæ of other species have been found in the nests of ants, while others have been found beneath the bark of old dead trees in moist places. One thing is very evident, namely, that there is abundant opportunity for adding to our scanty knowledge of the habits and life histories of these small but interesting insects.

Methods of control. — From the very nature of the pests they are hard to control. The smudges recommended for the black-flies will also repel the punkies. Screening is of no avail because they pass through any useful mesh. Applications of certain substances to the face and hands, as is done to repel mosquitoes, are often useful in preventing attacks of the punkies.

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See the article by Pratt for further references on the habits and distribution of "punkies."

THE BLACK-FLIES

Simulium venustum et al.

The black-flies, although not strictly household insects, are yet very annoying to people living in certain parts of the United States especially in certain wooded areas of the more northern latitudes. The black-flies are also very troublesome to campers, summer residents, lumbermen, and hunters, whenever they invade the territory of these insects during the breeding season. Moreover, a noted worker, Sambon, has come to the conclusion, from certain careful observations he has made, "that a minute blood-sucking fly of the genus *Simulium* is, in all probability, the agent by which pellagra is conveyed." The fact that the dreaded disease pellagra, which seems to be growing more common in the United States, may be distributed through the agency of black-flies has aroused much interest in these insects. All of the black-flies with which we are concerned belong to the genus *Simulium*.

Description, distribution, and habits of black-flies. — These insects are members of the order Diptera, and the females have strong piercing and sucking mouth parts. The mouth parts of the males are not so well developed and seem incapable of drawing blood. The black-flies have short, stout, black bodies with broad wings and a hump-shouldered appearance, due to the head's being bent under the large humped thorax. They are all small, varying in length from $\frac{1}{25}$ to $\frac{1}{6}$ of an inch. They are remarkable for the immense numbers in which they swarm from streams in early spring and for the fierceness and persistence with which the females of certain species puncture the flesh of man and beast whenever opportunity is offered. The males, as indicated by the structure of their mouth parts, are harmless. In general, black-flies are more annoying to man than strictly injurious, although several cases of reputed deaths due to the bites of these flies are on record. Some people certainly suffer much torture from the attacks of black-flies in northern latitudes. They are active during the day only and seem to prefer bright sunshiny weather. It is said that the flies will occasionally bite on moonlight nights.

The young, or larvæ, of black-flies live in swiftly flowing water. The eggs are laid in patches beneath the water and attached to stones or other objects. Here they hatch and the larvæ finally transform to pupæ. The adults escape from the pupal skins and rise to the surface each in a bubble of air. In some instances so many of the adults emerge at the same time that the water is said to fairly boil as each one arises in its air bubble.

There are two species that occur, at times in vast swarms, in the Mississippi Valley from Illinois southward, namely, the turkey-gnat (*S. meridionale*) and the buffalo-gnat (*S. pecuarum*). These are essentially southern forms, although they occur from New Hampshire to Texas. They are a most serious pest to stock in the South and often cause a tremendous loss of life among mules, cattle, sheep, hogs, and fowls along the regions bordering the lower Mississippi. The animal attacked becomes frantic and runs wild at first, but finally grows quiet, lies down, and dies, perhaps all within the space of three or four hours. Even deer come to the smudges built by the planters and occasionally allow people to rub the gnats from their bodies.

The black-flies of the North are *S. venustum*, *S. vittatum*, and *S. hirtipes*. It is generally supposed and generally said that the first species is the one particularly troublesome to man in the northern woods. This species ranges from Maine to Florida and Texas and evidently has two or three generations during a season. This would lead me to think that *S. venustum* is not the biting species in the Adirondacks, or else the first generation is composed of biting individuals, while the females of the later generations do not bite. The writer has spent two seasons at Cranberry Lake in the Adirondacks from the 1st of July to the 5th of September and has not been troubled with black-flies. The inhabitants in the vicinity of Cranberry Lake say that they are not troubled with black-flies after the middle of July. There is also a saying that when the black-flies put on their white stockings the biting is over. *S. venustum* is the species with white-banded legs or, as they say, "white stockings." Moreover, Needham, who has observed this species in the Adirondacks, says, "It must be another, earlier species of black-fly which makes all the trouble in the Adirondacks with its bite; for this one is quite peaceably disposed." On the other hand, *S. hirtipes* occurs in the Adirondacks, is known to be a vicious and persistent biter, and has only one generation a year, which appears in May and June. It is quite possible that this is the particularly annoying species in the Adirondacks.

Injuries by black-flies to man. — The injuries to human beings by black-flies are, on occasion, very severe. The effect of the bite of a black-fly is much more severe than that of a mosquito. It is evident that the saliva injected into the wound by the fly has a serious effect both on the lower animals and on man, although man seems more resistant than the former. There are several cases of deaths produced by the bites of black-flies that seem fairly well authenticated. The bite of a black-fly has been likened by Webster to the rude puncture of a blunt, hot awl, leaving a dull aching pain behind.

C. V. Riley, writing of the buffalo-gnat in 1886, says: "Yet sufficient facts are on record to show that if the gnats attack a person suddenly in large swarms and find him unprepared or far away from any shelter, they may cause death. . . . In 1884 several persons were killed by buffalo-gnats. H. A. Winter, from near Helena, Arkansas, while on a hunting trip, was attacked by them one and a half miles from home while passing some low ground. Running towards a house, he was seen to fall dead. All exposed parts of his body had turned black. Another man was killed near Wynne Station, Arkansas, on the Iron Mountain Railroad."

Webster says that during the scourge of black-flies in the South from 1881 to 1884 several people were killed in Louisiana and Arkansas by the bites of these gnats, as he was able to prove by the testimony of physicians who attended the victims.

A. E. Buck gives a more detailed case of death by buffalo-gnats in a letter written to Webster. It seems that a Mr. Stokes, nephew of Buck, went fishing in company with a party and they all crossed over to an island where the gnats were very numerous. The members of the party, with the exception of Stokes, finally left the island, taking the boat with them. Stokes could not swim and was consequently left to the mercy of the flies. It rained and the fire that he had went out, so that he was deprived of the benefit of the smoke. He fought the gnats until near night before he could make any one hear. He was finally rescued, however, but died before morning. The narrator says, "There is no doubt but that the buffalo-gnats killed him."

The effect upon man of the species especially obnoxious in the northern woods has never proved to be so serious, yet their bites are severe, as any one familiar with them can attest. Packard describes these pests so well, as he found them along the Labrador Coast, that he is worth quoting in full. "The black-fly is even a more formidable pest than the mosquito. In the northern subarctic regions, it opposes a barrier against travel. The Labrador fisherman spends his summer on the sea shore, scarcely daring to penetrate the interior on account of the swarms of these flies. During a summer residence on this coast, we sailed up the Esquimaux River for six or eight miles, spending a few hours at a house situated on the bank. The day was warm and but little wind blowing, and the swarms of black-flies were absolutely terrific. In vain we frantically waved our net among them, allured by some rare moth; after making a few desperate charges in the face of the thronging pests, we had to retire to the house, where the windows actually swarmed with them; but here they would fly in our faces, crawl under one's clothes, where they even remain and bite in the night. The children in the house were sickly and worn by their unceasing torments; and the shaggy Newfoundland dogs, whose thick coats would seem to be proof against their bites, ran from their shelter beneath the bench and dashed into the river, their only retreat. In cloudy weather, unlike the mosquito, the black-fly disappears, only flying when the sun shines. The bite of the black-fly is often severe, the creature leaving a large clot of blood to mark the scene of its surgical triumphs."

In Agassiz's "Lake Superior," written by Cabot, we get some interesting notes on the black-fly as it occurred in 1848 in the region of the Great Lakes. At Sault Ste. Marie on June 28th they made the acquaintance of the "black-fly, a little insect resembling the common house-fly, but darker on the back, with white spots on the legs, and two-thirds as large, being about two lines in length. They are much quicker in their motions, and much more persevering in their attacks than the mosquito, forcing their way into any crevice, for instance, between the glove and coat-sleeve. On the other hand, they are easily killed as they stick to their prey like bull-dogs."

Farther north they met the fly in more force, as the narrative testifies. "Neither the love of the picturesque, however, nor the interests of science, could tempt us into the woods, so terrible were the black-flies. This pest of flies, which all the way hither had confined our ramblings on shore pretty closely to the rocks and the beach, and had been growing constantly worse and worse, here reached its climax. Although detained nearly two days . . . — yet we could only sit with folded hands, or employ ourselves in arranging specimens, and such other occupations as could be pursued in camp, and under the protection of a 'smudge.' One whom scientific ardor tempted a little way up the river in a canoe after water-plants, came back a frightful spectacle, with blood-rings around his eyes, his face bloody, and covered with punctures. The next morning his head and neck were swollen as if from an attack of erysipelas."

One wonders if a person, forced to remain on an island all day with these pests and without a smudge for protection, could survive the attacks of these northern black-flies.

Life history of a black-fly. — The life histories of most of our black-flies are very imperfectly known. The species (Fig. 116) *S. pictipes* occurs abundantly in the streams in the vicinity of Ithaca, New York. In the summer of 1889 Miss R. O. Phillips studied the life history of this species in detail, but her results embodied in a thesis have never been published. The following account of this black-fly based upon Miss Phillips's work will serve as generally representative of these insects.

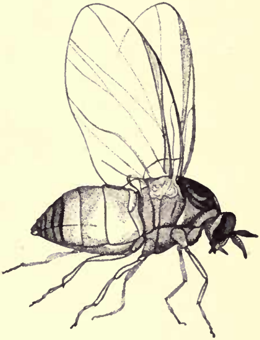

Fig. 116. — A black-fly (*S pictipes*). (× 10.)

The female flies hover in small swarms over a thin sheet of swiftly flowing water. Now and then one darts downward and quickly fastens an egg to the surface of the rock beneath the water. The eggs are light yellow at first and are laid in patches a foot or more in diameter. The eggs, which soon turn brown after being deposited, depend upon sunlight for their development. Under favorable conditions they begin to hatch in about eight days. The larvæ are long and slender, more or less cylindrical in shape, although smaller in the middle and blackish in color (Fig. 117). At the posterior end of the body is a disk-like sucker fringed with minute hooks by which the larva fastens itself securely to the rocks. The larvæ attached by the posterior ends stand upright in the water unless the current is too swift, in which case their bodies incline downstream. They are so numerous in many places that they form a black moss-like carpet over the rocks for large areas. The head of the larva bears two fan-shaped organs (Fig. 117), each one having about 60 rays. These organs are evidently for the purpose of creating currents of water directed toward the mouth and bearing particles of food. When disturbed, the fans are drawn backward and folded up like an ordinary fan. Just back of the head on the ventral side of the body is a fleshy proleg terminating in a sucker fringed with hooks similar to the posterior sucker already described. By means of the anterior and posterior suckers the larva is able to walk with a looping gait similar to that of a measuring worm. Moreover, the larva possesses the power of spinning silk from its mouth. This is undoubtedly an adaptation to its environment or the situations in which it lives. When a larva leaves its old position for a new one, it spins out a silken thread from its mouth, which is securely attached at the free end. To this thread the larva tightly clings as it loops along, lest it be washed away by the swift current before it has reached its destination and becomes fastened to the rock again by the posterior sucker. The larva breathes by means of three much

FIG. 117. — Larva of the black-fly (*S. pictipes*), enlarged.

branched tracheal gills pushed out between the last two segments of the abdomen. The length of the larval stage is about four weeks during the summer months. This stage is much lengthened by cool weather. In fact, the insect passes the winter in the larval stage.

In order to live and flourish, the larvæ of black-flies must have fresh, flowing water full of tiny plant and animal life. As soon as the larvæ are taken out of the water or even placed in quiet standing water, they die.

When the larva completes its growth, it spins a boot-shaped cocoon which is securely attached to the rocks by the sole but is open at the top. Within the cocoon the larva changes to a pupa which must also live in fresh, swiftly moving water. The pupa breathes by means of two tufts of respiratory filaments borne on the thorax. Each tuft consists of nine filaments, one of which is slightly shorter than any of the other eight (Fig. 118). The pupal stage lasts about three weeks, at the end of which period the adult fly emerges and quickly rises to the surface inclosed in a bubble of air. There seem to be two or three generations during a season at Ithaca, New York.

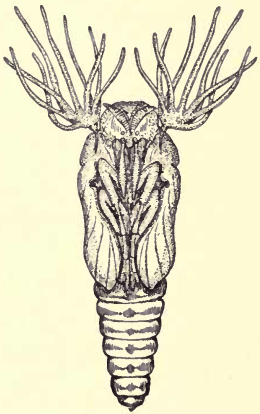

FIG. 118. — Pupa of a black-fly (*S. pictipes*). (× 16.)

The life histories of other black-flies, at least what we know of them, are similar in general to the one just described. So far as we know, all black-flies must have water in which to breed and apparently the water has to be moving. Some species of black-flies breed in small streams and some of them in larger rivers. Some seem to delight in swiftly flowing mountain streams and brooks, while others occur in enormous numbers in the larger and more quiet rivers. Twenty-five species of black-flies have been found in North America and fifteen of these occur in the United States.

Methods of control. — For protection from black-flies, there are two lines of procedure to follow — driving them away with some form of repellent or destroying the larvæ and pupæ in the streams with some insecticide. Campers, hunters, woodsmen, and permanent residents use repellents almost entirely to drive the flies away. Evergreen branches or damp moss or lichens serve very well on a camp fire. These materials produce a thick smudge that drives the flies away. In the Adirondacks, smudges for the home are built very largely of hardwood chips, beech perferably. These are also used at night to drive away mosquitoes.

Pyrethrum, Persian insect powder, or buhach, is used to drive the flies out of houses and tents. Lugger says it is used in the houses and stores of the Hudson Bay Company for this purpose. A little of the powder is burned on a piece of bark and the fumes either kill or stupefy the tormenters. Planters in the South collect during the year all sorts of materials which will produce a dense stifling smoke. They use leather, dried dung, and old rags and clothing. As soon as the gnats appear, the smudges are started and they are kept up until the insects disappear. Smudges are located in the fields, to protect the working teams, and in towns fires are kept before the doors of livery barns.

The destruction of the larvæ of black-flies in streams may be accomplished by pouring phinotas oil into the water, by damming the smaller streams, and by sweeping the larvæ from the rocks in swift shallow streams. Phinotas oil was first used by Conradi in the streams of northern New Hampshire. The wasteway of a dam was found to contain great numbers of the larvæ, covering a space approximately 5 feet wide by 20 feet long. One-half of a gallon of phinotas oil was poured into the water, with the effect of killing all of the larvæ and abating the nuisance of flies at the near-by summer hotel. In later experiments directed by Sanderson, a net was stretched across a small stream and the water oiled for a distance of 100 yards above the net. The fish descended the stream ahead of the oil and were caught by the net, where they were held until the oil had passed on. Many of the fish were overcome by the oil at first, but within 15 to 20 minutes the water cleared up and all of them revived without any apparent ill effects. In a subsequent experiment where no net was used the fish were subjected to the effect of the oil so long that many of them were killed. In every case the larvæ of the black-flies were destroyed. The objection to the use of this oil is its effect upon fish. It would probably not be safe to use it in streams flowing into private ponds or lakes stocked with fish, at least not in the part of the streams close to the ponds or lakes.

When the larvæ are found in restricted areas in small shallow streams, it is often possible to dam the water, thus increasing its depth and drowning the larvæ. We have already pointed out that the larvæ cannot live in deep quiet water. Conradi also found that he could destroy the larvæ in swift shallow streams by sweeping them from the rocks with stiff brooms. He says that miles of such breeding grounds can be swept with a stable broom in a day. If the larvæ are carried into deep quiet water, they die, but if into other shallow places, they reattach themselves and go on developing.

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CHAPTER XIV

SOME TROUBLESOME INVADERS OF THE HOUSEHOLD

THERE are a few insects and related animals that normally live out-of-doors but at times invade the house and cause annoyance and injury. Two of the mites, certain scorpions, and the house centipede are among such offenders. White ants invade the house and undermine the framework of buildings, while book-lice often increase in enormous numbers and the spring-tails appear in unexpected places.

A PREDACEOUS MITE

Pediculoides ventricosus

Webster has given a most interesting account of a mite (*P. ventricosus*) that has proven noxious to man. Undoubtedly, the attacks of this mite have been diagnosed as those of chiggers. In 1908 and 1909, threshermen, harvest hands, workers in potteries, and other laborers who handled straw in Ohio suffered greatly from what was supposed to be chiggers. In the light of present knowledge it is probably safe to say that most of these attacks were by the predaceous mite named above, and not by chiggers. Webster's researches have shown that this mite is parasitic upon the wheat joint worm and upon the larvæ of the Angoumois grain moth, a pest of wheat. Moreover, records show that the wheat joint worm was especially abundant in Ohio during the years 1908 and 1909. Therefore, all people handling straw in Ohio, at least, were probably attacked by these mites, which were present in the straw probably, for the most part, as parasites on the wheat joint worm.

Several very interesting cases of injury by this mite to people who slept on straw mattresses have been reported by Goldberger and Schamberg. An outbreak of dermatitis took place in 1909 among some sailors on a private yacht anchored in the Delaware River in Philadelphia. An investigation of these cases, by the two physicians, showed that the straw in the mattresses on which the sailors slept was infested by myriads of this predaceous mite. Experiments made with the mites on other individuals soon demonstrated that the mites in the straw caused the skin eruptions on the bodies of the sailors. Other sailors in other boats plying along the river were reported about the same time as suffering from the same trouble. It was soon shown that these men also were sleeping on new straw mattresses. Other cases occurred in Philadelphia, practically every one of which was traced to a new straw mattress. The straw used in these mattresses was eventually traced through the manufacturers as having come from New Jersey and Indiana. The straw from New Jersey was infested with the mites, which were probably parasitic upon the larvæ of the Angoumois grain moth which was abundant on wheat in New Jersey that season. The straw from Indiana was probably infested with the joint worm, which accounts for the presence of the mites in those mattresses.

The whole series of investigations by Webster and his associates and by the physicians Schamberg and Goldberger afford a most interesting illustration of the oftentimes intimate interrelationships of animals and plants and the incidental effect upon man.

Nature of the injury. — The presence of the mites on the human skin causes a severe eruption or dermatitis. The eruption is liable to cover the neck, chest, back, arms, and legs. It consists of wheals or inflamed spots from the size of a pea to that of the finger nail. In severe cases there may be thousands of these wheals on the body. The spots are round, oval, or irregular in shape, and of a rose color.

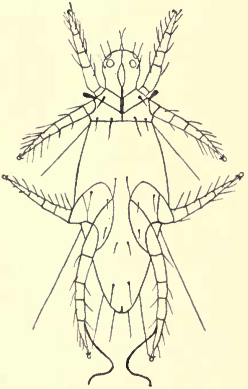

Fig. 119. — The female mite, much enlarged.

Itching is one of the first symptoms of the trouble and is especially intense at night. In some cases the temperature rises, while in other cases headache, nausea, and a mild form of diarrhea may develop. Occasionally patients complain of pains in the joints and in the back. Ordinarily the itching subsides in 12 to 36 hours, although it may continue for weeks if the mattress is continually used.

Life history and habits of the mite. — The adult female mites are so small as to be almost invisible to the naked eye. The body is elongated and furnished with four pairs of legs (Fig. 119). In this stage the mites are active and readily crawl about in search of something to devour. They are predaceous, as we have already mentioned, and live upon the larvæ of the wheat joint worm, Angoumois grain moth, wasps, and other insects. When a female mite finds a larva, it punctures the skin and begins to suck the juices. In a day or two the posterior segments of the abdomen begin to enlarge and continue to do so until they become fifteen or twenty times as large as the anterior part of the body. In this condition the females do not move (Fig. 120).

FIG. 120. — The female mite when full of eggs, enlarged.

Within the enlarged abdomen, the eggs are continually forming and developing the young mites. The young mites do not leave the body of the mother, but pass through all of their changes and actually become mature before they pass out of the body. The females are prolific. The number of young produced by a single female varies from a few to nearly 300.

Methods of control. — In households, the remedy is perfectly obvious. Since the mites are found in straw contained in mattresses, ticks, or in straw placed beneath carpets, they can be exterminated by removing the mattresses, ticks, and straw. The mattresses could be placed in storage in some outbuilding and if left there long enough would finally become free of the mites, for the latter would eventually die for want of food. The mattresses could probably be fumigated with sulfur or subjected to steam to kill the mites.

Webster found that, in case of the infestation of straw in the East where the grain moth was present, if the wheat was threshed direct from the shock, there would be almost no occurrence of the grain moth, and consequently no mites.

In Ohio, Indiana, or Illinois, where straw is infested with the wheat joint worm, the problem is a little different. In those states wheat following wheat is more apt to be infested with the joint worm. Likewise, wheat grown on poor soil and early sown wheat seem to be worse infested. To escape the joint worm, then, wheat should be sown moderately late, on good soil and on land not devoted to wheat the previous year. Since the joint worm winters over in the stubble, this should be burned, if possible, during the fall, winter, or spring. Any measure lessening the joint worm will lessen the chances of infestation by mites (Fig. 121). It would be wise, when obtaining straw for beds, to determine if possible, whether the joint worm was present in the field in which the wheat was grown. As a further safeguard, oat straw would be preferable to wheat straw whenever it could be obtained.

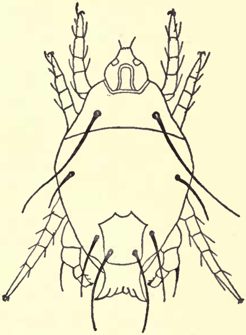
Fig. 121. — The male mite, enlarged.

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THE CLOVER MITE

Bryobia pratensis

This pest is a true mite and is more closely related to the spiders than to insects. It is found on a number of plants, especially clover, alfalfa, certain forest and shade trees, and on fruit trees. We have seen large areas of alfalfa in Texas literally covered with the eggs, young, and adults of this pest. It is rather partial to red clover and sometimes causes serious injury to this crop. During the season of 1909 a good many inquiries were made regarding great quantities of small reddish eggs found on the branches of fruit trees. These were the eggs of the clover mite. It is a serious pest to fruit trees along the Pacific Coast and in the higher portions of Colorado and other Western states. The foliage of affected trees becomes pale and sickly in appearance, and the egg-shells and cast skins of the mites are often so numerous on the branches that the latter present a scurfy appearance. Moreover, it often attacks deciduous trees like the poplar, elm, and black walnut. But the feature with which we are chiefly concerned here is its rôle as a household pest. During the past season a correspondent, inclosing many specimens of the clover mite, said that they were crawling up the sides of her house in immense numbers and entering the rooms, to her very great annoyance. There are many instances of these household invasions on record. So far as we are aware, the mites do not injure household goods, clothing, or books, but when the walls, furniture, and bric-a-brac, become covered with myriads of these reddish mites, the annoyance is unbearable and something must be done. A correspondent from Ohio wrote to *Insect Life* describing an invasion of the mites and added that, in the spring, the grass was nearly covered with them close to the house. This will often be found to be the case and this habit of the pest of living on grass near a dwelling explains its invasion of houses and, at the same time, offers a chance of destroying it before it enters the house.

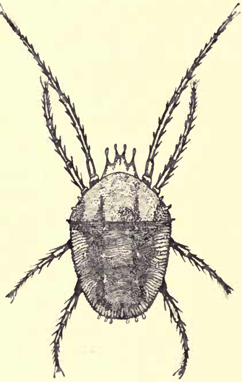

FIG. 122. — The clover mite, adult, enlarged.

Nature of the pest. — This mite is related to the common red spider that attacks house plants and plants in greenhouses, but it is about twice as large as the red spider (Fig. 122). It is reddish-brown in color, about three-tenths of an inch long, and has a very long pair of front legs, as shown in the illustration. Its mouth parts are formed for sucking and the body is oval and apparently all of one piece.

Its life history and habits. — In the higher altitudes and in its more northern range, this mite passes the winter largely in the egg state. The eggs may be found on the bark of shade trees, in the crotches and on the branches of fruit trees, often in great numbers. We often receive branches of pear trees thickly coated with the eggs of this pest.

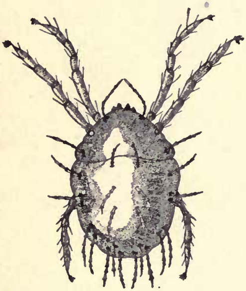

FIG. 123. — A young clover mite, enlarged.

In the warmer regions of its range it is said to pass the winter more often, at least in the adult state, seeking hibernation quarters whereever they may be found.

It is owing to its habit of seeking some place for shelter that it enters dwelling-houses in the fall of the year, sometimes in great numbers and thus becomes a veritable pest. This is especially apt to occur in the states of the Mississippi Valley and there are records of its happening in other states. It occasionally occurs as a pest (Fig. 123) to clover and certain grasses near a dwelling-house, even on the lawn; and, in this case, it will be very apt to enter the house in the autumn after it quits feeding and begins to seek winter quarters.

Methods of control. — Screens at windows are not much protection, because the mites can readily crawl through the meshes. If the mites are discovered in time, as they are crawling up the sides of the house, they may be checked by spraying the walls with kerosene oil. It will take thorough, vigorous action to check them.

After they have once entered a house, spraying them wherever possible with benzine will kill all it hits. The rooms may be fumigated with sulfur, at least 2 pounds to every 1000 cubic feet of space, but it must be remembered that the fumes may injure nickel and brass fittings, gilt picture frames, and wall paper. Fresh buhach sprinkled liberally about the room and actually on the mites whenever possible will kill many of them.

If the mites are discovered on the lawn, near the house, they should be killed by spraying the grass with a 10 or 12 per cent solution of kerosene emulsion.

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THE HOUSE CENTIPEDE

Scutigera forceps

The house centipede occurs commonly in public buildings, and frequently in dwelling-houses in the warmer moist regions of the Gulf states. It was a frequent visitor in the classrooms and laboratories of the author, which were situated in the basement of a large brick building. It is, however, not confined to the southern tier of states, but has slowly enlarged its territory and gradually spread northward and westward until it is now found as far north as New York and the New England states and has crossed the Mississippi on its way to the Rockies.

Its habits and appearance. — The house centipede is referred by most authors to that group of animals known as the *Myriapoda* (many-footed). Later writers tend to place it in a distinct and separate class, *Chilopoda.* The near relatives of the house centipede are found out-of-doors, mainly in the woods and fields. They are shy creatures, hiding away during the day beneath logs, stones, and leaves.

The house centipede prefers warm, moist situations in basements, greenhouses, bathrooms, and pantries, and preferably remains hidden during the daytime, although I have occasionally seen them crawling up walls and along floors in the middle of the day. When seen scudding across the floor, it is usually the result of having been disturbed in its hiding place behind furniture or other objects with a consequent hurried and rather blundering attempt to find another nook in which to ensconce itself. It may run rapidly for a little ways, then stop suddenly and remain motionless for a few moments, again quickly resuming its rapid run across the floor. In these apparently rather aimless bursts of speed it has the somewhat disconcerting habit of often heading straight for the observer, much to the consternation of the latter, especially if it be a woman or child.

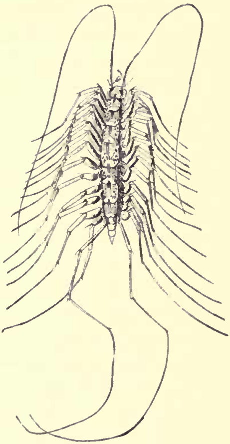

FIG. 124. — The house centipede. (× 1.)

This centipede has a narrow, slender body about one inch in length in some specimens and slightly more than that in others. The body is greenish-yellow in color and the back is marked with three dark longitudinal stripes. From the head there extend two long, thread-like antennæ and along each side of the body are fifteen long, slender legs, thus making fifteen pairs of appendages with which to move about (Fig. 124). Small wonder that it can move with considerable celerity and rapidity. The last or hind pair of legs is nearly twice as long as the others and extends backward much as the antennæ extend forward.

The animal is a very delicate one and so easily crushed that it is almost impossible to catch one alive and whole. When it is crushed or killed, the legs invariably curl into a tangled mass resembling a bunch of snarled threads. Hence has originated its common name, "skein centipede." A correspondent of *Insect Life* gives a very clear description of this animal, emphasizing the skein effect. She says: "The first I ever saw was five inches long, at least. I thought it was a skein of brown silk in a tangle, and picked it up from the carpet with my thumb and finger. I have never seen another as large, but the wet weather brings them into the bathroom in two sorts, one as I have described it, brown and tangled, the other of the same general shape, but with distinct antennæ at one end and something similar at the other, black and smoky in color."

This animal grows by shedding its skin from time to time, in a manner similar to insects. These cast skins have the legs greatly entangled, with the whole rolled up very much resembling a tangle of strings. The correspondent evidently picked up one of these cast skins. The other form of which she speaks was the living animal.

Its mouth parts and food. — Its mouth parts are formed for biting and consequently it is fitted for preying upon other animals. Its food probably consists chiefly of insects, for it has repeatedly been seen to catch and kill cockroaches, and has also been observed to catch and kill house-flies, small moths, and other insects. It is also supposed to feed upon the bedbug.

It has been difficult to keep this centipede in captivity where its feeding habits might be observed. When confined, it soon dies. Miss Marshall, however, of Albany, New York, succeeded in keeping a house centipede in an ordinary drinking cup with muslin tied over the top for more than three months by supplying it daily with three or four drops of water. She gave it occasionally small flies and young croton-bugs, which it ate. Evidently a small supply of water is absolutely necessary to sustain its life.

Hargitt succeeded in keeping them alive several days and inducing them to eat croton-bugs and house-flies. Miss Murtfeldt found one of them in her house that had captured a small white moth and had eaten quite a hole in the side of the thorax of its victim. She describes the legs of the centipede as moving so swiftly during the struggle with its prey that they were indistinguishable and appeared like the spokes in a rapidly revolving wheel. Because of its habits of preying upon insects, this centipede is not regarded as a wholly unwelcome guest in houses. Unhappily it has obtained an unsavory reputation because it evidently does, under provocation, occasionally bite human beings and seems to inject a poison into the wound that, in some persons, causes considerable painful irritation.

Lintner relates the case of a man's being bitten in two places on the body by this centipede. The animal had hidden between the sheets of the bed and during the night the sleeper felt the pain and getting up found the centipede. "The flesh around the bites became much inflamed and swollen but did not fester." He also records another case of a woman's having stepped on a centipede with her bare foot in the dark. The sensation was much like that of stepping on a tack. The foot became swollen but yielded to a treatment of ammonia and camphor. From what evidence we have it would seem that the bite of this centipede is not highly venomous. It undoubtedly will vary in its seriousness, according to the susceptibility of the person bitten. Some people will suffer much more than others, just as in the case of bee stings. It is doubtful if this centipede will deliberately attack a human being. When stepped upon or cornered in a bed, it may bite in self-defense. The writer, during his many years' residence in the South, never knew of a person's being bitten.

So far as the writer is aware, almost nothing is known of its life history. Half-grown specimens are sometimes found in the summer and a very young specimen found by H. G. Hubbard beneath a moist piece of log differed from mature forms chiefly in the possession of fewer legs. Where its eggs are laid, how they look, and how long the young take to become adults are questions unanswered as yet.

Methods of control. — It is unfortunate that there is so strong a repugnance toward this animal. Its appearance is wholly against it, for it is undoubtedly of considerable benefit in a house from its habits of catching and killing insect pests.

If one desires to get rid of the centipedes, every one of them seen should be killed. All possible objects that afford protection or hiding places for them in moist rooms should be removed. A liberal use of fresh buhach powder about their haunts will usually be fairly effective.

SCORPIONS

In the Southwest, especially in Texas, New Mexico, Arizona, and also in Southern California, scorpions are often found in outhouses, barns, and dwellings. They are frequent among boxes and lumber piled up in storage rooms, in closets, and other hiding places. The species familiar to the writer and seen so much in Texas is a small one usually about $2\frac{1}{2}$ inches in length. The body, like the bodies of all scorpions, is divided into two portions, a rather large anterior portion, consisting of the head, thorax, and front part of the abdomen, and a long slender portion, usually denominated the "tail," which is really the five posterior segments of the abdomen. The "tail" is armed at the end with a sting. Within the sting is a poison gland that opens through a duct just behind the tip of the sharp spine with which the sting terminates. On the thorax are four pairs of long legs and a large pair of long pincer-like organs resembling those of the cray-fish and lobster (Fig. 125).

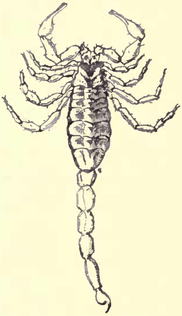

FIG. 125. — A scorpion. ($\times \frac{3}{4}$.)

The scorpions are nocturnal animals, for they remain quietly hidden during the day, coming out at night for their principal activities. They have the curious habit of carrying the tail-like portion of the abdomen bent upwards over the back. The scorpions feed upon spiders and insects, which they seize with their pincer-like organs.

The sting of the scorpion. — The sting of the scorpion is primarily a weapon for paralyzing its prey, although it is used when needed as a weapon of defense. It has been the experience of the writer that they never sting unless disturbed, but under provocation they can sting quite effectively.

While closing a window shutter in the dark, the author was stung severely by one of these scorpions, as was determined by actually finding the animal there when search was made in the light. The pain was more severe than that of a bee or wasp, but there was only a slight swelling of the finger. So far as that is concerned, however, the sting of a bee or wasp hardly ever causes the writer much pain or produces much irritation. The stings of these animals are quite frequently inflicted on children while the latter are at play and often cause a good deal of pain and irritation. The author recalls an instance in which a scorpion had hidden during the day in a child's night clothing hanging in a closet. When the child was undressed at night and clothed with the gown, it was severely stung and suffered acute pain, evidently being very susceptible to the poison. Because of these habits, the scorpions are considered somewhat of a nuisance and become the source of considerable worry and annoyance.

It is said that the larger species of scorpions found in the tropics are very poisonous. The reports that these animals kill their young and when closely cornered kill themselves with their own stings can hardly be considered anything more than fables.

Castellani and Chalmers say, in discussing the effects of the venom and bites of scorpions on man, that "the symptoms depend upon the size and nature of the scorpion. Thus, the sting of the small ($3\frac{1}{2}$ centimeters) *Euscorpius europæus* causes only pain, redness, and local swelling, whereas the larger tropical scorpions cause very intense pain of a burning character radiating from the skin, associated often with violent convulsions, mental disturbance, and hallucinations, profuse perspiration and secretion of saliva, and perhaps vomiting." They say that death may ensue from a stoppage of the respiration, which, however, is more liable to take place in the case of children than that of adults.

Control of the pest. — Very little can be said regarding the control of these pests. About all one can do is to kill them whenever seen and exercise all possible care to avoid them. If one does get stung, an application of ammonia and camphor ordinarily gives relief. An application of alcohol, witch hazel, or moistened baking soda will often allay the irritation and give temporary relief until a physician can be called. If the individual poisoned is particularly susceptible, it may become necessary to send for the family physician.

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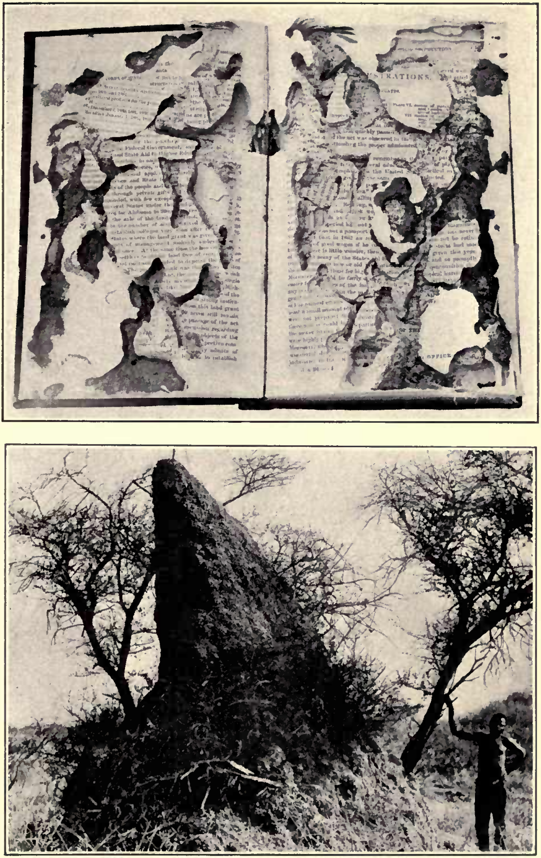
TERMITES OR WHITE ANTS

Termes flavipes et al.

The so-called "white ants" are not ants and are not even closely related to the true ants. As a matter of fact, they are much nearer relatives of the cockroaches and earwigs than of the true ants. In the South, they are widely known as wood lice because they are always found burrowing in pieces of wood. The termites resemble the true ants, however, in certain notable habits. Like the ants, they are social and live in colonies. Moreover, there are several kinds of individuals composing the colony, much as one will find in a colony of true ants. It is for these reasons that they have been called ants. Moreover, they are light colored or dirty-white, hence the common appellation, "white ants." The termites become decidedly injurious at times to books and buildings, as we shall see.

Distribution and habits. — These insects are widely distributed over the world. They are found everywhere in the United States, but are apt to become more of a pest in the warmer Southern states than farther north. In fact, it is in the tropics that termites are really found in all their fullness of life and development. Drummond's account of the termites and their habits in Central Africa is a marvelous story of insect life. Our own Brazilian species of termites seem to be quite as interesting as the African ones, if we are to judge from the scattered accounts that we have. In the tropics, these insects construct huge mound nests (Plate VI) twelve feet or more in height and build covered ways up the trunks of trees and from one



Book injured by termites, above; nest of termites, below.

place to another, for the workers of most species are blind or possess imperfect vision and do not travel in the light.

Our species in the United States live in old logs, dead or decaying wood, in sills of buildings, or in the ground under stones. They do not build mound-like nests or covered ways along tree-trunks and consequently are not particularly conspicuous insects here.

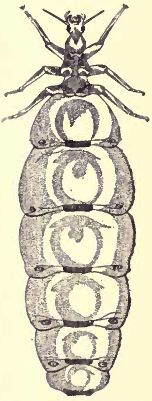


FIG. 126. — A queen termite. (× 1.)

The common white ant (*Termes flavipes*) is found from the Atlantic to the Pacific and from Canada to the Gulf of Mexico. It has also been carried to Europe, where it is a serious pest to books and buildings.

A community and its members. — Like the true ants, honey bees, hornets, and others, the termites live in communities or colonies and each community may be very large or quite small as circumstances determine. Several kinds of individuals, or castes, as they are often called, exist in each colony. In a typical colony of a typical species, for example, an African species, there is a queen grown to enormous size, sometimes six or seven inches long, perfectly helpless and with no other business than to lay eggs (Fig. 126). She is fed and cared for by the workers. It should be said that no true queen has ever been found in the colonies of our common white ant (*Termes flavipes*). In addition to the queen there is the king, or male, the workers, which are wingless, usually blind, and always very numerous, the soldiers, which have large heads and strong jaws, and finally, at certain times of the year, great numbers of winged males and females. The workers and soldiers are undeveloped individuals of both sexes and, in this respect, differ from true ants, in which the workers are undeveloped females. The workers perform all the labor of the colony, assisted somewhat by the soldiers, care for the queen, secure food, care for the young, and build the nests. The soldiers (Fig. 127) are the defenders of the colony.

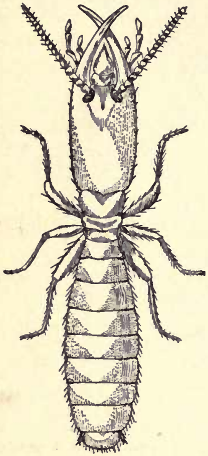


FIG. 127. — A soldier termite. (× 13.)

In the spring of the year, enormous numbers of the chestnut-brown to blackish winged males (Fig. 128) and females emerge from the colonies and begin their flight. The wings of these individuals are long and shining and very pale brown in color. The individuals in these swarming flights are so abundant that they can often be swept up by the quart, and because of such great numbers these insects have become objects of rather wide popular acquaintance. After the flight, a pair may settle on a decaying log or stump, break off their wings, at a breaking joint close to the body, and start a new colony. This, at least, is thought to be the manner in which a new colony of *Termes flavipes* is founded, but very little absolutely definite is known about it. Probably the usual way of founding new colonies is by the division of old ones by the transportation in a log or piece of wood of a part of a colony.

Food and injuries. — The food of white ants consists, usually, of dead or decaying wood or other vegetable matter. They usually, at least our native species, select moist wood or books or papers stored in moist situations.

Fig. 128. — Winged male termite, enlarged.

Their food seems to consist of what they are able to extract from the finely divided materials formed in excavating their tunnels. Moreover, they consume the cast skins of the developing members and even devour certain superfluous individuals of the colony. Unfortunately, white ants do not always confine themselves to dead or decaying wood.

These insects were first brought forcibly to the attention of the author by their destruction of seedling pecan trees in the nursery row in Mississippi. The particular nursery in which the injury occurred had been lately established on virgin sandy soil filled with dead pine stumps and their decaying roots. It became quite evident during our investigations, that these termites had deserted their normal food supply and had transferred their attention to the diminutive pecans by mining out the very hearts of them. We have records, also, of serious injury to the crowns and roots of orange trees in Florida and to pecan, chestnut, and walnut trees in Georgia. In Boston, some valuable trees were so injured by termites that they had to be cut down and destroyed. In greenhouses, termites sometimes injure cuttings, potted plants, and plants with herbaceous stems, like geraniums and chrysanthemums. In such cases, the decayed wooden benches or woodwork of the house are often the sources from which the pests come. Indeed, relief from injury has been obtained by the removal of the decayed wood in which the termites had homes. The modern, iron-framed greenhouses with iron and cement benches furnish few homes for these pests.

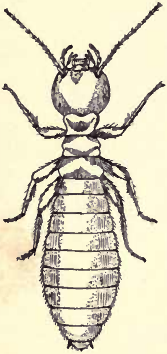


Fig. 129. — A worker termite. (× 9.)

Since the workers (Fig 129) are blind and avoid the light and the bodies of termites are soft and not able to withstand drying, the injuries of these pests are hidden and often unknown until suddenly a building collapses or a piece of furniture falls to pieces or the inside of an unused book is found literally eaten away. No evidence of the presence of the culprits inside is obtained from an outside examination. A piece of timber may appear perfect from the outside and yet be nothing but a shell through which one can push the finger as through paper. Here, again, termites were brought forcibly to the attention of the author through their work of mining in some wooden blocks used as supports for a poultry house in Mississippi. One corner of this house, which had been erected for experimental purposes, suddenly began to settle. On examination, the wooden blocks under this corner were found literally converted into mere hollow shells by the insects, and consequently unable to support the weight of the building. Drummond, in his "Tropical Africa," writes of this phase of the termites' work as follows: "You build your house, perhaps, and for a few months fancy you have pitched upon the one solitary site in the country where there are no white ants. But one day suddenly the door-post totters and lintel and rafters come down together with a crash. You look at a section of the wrecked timbers and discover that the whole inside is eaten clean away. The apparently solid logs of which the rest of the house is built are now mere cylinders of bark, and through the thickest of them you could push your little finger. Furniture, tables, chairs, chests of drawers, everything made of wood, is inevitably attacked, and in a single night a strong trunk is often riddled through and through, and turned into match-wood. There is no limit, in fact, to the depredation of these insects, and they will eat books, or leather, or cloth, or anything; and in many parts of Africa I believe if a man lay down to sleep with a wooden leg it would be a heap of sawdust in the morning."

A most interesting account of damage by white ants to a dwelling-house and adjacent buildings in Illinois has been related by Forbes. It so well describes the injuries sometimes committed by these insects that it is given here in full: —

"A remarkable case of injury to a small dwelling-house, built on an open prairie in Putnam County, was brought to my attention by a letter from H. K. Smith, written April 19, 1886, in which he reported that some insect unknown to him was literally eating up a neighbor's house, granary, etc. Visiting this place, I found that the house (built twenty-one years before) consisted of a small main building resting on a brick foundation, and an additional lean-to, the floor-sills of which were laid upon the ground. About six feet from the house was a so-called cave, built in 1879 and lined with new lumber — pine and oak plank — the latter of which had been brought from a sawmill about two miles away. Around the yard, passing a few feet from the house, was a post and board fence, and about thirty feet away was a granary with small out-houses near by.

"The ants were first noticed in 1881, when they were seen to collect on the floor, under a jar which had been left there for several days. In 1884 the wooden walls of the 'cave' broke in, and in 1886 it collapsed completely, all the lumber in it being practically destroyed. The fragments of this wood remaining contained a great number of white ants at the time of my visit. They were also found in several posts of the fence six or eight feet away, but had not visibly affected a young ash-tree about ten feet from the cave. The lean-to, on the other hand, was thoroughly infested by them, the surface of the sills being generally gnawed or riddled to the depth of an inch or more. The clapboards, eaten in many places to a shell, were readily broken by the fingers, the ends of the boards especially being eaten and broken away. The window-casing above and below the window was almost completely hollowed out; even the shingles on the roof contained many ants; and the floor was also somewhat eaten. This damage extended across both ends of the lean-to, which was about ten feet wide, but did not reach the main part of the house.

"Two years before, in 1884, the owner had taken a board from the cave to the granary, and in 1886 the floor of the oats bin had broken through, spilling the oats upon the ground. An examination of pieces of wood from this building showed that the ants had practically eaten up the floor, and that they had also gnawed away the surface of the wooden lining of the bin as high as the grain extended sometimes to a depth of half an inch or more. In the woods, near the sawmill, whence the oak lumber for this farmer's cave originally came, I found an abundance of white ants in fallen rotten wood.

"After my visit the owner destroyed his granary and thoroughly cleaned out the cave, burning up all the damaged wood, but neglected to follow my advice to kill all the ants on his premises with kerosene or gasoline. They were consequently still continuing their injuries to the house in 1888, and had also infested a corn-crib near by."

There are other instances on record of injury to buildings by termites in this country. A large area of the flooring in the United States National Museum was, at one time, seriously undermined and weakened by a colony of termites that could not be located. It finally became necessary to replace the wooden floor entirely by one of cement. Marlatt tells us that "a few years ago it was found necessary to tear down and rebuild three frame buildings in Washington in consequence of the work of this insidious foe."

W. G. Johnson records an interesting and serious injury to a large church in Baltimore. The winged individuals of the termites had swarmed in great numbers in the Sunday School room of the church during service and caused a good deal of confusion. On investigation, the floor joists, which rested directly on the ground, were found to have been entirely honeycombed. Even the laths and studding of the walls of this room had been badly mined, so that eventually all the woodwork in the room had to be removed and replaced with new.

Since the introduction of our species of termites into Europe, it has caused considerable injury there. Some years ago it entered one of the Imperial hothouses at Vienna and caused such persistent and decided injury, in spite of all that was done to prevent its ravages, that the building had finally to be torn down and replaced with one of iron framework.

There are also several instances of injuries by termites to stored documents, books, and papers. In the Department of Agriculture at Washington, a great many records and documents had been stored in a moist vault in the basement of a building and left undisturbed for several years. When they were finally examined, they were found practically ruined by the excavations and minings of white ants. Much the same experience was had in Illinois where an accumulation of books and papers belonging to the state was destroyed by the work of termites.

It is said that white ants are responsible for a good deal of injury to potatoes growing in soil rich in vegetable matter or in new land containing decaying roots, stumps, and branches. The injuries consist of irregular pits bored into the potatoes or of much larger and irregular excavations extending into the flesh of the tubers to the depth of a fourth of an inch or even more. In the particular instance in which this injury was definitely traced to the termites, the potatoes were growing in soil recently cleared of an old apple orchard.

Methods of control. — It must be borne in mind that these pests live permanently in dead wood only and that if the colony can be located and the vegetable material in which it lives destroyed, the trouble will cease. In the case of the injury to pecan seedlings, the trouble ceased as soon as all roots, stumps, and other decaying débris had been removed from the field. Again, our species selects moist situations and attacks books and papers stored in moist, damp basements. Therefore, if we would protect books from these pests, we should store them in light, dry rooms.

Basement floors and all underground parts of buildings, at least in the tropics, should be made of cement, brick, or stonework. Rooms containing books and papers infested with termites may be fumigated with hydrocyanic acid gas as already outlined in Chapter XVII. In this case, however, care should be taken to scatter the books and papers about more or less so that the gas will have free access to the insects and their mines.

Termites may be fought somewhat like the true ants. An effort should be made to locate the nest and then it should be destroyed if possible. There is nothing to be gained by giving any attention to the swarming individuals except in watching them to determine the point from which they are emerging. If this can be discovered, it will give a clew to the location of the colony and operations against the pest should begin at once, especially if they are located in a building. The timbers containing the nest may be removed and burned, or, possibly, they may be treated with live steam or soaked with kerosene. If the timbers are situated so that they can be subjected to a temperature of 125° F. or over for a few hours, the insects in their different stages may be destroyed. It should be borne in mind, also, that swarms of winged individuals indicate the presence of danger.

In the tropics, much more care and attention must be given to the prevention of injuries from this insect.

In South Africa a machine known as the "universal ant destroyer" is much used for killing the termites in their nests. The machine consists essentially of a stove, or brazier, and a force pump. A mixture of white arsenic and sulfur is burned on the hot coals of the stove and the fumes are forced by the pump into all parts of the nest.

The author is not aware that the results of any definite experiments on the treatment of timbers with preservatives to protect them from white ants have ever been published. The late C. B. Simpson, entomologist in the Transvaal of South Africa, had a series of such experiments in progress but it was probably never completed. The treatment of timbers with creosote has been recommended for protection against the injuries of white ants, but the author is not aware of any definite experiments to demonstrate its value.

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SPRING-TAILS

The spring-tails are very small insects rarely coming under the observation of any one but entomologists. Occasionally, however, they occur in vast numbers over limited areas so that, despite their small size, they become very conspicuous. The author has seen thousands of individuals of certain species on the surfaces of pools of water in Texas. The water actually appeared black from the presence of the countless bodies of these tiny insects. One species, known as the snow-flea (*Achorutes nivicola*), is sometimes found in large numbers on the snow toward spring. Occasionally, the individuals of this species become so abundant in maple sugar-bushes that they cause considerable annoyance by getting into the sap. The spring-tails are widely distributed and occur at various altitudes and under widely differing climatic conditions. They seem, however, to agree in one characteristic, namely, they all demand a certain amount of moisture and seem unable to exist for any length of time in dry situations.

The name spring-tails. — These tiny insects possess the capacity of leaping or springing suddenly and when disturbed or alarmed will try to escape by a succession of quick leaps. On the end of the abdomen is a tail-like appendage forked toward the extremity. In the dead insect this appendage extends straight backward from the body; but in the living insect it is bent forward under the body, where it is apparently retained in position, in some species, at least, by means of a catch projecting from the under surface of the body near the anterior end of the abdomen. The catch is not present in all species.

When this tail-like organ is suddenly straightened by the insect, its body is thrown into the air and projected some distance forward. The action and situation of this spring-like organ have given these queer insects the name of spring-tails.

Injuries of the spring-tails. — The following letter accompanied with specimens from a correspondent sets forth in a clear way one form of annoyance occasionally caused by these insects. "We keep our milk in a cave dug into the sand and rocked up on the sides but not 'pointed up.' It is covered with rough boards supported by pine poles in which borers are working. The cave was dug last fall. The floor is well-drained coarse sand. We cover the milk to prevent the insects in the sample bottle getting in, but to no purpose. We have used two thicknesses of cloth held down by tight cord and heavy cover on top. We have also used paper similarly fastened, but to no profit. The insects get in, in spite of everything. Through a small glass they appear like maggots, but often individuals will jump a couple of inches like fleas. They are not in the cow, for milk set in the house does not show them, but of course we cannot keep milk in the house these days. What are they, how do they get in the milk, and how can we keep them out?" Although the specimens were badly broken down, we were able to identify them as spring-tails, but could not determine the species. It is altogether likely that the dampness of the milk cellar attracted them, and it is quite possible that they fed upon the cream in the milk receptacles. It is believed that spring-tails live largely, if not wholly, upon decaying vegetable matter.

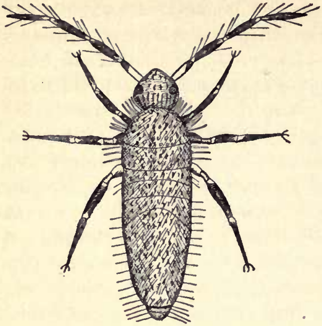

FIG. 130. — The American spring-tail, enlarged.

The American spring-tail (*Lepidocyrtus americanus*). — Marlatt describes and figures a new species of spring-tail (Fig. 130) that is not infrequently found in houses in the city of Washington. The individuals are apparently often found beneath the window sills, in bathrooms, and "sometimes, under favorable conditions, in considerable numbers." They are apt to occur also in conservatories where house plants are kept and where the conditions are moist enough to make it agreeable for them. This species is shown in Fig. 131 after Marlatt. Note the spring-like appendage on the underside of the body, forked at the end and held in place by the catch.

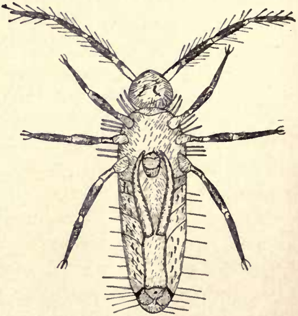

FIG. 131. — The American spring-tail, underside of body, enlarged.

Methods of control. — It should be borne in mind that the spring-tails demand certain degrees of moisture and cannot survive in dry situations such as are ordinarily found in most parts of a house.

In situations like the milk-house to which reference was made in the letter quoted, we would suggest that everything portable should be removed from the room, and the earth floor, walls, and shelves swept as clean as possible. Then a liberal application of dry, slaked lime should be applied to the floor, woodwork, and as much as possible to the walls. It would probably be helpful to add sulfur to the lime in almost any proportions desired.

When these insects become troublesome in the household proper, the moist objects or surfaces on which they gather should be removed, if possible. If it is not feasible to remove the moist objects, they could be dried by the application of slaked lime and sulfur, or in any other manner that may suggest itself as most convenient.

THE BOOK-LOUSE

Atropos divinatoria

Often, when an old book or paper yellowed with age that has lain long unhandled on the shelves is removed and the leaves turned, numerous, pale-colored, wingless, lice-like insects may be seen scudding across the pages and scurrying away to hide themselves in a crack or crevice. They are commonly known as book-lice and are so small that nothing can readily be made out about them unless a hand lens or magnifying glass is used. In fact, they are among the smallest of the insects and belong to the family *Psocidæ*, a group of insects probably most closely related to the bird lice. There are several species of the family Psocidæ occurring in dwelling-houses, but none of them except this one apparently ever becomes numerous enough to attract attention. It is only under extraordinary conditions that this book-louse becomes abundant enough to deserve notice. All of these house psocids are wingless insects low in the scale of development and usually quite insignificant.

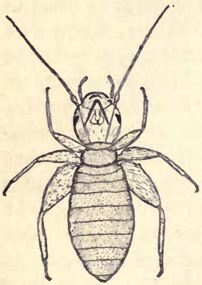

FIG. 132. — The common book-louse, enlarged.

This tiny book-louse (Fig. 132), together with another closely related species, is widely known as the "death-watch." It has long been held that these small insects are capable of making and do make a ticking noise similar to the Anobium beetle discussed in a later chapter. Many entomologists find it difficult to believe that such small and frail insects are capable of producing a sound audible to the human ear. They are of the opinion that the sound attributed to the psocid is really made by the Anobium beetle. This beetle lives in burrows in old wood and the book-louse is often found running about in the vicinity. It would be very natural to ascribe the ticking of the invisible beetle to the psocid which could be seen. It is said, however, that there is a marked difference between the sounds made by these two insects.

The Rev. W. Derham, an English rector and a careful observer, wrote an account many years ago of his observations on the ticking of the psocids. He says, "I am now so used to, and skillful in the matter as to be able to see, and show them, beating almost when I please, by having a paper with some of them in it conveniently placed, and imitating their pulsation, which they would readily answer." He found that they would tick continuously for hours with regular intervals between each beat, thus greatly resembling the ticking of a watch. The author is not aware that any careful observations on the ticking habits of psocids have been made by recent observers and the question still awaits a thorough investigation. The true death-watch psocid is said to be *Clothilla pulsatoria,* although some confusion regarding the species seems to exist.

There are other species of the Psocidæ, larger and with wings, that resemble plant lice and live out-of-doors on the trunks of trees, old walls, and stones covered with lichens and moss. These never become troublesome in dwelling-houses.

Food and habits of the psocids. — The book-lice have biting mouth parts and live upon the paste of book bindings and paper and upon animal or decaying vegetable matter. They also feed on flour, meal, and other cereals, and are quite destructive to specimens in natural history collections, especially to insect collections. The author has noticed this particularly in the South, where the bodies of small insects, like mosquitoes, have been badly eaten and the specimens practically ruined in a very short time.

These insects are also known to abound in barns among straw. Hagen says that he had "on one occasion found more than half of the refuse material left in a barn after threshing the grain to consist of a small species of psocus." Lintner tells us that McLachlan of London, England, has found myriads of the house species in the straw bottle envelopes in the wine cellar of his house. This occurrence of the insect in straw in barns may account for its occasional invasion of houses, as we shall see.

Extraordinary invasions of dwelling-houses. — Under ordinary conditions, this book-louse is not a serious pest in households. The few that may occur here and there in musty unused books and papers give no occasion for alarm or worry. It is only when some material in which they breed readily and rapidly is unwittingly allowed to lie in a room unused and undisturbed for a long time that they occasionally swarm over the house in almost incredible numbers. Straw or husk mattresses seem to be favorite breeding places for them and apparently afford about the only centers of infection for this pest. Fortunately, their invasions are rare. There are a few instances on record where this psocid has invaded households in immense numbers and has proven exceedingly difficult to eradicate.

One notable example is given in *Insect Life* in a letter written by Alfred C. Stokes of Trenton, New Jersey, Oct. 8, 1888. His letter detailing this invasion and describing the efforts to rid the house of the pest runs as follows: —

"In March, 1886, a lady here bought a new mattress composed of hair and corn-husks. It was used daily until the following August when the family left home for a six weeks' vacation. A day or two after the return in September, there were noticed on a pair of shoes, which had not been in recent use, several little colorless creatures resembling the common book-lice in appearance, some of which have been sent to you. Continuing the examination, what was her horror to find the under surface of the lower sheet and the upper surface of the mattress almost alive with the insects. To use her own language: 'A pin-point could not have been put down without touching one or more of the bugs.' Further search showed a very unpleasant state of affairs. The walls of the room were so covered with the insects that a sweep of the hand removed them by the thousand, and the other rooms in the house were almost as badly infested. The bureau drawers were swarming with them. They were behind the pictures and between the pictures and the glass in crawling cohorts. They were under everything and in everything. To say that the neat housekeeper was beside herself is putting it mildly indeed.

"The mattress was removed and examined. Without exaggeration, it contained millions. Then came the house-cleaning. The walls and floors were washed with a solution of borax and corrosive sublimate. Pyrethrum powder was freely used. All the carpets were sent to the steam cleaners. The furniture was beaten, cleaned, and varnished. The struggle was continued for a year with all the persistence of an extraordinarily neat housekeeper. The insects had the best of it and held possession in undiminished numbers. The family then removed to a hotel, while for days the closed house was fumigated by burning sulfur and the scrubbing processes were afterwards repeated. The insects were again diminished, but the least relaxation in the struggle was soon followed by an increase of the enemy. Again the house was vacated and the closed rooms were subjected to the vapor of benzine, basins and pans being filled and the fluid left to evaporate. The scrubbing processes were again repeated and the lady began to hope that the benzine had been the concluding touch, although she continued to have the creatures on her mind and to watch for them. Her hopes were vain. The insects are still in the house, two years after the removal of the mattress and in spite of all the harsh treatment they have received."

Lintner in his second report describes a very similar invasion by this same psocid. In this instance, two beds with bed ticks newly filled with straw were found swarming with the psocids one morning after the departure of two agents that had occupied only one of the beds for the night. The housekeeper, of course, attributed the infestation to the occupants of the bed, but that could hardly be possible. From all that is known of these pests it seems most likely that the straw used in the ticks must have been infested while in the barn.

Methods of control. — The use of straw husk-filled ticks or mattresses is to be avoided as far as possible, especially if they are to lie on a bed that is occupied only at rare intervals. Straw should be carefully examined before being used to fill bed ticks and if these pale, lice-like psocids are seen on it, it would be wiser to leave the straw to be fed to stock or to use it as stable bedding rather than to be taken into the house. Even though straw and husks are free of psocids when first appropriated, yet if left on unoccupied beds in dark, damp rooms until they become musty, the chances are strongly in favor of infestation.

Whenever straw or husk ticks or mattresses become infested, they should be removed at once and the contents burned.

In case of severe infestation as detailed in the foregoing nothing but heroic measures will avail. The carpets should be removed and the floors washed thoroughly with strong soapsuds. The old wall paper should be removed as completely as possible and the walls washed before repapering. It would be advantageous to spray the walls, especially around the window casings, with benzine or gasoline. Where possible, carpets and bedding should be steam cleaned. In country homes this is not always possible and here the carpets should be hung in the sun and brushed repeatedly and finally sprayed thoroughly with benzine or gasoline.

The infested rooms may be fumigated with sulfur, at least 2 pounds to 1000 cubic feet of space, with the room closed tightly and the cracks and openings calked as already explained.

Fumigation with hydrocyanic acid gas as detailed in a later chapter will also be found effective in destroying the pests.

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For more general literature on the Psocidæ see Lintner's Second Report, p. 203, and McLachlan's papers.

CHAPTER XV

SOME WOOD-BORING INSECTS AND THEIR RELATIVES

AMONG the insect pests that frequent households are certain wood-boring beetles that often become of considerable importance. These beetles sometimes seriously injure the beams and framework of houses and other buildings, besides damaging furniture and books. They bore long cylindrical tunnels through the wood, producing the effect known as "worm-eaten." The tunnels made by these small beetles in the wood are often so numerous that nothing but a mere shell is left of the beam or timber in which they are working. Their presence is usually indicated by circular holes on the surface of the wood and tiny heaps of yellow dust on the floor or ground beneath the place at which they are working. The beetles are not often seen because they remain hidden most of their life in their burrows.

POWDER-POST BEETLES

Perhaps chief among these offenders are the so-called powder-post beetles, particularly those of the family Lyctidæ. These small beetles (Fig. 133) attack stored hickory, oak, ash, and other seasoned hardwood materials. They are also found in rustic work and sometimes infest old furniture, ornamental woodwork, and the joists, floors, and timbers of houses. Generally the materials infested are badly damaged by the small exit holes of the beetles, and in many cases the inside of the wood is eaten away and reduced to a fine dust-like powder. In other instances the timbers may be so weakened as to become positively unsafe and a menace to human life. Hopkins says, "We have evidence of a railroad wreck in which many lives were lost, due to powder-post injury to the principal construction timbers."

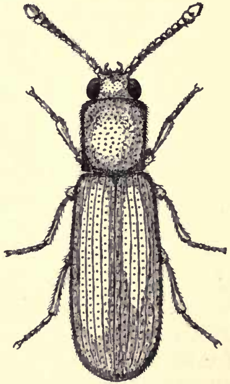

Fig. 133. — A powder-post beetle (*L. linearis*), enlarged.

Davis reports finding a species of these beetles, *Lyctus striatus* injuring a red oak floor in a college hall. The beetles issued from the sap wood only and were probably feeding there when the flooring was manufactured, at least two years before. In the fall of 1891 Webster found the same species injuring the floors and posts that supported the floors in the shops of a certain manufacturing concern in Ohio. He was able to trace the origin of the beetles to some oak lumber that had been piled in the yards for the purpose of seasoning it. When the wood had been taken into the shops to work it up, the beetles had been carried with it. The insects apparently were injuring only the sap wood of the floors and posts. Pettit has found the beetles working in finished oak and maple woodwork in Michigan, but again only in sap wood. We have found them injuring the timbers of barns.

It seems strange that these insects can find nutriment enough in the dry wood they chew to sustain life. It is a fact though that they do thrive on their diet of dry wood and the older and more seasoned the wood is the better the insects seem to like it and the more they seem to multiply and thrive. The conditions which seem most favorable for the attacks of the powder-post beetles are perfectly dry wood material or sap wood that has been stored away for one or more years. Manufactured articles, of considerable age, timbers and floors of old houses offer favorable points of attack. As a rule, the insects seem to prefer wooden articles that are not painted, although they will attack old wood that has been varnished, painted, or otherwise finished.

The adults of the powder-post insects are, for the most part, small, slender, dark brown to nearly black beetles. Some of the common species are not over three-sixteenths to a quarter of an inch in length. The species vary greatly in their habits and life history. When the wood attacked lies out-of-doors exposed to normal climatic conditions, the winter is passed by the insects in their burrows in an inactive dormant condition. When the beetles are working in wood in heated rooms, their activity may continue throughout the year. Normally, activities begin in the spring and the eggs are soon laid by the parent beetle. Each female deposits many eggs and as several females may lay their eggs in the same piece of wood there may be scores of larvæ within a comparatively small space. As a result, the whole interior of the infested material may soon be reduced to a mass of dry fine powder. The larvæ, as soon as they hatch from the eggs, tunnel in every direction through the wood, gnawing and feeding until they attain their growth. Each larva then enlarges the end of its burrow, forming a cell in which it changes to a pupa. The pupæ finally transform to the adult beetles, which emerge through tiny round holes cut in the wood.

Closely allied to the powder-post beetles is the "death-watch," *Anobium tessellatum*. This beetle has often been a source of annoyance to superstitious people who believe that its tick is prophetic of the death of some member of the family. It is a stout, reddish-brown beetle, attaining a length of one-fourth to one-third of an inch (Fig. 134). Two patches of pale whitish hairs extend across the back of the beetle, one near the base and another near the tips of the wing covers. There is also a patch of whitish hairs on the thorax. The head is bent beneath the thorax and wholly hidden from a top view. The death-watch is larger than most of the powder-post beetles and its destructive work in timber is correspondingly greater. It tunnels in wood, especially woodwork in houses and often causes considerable injury. Spence tells us that he often found workmen removing

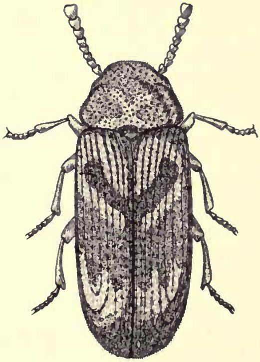

Fig. 134. — The death-watch beetle, enlarged.

the whole interior timbers of old houses in Brussels and replacing them with new ones. On investigation he found that the timbers, especially the floor joists, had been destroyed by the Anobium beetles "and that every year the same process, arising from the same cause, is called for in several of the old houses of the city," thus entailing an enormous expense.

This small beetle also bears a good deal of interest because of its rôle as the "death-watch." The ticking noise so often heard in old houses, and which is supposed to portend the death of some person, is probably due, for the most part, to this beetle and its close relative, *Anobium domesticum.* The ticking noise on a still night is amazingly clear, distinct, and penetrating. It is small wonder that the watcher by the quiet bedside of a sick patient in the silent hours of the night should be filled with a portentous dread of dire happenings. The ticking is caused by the insect striking its head or jaws against the walls of its burrow in the wood. The ticking is maintained for a few seconds, followed by an interval of quiet, after which it is again resumed, thus producing a regular succession of tappings. Perhaps the regularity and monotony of the tappings add to their mysteriousness. Swift discerned the real significance of these peculiar tappings and prescribed a method of dispelling the omen when he wrote: —

> A kettle of scalding hot water ejected
> Infallibly cures the timber affected;
> The omen is broken, the danger is over,
> The maggot will die, and the sick will recover.

It is held that the ticking is really a love call of one sex for the other. Those investigators who have observed the tappings most carefully say that the tickings are answered regularly, in the pauses, by a beetle in another location. The beetles and their noises have been subjects of investigation by several observers from early times. In 1867 Smith found it easy to induce some beetles that he had in captivity to beat whenever he wished. He simply tapped four or five times with a lead pencil upon the table near the box in which the insects were confined. He described their habits as follows: "Raising themselves on their anterior legs, they commenced bobbing their heads up and down rapidly, tapping with their mandibles on the bottom of the box. This performance I could elicit almost at pleasure: the number of taps varied from four to five — usually five are given. The insects have kept on repeating their love-call at intervals throughout the day. I fancy they are a couple of males. After inciting them to tap once or twice they become restless, and run about the box, occasionally stopping as if listening for a repetition of the sound: a few taps with the pencil sets them off again."

A later investigator, Morley, made some careful observations on the ticking of Anobium. He found that more than five ticks were made at a time. He was unable to count them, but estimated them at thirty or forty.

The foregoing beetle is not alone responsible for the tappings we sometimes hear in old timbers. A closely related species, *Anobium domesticum*, also ticks and has probably often been the cause of alarm to superstitious people.

In conclusion, it should be noted that these Anobium beetles are also injurious to books. This is notably true of *Anobium hirtum*, a native of southern Europe but now known to exist in the southern United States. This beetle has been found by Morgan injuring books in the State Library in Baton Rouge, and it has also been reported as seriously injurious to books in a library at Grand Coteau, Louisiana. How widely it is distributed in the United States is not definitely known. Books are liable to injury, however, from these different species of beetles.

PTILINUS

Another small beetle of the family Ptinidæ occurs in houses and is, at times, quite destructive to the woodwork. Perhaps the best known instance of its work is that given by Westwood. The beetles were found to have attacked a newly made bed-post and so injured it that it had to be burned two or three years afterward. The interior of the post had been mined until it was ready to crumble into dust. This happened in the days of the old-fashioned four-post bedstead. In these days of iron and brass bedsteads these tiny beetles must find that their jaws have fallen on hard places. The fashions are changing, however, and the famous wooden furniture of our forefathers seems to be slowly coming back into favor. Thus the beetles may again find their old tastes reviving and the means at hand to satisfy them.

The species principally at fault, *Ptilinus pectinicornis*, has a cylindrical, reddish-brown body and a rounded black thorax. The male beetle has most extraordinary antennæ for so small an insect. The antennæ seem to bear a long fringe on one side. This is due to the fact that each segment of an antenna, except the first two and the last, bears a long lateral appendage. The females, which seem to remain mostly within their burrows in the wood, have ordinary antennæ.

Felt reports a species, *P. ruficornis*, as injuring birch and maple floors in some cottages at Saranac Inn, New York.

WHITE-MARKED SPIDER-BEETLE

Ptinus fur

There are two other species of the family Ptinidæ belonging to the genus *Ptinus* and known as the spider-beetles that demand some notice. There is the white-marked spider-beetle, *Ptinus fur*, which is perhaps the more common of the two. Both are often found in the storerooms and cellars of houses, especially of those that have been occupied a long time.

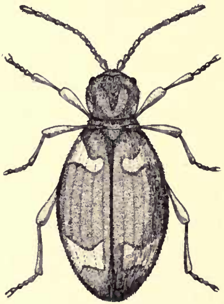

Fig. 135. — The white-marked spider-beetle, enlarged.

The white-marked species is a reddish-brown beetle with its body well covered with chocolate colored hairs (Fig. 135). The two sexes differ markedly from each other. The wing covers of the male are reddish-brown throughout, whereas each wing cover of the female is marked with two patches of white hairs. These patches tend to run together and form two white bands across the back of the beetle. The female, which is considerably larger than the male, attains a length of about one-eighth of an inch. Her body is stouter and rounder than that of the male. The body of the male is nearly cylindrical.

The materials infested by this insect are numerous. It has been known for years as a pest to books. Linnæus mentioned it as a pest in libraries as long ago as 1766. A French observer reports that the larva of this beetle, or of the drug-store beetle, penetrated directly through twenty-seven large quarto volumes in so straight a line that a string could be passed through the opening and the whole series of volumes suspended. In 1836 Audouin found great numbers of the larvæ of this beetle in flour in the village of Versailles, France. They had evidently committed serious damage to this stored product. Fletcher has also recorded its injuries to flour in Orillia and Toronto, Canada.

Chittenden relates an interesting and important outbreak of this insect in cotton seed stored in bags in a barn near Concord, New Hampshire. The insects "had devoured the bags and increased so enormously as to cover the buildings; had invaded neighboring houses, and were attacking clothing of all kinds." The owner was greatly worried lest the insect should prove a much more serious pest and spread through the town.

In addition to these notices, it has been found attacking wool, furs, clothing, roots, stuffed animals, dried plants in herbariums, insect specimens in collections, and various other animal and vegetable substances.

The larvæ of *Ptinus fur* are small and whitish in color, resembling closely those of the drug-store beetle. They cement the material together in which they are working, forming a delicate case in which they live. European observers generally credit the insect with one annual generation but, in Washington, it has been carried through all of its transformations in about three and one-half months. The pupal period lasted thirteen days.

The brown spider-beetle is often found associated with the species just discussed. There is not the great difference between the sexes that we find in the white-marked species. This species is widely distributed, having been reported from Europe, Asia, and America. It is a more or less serious pest to books. Leather-bound and sheep-bound books seem to be their favorite food in the book line. They usually bore galleries in the leather where it is joined to the back of the leaves of the book.

It is probable that there is little difference in the life history and habits between this and the preceding species. The larvæ of this species have been found in feathers, fur, dried mushrooms, in drugs, in the powdered leaves of senna and Jaborandi and other materials. In fact, the larvæ live upon much the same material as the larvæ of the white-marked spider-beetle.

METHODS OF CONTROLLING THESE SMALL BEETLES

In the case of the powder-post beetles it may become advantageous and, in fact, absolutely necessary to remove the infested timbers and replace them with new ones. This is especially true in case of those timbers that are used to support heavy materials. Again, it should be borne in mind that these beetles work only in sap wood. It is therefore of advantage to use only heart wood in construction, if it is possible to obtain it.

In those instances where it is not possible to remove the affected timbers, they may be treated to a thorough application of pure kerosene, benzine, or gasoline. Also, where conditions are such that the infested wood can be steamed thoroughly, this treatment will suffice to destroy the pests. Again, if the wood can be subjected to dry heat of sufficient degree for several hours, the pest will be killed. It has been demonstrated that certain mill insects may be killed if subjected to a heat of 125 to 130 degrees sustained for several hours or long enough to give it time to penetrate evenly all parts of the infested portion.

In case of the other beetles mentioned, the same methods of control will hold for them as for the drug-store beetle and the grain beetles already discussed.

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CHAPTER XVI

POISONOUS INSECTS AND THEIR RELATIVES

THERE exists in the minds of many persons a great deal of confusion and much misinformation regarding insects and allied animals that may possess the power of poisoning human beings. For example, there is a widespread and unwarranted idea that most if not all spiders are venomous and therefore dangerous. Moreover, the idea that poisonous insects are numerous and common is prevalent among many people. Undoubtedly considerable unnecessary fear exists regarding poisonous insects, much of which may be allayed if we can get at the truth.

When a person is bitten by a spider or punctured or stung by an insect, the effect will depend upon several conditions. First, it will depend upon the susceptibility of the person injured and upon the condition of the blood. Many persons are very susceptible to inflammation and pain from the stings of bees or wasps, while others suffer very little discomfort from the attacks of these insects. Again, the severity of a spider's bite may depend upon whether the wound becomes subsequently infected with harmful bacteria. The bite may cause some irritation and to allay it the patient scratches the wound, thus breaking the skin and inoculating the lesion with bacteria from the outside that may cause serious blood poisoning. Finally, the effect of an insect wound may depend upon the general health of the individual injured. A person in poor health may easily suffer considerable pain and discomfort from the puncture or sting of an insect, while another person in normal health may hardly notice an equally severe attack.

SPIDERS, THEIR VENOM AND BITES

The biting organs of spiders consist of two rather elongated jaw-like organs termed *chelicerœ*. Each chelicera is composed of two parts, or segments, the *base* and the *fang*. The base is rather large and more or less cylindrical or conical, but the fang is rather slender and hook-like or claw-like. The fang is connected to the base by a movable joint and moreover has within it a small canal which opens by a minute orifice near the tip (Fig. 136). All spiders possess poison glands that connect by minute ducts with the canals in the fangs of the cheliceræ. The poison, however, is not injected into the wound by pressure exerted by the fang upon the gland, but the gland itself is furnished with muscles, under the control of the spider, that eject the poison liquid. Thus it happens that a spider may or may not inject its

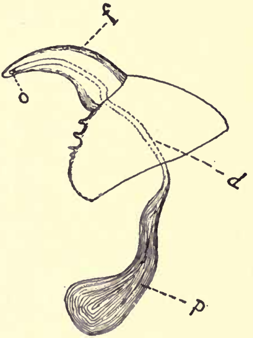


FIG. 136. — Chelicera of a spider; *p*, poison gland; *d*, duct; *o*, opening at tip of fang; *f*, fang; enlarged.

venom into the wounds made when it bites a victim. This may account, in part, at least, for some of the variations in the results of different spider-bites. The venom, says Castellani and Chalmers, "is an oily, translucent, lemon-yellow-coloured liquid with an acid reaction and a hot bitter taste."

The venom of spiders is undoubtedly of sufficient virulence to kill certain insects; although Blackwall came to the conclusion from his experiments that the deaths of spider-bitten insects resulted from the loss of blood rather than from the effects of poison. He found that bees, wasps, and grasshoppers survived the bites of spiders about as long as they did the effect of needle-pricks inflicted in the same parts of the body. Other experimenters have found that the bites of spiders are fatal to insects, probably due to the effect of the poison. The amount of poison necessary to paralyze or kill an insect, however, would not necessarily have much effect upon so large a body as that of a human being. There is much conflicting evidence regarding the whole matter.

Blackwall allowed spiders to bite him and could not distinguish the sensation from that of a needle-prick made upon the hand at the same time. On the other hand, Bertkau, when bitten, felt clearly the effects of an irritant poison in the wound, but suffered no serious consequences.

Baron Walckenaer tested the effect of spider-bites on his own person. He allowed himself to be bitten by some of the largest species of spiders found in the vicinity of Paris. With him the sensation from the punctures produced by the fangs was not unlike that produced by the prick of a fine needle. Moreover, there were no subsequent harmful effects. In his opinion, the venom of a spider has less effect on an individual than that of the sting of a bee or wasp. Eugène Simon was bitten on his finger by *Lycosa tarentula*. The sensation was like the prick of two needles. The pain was sharp and some blood flowed from the slight puncture, but the wound healed without any serious consequences.

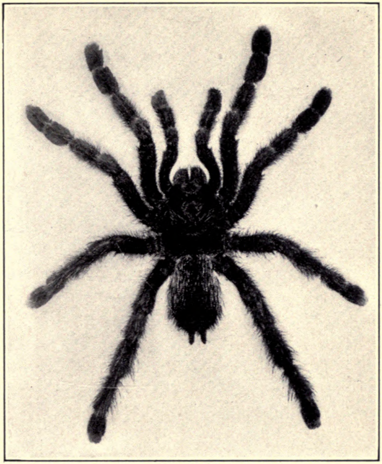
One more instance of a spider-bite should be related because it is an authentic case in which the spider was caught in the act of biting by a trained entomologist, who recognized the species and noted the effect of the bite on his own person. Theodore Pergande, an entomologist of high reputation, found a fine specimen of *Lycosa viridicola* in the kitchen of his residence in the city of Washington. He took hold of the spider and was bitten on the terminal joint of the thumb. The sensation was similar to the prick of a needle. The bite produced a red spot and mild piercing pains were felt in the thumb and all of the fingers of that hand for the rest of the day. The pains passed away, however, during the night and no further inconvenience was suffered, although the red spot remained for several days.

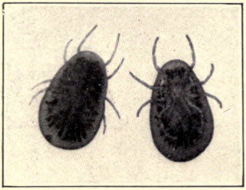
The tarantula (Plate VII) is perhaps, as Riley says, the most famed and defamed of all the spiders. The name is derived from the town Tarentum in Italy, but just what spider of southern Europe was supposed to cause the tarantula dance is not surely known. Probably it was a species of the family, *Lycosidæ*. Moreover, the confusion has been further increased by extending the name, tarantula, to a very different family of spiders. In the United States, the tarantula is *Eurypelma hentzi*, found in the Southern states. It is a large, black, hairy spider that lives in tubes dug in the earth.

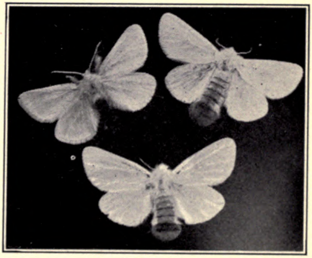
The superstition of the tarantula dance in southern Europe is curious and interesting. The victim of the bite, so the story goes, suffers little pain at first; but after a few hours becomes very sick, breathes with difficulty, and grows weak and faint. Then the patient is seized with a form of madness, weeps, dances, laughs, cries, skips about, passes through all sorts of contortions and finally, unless relieved, expires. The prevailing specific for this poison is music. At the sound of music the victim begins the peculiar movements known as the "tarentula dance." The dance is continued until the dancer breaks out in a profuse perspiration which forces out the venom. He then falls into a restful sleep from which he eventually awakes weak but relieved.

Eugene Murray-Aaron gives an interesting account of a bite by one of the large trap-door spiders, closely related to the American tarantula, while he was collecting in the West Indies. He says: "The creature was lurking in the dried sheaths of a bamboo clump that I was cutting down for building purposes, and it bit me twice on the back of the hand before I saw him (or rather her). From this bite, on which I used the usual remedies, I suffered more or less for four days and experienced slight pains for nearly a month. . . . I undoubtedly felt the symptoms that give rise to these stories (stories of the tarantula dance). For perhaps a half hour, about four days after the bite, I was afflicted with an utterly irresistible twitching of the muscles of the legs and arms, and the spasmodic action of the fingers, eyelids, and tongue was most distressing. Only the utmost exertion of my self-control kept me from making more of an exhibition of myself than I did."

On the other hand, Herbert Smith, who has traveled







Tarantula, above; chicken ticks and brown-tail moths, below.

and collected in Central and South America, says regarding a similar species of spider, "The only case of a Mygale (large trap-door spider) bite which has come under my observation was that of a man who was bitten on the foot deep enough to draw a little blood. There was hardly any swelling and he paid no attention to it."

There is one spider in the United States, known as the "hourglass" spider (Figs. 137, 138), *Latrodectus mactans*, that has a most unsavory reputation. It is practically the only spider in this country that entomologists are ready to admit as possibly seriously dangerous to human beings; yet here again there is no definite authentic proof that the bite of this spider will cause death. Riley and Howard relate two instances in which farm laborers near Greensboro, North Carolina, were, according to the testimony of the victims themselves, bitten by what was judged to be this spider. In the first case the victim died, while in the second case the

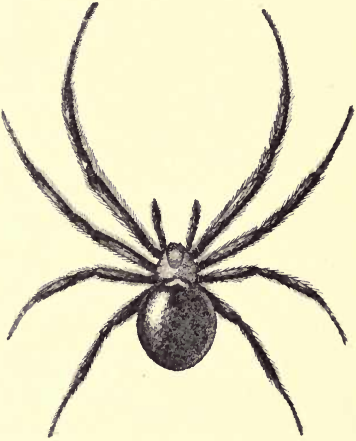


FIG. 137. — Hour-glass spider, dorsal view. (× 2½.)

man was two months in recovering sufficiently to return to work. E. R. Corson also furnishes, in Vol. 1 of *Insect Life,* several cases in which the evidence points strongly toward the hour-glass spider as one capable of seriously poisoning human beings.

There is also in southern Europe a spider of the same genus, *Latrodectus 13-guttatus,* known as the "Malmignatte," which is also considered extremely poisonous. In this instance, however, Lucas, an eminent authority on spiders, has several times allowed himself to be bitten by this particular spider without any ill effects. Amid such conflicting evidence it is impossible to say what is the real truth.

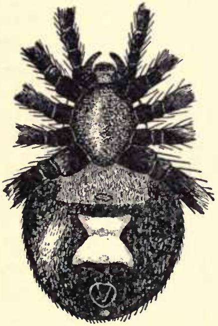


FIG. 138. — Hour-glass spider, ventral view. (× 4½.)

The author feels fairly safe and conservative, however, in saying that the hour-glass spider and the tarantula are the only spiders in the United States that need be feared by man. It seems safe to say that there is not a common spider in this country, outside of the two species just mentioned, that is capable of causing serious injury to a normally healthy person. It is possible that the bites of some of our larger spiders are capable of causing an irritation equal to a bee-sting to individuals in a weak condition physically, to those suffering from a blood disease, or to persons subject to erysipelas, or susceptible to poison-ivy and other similar affections.

The whole question, it seems to the writer, is fairly and conservatively summed up by McCook in the following words, so pertinent to the subject that we quote them in full: "Reasoning from analogy of other venomous animals, serpents for example, it is probably true that much of the effect of spider venom depends upon the condition of the spider itself as to degree of irritation, etc., at the time when the stroke is given. On the other hand, the physical condition of the person bitten also largely determines the effect of the bite. That which is harmless to one individual we know is often injurious or fatal to another; and that which at one period of life may produce serious results, at another time is comparatively harmless. It is, therefore, probably true that there are a few of our indigenous spiders, as *Latrodectus mactans* and *Phidippus morsitans*, which at certain times may inflict an injury upon certain individuals which may be serious and even fatal. But in the great majority of cases, there is no more, and indeed is less, reason to apprehend danger from a stroke or bite of a spider than from the sting of a bee or probe of a mosquito.

"In the case of the immense creatures (Mygalidæ) known as tarantulas, the matter, of course, is different. It would be strange indeed if such large animals, with so formidable fangs and such a considerable supply of venom in the poison glands, should not be able to inflict a serious wound. The cases which have been reported to me of injury resulting from the stroke of these large spiders, I consider sufficient to establish this fact, and to warrant the general feeling that they are animals to be handled with great care."

OTHER MEMBERS OF THE SPIDER GROUP

The scorpions, the itch mites, and the redbugs are members of the class Arachnida, to which the spiders belong. In former chapters, we have already discussed the effect upon human beings of the irritation caused by these animals. There remain of the Arachnida those gigantic mites, commonly known as ticks, and the spider-like animals, the *Solpugids*.

The ticks confine themselves, in this country, at least, mainly to quadrupeds. Occasionally certain species attack man and cause considerable irritation. The ticks are simply gigantic mites with a very tough leathery skin. The mouth parts consist of a beak or rostrum furnished with hooks at the free extremity. The ticks are parasitic during most of their life and are fastened to their hosts entirely by the rostrum, which is driven into the flesh and securely anchored there by means of the hooks at the end. In this position the tick sucks the blood of its host. The male remains small and is not often seen. The body of the female becomes distended until she resembles a large seed or bean. In some species, the body is brightly marked with brown, white, yellow, or red.

The life history of many species of ticks is now fairly well known. The southern cattle tick (Fig. 139) may serve as a representative example. When the female is full grown she drops from her host to the ground and lays from 2000 to 3000 brownish eggs in a rather compact mass. These ultimately hatch and the young ticks are known as "seed-ticks." The seed-ticks are active and ascend the nearest weed or bush, where they quietly wait until some animal passes near enough for them to catch hold.

Many of the seed-ticks never succeed in reaching a host and consequently perish. When once attached to its host, the cattle tick remains there until its growth is completed. Other species of ticks, however, drop from their host to the ground every time they pass through a molt. Since these ticks must find an individual host after every molt before they can make further growth, they run much risk of never reaching maturity, and many of them must die while young.

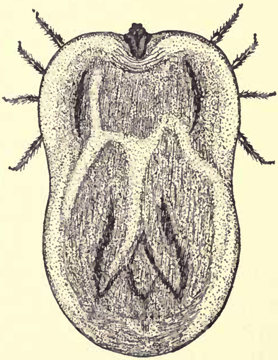


Fig. 139. — The southern cattle tick. (× 4½.)

Ticks have assumed great economic importance within the last few years, since it has been learned that they are the carriers of numerous diseases among domestic animals. In addition, it has been demonstrated that one species, *Dermacentor venustus,* is the carrier of the Rocky Mountain spotted-fever among human beings. This disease occurs in its most virulent form in the Bitter Root Valley in Montana, but it is known to occur in milder form in parts of Idaho, Wyoming, Utah, and Nevada. The bite of this tick is, of course, dangerous, because of the germs of the spotted-fever that are carried by it and injected with its bite into the blood of the person bitten.

There are at least four species of ticks that occur in the southwestern part of the United States that persist in attacking man whenever they get an opportunity. The bites of these ticks are said to be very painful and it would seem that the bite of one of them, at least, *Ornithodoros turicata,* causes inflammation and other disorders.

Ticks are abundant in woods and fields, especially farther south and often attach themselves to man. They immediately bury the rostrum in the flesh and often cause swelling and even tumors to form. Riley gives an instance of this kind that happened in Pennsylvania. A small girl who had been playing among the leaves in a wood complained of a pain in her arm. The next day an examination showed that a swelling had formed on the arm with a dark spot in the center, looking like a splinter. The child was taken to a physician, who found that the swelling was caused by a tick that had almost embedded its body in the flesh. The tick was removed with considerable difficulty and proved to be nearly one-quarter of an inch in length. Riley judged from the description that it was *Ixodes unipunctata.*

The writer recalls an instance of his youth in which a so-called wood tick became fastened to his neck with the rostrum embedded in the flesh. The irritation caused by the presence of the tick and the pain accompanying its forced removal are still vividly remembered. Probably the "wood tick" was a young tick of the genus *Ixodes.*

The "Miana bug" or "Malleh" of Persia is a tick, *Argas persicus,* of which many long and certainly exaggerated accounts have been written. It is, however, undoubtedly a serious pest in certain portions of Europe. It is said that they inhabit houses, like our common bedbugs, sucking the blood of human beings whenever the opportunity is offered, and inflicting painful wounds. They are reported so numerous in some villages that the inhabitants are forced to leave. We have two closely related species in this country, one of which is the common chicken tick of the Southwest, *Argas miniatus* (Plate VII).

The solpugids (Fig. 140) are spider-like animals, only a few species of which occur in this country. They are found in the southern and western portions of the United States, but are rarely seen, probably because they are chiefly nocturnal. They rest quietly during the day safely hidden beneath stones or sticks or in holes in the ground, but come forth at dusk to resume their activities. Some species, however, are active during the day. They are very agile creatures, for they can run swiftly in pursuit of their prey and one species, at least, is an expert tree climber.

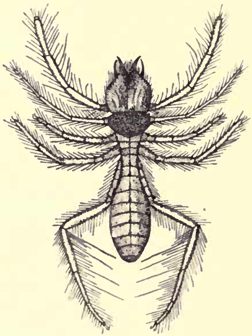


Fig. 140. — A solpugid.

There has been considerable controversy regarding the poisonous character of these animals. The people of Baku in southern Russia along the Caspian Sea look upon them as exceedingly dangerous; but no poison glands have ever been found in the Solpugids and several investigators have allowed themselves to be bitten by them without marked results. It seems quite safe to say that none of the species found in the United States are dangerous.

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CENTIPEDES

The centipedes belong to a group of animals more closely related to the insects than are the spiders. Earlier authors place the centipedes and millipedes together in the class *Myriapoda* (many-footed). More recent investigators tend to separate the two groups and rank each as a distinct class. So far as the writer is aware, the millipedes are harmless to human beings, and we have no concern with them. The centipedes, on the other hand, are reputed to be poisonous to man, especially the larger, tropical forms. The centipedes which we shall discuss and which are commonly known and dreaded, belong, for the most part, to the family *Scolopendridæ.* We shall refer to them as scolopendras or simply as centipedes.

The scolopendras have long bodies flattened above and below and divided into 21 to 23 ring-like segments. Each segment bears one pair of legs and the last pair is rather long. The head bears a pair of long antennæ (Fig. 141). They are active, swift-moving creatures and live, for the most part, in dark, obscure places beneath logs, stones, and dried leaves. They are ferocious and live upon other small animals. The larger species in the United States occur in the South and Southwest. Some of these, *Scolopendra heros* and *S. morsitans*, range from four to six inches in length, with a specimen occasionally exceeding six inches. In the tropics, even larger centipedes are found. One species, *Scolopendra gigantea*, of Brazil, often attains a length of twelve inches and sometimes exceeds this. The long powerful legs of centipedes enable them to catch running insects and other small animals incapable of flight. Their flat, thin bodies fit them to squeeze and wriggle through cracks and into crevices in pursuit of their prey.

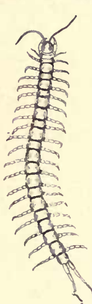
Fig. 141. — Centipede from Texas, much reduced.

What appears to be the first two legs of centipedes are really the *poison jaws* or *poison claws*, as they are more often termed. Each one of these claw-like appendages is composed of six segments, the last one of which is long and modified into a piercing fang. Moreover, each poison jaw has within it a canal that opens near the tip of the claw and communicates with a poison gland. The contents of this gland can thus be discharged through the canal of the *poison jaw* directly into the wound of the centipede's victim. There is no doubt then about the poisonous nature of these animals. The only question is regarding the effect of the poison on man.

Sinclair, an English observer, says the effect of the poison "fluid is instantaneous on the small animals which form the food of the centipedes. I have, myself, watched *Lithobius* in this country creep up to a blue-bottle fly and seize it between the poison claws. One powerful nip and the blue-bottle was dead, as if struck by lightning. I have also seen them kill worms and also other *Lithobius* in the same way."

Castellani and Chalmers say the poison of centipedes "causes local and general symptoms. At first there is itching, but this is quickly followed by intense pain, which extends all over the limb. A red spot appears at the side of the bite, which enlarges and becomes black in the center and sometimes there are lymphangitis and lymphadenitis. The general symptoms are great mental anxiety, vomiting, irregular pulse, dizziness and headaches. Small children have been known to die from the effects of a sting, adults as a rule recover in about twenty-four hours at most."

In 1896 W. W. Norman made a series of experiments with some Texas centipedes, *Scolopendra morsitans,* to determine the effect of their bites on mice.

In the first experiment, a mouse was bitten with the poison jaws of the centipede at 10 A.M. The mouse remained active during the day, but toward night became quiet, and the next morning was dead.

In the second experiment, a two-thirds-grown mouse was bitten twice in quick succession. The animal began at once to die, trembled, gasped, and fell over dead. Another adult mouse bitten by the centipede died the following night. Other experiments on mice showed that the bite when fairly made was fatal. He says there is no evidence, however, to substantiate the belief that the tips of all the legs of these large centipedes are poisonous and that they inflict severe wounds merely by crawling over the naked skin.

It would seem from all the evidence we have been able to glean, that the bite of a centipede will vary in its effect, depending probably upon the susceptibility of the person wounded. It is probably safe to say that the centipedes occurring in the United States are not to be considered seriously dangerous. The larger species of the Southwest had probably best be avoided, although there does not seem to be any reason for the hysterical fear of these creatures exhibited by some people.

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THE INSECTS

It is estimated that there are several million species of insects on the face of the earth, and we can truly say that only a very few of this vast number possess qualities poisonous to human beings. We must remember that a true insect is an animal possessing six legs, one pair of antennæ, and, in most cases, one or two pairs of wings. Moreover, the body of an insect is divided into three divisions, head, thorax, and abdomen. A fairly sure criterion to enable us to determine whether we are dealing with a true insect or with some other animal is the number of legs present. If there are three pairs, we may gener-

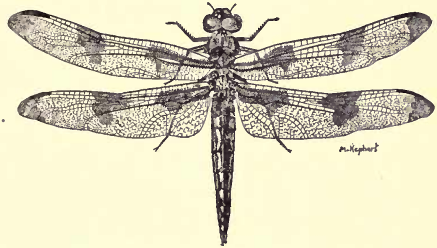


FIG. 142. — A dragon-fly. (× 1.)

ally be sure that we have a true insect, although young mites and ticks have but six legs.

Starting among the lower orders of insects, perhaps the dragon-flies (Fig. 142), snake doctors, devil's needles or spindles, as they are variously called, first demand our attention. There is a prevalent idea, among children at least, that these insects sew up human ears, bring dead snakes to life, and perform other similar miracles. All this may be dismissed with the remark that they are perfectly harmless.

The earwigs (Fig. 143) are said to have received their name from the supposed habit they have of crawling into people's ears. It is a curious but not easily explainable fact that these insects are given names in every country in which they occur that have reference to this attributed habit of entering the ears of human beings. For instance, in Germany an earwig is known as an *Ohren-wurm*, while in France it is known as *perce oreille*. Despite this widespread and persistent attempt to connect these insects with human ears, by name at least, there does not appear to be one iota of evidence to show that the earwigs are any more apt to get in one's ears than are other insects. In fact, there are on record a few cases where other species of insects have accidentally crawled into the ears of people, but never a case has been reported, so far as the author is aware, of an earwig's performing a like feat. It seems to be the general consensus of opinion among entomologists that earwigs are harmless insects.

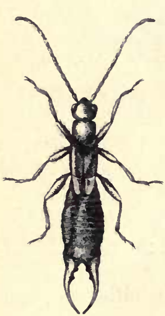


Fig. 143. — An earwig. (× 2.)

There are in the order *Hemiptera* several species that may cause severe pain by the punctures of their probosces. Among these are the small water insects, known as back-swimmers, *Notonectidæ*. The back of one of these insects is more or less keeled like a boat and, unlike all other aquatic insects, these notonectids swim on their backs, using the hind pair of legs as oars. They possess a short, powerful beak with which they can inflict most painful stings, which they will sometimes do if handled roughly. Under ordinary conditions they try to escape from man. Riley says that the pain from the puncture of the proboscis may last "sometimes for hours."

Those long slender aquatic insects known as water scorpions of the family *Nepidæ* are also said to be capable of inflicting painful wounds with their probosces.

Probably the large water bugs of the family *Belostomidæ* are better known for the painful wounds they make with their rostrums. These insects are also known as electric light bugs from their habit of congregating around electric lights at night. They normally live in ponds, lakes, and streams, but are often attracted by the bright street lights in great numbers. The two more familiar species are large, brownish, flat bugs nearly two and one-half inches long and furnished with large strong wings with which they fly long distances (Fig. 144). Each of these bugs possesses a short but powerful beak with which it can inflict painful wounds. Moreover, there are two prominent poison glands connected with the mouth parts from which a poisonous substance may be injected into the wound made by the rostrum. Normally, these water bugs live upon other insects, small fishes, and tadpoles, which they kill with their poisonous punctures. Their presence in fish ponds is undesirable, because of their depredations among the small fishes.

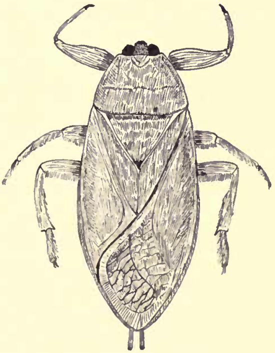


FIG. 144. — An electric light bug (*Belostoma*). (× 1.)

The effect of their punctures in the flesh of man is often quite severe. Intense pain, swelling, and inflammation follow the stab of the beak. The pain, soreness, and general effect of the puncture may last for several days. In handling live specimens of the giant water bugs considerable care should be exercised to prevent the insects from obtaining an opportunity to insert their beaks.

A word should be said regarding the so-called seventeen-year locust, or more properly, the seventeen-year cicada. Whenever outbreaks of this insect occur, there are always many accounts in local papers of the stings inflicted by the cicada on human beings. Several entomologists have been at great pains to trace these reports to determine the truth of them. In every case where this has been done the reports have been found to have been without any foundation at all or greatly exaggerated. In cases where apparently there was some truth in the report, investigation showed that the "sting" or "bite" was probably due to some other insect.

It is probable that the cicada can pierce the flesh with its beak and perhaps occasionally does so. There is, however, no evidence to show that there is any poisonous substance injected into the wound or that the "sting" causes serious pain or discomfort. We are obliged to conclude that the periodical cicada is a harmless insect.

The family of bugs known as the assassin bugs, *Reduviidæ*, contains many species that are capable of inflicting very severe wounds on human beings. The so-called kissing bug belongs to this family. It should be said, however, that most of these bugs will not harm man unless driven to it.

A few years ago many accounts appeared in the newspapers regarding the "bites" of the so-called kissing bug.

The kissing bug craze apparently began in the city of Washington, but soon spread over the whole United States.

L. O. Howard investigated the matter at the time and found that at least two species were apparently responsible for the origin of many of the reports. He found that these two species, the "cannibal bug," *Reduvius personatus*, and the kissing bug, *Melanolestes picipes*, were more abundant than usual around Washington and that they had been taken in the act of biting people.

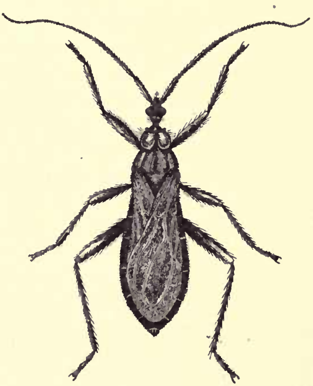


FIG. 145. — The cannibal bug (*R. personatus*). (× 2.)

The cannibal bug (Fig. 145) is a European species that was introduced into this country many years ago. It frequents houses for the purpose, apparently, of preying upon bedbugs. The young of this insect are covered with a sticky substance to which all kinds of lint and dust adhere, so that they are most completely masked by particles of dust and foreign materials.

In fact, a young bug resembles an animated moving mass of lint. Comstock has very aptly called this insect the "masked bedbug hunter." They live, however, upon flies and other insects as well as upon begbugs. Riley in describing the habits of the insect says: "They move very deliberately step by step, with a long pause between each motion, which is executed in a sudden and jerky manner; their antennæ move at the same rate. If a fly or another insect is offered, it is first touched with the antennæ, a sudden spring follows, and at the same time the beak is thrust into the prey."

The bite of this insect is very painful and leaves a feeling of numbness. Howard relates a case in which a girl was bitten on the neck by this insect. The puncture was followed by considerable swelling. LeConte, writing of this same species, under the name, however, of *Reduvius pungens,* says, "This species is remarkable for the intense pain caused by its bite. I do not know if it ever willingly plunges its rostrum into any person, but when caught or unskillfully handled, it always stings. In this case, the pain is almost equal to that of the bite of a snake and the swelling and irritation which result from it will sometimes last a week. In very weak and irritable constitutions it may even prove fatal."

The so-called "black corsair," *Melanolestes picipes,* is widely distributed throughout the United States. It is a black bug sometimes with a reddish hue on the back and legs and about two-thirds of an inch in length. It hides beneath stones, logs, etc., and can run swiftly.

Lintner quotes a letter from a resident of Mississippi regarding the bite of this insect. The correspondent wrote as follows: "I send a specimen of a fly not known to us here. A few days ago it punctured the finger of my wife, inflicting a painful sting. The swelling was rapid, and for several days the wound was quite annoying. You will observe the peculiar proboscis with which it was made."

Howard gives several instances of bites by this insect. In one case the bite was upon the cheek and was followed by much swelling but no great pain. In another instance, a person was bitten on the end of the middle finger. The first sensation was much like that of a bee sting, but the pain soon became very much worse, followed by a feeling of weakness accompanied with vomiting. The pain extended up the arm and the sickness lasted several days. In another case, the patient was bitten while in bed with painful results and considerable swelling. It is important to note that these insects will enter houses and bite persons. Without doubt, a closely related species, *Melanolestes abdominalis,* is also capable of inflicting severe wounds.

There are two species of bugs that occur in the southern and southwestern portions of the United States that are evidently responsible for many of the punctures attributed to kissing bugs. These are the two-spotted corsair, *Rasahus biguttatus,* and its close relative, *Rasahus thoracicus.* The first species is recorded as common in houses in the South, where it preys upon bedbugs. The same species has been supposed to be common in California, and A. Davidson, formerly of Los Angeles, has attributed nearly all of the so-called spider bites in Southern California to the punctures of this insect. He describes the injuries produced in some detail: "Next day the injured part shows a local cellulitis with a central dark spot; around this spot there frequently appears a bulbous vesicle about the size of a 10-cent piece filled with a dark grumous fluid; a small ulcer forms underneath the vesicle, the necrotic area being generally limited to the central part, while the surrounding tissues are more or less swollen and somewhat painful. In a few days with rest and proper care the swelling subsides, and in a week all traces of the cellulitis are usually gone." Davidson treated the cases with a solution of corrosive sublimate, 1 to 500 or 1 to 1000, applied to the affected portion. It would seem from a careful study of the species from the Southwest by Heidemann, that the more common species in that region is the *Rasahus thoracicus*.

Probably the best known of all these bugs, at least so far as its life history goes, is the blood-sucking cone-nose, *Conorhinus sanguisugus*. In the Southwest it is known as the Mexican bedbug or, simply, the big bedbug. It is common in houses and its bite seems to be very severe and painful. It is confined to the Southern and Western states.

LeConte in describing this insect says: "This insect, . . . inflicts a most painful wound. It is remarkable also for sucking the blood of mammals, particularly of children. I have known its bite followed by very serious consequences, the patient not recovering from the effects for nearly a year." We might add that we have found the large nymphs of this bug in Mississippi attacking young chickens and causing serious injury. Miss Kimball reports the same habits of the bug and adds that when abundant they attack horses in barns.

The cone-nose is a large bug about an inch long with a flat brownish body. The edges of the abdomen, which are thin and project on each side beyond the wings, are variegated with pink and dark areas, as shown in the drawing (Fig. 146). The head is long, narrow, pointed, and furnished with a strong beak. It is a nocturnal insect and often flies into rooms through the open windows at night.

The eggs, which are white but later change to yellow and pink, are laid out-of-doors normally and hatch in about twenty days. Marlatt says there are four stages in

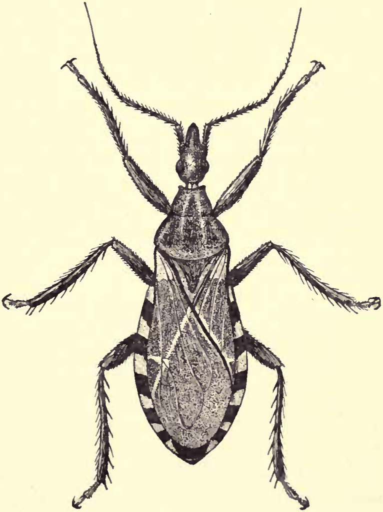


FIG. 146. — The blood-sucking cone-nose. (× 3.)

the development of the young to adults and that in all of them the insect is very active.

The bite of the cone-nose, like that of most insects, will vary in its effects with the nature of the individual bitten. The piercing of the skin, says Marlatt, "is evidently accompanied by the injection of some poisonous liquid or venom, making a sore, itching wound, accompanied with a burning pain sometimes from two to four days, and often associated with swellings which may extend over a good deal of the body. That there is a specific poison injected is indicated, rather conclusively, by the very constant and uniform character of the symptoms in nearly all cases of bites by this insect." It is known that a closely related bug, found in California, is attracted by carrion, and it is thought that part of the serious effect of the punctures by the cone-nose may be due to inoculation of the wound with bacteria obtained from decaying animal matter. Undoubtedly, the wounds made by these different kissing bugs are often infected with harmful bacteria, which are responsible for some of the trouble.

Miss Kimball says that some relief from the bites of the cone-nose may be had by bathing the parts with camphor and ammonia. Bathing the wounds with sweet oil has proven of value in some cases.

There are other closely related bugs of the family Reduviidæ that, on occasion, may puncture human beings and cause considerable pain and discomfort.

We have already discussed, rather fully, the bites of certain dipterous insects, such as the mosquitoes, black-flies, punkies, and others. A short account of the "screw worm" fly, however, should be included here.

The "screw worm" is the larva of a small fly, *Chrysomyia macellaria*, about two-fifths of an inch in length and of a bluish-green color with metallic reflections. On the back of the thorax there are three longitudinal black stripes. This fly is said to be distributed from Canada to Patagonia, but its activities and injuries in the United States are confined largely to the Southern states. It lays its eggs in a wound on some animal or in decaying animal matter. A single fly may deposit three or four hundred eggs in a very few moments. The eggs hatch within a few hours and the maggots burrow into the tissues of the wound or into the decaying mass. The flies are a great pest to cattle, and other domestic animals, for when an opportunity occurs, the eggs are deposited in flesh wounds or sores, where the maggots cause serious injury. When the maggots are mature, they fall to the ground, where they bury themselves and pupate. The life cycle may be passed in two to three weeks.

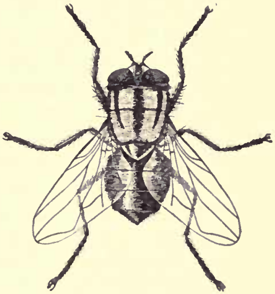


FIG. 147. — Screw worm fly. (× 3½.)

The attacks of this pest on man are usually made by a deposition of eggs in the nostrils or mouth while the victim is asleep. Snow has related several cases of infestation of man by this fly. In most of these cases the patients were sufferers from catarrh, which may account for the attraction of the flies. Also, in most of the cases where the facts were known, the eggs had been deposited in the nostrils or mouths of the patients while asleep. In one case, a fly attacked a man while riding in a buggy and deposited eggs in his nose before he could prevent it. In most of the cases the maggots burrowed through the tissues of the nose, mouth, and soft palate, even honeycombing the bones, and generally proved fatal to the victim.

There are many instances of the occurrence of the larvæ of bot-flies, known as warbles, in man. The ox bot-fly, or heel fly, *Hypoderma lineata,* occasionally deposits its eggs in the flesh of man, where they hatch, but the larvæ do not seem to find conditions suitable to their development and usually emerge before complete maturity. The European ox bot-fly, *H. bovis,* now known to occur in this country, attacks man rather more frequently, particularly in Norway.

There is in South America a bot-fly that deposits its eggs so commonly beneath the skin of the natives that it has been termed the bot-fly of man, *Œstrus hominis.* There seems to be considerable doubt, however, regarding the exact species. Moreover, this same fly also attacks monkeys, dogs, and other mammals. Foreigners visiting the localities infested by this fly are apt to be attacked, especially when bathing. The presence of the maggots beneath the skin does not seem to cause any great uneasiness among the affected natives, although LeConte says, "they produce a swelling having the appearance of an ordinary boil in which at times is felt for a few seconds an acute pain when the worm moves." Blanchard refers, in an extended paper, to two species, *Dermatobia noxialis* and *D. cyaniventris,* as affecting man throughout tropical America.

The cat and dog fleas and the human fleas, with their relation to disease, have been fully discussed in a former chapter. The bites of these common fleas and their annoyance to man are really very trifling compared with the injuries of the sand flea, *Rhynchoprion penetrans,* also known as the jigger, chigoe, chique, etc., of tropical and subtropical America. This flea affects the lower mammals as well as man.

The female fleas burrow into the flesh, especially beneath the toe nails, where the presence of the insect causes swelling and finally ulceration that often terminates fatally.

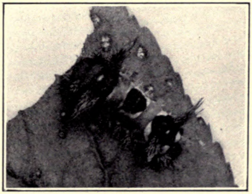
In the order Lepidoptera, composed of the butterflies and moths, we find certain caterpillars with protruding "horns" or filaments that strike terror to the hearts of many timorous people. The tomato worm, with the horn near the posterior end of the body, is looked upon with great fear under the delusion that this horn possesses deadly poisoning power. As a matter of fact, the tomato worm and its similarly appearing relatives are perfectly harmless creatures. So it is with the thousands of other various species of caterpillars found in North America with the exception of perhaps 18 or 20. C. V. Riley, in his Fifth Missouri Report, gives a list of fifteen stinging or urticating caterpillars. To this list we must now add the caterpillar of the brown-tail moth and a few others of slight irritability. So that out of the more than six thousand species of caterpillars in America north of Mexico we shall not find more than 18 or 20 that are poisonous and none of these, so far as the author is aware, with the exception of the brown-tail moth, is really to be considered as very serious.

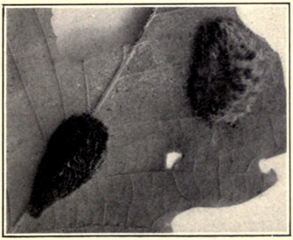
The few caterpillars that possess nettling or urticating powers bear sharp, penetrating, poisonous spine-like setæ. In several species, the spines of these caterpillars produce distinct irritation and annoyance whenever they come in contact with the skin.

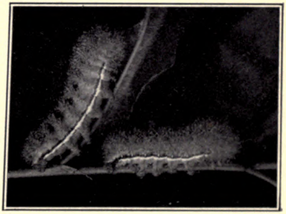
Notable among these are the caterpillars of the flannel moths, especially *Lagoa crispata*. The caterpillars of this moth are from three-quarters of an inch to an inch in length. They are short, thick, and fleshy and covered with a dense coat of long, silky brown hairs that project upward and meet to form a ridge or crest along the middle of the back (Plate VIII). Interspersed among these are short, stiff, hollow spines containing a poison secreted by certain cells in the skin at the bases of the spines. When the caterpillar comes in contact with the flesh of a person's body, the tips of the spines penetrate the skin and evidently set free within the wound a poison. The result is a distinct irritation varying in its intensity according to the susceptibility of the person attacked. The structure and effect of nettling hairs are more fully explained in the discussion of the brown-tail moth.

These caterpillars feed upon blackberry, oak, apple, pear, plum, cherry, and birch. They have been described as appearing like half a hen's egg cut lengthwise and laid flat side down on a leaf. The eggs are bright yellow and laid on end in rows and covered with scales from the moth. The larvæ molt five times and spin dense cocoons, in which they pass the winter, the moths appearing in the spring.

The beautiful io moth, *Automeris io,* with the conspicuous spots on the hind wings, also has a nettling caterpillar. The female moth has an expanse of wings of three to three and one-half inches. The front wings are dull purplish brown and the body, together with the bases of the wings, is covered with long silky hairs. The male is smaller and brighter colored, being of a deep yellow marked with purple-brown. The moths deposit their cream-colored eggs in clusters on corn, cotton, cherry, apple, elm, and oak. These hatch into small caterpillars covered with six rows of branched, black spines. They molt and grow







Caterpillar of buck moth above; saddle-back caterpillar in middle; larvæ of flannel moth and of io moth, below.

until the adult caterpillar becomes two inches or more in length. Moreover, the full-grown caterpillar differs very much in appearance from the young ones. It is now vivid green in color and the spines are green but tipped with black. There are also two conspicuous lines along each side of the body, the lower one of which is white and the upper red (Plate VIII).

Like the flannel-moth caterpillar, the spines are hollow and contain a poisonous substance that causes irritation when the tips of the spines penetrate the skin. This caterpillar is probably most abundant and most often seen of any of the nettling species. At least, it has been sent to the author more frequently than any of the others.

Fig. 148. — The buck moth (*H. maia*). (× 1.)

The larva of the buck moth, *Hemileuca maia*, is also quite notorious as a stinging caterpillar. The moth is a very handsome one with a wing expanse of two to over two and one-half inches. The wings are thinly clothed with pinkish-brown scales except for a wide creamy-white band running crosswise of each wing (Fig. 148). The female deposits 100 to 200 eggs in a ring around a small branch (Fig. 149). They remain here all winter, but hatch early in the spring, sometimes before the buds break. The caterpillars are gregarious and in traveling are processional, following one another mostly in single file. They molt five times, finally becoming from one and three-fourths to two inches or more in length. The caterpillar (Plate VIII) is brownish-black and the body is more or less covered with oval, yellow elevations, or papillæ. On each segment of the body, except the eleventh, there are at least six fascicles of spines. On the eleventh there are only five, but on several of the segments there are eight. The spines in the two median rows of fascicles, which are shorter and lighter in color than those of the outside rows, are more irritating than the others.

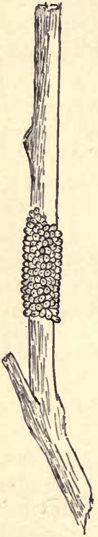


Fig. 149. — Eggs of the buck moth. (× 1.)

The spines are evidently like those of the io caterpillar in structure and cause very similar irritation when they come in contact with the flesh. Those who have had experience say that the nettling power of the buck moth caterpillar is not as serious as that of the io caterpillar.

The saddle-back caterpillar, *Sibine stimulea*, is an interesting larva from its peculiar form and coloration. It is flat on the under side but rounded above and reddish-brown in color. Over the middle portion of the back is a bright, pea-green patch, the saddle-blanket. In the center of the blanket is the saddle, a broadly elliptical, purplish-brown patch often edged with white (Plate VIII). The body of the caterpillar is armed along the sides with fascicles of spines and has two large tubercles at the anterior and posterior ends bearing spines. It feeds upon corn, rose, apple, grape, currant, cherry, raspberry, blackberry, and other plants. The moth is of a deep, rich, reddish, velvety-brown color with a wing expanse of about an inch and a quarter.

The spines of this caterpillar have much the same nettling power as those already discussed. The irritation is similar to that caused by the io moth. The parts touched swell, become inflamed, and watery blisters appear. In extreme cases numbness of the entire arm may follow.

The hag-moth, *Phobetron pithecium,* caterpillar is another mildly stinging larva of a most curious shape. Its dark brown body is much flattened and bears eight remarkable, fleshy appendages protruding from the sides. When the caterpillar is roughly handled, some or all of these fleshy appendages become detached from the body.

Hubbard gives the following description of the hag-moth caterpillar: "This insect receives its name from the curious hairy appendages which cover the back and project from the sides of the larva and have a backward twist like locks of dishevelled hair. They are, in fact, fleshy hooks, covered with feathery, brown hairs, among which are longer, black stinging hairs." There seems to be a difference of opinion regarding the power of this caterpillar to sting. Lintner quotes a correspondent to the effect that although dozens of them were handled every year in all stages and all ages, yet none of them showed any indication of a power to sting. Another correspondent says, "This little worm has a Victor-Hugo-devil-fish sort of look, but cannot sting, and is perfectly harmless."

In addition to the nettling caterpillars already discussed, the following species occurring in this country have been listed by Riley as possessing urticating powers to a more or less degree: *Megalopyge opercularis, Euclea pænulata, Euclea querceti, Euclea chloris, Adoneta spinuloides, Monoleuca semifascia,* and *Acronycta* sp. To these may be added a few that are only mildly nettling, for example, *Euclea indetermina, Packardia geminata, Natada nasoni, Halisidota caryæ* and *Hemerocampa leucostigma,* the last two of which can hardly be put among the urticating species. Concluding the list, however, is the worst one of all, the brown-tail moth (*Euproctis chrysorrhœa*) of New England. This insect was introduced into this country from Europe in the early nineties.

The brown-tail moth, now distributed over a large part of New England, is proving itself a many-sided pest. The caterpillars not only devour the foliage of pear, apple, peach, and other fruit trees, forest trees, and shrubs, but cause serious injury through the medium of their stinging, nettling hairs.

The eggs are laid on the undersides of leaves in July in masses of about 300 and covered with hair. They hatch early in August and the young caterpillars feed on the leaves. A little later they begin to fasten a number of leaves together with silk, forming nests, or webs on the ends of the branches. At the approach of cold weather 200 or more of the partly grown caterpillars crawl into each nest and remain there until the following spring. In the spring, the caterpillars emerge from their winter nests and commence feeding as soon as the buds begin to swell. They eat voraciously, molt several times, and become full-grown during June. In the latter half of this month, the caterpillars spin their cocoons, where they remain in the pupal stage for about twenty days, when the moths appear.

The moth is snow-white except for a brownish shade on the back of the abdomen and a large globular tuft of golden brown hairs on the end of the body. It is this tuft of conspicuous brown hairs that gives it the name brown-tail moth (Plate VII).

The caterpillar, when full-grown, is an inch and a half to an inch and three-quarters in length, reddish-brown in color, with a broken white line along each side, and two red tubercles on the back near the posterior end. The body is covered with long, branching, brittle hairs, and bears many very short, small ones which are barbed and constitute the nettling hairs.

Wherever these caterpillars are in abundance in the vicinity of human beings, a disease, known as "brown-tail rash" appears. The disease affects mostly the neck, hands, and face, although it may break out all over the body. It begins with an intense irritation followed by eruption resembling eczema, each eruption with a watery blister on top. Sometimes large pustules containing pus form on the skin. The first attack usually lasts a week or ten days. One can, however, be poisoned as often as the caterpillars strike the skin. The trouble is said to be much worse than that caused by poison ivy, and harder to eradicate. It does not, except possibly in rare cases, when combined with other troubles, terminate fatally. It seems to be especially severe on persons suffering from dropsy and tuberculosis. The disease is caused by the nettling hairs of the caterpillars penetrating the skin. It may be contracted simply by coming in the vicinity of the caterpillars, although not in actual contact with them, for the fine hairs are blown everywhere by the wind. Clothing hung out of doors near the larvæ becomes covered with the hairs which may nettle the whole body when the garments are worn.

Moreover, the cocoons of the insect contain nettling hairs derived from the caterpillars and are dangerous to handle. Finally, nettling hairs become scattered over the bodies of the moths, and are found among the long hairs in the tuft on the end of the abdomen.

Fig. 150. — Poisonous hairs (P) and ordinary hairs (R) of the brown-tail moth caterpillars.

Unquestionably, "brown-tail rash" or dermatitis is the severest disease caused by nettling caterpillars in this country. For many years, it was held that the disease was caused merely by the mechanical irritation produced by the hairs when in contact with the skin. This, however, has been disproved and the real cause shown by Tyzzer of Harvard University.

The nettling hairs of the caterpillars are short, straight, tapering, needle-pointed shafts, barbed for their entire length (Fig. 150). These short, brown, nettling hairs are found on the tubercles on the back and sides of the abdomen. They seem to be hollow and filled with a fine granular material that evidently contains the urticating properties. The evidence indicates that the poisonous material passes out of the hair at the basal point, although Tyzzer was never able to demonstrate the presence of an actual opening at this end of the hair. When these nettling hairs are mingled with a drop of blood on a slide under the microscope, there is a profound effect. The strings of red blood corpuscles are broken apart and each corpuscle becomes greatly changed in shape. It is probably safe to say that similar changes take place in the blood when these hairs penetrate the skin, thus producing the dermatitis.

Many remedies have been advertised and recommended for the brown-tail rash, some of which have afforded relief. For a time, the liberal use of vaseline was recommended, but of late certain mixtures producing a cooling effect have been more commonly used with more satisfactory results. External applications of alcohol and witch hazel afford considerable relief. According to Howard, a mixture compounded after the following prescription has been tried repeatedly with good effect: —

Menthol	grains 10
Zinc oxide	drams 2
Aq. calcis	ounces 8
Acid carbolici	drops 15

For nettling insects, in general, weak solutions of ammonia or ordinary baking soda moistened with water and applied to the affected areas in a paste will allay the irritation and give relief.

The large order of insects composed of the beetles, *Coleoptera*, contain very few poisonous forms existing in this country and very few in the world. It is said that some beetles are capable of inflicting severe bites. The saw-toothed grain beetle, *Silvanus surinamensis*, has the reputation of biting people. The larva of a beetle in Angola, Africa, is said to be able to inflict wounds on the soles of the feet by means of their stiff bristles. A most virulent poison is obtained from the larva of a Chrysomelid beetle, *Diamphidia simplex,* that occurs in Africa. The African bushmen use the poisonous properties of these larvæ to poison their arrow heads. Some authorities believe the poison is really due to a toxin produced by some micro-organism growing in the decomposing larvæ.

The blister beetles of the family Meloidæ possess poisonous qualities. The powdered bodies of these beetles are used in medicine for producing blisters on the human flesh. The well-known European Spanish fly, *Cantharis vesicatoria,* is most commonly used for this purpose. It is distributed all over the temperate regions of Europe.

We have several species of blister beetles in the United States, many of which contain vesicant properties to a greater or less extent. Many of our species are injurious pests to plants, especially to potatoes, asters, and roses. They come in great swarms, remain a few days, doing much injury, and then suddenly disappear. The life histories of these blister beetles are very complicated and interesting. It has been shown that the larvæ of some species live upon the eggs of grasshoppers and in the nests of solitary bees and pass through many remarkable transformations before becoming adults.

The vesicant properties of these blister beetles are due to a peculiar, volatile crystalline substance known as *cantharidin.* The powdered bodies of the beetles are known to pharmacists as *cantharides.* The substance, cantharidin, is soluble in alcohol, ether, or essential oils, and externally it produces blisters, while internally it is a violent, irritant poison. It is said that $\frac{1}{100}$ gr. put on the lip will cause a blister.

The ants, bees, wasps, and their relatives that constitute the order Hymenoptera, are the final insects to be considered among those irritating to man.

The Hymenoptera is divided into two large subdivisions, the boring Hymenoptera and the stinging Hymenoptera. The members of the boring Hymenoptera have the end of the abdomen furnished with an ovipositor in the form of a boring organ with which holes or openings may be made in the fruit, leaves, or stems of plants, or in the bodies of other insects, in which the egg may be deposited. The boring Hymenoptera, represented by the sawflies, horntails, gall-flies, ichneumon-flies, and others do not generally attack or seriously annoy man. It is said that species of the genus *Ophion* occasionally sting human beings, causing a transient but intense pain.

It is among the stinging Hymenoptera that we find the distinctly annoying forms, such as the bees and wasps. The members of this subdivision have the abdomen furnished with an ovipositor modified into a weapon of defense, commonly known as the sting. It should be understood that since the sting is a modified ovipositor, only the females possess a sting. Male wasps, bees, and hornets, do not, indeed cannot, sting.

The sting of a worker (infertile female) honey-bee consists of a straight, tapering, spear-like hollow organ composed of three pieces surrounding a central canal. The base of the sting is enlarged into a bulb-like portion which is hollow and connects with the canal in the sting. There are two sets of poison glands connected with the sting, one of which contains a liquid substance having an acid reaction and supposed to consist mainly of formic acid, while the other gland contains an alkaline secretion, and is known as the alkaline gland. Both glands connect with the bulbous portion of the sting and thence with the canal in the center, so that the poison runs down this canal directly into the wound made by the sting. The end of the sting is barbed. Experiments by Carlet seem to show that it is only when the acid and alkaline contents of the two glands mix that a poisonous effect is produced. He showed that flies artificially inoculated with the secretion of either gland alone lived a long time, even in spite of the necessary mutilation; but when a fly was inoculated with the acid secretion and then with the alkaline secretion, it died in a much shorter time — supposedly when the two secretions came together in the body. This detailed description of a bee sting with its poison glands will serve to convey some idea of the stinging mechanism of the bees, wasps, and hornets, for they are probably all similar, although perhaps differing in detail and in complexity.

Among the stinging Hymenoptera, the common ants are too well known to need detailed description. The females and the workers (undeveloped females) of many ants possess stings furnished with poison glands. The stings of ants, however, are not barbed and may therefore be withdrawn from the wound. The mound-building prairie ant of the West and the agricultural ant of Texas sting severely when molested. Some ants can bite sharply with their jaws, at the same time injecting formic acid into the wound.

The cow-killer ants or velvet ants of the South and Southwest are usually brilliant insects with red and black bodies densely clothed with hair. They have a very large sting and can inflict severe and painful wounds. As the name indicates, they are supposed, in Texas, to kill cows. At the same time, the name is an indication of the severity of the sting.

Most persons are acquainted with the paper wasps, commonly known as hornets and yellow-jackets. The stings of these insects are certainly most effective organs of defense. The effect varies among different individuals. The wounds are very painful and produce much inflammation and prodigious swelling on some individuals, while on others unless stung many times the effect is transient.

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CHAPTER XVII

THE USE OF GASES AGAINST HOUSEHOLD INSECTS

It is often advantageous to use some killing substance that will penetrate all parts of a building and reach the smallest cracks and crevices to which insects may retreat. The material best suited to such a requirement is some form of gas. Hydrocyanic acid gas and the gas from burning sulfur are the two gases most used for fumigating buildings to destroy insects. Heated air would be an ideal insecticide if it were more easily available.

HYDROCYANIC ACID GAS

Hydrocyanic acid gas has been much used of late years against insect pests of dwellings, barns, granaries, elevators, mills, and greenhouses. It has also been extensively used for many years in the fumigation of citrus trees in California and Florida to control scale insects and white flies. Nurserymen fumigate their stock with hydrocyanic acid gas to destroy any pests that otherwise might be distributed to the purchasers. This gas is undoubtedly a very effective agent for the destruction of certain household insects if properly used. The gas was perhaps first used in 1898 by C. L. Marlatt in fumigating certain leather-covered furniture infested with book lice.

Since that time the gas has been used by many people in different parts of the United States for the destruction of various insects. The author has treated many single rooms, entire dwelling-houses, and one large dormitory building annually for several years with this gas. In nearly every instance the treatment has been satisfactory. Where it has not produced the desired result, it has been due to defective calking of cracks and holes or to a poor quality of chemicals.

It should be said, however, that the susceptibility of insects to the effects of this gas varies considerably. For example, the snout-beetles, commonly known as weevils, are much harder to kill with this gas than moths, butterflies, or bugs. In general, it may be said that the soft-bodied insects succumb more readily to the effects of the gas than do the hard-bodied ones, like the beetles. Fortunately, most of the abundant and serious household pests are soft-bodied insects and, therefore, are easily overcome by the gas. In addition, the gas will kill rats and mice, and it is said will always drive them out where they will die in the open.

Moreover, the gas is not inflammable or explosive. In this respect it differs markedly from the vapor of carbon bisulfide. Again, hydrocyanic acid gas does not bleach the colors of wall papers, draperies, or other household fabrics. In general, it may be said that the gas does not attack metals or gilt on picture frames and furniture. It will, however, slightly tarnish nickel fixtures in bathrooms. The effect seems to be very superficial, because it is easily removed by wiping the fixtures with a cloth. Indeed, if the fixtures are covered or wrapped with towels, they will not be affected. The gas has no deleterious effect on dry food products, like bread, crackers, cakes, meats, and similar materials. In fact, some experiments performed by R. Harcourt at the Ontario Agricultural College showed that flour fumigated with hydrocyanic acid gas made just as good and, in some instances, apparently better bread than the normal flour. On the other hand, wet food-stuffs like butter, milk, and cream are liable to absorb some of the gas and should be removed before fumigation.

The poisonous nature of the gas. — There is, however, one serious drawback to the general use of this gas. It is one of the most poisonous substances known. It is a deadly poison to all forms of animal life including man. A few full inhalations of the gas will produce asphyxiation. Moreover, the potassium cyanide, from which the gas is derived, is a most virulent poison. A very little of it accidentally eaten will produce death. This poisonous quality of the cyanide and of the gas militates against the use of the latter as a universal and general insecticide and it necessitates great care and precaution in handling the materials.

Notwithstanding the poisonous nature of the gas and the cyanide, we do not believe any careful, thoughtful person should be deterred from employing this method of controlling household pests. The writer has used over 340 pounds of the cyanide and fumigated over 250 rooms every year for several years without the slightest accident to any one connected with the work. The nature of the gas demands calm, thoughtful, and orderly methods of work.

The greatest care must always be exercised in fumigating houses or rooms that are being occupied. Before fumigation a house should be vacated. There may be danger in fumigating one house in a solid row of houses, if it should happen that there was a crack in the walls through which the gas might find its way. It also follows that the fumigation of one room in a house might endanger the occupants of an adjoining room, if the walls between the two rooms were not perfectly tight. It is absolutely essential to keep all of these points in mind and to do the work deliberately and thoughtfully.

Generation of the gas. — Hydrocyanic acid gas is gener-

Fig. 151. — Materials used in fumigation.

ated from the salt, potassium cyanide, by treating it with sulphuric acid diluted with water. Experiments and experience have shown that the cyanide should be at least 98 per cent pure in order to give satisfactory results. Potassium cyanide is presented to the trade in varying grades of purity, from 40 per cent to 100 per cent actual cyanide. When diluted, a useless salt, usually sodium carbonate or sodium chloride, is used, which is of no value in fumigation. Indeed, the sodium chloride may be of positive detriment. The purchaser of cyanide should, therefore, insist on its being at least 98 per cent pure, and it ought to be bought for not more than forty cents per pound retail in small quantities. In large quantities it should be purchased for much less.

The crude form of sulfuric acid may be used. It is a thickish brown liquid and should test about 1.84 sp. gr. or 66° Beaumé. It should not cost more than four or five cents a pound. If a room is made tight, one ounce of the cyanide for every one hundred cubic feet of space has been shown to be sufficient. In cases of loosely constructed buildings that cannot be tightly calked double this amount may be used. The ingredients (Fig. 151) are combined in the following proportions: —

Potassium cyanide	1 ounce
Commercial sulfuric acid	1 fluid ounce
Water	3 fluid ounces

Method of procedure. — It will be simpler to take a single room as an example. Suppose the room to be 12 by 15 by 8 feet. It will contain 12 × 15 × 8, or 1440 cubic feet. For convenience, the writer always works on the basis of complete hundreds, and in this case he would work on the basis of 1500 cubic feet, preferring to err on the side of too much than too little. The room, then, would require 15 ounces of cyanide, 15 ounces of sulfuric acid, and 45 ounces of water.

First of all, the room should be made as tight as possible by stopping all the larger openings, like fireplaces and chimney flues, with old rags or blankets. Cracks about windows or in other places should be sealed with narrow strips of newspaper thoroughly soaked in water. Strips of newspaper two or three inches wide, that have been thoroughly wet may be applied quickly and effectively over the cracks around the window sash and elsewhere. Such strips will stick closely for several hours and may easily be removed at the conclusion of the work. Careful attention should be given to the matter of tightening the room. The gas will so quickly dissipate itself through holes and cracks, if these are left open, that its effectiveness will be greatly lessened, if not entirely lost.

While the room is being made tight, some one should measure out the ingredients according to the formula already given. The water should be measured and *poured first* into a stone jar holding at least two gallons. The jar should be placed in the middle of the room with an old rug or several newspapers under it to protect the floor. If the generating jar is too small, the liquid may boil over and injure the floors and rugs. Careful attention should be paid to protecting polished floors, valuable rugs, and carpets. The latter had better be removed entirely. If the room is a large one, a larger jar, or two or more small ones, will be necessary to hold the requisite amount of cyanide, acid, and water in order to prevent spattering.

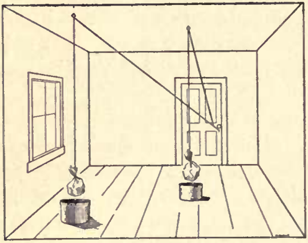

FIG. 152. — A room "strung" for fumigation."

The required amount of sulfuric acid should then be poured rather slowly into the water. *This procedure must never be reversed,* that is, the *acid* must never be poured into the jar first. The cyanide should be weighed and put in a paper bag beside the jar. All hats, coats, or other articles that will be needed before the work is over, should be removed from the room. When everything is ready, the operator should drop the bag of cyanide gently into the jar, holding his breath, and should walk quickly out of the room. The steam-like gas does not arise immediately under these conditions, and ample time is given for the operator to walk out and shut the door. If preferred, however, the paper bag may be suspended by a string passing through a screw eye in the ceiling and then through the keyhole of the door. This is called stringing a room (Fig. 152). In this case the bag may be lowered from the outside after the operator has left the room and closed the door.

The writer has most often started the fumigation toward evening and left it going all night, opening up the rooms in the morning. The work can be done, however, at any time during the day and should extend over a period of five or six hours, at least. Experiments show that better results will be obtained in a temperature of 70 degrees F. or above, than at a lower temperature.

At the close of the operation, the windows and doors may be opened from the outside. In the course of two or three hours the gas should be dissipated enough to allow any one to enter the room without danger. The odor of the gas is like that of peach kernels and is easily recognized. The rooms should not be occupied until the odor has gone.

Fumigating a large house. — The fumigation of a large house is simply a repetition in each room and hall of the operations already described for a single room. All of the rooms should be made tight and the proper amounts of water and sulphuric acid should be measured and poured into the jars placed in each room with the cyanide in bags beside them. When all is ready, the operator should go to the top floor and work downward, because the gas is lighter than air, and tends to rise.

The following account of the manner in which the author has fumigated a large dormitory for several successive years will give the method of procedure in working with an entire building of large size: —

The dormitory building in which the work has been done is a large four-story structure in the form of an E, and contains, all told, 253 rooms of different sizes on the different floors. It takes about 340 pounds of cyanide (98 per cent pure) and the same quantity of sulfuric acid to give the building a single treatment, not including the halls, which are thoroughly scrubbed with lye and water.

Our first work was to measure the rooms and compute the cubic contents of each. With the exception of a few corner rooms, they are as follows:

Floor	Cu. Ft.	Cyanide	Water[1]	Acid
4	1960	1¼ lb.	1200 cc.	600 cc.
3	2352	1½ lb.	1440 cc.	720 cc.
2	2352	1½ lb.	1440 cc.	720 cc.
1	2744	1¾ lb.	1680 cc.	840 cc.

In computing the amounts of cyanide, water, and acid to be used, we always raise the cubic feet in any given room to the next even hundred. For example, the capacity of each room on the fourth floor, which is 1960 cubic feet, was considered to be 2000 cubic feet.

[1] At this time we used 2 ounces of water to one ounce of acid and considered 30 cubic centimeters as the equivalent of 1 ounce.

In the fumigation, we attempted to treat one-fifth of the building each successive day. It is to be noted that there are three wings and a long front, twice as long as each wing. This affords a natural division of the building into five parts, each division containing an average of about 50 rooms. We begin on one wing by setting several men to calking the windows and transoms with strips of newspaper about three inches wide and thoroughly soaked in water. The paper is first torn into strips and then placed in pans of water, where it is allowed to remain until thoroughly soaked. These wet strips are then quickly and effectually applied to the top, bottom, and sides of each window and transom and to other cracks that may be found in the rooms.

At the same time two men are placing ordinary china washbowls in each room, with the proper amount of water and acid in each. Beside each bowl is also placed the proper amount of cyanide on a piece of newspaper spread flat on the floor.

We usually try to begin at such a time in the day that the rooms in one wing will be ready for fumigation at about 6 P.M. It takes the force enumerated about four or five hours to do this, so that we should begin about 1 P.M. As a matter of fact, the time varied considerably owing to unforeseen additional labor. When everything is ready, two men go to the top floor, and beginning at one end of the hall pass into opposite rooms, one man on each side of the hall, gather the edges of the newspaper in the fingers and pour the cyanide directly into the acid and water, and walk quickly out of the door, closing the door after them. There is little danger, apparently, in pouring the cyanide directly into the acid and water, if one does it coolly and quickly and holds the breath for a few seconds until the door is reached. The chemical reaction is very rapid and begins immediately, but by reaching the hand out over the bowl and then turning the head a little away and holding the breath a few seconds, we have never in all of our work — and we have always done it that way — experienced the slightest annoyance from the gas. By passing rapidly down the hall from room to room and floor to floor two men will set the whole 50 rooms off in ten or fifteen minutes.

Our success was very gratifying indeed, although we had some complaints of bedbugs in a few rooms late in the season. This, in most instances, could be traced to some old wooden bedsteads, that had not been fumigated, and which were to be thrown out and destroyed, but which were used afterwards by students who, coming late in the session and finding these old bedsteads, utilized them instead of buying new ones. In a few cases it was probably due to the large cracks around the doors, through which the gas dissipated itself into the halls. To obviate this difficulty we tried a plan later that seemed to work very well and proved more effective.

Instead of calking all the rooms in a division we simply calked the rooms on the top floor of that division first and then fumigated them at once. As the operator would close the door of a room, two men, who stood ready with water-soaked strips of paper, would quickly seal the cracks around the edges of the door and the keyhole. These two men would calk a door in less than two minutes and the rooms must have been made as tight as is possible under average conditions. All of the rooms on that floor were treated in this way, after which the force passed to the floors below in succession, treating each in the same manner. Although it took about one hour to treat each floor, not the slightest inconvenience or annoyance was experienced by the men from the gas on the floor or floors above. There is another advantage in this method. Where the sun shines in windows the strips of paper, although we used three thicknesses and soaked them thoroughly, were apt to dry and curl away from the cracks if left too long. By treating a floor as soon as ready, we obviate this difficulty and get the full effect of the gas.

Points that should be kept in mind. — It is claimed that better results will be obtained when the temperature of the rooms is maintained at 70 degrees F. or above than at 50 degrees or below. Most insects become inactive and torpid at temperatures below 50 degrees and in this condition are apparently less easily affected by the gas. For this reason the fumigation had probably best be done in the summer if possible.

In pouring the acid great care should be taken to prevent it from spattering on the hands and face.

The cyanide, to give most complete chemical reaction, should be broken up into pieces about the size of hickory nuts. This is best done on a hard brick or cement pavement. The hands should be protected with gloves and washed at intervals to remove the fine particles of cyanide from the skin.

The doors of the house under treatment should be locked and conspicuous signs of danger should be placed at the main entrances.

The work should be done by a calm, thoughtful, and careful person — best by one who has had some experience.

The gas is lighter than air and one should always start in the rooms at the top of the house and work down.

Empty the contents of jars, after the fumigation is over, in the sewer or other safe place. The jars are perfectly good to use again for any purpose but, of course, should be thoroughly washed to remove all traces of the acid and cyanide.

CARBON BISULFIDE

The vapor of carbon bisulfide was probably first used to kill insects about the middle of the nineteenth century. Since that time its use for this purpose has steadily increased until now it is counted among our most useful insecticides.

Carbon bisulfide is a colorless water-like liquid one-fourth heavier than water. When pure, it has a not unpleasant odor and will not stain or injure the finest fabrics. The commercial product, however, has a slightly yellowish tinge and a most unpleasant odor, due to its impurities. The commercial product is apt to leave a slight residue after evaporation and therefore usually leaves a stain on the fabrics which it touches. Carbon bisulfide evaporates very rapidly when exposed to the air. The vapor, which is 2.63 times heavier than air, settles rapidly downward. Unfortunately, it is both inflammable and explosive. It ignites at 300 degrees F., and therefore cannot be approached with a lighted lantern, lamp, pipe, cigar, or with fire in any form.

Effect of vapor on man. — The vapor of carbon bisulfide is poisonous to man, but it is not nearly so virulent as hydrocyanic acid gas. When large quantities of the vapor are inhaled for a considerable period, it produces giddiness, followed by vomiting and finally death if the inhalation continues long enough. Those who have worked with carbon bisulfide find the effects of continued inhalation of the gas to be about as follows: the unpleasant odor first disappears, showing that the sense of smell becomes deadened; the heart beats more rapidly and all of the senses become gradually deadened, so that the operator does not realize that anything is wrong with him; before this effect has proceeded far enough to be dangerous the operator becomes giddy and loses all sense of pain. When this stage is reached, the operator should go at once into the fresh air, after which all the unpleasant effects will soon disappear. The danger of inhaling the vapor of carbon bisulfide is very slight indeed compared with that of breathing hydrocyanic acid gas. Really there is very little danger in the use of this liquid because circumstances under which one could inhale enough of the vapor to cause death could hardly occur unless one were accidentally locked in a room for some time with a quantity of the gas.

Its insecticidal power. — The power of carbon bisulfide vapor to kill insects varies with the species of insects, with the material in which the insects are living, with the tightness of the box or room in which the gas is liberated, with the amount of gas used, and with the period of time over which the insects are exposed to the gas. For instance, the grain moths are killed more easily than the grain weevils. Adult insects are killed more easily than the larvæ and pupæ in their burrows in grains of corn and wheat. Adult insects when free in a room are more easily killed than when burrowing in the depths of bran, flour, or meal. The vapor is much more effective in a tight room than in one with many openings. Finally, the vapor is apt to be more efficient if its effect is continued over a long period than over a short one.

Unfortunately, the vapor does not penetrate dry cereals, like flour, bran, and meal, as thoroughly as it ought, to give wholly satisfactory results. Smith found that three pounds of carbon bisulfide to one thousand cubic feet in a practically air-tight room for twenty-one hours did not kill over 70 per cent of the larvæ and pupæ of the Angoumois grain moth or rice weevil. It did, however, kill practically all of the adults.

Again, the effect of the vapor on flour has been carefully noted by Harcourt. He fumigated a sample of flour with carbon bisulfide for twenty-four hours. From this sample he made three different bakings, varying from two to two and one-half months apart. In each case the flour treated with the carbon bisulfide did not produce as good bread as the untreated, normal wheat flour. "The loaves were smaller, darker in color and poorer in texture and in general appearance." However, the third baking was the best and showed that the flour was recovering from the effects of the vapor. Probably all effects of the vapor would have disappeared in time.

It is generally said that even when the carbon bisulfide is poured directly upon food-stuffs their edibility is not impaired. All trace of the odor disappears in a short time after exposure to the air. Undoubtedly, this is generally true and most food-stuffs are not injured. Despite the objections already noted to the use of carbon bisulfide, it still remains one of our most useful insecticides for certain insects.

Directions for its use. — In the first place, the room which is to be fumigated must be as near air-tight as possible. If it is full of openings and cracks, satisfactory results must not be expected. Whenever practicable, it would be best to place the material to be fumigated in a tight box or barrel. In any case, two or three pounds of the carbon bisulfide should be used to every one thousand cubic feet of space. The fumigation should extend over a period of at least forty-eight hours and the temperature should be from 65 to 75 degrees F. The larger the surface of the liquid there is exposed to the air the quicker it will evaporate and the greater volume of gas there will be in the room at a given time. Therefore, the liquid should be exposed in wide shallow pans or poured directly upon the material.

One of the most convenient ways to fumigate peas, beans, corn, or similar seeds is to place them in a tight box or barrel and fill the receptacle to within eight or ten inches of the top. The requisite amount of carbon bisulfide should then be poured into a wide shallow pan and set on top of the seed. As quickly as possible the top should be covered air-tight. Perhaps several thicknesses of newspapers or building paper with thick blankets over these would make the opening tight. The fumigation should be allowed to extend over a period of forty-eight hours at least and no fire in any form should be brought near the receptacle until it has been opened and well aired.

SULFUR

The fumes of burning sulfur, sulfur dioxide, have long been used as a disinfectant and insecticide; but since the fight against the malarial and yellow fever mosquitoes this gas has assumed an added importance. It is used almost entirely by city health boards, physicians, and investigators in fumigating rooms and buildings to destroy mosquitoes. The gas is produced by burning flowers of sulfur or lump sulfur.

There are certain objections to the use of sulfur as a fumigant in the household. The gas is liable to bleach wall papers and fabrics and to tarnish metals, like brass, copper, silver, and gilt. The bleaching effect will depend upon the amount of moisture present in the rooms. It is desirable, when fumigating with sulfur, to have the buildings and contents as dry as possible in order to avoid the formation of sulfuric acid which causes the bleaching. Again, it has been shown that the gas affects the baking qualities of wheat flour at least. It is presumable that the fumes would also affect other ground cereals used for baking, as graham flour and meal. Harcourt has shown that wheat flour fumigated with sulfur dioxide makes very sticky, fluid-like dough that is not at all satisfactory. He has also shown that the loaves baked from this flour did not rise well and were smaller in volume than those from the untreated flour. Moreover, sulfur fumes, when used strong enough to kill insects in grain, destroy the germinating power of the seeds. The grain is not injured for purposes of food, but its usefulness for planting is destroyed. This fact should be borne in mind when using sulfur as a fumigant in the household. Corn, wheat, or other grains stored for seed planting purposes should be removed and not subjected to the action of the fumes.

Notwithstanding these objections, sulfur dioxide is now considered the most reliable of all fumigants in epidemics of yellow fever and in all cases where mosquitoes are concerned.

Howard says that Rosenau of the U. S. Public Health and Marine-Hospital Service has made a rigid series of experimental tests with sulfur dioxide and concludes that it is unexcelled as an insecticide. "He shows that very dilute atmospheres of the gas will quickly kill mosquitoes, and that it is quite as efficacious when dry as when moist. He shows that it has surprising power of penetrating through clothing and fabrics, and that it will kill mosquitoes even when hidden under four layers of toweling in one hour's time and with very dilute proportions."

Directions for use. — The rooms to be fumigated are made as tight as possible in the same manner as described in the case of hydrocyanic acid gas. All objects of a metallic nature should be removed or tightly covered with paper or coated with vaseline. The sulfur should be used at the rate of 2 pounds to each 1000 cubic feet of space. If the room is rather open, this quantity may be increased. The sulfur may be burned by putting it in an old kettle, baking pan, or similar dish that is not held together with solder, and setting it on bricks or in a pan of cold ashes to keep it from burning the floor. A teacupful of wood alcohol poured directly into two pounds of sulfur and then lighted will serve to burn the sulfur completely and readily. Sulfur in the form of candles is for sale at most drug stores. These are particularly convenient because they burn readily when lighted. The following directions for fumigating with sulfur dioxide given out by the health authorities of New Orleans cover the ground so clearly that we repeat them here: —

"Remove all ornaments of metal, such as brass, copper, silver, and gilt from the room that is to be fumigated. All objects of metallic nature which cannot be removed can be protected by covering the objects tightly with paper, or with a thin coating of vaseline applied with a brush.

"Remove from the room to be fumigated all fabric materials after thoroughly shaking. Open all drawers and doors of furniture and closets.

"The room should be closed and made as tight as possible by stopping all openings in chimney, floor, walls, keyholes, and cracks near windows and doors.

"Crevices should be closed by pasting strips of paper (old newspapers) over them with a paste made of flour.

"The sulfur should be placed in an iron pot, flat skillet preferred, and then placed on bricks in a tub or other convenient water receptacle with about an inch of water in the bottom. This is a precaution which must be taken to guard against accidents, as the sulfur is liable to boil over and set fire to the house.

"The sulfur is readily ignited by sprinkling alcohol over it and lighting it.

"The apartment should be kept closed for two hours, and then opened up and well ventilated."

FORMALDEHYDE NOT AN INSECTICIDE

Formaldehyde is a gas with a very penetrating odor, intensely irritating to the mucous membranes of throat and mouth, but not a poison in the generally accepted use of that term. It is an excellent disinfectant, for it is fatal to those minute plants known as bacteria or loosely as "germs." The gas is sold in the form of an aqueous solution under the name of formalin, which is supposed to contain 40 per cent of formaldehyde.

Formaldehyde is particularly desirable as a fumigant for disinfection because it does not corrode metallic substances with the exception of unpolished steel and iron which it attacks slightly. The gas does not bleach or injure household fabrics. It is also a real deodorant, for it acts chemically upon the gases causing the odor, and forms others without any smell.

Notwithstanding all the good points in favor of formaldehyde as *a disinfectant it is not an insecticide.* Although it will kill those minute plants, bacteria, it will not kill, to any extent, those small animals, insects. There are several experiments on record to show that formaldehyde will kill very few insects even when unusually large quantities of the gas are liberated in an air-tight space.

"The Public Health and Marine-Hospital Service report formaldehyde as not possessing insecticidal properties against mosquitoes." C. L. Marlatt proved by experiment that even though the gas was generated to three or four times the amount necessary for disinfection purposes it only killed a few angoumois grain moths and apparently did not injure bean weevils at all. C. P. Lounsbury, South Africa, reports that the gas did not kill bedbugs although it apparently killed some house-flies and aphids during an exposure of two days. Lampert of Germany found that formaldehyde would not kill insects. M. V. Slingerland found that bedbugs and cockroaches were not killed after a thorough fumigation for twenty-four hours.

All the evidence the writer can find seems to show conclusively that formaldehyde has so little value as an insecticide that it should never be used for that purpose.

THE USE OF HEAT AGAINST INSECTS

Within the last few years heat has been used to some extent in mills in the western part of the United States, at least, to kill mill insects. From the experiments and reports of Dean of Kansas it would seem that heat is a very efficient and satisfactory agent for destroying insects infesting grains in mills. There seems to be no reason why it would not be efficient for killing household insects if it can be made available. The temperatures necessary to kill stored grain insects are not high. They range from 118 degrees to 125 degrees or above. It is doubtful, however, if it would be possible to develop even these degrees of heat in most households. It might be done in hotel kitchens and similar places where there are large boilers and ranges. In ordinary kitchens the range might be supplemented by one or two oil-stoves or a gas heater and the temperature raised to the desired point.

Felt has shown that cockroaches succumb to a heat of 120 degrees. A temperature of at least 120 degrees should be maintained for an hour or more to give it time to penetrate to the insects. In the case of mills the heat is maintained several hours to allow it to penetrate all the infested parts.

Heat is undoubtedly of great use in killing powder-post beetles in furniture, and similarly infested wood. The practical use of heat in killing household insects has never been investigated, in this country, at least, and no definite recommendations can be made. The writer would suggest that before attempting to raise the temperature of a room it should be made as tight as possible in order to prevent the escape of the heat.

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