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No. 194

ALBANY, N. Y.

FEBRUARY 1, 1917

The University of the State of New York
New York State Museum

JOHN M. CLARKE, DIRECTOR



HOUSEHOLD AND CAMP INSECTS

By EPHRAIM PORTER FELT Sc.D.

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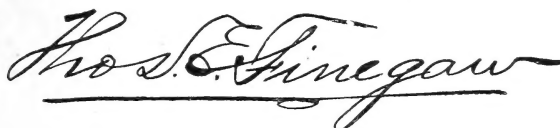
I beg to transmit herewith and to recommend for immediate publication as a bulletin of the State Museum, the accompanying manuscript which is entitled *Household and Camp Insects*, which has been prepared by Dr E. P. Felt, State Entomologist. This manuscript is accompanied by the necessary illustrated material, practically all of which is to be reprinted from previous bulletins of this Department.

Very respectfully yours

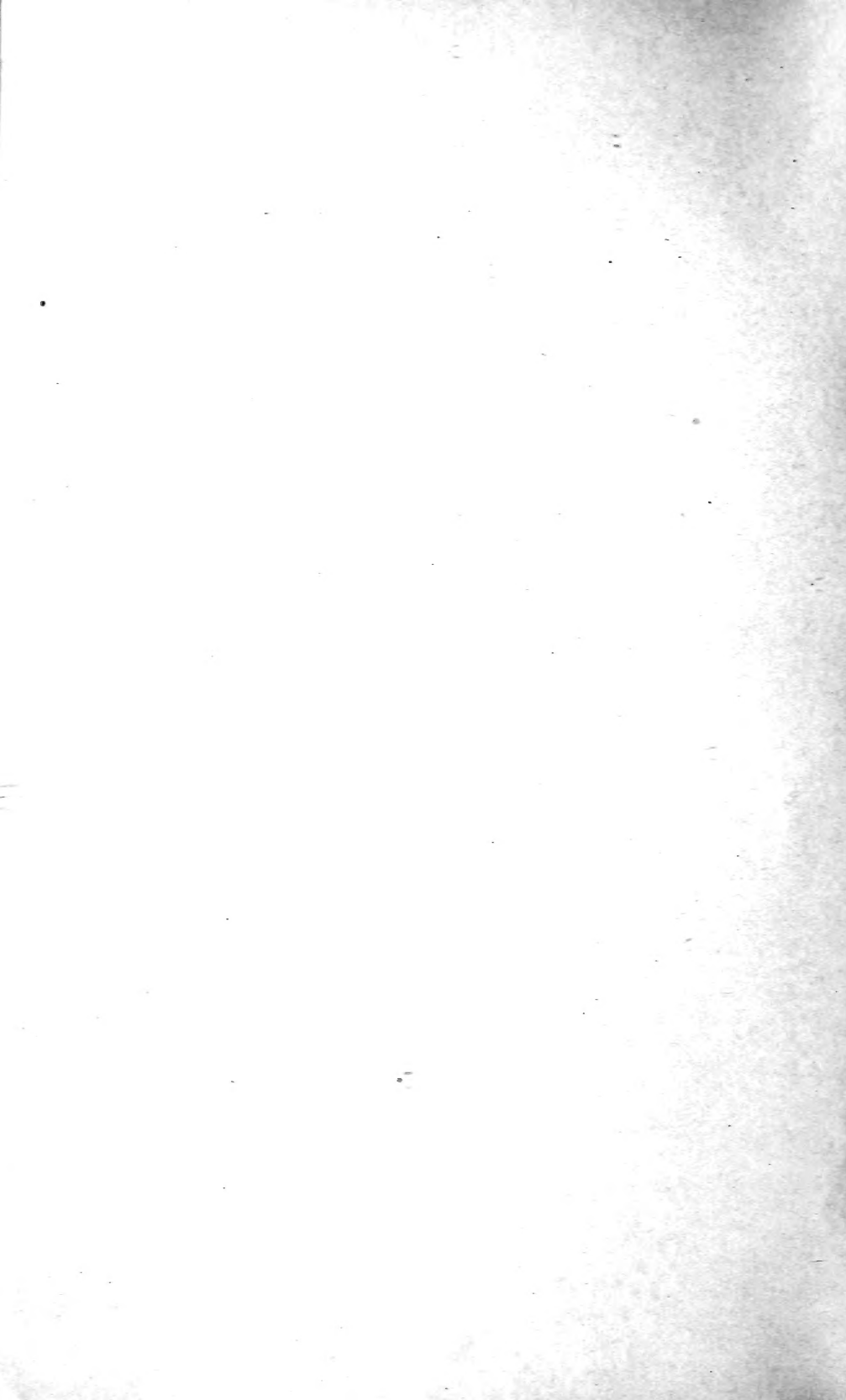
JOHN M. CLARKE
Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this
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Deputy Commissioner of Education



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JOHN M. CLARKE, Director

HOUSEHOLD AND CAMP INSECTS

BY EPHRAIM PORTER FELT SC.D.

INTRODUCTION

The almost constant demand for information relating to household insects has resulted in practically exhausting the edition of Museum Bulletin 136 dealing with the control of flies and other household insects. There have been since the above-mentioned bulletin appeared several important discoveries in relation to remedial measures, in particular the availability of dilute solutions of arsenite or arsenate of soda and the comparatively inexpensive and nearly harmless sodium fluoride for the destruction of ants and some other insects, and the efficiency of superheating. The household insects are, broadly speaking, the camp and field pests of man, and since under army conditions the need for control in the one situation or the other may alternate rapidly, it was considered advisable to cover both phases in this publication. There have been added, largely for convenience, brief discussions of control measures for a few of the more important pests of domestic animals.

The rôle played by insects as carriers of disease is appreciated only in part. The movement and intermingling of large bodies of men having different sanitary ideals is a menace to those with higher standards, and this danger is not lessened by the present disturbed conditions of commerce. Fraternization, voluntary or involuntary, has its perils as well as advantages. Important lessons in the control of insects under camp and field conditions have been learned during the great struggle now approaching its third anniversary. A general knowledge of the habits of these pests and methods of controlling them, unpleasant though it may be, means greater comfort, better health and increased efficiency.

It will probably be impracticable for some years to come to keep dwellings entirely free from insects, yet it is feasible to prevent pests becoming uncomfortably numerous in houses and in the vicinity of dwellings and to make it nearly impossible for insects to gain access to disease germs and thus serve as carriers of dangerous infections.

FLIES

There are a number of flies which occur in houses, about buildings, stables and camps. The house fly is the most important and frequently comprises about 98 per cent of those found in dwellings. The cluster fly and various meat or blow flies are the insects usually seen in houses during the winter or early spring. The house fly appears comparatively late. Each species of fly has its peculiar habits, which must be taken into account in any serious attempt to solve the fly problem, though broadly speaking conditions favorable or unfavorable to the breeding of one species of fly are very apt to have a corresponding effect upon other species. Flies are active, with keen senses, and consequently readily find attractive food or breeding conditions even at considerable distances. For example, Bishopp *in lit.* states that he succeeded under rural conditions in recovering a considerable number of house flies and several species of blow flies at distances of 5 miles from the point of liberation. Exact knowledge of the preferences or the behavior of flies is essential to successful control.

The effect of environment upon flies was shown by the fact that from 800,000 to 500,000,000 aerobic bacteria to a fly were found on insects taken in either insanitary or congested city areas, while the number for those captured in the more sanitary or less-congested suburban districts ranged from 21,000 to 100,000. It was also found that flies caught in milk shops apparently carry more bacteria than those from other stores handling exposed food in similar neighborhoods. The reason is probably because milk, when accessible during the summer months, is a suitable culture medium for bacteria, and the flies first inoculate the milk, later reinoculate themselves, and then more of the milk, thus establishing a vicious circle.¹

House flies, blow flies and flesh flies are the more prevalent species about packing houses and abattoirs. The common black blow fly, *Phormia regina*, is the most troublesome, and is often supplemented in the middle of the season by green flies,

¹ Cox, Lewis & Glynn. Jour. Hyg., 12:290-319. 1912.

Lucilia, and the large blue bottle flies, Cynomyia and several species of Calliphora.²

The effect of insanitary conditions and favorable weather changes is strikingly exemplified in the following: In February and March 1909 it was unusually cold at Cairo, Egypt. April 24th heavy rains fell, followed by a hot wave May 1st and by the appearance 14 days later of a plague of flies, the latter evidently having bred in the accumulated filth which, moistened and warmed, afforded almost ideal breeding conditions.³

House Fly

Musca domestica Linn.

The house fly is most easily recognized as the rather slender, dull-grayish insect some one-quarter of an inch long, which abounds in and about dwellings during warm weather, especially in mid-summer. It is easily distinguished from the stouter, metallic-blue or green bottle flies or meat flies occasionally seen in houses, especially about meats.

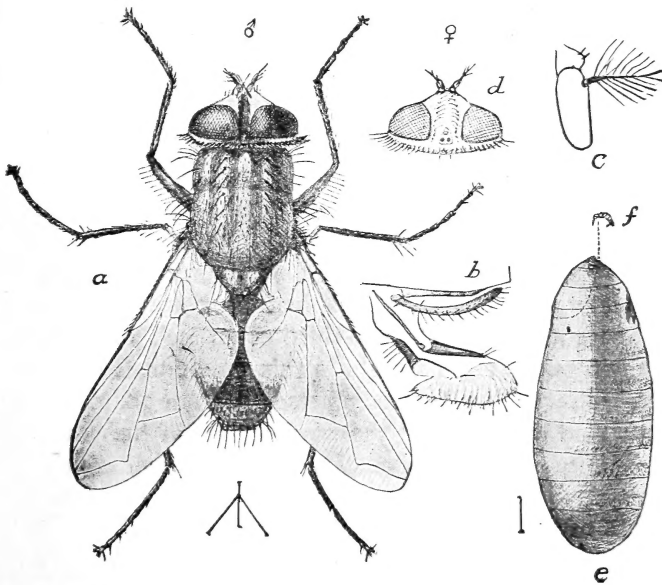


Fig. 1 Typhoid or house fly; *a*, male, seen from above; *b*, proboscis and palpus from the side; *c*, tip of the antenna; *d*, head of female; *e*, puparium; *f*, the anterior breathing pore or spiracle, all enlarged. (After Howard & Marlatt, U. S. Dep't Agr. Div. Ent. Bul. 4 n. s. 1896)

² Bishopp Jour. Econ. Ent., 10:269-77. 1917.

³ Ross. Sci. Amer. Supp., 2003, p. 322-23, May 23, 1914.

Description. The egg of the house fly is a slender, whitish object, grooved on one side somewhat like a grain of wheat, and only one-twentieth of an inch long.

The maggot or, more properly, larva, is whitish, at first very small, and when full grown about one-third of an inch long. The body tapers from the large, nearly truncated posterior extremity to the slender head.

The resting or transforming stage, known as the puparium, is oval, brownish, ringed and scarcely one-quarter of an inch long.

Habits. The house fly breeds by preference in horse manure, though it occurs to a limited extent in cow manure, human excrement and miscellaneous collections of organic matter.

It winters in the latitude of New York probably mostly as a larva, possibly sometimes in the puparium. The work of Dove⁴ in Texas shows that even in that southern latitude the house fly does not winter as an adult, though when breeding media have a temperature of from 46° F. to 65° F. adults may emerge from puparia, a process which may continue through most of the winter during mild weather. Repeated observations in New York State convince the writer that the house fly appears relatively late in the spring, from early May to June. There is, following issuance, an interval known as the preoviposition period, during which no eggs are deposited. This may range in Texas from 4 to 20 days, the usual time during the summer being from about 4 to 9 days.⁵ The eggs are deposited upon manure and other suitable material. The flies penetrate to only a very slight extent into dimly lighted or dark places in order to deposit eggs.⁶

The maggots hatch in less than 24 hours, and complete their growth under favorable conditions in from 5 to 7 days. The white, conical maggots, then about one-third of an inch long, transform to oval, brown puparia and remain in this condition from 5 to 7 days. The life cycle is therefore completed in from 10 to 14 days, the shorter period being true of the warmer part of the year, especially in the vicinity of Washington, D. C., and farther south. One fly may deposit 120 eggs, and there may be 10 or 12 generations.

Recent observations⁷ show that the maggots or larvae thrive only in substances which are more or less alkaline, and that they are unable to develop to maturity in the presence of comparatively small amounts of organic or other acids. They are also sensitive to

⁴ Jour. Econ. Ent., 9:528-38. 1916.

⁵ Bishopp, Dove & Parman. Jour. Econ. Ent., 8:54-71. 1915.

⁶ Felt. Jour. Econ. Ent., 3:24-26. 1910.

⁷ Evans. Jour. Econ. Ent., 9:354-62. 1916.

excessive moisture and are found only in the dryer portions of manure heaps. It is stated that while this insect breeds in large numbers in stable refuse stored close to buildings, the open pile located far from houses is but little frequented by house flies.⁸ It is possible that the state of fermentation is more important than proximity to dwellings or other shelters, though the latter doubtless have an influence. The maggots thrive only in certain portions of the manure pile, namely, in a layer some inches deep and lying a few inches below the surface where there may be found a moderate amount of heat and moisture, an excess of either being fatal or compelling migration. They can exist to only a relatively slight depth in well-packed manure.⁹ It has been shown that 98 to 99 per cent of the maggots occurring in manure can be driven out, provided there is sufficient moisture.¹⁰ The full-grown larvae (at least 70 per cent) prior to changing to the resting or pupal stage, desert the earlier habitat for dryer portions of the pile, or may leave it entirely and transform in the soil a foot or two away.

The investigation of fly conditions in a western city resulted in trapping approximately 96,000 flies representing some 25 species, over 88,000 being house flies. The others present in greatest numbers were *Muscina stabulans*, *Lucilia sericata* and *Phormia*. Probably 90 per cent of the flies taken on garbage were house flies, while of those captured in the open with human excrement as a bait, nearly 21 per cent were various species of flesh flies or sarcophagids.¹¹

The favorite breeding place of the house fly is horse manure, though cow manure, especially if there be present a little straw or ensilage, may prove to be an important breeding medium. Chicken manure is an acceptable breeding place when moist.¹² Flies were reared in large numbers from waste ensilage, and infestation also occurred in the silo, especially near the edge where decomposition had begun. It was not necessary that the material be soaked with urine.¹³

Garbage produced 22 per cent each of the house fly and *Phormia regina*, 50 per cent *Lucilia sericata*, and some other flies at Boston, Mass.¹⁴

⁸ Eltringham. Jour. Agr. Sci., Cambridge: 7:443-57. 1916.

⁹ Hewitt. Jour. Econ. Ent., 7:281-89. 1914.

¹⁰ Hutchinson. U. S. Dep't Agr. Bul. 14. 1914.

¹¹ Parker. Mont. State Bd. Ent., 1st Rep't, p. 38-50. 1914.

¹² Richardson. N. J. Agri. Exp. Sta. Rep't, p. 382-99. 1915.

¹³ F. B. Milliken. Jour. Econ. Ent., 4:275. 1911.

¹⁴ Paine. Psyche, 19:156-59. 1912.

Some idea of the varied materials in which the house fly breeds may be gathered from the following: decaying potatoes, decaying melons, mixtures of kitchen refuse, paunch contents from animals, bases of stacks of straw or wheat which have become well rotted, ensilage scattered about silos or troughs, chicken manure in poultry houses, fermenting cotton seed hulls mixed with bran, etc.¹⁵ In fact, a considerable variety of organic materials, provided there is sufficient moisture and heat and not too much acid, are potential breeding places for this insect and a number of its associates.

Experience shows that ordinarily flies do not travel great distances, and in most instances probably breed within 300 or 500 feet of the places where they are extremely abundant. This is supported by the fact that very frequently the elimination of a nearby breeding place, such as the removal of a horse from an adjacent barn, is followed by a marked reduction in house flies. Nevertheless recent studies¹⁶ by Parker led him to conclude that the house fly is more or less of a migratory insect, and he has succeeded repeatedly in capturing marked flies a mile or more from the place where they were liberated, even under conditions where it was necessary for the insects to cross a small city with its numerous attractions and traverse comparatively unattractive prairie. There is in addition the record given above of house flies being taken in considerable numbers 5 miles from the point of liberation. A plague of flies on cribs and water works situated $1\frac{1}{4}$, 5 and 6 miles in Lake Erie¹⁷ indicated an extended movement or drifting under certain conditions. These records presumably show the approximate maximum flight or drifting rather than the normal spread of large numbers, relatively speaking. The dissemination of these insects is very probably proportional to the attraction and more or less related to weather conditions and air currents. House flies tend to travel either against or across the wind, probably being influenced largely by odors, and fine weather and warm temperatures are important factors.¹⁸ It is well known that flies may be carried by vehicles of various kinds, especially butcher carts, grocery wagons and electric or steam cars, though it is probable that these agents transport relatively small numbers of insects. These, however, might be important if the flies were carried from centers where contagion abounded.

¹⁵ Bishopp, Dove & Parman. *Jour. Econ. Ent.*, 8:54-71. 1915.

¹⁶ Parker, R. R. *Jour. Econ. Ent.*, 9:325-54. 1916.

¹⁷ Hodge. *Science*, 38:512-13. 1913.

¹⁸ Hindle & Merriman. *Jour. Hyg.*, 14:24-25. 1914.

Disease and flies. The feeding habits of the fly admirably adapt it to the spread of disease. It is well known that moist materials, such as various foods or pathogenic discharges from the human system, are attractive to these insects, and there is abundant evidence to show that they pass quickly from one to the other. The fluids are sucked up into the crop and at times may be regurgitated. The crop contents of a fly may literally swarm with disease germs, especially in insanitary areas, and investigators have demonstrated that certain disease germs may pass through the digestive tract of the fly in a viable condition. This means that disgorged material from the crop, the normal dejecta of the fly, and any particles from the hairy legs or bodies may convey a serious, if not deadly, infection. Flies are active agents in the dissemination of typhoid fever and other diseases of the digestive tract, such as cholera and summer diarrhoea of children, and carriers of the germs of tuberculosis, anthrax, plague, trachoma, septicemia, erysipelas and yaws. There is also evidence to show that the house fly is a probable carrier of trypanosomiasis.¹⁹ It is very probable that other infections may be conveyed by this insect, and the obvious deduction is that it is an extremely dangerous pest in all places where pathogenic material may be exposed.

The typhoid outbreak in army camps during the Spanish War was due in very large measure to flies carrying disease from latrines to mess tables. It is particularly dangerous under such conditions to eat cold foods of any kind. This is exemplified by a typhoid outbreak occurring in the Minnesota iron range where there were abundant opportunities for fly infection. The Finns and Swedes, though far more cleanly in habits and environment than the Austrians and Italians, were chief sufferers, due to the fact, it is believed, that the former two lunched frequently during the day upon cold food which was freely accessible to insects, while the Italians and Austrians ate hot meals and used but little milk.²⁰

The effect of adequate precautions is shown by the following: Soldiers quartered on Brandywine creek, Pennsylvania, used as a sink an abandoned, bottomless canal boat in the Delaware river, and not a single case of intestinal disease occurred.²¹ Furthermore, infection with typhoid fever is much less frequent among messes

¹⁹ Darling. Internat. Cong. Hyg. & Demog. Trans., xv, sect. v, 1913.

²⁰ Washburn. State Ent. Minn., 13th Rep't, p. 135-41. 1910.

²¹ Skinner. New Orleans Med. & Surg. Jour., 61:950-59. 1909.

which have their mess tents screened than it is among those taking no such precaution.²²

The possibilities of infection can hardly be overestimated, when it is recalled that typhoid germs may be discharged from the human system several weeks before diagnosis is possible, continue in numbers 6 to 8 weeks after apparent recovery, and in exceptional cases may persist during a period of years, even though the individual is apparently in excellent health. Even the urine from such persons may contain living typhoid bacilli.

The first essential in view of the above is to prevent the spread of disease by the prompt disinfection of all discharges, both fluid and solid, from typhoid fever and other patients, thus making impossible, so far as individual cases are concerned, fly infection. Such treatment should include all cases where there is even a remote possibility of insects or other agents carrying the disease. A very cheap and effective disinfectant, according to Doctor Veeder, is a strong solution of common blue vitriol or sulphate of copper, a few pounds being sufficient for a hoghead full of disinfectant.

The greatest care should be taken to exclude flies from the sick room or hospital, especially where there are contagious diseases. The pests not only annoy the patients but may carry the disease to others. Accumulations of exposed fecal matter in the vicinity of human dwellings or camps should not be tolerated, since disease can be easily contracted from such sources. It should be remembered that deposits of human excrement in the open are equally dangerous and that there is a similar menace along the shores and about wharves where excreta are not properly cared for, and sewer mouths frequently exposed.

Fly control. The old-fashioned box privy should be abolished, unless it is conducted as an earth closet and the contents kept covered with lime or dry earth so as to prevent both the breeding and the infection of flies. This also applies to camp latrines. A modern water-closet and cesspool is by far the safest and best method of caring for these wastes.

Keeping manure and other fly-breeding materials in fly-proof pits, or the removal of all such matter at frequent intervals, is a most logical way of handling the problem, and though it appears easy, execution under practical conditions is difficult.

²² Anderson. Amer. Public Health Rep't. 34:97-105. 1909.

Manure from domestic animals should be stored in pits or cellars, removed, preferably at daily intervals and spread upon the fields, treated with a larvicide or disposed of in some manner which will make breeding impossible.

The essential in the manure pit is that it be fly-proof. It may be under or beside a stable and the trap or door through which the manure is thrown should, if possible, be moderately dark and at the other end, or above, there should be a fairly light window or fly trap in order to attract insects away from the entrance. This arrangement largely prevents the escape of flies whenever manure is thrown in or carried away.

The removal of manure, preferably at daily intervals in cases where there is no pit or cellar, if thoroughly done, means that local breeding is impossible if it be properly spread and that the contained eggs and young maggots quickly perish from exposure.

In Rouen heaps are made of old manure, which are dusted with quicklime, covered with earth and planted with grass or other seeds. A narrow gage line has also been used to convey manure to a natural depression where it is covered with quicklime and earth and then planted as above.²³

Larvicides. There are several larvicides which can be used for the destruction of maggots in the manure.

Hellebore, one-half pound to 10 gallons of water, applied to 8 bushels of manure, is an effective larvicide and not injurious to plants.²⁴

Borax used at the rate of two-thirds of a pound to 10 gallons of water and sprinkled over 8 bushels of manure is the least expensive and the most effective larvicide. Borax has an injurious effect on plant growth, and not more than 15 tons of manure treated in this way should be used to an acre in order to avoid the possibility of subsequent injury.

Iron sulphate, 2 pounds dissolved in a gallon of water and used at the rate of 1 gallon to 30 gallons of manure, will kill a very large percentage of the larvae, provided the iron sulphate is carefully mixed with the manure. Surface treatment is not entirely satisfactory.²⁵ Other workers report this chemical as unsatisfactory.²⁶

²³ Marette. Jour. Roy. Army Med. Corps, 24:359-66. 1915.

²⁴ Cook & Hutchison. U. S. Dep't Agr. Bul. 408. 1916.

²⁵ Richardson. N. J. Agr. Exp. Sta. Rep't 1914, p. 392. 1915.

²⁶ Cook, Hutchison & Scales. U. S. Dep't Agr. Bul. 118, p. 24. 1914.

Arsenical dip, extensively used in the West and Southwest to kill ticks on cattle and sheep, practically destroyed the larvae, and the same is true of potassium cyanide in solutions of .1 or .2 per cent. Neither of these preparations is recommended because of their very poisonous qualities.

Calcium cyanamid in mixtures with 2 to 4 pounds of acid phosphate proved effective in cages and boxes where the surface exposure of the manure was approximately 4 square feet. Used at the rate of one-half of a pound to a bushel of manure and mixed with acid phosphate or kainit, it showed an apparent larvicidal action of 98 per cent in open pile experiments.²⁷

Solutions of aniline 1 to 200, and emulsions of nitro-benzine (1 pound or one-half pound to one-half pound or one-quarter pound respectively of fish oil soap and 10 gallons of water) proved effective larvicides and did not injure the manure.²⁸

Aniline, betanaphthol, cresylic acid, paradichlorobenzine, formaldehyde, nitro-benzine, oxalic acid, kerosene emulsion, kainit, pyroligneous acid, sodium chloride, copper sulphate, lime-sulphur solution, Paris green and ammoniacal gas liquor have been tested and rejected either on account of inefficiency or cost. See United States Department of Agriculture Bulletins 118 and 245.

The treatment of waste organic matter with crude petroleum, or incineration, is a very effective check on fly development.²⁹

Residual oils of tar, oils freed of naphthalene and dephenolized, with the addition of resinate of soda, may be mixed with water in the proportion of 2.5 per cent to form an emulsion which may be spread as a thin film over extended surfaces of decomposing matter. It repels Diptera and largely reduces stench.³⁰

Maggot traps. These, if properly operated, will destroy 98 to 99 per cent of the larvae.³¹ They depend for efficiency upon the migrating habit of the full-grown larvae, a movement which is greatly accentuated when the manure is well moistened, though about 70 per cent of the maggots will leave moderately dry manure. The simplest plan is to place manure upon a low rack over a shallow pool of water, preferably with bottom and sides cemented, into which escaping larvae drop and are drowned. The efficiency of the

²⁷ Cook & Hutchison. U. S. Dep't Agr. Bul. 408, p. 18. 1916.

²⁸ Cook & Hutchison. U. S. Dep't Agr. Bul. 408, p. 19. 1916.

²⁹ Bishopp. Jour. Econ. Ent., 10:269-77. 1917.

³⁰ Rev. Appl. Ent., 3:169. 1915.

³¹ Hutchison. U. S. Dep't Agr. Bul. 14, Feb. 28, 1911.

device is greatly increased by systematic moistening of the manure upon the rack.

A modified maggot trap consists of a series of tins placed at intervals along the edges of the manure pile, each containing several inches of sand or chaff and sunk so that slits cut in the tins are flush with the surface. The migrating maggots find suitable quarters in these tins, and may be destroyed in large numbers.³²

Another type of maggot trap especially effective against blow flies and flesh flies consists of wire netting containing pieces of meat, fish or similar material suspended over a trough or vessel partly filled with iron sulphate solution. The insects oviposit upon the bait and the maggots are destroyed as they drop into the solution below.³³

Fly poisons. Formaldehyde, a 40 per cent solution, diluted with five or six times its volume of water or milk, is one of the safest and most effective. A little sugar or other sweet may be added to the solution. Put the mixture in shallow dishes in places where flies are numerous. This will be more effective if a little bread is added and water or other fluids attractive to flies are not near at hand.

Sodium salicylate in a 1 per cent solution is slightly less efficient than formaldehyde. It is less objectionable in a concentrated form, is a solid which does not lose its strength, and in the preparation of the solution a considerable variation in strength is permissible. Furthermore, it can be used on fly papers.³⁴

Cobalt is reported as of variable efficiency and peculiarly attractive to flies when used with bread, while bichromate of potash is practically of no value.³⁵

Arsenate of soda 4 pounds, molasses 2 quarts and water 50 gallons, applied to manure kills 98 per cent of the maggots, provided enough is used to moisten the surface thoroughly.³⁶ It or similar preparations also destroy flies and their eggs.³⁷ Arsenate or arsenite of potash may be substituted, and when sprayed on plants in the garden, or applied to bunches of straw hung outside of houses, results in the speedy death of many flies.³⁸ The deadliness of this poison is a serious drawback to its general use.

³² Murette. *Rev. Appl. Ent.*, 4:20. 1916.

³³ Noel. *Rev. Appl. Ent.*, 2:68. 1914.

³⁴ Phelps. *U. S. Pub. Health Rep'ts.* 31:3033-35. Washington. Nov. 1916.

³⁵ Morrill. *Jour. Econ. Ent.*, 7:268-74. 1914.

³⁶ Howard. *State Ent. Minn.* 15th Rep't, p. 57-60. 1914.

³⁷ *Rev. Appl. Ent.*, 3:170. 1915.

³⁸ Berlese. *Redia*, 8:462-72. 1913.

Fumigants. Phenol-camphor is prepared by heating and liquefying carbolic acid crystals and then pouring the fluid over an equal quantity of camphor gum. Fumigation with 4 ounces of this to 1000 cubic feet of space, continued for 2 hours, destroys flies and mosquitoes. The phenol-camphor is vaporized by heat. Not more than 8 or 10 ounces should be placed in a basin, preferably of agate-ware, and rapidly volatilized over a lamp or other flame, care being taken not to overheat the dish or ignite its contents.³⁹

Formaldehyde 40 per cent, used at the rate of 1 pound to 8 ounces of potassium permanganate to each 1000 cubic feet of space, destroyed practically all flies, provided the room was left closed for 4 hours. The permanganate should be spread evenly over the bottom of a large enameled pan and the 40 per cent formaldehyde (undiluted) poured over it, the room previously being made nearly gas-tight.³⁹

Fly baits. Flies are attracted to very many organic compounds. Sweet milk combined with bread is one of the best, though it is not considered by some equally attractive as formalin or alcohol mixtures. Beer is very attractive. Overripe fruit and stale meat draw many flies. Dry blood is more attractive than flesh and decomposed meat or fish. The offensive odor of some of the above precludes their use as bait in many places.

Sticky fly papers are very generally employed for capturing these pests indoors. There are several forms upon the market, all cheap and mostly very effective.

The following mixtures are recommended for trapping flies in case the commercial fly papers are not readily available: (1) 6 parts colophony, 4 parts rape seed oil, 3 parts resin, melted together; (2) 8 parts resin, 4 parts each of turpentine and rape seed oil, $\frac{1}{2}$ part honey; (3) 1 pound resin, 3 ounces each of molasses and linseed oil, boiled together to form a thick paste.⁴⁰

Fly traps. Various designs have been used somewhat extensively during the last few years and are of material assistance, particularly in keeping flies out of dwellings or other shelters, and there is no reason why they should not be used to some extent, at least, in stables and barns. They are simple in construction, by no means expensive, and require little attention. The essentials are an attractive bait, readily accessible to the insects and so arranged that after feeding, the flies will naturally ascend toward the light and

³⁹ Howard, State Ent. Minn. 15th Rep't, p. 57-60. 1914.

⁴⁰ Rev. Appl. Ent., 4:53. 1916; Queensland Agr. Jour., 4:352.

enter the trap either through a long slit or a small circular hole, depending upon whether the trap is box-like or cylindrical. The larger barn traps may have a length of 2 feet, a height of a foot or so, and a width of about 8 inches. The baseboard carries the bait to which the flies gain ready access and is covered by slanting wire walls, so that the flies, when through feeding, pass up into the screen-covered body of the trap. Provision should be made for the ready removal and destruction of the insects. Small wire traps,

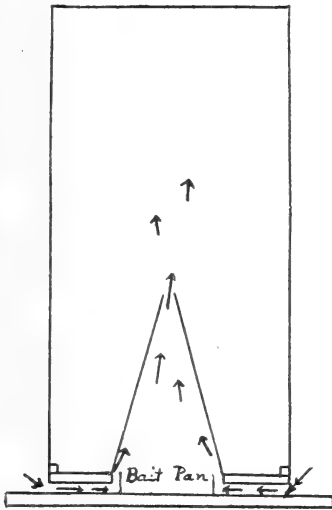


Fig. 2. Sectional diagram of Minnesota fly trap. (Author's illustration)

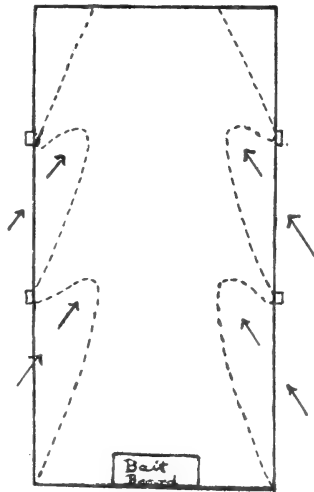


Fig. 3. Sectional diagram of the Hodge barn trap. The dotted lines show the approximate position of the wire screen. (Author's illustration)

suitable for dwellings, are readily available, and it is comparatively easy to make larger ones from materials at hand. Barrel hoops supported by perpendicular strips form a very convenient framework for a cylinder of wire within which may be fitted the cone, and below which should be attached a feeding board. It is then necessary only to provide for the easy destruction and removal of the captured insects.

A modified box trap can be inserted in the wall of a manure pit, thus capturing all flies which try to escape, or it may be double, adjusted to a suitable window, and arranged so as to catch flies both as they attempt to enter and leave. This last was devised by Professor Hodge.

Camps and fly control. The control of flies under camp conditions is difficult, and the following excellent summary gives the essentials in a successful effort to keep these pests within bounds:

Flies breed in scrapings from the picket line as well as the better known materials, such as kitchen garbage.

Excreta were cared for in the usual fly-proof latrine boxes, the pits being burned out daily with crude oil and hay, filled up, and new ones dug when necessary. Solid matter from the kitchen was burned on open fires, the liquids being evaporated by one means or another on these or on separate fires.

Picket lines were scraped daily, burned once a week, and the material hauled to the dump along with ashes and burned tin cans from the kitchen.

Preventive measures consisted in burning kitchen garbage, in cleaning the picket lines each morning, particular care being taken to prevent holes, and once a week the surface was burned off in the usual manner. A space was marked on the dump and all scrapings from the picket lines were hauled out and spread over this area. It is important not to allow the manure to be spread thicker than 4 inches; otherwise it will not dry out quickly. It is also important to have the surface completely covered since it will be easier to burn.

All kitchens were screened and every effort made to prevent the pollution of ground in and around the kitchens. Polluted areas, should these occur, should be immediately scraped, the scrapings burned and the spot covered with lime. All solid and liquid garbage must be burned immediately and no soiled vessels allowed around.

Each company should provide itself with at least two dozen fly swatters, the more the better. It should turn out a detail of 20 men to swat flies each morning or evening, or both, in the kitchens, mess shacks, storage tents, etc. Every company should make a number of fly traps and keep them baited at all times, cleaning them every morning and rebaiting them. Rear orderlies were required to keep fly swatters at all times in the rear and to kill all flies in the rear several times a day. The hospital corps was turned out each day to assist in killing flies and to supervise the management of fly traps. These measures were supplemented by the use of a formalin poison.⁴¹

⁴¹Michie. Mil. Surg., 35:132-48. 1914.

The surroundings of the camp should be given careful attention and the dump located so that the usual breezes will carry odors and insects past or away rather than toward the camp. A little discrimination in the location of picket lines will lessen the chances of flies attracted by the animals drifting into camp. A few fly traps along picket lines would materially reduce the numbers of flies in such places, and here it may be advisable to employ more offensive baits than would be tolerated within the camp limits. It is very desirable that all structures within a mile of camp should be kept in a good sanitary condition, and it may be necessary to extend military supervision to a greater distance, since camps near insanitary settlements, city or village dumps, etc., are very likely to be seriously troubled by flies.

Little House Fly

Fannia canicularis Linn.

This small fly is found rather commonly upon windows in houses and is frequently mistaken for an under-sized or young house fly. It is recorded⁴² as being more abundant for a short time during the early part of the summer than the house fly.

The maggots may be found in decaying and fermenting organic matter, including excrement. They are very different from those of the house fly in that the body segments are ornamented with transverse series of moderately long, somewhat spiny processes. The development of the larvae requires a week and may last for 3 or 4 weeks. The pupal period occupies 7 to 21 days or longer.

A closely related species, *F. scalaris* Fabr., is called the latrine fly,⁴³ on account of its commonly breeding in human excrement. Its habits are very similar to those of *F. canicularis*.

Cluster Fly

Pollenia rudis Fabr.

This fly is responsible, possibly more than any other, for a widely current belief that the house fly winters in dwellings. It is the one commonly found in such places during the winter and early spring, and has received its common name because of its frequently enter-

⁴² Hewitt. The House Fly, p. 187. 1914.

⁴³ Hewitt. The House Fly, p. 193. 1914.

ing houses in large numbers and forming conspicuous clusters in closets, unused rooms or other retreats. It is easily distinguished by its somewhat larger size and the black thorax covered rather thickly with tawny hairs which frequently incline to a grayish shade. This insect is also known as the "buckwheat fly" because of the frequent association between its occurrence and buckwheat. Investigations in Europe and this country have shown that the larva is parasitic in certain earthworms and Doctor Townsend is of the opinion that there may be two generations in the latitude of Washington, though available data indicate but one in New York State.

Clusters of the flies can be destroyed by dusting them liberally with fresh pyrethrum or insect powder, or the insecticide may be molded into moist cones and burned. In any event the stupefied insects should be swept up and destroyed. It has been found extremely difficult to fit windows and screens tightly enough to exclude these flies, and with this in mind we would suggest that trouble may be avoided to some extent at least by keeping the rooms open and thoroughly ventilated, since this fly displays a marked preference for dark and undisturbed retreats.

Biting House Fly

Stomoxys calcitrans Linn.

This insect resembles the house fly very closely indeed and is most easily distinguished by the moderately sharp pointed mouth parts which differ greatly from the stout, lobed proboscis of the house fly. It is this insect which has given rise to the general belief that house flies may bite before a rain. It is more an outdoor stable fly than a house fly. This insect has been under suspicion as a carrier of infantile paralysis, but this has by no means been proved, though it or a closely allied species is credited with being an agent in the dissemination of surra.⁴⁴

There is also a record of *Stomoxys* being a mechanical carrier of a plague-like disease in rodents, which can be transmitted to man.⁴⁵

The maggots of this insect develop freely in decaying oat rather than wheat straw, or in strawy manure. The eggs are laid in masses several inches below the surface. The female may deposit at least 632 and possibly 820 eggs. As many as twenty lots may be deposited by one fly.⁴⁶ They hatch in from 1 to 4 days, the larval

⁴⁴ Hoole. Ceylon Admin. Rep'ts Vet. 1911-12.

⁴⁵ Wayson. Pub. Health Rep'ts, Washington, 29:3390-93. 1914.

⁴⁶ Mitzmain. Phil. Jour. Sci., 8:29-48. 1913.

period extends from 11 to over 30 days, and the pupal stage from 6 to about 20 days. The period from egg to adult may vary from approximately 19 to over 42 days. Outbreaks are greatly favored by a rainy period saturating accumulations of straw.

Stock may be protected from this biting fly with blankets of double thicknesses of burlap. Darkened stables are also helpful, provided all flies are dislodged with some type of brush as the cattle enter the barns. Disposal of straw so as to prevent accumulations becoming saturated and thus affording ideal conditions for breeding is a most effective preventive measure.⁴⁷

The biting house fly may be destroyed with a poisoned bait containing 1 per cent sodium arsenite and 10 per cent sugar.⁴⁸

Stable Fly

Muscina stabulans Fall.

The stable fly is very similar to the house fly though somewhat larger, and is found in houses usually in the early summer about the same time as the small house fly.

The eggs are laid and the larvae feed upon various kinds of decaying or decomposing organic matter, and have been recorded as predaceous upon house fly maggots. They have been found in the dung of cattle and horses, on raw and cooked meat, on carcasses of different vertebrates and invertebrates, in rotten bulbs and vegetables, on fungi, old cheese, etc. As many as 160 eggs may be deposited by one female and development may be completed in about a month, making possible the production of several generations in one season.⁴⁹ There are several records of this species causing intestinal myiasis.

Blow Flies and Bottle Flies

The queen blow fly, *Phormia regina* Meign., is the common black fly, markedly larger than the house fly, so frequently seen in early spring in houses, and the one commonly bred in animal wastes and garbage. It is one of the more abundant species about slaughterhouses and abattoirs. This species has in Texas a preoviposition period of 7 to 18 days, an egg stage of 1 to 4 days, a larval development of 4 to 15 days, a pupal stage of 3 to 13 days, the total life cycle being completed in from 10 to 25 days.⁵⁰

⁴⁷ Bishopp. Jour. Econ. Ent., 6:112-26. 1913.

⁴⁸ Rev. Appl. Ent., 4:27. 1916.

⁴⁹ Hewitt. The House Fly, p. 209. 1914.

⁵⁰ Bishopp. Jour. Econ. Ent., 8:327. 1915.

The large blue bottle fly, *Cynomyia cadaverina* Desv., an associate of *Phormia*, is a frequenter of pantries and cellars and oviposits on food products of animal origin, such as smoked, uncured and cooked meat. The preoviposition period is 7 to 20 days, the egg stage lasts from 1 to 2 days, the larval development occupies 3 to 5 days, puparia being formed 5 to 39 days after the larvae hatch, and the pupal stage lasting 6 to 58 days. Thus the life cycle may vary from 13 to 99 days.⁵¹

The blow fly, *Calliphora erythrocephala* Meign., has a preoviposition period of 12 to 17 days, and an egg stage of 24 hours. The larvae migrate from the food 3 to 4 days after hatching, and the pupal stage lasts from 7 to 9 days, the life cycle being completed in 15 to 20 days.⁵²

The "screw worm" fly, *Chrysomya macellaria* Fabr., winters as a larva, the flies appearing shortly after warm weather begins. The preoviposition period lasts from 3 to 18 days, and eight consecutive ovipositions by one fly have been observed, the period between each ranging from 1 to 7 days. From 40 to 248 eggs may be deposited in one batch, and a female may lay 1228. The eggs hatch within a few hours, pupation occurs within 6 to 20 days, and the pupal period ranges from 3 to 27 days. This species breeds in animals which have recently died.⁵³

This fly has caused numerous losses among cattle and other domestic animals owing to its habit of depositing eggs in recent flesh wounds or sores. The maggots aggravate the injury, and unless quickly discovered may produce serious results. The fly also attacks man, depositing eggs in the nostrils or mouth while the victim is asleep. Such attacks are usually limited to sufferers from catarrh. The maggots work rapidly and unless speedily discovered and destroyed, the tissues of the nose, mouth and soft palate may be honeycombed and the victim lose his life.

The green bottle fly, *Lucilia caesar* Linn., winters as a larva or pupa, the flies appearing on the first warm days. The preoviposition period lasts from 6 to 20 days, the eggs hatch in less than 24 hours, the larvae migrating 2 to 5 days later. The pupae are formed 3 to 12 days after hatching, and the pupal period ranges from 5 to 16 days. The total developmental period is from 11 to 24 days.⁵⁴

⁵¹ Bishopp. Jour. Econ. Ent., 8:327. 1915.

⁵² Bishopp. Jour. Econ. Ent., 8:327. 1915.

⁵³ Bishopp. Jour. Econ. Ent., 8:325. 1915.

⁵⁴ Bishopp. Jour. Econ. Ent., 8:326. 1915.

The closely allied bottle fly, *Lucilia sericata* Meign., winters as larvae and pupae and flies in early spring before Chrysomyia. It breeds in decaying animal matter, the preoviposition period in summer being 5 to 9 days. The egg stage lasts less than 24 hours, pupae being formed in 3 to 9 days after hatching. The period from egg to adult is 9 to 21 days.⁵⁵

These blow flies, bottle flies or flesh flies, as they are variously called, breed in a considerable variety of animal matter, and their presence in any numbers would be presumptive evidence of a moderately near breeding place. Burning carcasses or burying them to a depth of at least 2 feet is advised. A few inches of soil packed well over a carcass will prevent infestation, though not emergence of flies from infested carcasses. Wounds should be protected from flies, the best larval destroyer being chloroform and the best protective pine tar.⁵⁶

Fruit Flies⁵⁷

These light brown flies, only about one-eighth of an inch long, are most commonly found about the pomace of cider mills and on overripe or partly decaying fruit. They are attracted by fermented liquids, such as wine, cider, vinegar and beer, and may frequently be observed on the sides of jars containing preserved fruits. There are two species which appear to be most abundant. It is very difficult to keep these insects out of houses on account of their small

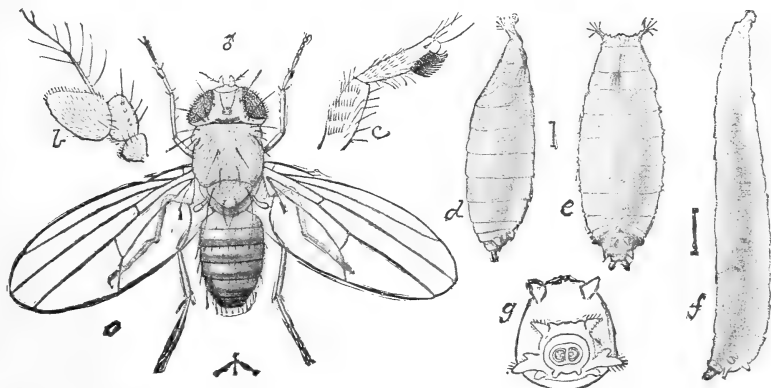


Fig. 4. Fruit fly: *a*, adult fly; *b*, antenna; *c*, base of tibia and first tarsal joint; *d*, puparium, side view; *e*, same dorsal view; *f*, larva; *g*, anal segment of same; *a*, *d*, *e*, *f*, much enlarged; *b*, *c*, *g*, still more enlarged. (After Howard, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

⁵⁵ Bishopp. Jour. Econ. Ent., 8:326. 1915.

⁵⁶ Bishopp. Jour. Econ. Ent., 8:328-29. 1915.

⁵⁷ *Drosophila ampelophila* Loew and *D. amoena* Loew.

size. Doctor Howard has listed these forms as likely to be disease carriers.

These little insects rarely enter the house unless attracted by overripe or canned fruit. The latter should be hermetically sealed, making it safe from injury, and stored in the cellar or other place comparatively inaccessible to the flies, as soon as convenient. These small flies can easily be destroyed with fresh pyrethrum powder.

House Centipede¹⁵

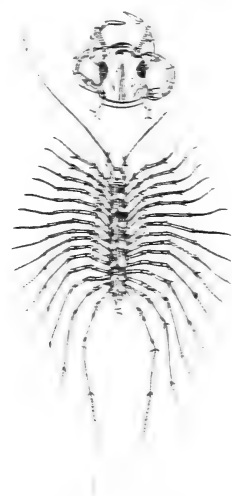


Fig. 3. House centipede seen from above, enlarged; the head and legs enlarged after

This light-brown, rapidly running, sprawly legged centipede arouses more or less aversion and terror through apprehension. Like other centipedes, it is capable of inflicting a somewhat poisonous bite though, as a rule, it is only too glad to escape. The house centipede has become well established in the dwellings of Albany, N. Y., and is presumably more or less abundant in other cities of the State. It is beneficial in that it is known to prey upon house flies, cockroaches and other insects. Its presence in a house should be welcomed, since it is capable of inflicting no injury aside from a somewhat poisonous bite, the latter being extremely rare.

¹⁵ *Scutigera forceps* Raf.

Wasps and Hornets

The paper wasp and the common wasp frequently occur about buildings and are of considerable service in destroying flies. Occasionally, if exceptionally abundant, they may become a nuisance

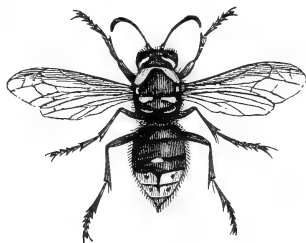


Fig. 6 Hornet enlarged
(after Riley)

on account of the danger from stinging. These insects can easily be excluded by the use of screens and in case of their being excessively abundant, the nests should be found and the inmates destroyed at night with chloroform or bisulfid of carbon.

MOSQUITOES

A large number of species occur in the United States, about sixty being known in New York State. Fortunately, owing to restrictions imposed by habits, comparatively few species are suffi-

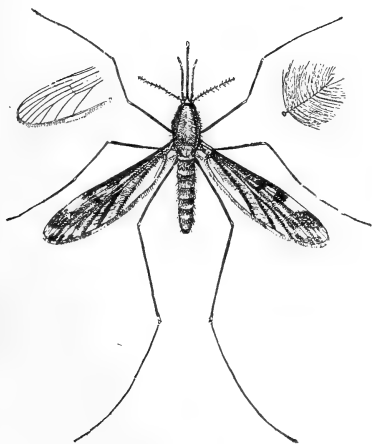


Fig. 7 Malarial mosquito, female,
with male antenna at right and wing
tip showing venation at left. (Re-
duced from Howard, U. S. Dep't Agr.
Div. Ent. Bul. 25. n. s. 1900)

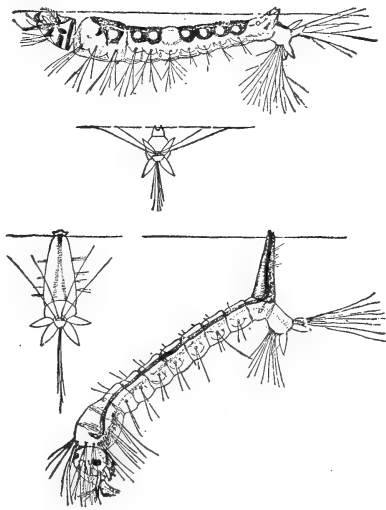


Fig. 8 Characteristic feeding position of
malarial mosquito wriggler in upper figure,
and that of the common mosquito in lower
figure. (Reduced from Howard, U. S.
Dep't Agr. Div. Ent. Bul. 25. n. s. 1900)

ciently abundant as to be seriously troublesome. The larvae or wrigglers of all mosquitoes require water for development. Those of a few species are limited to such peculiar situations as potholes, cavities in tree trunks, and one New York species occurs only in the water of pitcher plants. The more abundant species do not limit breeding so closely, though many have such a well-marked preference for grassy pools, woodland pools, brackish water, etc., that identification of the mosquito affords a valuable guide to the probable breeding place.

Malarial mosquitoes, *Anopheles*, are easily recognized by the usually spotted wings and especially by the characteristic resting position, the beak and body being in almost a straight line and at a considerable angle to the supporting surface. The larvæ or wrig-

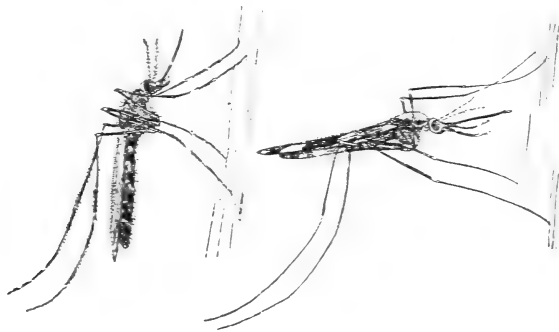


Fig. 9. Common and malarial mosquitos at rest, the latter to the right. (Reduced from Howard, U. S. Dep't Agr. Div. Bul. 25. n. s. 1900)

glers have no conspicuous air tube and remain in a characteristic nearly horizontal resting position just beneath the surface film. They are usually rather strongly marked with bright or dark brown and green. The larvae occur commonly in springs or water holes, in stream beds, occasionally along the edges of running streams, and not infrequently in grassy pools. The adults are rarely numerous, fly at twilight, and are of importance largely because certain species may carry malaria. Breeding is more or less continuous during the warm months of the year, the mosquitoes wintering in any shelter, frequently in houses, and occasionally flying in mid-winter. The most common species in New York State is *Anopheles punctipennis* Say, a strongly marked form, while *A. maculipennis* Meign. is less abundant and the more common malaria carrier.

The house or rain-barrel mosquito⁵⁹ is a modestly colored brown mosquito which is frequently troublesome about dwellings and winters in cellars or other retreats. The long-tubed larvae or wrigglers of this mosquito are found almost exclusively in artificial collections of water, especially tubs, rain barrels, eave troughs, etc. The conspicuous, moderately stout air tube near the posterior extremity of the body has a length about five times its diameter.

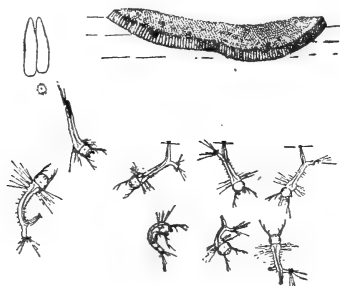


Fig. 10 House mosquito Egg mass with enlarged eggs above and at the left; young wrigglers below. (Reduced from Howard, U. S. Dep't Agr. Div. Ent. Bul. 25. n. s. 1900)

This common, semidomesticated species deposits its black, raftlike clusters of eggs upon standing water with the approach of warm weather, and breeding may be continued under favorable conditions till checked by frosts in the fall. There are records of this insect breeding in large numbers in sluggish, foul streams, though this is somewhat unusual.

The yellow fever mosquito⁶⁰ is medium sized, dark brown, and with a strongly contrasting silvery white lyre-shaped mark on the thorax. It is widely distributed in the southern states, and may occasionally establish itself farther north during the summer. It is frequently known as the "day mosquito" and is of particular interest because of its being the only known carrier of yellow fever. It must, however, like the malaria mosquito, become inoculated before it can in turn transmit the disease to man. This mosquito appears to have in the south much the same habits as our northern house or rain-barrel mosquito does in the north. It breeds by preference in the water of cisterns, tanks and other places, and appears to be unable to sustain itself in the open. The larvae or

⁵⁹ *Culex pipiens* Linn.

⁶⁰ *Aedes calopus* Meign.

wrigglers are peculiar in that they hang nearly perpendicularly from the surface film. They can remain below the surface a long time. It remains only to mention the vital importance of preventing this mosquito gaining access to yellow fever patients, if outbreaks of this plague are to be avoided in the future.

The salt marsh mosquito⁶¹ is typical of several species which breed by preference in brackish water. This mosquito is easily recognized by its broadly white-banded legs, beak and body, the latter in addition bearing a conspicuous longitudinal white stripe.

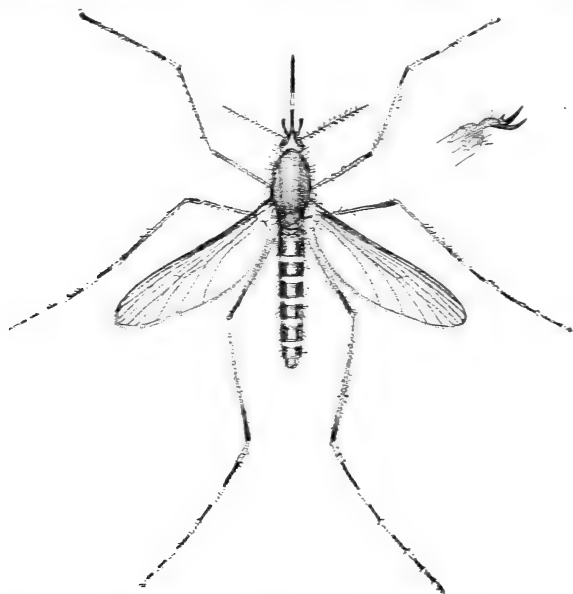


Fig. 11 Salt marsh mosquito from above, the toothed front claw more enlarged. (After Howard, U. S. Dep't Agr. Div. Ent. Bul. 25. n. s. 1900)

It differs greatly from the house mosquito in that it may fly or drift with the wind considerable distances, there being authentic records of this species, together with two common associates,⁶² having been taken 40 miles from the nearest available breeding place. Occasionally hosts of these insects invade New York City, coming from somewhat distant marshes. The short-tubed, dark-colored wrigglers occur in brackish pools on the salt marshes, being by far the most numerous within two or three hundred feet of the high land, this being an area flooded only by high tides. These

⁶¹ *Aedes sollicitans* Walk.

⁶² *Aedes taeniorhynchus* Wied. and *A. cantator* Coq.

more or less regular overflows of water and occasional heavy rains result in successive batches of eggs hatching and the production of hosts of mosquitoes from time to time during the season.

The swamp mosquito⁶³ under certain conditions becomes very abundant and annoying. This is a medium or small mosquito with the tarsal segments narrowly white-banded basally. It is one of the more abundant of the woodland mosquitoes and is typical of other species occurring under similar conditions, some of which are locally abundant and very annoying.

The irritating mosquito⁶⁴ is easily recognized by its large size and the strongly contrasting colors, especially the broad, white band near the middle of the beak, and the similar bands on the legs, the broad one on the posterior tibiae being characteristic. The abdomen is distally white-banded and the wings, with their large, white and dark-colored scales, have a somewhat peculiar mottled appearance. This insect is one of the fiercest and hardest biters, entering houses readily. It is peculiar among native forms in that the wrigglers or larvae attach themselves by the strongly tapered and pointed airtube to the submerged roots of cat-tails, water loose-strife and possibly other plants. This peculiar habit restricts breeding to permanent swamps, particularly cat-tail areas, having more or less floating or semifloating vegetation.

Other mosquitoes may be locally abundant, and in some cases even more serious pests than those briefly noticed above. It is impossible to treat all these within the limited space available, and as many of the statements relating to the forms noticed are also true of others, such treatment is unnecessary.

Mosquito Control

It is self-evident that the disease carriers, the malarial mosquito and the yellow fever mosquito, are of primary importance wherever there is an opportunity for these insects to become infected and thus in turn be able to act as carriers of these diseases. The keeping of all such mosquitoes from sources of infection renders them harmless so far as dissemination of disease is concerned, and if for any reason this is impractical, a thoroughgoing campaign of destruction is the only safe course to pursue. This is especially true of the yellow fever mosquito.

⁶³ *Aedes sylvestris* Theo.

⁶⁴ *Mansonia perturbans* Walk.

The flight of mosquitoes is of considerable importance in control work, and with the exception of the salt marsh mosquito and some of its less important associates, most mosquitoes breed in the near vicinity of places where they are abundant, although this is by no means invariable, since there are records of even the house mosquito drifting or flying well toward a mile from a particular breeding place. The mere presence of numerous mosquitoes does not necessarily imply breeding places in the immediate vicinity at that time, since some mosquitoes are rather long-lived and may persist for some time after the temporary breeding pools in which the larvae lived have disappeared. It is possible to trace the flight of mosquitoes, and under certain conditions important because of its bearing upon local control work. Staining adults is a very convenient method, and for this purpose aqueous solutions of eosin, fuchsin, gentian-violet, Bismark-brown, methylene blue and orange-G. may be used in a dilution of about 1 gram to 50. Stain in the evening about 2 hours before the mosquitoes are released, applying just enough so that it will quickly dry and not saturate the insects. The stained individuals are best recovered in buildings by hand and trapped elsewhere.⁶⁵ The weather, direction of wind, topography, etc., all have an influence on the movement of insects and should be given due consideration.

The screening of houses, tents, etc., for the exclusion of mosquitoes and the use of repellent materials are purely temporary and should be considered simply as desirable first aids.

Satisfactory mosquito control, broadly speaking, means the elimination of breeding places, and in this undertaking a rigid attention to details is necessary. The apparently unimportant and usually overlooked breeding places are those most likely to be troublesome. The small pool is more dangerous than the pond or lake, and the isolated collection of water beside a stream is fully as likely to produce troublesome mosquitoes as the permanent pools of a swamp. The mud holes in roads (especially if not constantly traversed), the stagnant water of roadside ditches, and even the collections of water in the hoof-prints of animals, or in vacant lots, are very likely to produce numerous mosquitoes. The rain barrels and wash tubs so frequently used to collect water from roofs, and the much smaller quantities found in rejected containers such as old firkins, tin cans, etc., may produce bloodthirsty hordes. Water in cisterns, in sewer catch-basins, and nearly stagnant pools in sluggish streams are all favorite breeding places.

⁶⁵ Zetek. Ent. Soc. Amer. Ann., 6:14-15. 1913.

The most effective measures for the prevention of mosquito breeding are the draining or filling of all such areas, the elimination of useless water containers, and the adequate care of others. The drained or filled areas are permanently eliminated as breeding places. The use of kerosene or a moderately heavy crude petroleum distillate is a very effective method of destroying mosquito larvae, since with few exceptions they must come to the surface in order to obtain air, and the film of oil, if maintained, means the speedy destruction of the larvae. It is even possible to use oil on cisterns providing the water for domestic use is drawn from below the surface, or any such containers can be protected by mosquito-proof coverings, either wooden with a screened ventilator, or a tight screen. The essential is to prevent ingress or egress of the insects. The systematic sterilization by heat of old tin cans and then battering them so as to prevent their holding water, is an excellent practice for the control of flies as well as mosquitoes.

A very efficient larvicide has been developed by the Isthmian Canal Commission.⁶⁶ It is prepared as follows:

"One hundred and fifty gallons of carbolic acid is heated in a tank to a temperature of 212° F.; then 150 pounds of powdered or finely broken resin is poured in. The mixture is kept at a temperature of 212° F.; 30 pounds of caustic soda is then added and the solution kept at 212° F. until a perfectly dark emulsion without sediment is obtained. The mixture is thoroughly stirred from the time the resin is used until the end.

"The resultant emulsion makes a very good disinfectant or larvicide. In fact, 1 part of it to 10,000 parts of water will kill *Anopheles* larvae in less than one-half of an hour, and 1 part to 5000 parts of water will kill *Anopheles* larvae in 5 to 10 minutes or less." This was prepared in 1909 at a cost of \$.1416 a gallon, and has demonstrated its utility under exacting tropical conditions.

Flake naphthalene scattered upon the surface of water at the rate of 1 gram to 462 square centimeters of surface killed mosquito larvae in 24 hours, and the author is of the opinion that the same effect may be obtained by suspending the naphthalene over the water and thus avoid tainting it, something very desirable for cisterns and wells.⁶⁷

A mosquito trap has been designed to fit an opening in a tent or building. It consists essentially of a rectangular frame carrying a

⁶⁶ Howard, Dyar & Knab. *The Mosquitoes of North and Central America and the West Indies*, 1:385-86. 1912.

⁶⁷ Bacot. *Brit. Med. Jour.*, July 4, 1914, p. 15.

semicircular outer envelop of mosquito wire, 18 meshes to the inch, protected on its concave surface by two removable V-shaped sections, each with the edges at the apex of the "V" separated a short distance in much the same way as the ordinary fly trap, and one leading to the other and the second into the trap. The use of two is probably for the purpose of offering greater obstacles to the escape of mosquitoes.⁶⁸ This or a similar trap is not only of service in reducing the numbers of mosquitoes in buildings, but is also of value in determining the extent and direction of flight.

Adult mosquitoes may be destroyed in buildings and other inclosures by fumigation with various materials, such as burning moistened pyrethrum, volatilizing Mimms culicide or camphor phenol (3 ounces to 1000 cubic feet), cresyl (5 grams to 40 cubic feet), or cresol (165 cc. to 2640 cubic feet).

Among repellants may be mentioned oil of pennyroyal, oil of citronella, oil of peppermint, or a mixture of oil of citronella 1 ounce, spirits of camphor and oil of cedar .5 ounce. Any of these may be combined in the proportions of a few drops to a half ounce of vaseline or lanolin which will greatly increase their effectiveness, since the grease holds the odor and prevents rapid evaporation.

BLACK FLIES

The black flies,⁶⁹ or buffalo gnats, are small, stout, black insects about one-tenth of an inch long, some with white-banded legs, which are most easily recognized by their appearance, and in the case of certain bloodthirsty species, such as the buffalo gnat, by their settling upon man and animals in large numbers and drawing blood. These insects are especially likely to establish themselves in an almost continuous row just behind the ears or along the hat band, if a hat is worn. They are particularly abundant and annoying in wooded areas of the Adirondacks, in portions of Minnesota, and in some of the southern states, especially from Tennessee south. They are especially likely to be injurious after floods, and in Mississippi have caused the death of cattle, horses and mules, and in more than one instance imperiled human life. Unsuccessful attempts have been made to prove a connection between these insects and the spread of pellegra.

The greenish or dark-colored gelatinous larvae occur mostly on rocks in comparatively shallow water, frequently forming almost continuous patches with an area of several square feet. The biting

⁶⁸ Zetek. Ent. Soc. Amer. Ann., 6:17. 1913.

⁶⁹ Simulium sp.

species appear in large numbers at about the same time each year, and in the Adirondacks one may roam in woods in early August comparatively free from black flies and yet find hosts on ascending some of the higher mountains. This is due to the fact that the development of the flies is later at the greater elevations.

Experiments in recent years have demonstrated the practicability of destroying these larvae in streams by applying an oil preparation such as Phinotas oil. This is heavier than water, settles to the bottom, and a film of oil may be found upon stones 48 hours after application. Black fly larvae may be killed one-eighth of a mile below the point of application. The one objection is that fish may also be destroyed unless this compound is used in small quantities. The larvae can be swept from rocks, in case treatment with chemicals is impracticable, and after dislodgment caught and removed on a wire netting.⁷⁰

Floods, as has been observed in the South, are favorable to black fly development; consequently a judicious regulation of stream flow has an important effect in reducing the numbers of these pests.

Stock in badly infested regions may be protected by blankets, smudges or repellent applications, a number of which are given on page 78.

FLEAS

Pulex, *Ctenocephalus* et al.

The more common flea about dwellings in the eastern states is the cat and dog flea,⁷¹ while on the Pacific coast the human flea⁷² is the troublesome species.⁷³ These insects occur upon their hosts, and according to the investigations of Doctor Mitzmain,⁷⁴ the human flea appears to pass a portion of the winter on dogs. There are numerous species of fleas, most of them closely restricted to certain hosts, and a few, as will be seen below, are important carriers of disease.

The minute white eggs of fleas are dropped mostly about the sleeping-places of their hosts, and the slender, active larvae feed upon the organic matter found in the dust. They are particularly likely to thrive in cracks and crevices of floors. The egg stage of the cat and dog flea may last 2 weeks, the larval period 12 days, and the pupal period 10 to 16 days, making a total for the complete

⁷⁰ Weed. U. S. Dep't Agr., Div. Ent., Bul. 46, p. 108-9. 1904.

⁷¹ *Ctenocephalus canis* Curtis.

⁷² *Pulex irritans* Linn.

⁷³ Mitzmain. Pub. Health Bul. 38. 1910.

⁷⁴ Pub. Health Bul. 38. 1910.

life cycle of 5 to 6 weeks. The human flea develops somewhat more rapidly, the egg stage being given as from 4 to 6 days, the larval period 11 days, and the duration of the pupal stage 12 days, making a generation possible in 4 to 6 weeks. The Indian rat flea⁷⁵ has an egg period in India of 2 days, though in California, according to Mitzmain,⁷⁶ it may vary from 9 to 13 days, while the usual larval existence, 8 to 24 days as given by American and English authorities, is extended in California under laboratory conditions to rarely less than 28 and even 30 days, and sometimes longer. The adults of this species may live on rats in India for 41 days, the

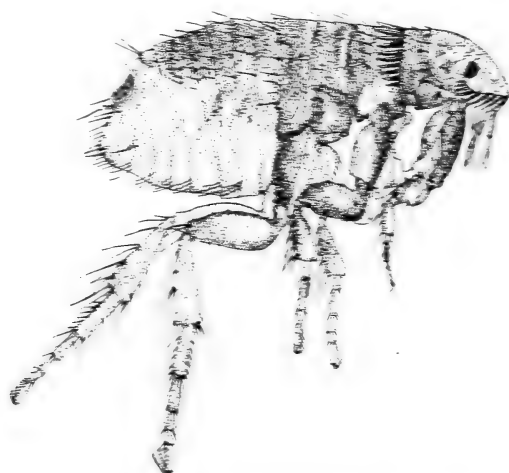


Fig. 12. Rat and dog flea, seen from the side, enlarged. (Walker's illustration.)

maximum on an exclusive diet of human blood for that locality being 27 days, though in California the species may be kept alive under such conditions for 36 days. Fleas may live in bran in the absence of liquid food for 6 days, and in sand with moist cow dung for 13 days.

Sandy soil is most suitable for flea development, and undisturbed dry dust in buildings and sheds appears particularly favorable. The custom of setting buildings on foundations some distance from the ground, prevalent in the South, thus giving opportunity for cats, dogs and other animals to range beneath over a usually dry soil, affords almost ideal conditions for the development of these pests, and sometimes results in a general infestation of adjacent lawns.

⁷⁵ *Xenopsylla cheopis* Roth.

⁷⁶ Pub. Health Bul. 38, 1910.

The deadly bubonic plague is carried by a number of fleas, notably the Indian rat flea, the European rat flea,⁷⁷ the human flea,⁷⁸ the European mouse flea,⁷⁹ the dog flea,⁸⁰ the squirrel flea,⁸¹ the cat flea,⁸² and the rat fleas.⁸³ This is of grave importance, since the Indian rat flea is abundant in parts of the seaport cities of the Pacific and Gulf coasts of the United States, while away from the waterfront its place as a rat parasite is largely taken by the European rat flea and the mouse flea. A recent study of rat fleas at Providence, R. I., showed that the Indian rat flea comprised 75 per cent, the European rat flea 22 per cent, the European mouse flea 2.5 per cent, and the dog flea .5 per cent on a total of 341 rats examined. The average between July and September was 10.2 fleas to a rat, and from October to December 3.7.⁸⁴ Consequently it is only necessary to introduce an infected rat in any of these localities to make possible an outbreak of this deadly plague, something which may easily result under present disturbed trade and traffic conditions. Indian rat fleas are not very active and individuals from plague-stricken rats are likely to reach only human beings living in the same house.⁸⁵ This species is able to transmit plague 33 days after feeding upon an infected animal. The European rat flea is able to carry plague bacilli for periods of from 2 to 47 days in the absence of the host.⁸⁶ British troops at Hongkong provided only with boots were much bitten by fleas and many contracted plague; while others in India equipped with "putties" did not contract disease because fleas could not get at their ankles.⁸⁷

The European hen flea⁸⁸ has been recorded from both New York and Massachusetts, while the so-called "sticktight" flea⁸⁹ is an important and common pest of poultry in the southern and

⁷⁷ *Ceratophyllus fasciatus* Bosc.

⁷⁸ *Pulex irritans* Linn.

⁷⁹ *Leptopsylla musculi* Duges.

⁸⁰ *Ctenocephalus canis* Curtis.

⁸¹ *Hoplopsyllus anomalus* Baker and *Ceratophyllus acutus* Baker.

⁸² *Ctenocephalus felis* Bouché.

⁸³ *Ceratophyllus anisus* Roth. and *Pygiopsylla ahalae* Roth.

⁸⁴ Robinson. Amer. Jour. Pub. Health, p. 773-76. 1913.

⁸⁵ Schwellingrebel. Centralbl. Bakt. Parasit. Infektions, 74:456-66; 592-593. 1915.

⁸⁶ Bacot. Jour. Hyg., Cambridge. Plague Sup., 4:770-73. 1915.

⁸⁷ Gossard. Jour. Econ. Ent., 2:320. 1909.

⁸⁸ *Ceratophyllus gallinae* Schrk.

⁸⁹ *Echidnophaga gallinacea* Westw.

western portions of the United States. The southern Chigoe flea⁹⁰ or "jigger" is related to the "sticktight" flea, but instead of remaining attached to the surface of the host as in the case of that species, the female, after fertilization, burrows into the flesh until it may become completely imbedded. Cats, dogs, cattle, sheep, horses and even birds are infested, though it is of special importance because of its attacking man. This pest usually confines itself to the feet, the female entering between the toes or under the nails, often producing ulcers, and frequently producing permanent crippling.

Control. Domestic animals allowed in houses should be provided with a sleeping mat or blanket, and the latter taken up frequently, shaken and the collected dust burned. Infested animals should have a quantity of fresh pyrethrum powder rubbed into the hair. This stupefies the fleas, causing them to drop, and then they may be swept up and burned. Washing with a 3 per cent solution of creolin or a similar preparation is also very effective. In the case of cats at least, this should be followed by washing with warm soap and water in order to remove the creolin and thus avoid a possible slight burning. Dusting with pulverized naphthalene will drive the fleas from the animals, though it may sicken cats slightly for a day or two. "Sticktight" or chicken fleas may be destroyed by applications of kerosene and lard (1 part kerosene to 3 parts lard) to the assembled masses of fleas.

Flea control⁹¹ in dwellings would be simplified by keeping all domestic animals outdoors, and as fleas can live for a time at least upon various hosts, the quartering of different animals in close proximity is favorable to flea infestation.

Fleas may be trapped on sticky fly paper laid upon the floor, worn as a sort of emergency leggings, or on a slender roll easily inserted and removed from a larger roll of wire netting. This latter device, which can be of almost any dimensions, is particularly useful about dwellings, and if properly constructed can be used in beds, since the insects are easily trapped and there is no danger of smearing clothing with the adhesive.

One of the simplest methods of destroying fleas in infested dwellings is fumigation with flake naphthalene, using 5 pounds to an average sized room, and closing it for 24 hours. The naphthalene may be spread out upon newspapers and used repeatedly.

⁹⁰ *Dermatophilus penetrans* Linn.

⁹¹ See also Bishopp, U. S. Dep't Agr. Bul. 248. 1915.

The dusting of places haunted by fleas with sodium fluoride, a comparatively new insecticide, is suggested as a promising method of destroying these insects, since it has given very good results with both cockroaches and ants.

The washing of walls and floors of infested buildings with an emulsion consisting of crude oil 80 per cent and whale oil soap 20 per cent, diluted with 9 parts of water, destroys all stages, can be applied with safety and is readily washed from the floor. A gallon is sufficient for a room 12 by 12 feet.⁹²

Two ounces of cresol, if properly vaporized, produces a grayish vapor highly poisonous to fleas, though not offensive or injurious to man or domestic animals. The room should be kept closed until the vapor disappears. Burning cresol produces a dense black smoke harmless to the insects, and this should be avoided.⁹³

Infested ships or buildings, where practicable, may also be treated with Clayton gas, burning sulphur or hydrocyanic acid gas, all well-known and very efficient insecticides.

General infestations by fleas usually originate in some dusty, undisturbed shelter, and the first step should be to ascertain these localities and stop breeding by thorough cleaning, or treatment with one of the above-mentioned materials. In the case of infested yards or lawns, all rubbish underneath the building should be removed and burned, and the surface of the ground dressed with lime, sulphur or sprayed with an insecticide. The grass of the lawn should be cut as close to the ground as possible, the trimmings burned, and the lawn kept well watered. The elimination of dry dust and an abundance of moisture are very detrimental to fleas.

Cases occur in the southern and west central United States in which pigs appear to be the source of serious flea infestations, due in many instances to their having free run under buildings. Fleas may be destroyed on pigs by dipping the animals in a creosote bath, or by sprinkling them with crude petroleum during feeding times.⁹⁴ They should be prevented from sheltering under buildings, and the infested ground treated as described above.

⁹² Jackson. Jour. St. Med. London, 24:277-84. 1916.

⁹³ Lane. Ind. Med. Gaz., 1:104-5. 1915.

⁹⁴ Bishopp. U. S. Dep't Agr. Farmers Bul. 683. 1915.

BODY PARASITES

Bedbug

Cimex lectularius Linn.

This pest is especially likely to be abundant in old houses where cracks and crevices abound, and its ability to endure long fasts enables it to maintain itself for considerable periods in uninhabited houses, even though there be no mice or other animals upon which it can prey.

This insect has a habit of feeding to repletion and then seeking shelter where it may remain 2 or 3 days. The oval white eggs are deposited in cracks and crevices in batches of 6 to 50 or thereabouts.

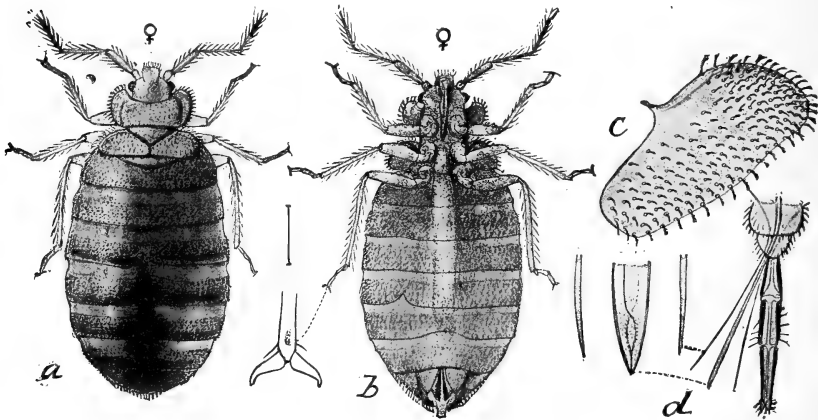


Fig. 13 Bedbug: *a*, and *b*, adult females from above and below, gorged with blood; *c*, and *d*, structural details. (After Marlatt, U. S. Dep't Agr. Div. Ent. Bul. 4, n. s. 1896)

The yellowish white, nearly transparent young hatch in a week or 10 days, and approximately 11 weeks are necessary to complete development, though this is probably greatly modified by the degree of warmth and the abundance of food. It is said that ordinarily only one meal is taken between each of the 5 molts preceding maturity. The ability of these insects to live without food has an important bearing on the prevalence and control of the pest. Newly hatched bedbugs, those which have had no opportunity of feeding, may live on an average 28.1 days, the maximum being 41, and the minimum 17 days. Partly grown individuals captured and therefore with no record as to previous feeding, lived from 17 to 60 days, and fullgrown adults from 2 to 60 days.⁹⁵ Unfed bugs at tempera-

⁹⁵ Girault. Jour. Econ. Biol., 7:163-88. 1912.

tures of from 60° to 65° F. may live for 136 days, and after meals for 9 months.⁹⁶ Unfed nymphs have been kept alive in a bottle for 75 days.⁹⁷ These pests are also known to feed to a certain extent upon mice and some domestic animals, and this habit may frequently explain the abundance of the bugs in uninhabited dwellings.

This insect, with its nocturnal habits, may easily be an important factor in the dissemination of disease. It has been shown capable of transmitting bubonic plague and South American trypanosomiasis, and Nuttall has succeeded in transmitting European relapsing fever from mouse to mouse. It is claimed, and not without some foundation, that oriental sore, tuberculosis and even syphilis may be carried by this pest.

Control. The elimination of cracks and crevices, loose wall paper, wooden bedsteads and similar hiding places is a great assistance in checking this pest. In the older types of dwellings cracks and crevices should be stopped so far as possible and the joints of old-fashioned bedsteads treated liberally with kerosene, benzine or similar oils. Hot water can also be employed. A 5 per cent solution of carbolic acid killed bugs in 10 minutes.⁹⁸ Medical turpentine with its own volume of soap suds is very effective.⁹⁹

Superheating, where practicable, is very effective. A temperature of 120 to 130° F. for 15 minutes is fatal to the bedbug and presumably its eggs. A maximum temperature in the building of 160° F. continued for several hours results in the destruction of all the pests. This is frequently possible with ordinary heating apparatus, especially if it can be supplemented by using oil or gas heaters in a few of the rooms.

Fumigation with sulphur or hydrocyanic acid gas, where conditions permit, is very effective.

Bedbug Hunter

This species¹ occasionally occurs about houses and with one or more allies was widely noticed by newspapers in 1898 under the name of "kissing bug." This brownish or black insect is about three-fourths of an inch long and has somewhat the same shape as the malodorous squash bug of the garden. It is beneficial, since it

⁹⁶ Bacot. Bull. Ent. Res. London, 5:111-17. 1914.

⁹⁷ Riley & Johannsen. Med. Ent., p. 89. 1915.

⁹⁸ Blacklock. Ann. Trop. Med. Parasit., 6:415-28. 1912.

⁹⁹ Housain. Ind. Med. Gaz., Feb. 1913, p. 84.

¹ *Opsicoetus personatus* Linn.

preys upon insects. The grayish, sprawly legged young are unusually interesting on account of their being covered with particles of lint. This gives them a nondescript appearance and undoubtedly is of service in enabling them to creep up unobserved upon their prey.

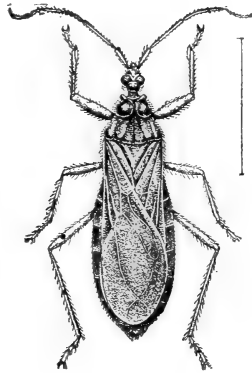


Fig. 14 Masked bedbug hunter from above, about twice natural size. (After Howard, U. S. Dep't Agr. Div. Ent. Bul. 22. n. s. 1906)

Body Louse

Pediculus corporis De Geer

The body louse is similar to the head louse. It has different habits and is considered a distinct species. It is considerably larger than the head louse, has longer antennae, and is of a dirty white color. This parasite usually conceals itself in the folds of the clothing, deposits eggs along the seams and wrinkles, and passes to the skin only for the purpose of feeding, which latter is said to occur twice a day. This pest is by far the most troublesome parasite of camp life, and is the familiar "grayback" of Civil War days.

Habits and endurance. A female may deposit nearly 300 eggs,² which latter hatch in 3 to 4 days, maturity being reached in 15 to 18 days. Legroux³ gives 8 to 10 days as the duration of the egg period, while Peacock⁴ places it at 10 to 12 days, and states that eggs may remain viable away from the body for a period of 40 days. He adds that the areas favored for oviposition are, in the

² Parasit. 9:296. 1917.

³ Bul. Soc. Path. Paris, 8:470-73. 1915.

⁴ Brit. Med. Jour., no. 2891, p. 746. 1916.

order of their importance, the fork of the trousers and the arm pits, the triangles at the tail of the shirt; next are the trousers and shirt seams, and then the neck. Eggs have even been found on the beads of rosaries. The insects accumulate where there is warmth, humidity and shelter.

These parasites may survive separation from the human body for a period of 9 days. They may penetrate dry sand or earth to a depth of 12 inches and live beneath it for 4 days.⁵

The base trenches are somewhat less infested than dugouts, though troops suffer about equally in both owing to the impossibility of changing underclothes in the former. Blankets are considered as minor factors, though straw may protect living insects for a period of 7 days, and thus be a source of infestation.⁶

Body lice may be blown from partly stripped men for several feet and perhaps farther.⁷ When at a greater distance than 15 to 18 inches from the skin, they wander about aimlessly, although when not feeding the lice attach themselves to fragments of clothing, which is very probably the explanation of typhus infection among doctors.⁸ Underfed or cold lice do not oviposit. The eggs are probably not laid on straw bedding under natural conditions, since egg laying ceases at 76° F., and a daily fall of temperature to 61° F., even though it lasted for 2 hours only, caused a considerable reduction in the number of eggs. It is probable that hatching and oviposition would stop if at night all clothes were removed and placed where the temperature were 61° F. or lower, and the bedding was left during the day in an unheated place.⁹

Lice are able to live without food for 2 to 5 days at a temperature of 85° F. in moist air, and from 2 to 3 days in dry air. At 68° F. they live from 3 to 6 days in moist air and from 2 to 4 days in dry air, while at 60° F. they live respectively 4 to 6 and 4 to 5 days.¹⁰ The louse becomes rigid with cold at 10° F., but revives when the temperature rises. Dry heat at 104° F. will kill a gorged louse in 6 hours, or a hungry one in 2 hours.¹¹ Dry heat about 129° F. causes death after one-half to three-quarters of an hour.¹²

⁵ Hase, *Rev. Appl. Ent.*, 5:44. 1917.

⁶ *Brit. Med. Jour.*, no. 2891, p. 746. 1916.

⁷ Schilling, *Munchener Med. Wochenschr.*, 63:1176. 1916.

⁸ Swellingrebel, *Rev. Appl. Ent.*, 5:33-34. 1917.

⁹ Sikora, *Centralblat. f. Bakt. Parasit. u. Infektionskrankheiten*, 76:523-37. 1915.

¹⁰ Englehard, *Rev. Appl. Ent.*, 4:50. 1916.

¹¹ Zucker, *Centralbl. f. Bakt. Parasit. u. Infektionskrankheiten*, 76:294-307. 1915.

¹² Bacot, *Brit. Med. Jour.*, Ja. 29, '16.

Lice are killed in 3 hours at a temperature of 113° F., in 1½ hours at a temperature of 122° F., in 20 to 30 minutes at a temperature of 140° F., and in 5 to 10 minutes at 177° F. The eggs require a little longer treatment. In practice, one hour at 140° F. should be sufficient.¹³ A 10 minute exposure to a temperature of 160° F. kills the nits with certainty.¹⁴ It is probable that neither lice nor eggs can survive an exposure to 140° F. for a period of 30 minutes, and the only reason for prolonging the treatment with higher temperatures is to insure that this minimum be attained in all parts of the clothing or other material treated.

Some idea of the fecundity and prevalence of this pest may be gained from the above and prepare us for believing that 95 per cent of a battalion which had seen 6 months service were found lousy, the average number of lice per man being 20, and 5 per cent were dangerous carriers, each bearing between 100 and 300 lice, and that in exceptional cases over 20,000 lice and eggs may be found upon a badly infested garment.¹⁵ These parasites make the men uncomfortable, seriously interfere with sleep, and thus decrease efficiency to a material extent, not to mention the possibilities of their carrying disease.

A careful study of the problem¹⁶ shows that living-places such as dugouts, billets and bivouacs are of comparatively slight importance in disseminating this pest, and the same is true of such materials as blankets, straw and bedding. The infested soldier, his clothing and kit, due to the intimate association inevitable under camp conditions, appears to be by far the most important source of infestation. The parasites, as noted above, may be transferred by the wind from soldiers to medical inspectors, and the ordinary dressing and undressing in tents may easily result in dislodging the pests and infesting tentmates or chance companions. Any large assemblage of recruits is likely to contain a few verminous individuals, possibly unconscious of their condition, and these are in most instances the primary cause of the trouble, which is greatly aggravated in many instances by the limited sanitation possible under camp conditions. Personal cleanliness, such as bathing and frequent changes of underwear, especially if precautions are adopted to prevent infestation from verminous individuals, are important control measures. The wearing of silk underclothes is one of the best preventives.¹⁷

¹³ Heymann. *Bul. Inst. Pasteur*, 14:91. 1916.

¹⁴ Kisskalt & Friedmann. *Deutsch. Med. Wochenschr.*, p. 154. 1915.

¹⁵ Peacock. *Brit. Med. Jour.*, 2892, p. 784-88.

¹⁶ Peacock. *Brit. Med. Jour.*, 2892, p. 784-88.

¹⁷ Kisskalt. *Deutsch. Med. Wochenschr.*, p. 154. 1915.

Vermicides. Naphthalene 96 per cent, creosote 2 per cent and iodoform¹⁸ 2 per cent appears to be one of the best and speediest killing powders, though it should not be used too freely, as it is apt to cause severe smarting. The preparation should be used on the portions of the garments most likely to be infested, and it not only kills the lice but affords a considerable measure of protection for a period of 5 days.¹⁹ An ointment known as *vermijelli* is very effective, and when used with the naphthalene-creosote-iodoform powder, the general efficiency is greatly increased. The commercial naphthalene is more active than the pure, its lethal power being dependent in great part on the presence of hydrocarbons and coal tar derivatives. Creosote is a slower insecticide which acts over a longer period, and the iodoform greatly increases the adhesiveness of the mixture for cloth.²⁰ A mixture of one part each of naphthalene and camphor, with sufficient benzine to render them miscible, and this in turn mixed with 3 parts by weight of sawdust, is recommended as a preventive to be placed in small, flat sachets measuring $1\frac{1}{2}$ by $2\frac{1}{4}$ inches and worn next to the skin.²¹

Even a handful of finely powdered naphthalene put into the clothes through the opening in the neck and then sleeping with the clothes on the body has been found to result in complete disinfection if it be done 3 times at 4-day intervals.²²

A mixture consisting of 300 cubic centimeters each of the oils of lemon grass, pennyroyal and eucalyptus, and powdered naphthalene 100 drams, put on pieces of cloth or felt, 6-8 drops to each, and fastened to the underclothing at spots where lice generally congregate, will prevent breeding.²³

A mixture of tartaric acid and sodium sulphite slightly moistened with water may be placed in small linen bags and worn underneath the shirt. The temperature of the body produces a reaction which continues for 2 days, giving off a large amount of sulphurous acid which spreads underneath the shirt, kills all the parasites and does not affect the skin.²⁴

Precipitated sulphur, an extremely fine amorphous powder, does

¹⁸ The insecticidally inert, but cheaper, magnesium silicate may be substituted for iodoform (Kinloch. *Brit. Med. Jour.* 2892, p. 792. 1916).

¹⁹ Peacock. *Brit. Med. Jour.* 2892, p. 786. 1916.

²⁰ Kinloch. *Brit. Med. Jour.* 2892, p. 789. 1916.

²¹ Noel. *Rev. Appl. Ent.*, 4:53. 1916.

²² Beyer. *Military Surgeon*, 38:483-91. 1916.

²³ Legroux. *Bul. Soc. Path. Paris*, 8:470-73. 1915.

²⁴ Postnicov. *Rev. Appl. Ent.*, 3:122. 1915.

not irritate the skin as when the crystalline flowers of sulphur are used, and appears very effective. Sulphur ointments are uncomfortable, soil the clothes, and do not act within the clothes in which the lice hide. The effect of this treatment lasts about a fortnight in the case of individuals who perspire freely, and for others about a month.²⁵

Birch tar, crude rectified black or white, will keep away lice from 10 to 15 days, though it discolors linen somewhat.²⁶

An alcoholic solution of oil of bergamot 10 to 15 per cent, may be rubbed into the clothing, or a small bag full of cotton wool soaked in this liquid may be worn around the neck.²⁷

The following are considered among the best vermicides: (1) 35 per cent cresol and 65 per cent naphtha soap; (2) 35 per cent xylol and 65 per cent naphtha soap; (3) 5 per cent turpentine, 5 per cent petrol (gasoline), 2 per cent oil of cinnamon and 88 per cent talc.

The first is especially useful since it not only rapidly kills, but keeps lice away for several weeks.²⁸

The liquid of Malinin, consisting of 1000 grams of Persian insect powder extracted with 2700 grams of Russian turpentine for 5 days; the residue is pressed out and extracted again with 2700 grams of kerosene, after which both extracts are mixed and 250 grams of pure carbolic acid and 75 grams of oil of cloves added.²⁹ This may be sprayed upon infested men, their clothing, bedding etc. without injury, and is very effective in destroying lice and other insect pests.

Infested parts of the body may be rubbed with camphorated oil 10 per cent, oil of turpentine 15 per cent, camphorated spirit 10 per cent, chloroform water 5 per 1000, a mixture of equal parts of oil and petrol, xylol 90 drops mixed with 30 grams of vaseline, or a solution composed of 5 cubic centimeters anisol, 90 per cent alcohol 50 cubic centimeters and water 45 cubic centimeters.³⁰

Eucalyptus oil appears to kill the lice but does not destroy the eggs. It is more powerful though similar in action to camphorated oil. One-half an ounce is sufficient for 2 square feet of material if dropped on one side only.³¹

²⁵ Eysell. Arch. f. Schifs. u. Trop. Hyg., 19:238-40. 1915.

²⁶ Englehardt. Rev. Appl. Ent., 4:50. 1916.

²⁷ Galewsky. Deutsch. Med. Wochenschr., p. 285. 1915.

²⁸ Soulima & Ebert. C. R. Soc. Biol., 78:340. 1915.

²⁹ Tarassevitch. Nature (Moscow), 3:1514-18. 1914.

³⁰ Renault. Paris Med., 5:206-12. 1915.

³¹ Sergent & Foley. Bul. Soc. Path. Exot., 8:378-81. 1915.

Cyclohexanone alone or with cyclohexanol is now used in preference to anisol (methyl phenyl ether), inert powders being impregnated with these compounds.³²

Depediculization. The pests in garments and equipment can be destroyed by either dry or moist heat or the application of chemicals.

The Vondran hot air apparatus is an equipment with an electric blower which changes the air in a chamber 43 times in a minute, and a uniform high temperature is quickly reached. To destroy lice, 45 minutes at 178° F., or 40 minutes at 186° F. was sufficient.³³ In practice, heating for one hour at a temperature of 140° F. should be sufficient.³⁴

Clothing and bedding may be disinfested by using formaldehyde 12 per cent, and water vapor at 140° F. in vacuo. The preliminary heating requires 20 minutes and the temperature is then maintained at 140° to 144° F. for three-fourths of an hour.³⁵

Ironing the seams of clothing with a very hot iron is effective, especially applicable to the outer garments, it frequently being necessary to destroy the parasites in these at the time the men are bathing.³⁶

Infested clothing should be steamed under pressure 20 minutes or dipped in solutions of cresol, 2 per cent or stronger, for 10 minutes and hung up in the sun. Careful and vigorous brushing of uniforms in the open will rid them of both lice and eggs.³⁷ The brush may be moistened with a carbolic or cresol soap solution.³⁸

Clothes sprinkled with a 25 per cent solution of ammonia and put in a tightly covered box resulted in the death of both lice and eggs in an hour. The results are not so satisfactory when the clothes are wet.³⁹ Vermin in clothes may be destroyed with vapor of chloroform, carbon tetrachloride or methane, and sulphurous oxide.⁴⁰ The lice were all killed on infested clothes sprayed with benzine and put in a tightly closed container.⁴¹

Soap solutions containing 2 per cent of trichlorethylene or 10 per

³² Wesenberg. *Deutch. Med. Wochenschr.*, 41, 861-62. 1915.

³³ Baerthlein. *Rev. Appl. Ent.*, 5:43-44. 1917.

³⁴ Heymann. *Bul. Inst. Pasteur*, 14:91. 1916.

³⁵ Swellingrebel. *Rev. Appl. Ent.*, 5:33-34. 1917.

³⁶ Peacock. *Brit. Med. Jour.* 2892, p. 787. 1916.

³⁷ Legendre. *Bul. Soc. Path. Exot.*, 8:280-83. 1915.

³⁸ *Rev. Appl. Ent.*, 4:13. 1916.

³⁹ Beyer. *Mil. Surg.*, 38:483-91. 1916.

⁴⁰ Postnikov. *Rev. Appl. Ent.*, 3:122. 1915.

⁴¹ Renault. *Paris Med.*, 5:206-12. 1915.

cent of tetrachlorethylene will kill both adults and eggs in half an hour at ordinary temperatures.⁴²

All cracks and corners of an infested camp were washed with a 3 per cent solution of cresol soap and were then filled up. The building with a floor space of 450 meters was fumigated with 75 kilos of sulphur burned in 16 sulphur stoves, the burning being rapid and reaching its maximum in 45 minutes. After a 3 hour interval the doors and windows were opened, and except in two tightly packed parcels of clothes the lice and eggs had all been killed.⁴³

The control of vermin in the field is difficult under the best of conditions. Men should have an allotted time for the examination of their clothes for the occurrence of pests, and a general inspection by a company or sanitary officer should be made at least once a week. Men of careless habits should receive special attention, if only for the sake of their associates.

Depediculization in an army should be on a unit basis or it amounts to comparatively little, because reinfestation from occasional carriers or adjacent verminous commands is easy and usually rapid. Treatment with naphthalene or naphthalene compounds is one of the simplest and more effective methods, especially in the field. The most satisfactory solution of this problem is found in adequate bathing facilities so arranged in case there are vermin present that the men strip in one room, cleanse themselves thoroughly in a bathroom and emerge at the other end where they receive clean clothes or at least those which have been freed of vermin by heating (ironing, dry heat or steam). The essential in this process is an arrangement which will insure against reinfestation after the bath and a provision for treating the clothes as rapidly as the men bathe, a frequent necessity under camp conditions. Doctor Peacock⁴⁴ recommends that each division be provided with two baths, each capable of handling 80 bathers an hour, and with adequate disinfecting apparatus to care for the clothes.

Head Louse

Pediculus capitis De Geer

The head louse is smaller than the body louse, with shorter antennae and is more frequently seen on children than adults. The

⁴² Kinloch. Brit. Med. Jour. 2842. p. 1040-2841. 1915.

⁴³ Galewsky. Deutsch. Med. Wochenschr., 41: 652-53. 1915.

⁴⁴ Brit. Med. Jour. 2892. p. 788. 1916.

female may lay over 100 eggs in about 30 days. The egg period is about 6 days and the lice require approximately 18 days to attain maturity. The eggs or "nits" are whitish, pear-shaped, and fastened by their smaller ends to the hairs, especially those back of the ears. This parasite is almost entirely confined to the head, though it has been recorded as biting various animals. The restricted habitat makes it relatively easy to control.

Among school children the judicious use of a fine-tooth comb, or the application of a tincture or extract of larkspur is usually effective. Kerosene, if applied with discretion, will destroy the insects without untoward effects. Beyer⁴⁵ recommends putting a strip of parchment 4 to 6 inches broad around the head and forehead, holding the same with a bandage, and inside the projecting margin placing a well-fitted pad of gauze which is sprinkled with xylol and the whole is then covered by a pasteboard disk. The projecting margin of the parchment is now turned in over the pasteboard top and the entire covering held down by a bandage. The sprinkling may be repeated several times if necessary. Kinloch⁴⁶ states that the destruction of the pests may be secured in the hospital by going over the hair carefully with pieces of cotton wool moistened with either trichlorethylene or tetrachlorethane, and by this method there is no danger of irritating either the scalp or eyes. Shaving and washing the head of adults, followed by smearing with xylol, kerosene, acetic acid or liquid of Malinin, is recommended.⁴⁷

Crab Louse

Phthirus pubis Linn.

The flattened, broad, whitish crab louse is very different from either the head or body louse. Its very stout legs are tinged with red and add greatly to the crablike appearance of the parasite. It lives on all the hairy portions of the body except the head, and under exceptional conditions may be found on the head, though it displays a marked preference for the pubic region and the armpits. The pear-shaped eggs are attached to the hairs and hatch in 6 or 7 days, and in 15 days the young lice are mature. This pest will live apart from its host under favorable conditions for 10 to 12 hours.

⁴⁵ Mil. Surg., 38:486. 1916.

⁴⁶ Brit. Med. Jour., 2892, p. 792. 1916.

⁴⁷ Popov. Rev. Appl. Ent., 3:123. 1915.

These lice cause severe itching, followed by reddish inflamed spots, and if the infestation is not checked, more serious results may follow. Infestations have been contracted by using public water-closets. Unclean lodging houses and public bathtubs are also agents in the dissemination of this pest.

Repeated applications of mercurial ointment is the most satisfactory method of controlling this louse. This is a dangerous poison and it should be used with discretion. Vaseline mixed with yellow precipitate 1 to 50 is advised for the eyebrows and eyelashes.⁴⁸

Mites and Rash

There are several species of mites which are known to produce uncomfortable and sometimes serious irritation, generally diagnosed as rash.

The harvest mites, or chiggers, are mostly southern, occurring in the Gulf States northward to New Jersey and Illinois, and similar species are found in several European countries. The trouble is caused by microscopic, immature *Trombidium*. These young mites occur upon vegetation of different kinds, usually in shady situations, and are most likely to attack in the vicinity of the ankles, though they sometimes drop from trees and shrubbery and establish themselves on the neck or other parts of the body. The young mites burrow into the human skin and appear as small red spots which later become surrounded by a congested area which may be from less than one-fourth to one-half or three-fourths of an inch in diameter.

Prompt bathing, if exposure is suspected, may prevent the mites establishing themselves. Applications of hot water containing salt or strong soap are advised, and where exposure is unavoidable, flowers of sulphur rubbed over the legs and ankles is most satisfactory. Alkaline solutions counteract the acid poison. The destruction of mites in a field may be partly accomplished by cutting all useless grass, by close pasturing, dusting with flowers of sulphur or spraying with a dilute kerosene emulsion, much depending upon conditions.⁴⁹

The other mite infection is closely associated with wheat straw infested by joint worm, or grain affected by the Angoumois moth. The mite,⁵⁰ like the preceding, is microscopic in size, and when

⁴⁸ Renault. Paris Med., 5:206-12. 1915.

⁴⁹ Chittenden. U. S. Dep't Agr. Farm. Bul. 671. 1915.

⁵⁰ *Pediculoides ventricosus* Newp.

abundant may perhaps be best detected as a yellowish, mealy powder dropping from the infested straw or grain, as the case may be. This mite is primarily beneficial in that it preys upon two important grain pests and only occasionally troubles man. It produces, like the chigger, a dermatitis which may be diagnosed as rash and attributed to a number of causes other than the true one. Trouble of this kind is particularly likely to follow sleeping upon mattresses stuffed with infested straw or the handling of infested grain, and there are records of trouble of this kind following the unloading of Egyptian cottonseed. It is also troublesome at times in European countries.

Since this mite is most commonly associated with the joint worm and the latter winters in the stubble, raking over and burning the stubble in the spring is one of the best methods of preventing this mite becoming extremely abundant.⁵¹ Cooling lotions may well be applied locally to reduce irritation.

FABRIC PESTS

Clothes Moths

The small, white caterpillars of these insects, frequently in a cylindric, webbed case, are very different from the young of the carpet beetles noticed on page 53, one of which is frequently

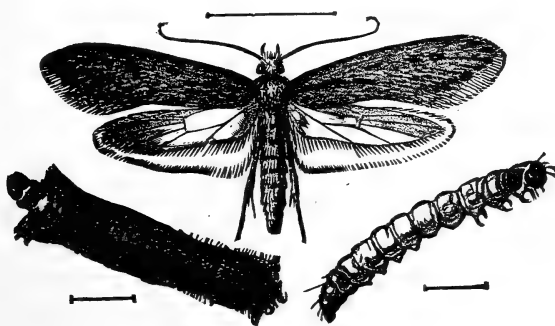


Fig. 15 Case-making clothes moth; adult; larva and larva in case; enlarged. (After Riley)

referred to as the Buffalo clothes moth. The true clothes moths are small, grayish yellow moths or millers, indistinctly dark spotted and having a wing spread of less than half an inch. The progeny of not all small moths are injurious to fabrics, though several such destructive species occur in this State.

⁵¹ Webster. U. S. Dep't Agr., Bur. Ent. Circ. 118. 1910.

Descriptions and habits. A common form is known as the case-making clothes moth,⁵² a species easily recognized in the immature stage by the small, white cylindrical case inhabited by a whitish, brown-headed caterpillar. The moths normally appear in early spring; they are only about half an inch long and obscurely marked with three dark spots on the forewings. The tiny, white eggs are deposited among the folds of garments. The caterpillars feed and grow slowly, sheltering themselves in the characteristic case. There is apparently but one generation annually and it is stated that the insects do not breed in winter, even in furnace-heated houses.

The webbing or southern clothes moth⁵³ is stated to be the more abundant and injurious species in the latitude of Washington and such appears to be true in both Albany and Ithaca. This species is about the same size as the preceding and has uniformly pale yellow-

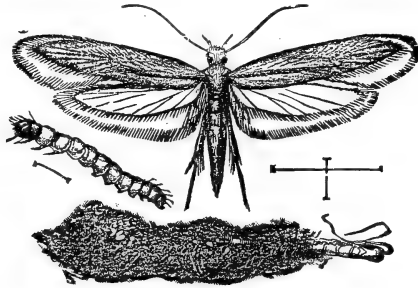


Fig. 16 Webbing or southern clothes moths: adult, larva, cocoon and empty pupal skin; enlarged. (After Riley)

ish wings. The young or caterpillar does not construct a case but lines its runways with fine silk. The minute, white eggs are deposited upon various fabrics and hatch in about 9 days. The development seems to be slow, as in the case of the preceding form, the moths occurring in early spring. This pest feeds upon a variety of animal materials, having been found in woolens, hairs, feathers and furs, and is frequently a troublesome pest in museums.

The tapestry moth⁵⁴ is larger than either of the above-mentioned clothes moths, it having a wing spread of about three-fourths of an inch. The base of the forewing is black and the outer portion a variable creamy white. This larger species is considered rare in this country, though apparently common in England. It displays a marked preference for the heavier fabrics, such as carpets and horse

⁵² *Tinea pellionella* Linn.

⁵³ *Tineola biselliella* Hum.

⁵⁴ *Trichophaga tapetzella* Linn.

blankets, and may be found in felting, furs, skins, carriage upholstery, etc.

Control measures. Clothes moths, like carpet beetles, fleas and some other household pests, thrive best in situations where there is relatively little disturbance. Clothing used almost daily and other fabrics subject to frequent handling, brushing or sweeping are relatively immune from injury. Woolens and furs are most likely to be damaged while in storage during warm weather. These, before being laid away, should be thoroughly aired, brushed and carefully examined for the presence of the destructive larvae. Then they should be packed in cedar chests or tight boxes, preferably with some naphthalene or camphor, as these latter materials are of some service as repellents. A very effective and cheap method of storing articles for the summer is to put them in tight pasteboard boxes and seal the covers firmly with strips of gummed paper.

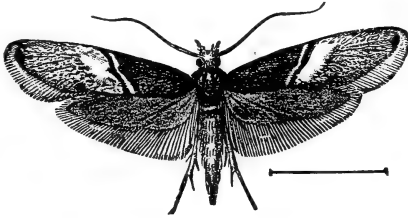


Fig. 17 Tapestry moth: adult, enlarged. (After Riley)

Valuable furs and similar articles are frequently deposited with storage companies. Experiments conducted under the direction of Doctor Howard, chief of the Bureau of Entomology, have shown that all danger of injury by clothes moths and their associates may be obviated by keeping the temperature at about 40° F. This is sufficiently low so that insects, even if present, will remain in a dormant and therefore harmless condition.

It is quite possible that fumigation with nitrobenzene (see page 80) would be a very effective as well as safe method of destroying household pests.

A very effective and safe method of destroying insects in stored furs and garments is by fumigation with carbon tetrachloride, using 6 pounds to 100 cubic feet of space. The insecticide is placed in large, shallow pans so as to assure rapid evaporation, and these in turn set on hot soapstones and the fumigation continued for a period of 24 hours. It is essential that the pans be large enough and the heat sufficient to vaporize the insecticide speedily; otherwise the results may not be entirely satisfactory.

In some instances superheating, especially if an electric heater is available, may be the best method of dealing with the situation. A temperature of 130° throughout the storeroom or clothespress for a period of 10 to 20 minutes ought to be amply sufficient, though it is advisable to allow some margin in the interests of thoroughness.

Occasionally a clothespress becomes badly infested by clothes moths. All garments should then be removed, aired, thoroughly brushed and care taken to destroy any larvae which may not have been dislodged by this treatment. The clothespress itself should be thoroughly brushed and cleaned. These measures should afford relief. It is a very poor plan to have in the attic or some unused part of the house miscellaneous woolens or other materials in which the pests can breed unrestricted, as such places are likely to serve as centers for the infestation of more valuable articles. Methods of fumigating are briefly discussed on pages 74-77.

Spraying with benzine or naphtha two or three times during warm weather is advisable for the purpose of preventing injury to cloth-covered furniture, cloth-lined carriages and similar articles in storage or unused for extended periods. Care should be exercised to prevent the inflammable vapor of these oils gaining access to fire of any kind.

Carpet Beetles

These insects, it will be seen by referring to page 49, are very different from the clothes moths though working somewhat in the same manner and frequently proving fully as injurious. There are two common species in this State, the older and better known Buffalo carpet beetle and another known as the black carpet beetle. The latter, in some localities at least, is decidedly more abundant and destructive than the former.

Description. The Buffalo carpet beetle⁵⁵ is a stout, oval beetle about one-eighth of an inch long or less and easily recognized by its black and white or yellowish white and red mottled wing covers, the red markings forming an irregular line with three lateral projections on each side down the middle of the back. The beetles are frequently rather numerous in houses in early spring and may be at once distinguished from the somewhat similar though decidedly different and beneficial ladybeetles or lady birds, by the fact that the carpet beetle has the under side distinctly concave and can be readily rolled when right side up, whereas the flat under surface of

⁵⁵ *Anthrenus scrophulariae* Linn.

a ladybeetle makes this impossible. The common name, Buffalo carpet beetle, is suggestive of the shaggy, stout grub or larvae nearly one-fourth of an inch long and frequently found in carpets, especially along seams or cracks in the floor. This pest has a uniform, hairy shagginess and a short tail of long hairs, quite different from that of the black carpet beetle grub to be described

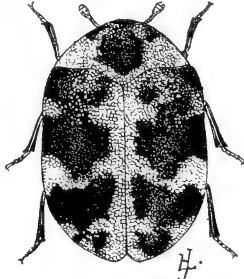


Fig. 18 Buffalo carpet beetle, seen from above, enlarged. (Author's illustration)

later. Feeding, and probably breeding, occurs throughout the winter in well-warmed houses. The ability of these insects to live under adverse conditions is strikingly illustrated in the case of a related species known as the museum pest,⁵⁶ which has lived and continued breeding for a period of 15 years in a tightly closed fruit can containing two small ears of very dry popcorn.

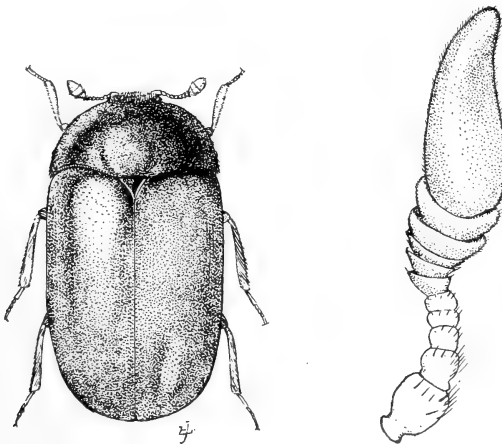


Fig. 19 Black carpet beetle, seen from above, enlarged; antenna of the male, still more enlarged. (Author's illustration)

⁵⁶ *Anthrenus verbasci* Linn.

The black carpet beetle⁵⁷ is a more slender, blackish or brownish beetle somewhat larger than the oval Buffalo carpet beetle though rarely attaining a length of three-sixteenths of an inch. Its decidedly somber colors and markedly more slender proportions distinguish it at once from the gayly colored Buffalo carpet beetle. It is also peculiar on account of the greatly produced terminal antennal segment in the male. The beetles are frequently found in warmed houses throughout the winter and it is probable that the grubs are active under such conditions. The slender, reddish brown grubs are about one-fourth of an inch in length and easily recognized by the nearly equally long, bushy tail of reddish hairs in connection with the short, sparse hairs of the tapering body.

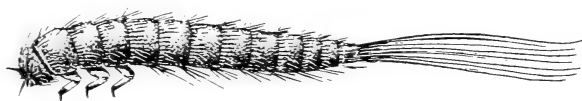


Fig. 20 The long-tailed grub of the black carpet beetle, x4. (Original)

The odd beetle⁵⁸ is a provisional designation for a unique species which may prove a domestic pest. Introduced from Europe a number of years ago, it has established itself in New York City, and last summer appeared in large numbers in a city dwelling. The larva or grub is approximately one-tenth of an inch long and presents a general resemblance to the small larva or grub of the much better known Buffalo carpet beetle, from which it is easily distinguished by the thick covering of somewhat club-shaped hairs. This insect was recorded as occurring in almost everything covered with tissue paper, and it is quite possible that it might establish itself in stuffed natural history specimens, such as birds, animal heads, etc. and, from such breeding centers, gradually spread throughout the building. Thorough cleaning of infested rooms and the free use of sodium fluoride appears to be the most practical method of checking an infestation.

Habits. Both of the carpet beetles are rather common on flowers the latter part of May and early in June and may be brought into houses therewith. They also occur on windows in early spring, are found in the fall and occasionally in the winter. Both play possum when disturbed. The eggs of the Buffalo carpet beetle

⁵⁷ *Attagenus piceus* Oliv.

⁵⁸ *Thelydrias contractus* Mots.

are deposited in convenient places and the young grubs develop rather rapidly. It is probable that there are not more than two generations in the North, though the insects are active in warm houses throughout the year. The black carpet beetle has very similar habits though the development of its grub appears to be much slower. It appears to be the more abundant species in Albany at the present writing. This latter insect is known to feed upon feathers and has been reared in flour and meal. Woolens are more liable to injury than other fabrics.

Control measures. Obviously it is advisable to destroy the beetles found about houses before they have had an opportunity of laying eggs. It is desirable to avoid bringing the pests into the house with flowers. Both of these insects breed in organic matter, presumably in outbuildings or outdoors, as well as within, fly to the flowers and may then, in the case of the Buffalo carpet beetle at least, be carried into dwellings before eggs are deposited. The substitution of rugs or matting for carpets is advised in localities where the pests are destructive.

Infested carpets should be taken up and thoroughly cleaned, and if badly infested, sprayed with benzine. This latter should invariably be done outdoors, owing to the extreme inflammability of this oil. Local injury can frequently be stopped by passing a hot iron over a damp cloth laid on the affected part of the carpet. The steam penetrates the fabric and destroys the pest in its retreat. The danger of subsequent injury can be largely avoided by filling all cracks and crevices in poorly constructed floors with putty, plaster of paris or a crack filler. Laying tarred paper under a carpet has been frequently advised as a preventive.

These insects can undoubtedly be destroyed by fumigation with burning sulphur, bisulphide of carbon or hydrocyanic acid gas. The first named is frequently employed and though the fumes are very pungent, liable to blacken silver and cause other damage, particularly if considerable moisture is present, it is one of the safest fumigants. Bisulphide of carbon, on account of its inflammability, is hardly a safe material to employ in dwellings. Hydrocyanic acid gas has been used extensively in the last decade for the destruction of household pests. Directions for using it are given on page 74.

For the treatment of garments and furs stored during warm weather, or kept in clothes presses, see the discussion on page 5.

Silver Fish, Bristle Tail or Fish Moth⁵⁹

This peculiar, elusive insect is frequently the subject of inquiry by careful housekeepers. It is rather common about houses though rarely seen. It is about three-eighths of an inch long, silvery gray and tapering. Perfect specimens have very long antennae and three equally long appendages at the posterior extremity.

Habits. This insect feeds upon nitrogenous or farinaceous matter such as the sizing of paper, starch, paste etc. It has even been known to eat off the faces of museum labels to such an extent as to render them illegible. It thrives best in places where there is comparatively little disturbance and is therefore rarely numerous in houses having few crevices and no storeroom where articles are allowed to remain undisturbed for months or even years at a time.

Control measures. This insect, if abundant, can be controlled to best advantage, according to Mr Marlatt, by slipping into their haunts pieces of paper liberally treated with a thick, boiled, starchy, preferably nitrogenous, paste poisoned with arsenic. This material should be used with extreme care and placed only where there is no danger of children getting hold of the poison. Ordinarily the dusting of this insect's haunts with fresh pyrethrum powder, followed by thorough cleaning, is preferable to the employment of an arsenical poison. Damage is most likely to occur in comparatively moist places or where articles are allowed to remain undisturbed for a year or more.

Book Louse

This is a pale louselike insect⁶⁰ only one-twenty-fifth of an inch long and frequently designated as the "death watch" because of the peculiar ticking sound it makes. This latter is supposed to predict an early death in the family. An allied species⁶¹ has similar habits and is considered to be the true "death watch." Both of these species, as well as allied forms, live upon vegetable matter and occasionally may become very abundant. There have been several records of this insect issuing in enormous numbers from mattresses stuffed with hair, corn husks or straw. An infestation of this kind can be controlled best by removing and burning the infested mattress. The apartment then should be thoroughly cleaned.

⁵⁹ *Lepisma domestica* Pack.

⁶⁰ *Atropos divinatoria* Fabr.

⁶¹ *Clothilla pulsatoria* Linn.

Crickets

These black, chirping, nocturnal insects⁶² and others occasionally make their way into houses and, for the most part, are not unwelcome. Sometimes they cause serious injury. Doctor Lintner records a case where a suit of clothes just from the tailor was completely ruined in a night by the common black field cricket,⁶³ which had entered an open window in some numbers. Such injury is exceptional. Crickets can be destroyed where necessary, by the use of ground-up carrots or potatoes to which a liberal amount of arsenic has been added. Recent experiments have also shown that they succumb readily to the grasshopper bait composed of twenty pounds of bran, 1 pound of Paris green, 2 quarts of cheap syrup, three oranges or lemons and 3½ gallons of water. The bran and Paris green are thoroughly mixed while dry; the juice of the lemons or oranges should be squeezed into the water and the remaining pulp and peel chopped fine and put in the water and the syrup added. The poisoned bran is then well dampened or mixed with this liquid. It is necessary to put the bait only in localities where the crickets are abundant. This is a deadly poison and should not be distributed where domestic animals, especially fowls, would have ready access to any quantity. Crickets may also be caught by taking advantage of their liking for liquids and placing low vessels containing beer or other fluids about their haunts.

FOOD PESTS

House Ants

There are several species of ants likely to occur in houses. These little insects are not specially destructive or obnoxious aside from their faculty of getting into everything.

The little red ant⁶⁴ is particularly troublesome, since its small size, it being only about one-sixteenth of an inch long, enables it to enter almost any receptacle not hermetically sealed. Furthermore, this little pest is very prolific and occasionally literally overruns buildings to the serious discomfort of the inhabitants. This tiny species is perhaps the most common and the most abhorred of all, owing to the difficulty of eradicating it.

⁶² *Gryllus domesticus* Linn. and others.

⁶³ *Gryllus luctuosus* Serv.

⁶⁴ *Monomorium pharaonis* Linn.

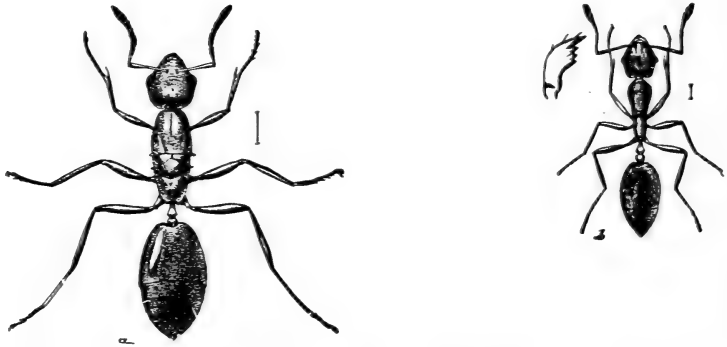


Fig. 21 Little red ant: a, female; b, worker or neuter, enlarged. (After Riley)

The little black ant⁶⁵ is about one-quarter of an inch long and though normally occurring under stones in yards, also invades the house in considerable numbers.

The pavement ant⁶⁶ is about three-eighths of an inch long and is very common along the Atlantic seaboard.

The large, black ant⁶⁷ is the giant among our household ants. It may be half an inch or more in length, is normally a wood feeder and has frequently been designated as the carpenter ant. This large species occasionally invades buildings, particularly in the country, lives in the timbers and makes systematic levies upon the food supplies of both kitchen and pantry. Occasionally this species may become very abundant in a dwelling.

Control measures. Dusting or blowing sodium fluoride about the haunts of ants, even when they were extremely abundant, has proved most satisfactory.⁶⁸

The recent work against the Argentine ant in the South has developed an improved arsenical syrup⁶⁹ which will not spoil and is said to be superior to any other formula tested on account of its stability at high temperatures, freedom from crystallization and continued attractiveness. It is made as follows: Prepare a syrup with 15 pounds of granulated sugar, 3½ quarts of water and one-quarter of an ounce of tartaric acid (crystallized). Boil for 30 minutes and allow to cool. Next dissolve three-quarters of an ounce of sodium arsenate (C.P.) in one pint of hot water, cool,

⁶⁵ *Monomorium minutum* Mayr.

⁶⁶ *Tetramorium caespitum* Linn.

⁶⁷ *Camponotus herculeanus* Linn.

⁶⁸ Gibson. Can. Ent., 48:365. 1916.

⁶⁹ Barber. U. S. Dep't Agr. Bul. 377, p. 18, 1916.

and add the poisoned solution to the syrup, stir well, and then add to the poisoned syrup $1\frac{1}{2}$ pounds of honey and mix thoroughly.

Ants may be destroyed by the use of a very weak solution of arsenic and syrup, which should be prepared by a druggist. It consists of a poisoned syrup of sugar or other cheap sweetening containing between one-fourth and one-eighth of 1 per cent of sodium arsenite. The most convenient way of using the poison is to saturate a piece of sponge with the syrup and place it in a large jar with a perforated cover. Ordinary pint fruit jars or even smoked-beef tumblers having tin covers perforated with nail holes, are perhaps as convenient as any. The baited jars should be placed in the vicinity of the nests and laid on the side or so located that they can not be filled with water, and at the same time be easily accessible to the ants. The insects will feed upon the poison readily and also carry it to the nests, the latter insuring the eventual extermination of the colony. Several baited jars can be used about a house or yard.

Trapping the ants by means of sponges dipped in sweetened water is frequently advised and gives good results if conscientiously carried out. First, attractive foods should be removed, so far as possible, prior to the distribution of the pieces of sponge saturated with sweetened water. These latter should be gathered from time to time and the ants clinging thereto destroyed by dropping in boiling water.

The common outdoor nests of ants, especially those made in the grass, can be destroyed by the use of carbon bisulphide. Make a hole several inches deep with a broom handle and put therein about 1 ounce of carbon bisulphide and cover quickly. In the case of a large nest, several holes should be made at a distance of a foot or a foot and a half and each charged with carbon bisulphide. A more recent method is scooping out a portion of the soil and filling the cavity with a solution of cyanide of potassium, using 1 ounce of this deadly poison to a gallon of water. Another probably equally effective way is the sprinkling of the surface of the nest with fine particles of potassium cyanide. This material, it should be remembered, is a most dangerous poison and every precaution should be taken to avoid disastrous results. The nests of the large black ant are usually found in timbers, such as studding in the walls and are therefore almost inaccessible. The writer has seen 2 by 4 joists badly riddled by the operations of this insect.

The little black ant and the pavement ant are very likely to build

nests outdoors under stones. Should these be found they can be destroyed by liberal applications of boiling water or spraying with kerosene.

Cockroaches

These insects with their active habits and almost omnivorous tastes, are found on ships, generally established in many cities and villages, and are likely to be carried along the main routes of travel by shipments of food stuffs or materials packed in the vicinity of foods. Old houses with their numerous crannies and crevices afford a multitude of hiding places and make it possible for cockroaches to exist in spite of persistent efforts to exterminate them.

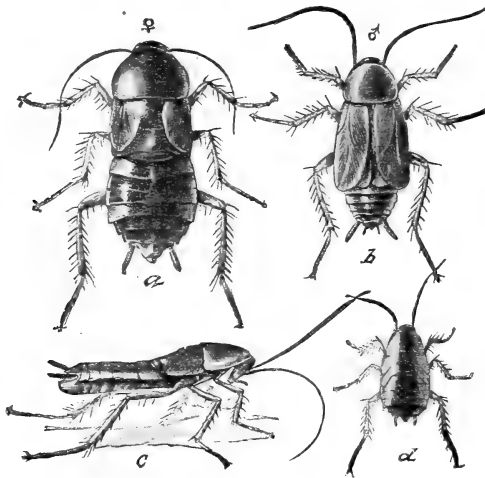


Fig. 22 Oriental cockroach: *a* and *c*, female from above and the side; *b*, male; *d*, a half grown individual; all natural size. (After Marlatt, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

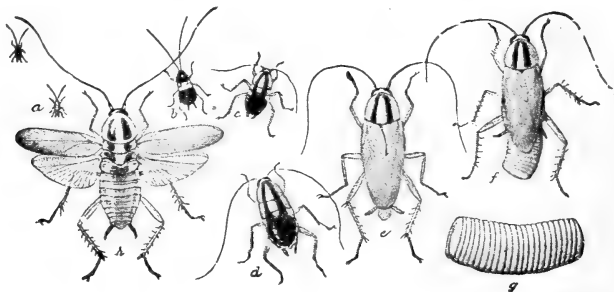


Fig. 23 Croton bug: *a*, *b*, *c*, *d*, successive stages in the development of the young; *e*, adult; *f*, female, with egg case; *g*, egg case enlarged; *h*, adult, with wings spread; all natural size except *g*. (After Riley)

Three species are common in America. The American cockroach⁷⁰ is a large, dark-brown insect nearly an inch and a half long and has well-developed wings. The oriental cockroach or black beetle⁷¹ is nearly wingless, dark brown or black, and about an inch long. The smallest and frequently the most abundant is the Croton bug,⁷² a light-brown, dark-marked insect only about three-fourths of an inch long. In addition, the Australian cockroach,⁷³ frequently brought to America in vessels, is a reddish brown insect about $1\frac{1}{4}$ inches long and easily recognized by the yellow irregular, oval markings just behind the head.

The larger American or European cockroaches are frequently abundant, though the Croton bug is usually more numerous. These insects find the dampness of water pipes very congenial, and on account of their favoring such places they are widely known as water bugs. These pests, both large and small, feed upon a great variety of vegetable and animal substances. The refuse scraps of the sink, the food on pantry shelves, prepared cereals, woolens, the leather of shoes, furniture or books, the sizing of paste, of cloth-bound books and similar materials are all liable to more or less injury by gnawing. Aside from the actual damage inflicted, the fetid roachy odor is imparted to infested food stuffs, rendering them unpalatable and unwholesome. The American cockroach has been fed upon cultures of cholera and the disease germs recovered from the insect's feces, in one instance 79 hours after feeding. Cockroaches have been observed to disgorge portions of their meals at various intervals after feeding, and in one case as long as an hour afterward cholera vibrios were found in the ejected materials.⁷⁴ There would seem to be equal probability of these pests conveying other diseases in the same manner. The development of cockroaches, despite their numbers, appears to be relatively slow, since the oriental cockroach requires from 3 to 5 months to attain maturity, while the American cockroach may not become fully grown in less than 12 months. The persistence of these insects in a building is explained in part by the fact that the oriental cockroach has been known to live 76 days without food, and can survive submersion in water for 20 minutes.⁷⁵

⁷⁰ *Periplaneta americana* Linn.

⁷¹ *Periplaneta orientalis* Fabr.

⁷² *Ectobia germanica* Linn.

⁷³ *Periplaneta australasiae* Linn.

⁷⁴ Barber. Phil. Jour. Sci., Feb. 1, 1914.

⁷⁵ Holt. Lancet, 4840, p. 1136-37.

Sodium fluoride, pure or diluted with equal parts of plaster of Paris or similar material and strewn about the haunts of these insects, is a simple and very effective method of controlling these pests. Powdered borax, or borax diluted with equal parts of naphthalene flakes, can be used in the same way. The distribution of these insecticides or proprietary remedies should be supplemented by persistent cleanliness in the elimination of inaccessible haunts so far as possible.

Superheating, where this is possible, is a comparatively simple and very effective means of destroying cockroaches, as well as other insects. The cockroach is unable to withstand a temperature of 120° F. for more than a few minutes, and the maintenance of a temperature of 150° to 160° F. in a house for several hours should result in killing all the insects.

It is very probable that the comparatively simple fumigation advised for fleas would be nearly, if not equally efficacious, against these pests. Fumigation with sodium or potassium cyanide, burning sulphur or carbon disulphide will destroy the pests, though it should be remembered that the first is a very active poison, that the second is liable to injure fabrics and tarnish metals, and that the third when diluted with air is a dangerous explosive.

Larder Beetle⁷⁶

The parent insect, a stout, dark-brown beetle with the base of the wing covers mostly yellowish, is frequently rather common about houses in May and June. This insect breeds by preference

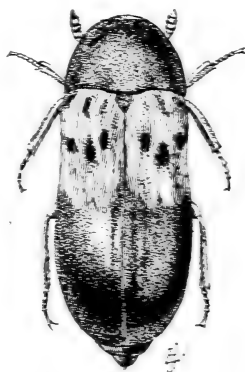


Fig. 24 Larder beetle.
seen from above, enlarged.
(Author's illustration)

⁷⁶ *Dermestes lardarius* Linn.

on animal matter such as ham, bacon, various meats, old cheese, horns, hoofs etc. The very hairy, brown grub is about one-half of an inch long when full grown.

Meats and other foodstuffs attractive to this insect should be stored in places inaccessible to the beetles. It is said that old cheese can be used very successfully for trapping the parent insects. Cheese or meat infested by the grubs should have the affected part cut away and the surface washed with a very dilute carbolic solution. The packing of meats in tight bagging is of considerable service in preventing attack.

Cheese Skipper

The cheese skipper⁷⁷ is the young of a small, black, glistening fly about three-sixteenths of an inch long. The white, cylindric maggots are easily recognized by their peculiar jumping power. This

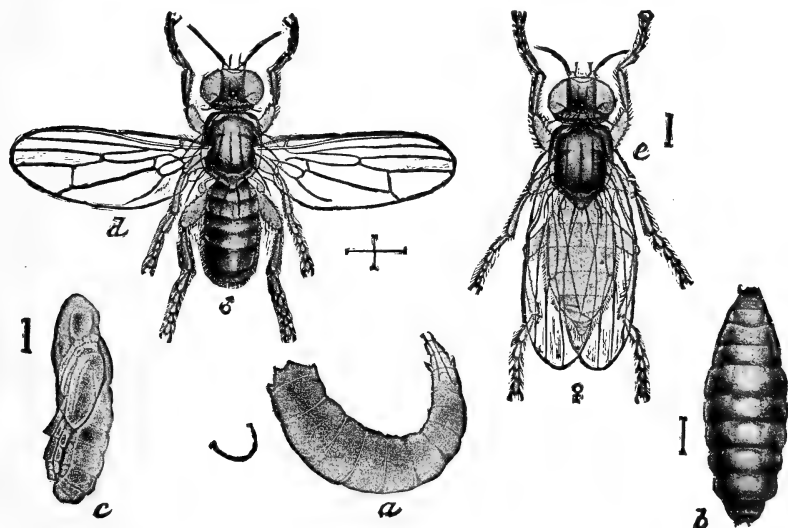


Fig. 25 Cheese skipper: a, maggot or larva; b, puparium; c, pupa; d, male fly; e, female; all enlarged. (After Howard, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

is accomplished by bringing the two ends of the body together and then suddenly straightening with a quick muscular action. The maggots of this insect are likely to occur on cheese, particularly that which has been kept for some time, and also upon ham. This species has proved to be a serious pest in some packing houses. It is more or less abundant about cheese factories.

⁷⁷ *Piophilidae casei* Linn.

This little pest can be best controlled by storing products likely to be injured, in a dark place. Scrupulous cleanliness is a most efficient preventive. Rubbing daily the bandages and sides of cheese, in hot weather, has been recommended for the purpose of destroying or brushing off eggs. The cheese may be washed with hot whey or with lye, the latter acting as a repellent. Smoked meats should be put in places inaccessible to the flies. A fine screen, 24 to the inch wire mesh, effectively excludes this little insect.

Cheese or meat infested by skippers is not necessarily ruined, since the injured parts can be cut out and the remainder used as food.

Cereal and Seed Pests

A number of these insects are likely to occur in houses and, on account of their somewhat similar habits, they are discussed under a general head. Most of these species are important because of their infesting cereals or cereal preparations of one kind or another.

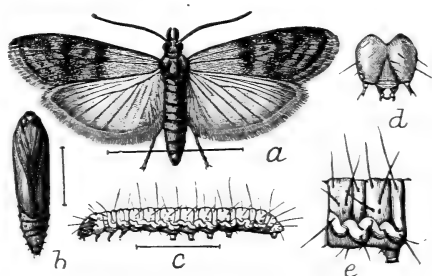


Fig. 26 Indian meal moth: *a*, moth; *b*, pupa; *c*, caterpillar from the side; *d*, head and *e*, first abdominal segment of caterpillar, more enlarged. (After Chittenden, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

The Indian meal moth⁷⁸ has a wing spread of three-quarters of an inch and is easily recognized by the outer two-thirds of the wings being reddish brown and with a coppery luster. It is one of the more common of our cereal pests. The whitish, brown-headed caterpillar lives in a large variety of substances, including all cereal preparations and such diverse materials as various nuts, dried fruits, seeds etc. The caterpillar spins a light web to which particles of its food and frass adhere, thus injuring much that is not consumed and affording a ready means of detecting the presence of the pest. The life cycle may be completed in 4 or 5

⁷⁸ *Plodia interpunctella* Hubn.

weeks, consequently there may be a number of generations in a year. Continuous breeding occurs in warm buildings.

The meal snout moth⁷⁹ with its different shades of brown and reddish reflections has a wing spread of about three-quarters of an inch. The whitish caterpillar has a brown head and lives in long silken tubes. It subsists mostly upon cereals though it has been

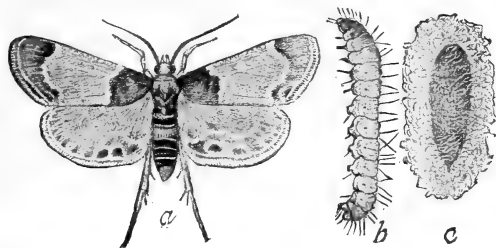


Fig. 27 Meal snout moth: *a*, adult; *b*, larva; *c*, pupa in its cocoon; twice natural size. (After Chittenden, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

recorded as feeding upon other seeds and dried plants and displaying a preference for clover. There are probably at least four generations annually since the life cycle may be completed in 8 weeks.

The European grain moth or wolf moth⁸⁰ is a grayish, irregularly dark brown-spotted insect having a wing spread of about half an inch. The yellowish white, brown-headed caterpillars are about one-fourth of an inch long and form characteristic dull reddish brown masses composed of groups of cocoons with the meshes loosely filled with brownish, gnawed materials. This

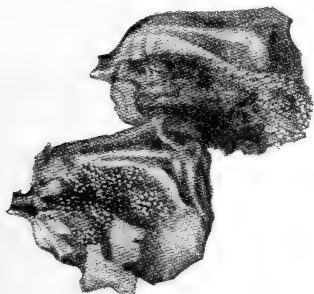


Fig. 28 Kernels of corn eaten by European grain moth, enlarged. (Author's illustration)



Fig. 29 Cocoon masses of European grain moth, enlarged. (Author's illustration)

⁷⁹ *Pyralis farinalis* Linn.

⁸⁰ *Tinea granella* Linn.

European insect, a serious enemy of stored grains, has been established in this country for several years and is likely to appear in seed warehouses and similar places without warning. Measures of value against other cereal pests are very effective in controlling this insect.

The saw-toothed grain beetle⁸¹ is one of the smallest and the most common of the grain beetles. It is only about one-tenth of an inch long, reddish brown, flattened and easily recognized by the peculiar saw-toothed edge along the sides of the thorax. This

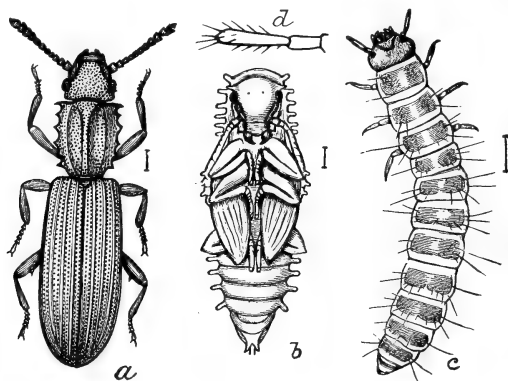


Fig. 30 Saw-toothed grain beetle: *a*, beetle, from above; *b*, pupa, from below; *c*, grub or larva; all enlarged. (After Chittenden, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

insect displays a marked preference for all cereal preparations though it also occurs in preserved fruits, nuts and seeds, and has been recorded as injuring yeast cakes, mace, snuff, and even red pepper. The pests breed for extended periods and continuously in packages of cereals stored in warm houses. A number of generations annually are possible, since the life cycle can be completed under favorable conditions in 24 days. The writer had his attention called several years ago to a case where this beetle multiplied by the millions in a brewery and spread therefrom to adjacent houses and caused a great deal of annoyance by getting into everything, not excepting clothing that was worn and bedding in use.

The confused flour beetle⁸² is a stout, rust-red beetle about one-sixth of an inch long and a not infrequent associate of the saw-toothed grain beetle. It likewise has a marked preference for cereal preparations, though it occurs in such diverse products as

⁸¹ *Silvanus surinamensis* Linn.

⁸² *Tribolium confusum* Duv.

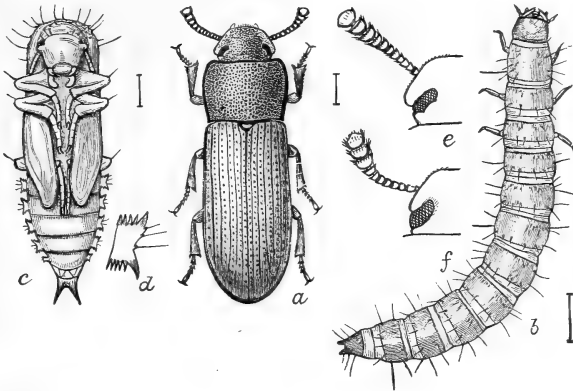


Fig. 31 Confused flour beetle: *a*, beetle from above; *b*, grub or larva, from above; *c*, pupa, from below; all enlarged; *d*, *e*, and *f*, structural details. (After Chittenden, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

ginger, cayenne pepper, baking powder, orris root, snuff, slippery elm, peanuts and various seeds. The life cycle may be completed under favorable conditions in 36 days and breeding appears to be continuous in warmed buildings. A closely allied form with similar habits, known as the rust-red flour beetle,⁸³ occurs mostly in the southern states though it is recorded from New York State and has been listed from New Jersey as associated with its close ally in various food products.

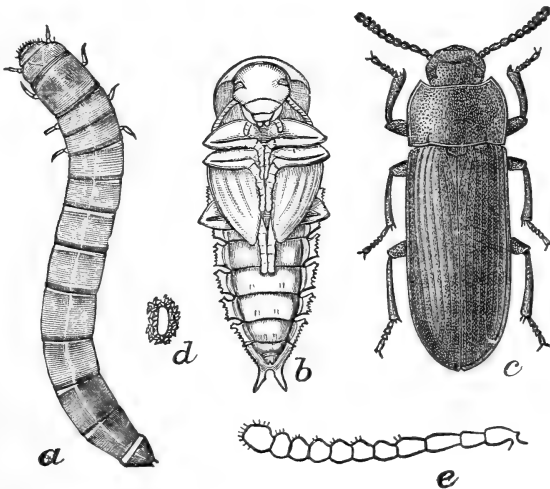


Fig. 32 Meal worm: *a*, larva; *b*, pupa; *c*, female beetle; *d*, egg, with surrounding case; *e*, antenna. *a*, *b*, *c*, *d*, about twice natural size, *e*, more enlarged. (After Chittenden, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

⁸³ *Tribolium ferrugineum* Fabr.

The meal worms are rather common pests of meal and other stable foods. It is the larvae and pupae of these insects which are reared in quantity by bird supply houses. The large brown or dark-brown parent beetles have a length of about five-eighths of an inch and are frequently found about houses. There are two closely allied species, the yellow meal worm⁸⁴ and the dark meal worm⁸⁵. Both occur under similar conditions and have nearly the same habits. The beetles are frequently attracted to light and normally are more abundant in the spring. The young or grubs are an inch or more in length, cylindric, yellowish brown, and require about 3 months to complete their growth. In addition to

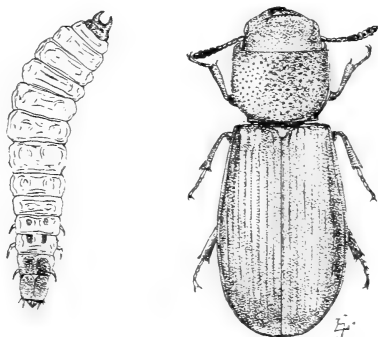


Fig. 33 Cadelle, beetle and larva, from above, enlarged. (Author's illustration)

meal and similar products, these insects have been found in adulterated black pepper, commercial soda ash, phosphate fertilizers, in the latter instance undoubtedly feeding upon organic matter, possibly cotton seed meal, a well-known food of these two species.

The Cadelle⁸⁶ is another inhabitant of grain bins. The beetle is rather stout, shining dark brown, about three-eighths of an inch long and possesses an unusual life duration, since adults have been kept alive nearly 2 years. The peculiar grub or larva, over an inch long, is easily recognized by its flattened appearance and the dark-brown plates just behind the head and at the opposite extremity of the body. It requires nearly a year to complete the life cycle. This species, according to Chittenden, is predaceous as well as herbivorous. The grub has a faculty for turning up in unexpected places as, for example, in milk which may have been adulterated with some farinaceous material. It has been found in white hellebore and even in granulated sugar.

⁸⁴ *Tenebrio molitor* Linn.

⁸⁵ *T. obscurus* Linn.

⁸⁶ *Tenebrioides mauritanica* Linn.

The drug store beetle⁸⁷ is a rather stout, light brown beetle about one-eighth of an inch long, which attacks a large variety of substances. It occurs in mills, granaries and warehouses, living upon flour, meal, breakfast foods, condiments, roots and herbs and

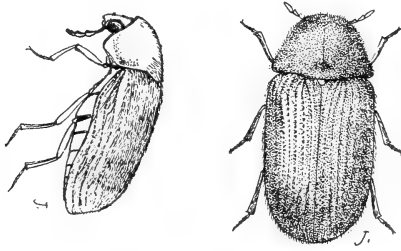


Fig. 34 Drug store beetle, seen from above and the side, enlarged. (Author's illustration)

animal substances, occasionally appearing in large numbers. It is by no means unimportant as a leather pest and has occasioned serious losses in boot and shoe factories and materially damaged the leather bindings of books, especially those kept in storage for a time. It has been known to colonize itself in a human skeleton which had been dried with the ligaments left on, and has been recorded as perforating tinfoil and sheet lead. Only 2 months are required to complete the life cycle, and in warm dwellings breeding may be continuous throughout the year.

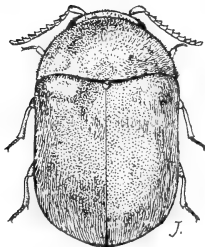
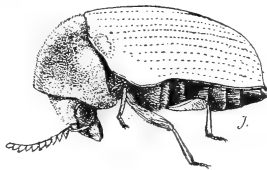


Fig. 35 Cigarette beetle, seen from above and the side, enlarged. (Author's illustration)

⁸⁷ *Sitodrepa panicea* Linn.

The cigarette beetle⁸⁸ is another tiny, omnivorous species. The adult is light brown, stout, slightly hairy and only one-eighth of an inch long. The period of larval growth is about 2 months and the life cycle may be completed in 47 days. The insect multiplies rapidly and is best known on account of its injuries to tobacco, cigarettes in packages being frequently perforated by this tiny pest. It is known to infest a large variety of food stuffs, including condiments, such as cayenne pepper, ginger and rhubarb, drugs of various kinds, like ergot and tumeric, and even dried herbarium specimens. It has also been recorded as destructive to silk and plush upholstery.

Spider Beetles

The white-marked spider beetle⁸⁹ is a small, reddish brown insect with four white marks on the wing covers. Its long antennae

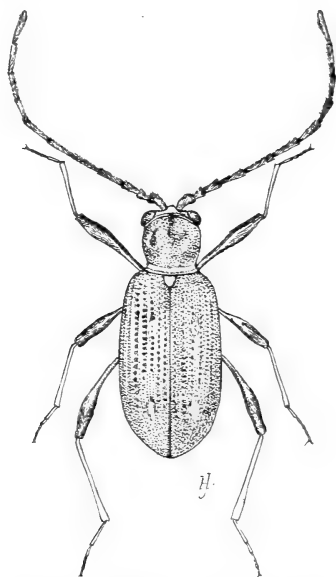


Fig. 36 Spider beetle, seen from above, enlarged. (Author's illustration)

and legs and subglobular body are suggestive of a spider, hence the common name. This species feeds upon a large variety of dried vegetable and animal substances, such as insect collections, dried plants and herbaria, red pepper, cotton seed, refuse wool, and is

⁸⁸ *Lasioderma serricorne* Fabr.

⁸⁹ *Ptinus fur* Linn.

said to be injurious to furs, clothing, roots, grain, stuffed animals, etc. It also damages leather-bound books. The life cycle in the latitude of Washington has been completed in about $3\frac{1}{2}$ months and it is therefore probable that there is more than one generation annually.

The brown spider beetle⁹⁰ lives with the preceding, has similar habits and differs particularly in the absence of the white markings.

The pea weevil⁹¹ and various bean weevils⁹² are stout, grayish weevils most easily recognized by their occurring respectively in peas and beans. The original infestation usually takes place in the

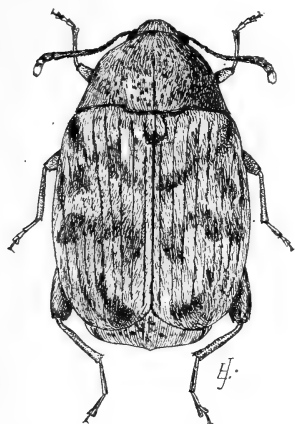


Fig. 37 Bean weevil, seen from above, enlarged. (Author's illustration)

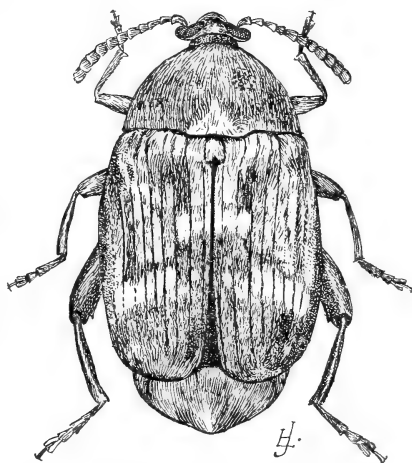


Fig. 38 Pea weevil, seen from above, enlarged. (Author's illustration)

field, though these insects are capable of breeding for extended periods in the dried seeds of their food plants. The presence of the beetles in a house is an almost infallible indication of infested peas or beans. It is usually more satisfactory to burn a small lot infested by these insects.

Control measures. It is comparatively easy, with the exercise of a moderate degree of care, to avoid serious injury by any of these pests, since they invariably require access to a liberal amount of food for an extended period. Any materials likely to produce numbers of these insects should not be allowed to lie undisturbed and accessible for a series of months. Most of these pests can

⁹⁰ *Ptinus brunneus* Duft.

⁹¹ *Bruchus pisorum* Linn.

⁹² *B. obtectus* Say and others.

easily be destroyed by heating the infested material for a period of 4 or 5 hours to about 125 or 150° F. This should be done carefully and time enough given so that the heat will penetrate and destroy all of the insects. Anything infested should be promptly cared for either by destroying the entire package or, if heating is inadvisable, by treating the same with carbon bisulphide.

Fumigation with carbon bisulphide is comparatively easy of execution since it is necessary only to put the material in a tight pail or can, put on the top a spoonful or thereabouts of the insecticide in a shallow saucer or plate, cover the receptacle tightly and allow the whole to stand for preferably 24 or 36 hours. This insecticide may be used on a large scale, according to Dr W. E. Hinds, at the rate of 10 pounds to 1000 cubic feet of space, provided the compartments are exceptionally tight and the temperature above 70° F.

STRUCTURAL TIMBER PESTS

White Ants⁹³

These insects, despite their general resemblance to the more common ants, are very different creatures. The flying ants, though having somewhat the same size as some of our winged, black ants, may be recognized at once by the numerous veins of the wings. White ants are frequently very injurious to buildings or their contents, particularly in Washington and to the southward. Occasionally they cause serious injuries in New York, and in at least one instance established themselves in safe deposit vaults and proceeded to destroy valuable records and to tunnel the wooden blocks of electrotypes. The whitish, wingless, antlike forms make large tunnels in woody and other vegetable fibers, invariably avoiding the light. They pass from one object to another only through covered galleries. The secrecy with which these pests operate enables them to cause extensive injury before their presence is suspected. These peculiar insects are familiar to many who have observed their operations in an old stump.

Control measures. Nothing but the most thorough work will clean a building or a vault of these insects, because their burrowing habits enable them to get beyond the reach of destructive gases. An infested vault should have everything removed, every crack and crevice thoroughly cleaned and then special attention given

⁹³ *Termes flavipes* Kollar.

to doors or other means of entrance, to see that there is no possibility of insects entering through an unsuspected crevice. Before replacing the contents of the vault, wood, papers or other materials likely to be infested should be most carefully examined and, if necessary, thoroughly heated or repeatedly fumigated with some gas. Great care should be exercised to prevent the reinfestation of any such place. It is even more difficult to control this pest in buildings, since if it becomes abundant nothing can be done aside from installing brick, stone or concrete foundations. This

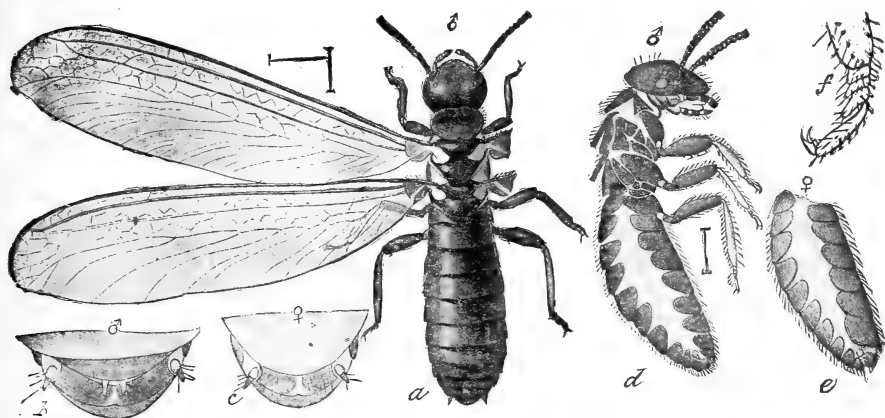


Fig. 39 White ants: *a*, adult male from above; *b*, posterior extremity of the same from below; *c*, the same of the female; *d*, male seen from the side; *e*, side view of the abdomen of the female; *f*, tarsus showing the segments and the claw; *a*, *d*, *e*, are enlarged; *b*, *c*, *f*, greatly enlarged. (After Marlatt, U. S. Dep't Agr. Div. Ent. Bul. 4. n. s. 1896)

form of construction is especially advisable in warmer sections of the country. Where books, papers and exposed woodwork only are infested, thorough and protracted fumigation with hydrocyanic acid gas, described on pages 74-77, may be advisable.

Powder Post Beetles

This name is applied somewhat indiscriminately to small insects which inhabit well-seasoned, hard woods, sometimes nearly riddling them, and produce piles of fine, powdery borings. Furniture, flooring, timbers, tool handles and almost any well-seasoned, hard wood may be invaded by these insects. They confine their operations very largely to the sapwood. One of the commonest of these pests is a slender, dark-brown or nearly black beetle⁹⁴ (figure 40)

⁹⁴*Lyctus unipunctatus* Herbst.

about three-sixteenths of an inch long. This or its close allies frequently attack timbers in dry cellars.

The small, red-horned borer⁹⁵ (figure 41) about three-sixteenths of an inch long, dark-brown and with reddish antennae, has been brought to our notice on account of serious injuries to birch and maple floors. Very little appears to be known concerning the life histories of these species, though the probabilities are that breeding is continuous, provided temperatures are not too low.



Fig. 40 Powder post beetle, *Lyctus*, much enlarged. (Author's illustration)

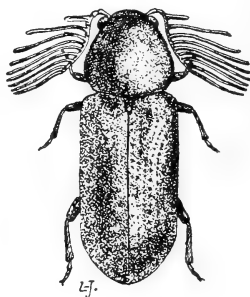


Fig. 41 Small, red-horned borer, much enlarged. (Author's illustration)

Control measures. All very badly infested, especially weakened, timbers should be removed. Some relief may be obtained by liberal applications, where conditions permit, of kerosene, gasoline or benzine. The pests can be destroyed by heat, steam being the safest and thoroughly effective, though dry heat may be employed. In either case it is essential to continue the operation until the infested wood is well warmed throughout and an attempt should be made to raise the temperature of the interior to 120 or 130° F., the latter being desirable.

Avoiding the use of infested timber is a self-evident protection and, so far as practical, sapwood should be excluded from important structural timbers.

FUMIGATION WITH HYDROCYANIC ACID GAS

This is one of the most effective methods of destroying insects in houses, particularly if the infestation is general. It should be remembered at the outset that potassium or sodium cyanide, sul-

⁹⁵ *Ptilinus ruficornis* Say.

phuric acid and their derivative, hydrocyanic acid gas, are among our most active and deadly poisons. They should be handled with extreme care and every precaution taken to avoid an accident, since a slight mistake may result in one or more fatalities.

One ounce of high-grade 98 per cent cyanide of potassium and one fluid ounce of the best commercial sulphuric acid diluted with 2 fluid ounces of water should be used for every 100 cubic feet of space. Pure sodium cyanide produces one-third more hydrocyanic acid gas to a pound than does the cyanide of potassium and is a very satisfactory substitute. If this be used instead of the potassium cyanide, $1\frac{1}{2}$ ounces of sulphuric acid and 3 ounces of water are advised for each ounce of the poison. Its slightly greater cost is balanced by the larger amount of gas. Sodium cyanide is now being manufactured in special one ounce molds for fumigation purposes. The amounts recommended above should be doubled for poorly constructed houses. The fumigation should last at least 30 minutes and it would be preferable to have it continued 3 or 4 hours, or if convenient, all night.

Rats and mice are also killed by this treatment and it is fortunate that these animals rush out into the open before succumbing, so that there is little or no danger of subsequent annoyance due to dead animals in the walls or under the flooring.

Prior to treatment all fluids, especially liquid or moist foods, should be removed from the house. Arrangements should be made to open the building from the outside after the fumigation is completed. Windows and doors should be sealed as tightly as possible, either by stuffing damp paper in the crevices or pasting strips of paper over cracks. Chimney places, ventilators and other orifices should be closed tightly. The gas is generated by dropping the cyanide of potassium, previously broken into lumps about the size of a walnut and preferably placed in thin bags or wrapped loosely in thin paper, into the requisite amount of diluted acid. The acid should be carefully diluted by pouring it slowly, accompanied by frequent stirring, into the necessary amount of water. This dilution should be slow enough to avoid all danger of this very strong acid splashing and perhaps causing dangerous burns. It will be found advisable to have one or more jars or generators in each room or hallway, since it is not wise to use more than 2 pounds of cyanide in a generator. The large, preferably deep, earthenware vessels used as generators should be placed near the middle of the room and on a thick layer of newspapers in order to avoid possible injury

from splashing acid. Precautions should be observed, if the building is in contact with others in a row, to see that persons in adjacent dwellings are warned and arrangements made so that the rooms next the treated building will be kept well-aired during the fumigation. It is unsafe to attempt to fumigate individual rooms in a house or a building in a row, unless one can be certain that there will be good aeration on all sides of the apartment or building. The deadly character of this gas is shown by the destruction of sparrows resting upon the eaves of a building during fumigation. One should not attempt to fumigate a building or a room alone, because an accident under such conditions is very likely to result fatally. Since hydrocyanic acid gas is lighter than air, operations should commence at the top of the building and proceed successively from floor to floor. Better still, place the requisite amount of the cyanide of potassium in thin bags, suspend each over its generator in such a manner that when a string near the exit is loosened, all will drop into the jars. The poison should not be in a thick paper bag, as the action of the acid may be seriously hindered if not almost prevented.

Under no conditions should anyone be allowed to enter the building prior to the completion of the fumigation and its thorough aeration. At least 30 minutes, and preferably an hour or more, depending somewhat upon the means of ventilation, should be allowed for this latter process. It is unsafe to enter any recently fumigated building until all the odor of the gas, resembling that of peach kernels, has disappeared. The contents of the fumigating jars should be carefully disposed of together with any remaining cyanide. These substances can either be buried deeply in the soil, or if in a city, may be poured into the sewer.

The following memoranda will doubtless prove of service in practical work:

- 1 Estimate the cubical contents and the amount of materials for each room.
- 2 Remove all liquids and moist foods in particular.
- 3 Seal all exits tightly with strips of paper or by filling crevices.
- 4 Provide for ventilation from the outside.
- 5 Weigh out the cyanide and place it in thin bags or do it up loosely in thin paper.
- 6 Place the generators in the various rooms, each upon a thick layer of newspapers.
- 7 Dilute the acid carefully and put it in the generators.
- 8 Distribute the amounts of cyanide to the various rooms.

- 9 Be certain that everything is all right and nobody in the building or room. *Notify* occupants of adjacent rooms or houses that the fumigation is to be commenced.
- 10 Drop in the cyanide, preferably from near the exit and close tightly.
- 11 Adopt suitable precautions to prevent the room or building being entered during the fumigation period.
- 12 Open the ventilators from the outside.
- 13 After the building has been thoroughly aerated, remove the generators and take care of their contents together with any excess of cyanide.

ANIMAL PESTS

Domestic animals, especially horses, are greatly disturbed and occasionally seriously injured by the activities of various flies and parasites, and below are given well-recognized preventive or remedial measures for some of the more common occurring under field conditions.

The bot fly⁹⁶ of the horse is a rather common insect which deposits its eggs on the hairs of the shoulders, forelegs, under side of the body, most commonly on the forelegs and shoulders. The eggs hatch when the horse licks itself and the ingested maggots establish themselves upon the inner walls of the stomach. The presence of but a few would probably have little effect, while large numbers must seriously interfere with the processes of digestion and assimilation.

Systematic currying or cleaning is of material assistance in dislodging the eggs and thus preventing the maggots developing. A mixture consisting of oil of tar 1 ounce, and olive oil 6 ounces, should be smeared daily on the chin and legs of the animal, and if there is an infestation of bots, the horse should be given 2 ounces of turpentine in 1 pint of raw linseed oil, followed in a few days by a dose of Barbadoes aloes.⁹⁷ This internal treatment should be given under the direction of a veterinarian.

The horn fly⁹⁸ is a recently established small fly which breeds in cow dung and is especially injurious to cattle, displaying a marked preference for the bases of the horns; hence the common name.

⁹⁶ *Gastrophilus equi* Fabr.

⁹⁷ Queensland Jour., 5:36. 1916.

⁹⁸ *Haematobia serrata* Rob.—Desv.

Various repellants are recommended for this and other flies worrying cattle. A preparation consisting of 2 quarts of crude cottonseed oil, 1 quart of kerosene, 1 pint of crude carbolic acid, 10 ounces of oil of tar, and 1 ounce of oil of pennyroyal, is very effective.⁹⁹

A mixture of 1 pound of rancid lard in one-half pint of kerosene, worked thoroughly together until a creamy mass forms, gives excellent results when rubbed with a cloth or the bare hand into the backs of cows, provided not too much is used. The effect lasts 2 or 3 days, and about three-eighths of a pound is used for each full-grown animal.¹

An emulsion consisting of common laundry soap 1 pound, water 4 gallons, crude petroleum 1 gallon, and 4 ounces of powdered naphthalene, applied once or twice a week with a brush, is said to protect cows for a week. Fish oil is one of the best repellants alone or in combination.²

A mixture consisting of 3 parts of fish oil and 1 part kerosene spread over sores gives excellent results.³

Pine tar creosote emulsion consisting of one-third of a pound of caustic soda, 89 per cent pure, dissolved in a known quantity of water for every gallon of pine tar creosote to be emulsified, and diluted with cold water to 3 or 5 per cent solutions, killed all the flies that were thoroughly wetted, and there was not the slightest evidence of damage to hair, skin or the exposed mucous membrane of the eyes or nostrils. The mixture is fully effective for only one day, and 3 per cent is the most satisfactory minimum strength.⁴

The biting horse flies, sometimes known as green heads, and in some localities as deer flies, are represented by a number of species. The maggots are aquatic, or occur in decaying organic matter, and consequently these pests are much more numerous in the vicinity of swamps and moist woodlands. Many of these flies have a habit of poising over the water and repeatedly descending to touch the surface. Very good results have been obtained by oiling frequented pools, the application being such that the oil will coat the whole surface.⁵ These insects are very local in habit, and it frequently happens that a little selection in the location of picket

⁹⁹ Ranck. Miss. Agr. Exp. Sta. Circ., July 1913.

¹ Washburn State Ent. Minn. 10th Rep't, p. 145-56.

² Grayville. U. S. Dep't Agr. Bul. 131. 1914.

³ Washburn. State Ent. Minn. 10th Rep't, p. 150.

⁴ Cory. Jour. Econ. Ent., 10:111-13. 1917.

⁵ Portchinsky. Rev. Appl. Ent., 3:195. 1915.

lines means that horses will enjoy comparative immunity from these pests.

Lice. Horses occasionally become infested with these parasites, and the use of any one of the following preparations has been advised:⁶

1 Gray mercury ointment, not more than 150 grains at each application, may be rubbed in, either alone or mixed with oil or soft soap. It must be brushed over the whole body, care being taken near the eyes.

2 An infusion of tobacco (1 to 25 or 30) with or without addition of vinegar; this is poisonous.

3 A mixture of 1 part petroleum to 10 of methylated spirit, or equal parts of petroleum and rape seed oil.

4 A 2 to 3 per cent solution of creolin in water, or a 3 per cent solution of liquid kresoli saponatus; both of these solutions must be brushed in.

5 Sabadilla vinegar 1 to 20. This is poisonous and should be well rubbed in at strongly infested spots only.

6 Fish oil may be used in the same way as 5.

7 In case of need the horse may be washed with soap and water, and while the coat is still damp, finely sifted beech ashes may be dusted on and well brushed in. To prevent eggs hatching, infested spots should be repeatedly washed with vinegar.

Lice on chickens may be destroyed by the use of sodium fluoride,⁷ pinches of the insecticide being distributed among the feathers next the skin; one on the head, one on the neck, two on the back, one on the breast, one below the vent, one on the tail, one on either thigh, and one scattered on the under side of each wing. This dust is somewhat irritating to the nose and throat, and if allowed to remain on the skin in any quantity for a great length of time, may cause slight local irritation.

Or sodium fluoride may be dissolved in tepid water at the rate of three-quarters to 1 ounce commercial powder, or two-thirds of an ounce of the chemically pure material to each gallon, and the fowl being held by the wings, quickly submerged in the solution, keeping the head out while the feathers are ruffled with the other hand to allow the dip to penetrate to the skin. The head then should be dipped once or twice and the bird elevated and allowed to drain a few seconds.

⁶ Rev. Appl. Ent., 4:10. 1916.

⁷ Farmer's Bul., U. S. Dep't Agr., May, 1917, p. 23.

Mercurial ointment diluted with 1 or 2 parts of vaseline was most effective when applied under the anus or vent, though a portion about the size of a pea could be rubbed into the base of the feathers.⁸

A 2 per cent chlorine solution and one-half pint of gasoline mixed together and then as much air-slaked lime poured into the liquid as it will take up, stirring thoroughly during the addition, makes a good lice powder.⁹

Mange produced by parasites is contagious and may spread directly from one animal to another, or indirectly by means of litter, rags, bandages, harness, stalls, stablemen and their clothing. The parasite may live away from the animal for some weeks.¹⁰ The following treatment is recommended:

Two pounds of burnt lime is gradually slaked with cold or hot water; 3 gallons of water is then added with continuous stirring. After allowing the lime to settle, the 3 gallons of liquid are drawn off and diluted with an equal quantity of water, and 6 gallons of petroleum then added. For animals with sensitive skins use even half or less the amount of petroleum. Store the liquids separately and mix just before using, rubbing the preparation into affected parts, which latter should have been previously shaved.¹¹

It is possible to destroy parasites on various animals by fumigating them with an atmosphere saturated with nitrobenzine. Treatment of an hour and a half destroyed the parasites on a dog, while sheep with very close wool were freed from 90 per cent of the ticks after a 12-hour fumigation, those which remained in the wool perishing, while some which escaped to the floor revived subsequently. Texas cattle fever ticks are killed after an exposure of 12 hours. At 83° F. one drop saturates a cubic foot of air, while at 40° F. only one-tenth of a drop is necessary.¹² Subsequent work has shown that animals may succumb to this treatment, and it is therefore not entirely safe.

⁸ Lamson. Jour. Econ. Ent., 10:71-74. 1917.

⁹ Tex. Dep't Agr. Bul. 35, p. 37. 1914.

¹⁰ Bd. Agr. & Fish., London, Leaflet 274. 1913.

¹¹ Richter. Deutsch. Tierartzl. Wochenschr., Hanover, 24:429-30. 1916.

¹² Moore. Jour. Econ. Ent., 9:71-80. 1916.

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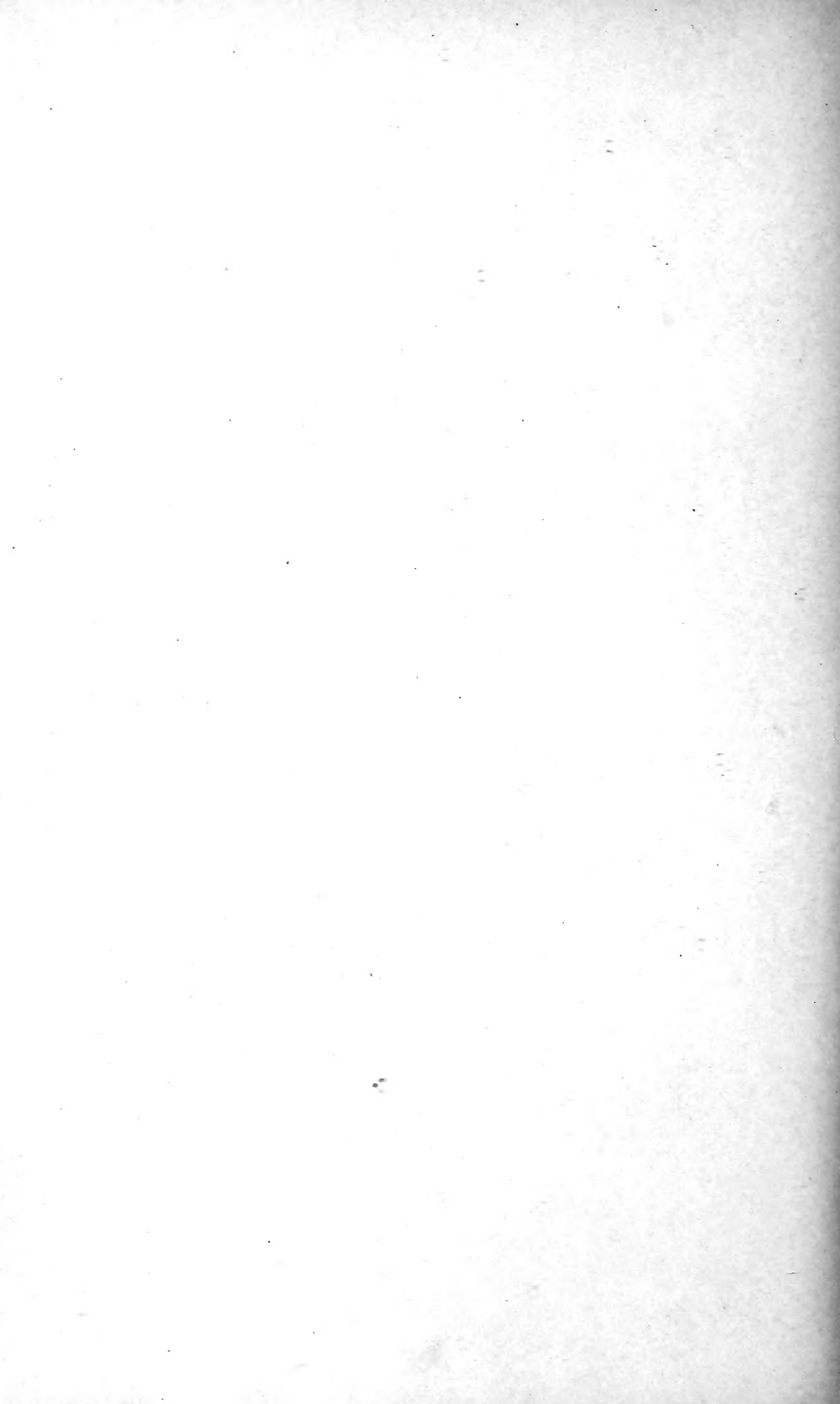
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