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United States Department of Agriculture,

DIVISION OF ENTOMOLOGY.

HOUSE FLIES.

(*Musca domestica et al.*)

There are several species of flies which are commonly found in houses, although but one of these should be called the house fly proper. This is the *Musca domestica*, and is a medium-sized grayish fly with its mouth parts spread out at the tip for sucking up liquid

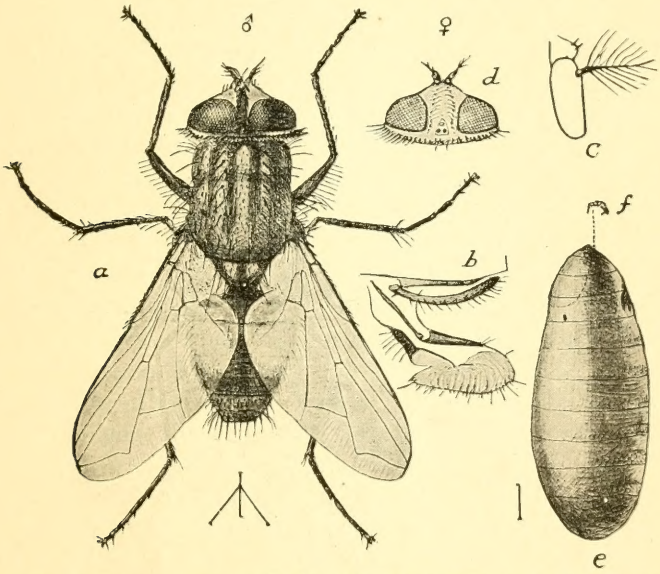

Fig. 1.—The common house fly (*Musca domestica*): *a*, adult male; *b*, proboscis and palpus of same; *c*, terminal joints of antenna; *d*, head of female; *e*, puparium; *f*, anterior spiracle—all enlarged (author's illustration).

substances. It breeds in manure and dooryard filth and is found in nearly all parts of the world. On account of the conformation of its mouth parts, the house fly can not bite, yet no impression is stronger in the minds of most people than that this insect does occasionally bite. This impression is due to the frequent occurrence in houses of another fly (*Stomoxys calcitrans*), which may be called the stable fly, and which, while closely resembling the house fly (so closely, in fact, as to deceive anyone but an entomologist), differs from it in the important particular that its mouth parts are formed for piercing the skin. It is perhaps second in point of abundance to the house fly in most portions of the northeastern States.

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A third species, commonly called the cluster fly (*Pollenia rudis*), is a very frequent visitant of houses, particularly in the spring and fall. This fly is somewhat larger than the house fly, with a dark-colored, smooth abdomen and a sprinkling of yellowish hairs. It is not so active as the house fly, and, particularly in the fall, is very sluggish. At such times it may be picked up readily, and is very subject to the attacks of a fungus disease which causes it to die upon window panes surrounded by a whitish efflorescence. Occasionally this fly occurs in houses in such numbers as to cause great annoyance, but such occurrences are comparatively rare.

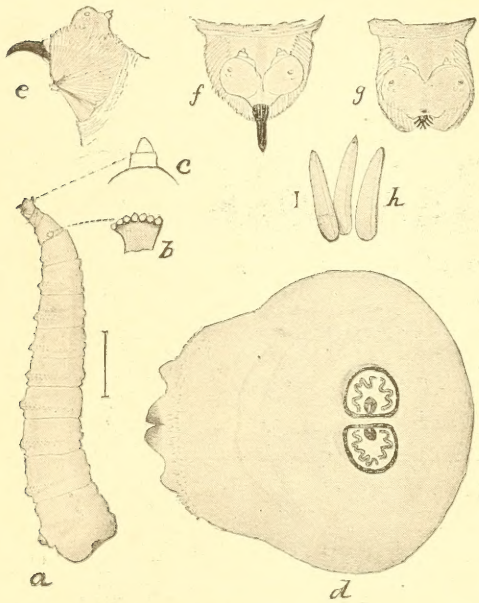

FIG. 2.—The common house fly: *a*, full-grown larva; *b*, one of its anterior spiracles; *c*, antenna; *d*, hind end of body showing anal spiracles; *e*, side view of head; *f*, head from above; *g*, head of young larva; *h*, eggs—all enlarged (author's illustration).

A fourth species is another stable fly known as *Cyrtoneura stabulans*, and a fifth, rather commoner than the last, is the so-called bluebottle fly (*Calliphora erythrocephala*). This insect is also called the blowfly or meat fly, and breeds in decaying animal material. Another species, about the size of the bluebottle, which breeds abundantly in cow dung and is also found in houses, although usually in less numbers than the others, is also commonly called the bluebottle or green-bottle fly (*Lucilia cæsar*).

There is still another species, smaller than any of those so far mentioned, which is known to entomologists as *Homalomyia canicularis*, sometimes called the small house fly. It is distinguished from the ordinary house fly by its paler and more pointed body and conical shape. The male, which is much commoner than the female, has large pale patches at the base of the abdomen, which are translucent. When seen on a window pane the light shines through that part of the body. It is this species that is largely responsible for the prevalent idea that flies grow after gaining wings. Most people think that these little Homalomyias are the young of the larger flies, which, of course, is distinctly not the case.

Still another species, and this one is still smaller, is a small jet-black fly known as *Scenopinus fenestralis*, which in fact has become

more abundant of later years. It breeds in the dust under carpets, and its larva is a white, very slender, almost thread-like creature.

Not much complaint would be made of house flies were the true house fly a nonexistent form. Under ordinary circumstances it far outnumbers all other species in houses. Common and widespread as this species is, there is very general ignorance, as with many other extremely common insects, as to its life history and habits outside of the adult stage. Writing in 1873, Dr. A. S. Packard[1] showed that no one in this country had up to that time investigated its habits, and that even in Europe but little attention had been given to it. He showed that the habits were mentioned in only three works, one of which was published during the present century, with figures so poor and inadequate as to be actually misleading. De Geer (1752) showed that the larva lives in warm and humid dung, but did not say how long it remains in the different stages. Bouché (1834) states that the larva lives in horse and fowl's dung, especially when warm. He did not, however, give the length of the larval state.

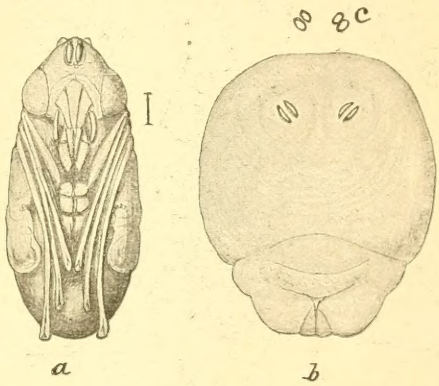

FIG. 3.—The common house fly; *a*, pupa removed from puparium; *b*, hind end of body of larva in second stage; *c*, anal spiracles of larva in first stage—all enlarged (author's illustration).

Dr. Packard studied the species with some care, and obtained large numbers of the eggs by exposing horse manure. He carefully followed the transformations of the insect, and gave descriptions of all stages. He found the duration of the egg state to be twenty-four hours, the duration of the larval state five to seven days, and of the pupal state five to seven days. The period from the time of hatching to the exclusion of the adult therefore occupies, according to Packard, from ten to fourteen days. His observations were made at Salem, Mass.

As is quite to be expected, as we go farther south, the house fly becomes more numerous and more troublesome. The number of generations annually increases as the season becomes longer, and with the warm climate the development of the larvæ becomes more rapid. A few rearing experiments were made in this office during the summer of 1895, and it was unexpectedly found that the house fly is a difficult insect to rear in confinement. Buzzing about everywhere, and apparently living with ease under the most adverse conditions, it is never-

[1] On the Transformation of the Common House Fly, with Notes on Allied Forms. Proc. Boston Soc. Nat. Hist., Vol. XVI, 1874, p. 136.

theless, when confined in the warm season of the year to a small receptacle, not at all tenacious of life. It results from this fact, for example, that it is almost impossible to ascertain the length of the life of the house fly in the adult condition. These breeding experiments in confinement showed that the house fly will lay its eggs freely on fresh horse manure in an undisturbed condition. When the manure is spread out the flies will not lay their eggs on it. They can very rarely be induced to lay their eggs upon anything but horse manure and cow manure, and their preference for the former is very marked. Although eggs were laid upon cow manure, the larvæ were unable to mature in this substance. The experiments, in fact, indicated that horse manure is by far the most favored breeding place of this species.

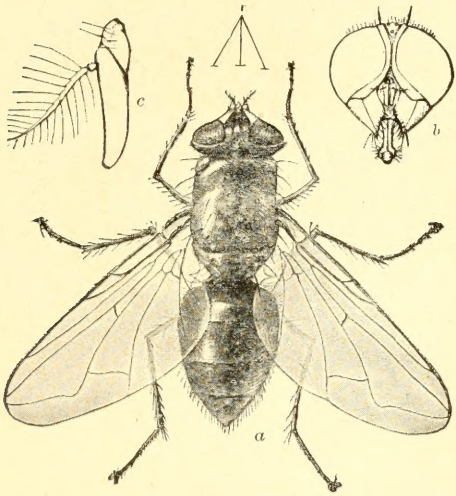

FIG. 4.—The green bottle fly (*Lucilia cæsar*): *a*, adult; *b*, head from front; *c*, antenna—all enlarged (from Ann. Rept. U. S. Dept. Agric., 1890).

Continuous observations indicated that the larvæ molt twice, and that there are thus three distinct larval stages. The periods of development were found to be about as follows: Egg from deposition to hatching, one-third of a day; hatching of larva to first molt, one day; first to second molt, one day; second molt to pupation, three days; pupation to issuing of the adult, five days; total life round, approximately ten days. There is thus abundance of time for the development of twelve or thirteen generations in the climate of Washington every summer.

The number of eggs laid by an individual fly is undoubtedly large, averaging about 120, and the enormous numbers in which the insects occur is thus plainly accounted for, especially when we consider the abundance and universal occurrence of appropriate larval food. In order to ascertain the numbers in which house fly larvæ occur in horse manure piles, a quarter of a pound of rather well-infested horse manure was taken on August 9, and in it were counted 160 larvæ and 146 puparia. This would make about 1,200 house flies to the pound of manure. This, however, can not be taken as an average, since no larvæ are found in perhaps the greater part of ordinary horse manure piles. Neither, however, does it show the limit of what can be found, since about 200 puparia were found in less than 1 cubic inch of manure taken from a spot 2 inches below the surface of the pile where the larvæ had

congregated in immense numbers. The different stages of the insect are well illustrated in the accompanying figures (figs. 1–3), and need no description.

Taschenberg, in his Praktische Insektenkunde (iv, 1880, 102–107), gives a good popular account of the house fly, but leaves the impression that the duration of a generation is much longer than we have indicated. He also states that the female lays its eggs on a great variety of substances, particularly on spoiled and moist food stuffs, decaying meat, meat broth, cut melons, dead animals, in manure pits, on manure heaps, and even in cuspidors, and open snuffboxes. The fact remains, however, that horse manure forms the principal breeding place.

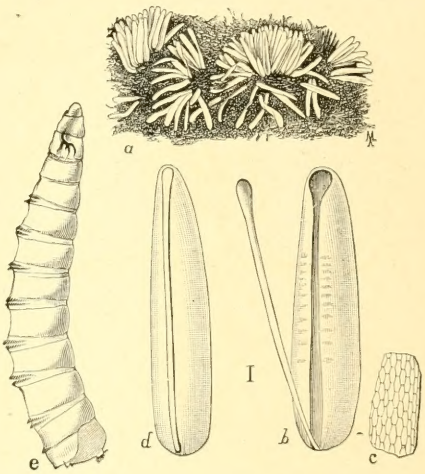

FIG. 5.—The green bottle fly: *a*, egg masses in cow dung; *b*, hatched egg; *c*, a portion of the egg surface seen under the microscope; *d*, unhatched egg; *e*, larva—all enlarged except *a* (from Ann. Rept. U. S. Dept. Agric., 1890).

REMEDIES AND PREVENTIVES.

A careful screening of windows and doors during the summer months, with the supplementary use of sticky fly papers, is a preventive measure against house flies known to everyone, and there seems to be little hope in the near future of much relief by doing away with the breeding places. A single stable in which a horse is kept will supply house flies for an extended neighborhood. People living in agricultural communities will probably never be rid of the pest, but in cities, with better methods of disposal of garbage and with the lessening of the number of horses and horse stables consequent upon electric street railways, bicycles, and horseless carriages, the time may come, and before very long, when window screens may be discarded. The prompt gathering of horse manure, which may be variously treated or kept in a specially prepared receptacle, would greatly abate the fly nuisance, and city ordinances compelling horse owners to follow some such course are desirable. Absolute cleanliness, even under existing circumstances, will always result in a diminution of the numbers of the house fly, and in fact most household insects are less attracted to the premises of what is known as the old-fashioned housekeeper than to those of the other kind.

During the summer of 1897 a series of experiments was carried out with the intention of showing whether it would be possible to treat a manure pile in such a way as to stop the breeding of flies. The

writer's experience with the use of air-slaked lime on cow manure to prevent the breeding of the horn fly suggested experimentation with different lime compounds. It was found to be perfectly impracticable to use air-slaked lime, land plaster, or gas lime with good results. Few or no larvæ were killed by a thorough mixture of the manure with any of these three substances. Chlorid of lime, however, was found to be an excellent maggot killer. Where one pound of chlorid of lime was mixed with eight quarts of horse manure, 90 per cent of the maggots were killed in less than twenty-four hours. At the rate of a quarter of a pound of chlorid of lime to eight quarts of manure, however, the substance was found not to be sufficiently strong. Chlorid of lime, though cheap in Europe, costs at the least 3½ cents a pound in large quantities in this country; so that the frequent treatment of a large manure pile with this substance would be out of the question as a practical measure.

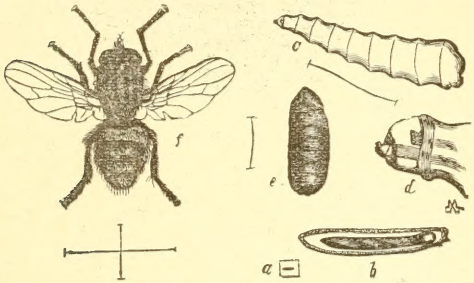

FIG. 6.—A stable fly (*Cyrtoneura stabulans*): *a*, egg; *b*, same enlarged; *c*, larva; *d*, head of same magnified; *e*, puparium; *f*, adult—all enlarged except *a* (after Comstock).

Experiments were, therefore, carried on with kerosene. It was found that eight quarts of fresh horse manure sprayed with one pint of kerosene, which was afterwards washed down with one quart of water, was thoroughly rid of living maggots. Every individual was killed by the treatment. This experiment and others of a similar nature on a small scale were so satisfactory that it was considered at the close of the season that a practical conclusion had been reached and that it was perfectly possible to treat any manure pile economically and in such a way as to prevent the breeding of flies.

Practical work in the summer of 1898, however, demonstrated that this was simply another case where an experiment on a small scale has failed to develop points which in practical work would vitiate the results.

The stable of the U. S. Department of Agriculture, in which about twelve horses are kept, is situated about 100 yards behind the main building of the Department and about 90 yards from the building in which the Division of Entomology is situated. The stable has always been very carefully kept. The manure has been thoroughly swept up every morning, carried outside of the stable and deposited in a pile behind the building. This pile, after accumulating for a week or ten days, or sometimes two weeks, is carried off by the gardeners and spread upon distant portions of the grounds. At all times in the summer this manure pile has been swarming with the

maggots of the house fly. It is safe to say that on an average many thousands of perfect flies issued from it every day, and that at least a large share of the flies which constantly bothered the employees in the two buildings mentioned came from this source.

On the basis of the experiments of 1897, an attempt was made beginning early in April, 1898, to prevent the breeding of house flies about the Department by the treatment of this manure pile with kerosene. The attempt was begun early in April and was carried on for some weeks. While undoubtedly hundreds of thousands of flies were destroyed in the course of this work, it was found by the end of May that it was far from perfect, since used at an economical rate the kerosene could not be made to penetrate throughout the whole pile of manure, even when copiously washed down with water. A considerable proportion of house fly larvæ escaped injury from this treatment, which at the same time was found, even at an economical cost, to be laborious, and such a measure in fact as almost no one could be induced to practically adopt.

There remained, however, another measure which nad been suggested by the writer in an article on the house fly published in 1895, namely, the preparation of an especial receptacle for the manure, and this was very readily done. A closet 6 by 8 feet had been built in the corner of the stable nearest the manure pile. It had a door opening into the stable proper, and also a window. A door was built in the outside wall of this closet, and the stablemen were directed to place no more manure outside the building; in other words, to abolish the outside manure pile, and in the future to throw all of the manure collected each morning into this closet, the window of which in the meantime had been furnished with a wire screen. The preparations were completed by the middle of June, and a barrel of chlorid of lime was put in the corner of the closet. Since that time every morning the manure of the stable is thrown into the closet and a small shovel full of chlorid of lime is scattered over it. At the expiration of ten days or two weeks the gardeners open the outside door, shovel the manure into a cart, and carry it off to be thrown upon the grounds.

Judging from actual examination of the manure pile, the measure is eminently successful. Very few flies are breeding in the product of the stable which formerly gave birth to many thousands daily. After this measure had been carried on for two weeks, employees of the Department who had no knowledge of the work that was going on were asked whether they had noticed any diminution in the number of flies in their offices. Persons in all of the offices on the first floor of the two buildings were asked this question. In every office except one the answer was that a marked decrease had been noticed, so that the work must be considered to have been successful.

The account of this remedial work has been given with some detail

since it shows so plainly that care and cleanliness combined with such an arrangement as that described will in an individual stable measurably affect the fly nuisance in neighboring buildings.

With the combined efforts of the persons owning stables in a given community, much more effective results can undoubtedly be gained.

We are accustomed to think of the house fly simply as a nuisance, but they are undoubtedly the carriers of the germs of typhoid fever, breeding in and frequently visiting uncovered uncared-for human excreta. The enforcement, therefore, of cleanliness in stables and the obligatory building of receptacles for horse manure, would seem to the writer subjects worthy the consideration of the boards of health of our cities.

The house fly has a number of natural enemies, and the common house centipede destroys it in considerable numbers; there is a small reddish mite which frequently covers its body and gradually destroys it; it is subject to the attacks of hymenopterous parasites in its larval condition, and it is destroyed by predatory beetles at the same time.

The most effective enemy, however, is a fungus disease known as *Empusina muscæ*, which carries off flies in large numbers, particularly toward the close of the season. The epidemic ceases in December, and although many thousands are killed by it, the remarkable rapidity of development in the early summer months soon more than replaces the thousands thus destroyed.

L. O. Howard,
Entomologist.

Approved:
James Wilson,
Secretary.

Washington, D. C., *July 11, 1898.*

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