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A CONTRIBUTION TO THE STUDY OF THE IN-  
SECT FAUNA OF HUMAN EXCREMENT.

[WITH ESPECIAL REFERENCE TO THE SPREAD OF TYPHOID  
FEVER BY FLIES.]

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[PLATES XXX, XXXI, FIGS. 17-38.]

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INTRODUCTORY.

In 1895 the writer became interested in the study of the common house fly (*Musca domestica*). Breeding-cage experiments described with some detail later on in this paper early convinced him that horse manure is the favorite food of this species. Even in the presence of kitchen garbage, cow dung, and human excrement, flies in confinement oviposited exclusively on horse manure. In the absence of the latter substance but in the presence of the others, he noted egg-laying on decaying fruit and on cow dung but the resultant larvæ failed to develop. He considered himself warranted in the statement that probably 95 percent of the flies found in cities come from the piles of horse manure everywhere so prevalent, especially in the vicinity of stables.

After the outbreak of the war with Spain, in the spring of 1898, a mild form of typhoid fever soon became prevalent in

concentration camps in different parts of the country. In many cases the fever was not recognized as typhoid at first but toward the close of the summer it was practically decided by very general blood tests that the fever which prevailed was not malarial but intestinal. The medical journals and the newspapers contained a number of communications from contract surgeons and others advancing the theory that flies were largely responsible for the spread of the disease, owing to the fact that in many of these camps the sinks or latrines were placed near the kitchens and dining tents and that the enormous quantity of excrement in the sinks was not properly cared for. One of the most forcible writers on this topic was Dr. H. A. Veeder, whose paper entitled 'Flies as Spreaders of Disease in Camps,' published in the *New York Medical Record* of September 17, 1898, brought together a series of instances and strong arguments in favor of his conclusion that flies are prolific conveyors of typhoid under improper camp conditions.

It should be stated at this point that the conditions which apparently brought about these results existed in violation of the distinct directions issued by the Surgeon-General of the Army, Dr. Geo. M. Sternberg,<sup>1</sup> in his Circular No. 1, published April 25, 1898. In this circular explicit directions were given to army surgeons regarding sinks which if explicitly followed would have prevented the spread of typhoid by flies. Two sentences may be quoted from this circular: "Sinks should be dug before a camp is occupied or as soon after as practicable. The surface of faecal matter should be covered with fresh earth or quick lime or ashes three times a day. \* \* \* No doubt typhoid fever, camp diarrhea, and probably yellow fever are frequently communicated to soldiers in camp through the agency of flies which swarm about faecal matter and filth of all kinds deposited upon the ground or in shallow pits and directly convey infectious material attached to their feet or contained in their excreta to the food which is exposed while being prepared at the com-

<sup>1</sup> Dr. Sternberg had as early as 1885, in his prize essay on 'Disinfection and Personal Prophylaxis in Infectious Diseases,' published by the American Health Association, showed that he was fully alive to the necessity of isolating and disinfecting excrement.

mon kitchen or while being served in the mess tent." Thus the Surgeon-General not only gave sound instructions but stated his reasons for these instructions.

In the fall of 1899 I had an opportunity to examine an ideal camp in which the latrines were properly and regularly treated. This was the great camp at the Presidio, San Francisco, California. At the time, several thousands of soldiers were encamped at that place, either about to go to or having just returned from the Philippines. In company with Col. W. H. Forwood, U. S. A., the medical officer in charge of the Department of California, I made a thorough inspection of the camp and saw plainly that there was not the slightest opportunity for the transfer of faecal microorganisms by flies to the mess tables or the kitchens. During the summer of 1900, I was able to contrast this excellent condition of affairs with a large militia camp where the sinks were supposed to be looked after twice a day but during two days there was no effort to cover any of the faeces. The camp contained about 1,200 men, and flies were extremely numerous in and around the sinks. Eggs of *Musca domestica* were seen in large clusters on the faeces and in some instances the batches were two inches wide and half an inch in depth, resembling little patches of lime. Some of the sinks were in very dirty condition and had a very disagreeable odor.

This condition of affairs in army camps in 1898 was not confined to the United States. An epidemic occurred in the camp of the Eighth Cavalry at Puerto Principe, Cuba, in which 250 cases of the fever occurred. The disease was imported by the regiment into its Cuban camp, and Dr. Walter Reed, U. S. A., upon investigation reported to the Surgeon-General that the epidemic "was clearly not due to water infection, but was transferred from the infected stools of the patients to the food by means of flies, the conditions being especially favorable for this manner of dissemination. \* \* \*"<sup>1</sup>

The agency of flies in the transmission of Asiatic cholera was convincingly shown at an early date by the observations

<sup>1</sup> Sanitary Lessons of the War, by George M. Sternberg, Surgeon-General, U. S. A., read at meeting of the American Medical Association, at Columbus, Ohio, June 6 to 9, 1899.—Phila. Med. Jour., June 10 and 17, 1899.

of Tizzoni and Cattani, Sawtchanko, Simmonds, Uffelmann, Flugge and Macrae, while Celli had shown as early as 1888 that flies fed on the pure cultures of *Bacillus typhi abdominalis* were able to transmit virulent bacilli into their excrement. Dr. Geo. M. Kober, of Washington, D. C., in his lectures before the Medical College of Georgetown University, for some years had been insisting upon the agency of flies in the transmission of typhoid, and in the report of the Health Officer of the District of Columbia for the year ending June 30, 1895, referred to the probable transference of typhoid germs from box privies and other receptacles for typhoid stools to the food supply of the house by the agency of flies.

In the winter of 1898-'99 an admirable paper by Dr. Geo. H. F. Nuttall, entitled 'On the Role of Insects, Arachnids and Myriapods as Carriers in the Spread of Bacterial and Parasitic Diseases of Man and Animals; a Critical and Historical Study,' was published in Volume VIII of the Johns Hopkins Hospital Reports. In this volume the previously published literature of the subject was carefully reviewed and the agency of flies in the transmission of intestinal diseases was made reasonably apparent.

In all this literature, however, the expression used in connection with insects was simply the word 'flies.' It seemed as though it were intended by the writers to mean either that all flies were concerned, or that there was but one kind of fly—presumably the house fly. It did not seem to be realized that there are many species of flies which are attracted to intestinal discharges, nor did it seem to be realized that while certain of these species may visit and do visit food supplies in dining-rooms, kitchens or elsewhere, many others are not likely to be so attracted. It occurred to the writer, therefore, during the summer of 1898 that from the scientific point of view and possibly also from the practical point of view there was a distinct necessity for careful investigation of the insect fauna of human excrement, especially of the flies which breed in human fæces or are attracted to them. Such an investigation was therefore begun and carried on, the main work being done during the summer of 1899. The results are contained in the present paper.

Before stating the results and before generalizing upon them it should be stated that owing to the prevalence of typhoid in the army during the summer of 1898, already referred to, an army typhoid commission was appointed in August of that year, at the request of the Surgeon-General, consisting of Drs. Walter Reed, U. S. A., Victor M. Vaughan, U. S. V., and E. O. Shakespeare, U. S. V. Several times after the work of the commission was well advanced newspaper items appeared in various papers stating that its members had been convinced of the important agency of flies in the transmission of the disease. Its report has not yet been published, but one of the members of the commission, Dr. Vaughan, read a paper before the annual meeting of the American Medical Association at Atlantic City, New Jersey, June 6, 1900, which in addition to being one of the most important contributions to the study of enteric fevers published of late years, gives forcibly the views of at least one member of the commission on the fly question.

Dr. Vaughan's paper was entitled 'Conclusions Reached after a Study of Typhoid Fever among American Soldiers in 1898,' and comprised 53 categorical conclusions. The one relating to flies was as follows:

"27. *Flies undoubtedly served as carriers of the infection.*

"My reasons for believing that flies were active in the dissemination of typhoid may be stated as follows:

"a. Flies swarmed over infected fecal matter in the pits and then visited and fed upon the food prepared for the soldiers at the mess tents. In some instances where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened with lime were seen walking over the food.

"b. Officers whose mess tents were protected by means of screens suffered proportionately less from typhoid fever than did those whose tents were not so protected.

"c. Typhoid fever gradually disappeared in the fall of 1898, with the approach of cold weather, and the consequent disabling of the fly.

"It is possible for the fly to carry the typhoid bacillus in two ways. In the first place fecal matter containing the typhoid

germ may adhere to the fly and be mechanically transported. In the second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and may be deposited with its excrement."

There were also many important conclusions which bear upon the fly question. For example, it was shown that every regiment in the United States service in 1898 developed typhoid fever, nearly all of them within eight weeks after assembling in camps. It not only appeared in every regiment in the service, but it became epidemic both in small encampments of not more than one regiment and in the larger ones consisting of one or more corps. All encampments located in the northern as well as in the southern states exhibited typhoid in epidemic form. The miasmatic theory of the origin of typhoid fever and the pythogenic theory<sup>1</sup> were not supported by the investigations of the commission but the doctrine of the specific origin of fever was confirmed. The conclusion was reached that the fever is disseminated by the transference of the excretions of an infected individual to the alimentary canals of others and that a man infected with typhoid fever may scatter the infection in every latrine or regiment before the disease is recognized in himself while germs may be found in the excrement for a long time after the apparent complete recovery of the patient. Infected water was not an important factor in the spread of typhoid in the national encampments of 1898 but about one-fifth of the soldiers in the national encampments in the United States during that summer developed this disease, while more than 80 per cent. of the total deaths were caused by typhoid.

In the work carried on by the writer and under his supervision in the investigation of the insect fauna of human excrement which is here described, he was assisted by Messrs. D. W. Coquillett, E. A. Schwarz, W. H. Ashmead, F. C. Pratt, Nathan Banks, and Aug. Busck, of his office force. Mr. Coquillett is responsible for the determination of all of the species

<sup>1</sup>This theory is founded upon the belief that the colon germ may undergo a ripening process by means of which its virulence is so increased and altered that it may be converted into the typhoid bacillus or at least may become the active agent in the causation of typhoid fever.

of Diptera mentioned; Mr. Schwarz named the Coleoptera, and Mr. Ashmead named the Hymenoptera. To Mr. Pratt more than to any one else is due the large amount of material studied. Undeterred by the extremely disagreeable nature of the investigation and with a rare enthusiasm, he devoted himself indefatigably to the work during the summer of 1899, making collections and conducting rearing experiments. In the autumn Mr. Pratt developed a severe case of typhoid fever and was confined in the hospital for more than six weeks. This fact may be coincidental but it is possible also that the fever may have been contracted as a result of his investigations. Messrs. Banks and Busck also collected a certain amount of interesting material, and Dr. A. D. Hopkins, while engaged on a special trip for this office to the West, collected additional material. The writer is greatly indebted to the following persons for collections of flies made in kitchens and dining rooms in different parts of the country, which collections are used as important checks in this paper in determining which species are most likely to carry bacteria from fæces to food: Professor W. B. Alwood, Agricultural Experiment Station, Blacksburg, Virginia; Professor H. A. Gossard, Agricultural Experiment Station, Lake City, Florida; Professor A. L. Quaintance, Experiment, Georgia; Professor H. A. Morgan, Agricultural Experiment Station, Baton Rouge, Louisiana; Dr. C. B. Davenport, University of Chicago, Chicago, Illinois; Professor H. B. Ward, University of Nebraska, Lincoln, Nebraska; Dr. R. H. Ward, Troy, New York; Alvin Davidson, Easton, Pennsylvania. The writer himself made similar collections at different points in California and at New Orleans, Louisiana, so that most sections of the country were represented.

#### GENERAL RESULTS OF THE INVESTIGATION.

In summing up the results of the work carried on by the writer the number of species of insects found breeding in or frequenting human excrement was very large. There were many coprophagous beetles—44 species in all—and many Hymenopterous parasites, all of the latter having probably lived in the larval condition in the larvæ of Diptera or Coleoptera

breeding in excrement. Neither the beetles nor the Hymenoptera, however, have any importance from the disease transfer standpoint. The Diptera alone were the insects of significance in this connection. Of Diptera there were studied in all 77 species, of which 36 were found to breed in human fæces, while the remaining 41 were captured upon such excrement. The following list indicates the exact species arranged under their proper families. The parenthetical remarks after each species should be estimated in the following order, from 'scarce' to 'extremely abundant': scarce, rather scarce, not abundant, moderately abundant, abundant, very abundant, extremely abundant.

REARED (USUALLY ALSO CAPTURED).

Family CHIRONOMIDÆ.

1. *Ceratopogon* sp. (scarce).

Family BIBIONIDÆ.

2. *Scatopse pulicaria* Loew (moderately abundant).

Family EMPIDIDÆ.

3. *Tachydromia* sp. (rather scarce).

Family DOLICHOPODIDÆ.

4. *Diaphorus leucostomus* Loew (scarce).
5. *Diaphorus sodalis* Loew (not abundant).

Family SARCOPHAGIDÆ.

6. *Lucilia cæsar* L. (abundantly captured; one reared).
7. *Sarcophaga sarraceniæ* Riley (abundant).
8. *Sarcophaga assidua* Walker (abundant).
9. *Sarcophaga trivialis* V. d. W. (abundant).
10. *Helicobia quadrisetosa* Coq. (very abundant).

Family MUSCIDÆ.

11. *Musca domestica* L. (abundant).
12. *Morellia micans* Macq. (abundant).
13. *Muscina stabulans* Fall. (abundant).
14. *Myospila meditabunda* Fabr. (abundant).

Family ANTHOMYIDÆ.

15. *Homalomyia brevis* Rondani (very abundant).
16. *Homalomyia canicularis* L. (moderately abundant).



17. *Homalomyia scalaris* Fabr. (scarce).
18. *Hydrotæa dentipes* Meig. (moderately abundant).
19. *Limnophora arcuata* Stein (moderately abundant).
20. *Ophyra leucostoma* Wied. (abundant).
21. *Phorbia cinerella* Fall. (abundant).
22. *Phorbia fusciceps* Zett. (moderately abundant).

## Family ORTALIDÆ.

23. *Euxesta notata* Wied. (moderately abundant).

## Family LONCHÆIDÆ.

24. *Lonchæa polita* Say (moderately abundant).

## Family SEPSIDÆ.

25. *Sepsis violacea* Meig. (extremely abundant).
26. *Nemopoda minuta* Wied. (very abundant).

## Family DROSOPHILIDÆ.

27. *Drosophila ampelophila* Loew (moderately abundant).

## Family OSCINIDÆ.

28. *Oscinis trigramma* Loew (rather scarce).

## Family AGROMYZIDÆ.

29. *Ceratomyza dorsalis* Loew (rather scarce).
30. *Desmometopa latipes* Meig. (rather scarce).

## Family EPHYDRIDÆ.

31. *Scatella stagnalis* Fall. (scarce).

## Family BORBORIDÆ.

32. *Limosina albipennis* Rond. (very abundant).
33. *Limosina fontinalis* Fall. (very abundant).
34. *Sphærocera pusilla* Meig. (abundant).
35. *Sphærocera subsultans* Fabr. (very abundant).

## Family SCATOPHAGIDÆ.

36. *Scatophaga furcata* Say (very abundant).

## CAPTURED (NOT REARED).

## Family CHIRONOMIDÆ.

1. *Chironomus halteralis* Coq. (scarce).

## Family TIPULIDÆ.

2. *Limnobia sciophila* O. S. (scarce).

## Family EMPIDIDÆ.

3. *Rhamphomyia manca* Coq. (not abundant).

## Family DOLICHOPODIDÆ.

4. *Neurigonia tenuis* Loew (scarce).

## Family SARCOPHAGIDÆ.

5. *Chrysomyia macellaria* Fabr. (rather abundant).  
 6. *Calliphora erythrocephala* Meig. (rather abundant).  
 7. *Sarcophaga lambens* Wied. (rather scarce).  
 8. *Sarcophaga plinthopyga* Wied. (rather scarce).  
 9. *Cynomyia cadaverina* Desv. (rather scarce).  
 10. *Phormia terrænovæ* Desv. (very abundant).

## Family MUSCIDÆ.

11. *Muscina cæsia* Meig. (scarce).  
 12. *Muscina tripunctata* V. d. W. (scarce).  
 13. *Stomoxys calcitrans* L. (rather abundant).  
 14. *Pseudopyrellia cornicina* Fabr. (abundant).  
 15. *Pyrellia ochricornis* Wied. (rather scarce).

## Family ANTHOMYIIDÆ.

16. *Hylemyia juvenalis* Stein (rather scarce).  
 17. *Hydrotæa metatarsata* Stein (rather scarce).  
 18. *Cœnosia pallipes* Stein (rather scarce).  
 19. *Mydæa palposa* Walker (rather scarce).

## Family ORTALIDÆ.

20. *Rivellia pallida* Loew (rather scarce).

## Family SEPSIDÆ.

21. *Piophilæ casei* L. (rather scarce).

## Family DROSOPHILIDÆ.

22. *Drosophila funebris* Meig. (scarce).  
 23. *Drosophila busckii* Coq. (scarce).

## Family OSCINIDÆ.

24. *Hippelates flavipes* Loew (rather scarce).  
 25. *Oscinis carbonaria* Loew (moderately abundant).  
 26. *Oscinis coxendix* Fitch (scarce).  
 27. *Oscinis pallipes* Loew (rather scarce).  
 28. *Elachiptera costata* Loew (moderately abundant).

## Family EPHYDRIDÆ.

29. *Discocerina parva* Loew (rather scarce).  
 30. *Hydrellia formosa* Loew (rather scarce).

## Family BORBORIDÆ.

31. *Borborus equinus* Fall. (very abundant, undoubtedly breeds here also).
32. *Borborus geniculatus* Macq. (moderately abundant).
33. *Limosina crassimana* Hal. (abundant).

## Family SYRPHIDÆ.

34. *Syritta pipiens* L. (scarce).

## Family PHORIDÆ.

35. *Phora femorata* Meig. (scarce).

## Family SCATOPHAGIDÆ.

36. *Scatophaga stercoraria* L. (moderately abundant).
37. *Fucellia fucorum* Fall. (rather scarce).

## Family MICROPEZIDÆ.

38. *Calobata fasciata* Fabr. (rather scarce).
39. *Calobata antennipes* Say (moderately abundant).

## Family HELOMYZIDÆ.

40. *Leria pectinata* Loew (scarce).
41. *Tephrochlamys rufiventris* Meig. (scarce).

The details not only of our observations but of what was previously known concerning each species, together with some account of the habits of each genus and family will be given later. It should be stated here that this list, containing as it does only a record of actual observations, should by no means be considered as indicating definitely the habits of the species or their relative abundance under other conditions. Thus, some of the species here indicated as scarce in connection with excrement, may be very common under other conditions, which would indicate that their occurrence upon excrement was more or less accidental. Moreover, certain of the species which have been captured on excrement but not reared from it are nevertheless undoubtedly excrement breeders as will be proved by future observations. Thus, we have in several cases certain species which have been reared while congeneric species have simply been captured, as, for example, Nos. 7 and 8 of the captured species are congeneric with 7, 8 and 9 of the reared series; 11 and 12 of the captured series are congeneric with 13

of the reared series; 17 of the captured series is congeneric with 18 of the reared series; 22 and 23 of the captured series are congeneric with 27 of the reared series; 25, 26 and 27 of the captured series are congeneric with 28 of the reared series; 33 of the captured series is congeneric with 32 and 33 of the reared series, and is undoubtedly an excrement breeder, and the same may be said of 36 of the captured series which is congeneric with 36 of the reared.

From these data it will be noticed that the most abundant species reared were *Helicobia quadrisetosa*, *Sepsis violacea*, *Nemopoda minuta*, *Limosina albipennis*, *Limosina fontinalis*, *Sphærocera subsultans* and *Scatophaga furcata*, while the most abundant forms captured on excrement were *Phormia terrænovæ* and *Borborus equinus*. It will also be noticed that among the reared forms there are ten others which are simply entered as 'abundant' and among the captured two others. With these facts in mind we are prepared to examine the results of the kitchen and dining room captures.

The results so far stated have a distinct entomological interest as regards the exact food habits of a large number of species, many of the observations being novel contributions to previous knowledge of these forms; but the practical bearing of the work is only brought out when we consider which of these forms are likely from their habits to actually convey disease germs from the excrement in which they have bred, or which they have frequented, to substances upon which people feed. Therefore collections of the Dipterous insects occurring in kitchens and pantries were made, with the assistance of correspondents and observers in different parts of the country, all through the summer of 1899 and also in the summer and autumn of 1900. Such collections were made in the states of Massachusetts, New York, Pennsylvania, District of Columbia, Virginia, Florida, Georgia, Louisiana, Nebraska, and California. Nearly all of the flies thus captured were caught upon sheets of the ordinary sticky fly-paper, which while ruining them as cabinet specimens, did not disfigure them beyond the point of specific recognition. The others were captured in the ordinary manner.

In all 23,087 flies were examined which had been caught in rooms in which food supplies are ordinarily exposed and which may safely be said to have been attracted by the presence of these food supplies. Of these 23,087 flies, 22,808 were *Musca domestica*, i. e., 98.8 percent of the whole number captured. The remainder, consisting of 1.2 percent of the whole, comprised various species, the most significant ones being *Homalomyia canicularis* (the species ordinarily called the 'little housefly') of which 81 specimens were captured; the stable fly (*Muscina stabulans*), 37 specimens; *Phora femorata*, 33; *Lucilia caesar*, 18; *Drosophila ampelophila*, 15; *Sarcophaga trivialis*, ten; *Calliphora erythrocephala*, seven. *Musca domestica* is, therefore, the species of great significance. *Homalomyia canicularis* is important. *Muscina stabulans* is of somewhat lesser importance. *Drosophila ampelophila*, as will be shown, is an important form, and had more of the captures been made in the autumn its numbers would probably have been greater, since beyond doubt it is an abundant species in houses after fruit has begun to make its appearance (say in August and September and on until winter time) in pantries and on dining room sideboards. The *Calliphora* and the *Lucilia* are of slight importance not only on account of their rarity in houses but because they are not true excrement insects. Other forms were taken but either their household occurrence was probably accidental or from their habits they have no significance in the disease-transfer function.

#### CONCLUSIONS.

It appears plainly that the most abundant species breeding in or attracted to human excrement do not occur in kitchens and dining rooms, but it is none the less obvious, as will be seen from the detailed consideration of *Musca domestica* which will be given further on, that while this species under ordinary city and town conditions as they exist at the present day, and more especially in such cities and towns or in such portions of cities as are well cared for and inhabited by a cleanly respectable population, may not be considered an imminent source of danger, it is, nevertheless, under other conditions a factor of the greatest importance in the spread of intestinal disease. In the account

which follows we have shown that the house fly prefers horse manure as a breeding place; we have shown, however, that in army camps where human excrement is left exposed it will and does breed in this substance in large numbers and may be attracted to it without necessary oviposition; we have shown that in towns where the box privy nuisance is still in existence the house fly is attracted to a certain extent to the excrement, and we have shown that it is so attracted in the filthy regions of a city where sanitary supervision is lax and where in low alleys and corners excrement is deposited by dirty people. I have seen excrement, deposited over night in an alleyway, in south Washington, swarming with flies in the bright sunlight of a June morning (temperature 92° F.) and within 30 feet of these deposits were the open doors and windows of the kitchens of two houses occupied by poor people, these two houses being only elements in a long row.

Now when we consider the prevalence of typhoid fever and that virulent typhoid bacilli may occur in the excrement of an individual for some time before the disease is recognized in him and that the same virulent germs may be found in the excrement for a long time after the apparent recovery of a patient, the wonder is not that typhoid is so prevalent but that it does not prevail to a much greater extent. Box privies should be abolished in every community. The depositing of excrement in the open within town or city limits should be considered a punishable misdemeanor in communities which have not already such regulations, and it should be enforced more rigorously in towns in which it is already a rule. Such offences are generally committed after dark and it is often difficult or even impossible to trace the offender; therefore, the regulation should be carried even further and require the first responsible person who notices the deposit to immediately inform the police so that it may be removed or covered up. Dead animals are so reported; but human excrement is much more dangerous. Boards of health in all communities should look after the proper treatment or disposal of horse manure, primarily in order to reduce the number of house flies to a minimum, and all regulations regarding the disposal of garbage and foul matter should be made more stringent and should be more stringently enforced.

INSECTS OTHER THAN FLIES WHICH WE HAVE FOUND ON  
HUMAN EXCREMENT.

As already pointed out, the beetles breeding in or attracted to human excrement have comparatively little significance in the transfer of disease. They are distinctly outdoor species and are seldom found away from excrement. The same may practically be said of the Hymenopterous insects which we have found. The parasitic forms are parasites of the maggots of the Diptera breeding in such excrement and the other forms are attracted to it only while fresh and containing more or less moisture. They are seeking the foul-smelling moisture and nothing more. None of them are household insects.

*Insects collected on or found breeding in Human Excrement  
during the summer of 1899.*

## Coleoptera.

## CARABIDÆ.

- Amara musculus Say (accidental).  
Stenolophus conjunctus Say (accidental).

## HYDROPHILIDÆ.

- Cercyon ocellatus Say.  
Cercyon hæmorrhoidalis Fabr.

## SILPHIDÆ.

- Silpha noveboracensis Forst.

## STAPHYLINIDÆ.

- Homalota sp.

“ “  
“ “  
“ “  
“ “

- Aleochara bimaculata Grav. (predaceous).

“ nitida Grav. “  
“ n. sp. “

- Trichiusa robustula Cas.

- Microglossa sp.

- Hoplandria lateralis Melsh.

- Quedius capucinus Grav. (predaceous).

- Staphylinus maculosus Grav. “

*Philonthus hepaticus* Er. (predaceous.)

“ *brunneus* Grav. “

“ *sordidus* Grav. “

*Tachinus fumipennis* Say.

*Oxytelus pennsylvanicus* Er.

“ *insignitus* Grav.

“ *nitidulus* Grav.

“ *exiguus* Er.

*Platystethus americanus* Er.

*Omalium repandum* Fauv. (accidental).

#### HISTERIDÆ.

*Hister interruptus* Beauv. (predaceous)

“ *abbreviatus* Fabr. “

*Carcinops conjunctus* Say “

*Saprinus assimilis* Payk. “

#### NITIDULIDÆ.

*Omosita colon* Linn.

#### SCARABÆIDÆ

*Canthon lævis* Drury.

*Onthophagus hecate* Panz.

“ *pennsylvanicus* Harold.

*Atænius cognatus* Lec.

*Aphodius granaricus* Linn.

“ *rubeolus* Beauv.

“ *stercorosus* Mels.

*Geotrypes blackburnii* Fabr.

*Trox asper* Lec.

“ *æqualis* Say

*Anomala undulata* Melsh. (accidental).

#### Hymenoptera.

#### BRACONIDÆ.

*Alysia rudibunda* Say.

*Aphæreta muscæ* Ashm.

#### FORMICIDÆ.

*Ponera pennsylvanica* Buckl.

*Lasius neoniger* Em.

*Teleomorium cæspitum* Linn.

*Camponotus pennsylvanicus* DeG.

#### ENCYRTIDÆ.

*Encyrtus* sp.



## CYNIPIDÆ.

Kleidotoma bakeri Ashm.  
 Hexaplasta sp.  
 Solenaspis hyalinipennis Ashm.  
 Psilodora erythropha Ashm.

## APIDÆ.

Apis mellifica L. (accidental).  
 Bombus pennsylvanicus Oliv. (accidental).  
 Halictus disparilis Cr. (accidental).

## Lepidoptera.

## PAPILIONIDÆ.

Papilio troilus (accidental).

## DETAILS CONCERNING THE EXCREMENT FLIES STUDIED.

In the following pages will be found a consideration of each species of fly captured or reared in the course of this work. They are arranged according to families in the systematic order followed in catalogues and monographic works on the order Diptera. A brief consideration of the habits of each family is given, and under the first species in each genus is presented a short statement of genus habits. Under each species is given, also briefly, some account of previous knowledge, and this is followed by a full record of the observations which have been made upon it in the course of this excrement fauna study.

No specific study of this nature seems to have been made previously. Some of the species treated here will be found mentioned in Mégnin's important work, 'La Faune des Cadavres,' and in Dr. M. G. Motter's important paper entitled 'A Contribution to the Study of the Fauna of the Grave' (Journal of the New York Entomological Society, Vol. VI, No. 4, pp. 201 to 231, 1898). Very careful studies of some of them have also been made by the Russian investigator, Professor J. Porchinski (usually spelled *Portschinski*) in his paper entitled 'Comparative Biology of the Necrophagous and Coprophagous Larvæ' (1885), known to the writer only through Baron Osten Sacken's paper entitled 'On Mr. Portschinski's Publications on

the Larvæ of Muscidae' (Berliner Entomolog. Zeitschrift, Bd. xxxi, 1887, heft I, pp. 17 to 28). Professor Porchinski's paper contains a series of important observations, and, according to Osten Sacken, "illustrates the wonderful power of adaptation of these larvæ to their environment, an adaptation which, in a certain measure, destroys the parallelism which we naturally expect to exist between the systematic characters of larva and imago. \* \* \* Distantly related species, belonging to different genera, issue from larvæ almost undistinguishable from each other. Again, closely related and almost undistinguishable imagos, species of the same genus, differ in their oviposition (size and number of eggs), and their larvæ follow a different law of development (as to the degree of maturity the larva reaches within the body of the mother and the number of stages of development it passes through)."

Interesting generalizations might be made from the present studies, but such work is foreign to the immediate purpose of the investigation. In examining the specimens, however, it will be noticed that there are three predominant types of flies, namely the medium sized gray, somewhat striped flies of the *Musca domestica* type, the metallic greenbottle or bluebottle flies, and the small, dark brown or black flies of the Homalomyia type. Several species, for example, belonging to different families, so closely resemble *Musca domestica* that even a trained entomologist cannot distinguish them without a close study of structural characters. This fact accounts for a very general popular misunderstanding as to the specific habits of *Musca domestica*.

#### DETAILED CONSIDERATION OF THE DIPTERA STUDIED.

##### Family CHIRONOMIDÆ.

The insects of this family possess almost no importance from the standpoint of this article. They are small slender midges or gnats rather closely resembling mosquitoes and flying occasionally in enormous swarms. The larvæ are aquatic or are found on moist sappy places on tree trunks, or occur in the earth or in dung. The adults are not especially attracted to any one class of substances but frequent moist places.

*Ceratopogon* species.

The very minute biting flies of this genus, one or more species of which are known in the north woods as the 'punkie' or 'no-see-um,' the latter name on account of their excessive minuteness, are either aquatic in their larval habits, the larva being a very long slender delicate whitish creature, or they live in the sap of trees. This seems to be the only generalization which has been made by previous workers. In the course of the present investigation, however, specimens of the undescribed species under consideration issued June 17 from miscellaneous exposed fæces collected for breeding purposes and placed under cover on June 13, 1899. Another specimen was captured on exposed fæces at Travilah, Maryland, in June of the same year. It is probable that this species has little significance from the disease point of view but this breeding habit record is novel.

*Chironomus halteralis* Coq.

The little midges of the genus *Chironomus* breed in water, in the earth, or in dung. The European *C. stercorarius* is a dung feeder and bears out Porchinsky's generalization as to the presence of viviparity in coprophagous Diptera since it is the only Nemocerous fly which is viviparous. The present species, which has just been described by Mr. Coquillett, was captured at Washington, D. C., upon a fresh deposit of human excrement May 16, 1899. It is possible that this species will ultimately be found to breed in excrement.

## Family TIPULIDÆ.

The insects of this family, commonly known as crane flies, are common and widespread in the larval state. They are generally found under the surface of the ground, particularly in rich or highly manured soils, in decomposing wood, or on the leaves of plants or in the water.

*Limnobia sciophila* O. S.

The larvæ of this genus are known to occur in decaying wood and in fungi. The present species is a western form, originally described by Osten Sacken from California. In the course of

this investigation it was captured in a privy in the Golden Gate Park, San Francisco, California, by Dr. A. D. Hopkins, but its occurrence there was probably accidental and the species probably has little or no bearing upon this work.

#### Family BIBIONIDÆ.

These insects, called by Comstock 'March flies,' are stout flies resembling the fungus gnats in some respects. Their larvæ vary in habits, some species feeding on decayed vegetable matter while others attack the roots of growing plants, especially grasses.

##### *Scatopse pulicaria* Loew.

The flies of this genus breed in decaying vegetable material, in sewers, and human excrement. The present species occurs both in Europe and in this country. In the present work specimens were bred June 17 and June 27 from miscellaneous exposed fæces collected June 13 and placed under cover, and other specimens were captured September 13, at Alexandria, Virginia, in a garden privy. Mr. Coquillett informs me that this species is common on our windows at certain seasons of the year; but it is not likely to be attracted to any other than foul or decaying matter.

#### Family EMPIDIDÆ.

The flies of this family, sometimes called 'dance flies,' are small or medium sized flies often seen in swarms in the woods flying up and down. The flies are predaceous and also frequent flowers. The larvæ live in decaying vegetable matter and may be carnivorous.

##### *Tachydromia* species.

This genus, of which between 15 and 20 species are known in this country, seems to be unknown in its early stages. We have not found the larva, but adults were reared June 27 from the same miscellaneous lot of exposed fæces collected June 13, 1899, and placed under cover.

##### *Rhaphomyia manca* Coq.

The larvæ of one European species of this genus are found in the earth. The genus is well represented in the United

States, nearly 100 species being known. *R. manca* was captured at Washington on human fæces on the Potomac Flats.

#### Family DOLICHOPODIDÆ.

The flies of this family are small in size and are usually of metallic colors. The adults are predaceous like the Empididæ and the slender cylindrical larvæ live in the earth or in decomposing vegetable matter.

##### *Diaphorus leucostomus* Loew.

The metamorphoses of the insects of the genus *Diaphorus* are recorded by Schiner as unknown. The present species occurs in the District of Columbia and Maryland, and was reared in a single specimen on June 16 from the miscellaneous lot of fæces collected on June 13.

##### *Diaphorus sodalis* Loew.

This species, originally described from New York, was captured by Mr. Busck in a privy at Twining City, Maryland, and was both captured and bred by Mr. Pratt at Travilah, Maryland. The bred specimens issued from excrement deposited May 29 and exposed two days. The captured specimens were taken during the time of exposure and the bred specimens issued sometime during June (exact date unfortunately not noted).

##### *Neurigona tenuis* Loew.

The metamorphoses of the insects of this genus seem to be unknown in Europe. The present species is an American form and was captured May 16, 1899, on a fresh deposit at Washington, D. C.

#### Family SARCOPHAGIDÆ.

The name of this family implies that its species are flesh feeders, but as a matter of fact they are rather variable in their habits. The larvæ of some feed upon the bodies of dead animals, others live in dung, in decaying vegetable matter and in fruits, while others are practically parasitic on living insects, and one genus (*Sarcophila*) is a parasite of mammalia and even of human beings, depositing its young in the nostrils where

they cause great suffering and even death. Several species of this group are referred to in the literature of *Myiasis*.

*Chrysomyia (Comptosyia) maccllaria* Fabr.

This insect, popularly known as the 'screw-worm fly,' is a famous species in the West. It is one of the most important of the insects which affect domestic animals and occurs throughout Central and South America, as well as in the United States. Its greatest damage to domestic animals is done in Texas. The fly lays its eggs on any spot where the skin has been injured, either from a scratch by a barbed-wire fence or the puncture of a thorn. A raw or slightly bloody surface attracts the flies which lay their eggs and the larvæ live in the flesh, making a large sore. The fly does not



FIG. 17. *Comptosyia maccllaria*—enlarged (original).

confine its attacks to domestic animals, but also frequently attacks man. The most common of such cases is where the fly has laid its eggs in the nostrils of some person, usually some one who is troubled with offensive catarrh. The eggs hatch and the larvæ work their way through the upper nostrils and destroy the tissues. The soft palate is frequently entirely destroyed. Fatal cases in men are not rare. The remedy is to syringe out the nasal passages with dilute carbolic acid. It also feeds in the larval state on dead flesh. Its puparia were found by Dr. Motter in his investigations on Grave Fauna and the same observer reared this species from larvæ found feeding on an exposed human corpse.

In the present connection, the screw-worm fly has been, on several occasions, captured on human excrement, although it is not an especially common species near Washington. It has been captured on human excrement in Washington, D. C., and at Cabin John Bridge, Maryland, and was also taken at Snickers Gap, Virginia, in an out-of-door privy.

*Lucilia cæsar* L.

This is another common and widespread form, abundant both in Europe and in North America, and possibly elsewhere. It is one of the shining green or bluish flies commonly found about dead animals and different kinds of excrement. Dr. Motter found its puparia on corpses in old graves and its larvæ feeding on an exposed corpse of a negro.

In the present investigation this species was taken at Washington, May 12, on human fæces exposed for six hours, and from fæces collected on that day, one adult was reared May 29. It was again captured on the 16th under similar conditions, and again, commonly under the same conditions, on June 6. It was captured, also under similar conditions, during the summer of 1899, at Twining City, Maryland, at Leesburg, Virginia, and at Cabin John Bridge, Maryland. In September, 1900, it was reared from animal and vegetable garbage at St. Elmo, Virginia.



FIG. 18. *Lucilia cæsar*—enlarged (original).

This species is not ordinarily found in houses, but may be driven in at the approach of a heavy storm, just as in the case of *Stomoxys calcitrans*, the biting fly. On May 17, 1899, for example, a heavy storm occurred about four P. M., and the next morning 28 specimens were found to have come into one of the rooms of my office. On June 1, at Travilah, Maryland, while Mr. Pratt was watching a fresh deposit, this species was common and flying quickly to and from the deposit. In one instance one settled on his cheek, much to his disgust.

In Europe, where this species is known as the greenbottle fly, it is apparently almost exclusively a carrion feeder. Porchinsky reared it from the dead bodies of sparrows and considered it a true carnivorous species, but larvæ hatching from eggs deposited on meat and subsequently transferred to cattle dung did not perish, but grew slowly.

*Calliphora erythrocephala* Meigen.

This is another widespread species common to Europe and North America. It is a large bluebottle fly of rather dull color,



FIG. 19. *Calliphora erythrocephala*—enlarged (original).

with black spines on the thorax. It is the common 'blow-fly' of Europe and is the species treated by Lowne in his classic 'Anatomy of the Blow-fly.' Its larvæ are said by Porchinsky to be structurally indistinguishable from those of *Lucilia caesar* except in size. The fly lays its eggs on meat and dead animals. It has never been reared by us, although Riley records it in the first Report of the

United States Entomological Commission as destroying the Rocky Mountain locust or Western grasshopper. In our investigations it was captured upon fresh human feces, 24 hours old, May 13, May 16 and June 6, 1899. This fly is occasionally seen in houses, but such appearances should usually be considered accidental. In October, 1899, Mr. J. E. Benedict, living in the suburbs of Washington (Garrett Park), found thousands of these flies in his cellar where he was at work. No cows or horses are kept near the house. There is a chicken yard, however, on the premises and there is an outside privy 50 feet from the cellar, which is used by all the members of the family. It is possible that these thousands of flies had entered the cellar for hibernating purposes, although the weather was still warm. Where they bred is not known; but there had probably been a dead animal in the neighborhood.



*Sarcophaga sarraceniæ* Riley.

This fly, which superficially resembles the house fly, except that it is twice or three times as large, belongs to the group of flesh flies, as the generic name indicates, and was originally bred from the animal contents of the cups of the pitcher plants of the genus *Sarracenia* by Riley. Riley considered it a variety of *Sarcophaga carnaria*, the widespread common flesh fly which

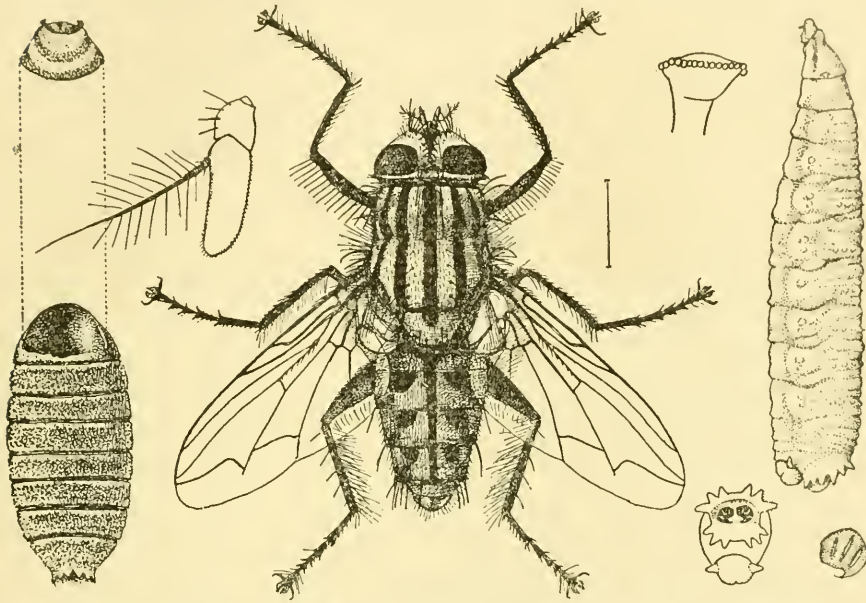


FIG. 20. *Sarcophaga sarraceniæ*: larva at right; adult in center; puparium at left—enlarged (original).

is a general scavenger in Europe and Australia, but its specific identity seems to be assured. This insect has been captured on and bred from human excrement on several occasions in the course of our work. It has occasionally been found in houses, though its presence there seems to be accidental. At Washington, it was captured on exposed fæces May 12 and issued on May 30 from fæces collected May 12. On July 2, at Piney Branch, D. C., an adult female of this species was observed to deposit eleven living larvæ upon fæces and then fly away. From this deposit, one adult issued on July 29. June 6, it was captured on a fresh deposit in south Washington, and adults is-

sued on June 17, in all 55 coming from this one deposit. From fæces collected June 13, adults of this species issued on June 26. From a child's fæces, exposed on July 7 in a back yard in northeast Washington, adults issued on July 21. From a similar deposit exposed July 9, in the same locality, adults of this species issued July 22. From a similar deposit exposed July 24, in the same locality, adults issued in numbers August 9 to 11, about thirty specimens being reared from a single deposit. The same species was also bred from excrement found in the latrines at the camp of the District militia at Leesburg, Virginia, June 19, 1899, and it was captured upon fæces at Marshall Hall, Maryland. It is a common, widespread and dangerous species.

*Sarcophaga assidua* Walker.

This species which seems to be restricted to the United States, or which, at all events, has not been reported from elsewhere, is a species which also resembles the house fly, having about the same size and being, therefore, considerably smaller than the last named species, *Sarcophaga sarraceniæ*. Nothing was definitely known of its breeding habits until the present investigations were begun. It was captured May 12, 1899, upon

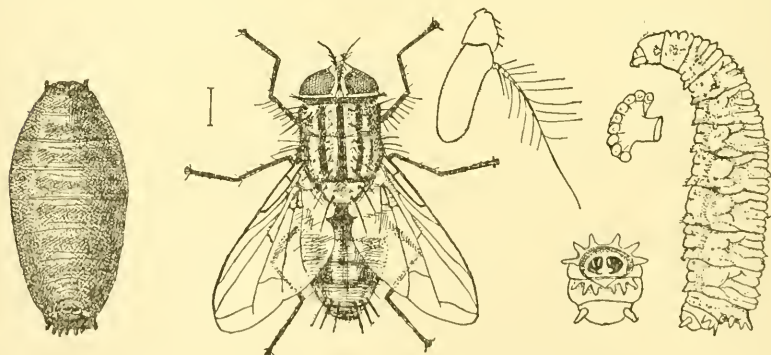


FIG. 21. *Sarcophaga assidua*: puparium at left; adult in middle, with enlarged antenna; larva with enlarged parts, at right—enlarged (original).

human fæces exposed six hours, and again on the same day upon older excrement. On July 3, a deposit was found at Piney Branch, Maryland, and was brought to my office and on July 25 a number of specimens of this species issued. On May 16,

several specimens were captured on a fresh deposit exposed only fifteen minutes on the grounds of the Department of Agriculture. It was also captured during the summer upon fæces of varying ages at Travilah, Maryland; Snickers Gap, Virginia; Cabin John Bridge, Maryland; Marshall Hall, Maryland, and at Leesburg, Virginia, the latter specimens at the militia camp previously mentioned. It was also bred from this material in the northeast Washington experiments, six specimens issuing July 18 to 26, from a child's fæces exposed in a back yard, July 9. September 9 it was reared from a deposit taken August 25 on the Potomac Flats and which was apparently about six days old when taken.

*Sarcophaga lambens* Wiedeman.

This fly, which is recorded from the West Indies and from Brazil, was taken from human excrement in Porto Rico by Mr. Busck in the spring of 1899.

*Sarcophaga plinthopyga* Wiedeman.

This species, which has been taken in Brazil, Dutch Guiana, West Indies and Nova Scotia, was also captured by Mr. Busck in Porto Rico in the spring of 1899.

*Sarcophaga trivialis* v. d. Wulp.

This species, originally described from Mexico, was captured on human excrement and bred from it at Travilah, Maryland; Washington, D. C., and at Snickers Gap, Virginia, in May, June and July, 1899, and was also captured during the summer at Cabin John Bridge, Maryland.

*Cynomyia cadaverina* Desv.

The flies of this genus live in the larval condition in foul animal matter and decaying flesh. The European *Cynomyia mortuorum* seems to be exclusively a carrion feeder, since larvæ transferred by Porchinsky from meat to cow dung and rotten fungi grew very slowly and finally perished. Several species are found in this country and the one under consideration was originally described from North or South Carolina. It has been captured at Washington, D. C., on exposed excrement.

*Phormia terrænovæ* Desv.

This species which is a medium-sized or rather small blue-bottle fly formerly placed in the genus *Lucilia*, would naturally be expected to undergo its metamorphoses in the excrement of mammalia or in decaying animal matter. It was originally described from Newfoundland, but is widespread in the United States. It has not been bred in the course of this work but seems to be abundantly attracted to human excrement, having been taken under many varying conditions at Washington, D. C., at Travilah, Maryland, and at Snickers Gap, Virginia. It was also captured about the deserted sinks at the D. C. Militia Camp at Leesburg, Virginia, in July, 1899.

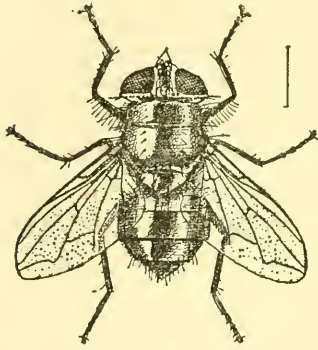


FIG. 22. *Phormia terrænovæ*  
—enlarged (original).

*Helicobia quadrisetosa* Coq.

The insects of this genus apparently feed customarily upon dead animal matter. The genus was originally described from specimens reared from a snail, as the name indicates, but since that time specimens have been reared from several different kinds of dead insects. The species under consideration seems to have been one of the most abundant flies bred and captured from human excrement. In the experiments in the early summer of 1899 it was bred from excrement exposed six hours on the grounds of the U. S. Department of Agriculture on May 12, the first adults issuing May 24. It was also bred in July from a child's fæces exposed in the back yard of a house in northeast Washington. It was also bred the same month at Travilah, Maryland, by Mr. Pratt, and was both captured and bred at Snickers Gap, Virginia, and in the sinks at the District of Columbia Militia Camp at Leesburg, Virginia, by Mr. Pratt. It was also captured and bred during the same summer by Mr. Busck from privy excrement at Twining City, Maryland, and was captured also by Mr. Busck at Charlestown, West Virginia,

in a privy. The species has not been captured in houses. It is evidently a very rapid breeder, and Mr. Pratt's notes indicate that between June 1 and June 7, 1899, an entire generation developed, that is to say, from larvæ deposited June 1 the first adult fly issued early in the morning of June 7. It is only fair to say that the weather was very warm, the average temperature being estimated at 90° F. This fly is one of the first to be attracted in the summer time to freshly deposited excreta and its larvæ appear to be eagerly sought for by the Hymenopterous parasite *Alysia rudibunda* Say.

Another undescribed species of the genus *Helicobia* was captured upon excrement by Mr. Busck, in Porto Rico, in February, 1899.

#### Family MUSCIDÆ.

This family is a rather unsatisfactory complex of forms, systematically speaking, and comprises many flies of such varying habits that it is difficult to generalize concerning them.

#### *Musca domestica* Linn.

The house fly was first studied by the writer in 1895. Its breeding habits were specifically mentioned by Packard in

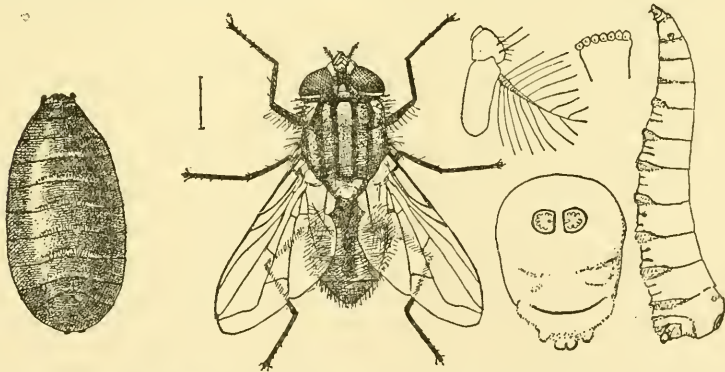


FIG. 23. *Musca domestica*: puparium at left; adult next, with enlarged antenna; larva and enlarged parts at right—enlarged (original).

1873, and by Taschenberg in 1880. Early accounts by De Geer (1752) showed that the larva lives in warm and humid dung, but the duration of the different stages was not mentioned.

Bouché (1834) stated that the larva lives in horse and fowl dung, but does not give the length of the larval stage. Packard (1873) showed that no one in this country had up to that time investigated the habits of the house fly, and that even in Europe little attention had been given to it. He bred a generation in fourteen days in horse manure, finding the duration of the egg state to be twenty-four hours, the larval state five to seven days, and the pupal state from five to seven days.

In the experiments made in my office in 1895 it was found unexpectedly that the house fly is a rather difficult insect to rear in confinement. Buzzing about everywhere and apparently living with ease under the most adverse conditions, it is nevertheless in the warm season, when confined to a small receptacle, not at all tenacious of life. The egg hatched in eight hours; the larvæ lived five days, and the pupæ five days; making the total time for the development of a generation ten days. This was at the end of June. About 120 eggs are laid by a single female, according to our observations; Porchinsky says 120 to 160.

These specimens were reared in horse manure. Subsequent experiments with cow manure were unsuccessful. We succeeded in getting only two flies to oviposit upon this substance, and although their eggs hatched, all of the larvæ died before attaining full growth. In the same way decayed fruit was tried. A single egg was laid upon a decaying blackberry, but this was the only one which could be obtained. These facts seem to indicate that horse manure is the preferred food of the adult fly, and that in all probability by far the greater number of the house flies in cities and towns come from horse manure.

Taschenberg (1880) gave a good popular account of the house fly, but gave the impression that the duration of a generation is much longer than we have indicated. He states that the female lays its eggs upon a great variety of substances, particularly on spoiled and moist foodstuffs, decaying meat, meat broth, cut melons, dead animals, in manure pits, on manure heaps, and even in cuspidors and open snuff-boxes. That the larvæ will successfully breed in such divers substances is, however, not stated by this author.

Down to the summer of 1899 we had been unable to breed a house fly from any other substance than horse manure. In the summer of 1898, while the concentration camp talk was in full blast, efforts were made to ascertain to what extent, even under abnormal circumstances, house flies would be attracted to or could be induced to breed in human excrement. Large earthen boxes were prepared with a gauze covering supported upon upright corner posts, making an enclosure with a cubic content of about twenty-seven feet. In these was placed freshly deposited excrement, and in it were liberated upon a number of occasions from one hundred to two hundred house flies. Not more than ten percent of the flies paid any attention to the excrement; about this percentage settled upon it and sucked up the moisture, flying away after a short interval. In not a single case was an egg deposited. This series of observations seemed very significant to the writer, and after they were concluded he was quite inclined to doubt the extensive breeding under any conditions of the house fly in human excrement. The erroneousness of this partly formed conclusion, however, was plainly shown the following summer, that of 1899. I had become convinced of the desirability of the most exact work upon this question, and elaborate observations were made, extending throughout the entire summer, the result being that it was shown beyond a doubt that the house fly may and does visit human excrement when fresh, and that it may and does oviposit in it, and that it may and does breed successfully in this substance. I am inclined to believe that what may be termed the psychological influence of confinement, even in so large an enclosure as the one used in the 1898 experiments, alarmed the flies, caused their early death, and prevented them from obeying their natural instincts and performing their natural functions. I recalled a similar effect upon the honey bee when enclosed in numbers under a gauze netting covering a large plant and containing perhaps fifty cubic feet of space. In that case also all of the bees died in a few hours. Therefore, in the summer of 1899 another line of experimentation was chosen. Human excrement was exposed under differing conditions in different parts of the surrounding country for a certain space of time and was then collected and

isolated, and the insects bred from it were all carefully mounted, preserved, and studied. At the same time the insects visiting the excrement in the field were noticed and many of them captured. As a result of such methods, the following facts concerning the house fly are recorded :

In the first place specimens of this species were collected in an outdoor privy at Falls Church, Virginia, in July, and a month later in a privy in Alexandria.

July 7, a child's fæces were exposed 48 hours in a woodshed, under cover, about six feet from a fly-infested kitchen in north-east Washington. Ten days later 22 specimens of *Musca domestica* were reared from this excrement, which in the meantime had been kept under cover. Certain other dipterous insects were also reared, which are referred to elsewhere.

On July 9, a large quantity of rather loose fæces of a child was exposed in the same way 48 hours in the same woodshed and afterward isolated. Nine days later two house flies issued, and others continued to issue during the next nine days until a total of 97 house flies and other dipterous insects had issued from the lot.

On July 24, child's fæces were exposed in the same way at the same place for three days, and 11 days later two house flies issued; 31 in all making their appearance during the following five days.

July 26, fæces of a child were exposed in a fly-infested kitchen for two hours, and were placed in a jar to breed. Ten days later ten house flies issued.

On June 7, a stool was found on the Department grounds, and when brought to the office insectary and placed upon one of the benches, house flies were attracted to it and walked all over it. They did not, however, deposit.

June 26, a similar experiment with a similar result.

June 24, a child's fæces were found on a floor in south Washington and were left exposed about four days. On the third day dipterous larvæ were seen crawling in it. July 1, pupæ were observed. July 3 and 4, four small specimens of *Musca domestica* issued.

July 2, specimens were captured upon fæces at Twining City, Maryland.



June 20, fæces taken in the latrines of the camp of the District of Columbia Militia at Leesburg, Virginia, were brought to Washington, and on the 1st of July two specimens of *Musca domestica* issued.

June 19, dried fæces collected in the same latrines were brought to Washington. June 27, one specimen of *Musca domestica* issued; June 28, three more; on July 1, one more. The troops had left the camp on June 16, and their sinks were left open, uncovered with lime, and dipterous insects bred freely.

June 20, another lot was collected in these sinks, and on July 7 one specimen of *M. domestica* issued.

In July one specimen was captured in a privy at Snickers Gap, Virginia, and one also in a privy at Marshall Hall, Maryland. Specimens were seen in privies at Leesburg, Virginia, and at the Bathing Beach, District of Columbia, in the latter part of May and the early part of June.

September 13, a few specimens of the house fly were captured on fæces in a privy, but no adults were reared.

July 24, 1900, a visit was made by Mr. Pratt to the summer camp of the District Militia at Gaithersburg, Maryland. The sinks were much better cared for than the previous year, but numbers of house flies were found about the sinks. Eggs of this species were seen in large clusters on fæces. In some instances the patches were two inches in diameter and looked like little patches of lime.

#### *Morellia micans* Macq.

This fly, which is a dark, shining, sometimes slightly bluish, species, about the size of the house fly, or perhaps averaging a little larger, seems to be an American species and is recorded by Osten Sacken from Baltimore. Its breeding habits seem not to have been previously known. This species was captured on human excrement at Washington, May 12, and began to issue from the same deposit on May 29, continuing to issue May 31, and June 1, 2, and 6, giving 17 days as a minimum duration for a generation. On June 4 a deposit which had been exposed for six days was placed in one of the breeding jars, and on June 8 specimens of this fly issued. A large number also issued on

June 14 from miscellaneous fæces collected on the 13th. The same species was also captured and bred at Travilah, Maryland, and was captured at Snickers Gap, Virginia, on exposed fæces,

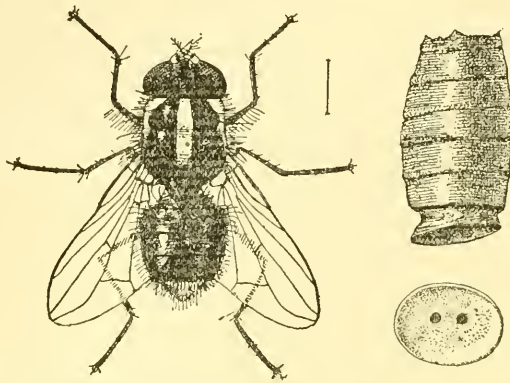


FIG. 24. *Morellia micans*: broken puparium at right—enlarged (original).

and at Leesburg, Virginia, in a privy. It seems, in fact, to be one of the most abundant of the true breeders in human excrement and one of the most specific. It apparently hibernates in larval and pupal states, entering the ground just below the excrement on which it has fed.

#### *Muscina stabulans* Fallen.

This fly is common throughout Europe and occurs also in North America. The larvæ usually feed upon decaying vegetable substances, fungi, etc., but it is recorded in Europe as feeding upon the larvæ of Lepidoptera and bees. Schiner also states that it breeds in cow dung, while Mégnin records its puparia as having been found upon the mummified bodies of children. In the course of the cotton worm investigation by this office it was found to prey upon the pupa of the cotton caterpillar. It was at first considered as a parasite, but Riley decided that it feeds on rotten chrysalids only. During the work of the Gypsy Moth Committee, the same species was reared from the pupa of the gypsy moth, possibly under similar conditions, *i. e.*, from pupæ which were already dead before the eggs of the fly were deposited. Gillette, in Bulletin 19 of the Colorado Agricultural Experiment Station, records the fact that

he found dying squash plants with the stems honeycombed below the ground by a white maggot. From these maggots he reared *Muscina stabulans*. Coquillett ('Insect Life,' VII, pp. 338, 339) determines this insect as *Cyrtonaura casia* and doubts the vegetable-feeding habit. In this case the eggs were probably to be found in the manure which was placed about the plants, or else the heavy manuring attracted the flies. In 1891 the fly was reared upon masses of the larvæ and pupa of the imported elm-leaf beetle which had congregated about the roots of trees upon the grounds of the U. S. Department of Agriculture (see Annual Report of Department of Agriculture for 1892, page 167). September 26, 1900, it was reared by Mr. Chittenden of this office from a rotten squash which had been infested with the pickle worm (*Margaronia nitidalis*). It thus seems to be an insect of somewhat variable habits, attracted, however, as a rule, to foul animal matter.

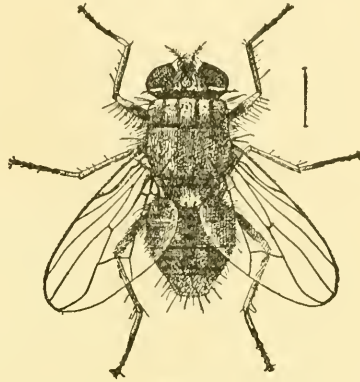


FIG. 25. *Muscina stabulans*—enlarged (original).

In May, 1899, it was captured at Washington upon human excreta exposed for six hours. This same thing occurred on six different exposures during this month. A typical case which may be described was that of observations on a mass of excrement found in an alleyway back of Tenth Street in southwest Washington, on June 6. It was a hot, summer day with a temperature of 92° F., and the small houses had kitchens practically opening on the alley. The writer and Mr. Pratt collected, that morning, on this excremental mass, *Muscina stabulans*, *Lucilia cæsar*, *Phormia terrænovæ*, *Calliphora erythrocephala*, *Limosina albipennis*, *Phorbia cinerella*, and seven specimens of *Musca domestica*, the common house fly. This is a typical case, illustrating the ready transfer of diseases of the alimentary tract to food in the poorer and dirtier parts of the city. Suppose, for example, that the excrement in question had

been deposited by a person in the early stages of typhoid fever, or with cholera. The flies in question might, any one of them, and especially the house flies and the species under immediate consideration, have flown ten or twenty feet or more to the adjoining kitchens and carried the germs direct to the food.

There were reared from this particular mass only *Sarcophaga sarraceniæ* and *Homalomyia brevis*. Fifty-five specimens of the former species made their appearance ten days later. The *Sarcophaga* is not a frequent visitor to houses, but the *Homalomyia* is frequently seen in human habitations.

On June 13 a miscellaneous lot of excreta in different stages was collected in south Washington and from these issued *Muscina stabulans* on June 23 and 29. This was the first time we had observed that the species breeds in this substance. In July additional specimens were captured in an outdoor privy near Washington in the District of Columbia, and at Twining City, Maryland. Under similar conditions other specimens were captured and adults were reared from the same material. In the fall series of observations of the same year, no specimens of this fly were captured or bred under such conditions.

The adult is shown in fig. 25, and the larva with anatomical details on Plate xxx, fig. 1.

#### *Muscina cæsia* Meig.

This species, found in Europe as well as in many different parts of the United States, was captured upon excrement at Washington, D. C.

#### *Muscina tripunctata* V. d. W.

This species, originally described from Mexico, was captured by Mr. Busck, on Culebra Island, Porto Rico, in February, 1899, on excrement.

#### *Myospila mediatubunda* Fabr.

This is a dull-colored fly, about the size of the average common house fly, rather more sordid in its general appearance, but very difficult to distinguish from the house fly at a casual glance. It is common to Europe and North America and is a widespread

species on both Continents. The former doubt as to the identity of European and American specimens has recently been dispelled by Dr. Gary de N. Hough. It was known to Porchinsky in Russia as a dung feeder although the kind of dung is not mentioned by Osten Sacken in his abstract of the Russian writer's paper. It lays not more than 24 large eggs which hatch in 24 hours. The larval period is of brief duration.

It was reared at Washington in nine specimens on May 30 from human fæces deposited May 12, 1899, and eight additional specimens issued on June 2. It was formerly reared on May

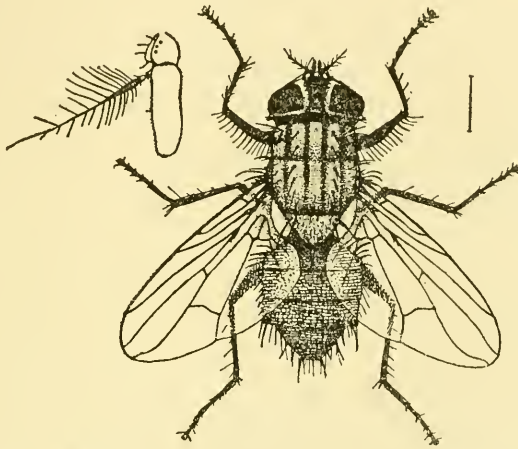


FIG. 26. *Myospila meditabunda*: adult—enlarged (original).

27 from deposits which had been exposed earlier in the month. It also issued on June 5 from twelve-day-old fæces, additional specimens issuing on the 6th from the same deposit. The minimum duration of a generation is thus 12 days. It was captured upon excrement at Travilah, Maryland, July 5, and several times at Washington, District of Columbia, and at Twining City, Maryland, in June.

*Stomoxys calcitrans* Linn.

This fly, common to Europe and North America, has a very wide distribution and is a well-known biting fly; it was probably introduced into this country from Europe at an early date. The larvæ live in fresh horse manure and the flies live chiefly

on the blood of vertebrate animals, frequently causing much annoyance to horses and cattle. They resemble the common house fly very closely, so closely, in fact, as to deceive most people. They do not frequent houses except on the approach of a rain storm and late in the autumn, but they will bite human beings, and the proboscis is so strong and sharp that they even bite through thin clothing. The fact that they enter houses before storms gives rise to the common expression that, "Flies

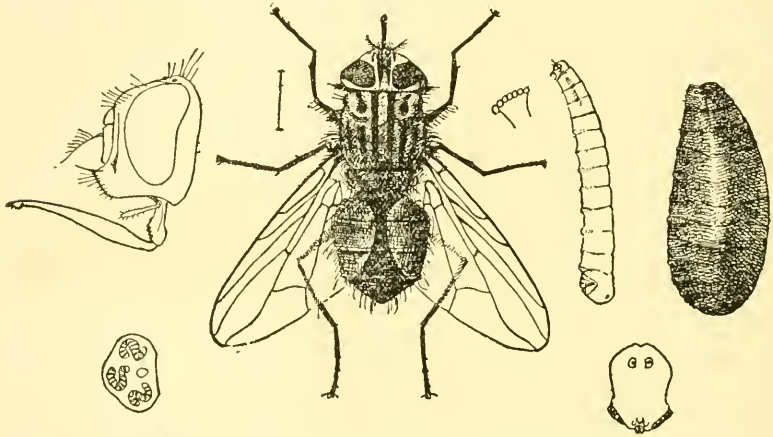


FIG. 27. *Stomoxys calcitrans*: adult, with enlarged side view of head at upper left; larva (two-thirds grown) at right; puparium at far right; anal segment of larva below, and enlarged anal spiracle of larva at lower left—enlarged (original).

begin to bite before a rain." From its biting and blood-sucking habits this insect has been suspected, in common with the true horse flies (all gadflies of the family Tabanidæ), of carrying the bacillus of anthrax, or 'malignant pustule,' and there is no reason why it should not transfer any blood-inhabiting micro-organism from domestic animals to man, or from one man to another. Packard (Proc. Bost. Soc. Nat. Hist., xvi, 145) found the pupa of this insect in horse dung and describes and figures it.

Our first experience with the breeding habits of this fly was in 1889, when studying the horn fly of cattle. August 20, 1889, four specimens of *Stomoxys calcitrans* were reared from horse manure collected at Washington, and on the 19th of the same month large numbers of adults were observed by Mr.

Marlatt, attracted to freshly dropped horse manure. January 20 and May 14, 1890, other specimens were reared from horse manure, the last lot of manure being collected on November 27, 1889, so that the insect hibernates in either the larval or pupal condition (probably the latter) in or just under old manure.

This species has not been bred from human excrement, but has been observed in out-of-door privies at Snickers Gap, Virginia, Alexandria, Virginia, and at Charlestown, West Virginia.

*Pseudopyrellia cornicina* Fabr.

The flies of this genus probably all resemble in their larval habits those of the genus *Pyrellia*, the larvæ of which live in foul animal matter. The present species is a shining, metallic fly. According to observations made by the writer in 1889, while studying the horn fly of cattle, it seems to be a very abundant feeder upon cow dung. In many fields in Virginia he found that almost every cow dropping of the previous day (this was in July) contained one or more clusters—one hundred or more in a cluster—of the elongated white eggs of this species, almost hidden from view, and evidently deposited after the dung had dried sufficiently to become somewhat hard on the top. The eggs had then been thrust into a crack

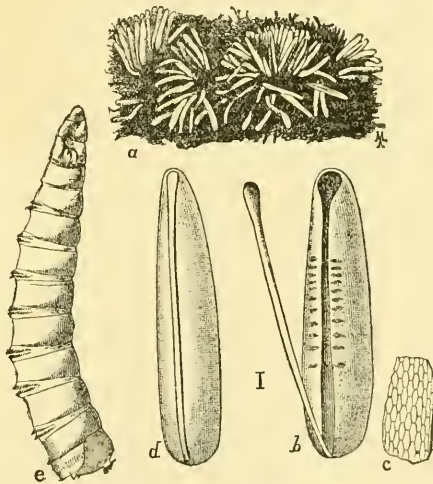


FIG. 28. *Pseudopyrellia cornicina*: a, egg mass in situ—natural size; b, egg showing method of hatching; c, sculpturing of egg; d, sound egg; e, full grown larva—all except a enlarged (from Annual Report U. S. Department of Agriculture, 1890).

and placed in little erect bunches near the surface. It was ascertained that a generation in midsummer averages from ten to fifteen days. About fifteen pounds of these cow droppings was brought to Washington and distributed in various standard breeding cages, and the numbers in which the adult flies issued from

the dung were almost inconceivable. Every morning for several days the breeding cages were apparently full of swarming masses of these flies. The species was at first identified as *Lucilia cæsar* L., and, as such, was mentioned on page 249 of Professor Riley's annual report as Entomologist in the Annual Report of the U. S. Department of Agriculture for 1890, and was figured on Plate VII of the same report. Eggs and larva are illustrated herewith, and the adult is shown at Plate XXXI, fig. 3.

In the course of the present work the adult fly has been captured upon human excrement at Snickers Gap, Virginia, but it has not been reared from this substance.

*Pyrellia ochricornis* Wied.

Flies of the true genus *Pyrellia*, as the names of two of the species (*cadaverina* L. and *cadaverum* Kirby) indicate, are found upon dead animals, although *P. serena* is said by Porchinski to be coprophagous. The species here mentioned is not known to occur in the United States. It was originally described from Brazil, and has also been reported from Cuba and Porto Rico, and was captured on human excrement at Culebra Island, Porto Rico, by Mr. Busck in February, 1899.

Family ANTHOMYIIDÆ.

This family comprises an assemblage of forms somewhat similar to the house fly but structurally distinct. They are difficult to separate. The larval habits are variable. Many of them attack vegetables, both healthy and diseased, as well as decaying vegetables, some are parasitic within living insects and others are found in excrement. Several forms are responsible for authentic cases of internal myiasis and have been taken into the alimentary canal with spoiled vegetables, retaining their vitality and in some cases issuing alive with the fæces.

*Homalomyia brevis* Rondani.

This is one of the small, shining, black flies, found more or less often in houses and which, by non-entomologists, are frequently considered to be immature house flies. Three species of the genus *Homalomyia* have been reared or captured in the



course of this work. The genus is one of wide distribution and has several representatives in Europe. They breed in decaying vegetables and dung, and are said to differ in their larval forms strikingly from the other members of the family Anthomyiidae. The observations of Dr. Motter would seem to indicate that one of our American species feeds on human cadavers. The present species is not so common in houses as its congener, *Homalomyia canicularis*, which will be mentioned later, but

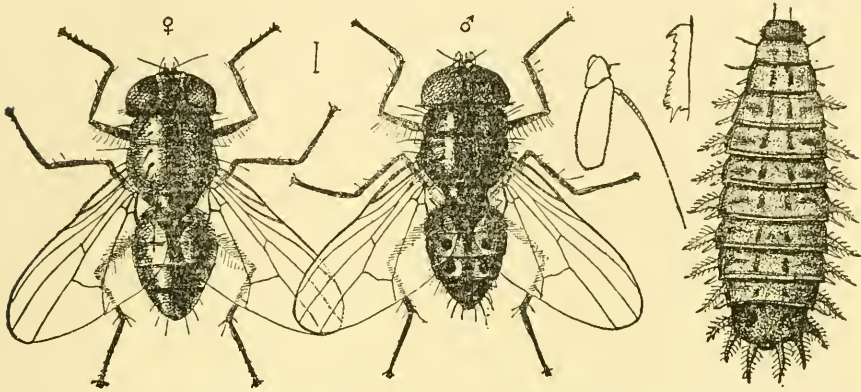


FIG. 29. *Homalomyia brevis*: female at left; male next, with enlarged antennæ; larva at right—enlarged (original).

this form was reared from human excrement and seems to be an abundant breeder in that substance. It was repeatedly bred in the experiments which have heretofore been mentioned, at Washington, namely: On May 30 it was reared from fresh fæces exposed May 12; on May 12 it was reared from an old deposit found on the grounds; on May 27 it issued from similar deposits, on June 2 from others; on June 22, after sixteen days it was reared in numbers from a deposit found fresh in south Washington; on June 8 it was reared from a deposit after 11 days. It was also reared in the northeast Washington experiments, and also bred from material gathered at Snickers Gap, Virginia, and at the militia camp at Leesburg, Virginia.

*Homalomyia canicularis* Linn.

This species, common to Europe and North America, is often found in houses, especially in the fall, and is the very small fly

with semi-transparent abdomen seen at such times on windows. This species is known in Germany as the little house fly ('Kleine Stubenfliege'). The larvæ are said by Schiner to live in decaying vegetable material. Heeger states that he reared it from larvæ found in the larvæ of *Epischnia canella*, a lepidopterous insect, and Roth found them in the nests of the common bumble-bee, *Bombus terrestris*. Hagen (Proc. Bost. Soc. N. H., xx, 107) reports a case in which a larva, presumably of this species, was found in the urethra of a patient. (Probably a case of pseudoparasitism.)

At Washington, one specimen issued on the 25th of May from human excreta gathered on the 12th of May, and the adult was also captured upon the same deposit before it was placed in the breeding cage. It was also reared on the 26th and 27th of June from miscellaneous material collected on the 13th. At Travilah, Maryland, it was captured upon exposed fæces June 15, 1899, and was also captured during the same month at Twining City, Maryland. Six specimens issued in January from excrement taken in a privy in Alexandria in October, 1899.

*Homalomyia scalaris* Fabr.

This species, also common to Europe and North America, is said to live, in Europe, in the larval state, in dry, human excrement. It was reared at Washington in a single instance on May 24 from fæces collected on the 12th.

*Linnophora arcuata* Stein.

The metamorphoses of the flies of this genus are not known. This species has been captured on excrement and bred from the same substance at Washington and at Travilah, Maryland, and was also captured upon excrement in Porto Rico by Mr. Buśck. From excrement deposited May 12 and exposed six hours adults issued June 16. On May 16 adults were almost immediately attracted to a fresh deposit. The adult is a small fly varying in color from grayish to nearly black.

*Ophyra leucostoma* Wied.

The larva of one European species of this genus, probably the species under consideration, is said by Schiner to live in

dung. *O. leucostoma* is found both in Europe and North America, and is recorded by Osten Sacken as common in the Atlantic States. It is a rather small, shining, metallic fly appearing like a small bluebottle fly. According to Bouché its

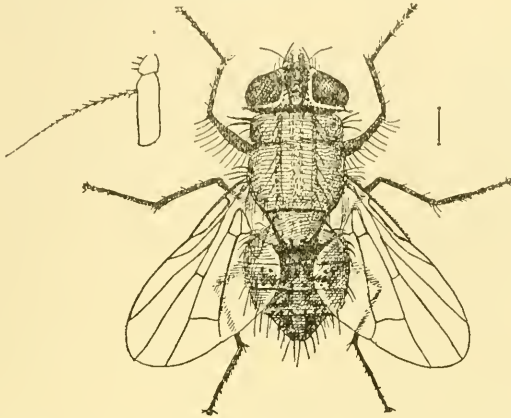


FIG. 30. *Limnophora arcuata*: adult—enlarged (original).

larvæ in Europe live in decaying vegetable material. It was reared June 30 from miscellaneous fæces collected during the early part of the month, many specimens being obtained in this way. It was also captured in the sinks at the District of Columbia Militia Camp at Leesburg, Virginia. It has not been caught in our series of fly-paper experiments, but on the evening of October 25, 1899, when the weather was warm and threatening, flies of this species swarmed in the second story of Mr. Pratt's house in southwest Washington.

Either this or a very closely allied species breeds in corpses in Europe, according to Mégnin, while this species was abundantly bred by Motter from the corpses of dogs in the course of his studies on the 'Fauna of the Grave.'

#### *Phorbia cinerella* Fall.

The present species is another small fly, common to Europe and North America, which the average person would be likely to take for a very small house fly. It has been captured and bred at Washington, District of Columbia, Leesburg, Virginia, and Snickers Gap, Virginia. It was first collected June 6 upon

exposed fæces in southwest Washington and was reared June 16 from miscellaneous fæces collected June 13. Numbers were reared from excrement brought from the District of Columbia Militia camp at Leesburg, Virginia, to Washington, and it was also captured in a privy near Washington.

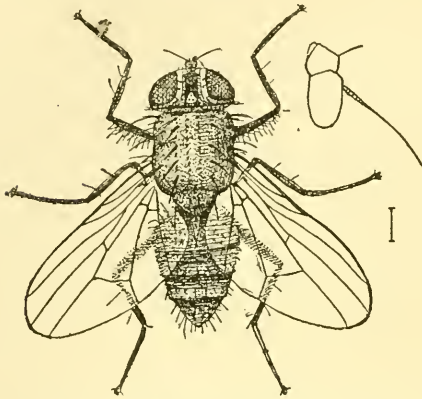


FIG. 31. *Phorbia cinerella*, with enlarged antenna at right—enlarged (original).

in June and also at Travilah, Maryland, by Mr. Pratt. It was also collected in a privy at Falls Church, Virginia, by Mr. Banks.

*Hylemyia juvenalis* Stein.

The larvæ of this genus are found in decaying vegetable material, in cow dung, and similar substances. The present species was captured upon human excrement at Marshall Hall, Maryland, September 17, 1899, by Mr. Pratt.

*Hydrotaea dentipes* Meig.

The larva of the flies of the genus *Hydrotaea* are found in cow dung and in decaying vegetables and according to Zetterstedt one European species has been found in human excrement. It is mentioned in works on internal myiasis. The present species is common to Europe and North America and is a small dark-colored fly superficially resembling the house fly. It was captured May 12, 1899, upon fæces exposed for six hours at Washington, District of Columbia, and again on deposits from three to six days old on the grounds of the U. S. Department of Agriculture. It was reared from a deposit col-

*Phorbia fusciceps* Zett.

This species, also common to Europe and North America, has been reared from pupæ of Lepidoptera and egg-cases of grasshoppers. It is also said to injure seed corn and beans in the ground. This species was reared at Wash-

ington, District of Columbia,

lected June 6 at Washington, District of Columbia, and was found by Mr. Pratt in a privy at Oxen Hill, Maryland.

*Hydrotæa metatarsata* Stein.

This species was captured upon a deposit at Travilah, Maryland, by Mr. Pratt.

*Cenosia pallipes* Stein.

The larvæ of this genus live in fungi, cow dung, and decaying vegetable material. The present species was captured in a door-yard privy in Alexandria, Virginia, September 13, 1899, by Mr. Pratt.

*Mydæa palposa* Walk.

This species was captured at Travilah, Maryland, in June, 1899, upon an old deposit.

Family ORTALIDÆ.

A group of flies with usually spotted or banded wings and frequently of metallic colors. The larvæ of one species occurs under the bark of pine and poplar and the larvæ of another work in the stalks of sugar cane and corn, either following damage by another insect or on healthy stalks.

*Euxesta notata* Wied.

This fly occurs throughout the eastern United States. It is a small shining species of somewhat coppery tinge, the wings bearing a brown spot at the tip. It has previously been reared from onions, cotton bolls, osage orange fruit and apples previously infested by Codling Moth; probably only follows work of other insects in such cases. It was reared in Washington, District of Columbia, June 8, 1899, from fæces exposed May 12 for six hours. It was also collected May 16 on a fresh deposit exposed for 15 minutes.

*Rivellia pallida* Loew.

The metamorphoses of the insects of this genus are recorded as unknown. *R. pallida*, originally described from the District of Columbia, was captured upon excrement at Rosslyn, Virginia, by Mr. Pratt.

## Family LONCHÆIDÆ.

This is a group of flies not distantly related to the Ortalidæ, and formerly included in the Sapromyzidæ. The metamorphoses are not well known but the larvæ of one species has been found in Europe in the stalks of *Verbascum*.

*Lonchæa polita* Say.

The present species is an American form and is rather widely distributed. It was reared at Washington, District of Columbia, June 16, 1899, from excrement exposed six hours on May 12, so that it breeds in human fæces. It was also bred June 27 from miscellaneous fæces collected June 13, time of exposure not known, so that the duration of the early stages in this case is uncertain. A European species of this genus was found by Mégnin on the dead body of a child.

## Family SEPSIDÆ.

This is a group of flies separated off from the old family Muscidæ, comprising small species the larvæ of many of which feed in decaying vegetable material.

*Sepsis violacea* Meig.

The little shining black rather slender flies of this genus are typical of the family in structure and habits. The metamorphoses are not fully understood, but the larvæ are known to breed in decaying vegetable matter. The species under consideration has a wide distribution in Europe, and is recorded by Mrs. Annie Trumbull Slosson from New Hampshire and by Dr. Jno. B. Smith from New Jersey. In the course of our excrement investigations it has been frequently found and has been both captured and reared in large series at Washington, District of Columbia, and at Travilah, Maryland, and has been captured upon human fæces at Twining City, Maryland, and at Snickers Gap, Virginia. It was taken on the 12th of May at Washington on fæces exposed six hours and was reared June 10th from the same deposit, making the duration of the early stages 29 days. It was also reared on the 20th of May from deposits collected on the 12th of May and exposed from three to six days, making a

minimum duration of the early stages in this case 23 days. From the same lot it was also reared on the 23d of May and was collected upon excrement on May 13 and May 16. A little later in the season, with warmer weather, it was reared, on June 10 after a period of immature existence of 14 days, and on the 23d of June was reared from a deposit of unknown age.

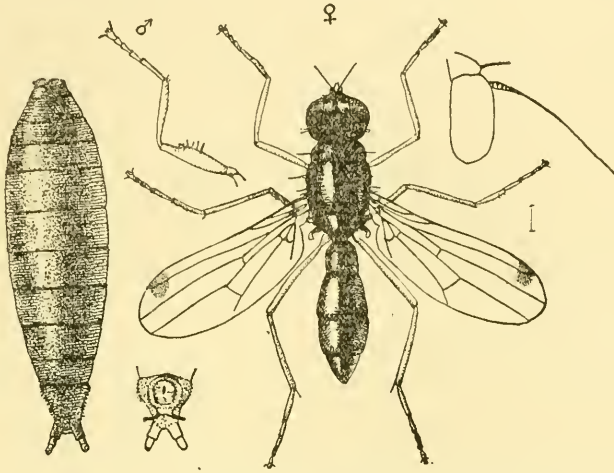


FIG. 32. *Sepsis violacea*: adult with enlarged antenna, at right; puparium at left—enlarged (original).

On September 11 it issued in swarms from a deposit collected August 18, and on the same day issued in great numbers from an old deposit collected on the Potomac Flats August 25. They also issued on this day in swarms from old excrement collected August 31.

#### *Nemopoda minuta* Wied.

The larvæ of one species of this genus (*N. cylindrica*, Desv.) has been found in Europe in human excrement. Therefore, the similar occurrence of the present species in this country was quite to be expected. *N. minuta* is an American species and was originally described from New York. It is superficially much like the preceding species but can at once be distinguished by the lack of the dusky spot near the tip of the wings. It has been taken in outdoor privies at Snickers Gap, Virginia (July

18), by Mr. Pratt, at Falls Church, Virginia, by Mr. Banks, and in the sinks at the District of Columbia militia camp at Lees-

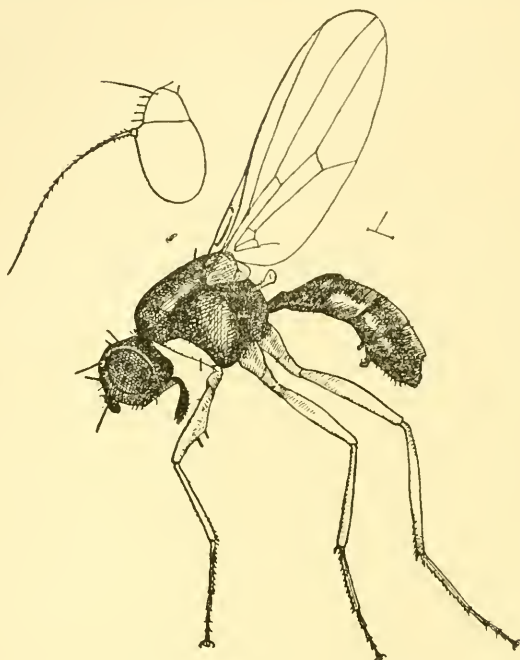


FIG. 33. *Nemopoda minuta*—enlarged (original).

burg, Virginia (July 19), by Mr. Pratt. It has been bred from human fæces at Washington by both Messrs Pratt and Busck.

*Piophilæ casei* Linn.

The little shining black flies of the genus *Piophilæ* breed in cheese, ham fat and in other fatty or spoiled and decaying animal matter. The present species is the parent of the common cheese maggot or skipper and is one of the species occasionally referred to in cases of myiasis interna since the larvæ have been known to pass alive through the alimentary canal of human beings. The same insect sometimes does considerable damage to hams in western packing and curing establishments. It breeds commonly in human corpses, probably only or mainly on adipose tissue and Dr. Motter found its puparia abundantly in 12 of the graves which he examined in 1896-97. Each fe-



male lays about 30 eggs and the duration of a generation in this country is frequently as short as 18 days. In Germany the average duration of a generation is four to five weeks and there are two and three generations during the summer, the larvæ over-wintering in the puparium. The species is of cosmopolitan distribution.

In the course of the present investigation this species was captured upon human excrement at Travilah, Maryland.

This species is shown in its different stages on Plate xxx, at fig. 2.

### Family DROSOPHILIDÆ.

The minute flies of this family, commonly known as fruit flies or pomace flies, are attracted to decaying vegetation, especially fruit, and are frequently found in houses in the autumn about dishes containing pears, peaches and grapes. They are attracted to fruit both for food and as places of oviposition since their larvæ live in decaying vegetable matter.

#### *Drosophila ampelophila* Loew.

This little pomace fly is the commonest species all over the United States and occurs also in the West Indies. It is also reported by Loew from South Europe. It does considerable damage to canned fruits and pickles, breeds in decaying apples and the refuse of cider mills and fermenting vats of grape pomace. It is a rather rapid breeder and a generation may be developed in 20 days or less. In the present series of observations it was captured upon human excrement at Charlestown, West Virginia, by Mr. Busck, and September 5, 1899, was reared from miscellaneous deposits collected at Washington, District of Columbia, August 31, so that it is a true excrement breeder. As this fly is as has just been stated in the remarks on the family Drosophilidæ frequently found in houses in the autumn about dishes containing fruit and as it also affects canned fruits, pickles, raspberry vinegar and similar substances, this discovery that it will and does breed in human excrement makes this species and the following very dangerous ones.

This species is shown in its different stages on Plate xxxi, at fig. 2.

*Drosophila funcbris* Meig.

This species is common to Europe and North America, and in habits resembles the preceding insect. We have bred it from rotten cherries from Massachusetts and it is recorded as breeding in the waste of pressed olives in Mauritius. It was captured upon human excrement at Travilah, Maryland, by Mr. Pratt.

*Drosophila busckii* Coq.

This insect was captured in a privy at Charlestown, West Virginia, by Mr. Busck. The same species was previously reared at this office from rotten potatoes and from burrows of *Chion cinctus*. It also occurs at Algonquin, Illinois.

Family OSCINIDÆ.

These are also small flies, usually either dark and shining or yellowish in color, the larvæ of which breed in the stems of grasses or are found in decaying vegetable material.

*Hippelates flavipes* Loew.

The metamorphoses of the very minute flies of this genus are unknown and its larval habits are unrecorded except in a single instance when *Hippelates convexus* was reared at this Department from the deserted burrow of a Lepidopterous larva in sugar cane from Florida. The flies themselves are very abundant, especially in the South, where they are found swarming about the eyes of animals and human beings, rendering life burdensome. Sores, ulcers and other open wounds have a great attraction for them and they are said by Hubbard to be responsible for the transmission of the disease known as 'pink-eye' occasionally prevalent, especially among school children, in Florida. The present species seems to be widely distributed in the Southern States, and has been captured on human excrement at Travilah, Maryland, at Leesburg, Snickers Gap and Rosslyn, Virginia. It is probably occasionally and perhaps often responsible for the carriage of putrefactive germs to open

wounds and is indirectly the cause of blood poisoning. This species is shown at Plate XXXI, fig. 1.

*Oscinis carbonaria* Loew.

The larvæ of the insects of this genus usually attack living plants not previously injured by insects, but a few species live in the deserted burrows of other insects. *O. carbonaria* was captured several times upon deposits at Washington (May 12, 13, 16 and 18) and at Snickers Gap, Virginia (July 18). It is an American species as in fact are all of the following species of this genus, *O. pallipes* occurring also in Cuba.

*Oscinis coxendix* Fitch.

This species, previously bred by Mr. Chittenden from the roots of *Ambrosia artemisiæfolia* at Washington, District of Columbia, was captured also at Washington on human fæces.

*Oscinis pallipes* Loew.

This species was captured September 17 on human excrement at Marshall Hall, Maryland.

*Oscinis trigramma* Loew.

This species was also captured on September 17 at Marshall Hall, Maryland, upon fæces and was bred September 5 from a deposit collected in Washington August 18 and which at that date was apparently about a week old.

*Elachiptera costata* Loew.

The larvæ of the insects of this genus attack living plants and decaying vegetation. Specimens have been reared at this office from plants of fall wheat received from F. M. Webster, at Lafayette, Ind. In the present series specimens were captured at Washington upon fresh excrement on May 12 and 13.

Family AGROMYZIDÆ.

This family is closely related to the Oscinidæ and it has practically the same habits. The larvæ of one genus prey upon living plant lice and scale insects but the others feed upon living

plants by forming burrows and mines in various parts of them but principally in the leaves.

*Ceratomyza dorsalis* Loew.

The transformations of one species of this genus are known in Europe and its larvæ mine the leaves of *Sonchus oleraceus*. *C. dorsalis* has been reared at this office from a puparium found in a mine in a leaf of timothy and similar rearings have been made by Mr. F. M. Webster. The previous statements as to breeding habits render the rearing of this species from human fæces something of a surprise, yet it was unquestionably reared on June 24, 1899, at Washington, from miscellaneous deposits collected in a low part of the city on June 13.

*Desmometopa latipes* Meig.

This insect, which occurs both in Europe and North America, and which would hardly be expected to breed in human excreta was reared, September 6, 1899, from a miscellaneous lot of deposits collected in Washington August 18.

Family EPHYDRIDÆ.

This family includes a number of insects of curious structure and strange habits. The larvæ as a rule are aquatic or sub-aquatic and are found in waters strongly impregnated with salts. They occur near salt wells, are found in the strongly alkaline lakes of the Western States, some species breed in pools of water strongly impregnated with manure and one form is found breeding commonly in the pissoirs of European cities. *Brachydeutera argentata* Walker, a handsome little species belonging to this family, has been reared by the writer from larvæ found in a small pool, on the grounds of the Department of Agriculture, which was strongly impregnated with horse manure from an adjoining manure heap.

*Discocerina parva* Loew.

This species, found only in America and the breeding habits of which are not known, was captured at Travilah, Maryland, May 29, and June 1, 1899, on human fæces. It is a very small, black, dull-colored and somewhat hairy species.

*Scatella stagnalis* Fall.

The metamorphoses of the insects of this genus are not known. The flies are found in damp places and on water plants. The present species is common to Europe and North America and is boreal in its distribution. It is a small fly with mottled wings. Specimens were captured at Washington, May 16, upon a fresh deposit which had been exposed only fifteen minutes. Two specimens issued August 30, from a deposit of unknown age collected August 18. This record is a novel one.

*Hydrellia formosa* Loew.

This is an American species which was captured upon an old deposit upon the Potomac Flats near the water, as was quite to be expected since the flies of this genus are most commonly found upon the leaves of water plants.

## Family BORBORIDÆ.

This is another group formerly placed in the old family Muscidae. The larvæ of very few species are known. These are found in dung and in decaying fungi. The little flies of this family, usually black in color, seem to be among the most abundant insects found in this country, not only upon human excreta but upon the dung of other mammalia. In the summer time they almost immediately swarm upon a fresh deposit. They occur very rarely, if at all, in houses.

*Borborus equinus* Fall.

Insects of this genus are known in Europe to breed in dung, including human fæces, and the flies are recorded by Schiner to be often found in great numbers on human excrement. The species are all rather small and dark-colored and are perhaps the most abundant of the excrement insects. One of the species of this genus (*B. venalicius*) was found abundantly in Cuba by Osten Sacken and as it is an African species it is considered probable that it was brought over in slave ships. *B. equinus*, like so many of the species which we consider in this connection, is common to both Europe and North America. It varies greatly in size, the largest specimens being five or six

times as large as the smallest ones. It was captured on human excrement at Washington, at Travilah, Maryland, and at Leesburg and Snickers Gap, Virginia, in April, May, June and July, 1899, and as early as the 25th of March, 1900, it was noticed by Mr. Pratt, on and around human fæces deposited near Chesterbrook, Fairfax County, Virginia. It was also seen about a dead horse. No other flies were seen at this time, probably on account of the cold weather following the 23d, which was warm, with a maximum temperature of 68° F. and a minimum temperature of 32° F. A wet snow followed on the 26th of March. The larva and puparium of this species were described by Haliday in the Entomological Magazine, III (1836), pp. 335-6. Eggs laid in the first week in October remained unchanged until the end of the month.

*Borborus geniculatus* Macq.

This is an European species, recognized here by Mr. Coquillett. Mrs. Slosson has captured it in New Hampshire on Mt.



FIG. 34. *Limosina albipennis*, adult—enlarged (original).

Washington. It was captured upon excrement at Washington and at Travilah and Marshall Hall, Maryland, by Mr. Pratt,

and was taken in a privy at Charlestown, West Virginia, by Mr. Busck.

*Limosina albipennis* Rond.

The flies of this genus resemble somewhat the species of *Borborus*, but are smaller, and are distinguished by the imperfect venation. The European records show that the larvæ of some species are found in decaying cabbages and among confervæ and in fungi growing on willows. *L. albipennis*, illustrated herewith, has been captured abundantly upon human excrement in the course of this investigation at Washington, at Travilah and Cabin Johns Bridge, Maryland, at Snickers Gap, Rosslyn and Leesburg, Virginia, and has been taken in privies at Alexandria, Virginia, by Mr. Pratt, and at Charlestown, West Virginia, by Mr. Busck. Specimens were reared early in the summer from fæces collected on the 12th of May, and other specimens were reared from excrement taken from the sinks of the militia camp at Leesburg, Virginia, in July. September 13 it was captured on excrement in a privy at Alexandria, Virginia. It seems to be a very abundant species in such localities but has not been taken in houses.

*Limosina crassimana* Hal.

This species, common in Europe, is recognized here by Mr. Coquillett. It has been captured on both fresh and old excrement at Washington, District of Columbia, by Messrs. Pratt and Busck, at Travilah, Maryland, by Mr. Pratt, and in a privy at Charlestown, West Virginia, by Mr. Busck.

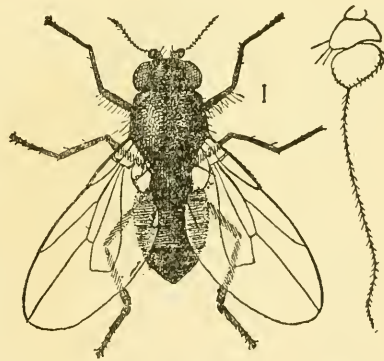


FIG. 35. *Limosina crassimana*, with enlarged antenna at right—enlarged (original).

*Limosina fontinalis* Fall.

This is another European species, recognized here by Mr. Coquillett, which has been captured at Travilah, Maryland, and

which was bred in Washington, on June 16, in large numbers from miscellaneous fæces of unknown age collected June 13. It was also bred from excrement taken from the sinks of the militia camp at Leesburg, Virginia, in July.

*Sphærocera pusilla* Meig.

The insects of this genus resemble the foregoing both in structure and in habits. The larvæ are recorded in Europe as feeding in horse dung and cow dung, and one species according to Signoret has been found on scale-insects. The present species is European, recognized here by Mr. Coquillett. It was reared May 20 from fresh excrement collected May 12, giving a very short period of development.

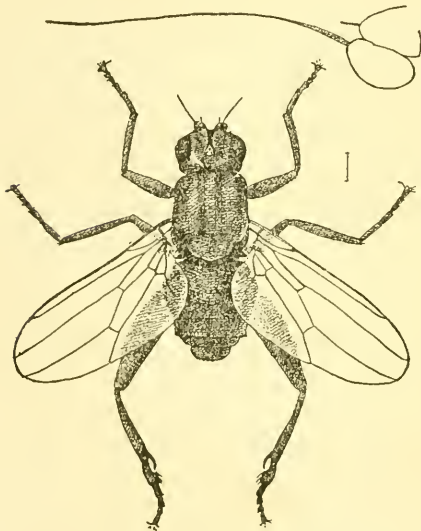


FIG. 36. *Sphærocera subsultans*—enlarged (original).

*Sphærocera subsultans* Fabr.

This is also a European species recognized here by Mr. Coquillett. It was reared with the foregoing species upon the 20th of May, from excrement deposited May 12. The same species swarmed upon a deposit during a storm which occurred on June 12. It was captured on other dates in May and in July at Washington by both Messrs. Pratt and Busck.

Family SYRPHIDÆ.

The species of this family, the majority of which are flower flies, are among the most numerous and best known flies. They abound in gardens in sunny weather. The larvæ are variable in habits, many being predatory, feeding upon soft bodied insects, while others live in foul water or in decaying vegetable



matter. Still others feed upon decaying animal matter, while others live in ants' nests. Still others are found in dung of various animals.

*Syrilla pipiens* Linn.

The larvæ of insects of this genus live in horse dung and cow dung in Europe. *S. pipiens* is found in Europe and North America, extending clear to the Pacific coast, and it is also found in Asia and Africa. It has been reported by Westwood as breeding in horse dung and by Scholtz in cow dung. The only specimen noted in the course of this investigation was taken in a privy at Newport, Oregon, by Dr. A. D. Hopkins.

Family PHORIDÆ.

The small flies of this family, which are brownish in color and hump-backed in shape, are occasionally found in houses. The larvæ feed on decaying vegetable and animal matter, such

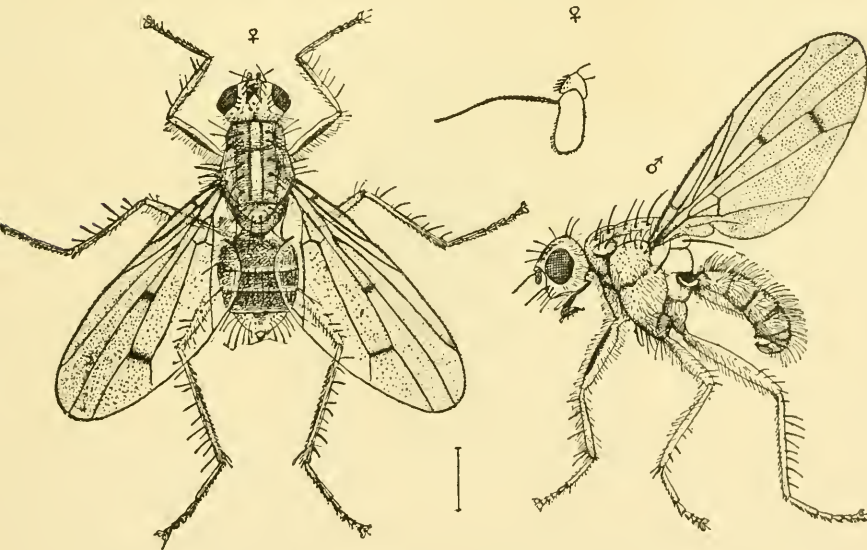


FIG. 37. *Scatophaga furcata*: male at right; female at left, with enlarged female antennæ above—enlarged (original).

as dead insects and snails, and are believed to be parasitic in other insects. Some forms have been found breeding in cadavers and have some medico-legal importance.

*Phora femorata* Meig.

A single specimen of a little *Phora*, which Mr. Coquillett thinks belongs to the European species *P. femorata*, was captured by Mr. Busck in a privy at Charlestown, West Virginia.

## Family SCATOPHAGIDÆ.

The insects of this family, popularly known as dung flies, as the scientific name indicates, are attracted to and breed in dung of different mammals, in human excreta and also in decaying vegetable material. They are as a rule slender, rather light-colored, bristly flies.

*Scatophaga furcata* Say.

The flies of the typical genus *Scatophaga* are known in Europe to live in dung and in human excrement and are also found in water. The present species, *S. furcata*, well figured in the

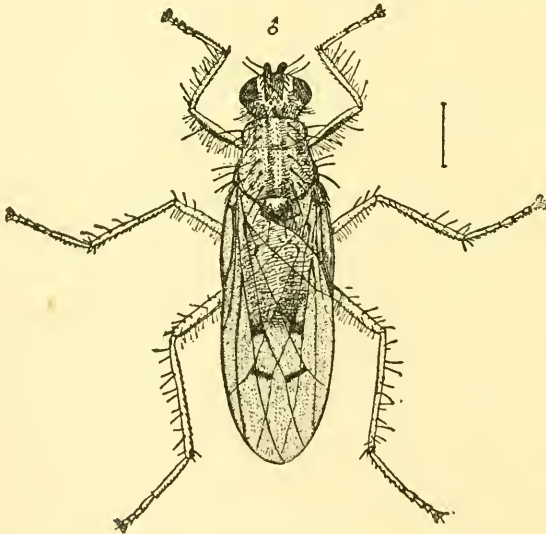


FIG. 38. *Scatophaga furcata*: male, with closed wings—enlarged (original).

accompanying illustrations, has been found all through the season on excrement at Washington and has been captured in a privy at Charlestown, West Virginia. It was not noticed during the early observations in the summer of 1899, although

more than 200 deposits were collected from May to October. On November 8, eight specimens were captured on a deposit in the field and very many were noticed upon fæces in a low part of Washington. November 10, with the thermometer at 65° (rather warm for this season of the year) very many more were noticed about fresh deposits, copulating and presumably ovipositing. Some of these deposits were placed in a breeding cage, and March 3, 1900, 12 adults issued.

*Scatophaga stercoraria* Linn.

This species, common to Europe and North America, was captured during the summer of 1899 on deposits at Travilah, Maryland, at Washington, District of Columbia, and in a privy at Charlestown, West Virginia.

*Fucellia fucorum* Fall.

Four specimens of this species were captured on excrement at Tybee Island, Georgia, in February, 1899, by Mr. Busck. Four other specimens were collected on Culebra Island, Porto Rico, in February by the same observer.

Family MICROPEZIDÆ.

These flies, somewhat related to the Sepsidæ, are little known and their metamorphoses do not appear to have been observed.

*Calobata fasciata* Fab.

Specimens of this species were collected upon human fæces by Mr. Busck in Porto Rico.

*Calobata antennipes* Say.

This species, reasonably common in the District of Columbia, is said by Mr. Burden, a Washington entomologist, to frequent human fæces in this vicinity.

Family HELOMYZIDÆ.

The flies of this family, which is not distantly related to the Scatophagidæ, occur in the larval condition in fungi and one species in Europe feeds upon truffles. These flies seem to prefer damp shady places and fly in the twilight.

*Leria pectinata* Loew.

The larvæ of the flies of this genus are known in Europe to occur in dung and in fungi, presumably decaying fungi. The flies lay their eggs in the excrement of dogs and other animals. The only observations upon this species made in the course of these investigations were by Dr. A. D. Hopkins, who collected specimens in a privy at Golden Gate Park, San Francisco.

*Tephrochlamys rufiventris* Meig.

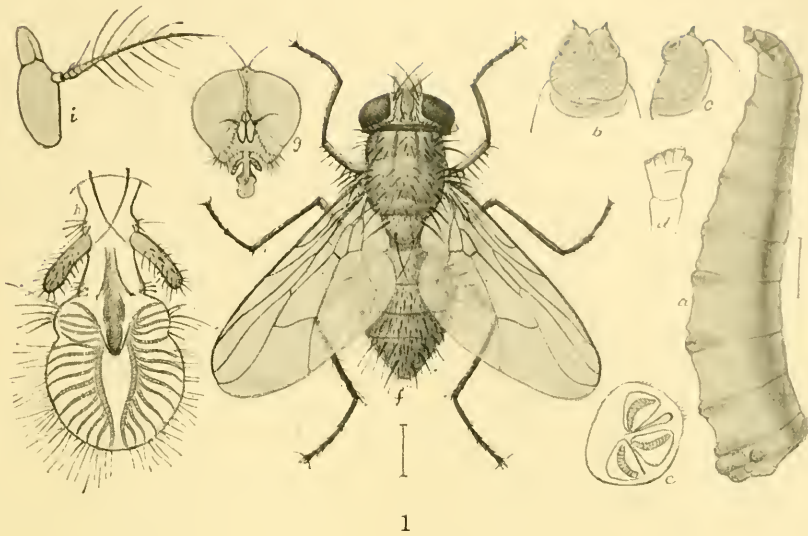
This species, common to Europe and North America, was taken in a privy at Newport, Oregon, also by Dr. Hopkins.



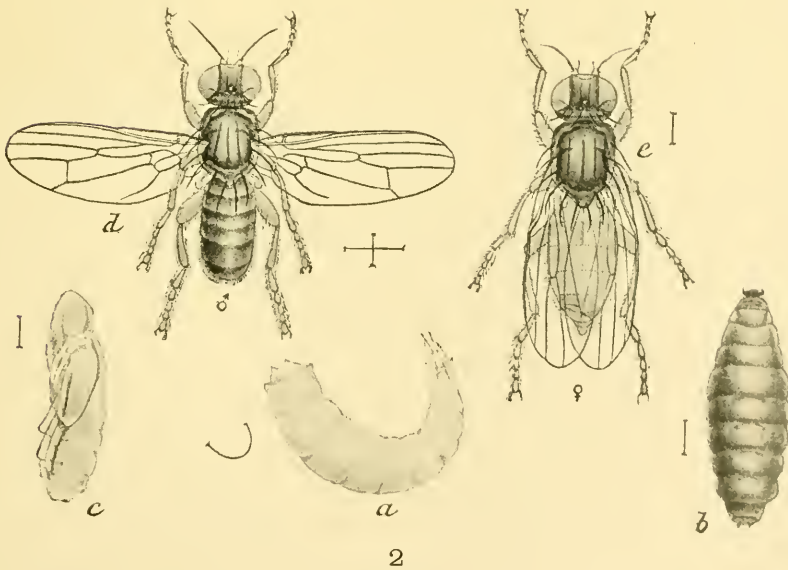
PLATE XXX.

[Enlarged.]

- FIG. 1. *Muscina stabulans*: *a*, full-grown larva; *b*, head of same from below; *c*, same from side; *d*, thoracic spiracles; *e*, anal spiracles; *f*, adult female; *g*, head of male from front; *h*, mouth parts of adult; *i*, antennæ. (From Annual Report U. S. Department of Agriculture, 1892.)
2. *Piophila casei*: *a*, full-grown larva; *b*, puparium; *c*, pupa; *d*, adult with wings expanded; *e*, same with wings closed in resting position. (Author's illustration.)



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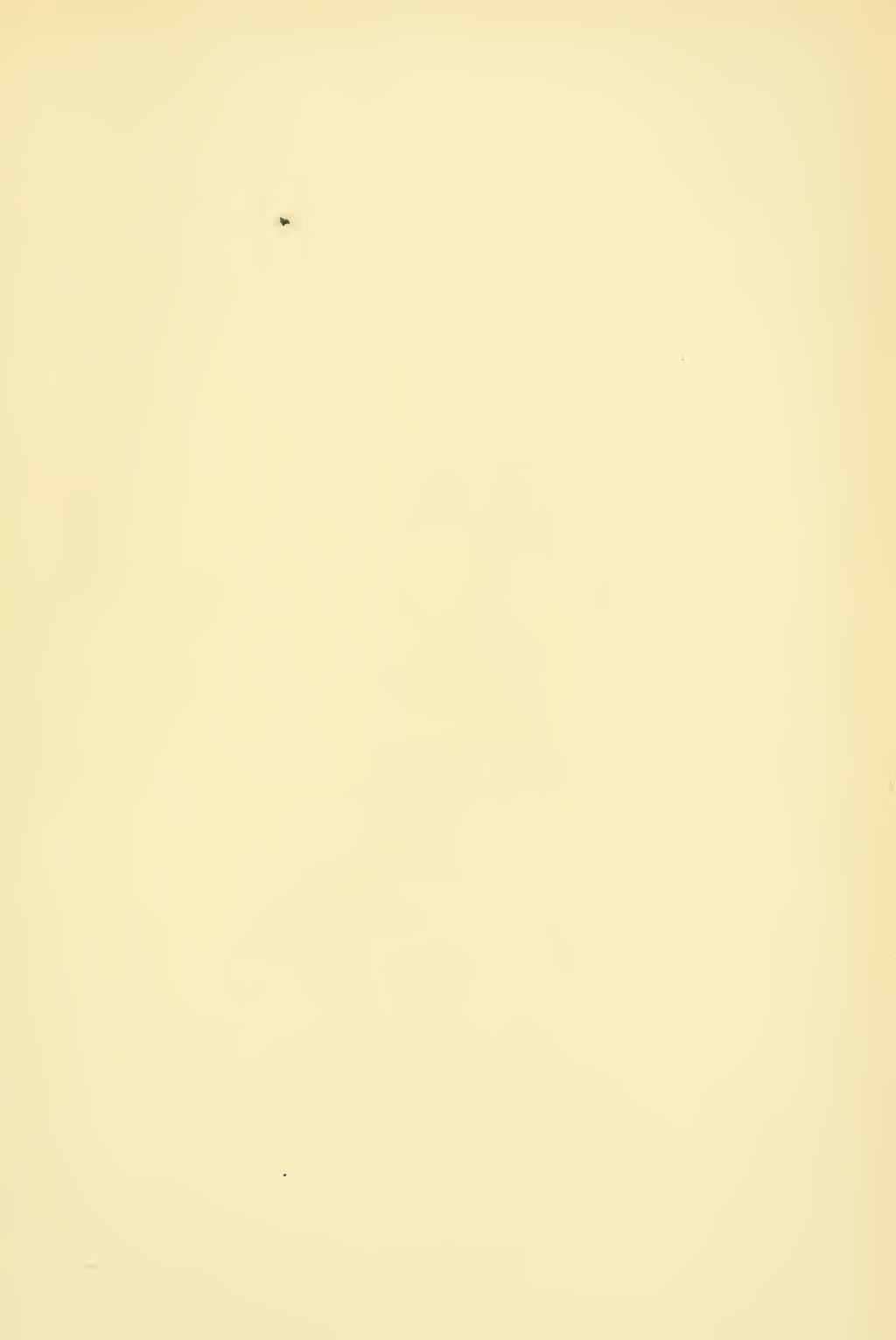
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1. MUSCINA STABULANS

2. PIOPHILA CASEI





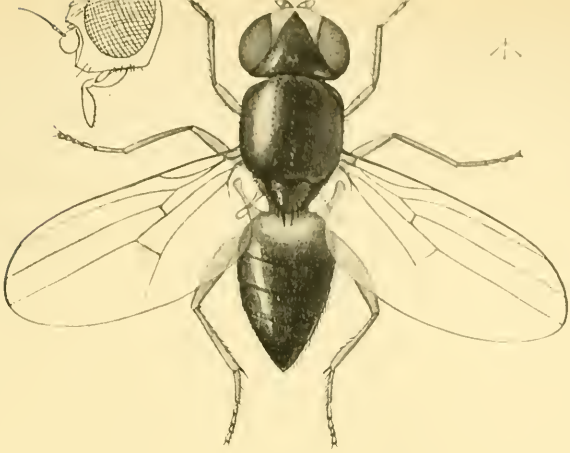


## PLATE XXXI.

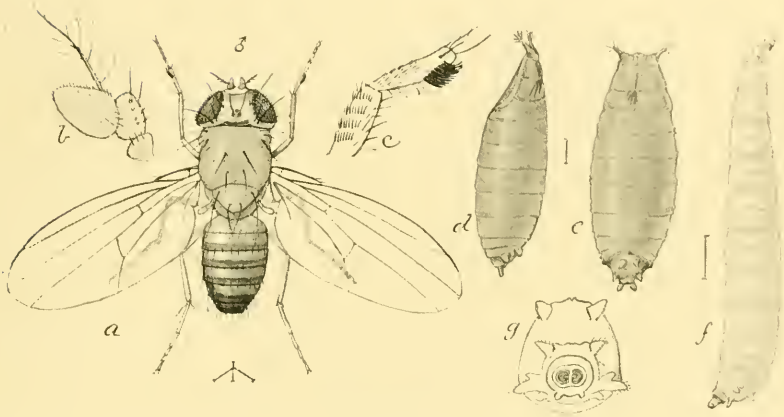
[Enlarged.]

- FIG. 1. *Hippelates flavipes*, with side view of head in upper left hand corner. (From Insect Life.)
2. *Drosophila ampelophaga*: *a*, adult; *b*, antenna of same; *c*, base of tibia and first tarsal joint of same; *d*, puparium, side view; *e*, puparium from above; *f*, full-grown larva; *g*, anal spiracles of same. (Author's illustration.)
  3. *Pseudopyrellia cornicina*: *a*, adult female; *b*, head of male from front; *c*, antenna. (From Annual Report U. S. Department of Agriculture, 1890.)

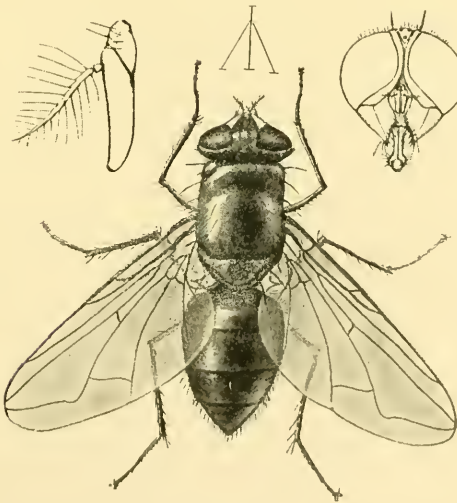
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1 HIPPELATES FLAVIPES

2. DROSOPHILA AMPELORACA

