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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.]

BY L. O. HOWARD, PH.D.

[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

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 mediatubunda* Fabr. (abundant).

Family ANTHOMYIIDÆ.

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. *Cænusia 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).

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 cæsar*, 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

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 funebris* 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.

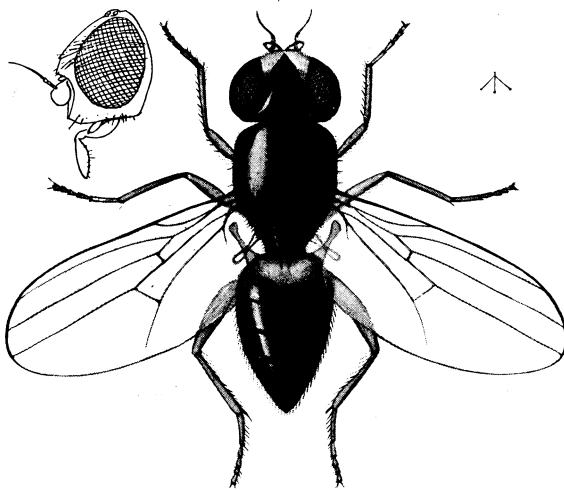
This family is closely related to the Oscinidæ and it has practically the same habits. The larvæ of one genus prey upon living plant lice and scale insects but the others feed upon living



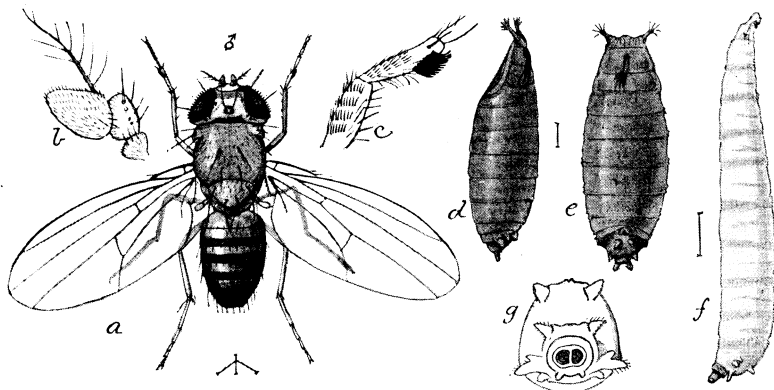
PLATE XXXI.

[Enlarged.]

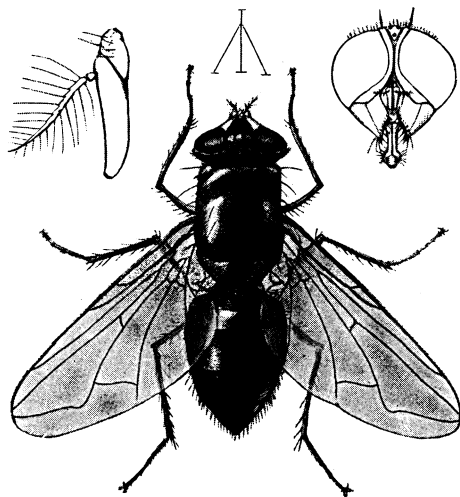
- FIG. 1. *Hippelates flavipes*, with side view of head in upper left hand corner. (From Insect Life.)
2. *Drosophila ampelophaga*: *a*, adult; *b*, antenna of same; *c*, base of tibia and first tarsal joint of same; *d*, puparium, side view; *e*, puparium from above; *f*, full-grown larva; *g*, anal 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.)



1



2



3

1 HIPPELATES FLAVIPES

2. DROSOPHILA AMPELOPHAGA

3. PSEUDOPYRELLIA CORNICINA