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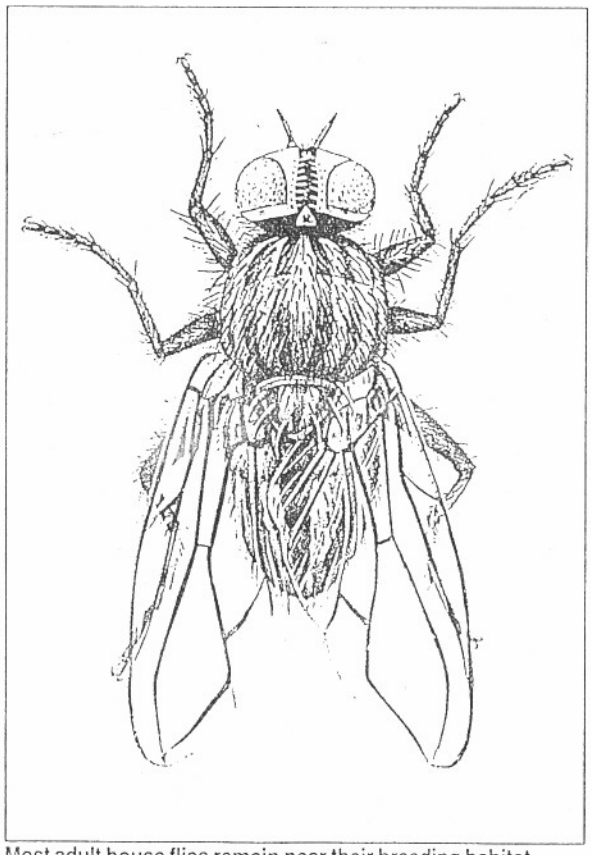
FLIES: A PRIMER

A PEST MANAGEMENT PROFESSIONAL'S GUIDE TO THE BIOLOGY AND RECOGNITION OF COMMONLY ENCOUNTERED FLIES.

BY R.C. AXTELL

The term "fly" refers to insects in the order Diptera, which means "two wings." There are many families of flies, but only a few are of importance to pest management professionals. All flies have two wings, which are usually, but not always, mostly clear. There is a *haltere*, or balancing organ shaped like a ball on a stalk, located behind each wing. There are three obvious regions of the body: head, thorax, and abdomen. The wings and halteres are attached to the side of the thorax. Like all insects, there are three pairs of legs attached to the thorax of the adult fly. Flies have relatively large eyes on each side of the head and antennae projecting from the upper part of the front of the head. The mouthparts project from the lower part of the head and differ in shape according to the feeding habits of the fly species.



Most adult house flies remain near their breeding habitat, where there are ample food and oviposition sites. (Illustration courtesy of Miles Inc.)

All flies develop through a process known as *complete metamorphosis*. The stages of complete metamorphosis include egg, larva, pupa, and adult. The first three stages are also sometimes referred to as the immature stages. The larval stage has no legs and is sometimes called a "maggot." The larva develops through several (usually three) instars by molting; each instar is similar in appearance but larger than the preceding one. A review of the biology and physical characteristics of the most common fly species follows.

HOUSE FLY

Musca domestica

The house fly is a cosmopolitan and universal pest. Its life cycle consists of an egg, three larval instars ("maggot"), pupa and adult.

• *Egg.* The egg is white, elliptical and bluntly rounded at both ends. The surface, or *chorion*, appears polished, but under magnification a pattern of hexagonal markings is visible. Cell division begins in the egg soon after it is deposited. The development and emergence ("hatching") of the first-instar larva requires about 13 hours at 80°F, and longer or shorter times at lower or higher temperatures. At 68°F and higher, the eggs hatch in 24 hours or less; only 8 hours are required at 95°F. At 61°F, the eggs require 49 hours to hatch. Below 50°F and above 108°F, few if any eggs will survive. There is no hibernation or estivation in the egg stage.

The mated female fly begins to deposit eggs about 3 days after copulation. An unmated female will deposit only a few or no eggs, and none of them will hatch. The female has sensory receptors on its ovipositor, and selects suitable sites for oviposition. Consequently, females will often be seen visiting spots in manure or other organic matter and seeming to "inspect" them before stopping at one site to deposit eggs. The number of eggs maturing in the ovaries at one time is 100 to 150 (averaging 120), and those will be laid during one day in one or more batches. A female typically lays 4 to 6 batches of eggs in its lifetime.

• *Larva.* The first-instar larva emerges from a slit the length of the egg. The egg "shell" (chorion) is left behind. The first-instar is very small and delicate. It is particularly susceptible to desiccation, and moves quickly into a moist portion of the substrate. All three instars of the larva have the same basic structure, but details are difficult to observe in the small first-instar.

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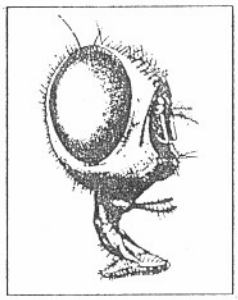
The larva is white and cylindrical with the posterior end broad and flattened; the anterior end tapers. There are no legs or appendages. At the tapered anterior end the larva has lobes with sensory receptors and a mouth with a dark, heavily sclerotized mouthhook to assist in feeding. The mouthhook is part of an interior dark structure called the cephalopharyngeal skeleton, which can be seen vaguely through the larval skin *(integument)*. A short distance behind the mouth is a small stalked lobed structure on each side of the larva. These are the *anterior spiracles*, which assist in air exchange. The anterior spiracles are present in the second- and third-instar larvae.



House fly head showing mouthparts (side view).

The broad, blunt posterior end of the larva has two distinctive dark structures, which are the *posterior spiracles*. These are the major means of air exchange. The spiracles lead to an internal network of *tracheae* (tiny tubes) which make up the respiratory system. The posterior spiracles become larger and more complex as the larva develops through the three instars. The appearance of the spiracles in the third-instar larva is distinctive, and can be used to identify house fly larvae. Each spiracle consists of a heavy sclerotized ring (called the *peritreme*), which surrounds three sinuous slits. A conspicuous round, clear area in the peritreme is called a *button*, and is the site of extraction of the spiracle of the previous instar during the molting process.

The development of the larva through the three instars depends on the temperature. Larvae can survive at temperatures as low as 28°F for several days. However, below about 50°F, the larvae will not develop and pupate. Larvae will be killed at about 115°F. They move in the breeding media to seek areas of optimal temperature and moisture. Larval development typically requires about 7 days at 80°F, and longer or shorter times at lower or higher temperatures. At 68°F, 8 to 10 days are required, and at 95°F, only 3 to 4 days. As the third-instar larva becomes older, it moves to drier and cooler areas and becomes inactive (stops feeding) before changing into the pupal stage.

• *Pupa.* The process of pupation by the third-instar larva involves a total breakdown and reorganization of the tissues and cells within the larval skin, or integument. In the process, the larva shortens and contracts so the integument becomes cylindrical and darkens to a rich, dark brown color. This thickened dark integument forms a case called a *puparium* or *pupal case*, inside which the pupa forms. The puparium looks like a hard plant seed. The adult fly develops from the pupa inside the puparuim and emerges by breaking open one end of the case.

The time required for development of the pupa to the adult ready to emerge is 3 to 21 days, depending on the temperature. At 80°F, about 6 days are required. At 69°F, 10 to 11 days are required; and only 3 to 4 days at 95°F. Below 52°F, the pupa will not develop, but low temperatures can be tolerated for a few days. Although the exact value is uncertain, the pupa is probably killed at about 115°F.

The pupa is protected by the puparium and is quite resistant to desiccation. Often, large numbers of puparia will be found in the dry margins surrounding rotting organic matter or other fly breeding media.

• *Adult.* The time for production of adult flies from eggs deposited by the previous generation is about 14 days at 80°F; at 68°F, 19 to 22 days are required; and only 6 to 8 days at 95°F. In cold weather, development slows; the adults become sluggish and will be found resting on building surfaces. The adult fly does not hibernate or go into diapause in response to changing day lengths, as is done by some insects.

After emerging from the puparium, the adult fly rests while the wings and body complete the hardening process. Newly emerged flies have crumpled, folded wings which expand as the fly dries and hardens. After one hour the fly is completely mobile and ready to seek food and mate. Male and female flies may be seen attached during the mating process. The female has a structure for storage of sperm, so after a single mating the female can lay several batches of fertilized eggs. Normally, a female mates only once in its lifetime. A volatile sex pheromone called muscalure, (Z)-9 tricosene, is produced by the female and attracts the male. After mating there is a preovipositional period of 3 to 4 days after which the female begins to deposit eggs.

Most adult house flies remain near the breeding habitat, where there are ample food and oviposition sites. If the fly density is high or the habitat becomes less suitable, house flies may disperse to nearby areas. Although house flies are capable of flying 1 to 3 miles, most movement is less than a half mile.

Both sexes of the house fly have fleshy, sponging mouthparts. During and after feeding, the flies regurgitate and defecate. The result is spotting of surfaces with brown-yellow regurgitation stains and dark granular feces. Large numbers of house flies will cause discoloration and darkening of the sites where they spend a lot of time resting. At night, the flies tend to rest in the upper parts of structures, where the stained areas will show the preferred sites. Round objects such as wires are favored resting sites, and are often coated with fly feces. The edges and junctions between boards are favored sites and will be stained.

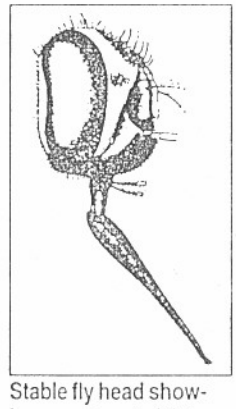
While feeding, the fly liquefies the food and draws it into its mouth through minute channels in its fleshy mouthparts. This feeding habit may result in the fly regurgitating disease pathogens into the feeding place, as well as leaving pathogens from the contaminated feet and body. The house fly feeds on a wide variety of organic matter and is not particular. Examples of nutrient sources are manure, animal feeds, decaying animal carcasses, and garbage.

• *Recognition of the adult.* The adult fly is gray in overall color, with four equally broad dark longitudinal stripes on the top side *(dorsum)* of the thorax. The abdomen has some yellow on the basal half, and the posterior part is brownish black with a dark longitudinal line along the middle of the top side of the abdomen. The head has two prominent large compound eyes. There are also three small round simple eyes on top of the head between the compound eyes. The compound eyes are closer to each other in the male fly than in the female. The broad fleshy mouthparts projecting from the lower part of the head are easily seen, and distinguish the house fly from the similar appearing stable fly.

• *Breeding habitats.* The house fly lays its eggs in organic matter, including animal manure, that has attractive odors and is within the moisture range of 40% to 70% water (by weight). The larva or maggots require the 40% to 70% moisture range for survival and development, while the pupae are found in drier areas. Consequently, any moist manure, garbage, and similar organic matter will support fly development.

STABLE FLY

Stomoxys calcitrans



Stable fly head showing mouthparts (side view).

The adult stable fly is about the same size as a house fly, but can be easily recognized by its distinctive mouthparts, which are formed into a stout, black proboscis ("beak") that is used to pierce the skin and imbibe blood. Both the males and the females are blood-feeders. In contrast, the house fly's mouthparts are broad, fleshy and not adapted for piercing the skin. The stable fly attacks all kinds of warm-

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blooded animals, including wildlife and humans.

In addition to the mouthparts, the adult stable fly differs from the house fly in that it has a checkerboard of dark spots on the top side of the abdomen. The stable fly has four dark stripes on the thorax similar to the house fly, but they are not as distinct.

The stable fly life cycle includes the same stages as the house fly: egg, larva (three instars), pupae, and adult. Stable fly eggs are similar to those of the house fly. The female stable fly requires one or more bloodmeals to produce each batch of eggs, and lays up to 800 eggs in its lifetime, usually in groups of 25 to 50 eggs.

The stable fly larva develops through three stages (instars) in the same manner as the house fly. The third-instar stable larva can be recognized by the unique appearance of the posterior spiracles. Each spiracle is roughly triangular in shape and has three sinuous openings set in a very thick dark ring (peritreme) with the button (clear area) in the center. This is quite different from the house fly, which has D-shaped spiracles with a thin peritreme and the button on one side rather than the center.

The stable fly pupa is contained in a puparium that resembles that of the house fly. Although there are minor differences, it is not practical to identify the species by looking at the puparium.

The life cycle (from egg to adult emergence) of the stable fly usually requires a slightly longer time than for the house fly. The entire life cycle requires 13 to 18 days at 75°F to 85°F. In the summer in temperate areas, the eggs hatch in 1 to 2 days, and larval development requires 6 to 8 days. The pupal stage lasts 6 to 8 days. Like all insects, the rate of development is faster at high temperatures and slower at low temperatures. At 50°F, development from egg to adult may require 3 to 5 months. There is no diapause or hibernation of any of the stages of the stable fly. The female must obtain frequent bloodmeals to continue producing eggs, and initially there is usually a period of 6 to 8 days before a newly emerged female begins to lay eggs (preoviposition period).

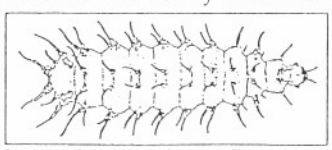
• *Breeding habitats.* Although the stable fly may be found breeding in the same places as the house fly, the stable fly differs from the house fly in preferring to lay eggs in a moist medium that contains a large amount of vegetative matter. Therefore, stable fly larvae are most likely to be found in piles of grass clippings, rotting hay, and other decomposing plant materials.

LITTLE HOUSE FLY

Fannia canicularis

The so-called little house fly resembles the house fly but is smaller (about two-thirds the size of the house fly). The name is a poor one because there are distinct differences between the little house fly and the house fly, and the similar names are confusing. There are other species in the genus that have very similar biology and appearance to *Fannia canicularis*, but usually are less common.

The little house fly is blackish gray with three faint dark longitudinal strips on the thorax. Also, the *Fannia* antenna has a simple long thin bristle, in contrast to the bushy branched (plumose) bristle arising from the antenna of the house fly.


Larva of the little house fly.

The larva stages of *Fannia* are distinctly different from those of the house fly. *Fannia* larvae are brown, broad and slightly flattened, with many branched projections. The larva develops through three instars, and the pupa is formed inside the integument of the last larval instar. Therefore, the pupal stage is brown, flattened, and with projections; it is totally different than the house fly pupa. The *Fannia* eggs are small, white, and with no distinctive features

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useful for identification.

The little house fly eggs hatch in 20 to 48 hours at 75°F to 80°F, and the larvae require 6 or more days to reach the pupation stage, which lasts 7 or more days. The life cycle from egg to emerging adult is 15 to 30 days depending upon the temperature. At any given temperature the life cycle is slightly longer than that of the house fly. Since the adult little house fly does not tolerate high temperatures as well as the house fly, the number of adults will often decline in midsummer after an early summer peak of abundance in temperate regions. Females of the little house fly produce a weak pheromone, (Z)-9 pentacosene, which aids in attracting the males from short distances (a few inches).

The little house fly has a distinctive behavior. It tends to hover and fly slowly in circles for long periods of time without resting. This is in contrast to the house fly, which flies erratically for short distances and rests frequently.

FALSE STABLE FLY

Muscina stabulans

The "false stable fly" is another example of a poor name. This fly is quite different from the true stable fly. The false stable fly is not a bloodsucker and has fleshy, sponging mouthparts like the house fly. It is larger and more robust than the house fly. The overall color is gray with four longitudinal dark stripes on the thorax. A distinctive feature is the pale yellow-orange color on the edge of the *scutellum*, which is the most posterior lobe of the thorax as viewed from above.

The stages in the life cycle are the same as for the house fly. The white eggs are similar to house fly eggs and are laid in batches. The larvae resemble those of the house fly. The third-instar larva has distinctive posterior spiracles, with each having three curved slits and a thick peritreme (dark ring surrounding the three spiracular slits). The larva feed on organic matter and sometimes prey on other organisms in manure, including house fly larvae. The amount of predation is limited, however, and is not a significant factor in controlling house flies.

BLOW FLY

Family Calliphoridae

The term "blow flies" refers to many species of robust bright-colored flies in the family Calliphoridae. Examples of common species include:

• *Phormia regina* (Meigen): black blow fly.

• *Phaenicia sericata* (Meigen): green blow fly.

• *Calliphora vicina* (Robineau-Desvoidy): blue blow fly.

Blow flies are readily recognized by the bright shiny colors and stout bristles on their bodies. The color is usually uniform for the entire body with no stripes on the thorax. The wing venation differs from most other filth flies.

Blow flies have the same basic life cycle and stages as the house fly, with white eggs, three larval instars, brown puparium containing the pupa, and adults. The blow fly's third-instar larva has posterior spiracles that vary among the species but differ from those of other filth flies.

The spiracles have three large slit openings angled towards each other at one end and surrounded by a peritreme (ring of dark cuticle), which may be incomplete in some species or with a large button in other species. Also, there are often very small fleshy lobes around the area of the spiracle.

Blow flies complete a life cycle from egg to adult in 10 to 20 days, depending on the species and temperature. Blow flies will develop in manure. Decomposing animal carcasses and garbage are the prime breeding sites for these species.

FRUIT FLY

Drosophila spp.

Fruit flies are small and vary in color from light brown to blackish brown. These non-biting flies are a nuisance when they become exceptionally abundant around structures.

A common species is *Drosophila repleta*, which is dull dark brown. The common fruit fly, *D. melanogaster*, is a light brown color and has red eyes. Fruit flies lay their eggs in any convenient decomposing organic matter, including manure and vegetative material.

Fruit flies may be recognized by their small size (⅛ inch) and simple wing venation. The life cycle includes the same stages as the house fly: egg, three larval instars, pupa and adults.

Due to their small size, it is extremely difficult to find the immature stages. The small white larvae resemble a house fly larva, but differ in having the posterior spiracles at the end of a short stout projection, which is curved upward. The pupa is not in a hard case; it is soft and has two anterior projections.

Development of *D. repleta* from egg to adult requires about 21 days at 68°F, 14 days at 75°F, and 12 days at 85°F, with about one-third of the time in the pupal stage at the higher temperatures. At 95°F, there is no development, and at low temperatures (about 63°F), development is prolonged to 70 days or more. Mating and oviposition take place in a temperature range of 60°F to 90°F. The rate of development of *D. melanogaster* is similar to that of *D. repleta*.

MOTH FLY

Psychoda alternata

Although there may be other species, *P. alternata* is the most common species of moth fly around structures.

Moth flies are easily recognized by their small size (⅛ inch) and uniform brown color. The body and wings appear "fuzzy" due to a dense covering with small scales. The wings are held upward from the body and are oval-shaped with many nearly parallel veins.

The small egg, larva (four instars) and pupa are difficult to find, and characteristics for their identification are not well known.

The biology of psychodid moth flies has been studied very little. They apparently complete a life cycle in 1 to 3 weeks, depending on the temperature. The species *P. alternata* at "room temperature" requires 21 to 27 days to complete the life cycle in 1 to 3 weeks, depending on the temperature. The species *P. alternata* at "room temperature" requires 21 to 27 days to complete the life cycle with the eggs hatching in 32 to 48 hours, larval development requiring 9 to 15 days, and a short pupal period of 1 to 2 days. **PCT**

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