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# The Role of Common Housefly as a Mechanical Vector of Pathogenic Microorganisms

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## ABSTRACT

The common housefly with the scientific name *Musca domestica* is a common pest of man known to cause nuisance, annoyance and has also been discovered to mechanically transport pathogenic microorganisms to man. Housefly is able to transmit disease to man because of its close association with man. Houseflies feed on liquid or semi-liquid food and therefore when they land on human solid food, they regurgitate liquid containing saliva and digestive juices which may contain pathogens accumulated in their esophagus from their previous feast on rotting and decaying matter such as human and animal feces. Structurally, the housefly is well suited in picking up pathogens. Housefly possesses wings therefore the continuous movement of house flies from filthy substances, such as human feces, animal excreta, carcasses, and garbage, to food makes them perfect candidate vectors for disease transmission. Several studies have shown that eggs of *Ascaris lumbricoides, Trichuris trichiura,* hookworm, *Enterobious vermicularis, Taenia species, Hymenolepis nana, Toxocara canis*, and *Strongyloides stercoralis* are transmitted by houseflies. Protozoan cysts and trophozoites such as *Entamoeba histolytica*, *Giardia lamblia* and bacteria such as Shigella species are also transmitted by houseflies. Houseflies can be controlled by various mechanisms which can be cultural, biological or by chemical means.

**KEYWORDS:** Housefly; Microorganisms; *Musca domestica;* Pathogen;

## 1. Introduction

The housefly, with the scientific name *Musca domestica* belong to order Diptera and family Muscidae, is the most frequent and widespread species of fly in the world. It is said to have originated from the savannahs of Central Asia and spread throughout the whole world, and they can be found in both rural and urban areas of tropical and temperate climates (Hussein and John, 2014). Houseflies accounts for about 90% of all the flies in human habitation worldwide (Nmorsi *et al*., 2006). There are about 170 genera and 4200 species in the family Muscidae, some are of medical importance including the housefly, *Musca domestica* (Service, 2012).The house fly belongs to a group often referred to as "filth flies"; the other members belong to the families Calliphoridae and Fanniidae (Szalanski *et al.,2020).* The house fly has been existing since the origin of human life and is well adapted to life in human habitations/dwelling (WHO, 2008). Houseflies are the most ubiquitous insects and are widely

distributed all over the world, but more adapted to tropical areas (Goulson *et al*., 2005).

*Musca domestica* is synanthropic and endophilic species, i.e. it lives in close association with human being and is able to complete its lifecycle within habitations of domestic animals and humans (Smallegange *et al*, 2007). They are day active and are normally found around human dwellings. House flies can harbor pathogenic microorganism, excreting viable isolates in their vomits and feces (Joyner *et al*., 2013), and can spread them mechanically to various hosts (Wang *et al.*, 2013). House flies are able to transport numerous pathogens from one place to another, therefore posing as risks to humans (Gaugler, 2016). Many Diptera play a remarkable role in the transmission of bacteria and parasites and can harbor different species of pathogenic microorganisms and is known to play a role in the epidemiology of many infectious diseases (Hald *et al*., 2008). Houseflies are one of the highest successful animals because of some major factors. They are found in all kinds of habitat and in all parts of the world. They feed on vast varieties of plant or animal material and have been incriminated as major cause of diseases for centuries. Insects are regarded as vectors when they transmit pathogenic organisms from human to humans or from animals to humans. Without the vector, the life cycle of parasites would not be completed and the pathogen will not live. Vectors can cause injury in a lot of ways. They may cause diseases, and this may happen through the consumption of food that contain human entero-pathogens, mechanically transmitted by houseflies (Gehad and Sherbini, 2010).House flies are able to transport disease-causing agents by attaching them to their mouth, body surface, foot, and wings (Vasan *et al*., 2008).

Houseflies have always been associated with human and domestic animals due to the plenty of food resources found in human homes and domestic garbage. These houseflies are of major concern due to their ability to act as vectors of several pathogenic organisms such as protozoa cysts, helminthes parasites, pathogenic bacteria, and enterovirus (Graczyk *et al.*, 2001). Flies are found both indoors and outdoors. Houseflies persist on decaying animal bodies, and in areas where feces, and a lot of garbage are left exposed. Flies have always been known to be attracted to dirty and contaminated environments. Evidence abound that the Nigeria environment is characterized by dirt, thus encouraging prolific breeding of the insects like houseflies (Tatfeng *et al*., 2005; Adeleke *et al.*, 2017).

Several studies have shown that eggs of *Ascaris lumbricoides, Trichuris trichiura,* hook worm, *Enterobious vermicularis, Taenis sp., Hymenolepis nana, Toxocara canis,* hook worm larvae, and *Strongyloides stercoralis,* protozoan cysts and trophozoites such as Entamoeba histolytica, Giardia species, Trichomonas species, Taenia species, Hymenolepsis species, Dipylidium species, Diphyllobothrium species and bacteria such as Shigella species, *Escherichia coli* are transferred by many species of house flies (Getachew *et al.*, 2007).

The most important pathogens that can be carried by house flies includes intestinal infections (such as dysentery, diarrhea, typhoid, cholera and some specific helminthic infections), eye infections (such as trachoma and conjunctivitis), certain skin infections (such as yaws, cutaneous diphtheria, some fungal infections and leprosy), as well as polio (*Sukontason et al., 2000*). It has been recently identified that house flies can potentially carry the bird flu virus, a serious danger to humans health all around the world (Abbas *et al*., 2015). A report has been described on the significant correlation between the prevalence of gastrointestinal diseases, such as diarrhea, and a seasonal increase in population of houseflies, which can be stopped by controlling the population of such flies using different approaches (Pava-Ripoll *et al., 2015*). Studies have also revealed house flies as carriers of *Salmonella* species (the cause of typhoid, food poisoning, and diarrhea) from slaughter houses to the fruit and food markets as well as residential areas (Olse and Hammack, *2010*).

## 2. Morphology

*Musca domestica* is one of the most common of all domestic flies. House flies are medium-sized non-metallic flies about 6–9 mm long, varying in color

from light to dark grey with some darker markings. They have four rather broad black longitudinal stripes on the hind surface of the thorax. The antennae, which are not easily seen, are concealed in depressions on the front of the face. Each antenna consists of three segments, the distal and largest of which is cylindrical and has a prominent hair, called an arista, which has hairs on both sides. The body of housefly is divided into head, thorax and abdomen. The head is hemispherical in shape and bears two compound eyes. (Service, 2012). Two simple eyes (ocelli) are present on dorsal side of the head. Two small and mobile antennae are present in the region of the head. The thorax is formed of three segments prothorax, mesothorax and metathorax. Each thoracic segment bears a pair of lateral legs. Mesothorax bears a pair of wings and prothorax bears a pair of spiracles, close to the wings (Marshal, 2006).

The abdomen is made up of ten segments. The first remains undeveloped; the second and 6-10 segments are very small. Segments 3-5 are normal. In females these segments form ovipositor to help in reproduction. In the males, the last abdominal segment serves as an external genitalia and the 9th segment bears a pair of claspers for copulation. The abdomen bears spiracles for respiration in both males and females. The last segment bears anal cerci in both males and females.

The mouthparts of housefly are of 'sponging type' i.e. these are adapted for sucking liquid or semi-liquid food like a sponge. Mouthparts are comprised of two fleshy, grooved lobes called the labella, which are attached to the lower lip, known as the labium. The lower surface of these lobes contains numerous transverse grooves that serve as liquid food channels. Houseflies can only intake food in liquid form. The mouthparts are suspended from the rostrum, which is a membranous projection of the lower part of the head. The larvae have mouth hooks used to filter-feed on masses of bacteria. Although they feed mostly on liquid food they can also use solid food by turning them into liquid food by spitting and vomiting on it.

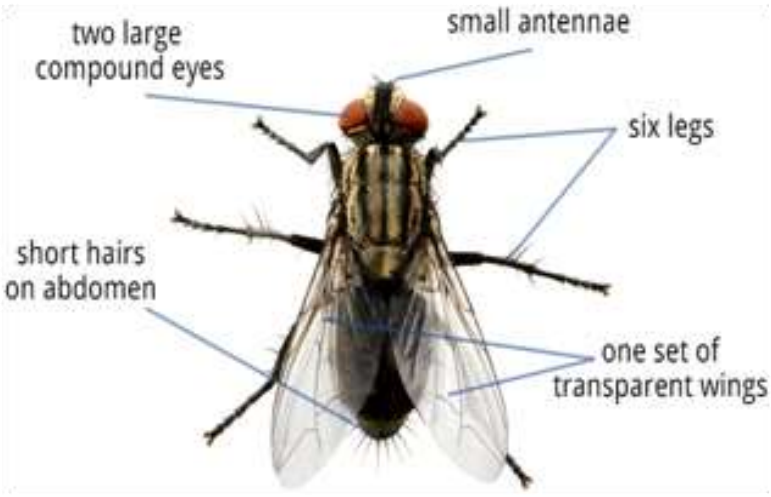


Figure 1: Adult Housefly (Bageboy, 2021)

## 3. Life Cycle

Houseflies undergo complete metamorphosis consisting of an egg, larva or maggot, pupa, and adult stage. Houseflies can complete their life cycle in as little as 7 to 10 days, so as many as 10 to 12 generations may occur in one summer. Eggs are laid in crevices and cracks to save them from desiccation. Filthy food, garbage and dirt are the major breeding sites for house flies (Service, 2012).Female *Musca domestica* lay their eggs on decomposing materials such as animal manure, poultry dung, urine-contaminated bedding, carcasses, decomposing organic materials found in rubbish dumps, household garbage and waste foods from kitchens. Some 75–150 eggs are deposited together, or in

separate batches. A fly may lay eggs 5–10 times in her lifetime, sometimes totaling up to 1000 eggs. The eggs are creamy-white, 1–1.2 mm long, and distinctly concave dorsally, giving them a banana shaped appearance. They can hatch after 10–16 hours, but this duration is longer in cool weather. Hatching is accomplished by the strip of eggshell between parallel ridges on the dorsal concave surface lifting up, and partially detaching itself from the rest of the egg. Eggs cannot withstand adverse weather and die if they dry out. Neither can they tolerate extremes of temperatures, most dying after exposure to temperatures below 15 °C or above 40 °C (Service, 2012).

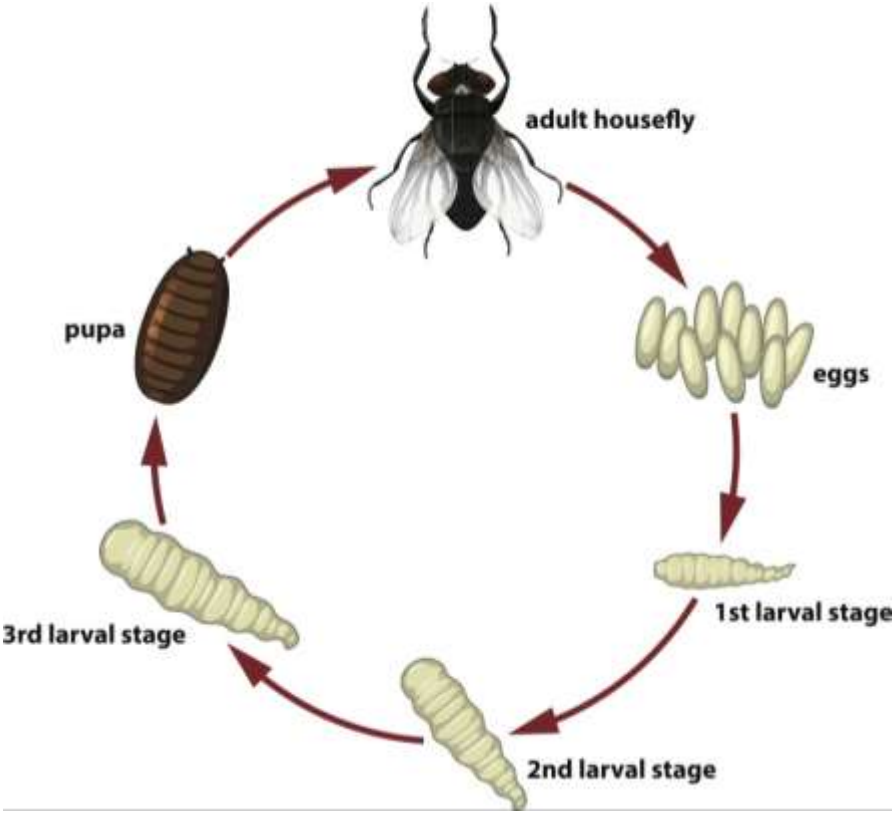


Figure 2: Life Cycle of Housefly (Ripley, 2019)

## 4. Medical Importance

House flies can transmit a large number of infections to humans because of their habits of visiting, almost indiscriminately, feces and other unhygienic matter and people's food. Pathogens can be transmitted by three different routes:

(1) By flies' contaminated feet, hairs on body and mouthparts. Most pathogens, though, remain viable on the fly for less than 24 hours, and there are usually insufficient numbers to cause a direct infection, except possibly with Shigella. However, if pathogens are first transferred to food they may then multiply sufficiently to reach the level of an infective dose.

(2) By flies vomiting on food during feeding, which they do frequently.

(3) By defecation, this often occurs on food. This is the most important method of transmission.

## 5. Habitat

Adaptation of insect life cycle is seasonally (Casey *et al.*, 2007). For maturity and reproduction flies need sugar and protein (Cervera *et al.*, 2009). House flies require protein for egg production because of

this property they are termed as anautogenous (Chajecka-Wierzchowska *et al.*, 2014). Factors such as temperature, diet of flies, water, age, quality and quantity of diet of larvae and the accessibility of substrates for oviposition affect the fertility rate of house flies (Ahmad *et al*., 2011). Temperature promotes the hatching of house fly within 24 hours. Organic substrates like livestock waste of cattle and poultry are the places where larvae feed (Davari *et al*., 2010). Various bacteria help in larval development they are present on the place where the eggs are deposited by the flies and on the membrane of flies (De Jesus *et al.*, 2004). Flies like human, animal manure, litter, waste around food, animal bedding, House fly develops on decaying organic matter as larvae , 8mm long pupa get developed after maggot crawl towards the dry and cool place, its color is reddish brown (Ahmad *et al*., 2011). Availability of breeding places, temperature, sun shine and humidity changes number of fly in any locality. Temperature is directly related with the growth rate and reproduction rate of houseflies. Scientist suggests that April month favors the reproduction of flies (Doud, 2012). As the colder climates are concerned they live with association to that of humans. They have the competence to carry 100 different pathogens which are responsible to cause salmonellosis, cholera, typhoid, parasitic worms and tuberculosis (Banjo *et al.,* 2005). Female houseflies' produces eggs but change in environmental condition can lead to houseflies to stop its egg production, where after they may remain in the environment until spring (Casey *et al.,* 2007). Water is vital requirement for housefly, and housefly cannot survive without it more than 48 hours. Housefly also feed on milk, liquids, juices, fruits, chicken and all the food materials present in human habitat. As these flies intake large quantities of food they have the capacity to deposit a large amount of pathogens. They are domestic flies and their habitat is close to humans and can fly far away from their breeding places. The ability of houseflies to develop and feed on the decaying organic matter has a unique importance for the recycling of nutrients in soil. Houseflies are always found in association with humans and this is actually the reason for their spread all over the world

## 6. Housefly and Associated Pathogens

Houseflies have been found to be associated with bacterial association external and internal surface but the microbes present in the gut of house flies are still not well characterized and how they transferred via food chain (Holt *et al.,* 2007).

Different pathogens have been separated from houseflies that may include, *Shigella, Yersinia enterocolitica, Actinobacter species, Klebsiella species, Proteus species, Enterococcus species., Sarcocystis species., Enterobacter species., Chlamydia species, Pseudomonas species, Toxoplasma gondii, Entamoeba coli, Giardia lamblia, Entamoeba histolytica, Endolimax nana, Trichomonas vaginalis and Cryptosporidium parvum.*

The study in Nigeria reported the presence of hookworms and Trichiuris trichiura isolated from house fly (Boucher *et al.,* 2013). The most surprising results about the housefly is that it carried approximately 6 x $10^6$ bacteria on the external surface and more than 100 from the digestive tract, pathogenic bacteria stay alive in the body of housefly and on the body of houseflies (Aslam *et al.,*2018). The gene sequencing of 16S rRNA genes analysis predicted a wide variety of new and unreported bacterial species that are associated with the gut of houseflies and hence put the light on the role of housefly as reservoirs against different human pathogenic bacteria (Ahmad *et al.,* 2011).

Different types of diseases like bacteremia, upper respiratory diseases, urethritis, complications of surgery and instrumentation, infant pulmonary diseases, and burning complications that all lead towards the new record about the flies (Kern and Perreten, 2013).

## 7. Control of Housefly

### 7.1 Cultural Control

One of the ways of keeping house flies away from the houses is gauze screening of windows, doors, and installation of doors that mechanically open and close (Lietze *et al., 2011*).

The best method is the proper disposal of garbage or any other organic matter properly which serve as breeding sites for housefly eggs. It is a fact that about 50% of house flies in cities exist due to bad management and disposal of waste materials from household, hospitals, companies and markets. Waste bins should have proper lids and garbage should be disposed regularly. Spilled food should be cleaned up immediately (Macovei *et al., 2008*).

### 7.2 Biological Control

Population of housefly may be suppressed by utilization of their natural predators like *Entomophthora muscae (*entomopathogenic fungi), nematodes, parasitic wasps (some pteromalid species), fire ants, predatory beetles (histerial and staphylinid species), and mites, flies and birds. Utilization of parasitic wasps does not harm humans and animals. They locate and kill houseflies in immature form but cannot completely eliminate housefly populations. So, utilization of wasps for house fly control in combination with other methods is necessary. Other biological control methods include the use of MdSGHV virus, bacteria, fungi, nematodes, parasitic, parasitoid and predatory insects (Skovgard, 2004).

### 7.3 Use of MdSGHV Virus

MdSGH is an abbreviation of Salivary Gland Hypertrophy virus of house flies (Geden *et al., 2011*). MdSGHV virus is a member of newly discovered family Hytrosaviridae. This family possesses pathogens which transmit diseases in mature forms of house flies. MdSGHV virus possesses enveloped and double stranded DNA. This virus infects both sexes but rate of infection in males is rapid. Young flies are not matured in females whenever they are infected by MdSGHV virus, it is because of yolk protein transcription and hexamerin production inhibition. As compared to healthy flies, infected flies show shorter life span and reduced rate of successful mating (Lietze *et al., 2011*)

### 7.4 Chemical Control

To reduce the population of house fly,the use of insecticides is very effective and valuable. Many insecticidal sprays which are prehyoid based can also reduce populations of house fly in humans' habitations. It was also observed that house flies showed resistance to DDT (Roca *et al.*, 2009). Use of insecticides for control of house fly population in the beginning is very effective but house flies may develop resistance to persistent insecticides use either because of its enzymes that may break down insecticides or of its behavioral adaptations due to which house lies may avoid insecticides.

### 7.5 Control by Radiation

The control of fly is seemed to be declined in its approaches because of insecticide resistance, ecological limitations and inefficient results by biological control. Ultra violet lights can kill the house flies up to some extent but can never decline their population as the key sources to growth of the flies are not controlled in this way. Certain electronic baits were considered to be the best choice for houseflies' control (Smallegange, 2004).

## 8. Conclusion

In some developing and many underdeveloped countries, open defecation is common and this attracts houseflies to human dwelling. Open gutters and poor environmental sanitation also attract houseflies and houseflies have been discovered to mechanically transport pathogens that are harmful to human health. It is therefore expedient to protect food, water and our body from houseflies.

### Recommendations

**1.** The control and eradication of houseflies should be implemented in areas where open defecation is common.

**2.** Food must always be protected from houseflies. In under developed countries, personal and environmental hygiene should be emphasized.

**3.** Breeding sites of houseflies should be reduced or totally eliminated, sources that attract flies like open feces, spoilt food and dead animals should be properly disposed.

**4.** Food, eating utensils and people should be protected from coming in contact with flies.

**5.** Latrines and toilets where flies cannot make contact with faeces should be put in place in communities.

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