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Role of housefly (*Musca domestica*, Diptera; Muscidae) as a disease vector; a review

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ABSTRACT
Housefly, *Musca domestica*, has a long history of association with animals, which still are suffering from its harmful impacts. It occupies human and livestock premises and acts as a source of nuisance and annoyance to them. The present bibliographical study explains role of House fly as a disease vector of humans and livestock. This article highlights various aspects of the life of the said pest that includes its general description-morphology, biology, life cycle, its pest status and major control strategies. The pest is cosmopolitan in nature and shows holometabolous metamorphosis as it passes through all stages of development like egg, larva, pupa and adult which takes 10 to 14 days for its completion. Its life span is between 15 to 30 days. With respect to control strategies of the said pest, it was reviewed that chemical control is the most common and efficient technique but dependence on insecticide for fly control is decreasing due to increased insecticide resistance and environmental constraints. Biological control with natural enemies also provides reasonable results for outdoor control. Indoors control is mainly dependent on light and odor baited traps. Therefore combinations of several methods for the control of House fly population like Integrated Pest Management (IPM) program is recommended for the effective and efficient results.

Keywords: *Musca domestica,* cosmopolitan, insecticide resistance, IPM

1. Introduction

Housefly (*Musca domestica)* exists as a major pest of humans, poultry and livestock facilities throughout the world [36]. House flies acts as carriers of disease causing agents like bacteria (*Escherichia coli, Shigella, Salmonella spp.*) [26] Which spread more than hundred diseases in humans [28] and animals like amoebic dysentery, helminthic and rickettisial infections etc [49]. Recently, house flies have been found to be potential carriers of bird flu virus that is a threat to humans, poultry and livestock industry throughout the world. It is reported that spreading of intestinal diseases like diarrhea in cities and countryside areas in developing countries like Pakistan is attached to seasonal abundance of house flies and by taking necessary steps to their control results in reduction of such diseases [19].

2. General Description

2.1. Morphology

Correct identification is a crucial factor for its control, so, its morphology is being described. Housefly has only one pair of membranous wings. It possesses prominent compound reddish eyes, tarsi five segmented with dull grey appearance. The length of fully mature fly is ¼ inches with four dark strips on thorax. Its abdomen possesses yellowish sides on its basal half. Its mouthparts are of sponging type as they do not possess teeth or sting and they work like a sponge to soak up the liquid food. Although they can feed only on liquid food but they can also use many solid food by changing them into a liquid through spitting or vomiting on it or readily dissolving it in the salivary gland secretions or in the crop. They eat any wet or decaying matter but are especially attracted to the pet waste because their odor is strong. Both male and female house flies feed on all types of human food, sweat, excreta, garbage and animal dung. In house flies, liquid food is sucked up and solid food is wetted with saliva so that it could easily be dissolved before ingestion. Water is a compulsory part of its diet as it cannot live without water for more than 48 hours. Other sources of food of house fly include milk, syrup, meat broth and many other materials present in human settlement areas. The requirement for food in house fly is twice or thrice a day [17]. Larvae of housefly are called maggots which are color with a length of about 0.3 inches [27].

2.2. Biology and Life Cycle of Housefly

The house fly belongs to super order Endopterygota as its wings develop internally during pupal stage and exhibits holometabolous metamorphosis by passing through all stages of insect development like egg, larva, pupa and adult. Its life is closely related to the availability of sufficient quantity of food and favorable temperature.

A female house fly may lay 4-6 hatches and each hatch consists of 75-150 eggs. Eggs are deposited in crevices to save them from desiccation. Filthy food and garbage are the major breeding sites for house flies [7]. Life span of adult housefly is about 15 to 30 days. Just on the day of their emergence, males are ready to mate but mating occurs when female is three days old [40]. After few days of copulation, oviposition takes place. Eggs are white in colour with pear shape having length of about 1-2 mm. Just after oviposition, within a day eggs are hatched into larvae (maggots) and after a week, the maggots (larvae) develop through three larval stages (instars). Maggots are without legs, 3-9 mm long, whitish in colour and saprophagus in nature as they feed on dead and decaying organic material, such as garbage or feces. They live for 14 to 36 hours. After completion of their third instar, maggots (larvae) crawl to a cooler and drier place where they change into pupae. The color of pupa is reddish or brown and length is about 8 mm. Finally, pupa changes into an adult house fly within 5 days. In warm climatic conditions, house fly completes its life cycle from 2-3 weeks. It produces a large population at a rapid pace due to the large number of egg production and high rate of development. In a year, it may produce 10-12 generations in temperate region. But in contrast, they may produce 4-6 generations in cold regions where its breeding is limited to warmer months [17, 18].

2.3. Status as Pest

Existence of common house fly is reported since the beginning of human life. House flies at larval and mature stages are observed in poultry farms, garbage, and slaughter houses and in fish markets [34]. Often they are found in oviposition form on human corpses [10]. House fly plays its role as a vector of diseases in humans, poultry and livestock from where it scatters to human habitats and activities [30]. It is a causative agent for the spread of various diseases like typhoid, dysentery, diphtheria, leprosy, tuberculosis and intestinal parasites in humans while diseases related to poultry and livestock includes fowl cholera and anthrax etc. Moreover they are also vectors and intermediate hosts of horse nematodes and some cestodes of poultry [27]. Their frequent movements between animal and human sources of food and filth make them best transmitters of animal disease causing the spread of pathogens. More than hundred different pathogens are reported in and on house flies. Usually transmission of pathogens occurs in three ways.

First, pathogens may stick to their body parts especially at their legs and proboscis. Second, pathogens are deposited along the vomit drop onto the food because their mode of feeding is sucking the food after liquification in regurgitated saliva. Lastly, pathogens are deposited in their feces after passing through the gut [11].

3. Various Controlling Methods

Generally, there is implementation of three types of control methods for suppression of house flies and other insects pests (aphid, [41] wasp) population. The methods include cultural, biological and chemical control. Utilization of all three methods has been described by various researchers.

3.1. Cultural Control

One cultural method for keeping house flies away from the houses is gauze screening of windows and doors, adjustment of exhaust (blower) above the doors and installation of doors that mechanically open and close. But for indoor conditions, electrocuting light traps and odour baited traps are used. Utilization of large sticky traps is more effective for this purpose but its use is limited due to a drawback present in its use is that dust particles are rapidly accumulated on the sticky material [17]. Odour baited traps due to their unpleasant smell are not preferably used. Moreover, the light and odour baited traps are also involved in killing of beneficial insects. Mostly, very less quantity of housefly population is trapped by utilization of these traps due to unsuitable environmental factors like odour sources and light conditions [3].

The best cultural method is the disposal of garbage or any other organic matter properly which are breeding sites of housefly eggs. It is a fact that about 50 percent of house flies in urban areas exist due to bad management of disposing of waste materials of household, hospitals and markets. Waste material containers should have proper lids and garbage should be regularly disposed. Straw, manure and spilled feed should be cleaned up at regular intervals, at least twice a week. At the disposal sites of garbage, the waste materials should be covered with a layer of about 15 centimeters soil or any other suitable inorganic material every week [18].

3.2. Biological Control

Population of housefly may be suppressed by utilization of their natural enemies like *Entomophthora muscae* (entomopathogenic fungi), nematodes, parasitic wasps (some pteromalid species), fire ants, predatory beetles (histerial and staphylinid species), and mites, flies (*Hydrotaea aenescens* wiedeman) and birds. Utilization of parasitic wasps is not harmful for humans and animals. They search out and kill houseflies in immature form but cannot eliminate complete housefly populations. So, utilization of wasps for house fly control in combination with other methods is advised [47]. Other biological control methods include the use of MdSGHV virus, bacteria, fungi, nematodes, parasitic, parasitoid and predatory insects etc.

3.2.1. Use of MdSGHV Virus

MdSGH is an abbreviation of Salivary Gland Hypertrophy virus of house flies. It was first discovered in Florida, U.S.A. in 1990 [6]. MdSGHV virus is the member of newly discovered family Hytrosaviridae. This family possesses pathogens which transmit diseases in mature forms of house flies and other flies etc [21]. MdSGHV virus possesses enveloped and double stranded DNA. This virus infects both sexes but rate of infection in males is rapid [22]. Young flies are not developed in females whenever they are infected by MdSGHV virus, it is because of the inhibition of yolk protein transcription and hexamerin production [24]. As compared to healthy flies, infected flies show shorter life span and reduced rate of successful mating [23]. About epizootiology and ecology of this virus, less information is available, probably due to its recent discovery [6]. Utilization of this virus as a biopesticide can be improved by further research.

3.2.2. Use of Bacteria

Maggots of house flies could be controlled by feeding *Bacillus thuringensis* to cattle and chickens and by transferring these bacteria to their breeding sites in manure [29].

According to Rupes, house fly control was also reported by directly including these bacteria in breeding substrates of house flies [39].

In early research, as biological control agent such as bacterial *Bacillus thuringensis* strains were applied which produces exotoxin [5] but resistance in house flies against exotoxin was developed quickly in those that already showed resistance to chemical insecticides [51]. According to Johanson, different strains of bacteria show resistance against house flies and also proved that all housefly active strains of bacteria possess endotoxin Cry 1B which play basic role in their control [14, 25]. New strains of bacteria i.e., *Bacillus thuringensis* have been discovered in different countries of the world including Korea, Egypt and South Africa for housefly control [31]. In South Africa, it was also reported that strains of locally obtained strains of *Bacillus thuringensis* subspecies *israelensis* (*Bti*) show little effect for control of housefly populations either due to the acidic conditions (pH) of digestive system of flies or deficiency of receptors for endotoxin [33].

3.2.3. Use of Fungi

It was reported that whenever adult house flies were exposed to conidia of fungi (like *Entomophthora muscae* and *E. schizophorae*), they were killed within 4-6 days. The intensity and time period of conidial discharge for its proper functioning is correlated to relative humidity and temperature [15]. In temperate regions, infection rate of house flies with natural epizootics is more than 50% in fall season [46].

The disadvantage of *Beauveria bassiana* and *Metarhizium anisopliae* is that these kill house flies in longer time that is 4-6 days but in comparision to these, recent 34 strains of fungi show lesser killing time of house flies that is less than 24 hours [32]. Moreover, better results can be obtained by genetic modification of the pathogen fungi [8].

3.2.4. Use of Nematodes

Population of house fly can be controlled by nematodes like *Steinernematids* and *Heterohabditids* [48]. According to an early report, nematodes were more suitable for suppression of house fly populations in poultry farms in British Columbia [2]. But one drawback was that they did not show better results in pig and poultry manure [37, 38]. On the other hand, whenever manure of cow is mixed with soil or bedding, it gives good results as this habitat is favorite for nematode utilization [48]. Moreover, nematodes are easily available at commercial scale proving them better for control of house fly population at larval stages.

3.2.5. Use of Essential Oils obtained from plant sources

It is reported that essential oils possess fumigant insecticide properties due to the presence of acetyl cholinesterase inhibition and octopaminergic action [13]. By the use of botanical oils, change in behavior of house flies like attraction, repellence and toxicity on their contact to flies at different developmental stages have been reported [20]. Essential oils possessing specific amounts of 1, 8 – cineole, menthol, limonene, and pulegone show effective toxicity to adult house flies. It is reported that combination of effective oils against house flies like bay laurel, blue gum, pennyroyal mint, peppermint and rosemary etc., show better results than the products that are limited to single active constituent [50]. It is suggested that new formulation and better use of synergists (botanical essential oils) will show better results to the biological control of house fly population.

3.2.6. Use if insects as predator, parasite or parasitoid of Housefly

Macrochield mites and Histerid beetles eat up eggs and larvae of house fly population at large scale [1]. It is reported that larvae of *Hydrotae* (Ophyra) are proved facultative predators for control of house fly population [12]. Pteromalid parasitoid that feeds on house flies at pupal stage is used as a more suitable biological control agent of house fly population from decades [9].

3.3. Use of Chemical Control

To decrease the population of house fly, use of insecticides is very effective and valuable.

It is observed that housefly baits like Quick Bayat–R and Golden Marlin–R are generally sugar based and possess a compound that attracts the mature house flies towards them and so whenever house flies approach them due to this attraction, they are killed by feeding on these baits (insecticides). Many sprays which are prehyoid based insecticides can also suppress populations of house fly population in humans dwelling areas. It was also observed that house flies showed resistance to DDT [35], carbamate, pyrethoid and organophosphates insecticides [4]. Moreover resistance against growth regulators like Cyromazine and Diflubenzuron [44] was also observed. Use of insecticides for control of house fly population in the start is very effective but house flies may develop readily resistance to persistent insecticides either because of its enzymes that may break down insecticides or of its behavioural adaptations due to which house lies may avoid insecticides [45]. Moreover, cross resistance also has been observed like juvenile hormone mimics [43, 45].

There are certain factors which make the use of insecticides less effective like resistance and tolerance of house flies for insecticide use, increasing costs of insecticides and toxicity level of insecticide for organisms other than house flies. Further, it appears hard to discover new insecticides and the costs of their development are high [42].

4. Conclusion

It is suggested that more work is needed to improve all control methods like cultural, biological and chemical methods to control the negative impact of housefly as a major pest of humans, poultry and livestock. Finally combination of different methods for prevention and controlling infestations of house flies that is integrated housefly control program (IPM – Integrated Pest Management) is recommended.

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