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Review Article

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# MYIASIS, DIPTERAN FLIES AND THEIR IMPLICATIONS IN FORENSIC ENTOMOLOGY

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**Abstract:** Myiasis is a pathological condition caused by the larval infestation in human or animal tissues. It is caused by the larvae of dipteran flies which are cosmopolitan in distribution. It occurs frequently in tropical countries and developed due to poor hygienic conditions. In human beings, the most commonly affected sites are the skin, mouth, ears, eyes, nose, anus and vagina. The diagnosis of the disease includes examining the larvae in the wounds and lesions. Pain and irritation in the affected body parts are the general complaints by the patients. The treatment is generally carried out by local disinfection and removal of larvae from the affected area. Effective fly control measures and good hygienic conditions should be adopted to control the disease. Insect life cycle stages found on the body and crime scene may be used in the estimation of post-mortem intervals (time since death) in forensic investigations. Insect evidence can also be used in the conditions of myiasis in living beings. Neglect or cruelty results in the untreated wound, and accumulation of faeces or urine, therefore attract the flies to oviposit. These eggs, larvae, etc. can be collected from the wound and presented in the court of law. A forensic entomologist can determine the minimum time since abuse or the duration of neglect by estimating the temperature, species, and age of the insect.

**Keywords:** Dipteran flies, Forensic entomology, Insects, Myiasis.

## INTRODUCTION

The term myiasis was first coined by Hope in 1840 (Rawat *et al.*, 2015). It is derived from the Greek word "*myia*," which means infestation of vital tissues of humans or animals by dipteran fly larvae (Pereira *et al.*, 2010). Hope (1840) defined myiasis caused by specifically with dipterous larvae, rather than insect larvae in general, which was called scholechiasis. He also discussed several cases of myiasis from Jamaica that occurred due to some unidentified larvae, which may be fatal. He identified some of the myiasis cases caused by blue fly larvae, considered as the early reference of the larvae of the New World screwworm, *Cochliomyia hominivorax*. Many species of Sarcophaginae have been known to cause myiasis in humans, and animals like sheep and turtles (Pape, 1996).

Zumpt (1965) defined myiasis as "The infestation of live vertebrate animals with dipterous larvae, which, at least for a certain period, feed on the

host's dead or living tissue, liquid body substances, or ingested food." Myiasis causes a severe problem for livestock industries all over the world (Gabriel *et al*., 2008). Myiasis is found worldwide and more frequent in populations belong to rural and low socio-economic localities. Diptera larvae offer valuable facts regarding the period of abandonment or neglect (Goff *et al*., 2009). It has been seen that many insect's larvae feed on dead tissue and clean wounds. The maggot debridement therapy has been used in medicine for centuries (Baer, 1931; Sherman and Pechter, 1988).

Myiasis causing flies and their larval stages has been extensively studied by several researchers. Sukontason *et al*. (2002) studied larval forms of *Megaselia scalaris* (Loew), humpbacked fly, (Diptera: Phoridae). *M. scalaris* has been reported to cause myiasis in humans and has forensic importance. Awad *et al*. (2003) reported a flesh fly *Parasarcophaga argyrostoma* (Diptera: Sarcophagidae) as an agent of human cutaneous wounds and genito-urinal (vaginal) myiasis. Giroux and Wheeler (2009) reported some *Neobellieria* species (Diptera: Sarcophagidae) develop in vertebrates and known as myiasis-causing species. According to Poddighe *et al*. (2010) the nasal botfly *Oestrus ovis* (Diptera, Cyclorrhapha: Oestridae) has been found to cause myiasis and females larviposit into the animal's nostrils thereby affecting the health of sheep, goats, and humans. Three myiasis causing flies including *Sarcophaga* sp, *Chrysomya albiceps* and *Lucilia sericata* were studied by Shiravi *et al*. (2011) in Iran. Pimsler *et al*. (2014) presented *Baesoxipha plinthopyga* (Wiedemann), a forensically important flesh fly belonging to the family Sarcophagidae, and known to cause myiasis.

All the insects including flies are kept in class Insecta of phylum Arthropoda (Verma and Prakash, 2020) and studied under a separate branch called Entomology. The forensic entomology deals with the application of the study of insects in legal matters. It is usually used to determine the minimum time elapsed since death in murder and illegally killed wildlife investigations (Anderson, 1999a and 1999b). Forensic entomologists can also determine the minimum time and /or the length of time of neglect or abuse in living humans and animals (Pechter and Sherman, 1983; King and Flynn, 1991; Goff *et al*., 1991; Thomas *et al*., 1996). In many cases, myiasis may be occurred due to intentional neglect or cruelty. Insect evidence such as eggs, larvae, pupae, etc. can indicate the duration of wound or neglect. Therefore, insects can be presented as physical evidence of the crime in the court of law (Anderson and Huitson, 2004).

**CLASSIFICATION**

On the basis of infection sites and degree of parasitism, myiasis is grouped as under:

**Classification according to the site of the injury on the host body:**

Zumpt (1965) classified the Myiasis into Sanguinivorous, Dermal/subdermal, Naso-pharyngeal, Intestinal, and Urogenital Myiasis. Bishopp (Patton, 1921) categorized Myiasis into Bloodsucking, Tissue-destroying, Subdermal migratory, Infestations of the head passages, and Intestinal/urogenital. James (1947) categorized Myiasis into Bloodsucking, Furuncular Creeping, Traumatic/wound, Anal/vaginal, Nose, Mouth and sinuses, Aural, Ocular, Enteric, Anal/vaginal, Urinary passages, and Anal/vaginal.

**Classification depending on the degree of parasitism:**

Patton (1921) categorized Myiasis into- Specific (larvae invade live tissue. Host is necessary for the completion of life cycle of Parasite), Semi-specific (generally larvae develop on decaying organic matter, such as carrion, but larviposition may occur on live tissue. Eggs or larvae enter into the host through open wounds or sores), and Accidental (eggs or larvae get an accidental entry in one's body along with food or through oral or urogenital openings). Zumpt (1965) classified it as Obligatory, Facultative, and Pseudomyiasis. Kettle (1984) further differentiated the facultative species into Primary species (initiate myiasis), Secondary (only invade after other species have initiated it), and Tertiary (normally free-living, but may infest live tissue when the host is near death). Shinohara *et al*. (2004) classified as primary

(larvae feed on the living tissue) and secondary (when larvae feed on dead tissue).

**DIPTERAN FLIES CAUSING MYIASIS**

Calliphoridae, Oestridae, and Sarcophagidae are the three main fly families causing myiasis in livestock and humans. Besides three families, some flies belonging to Muscidae, Fanniidae and Syrphidae are also known to cause myiasis. The dipteran flies causing myiasis were categorized into specific, semispecific and accidental myiasis (Patton, 1921).

| **Family** | **Myiasis producing Dipteran fly fauna** | | |
|---|---|---|---|
| | **Specific myiasis** | **Semispecific myiasis** | **Accidental myiasis** |
| Calliphoridae (blowflies) | *Cordylobia anthropophaga* (tumbu fly) | *Lucilia* spp. (green-bottle fly) | |
| | *Cochliomyia hominivorax* (new world screwworm fly) | *Cochliomyia* spp. (screw-worm fly) | |
| | *Chrysomya bezziana* (old world screwworm fly) | *Calliphora* spp. (blue-bottle fly) | |
| | *Auchmeromyia senegalensis* (Congo floor maggot) | *Phormia* spp. (black-bottle fly) | |
| Oestridae (botflies) | *Dermatobia hominis* (human bot fly) | | |
| | *Oestrus ovis* (sheep bot fly) | | |
| | *Hypoderma* spp. (cattle botflies or ox warbles) | | |
| | *Gasterophilus* spp. (horse botfly) | | |
| | *Cuterebra* spp. (rodent and rabbit botfly) | | |
| Sarcophagidae (fleshflies) | *Wohlfahrtia magnifica* | *Sarcophaga cruentata* (= haemorrhoidalis) | |
| | | *Blaesoxipha plinthopyga* | |
| | *Wohlfahrtia meigeni* | *Wohlfahrtia nuba* | |
| | *Wohlfahrtia vigil* | | |
| Muscidae | *Passeromyia* spp. | | *Musca domestica* (housefly) |
| | *Philornis* spp. | | *Muscina* spp. |
| Fanniidae | | | *Fannia* spp. (latrine fly) |
| Syrphidae | | | *Eristalis tenax* (hoverfly/drone fly) |

**IMPLEMENTATION OF DIPTERAN FLIES IN FORENSIC ENTOMOLOGY**

In the circumstances of neglect or abuse, wounds appear on the victim's body. Lesions, blood, necrotic tissue, and accumulation of excrement near the genitalia work as cues for attracting flies. Flies arrive and oviposit on the wound. Fly larvae that emerge from the egg feed on the host tissue for a fixed time and metamorphose into second instar, third instar, and pupal stages simultaneously. After a fixed time, the adult fly emerges, leaving the empty pupal case on the spot. The rate of development of a fly species is temperature-dependent and predictable. All the insect evidence, with details of date, time of collection, surface temperature, and site of infested wounds, are analyzed by a forensic entomologist.

In the cases of myiasis, forensic entomologists identify the collected insect evidences and estimate their approximate age. The entomologists infer the length of time of neglect or cruelty in humans and animals by correlating the species with the stage of insects. Therefore during investigations, the duration of fly activity on the victim's body can be used to estimate the minimum time of possible neglect or abuse.

**CONCLUSION**

Facultative parasites are the most important group of myiasis-causing flies. Myiasis prevails in the cases of excessive neglect, both of humans and animals. Legal action can be taken on the farmers and pet owners for animal welfare in the cases of animal neglect myiasis.

Human myiasis is most common in disabled and abuse cases. Young, old age and incapacitated or helpless people who are not capable to maintain hygiene are more susceptible. Populations living in low socio-economic conditions are not able to sustain good personal hygiene. Ulcerous lesions and bedsores are found to be prone areas for larval infestations. Due to the effect of some drugs or Alcohol consumption people may be unconscious and unaware of fly activity. In many cases, the cause of myiasis may be deliberate neglect or cruelty. Fly eggs, larvae, or pupae may be found on and in the wound. Larvae removed from a body should be collected and preserved properly so that they can be used in forensic investigation (Anderson and Cervenka, 2002; Catts and Haskell, 1990). In cases relating the living, an understanding of myiasis and detection of insect evidence may be an important factor in resolving the case. Older larvae may migrate, so bedcovers and the surrounding area should be searched for post-feeding larvae, pupae, and pupal case for accurate determination of the length of time of abandonment (Anderson and Huitson, 2004). In the cases of intentional neglect or cruelty, forensic entomology can provide significant evidence of the period of neglect or abuse to support the trial.

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