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# Characteristics of Dipteran Insects

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## Abstract

Diptera means two wings (Di: two, pteron: wing). They have complete metamorphosis and they are holometabolous insects which means there are 4 stages (egg, larvae, pupae and adult). The name of larval stage is “maggot”. Some of the dipteran insects cause damage in agricultural production. Some are harmful for humans. Dipteran insects have two wings. Hind wings are reduced and they are called “halteres”. Function of halteres is balancing when the insects fly. Except mosquitoes, dipteran insects have sponging-sucking mouthparts. Important examples for dipteran insects are Olive fruit fly and Medfly which cause damages in agricultural production. OFF is the most destructive pest in olive growing areas and Mediterranean fruit fly cause damages in fruit production.

**Keywords:** characteristics, diptera, haltere, holometabola, mouthpart

## 1. Introduction

Many insects are called flies such as butterflies and dragonflies, but only insects belonging to the order diptera are known as “true flies.” Dipteran insects (flies and mosquitoes) are holometabolous insects which means they have complete metamorphosis life cycle. Dipteran insects have 4 stages in their life cycle (adult, pupae, larvae and egg). Name of larval stages of these insects is “maggot”. Adults of this order are recognized according to wing types. Front wings are developed for flying. Other pairs of wings are undeveloped and they have balancing function when insects fly. These type wings give order its name: two (di-), wings (ptera). One pair of wing provides flying of insects and other pair developed into balancing structures. The name of other pair of wings which provide balancing during flight, called “halteres”. Except mosquitoes, dipteran insects have sponging-sucking mouthparts. Mosquitoes and some other have piercing-sucking mouthparts. The Diptera order is divided into two or three subclasses: Nematocera and Brachycera, the second being Orthorrhapha and Cyclorrhapha [1]. There are approximately 152.000 identified species in this order which are distributed about 130 families [2]. Houseflies, hoverflies, mosquitoes and fruit flies are the most important species which belong to the diptera order. Houseflies carry diseases such as cholera and dysentery. The fly cause serious problems by carrying disease organisms onto food. They take disease organisms from leg hair or eat them and then feed them to other foods. The adults of hoverflies feed mainly on pollen grains. The larvae of some species eat rotten plant and animal materials in the soil or in ponds, lakes and streams.

Another species of hoverflies’s larvae are predators and feed on some harmful insects such as aphids and thrips etc. So, the larvae of these species are important for biological control as natural enemies.

The females of mosquitoes suck the blood of human and several animals such as farm animals and wild animals. Mosquitoes are vector insects and cause the spread of serious illnesses such as malaria and leishmaniasis etc. [3]. Fruit flies are the most destructive pests in horticultural growing. For example, Olive fruit fly are the main pest in growing areas where table and olive oil production are made throughout the world.

General objectives of this chapter is to provide information about the habitats, feeding patterns and life cycles of insects belonging to the order Diptera, and the stages in which they exist in their life cycle; However, it is to provide information on the characteristics of each stage (adult, egg, larva and pupa) in the life cycle of these insects. In addition, to give information about the role of insects in this order for human and animal health and agricultural production.

## **2. Characteristics of Diptera insects**

Dipteran order has 125.000 insect species and is one of the biggest order throughout the world and is highly diverse. Our world score is based on data from higher than 152.000 known species and higher than 130 identified families and these data are from the "World Diptera's Bio Systematic Database" [2]. Diptera order has the fourth place after the Lepidoptera, Hymenoptera and Coleoptera. Many species belonging to the order Diptera are found in almost all zoogeographic regions of the world. These species are well adapted to a broad range of habitats. Except the depth of oceans, they can live many habitats on earth [1]. Maximum nutrient and biomass formation occurs in the maggots of Dipteran order, and the adult this order usually receives the energy which they need to feed their muscles which have functions for flying. Widely the broad range of insects (flies) looking for food, the food of those insects includes honey extract or nectar, blood of vertebrate, pollen, hemolymph of other insects, and another liquefied or liquefied biological resources which are suspended or dissolved in vomiting fluid or saliva. Few groups of adults are predators. Other few groups are completely devoid of mouthparts, so they do not receive food. Therefore, they have short life span. Larval stage of many species, as they exist, live in water, alive plant tissues and rotten organic matter. Moreover, they live as parasites or parasitoids of several animals. These larvae need a humid and wet atmosphere. In addition, the eggs these species hatch in water surfaces and larval stage occurs on the water surfaces. Maximum larvae live freely, also can be found in water, sediments, trees, fruits or decaying biological material, while other larvae are found in the tissues of living beings [2].

## **3. Life cycle of Diptera insects**

Diptera insects are holometabolous (complete metamorphosis) which means that they have 4 stages in their life cycles (adult, egg, larvae and pupae). Adult females lay their eggs and the amounts of eggs vary according to species. The females of some species lay a few eggs, some other lay thousands of them. Generally, females lay their eggs near the water and lay them as a group or singly.

### **3.1 Egg**

The eggs are laid grouped or individually by adult females, and the females usually lay their eggs in water and are sometimes attached to materials. Except for diapause eggs, eggs tend to stand only last for a few days, which are used to prevent lack of water or unwanted temperatures in the ecosystem [4].

Mosquitoes which belong to the order of diptera and Culicidae family, lay their eggs in bunches or can lay singly in or near water (**Figure 1**). In contrast, some dipteran insects such as Olive fruit fly (*B. oleae* Rossi) (**Figure 2**), Medfly (*C. capitata* Wiedeman) which belong to the Tephritidae family and Spotted wing Drosophila (*D. suzukii* Matsumura) which belongs to Drosophilidae family, lay their eggs inside the developed fruits.

Usually, adult flies lay their eggs, which will pass into the larval stage within a few hours or days after hatching. Amounts of eggs which are laid by adult females vary between 1 and 250. However, multiple sequential egg batches can be made. Females of Medfly lay 300 eggs in her lifetime. Besides, the Green bottle fly (*Lucilia sericata* Meigen) lay about 2000 eggs in confinement. However, in a casual environment where energy and time are beginning to look for suitable areas to lay their eggs, the total number may be less than 1000 [2].

### 3.2 Larvae

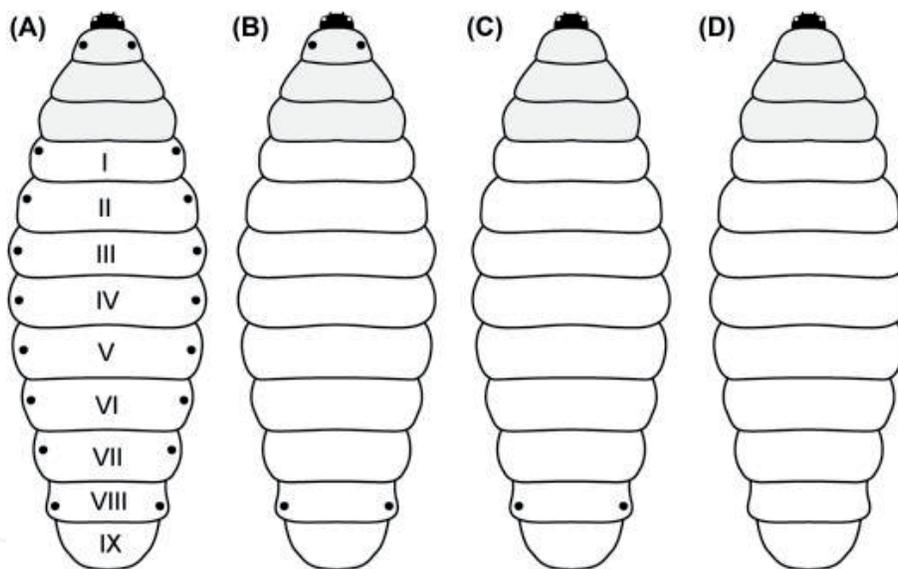
Larvae of dipteran insects are easily known by the absence of thoracic structures (legs). This type of larvae is called Apod larvae. Body parts of larvae are usually fleshy (thorax and abdomen). The whole body of larvae is tubular and long. Larvae are approximately 2 or 25 mm, but some species can be reached about 10 cm length. There are 12 segments in the bodies of larvae and that segmentation pattern is most common. 3 of them is found in thorax and 9 of them in the abdomen [4]. Some true midges, commonly seen in anoxic habitats such as blood worms, have an pigment which has invertebrate form and respiration function. This is called “hemoglobin” that helps to capture oxygen molecules [4] (**Figure 3**). After the eggs hatch, the larvae of the maximum species pass 3 to 4 stages on land or close to the bottom or above the water surface. For instance, females of Olive fruit fly And Spotted wing Drosophila lay their eggs inside the developing fruit [5] (**Figures 4 and 5**). After the emerging of larvae, they consume the rotten material in which they are laid. They eat more foods to store energy and nutrients for pupa stage [1]. Larval period is completed from nearly 2 weeks to several months. Larvae of Diptera insects do not have wing pads but are found in pupae [4]. Respiration process takes place above the skin of many larvae of dipteran insects. There are small gills above the skin of some



**Figure 1.**  
*Standing water mosquito and eggs.*



**Figure 2.**  
*Egg of olive fruit fly inside olive fruit.*



**Figure 3.**  
*Places of respiratory spikes in Diptera larva. (A) Peripneustic, (B) Amphipneustic, (C) Metapneustic, (D) Apneustic.*

taxa. Other larvae of dipteran insects have spikes and they absorb oxygen from atmosphere by using long or short breathing tubes.

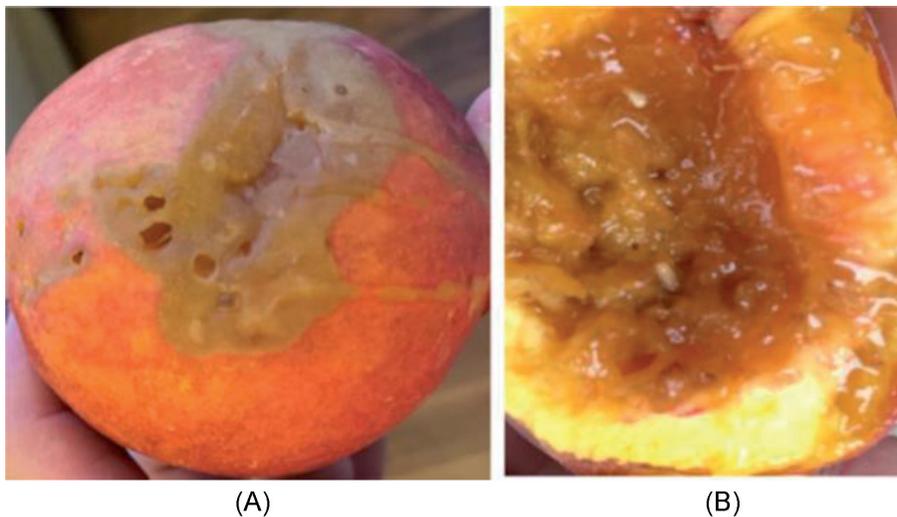
### 3.3 Pupae

Pupae of dipteran insects have a non-functional mandible (adecticeous). Their appendages can be independent from their body (externally) or attached to the body (obtect). Pupae of exarate types are hidden inside the hardened skin (puparium) of the final stage of larvae [2].

The pupae stage of dipteran insect varies significantly in shape. The pupae of some flies look like cross shape between larvae and adult, while other pupae shape of flies are featureless and they have a structure similar to seeds. The first forms are typical for Nematocera and are defined as having obtect or body-attached



**Figure 4.**  
*Larva of the olive fruit fly.*



**Figure 5.**  
*Spotted wing drosophila: (A) egg-laying areas and (B) larvae of spotted wing drosophila.*

appendages. For example, the pupae of a Crane fly (Tipulidae) have identifiable head, thorax and abdomen, but covers of antennae, legs and wing pads attach to the body of pupae. The exterior of the Nematocera pupa can be decorated with spines, breathing apparatus which are similar to gill or locomotory paddles.

Brachycera and Cyclorrhapha form the pupal stage in a different and more discreet way. The so-called higher Diptera family produces pupae that are described as coarctates, meaning “compressed” or “constricted”. These taxa (eg Syrphidae, Drosophilidae, Muscidae) form a puparium consisting of hardened skin of the late larval stage [6] (**Figure 6**). The pupation of some flies occurs in the olive fruit or under the soil [5]. After the oviposition, the eggs hatch and the larvae feed on the fleshy part of the fruit, but leaves the fruit when ripe and some continue to appear inside the fruit. Larvae fall to the ground and pupation takes place in the soil [7].

### 3.4 Adult

Adults of dipteran insects have segmented body which includes head, thorax and abdomen parts. They have compound eyes which are found both side of head [1]. The size and shape of compound eyes are highly variable.



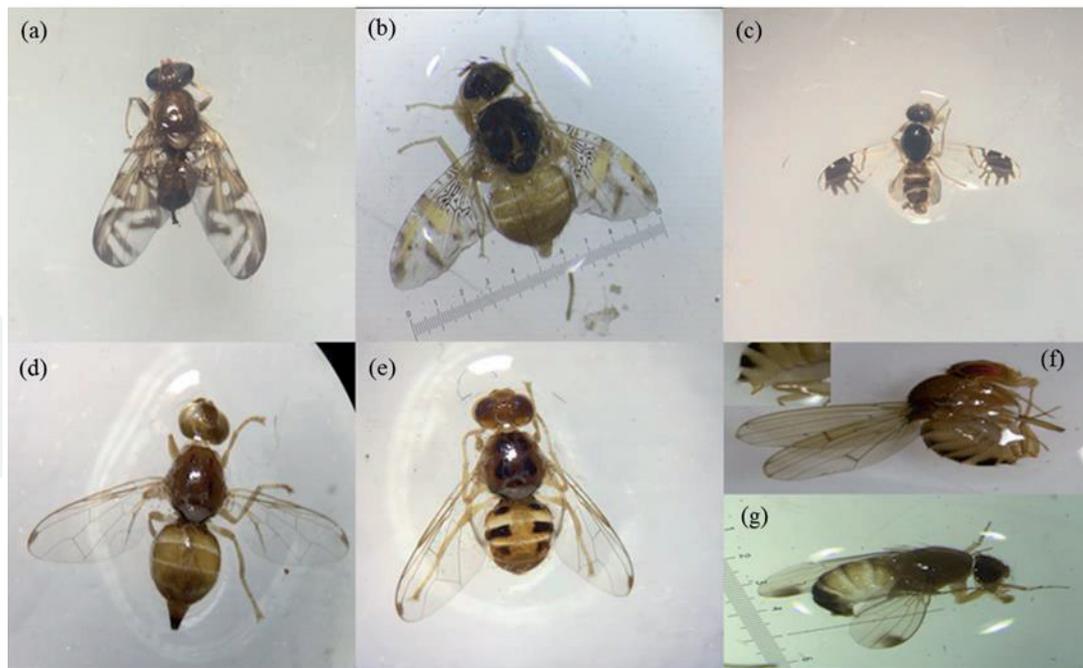
**Figure 6.**  
Female, serrate ovipositor, male with typical black spots, larvae inside the fruit and pupae of Spotted wing *Drosophila*.

Adults have dark reddish to black color compound eyes. Some families of dipteran insects have crossbands or spots of different colors such as Tabanidae, Syrphidae, Tephritidae, Sciomyzidae families [8].

There is small space in front of the head of adult dipterans. The function of this small space is to help the adults to see wider area when insects fly. Body color of adults changes from brown to black, orange or yellow, depending on the dipteran species [1]. For instance, body color of adults of *B. oleae* is brown and there are black spots in two sides of thorax and abdomen parts (Figure 7).

Thorax color of Spotted wing *Drosophila* is pale brown and there are horizontal black lines in the abdomen. Males have spots on their wings. Adult males of the *D. suzukii* are easily recognized a single black spots which are found on the outer edges of wings. Furthermore, two dark spots (sex comb) are found both of the forelimbs. Adult female of *D. suzukii* has a long, sclerotic, serrated ovipositor, unblemished open wings and comb on their feet [9] (Figures 7 and 8). Adult females of dipteran insects have ovipositor which is found at the end of abdomen. Females use this organ to lay their eggs inside the fruit. Females of OFF and Medfly lay their eggs (oviposition) inside the mature fruits by using their ovipositors.

Length range varies of adults varies according to dipteran species between 1 to 12 mm, but relative huge species are between 25–60 mm [4]. Sensory organ is found in front of the head of adults which is called antennae. Antennae are filiform



**Figure 7.**  
 General view of fruit fly adults. *Euleia heraclei* (a), *Ceratitis capitata* (b), *Trupanea amoena* (c), *Bactrocera zonata* (d), *Bactrocera oleae* (e), *Drosophila suzukii* female and serrated egg laying organ (f) and male (g).



**Figure 8.**  
 Spotted wing drosophila: (A) the black spots in the wings of male, (B) female, (C) egg laying organ (ovipositor) of female.

and front wings are developed to fly and hind wings are undeveloped (halteres) to balance when insects fly and tarsi 5-segmented [2].

#### 4. Conclusion

Dipteran order has 125,000 insect species and is one of the biggest order throughout the world and is highly diverse. Diptera order has the fourth place after the Lepidoptera, Hymenoptera and Coleoptera. Houseflies, hoverflies, mosquitoes and fruit flies are the most important species which belong to the diptera order. Fruit flies cause destructive damages in agricultural production. Besides, houseflies transmit serious diseases by carrying disease organisms onto food such as cholera and dysentery. Mainly, adult hoverflies consume pollen grains. Larvae of some species feed on rotten plant and animal materials in lakes, streams and ponds or inside the soil. Another species of hoverflies's larvae are predators and feed on some harmful insects such as aphids and thrips etc. So, the larvae of these species are used in the biological control of harmful insects as natural enemies. The females

of mosquitoes have piercing-sucking mouthparts and suck the blood of human, livestock and animals by using their mouthparts. Mosquitoes are vector insects and cause the spread of serious illnesses such as malaria and leishmaniasis etc. Many of the flies which belong to Tephritidae and Drosophilidae families, cause serious damages in the agricultural production such as Olive fruit fly, Medfly, Peach fruit fly, Celery fly Spotted wing drosophila. Dipteran insects can be recognized by some features such as developed membranous front wings and hind wings are undeveloped and called "halteres" which have functions as balancing when insects fly. Dipteran insects have complete metamorphosis (holometabolous) life cycle which means that there are 4 stages (egg, larvae, pupae, adult). Females of the adults lay their eggs into the food source or water. Eggs hatch and larvae complete their development. Pupation occurs under the soil, plant and animal tissues and water. The richness of the species in this order, the living in different ecological conditions and the morphological differences show people that this order is economically important and externalizes the diversity of invertebrate creatures in the world. There are insects in the Diptera order that cause serious problems in human, animal health and agricultural production. It is important to know the life cycles and habitats of these insects. Accordingly, the issues are followed (life cycle and habitats) to minimize disease transmission and damage in agricultural production. Another studies which will do in the future, will be useful in determining the economic effects of diptera insects on human health and agricultural production.

### **Conflict of interest**

Author has no conflict of interest.

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