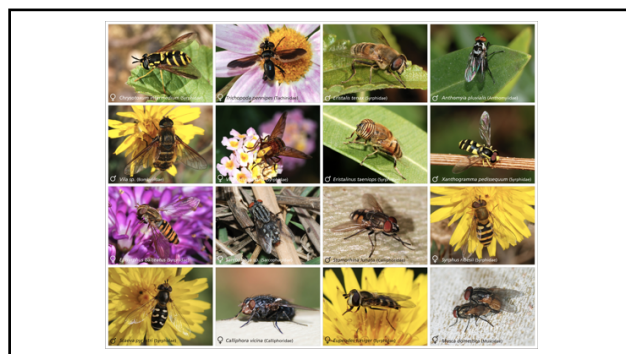




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2

**Diptera**  
Derived from the Greek words: "di" meaning two, and "pteron", meaning wing.

All Diptera adults have **only one pair of fully developed wings**: the hind pair is entirely absent or reduced to small balancing organs called **halteres**.

**This is the major diagnostic character for the order.**

3

**Diptera**

- Common name: **Flies**
- Nearly **150,000** species have been described worldwide ca.19,500 occurring in N. America (**4th largest order**).
- However, some specialists estimate that there may be more than **1,000,000** Diptera species in the world.
- Views on Diptera classification have changed a lot in the last two-three decades.

4

### Diptera

- No current consensus pertaining to higher ranks assigned to different groups.
- Until a new consensus is reached many taxonomists still follow the general classification presented by **McAlpine et. al.** in **The Manual of Nearctic Diptera 1981-1989** with the realization that there are paraphyletic groups within traditionally recognized suborders that need to be sorted out.

5

### Diptera

**Monophyletic** taxon is defined as one that includes the **most recent common ancestor** of a group of organisms, **and all of its descendants (a)**

A **polyphyletic** taxon is defined as one that **does not include the common ancestor** of all members of the taxon **(b)**

**Paraphyletic** taxon as one that includes the most recent common ancestor, **but not all of its descendants. (c)**

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Concepts of monophyly, polyphyly, & paraphyly

6

### Diptera Suborders

- Diptera is divided into two suborders.
  - Nematocera** ~ **lower Diptera**
  - Brachycera** ~ **Higher Diptera**
- Earlier classification systems included two other suborders:
  - Orthorrhapha**
  - Cyclorrhapha**
  - (both fall within Brachycera)
- So
  - Nematocera**
  - Brachycera** (Orthorrhapha, Cyclorrhapha)

7

### Nematocera Lower Diptera

- Contains the oldest families of Diptera.
- Most adults are small delicate flies with 6-14 segmented antennae of simple structure.
- 3-5 segmented maxillary palps.
- Larvae have a well-developed head and chewing mouthparts that move in a horizontal plane.

8

### Brachycera Higher Diptera

- Adults are rather stout flies with antennae having fewer than seven segments.
- Often with an **arista** (specialized bristle or hair like process on the antenna) or style
- **Maxillary palps are unsegmented.**
- Larvae are maggot-like, with sickle shaped mandibles that move in the vertical plane.



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### Economic Value of Dipterans

- No animals, **except perhaps humans themselves**, are responsible for greater loss of human life and economic loss than Diptera.
- More than **50% of the world's population** is diseased from fly-borne pathogens and parasites.
- Diseases vectored by Diptera have **changed the course of battles** and retarded the economic development of many societies.
- Agricultural losses suffered each year because of pest flies are exceeded by only several other orders.

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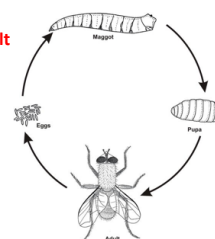
### Economic value of Dipterans

- On the other hand, extremely **beneficial species** exist:
  - i.e., as parasitoids and predators of other insects Diptera rank in value with the Hymenoptera.
- The role of flies in the **debris cycle—processing** dead plant and animal material is exceeded only by that of bacteria and fungi.
- Flies also play an important role as **pollinators**.

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### DIPTERA: Biology and Ecology

- Holometabolous: **egg, larva, pupa, adult**



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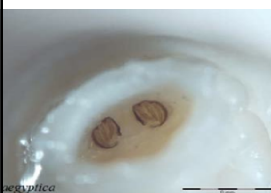
**LARVAE**



- Variation is so great among larval morphological characters that no one character or group of characters can separate all Diptera larvae but is found in some other insect orders is the **absence of jointed thoracic legs** (prolegs are present in some species).
- This coupled with the fact that **most free-living Diptera larvae are elongate-narrow/ cylindrical with active directional movement will distinguish most larvae as Diptera.**
- Most legless larvae of other orders are rather swollen and movements if any are slow and undirected.

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**LARVAE**



- Diptera larvae have **spiracles present or absent**
- Configuration of spiracles**, including number and shape of openings, and their location are important characters used to identify larvae.
- If more than one pair of abdominal spiracles is present, the **posterior pair is larger than the other, and usually faces posteriorly.**
- The posterior pair is usually bordered by accessory lobes or situated in a tubular projection.**
- In other orders the posterior spiracles are usually located laterally on segments without bordering lobes and are similar in size to other spiracles.

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**LARVAE**

- Lower Diptera (Nematocera)** go through 4-9 larval instars (usually 4) while **higher Diptera (Brachycera)** only have 3 larval instars.
- Development can be as short as 2 days in carcasses or as long as 2 years in cold wet habitats.
- Diptera larvae have antennae (usually relatively short) that are 1-6 segmented, although most species have no more than 3 segments.

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**Larval habitat**

- Over 50% of Diptera larvae are aquatic, which includes most members of Nematocera, and Brachycera.
- Even the terrestrial species are usually found in moist places.
- Most Diptera larvae are extremely limited by dry conditions.
- Most aquatic larvae are burrowing detritivores and carnivores in bottom sediments, or herbivores in aquatic plant stems, leaves, or roots.

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### Larval habitat

- Many terrestrial larvae are stem, leaf, or root miners;
- some cause gall formations.
- Some terrestrial groups are associated with decaying animal or plant matter.
- Terrestrial larvae can be detritivores, predacious or parasitic on other invertebrates and vertebrates including humans.

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### Immature Diptera Morphology/Terminology

#### Head:

**Nematocera: Eucephalic:** well-developed, fully head capsule; mandibles with teeth operating in a horizontal plane

**Orthorrhaphous Brachycera: Hemicephalic:** head is reduced or incomplete posteriorly and partially retracted within the thorax; sickle-shaped mandibles are present that operate in a vertical plane

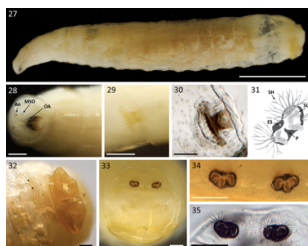
**Muscomorpha (= cyclorrhaphous Brachycera): Acephalic:** further reduction and loss of sclerotization of the external parts of the head; almost complete retraction within the thorax; internal cephalopharyngeal skeleton (sclerotized largely internal structures of the head that include the mandibles and several sclerites).



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### Ecdysial scar:

Place where the trachea of the pervious instar was withdrawn molting, leaving a sealed conspicuous spot



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### Symmetrical spiracles:

A uniform series of small spiracular openings surrounding one or more ecdysial scars, or a simple central spiracular opening surrounded by a rather uniform sclerotized collar.



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**Asymmetrical spiracles:**

most common within Diptera; three or more spiracle openings are dominantly to one side of the ecdysial scar.

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**Apneustic:** no functional spiracles

**Amphipneustic:** one pair of thoracic spiracles and one or two posterior pair of abdominal spiracles are open and functional

**Hemipneustic:** spiracles are present on the thorax and abdominal segments 1-7

**Holopneustic:** all spiracles are open and functional

**Metapneustic:** only the last pair of spiracles are functional (open)

**Peripneustic:** Nine pairs of functional spiracles, one on the thorax and eight on the abdomen.

**Propneustic:** only the first (anterior) pair of spiracles are functional

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**Pupae**

Dipteran pupae are always **adecticous** (no functional mandibles).

- Nematocera, and orthorrhaphous Brachyceran form **obtect** pupae (appendages are tightly pressed to the body).
- Muscomorpha pupae are secondarily **exarate** (legs and wings are free from the body) and **coarctate** (enclosed in a puparium [hardened cuticle of the third larval instar]).

**EXARATE**      **PUPAE**      **Nematocera**

**Brachycera**      **OBTECT**

**COARCTATE**

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**Key Families**

**Nematocera**

- Tipulidae (Crane flies):**
  - This is a very diverse group and the largest family in Diptera.
  - Adults are short-lived and usually do not feed; however, several species are nectar feeders.
  - Larvae are sometimes called **leatherjackets**; many larvae are elongate/ cylindrical, often with flesh projections surrounding the caudal spiracle disc.
  - Most larvae are found in aquatic or semiaquatic environments, or live in decaying vegetation. A few species live under bark or in fungi, others are leaf feeders (particularly violets).

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### Tipulidae (Crane flies):

- Most larvae are saprophagous on organic matter, but some species are specialized (e.g., herbivores, lepidopteran larvae, and some species are predacious).
- Most species are of no economic importance. The European crane fly, *Tipula paludosa*, is a serious pest of grain, turf, or gardens.



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### Chaoboridae (Phantom midges):

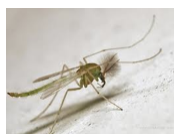
- Chaoborids are closely related to Culicidae; adults are small mosquito-like flies but have a short proboscis and only marginal wing scales.
- Larvae are aquatic and are good general predators (Culicidae, other invertebrates).
- Larvae have prehensile **antennae** (antennae are adapted for wrapping around prey, apical spines are also present on antennae for grabbing prey), a broad head, and a distinctly enlarged thorax composed of fused segments.
- Some species have translucent air sacs giving them a translucent appearance and the common name **phantom midges**. Larvae are also known for vertical movements in the water column over 24 cycle.



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### Chironomidae (Midges):

- Adults are delicate flies without a proboscis and they do not bite or take blood meals.
- Most adults are assumed not to feed; however, there are a few reports of adults ingesting honeydew.
- Chironomids can be seen in immense mating swarms which are composed of almost all males; females dart into the swarm and then mating begins (swarms can be pestiferous along lakes).
- Adults at rest often raise the front legs and vibrate the legs.



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### Chironomidae (Midges): Larvae

- Larvae are aquatic or semiaquatic. Many species construct cases of fine substrate materials bound together by a salivary secretion; most larvae are microphagous—feeding on finely divided detritus, algal cells, and small animals.
- Larvae of *Tanypodinae* are predacious. Larvae are recognized by the completely exerted head capsule, paired prolegs on the prothorax, and often on the caudal segment, and an apneustic respiratory system.

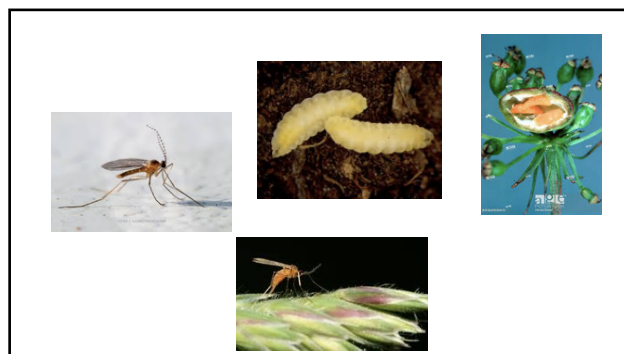


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### Cecidomyiidae (gall midges):

- Larvae of 2/3 of the N. American species make galls on plants.
- The form of the gall is often characteristic of the specific fly causing the plant deformation.
- The complex relationships between gall midges and host plants has generated a lot of interest among plant scientists and ecologists.
- Many other cecidomyiid species live in decaying organic matter, some species are fungal feeders, some species are predacious (mites, insect larvae, aphids and psyllids, and several species live with ants or termites.
- Adults of many species form mating swarms. Larvae have a cone-shaped head; most larvae have a sclerotized, apically forked spatula on the ventral surface of the prothorax and are often brightly colored, orange, pink, yellow.

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### Cecidomyiidae (gall midges):

- Larvae of some fungus-feeding species reproduce themselves.
- Daughter larvae will form inside a mature larva which eventually consume the mature larva.
- This process may be repeated for several generations until the last larvae pupate. This process maximizes production of adults and possibly overcomes to some extent the risks involved in locating and surviving on a rare and patchy larval host.
- Important species of economic importance: Hessian fly, *Myetiola destructor* (say) in winter wheat; alfalfa gall midge, *Asphindylia websteri* Felt; sorghum midge, *Contarinia sorghicola* ( Coquillett); guar midge, *Contarinia texana* ( Felt)

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### Other families include

- Culicidae (mosquitoes);




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**Suborder Brachycera**  
**Xylophagidae:**

- Xylophagids are relatively un-common flies of medium to large size.
- They are black, sometimes marked with yellow, or all reddish yellow.
- They usually live in wooded areas, and feed on sap or nectar. The larvae live in the soil *and decaying logs*



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**Suborder Brachycera**  
**Stratiomyidae : Soldier Flies**


- This is a fairly large group most of which are medium-sized or larger and usually found on flowers.
- Many species are brightly colored and wasp like in appearance. The larvae live in a variety of situations.
- Some are aquatic and feed on algae, decaying materials, or small aquatic animals; some live in dung or other decaying materials, some live under bark, and others are found in other situations.



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**Suborder Brachycera**  
**Xylomyidae**


- These are rather slender, wasp-like flies, 5-15 mm long, rather brightly colored with pale markings on blackish background.
- The most common flies in this small group are the species of *Xylomyia*, which are slender and ichneumonid like.
- The xylomyids are usually found in wooded areas. The larvae live under bark, and are predaceous or scavengers.



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**Suborder Brachycera**  
**Rhagionidae -Snipe Flies**

- Snipe flies are medium-sized to large, with the head somewhat rounded, the abdomen relatively long and tapering, and the legs rather long.
- Many species have spotted wings.
- The body may be bare or covered with short hair.
- Most snipe flies are brownish or gray, but some are black with spots of white, yellow, or green.
- They are common in woods, especially near moist places, and are usually found on foliage.
- Both adults and larvae are **predaceous** on a variety of small insects



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### Suborder Brachycera

Tabanidae-Horse Flies and Deer Flie

- About 350 species of tabanids occur in North America.
- They are medium-sized to large, rather stout-bodied flies.
- The females are **bloodsucking** and are often serious pests of **livestock and people**.
- The males feed chiefly on pollen and nectar and are often found on flowers. The two sexes are very easily separated by the eyes, which are contiguous in the males and separated in the females.
- The eyes are often brightly coloured. The larvae of most species are aquatic and predaceous, and the adults are generally encountered near swamps, marshes, ponds, and other situations where the larvae live.
- Most horse flies are **powerful fliers**, and some species apparently have a flight range of **several kilometres**.

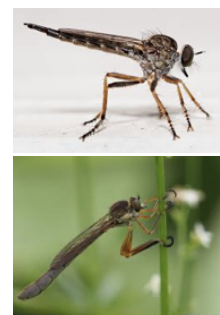


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### Suborder Brachycera

Asilidae : Robber Flies and Grass Flies

- This is a large group, which are quite common.
- The adults can found in a variety of habitats, but each species usually lives in a characteristic type.
- Adults are **predaceous** and attack a variety of insects, including wasps, bees, dragonflies, grasshoppers, and other flies.
- They often attack an insect as large as or larger than themselves.
- Most asilids capture their prey on the wing, but the grass flies (Leptogastrinae) usually attack resting insects.
- Some of the larger robber flies can inflict a painful bite if carelessly handled.

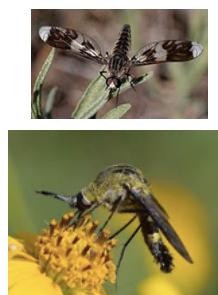


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### Suborder Brachycera

Bombyliidae-Bee Flies

- Bee flies are fairly common insects, probably more common in the arid areas.
- Most are stout-bodied, densely hairy flies of medium to large size.
- A few are slender and not very hairy, and some are very small.
- Many have a long, slender proboscis.
- Bee flies are found on flowers or hovering over or resting on the ground or grass in open sunny places.
- Bee fly larvae, as far as known, are either **parasitic** on the immature stages of other insects (Lepidoptera, Hymenoptera, Coleoptera, Diptera, and Neuroptera), or **predaceous** on grasshopper eggs.



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