Chapter XII —Order Diptera 

(Two-winged or "true flies") (Flies, Mosquitoes, Midges)

- (Williams & Feltmate, 1992)
  - Superphylum Arthropoda
    - (jointed-legged metazoan animals [Gr, *arthron* = joint; *pous* = foot])
  - Phylum Entoma
  - Subphylum Uniramia
    - (L, *unus* = one; *ramus* = branch, referring to the unbranched nature of the appendages)
  - Superclass Hexapoda
    - (Gr, *hex* = six, *pous* = foot)
  - Class Insecta
    - (L, *insectum* meaning cut into sections)
  - Subclass Ptilota
  - Infraclass Neopterygota

The Diptera, or true flies, are a large order of endopterygote Neoptera. It is estimated that the order contains about 200,000 species, worldwide, although only just over half of these have been described. Clearly, the Diptera have been much more successful than their presumed sister-group, the Mecoptera (scorpionflies) which has less than 400 described species.

Aquatic dipterans represent some of the best known insect forms, including mosquitoes, black flies, midges, crane flies and horse flies, many of which are the most troublesome of all insect pests, particularly in terms of human health and economics. Despite this, many groups of aquatic Diptera play pivotal roles in the processing of food energy in aquatic environments and in supporting populations of fishes and waterfowl.

Approximately 10% of all dipteran species are aquatic in their larval stage. Eggs and pupae of these species are also aquatic, whereas adults are always terrestrial.

Some 32 families of Diptera contain species whose larvae are either aquatic or semiaquatic. These are contained in two suborders, the more primitive **Nematocera** (literally translated as "thread-like horn", and referring to the nature of the adult antenna), and the **Brachycera** ("short horn"= short antenna). Detailed coverage will be confined (in separate files) to five groups that are important from ecological and/or human welfare perspectives, namely the **Chironomidae (midges), Culicidae (mosquitoes), Tipulidae (crane flies), Simuliidae (black flies), and Chaoboridae (phantom midges)**.

Life History

Egg-laying behavior is diverse in the aquatic members of this holometabolous order. Some scatter eggs just below the surface on vegetation or on mineral substrates; others deposit eggs in gelatinous masses at, below, or above the water surface on emergent objects.

The number of larval instars varies among dipterans; nematocerans have 4, cyclorrhaphans have 3, and orthorrhaphans may have 8 or 9. Larval stages as short as several weeks and as long as two years have been reported, depending on the species, water temperature, and food conditions. The pupal stage lasts approximately two weeks, except in species that overwinter as pupae. Most species overwinter as hibernating eggs, as larvae, or, rarely, adults. Some arctic chironomid larvae coil up in cocoons and overwinter under freezing conditions.

Females of many species are anautogenous, requiring a blood meal to acquire enough protein to produce eggs (Ceratopogonidae, Culicidae, Simuliidae, Tabanidae), and some are vectors of animal or human diseases or both.

Mating of many nematocerans and some brachycerans (e.g., Tabanidae) occurs in swarms. Some species swarm over sand or cow dung or many objects that serve as swarm markers; others swarm around their hosts for both mating and feeding. After mating occurs, females leave the swarm to oviposit. Males of some empidids offer nuptial gifts (usually food) to their mates and copulate while the females are eating.

Most aquatic dipterans are univoltine, but under favourable conditions some may complete more than one generation a year. Some species may take two or three years to complete development in colder climates. One arctic chironomid is reported to have a seven-year life cycle.

Habitat and Distribution

It is evident that the Diptera or two-winged flies are by far the most diverse order of insects in fresh water; they are in fact the most diversified of any major taxon of freshwater organisms. The aquatic legless larvae of the Diptera certainly outnumber, in both individuals and species, all the other aquatic insects taken together. The separation of the Diptera, as potential or actual inhabitants of deep water, from the other orders of immature aquatic insects is justified by the fact that an elaborate classification of lake types has been built upon the ecology of the deep-water Chironomidae (true midges) and their associated organisms. The question as to why, among all the aquatic insects with gills, this family of Diptera has alone significantly exploited the depths of lakes is of considerable interest. Because they are the only order that has become fully emancipated from restriction to quite shallow littoral waters, the problems that the Diptera present may often be quite different from those posed by other aquatic insects. Though some, such as the mosquitoes, have larvae that surface for air, the existence of dermal respiration often involving some sort of blood gill is usual in the order and has evidently permitted it to extend far into the profundal region of bare sediment. The generally small size, at least in the lacustrine Diptera, is doubtless important in this invasion.

Dipteran larvae occur in almost every conceivable aquatic habitat, from the bracts of pitcher plants (Culicidae: *Wyeomyia*), tree holes (e.g., Chironomidae and Culicidae), saturated soil, and mud puddles, to streams, ponds, large lakes, rivers, and even the marine rocky intertidal zone. Stratiomyids have been recorded from geyser-fed thermal pools that reach temperatures up to 49 deg. C, and ephydrids from natural seeps of crude petroleum. Dipterans are found in rushing streams (Blephariceridae, Deuterophlebiidae), stagnant pools, hot springs, and frozen sediments. The only aquatic habitat where dipterans have not been recorded is the open ocean.

They are classified as clingers, sprawlers, planktonic swimmers, burrowers, climbers, and miners.

Table XII-1: Families of Diptera that contain aquatic or semiaquatic species, together with descriptions of larval habitats (Williams & Feltmate, 1992)

Family	Distribution and Habitat
Suborder - Nematocera	
Infraorder Tipulomorpha	
Superfamily Tipuloidea	
Tipulidae	(crane flies)- fast & slow-flowing streams & rivers; springs; hygropetric habitats; ponds & lakes, esp. in shallow water; fresh & brackish water marshes; wet moss; tree holes & other phytotelmata; marine intertidal zone; saturated soil; temporary pools; floodplains
Infraorder Psychodomorpha	
Superfamily Blephariceroidea	
Blephariceridae	(net-winged midges)- fast-flowing, cool streams, generally at high altitude
Deuterophlebiidae	(mountain midges)- fast-flowing, cool streams, generally at high altitude
Nymphomyiidae	among moss in cool, fast-flowing streams
Superfamily Tanyderoidea	
Tanyderidae	(primitive crane flies)- shallow water at margins of stream & rivers
Ptychopteridae	
Ptychopterinae	drainage ditches, esp. those contaminated with manure; beaver ponds
Bittacomorphinae	(phantom crane flies)- very shallow woodland pools
Superfamily Psychodoidea	
Psychodidae	(moth flies)- fast streams, esp. margins; littoral zone of lakes, esp. in detritus; marine beaches
Infraorder Culicomorpha	
Superfamily Culicoidea	
Dixidae	(dixid midges)- sheltered regions of streams, also in detritus; pond & lake at margins or under surface film
Chaoboridae	(phantom midges)- lakes in profundal, littoral or open water zones; boggy pools; temporary fresh waters; small springs, esp. limnocrenes
Culicidae	(mosquitoes)- ponds & lakes; pools and slow sections of streams & rivers; bogs; marshes; woodland pools; temporary waters; salt marshes; marine rockpools; phytotelmata; water tanks; small container habitats e.g. tin cans, tires, bottles, coconut shells
Superfamily Chironomoidea	
Thaumaleidae	(solitary midges)- hygropetric habitats; small, cold streams, esp. margins; wet moss
Simuliidae	(black flies)- fast-water regions of streams & rivers; wave-swept, littoral zone of large lakes
Ceratopogonidae	(biting midges, no-see-ums)- littoral & open water zones of lakes, also at margins esp. in algal mats; streams & rivers, esp. margins & in detritus; tree holes; temporary pools; moist soil; salt marshes; marine beaches; some species associated with pollution
Chironomidae	(midges)- most types of waterbody, including intertidal rockpools & coral reefs; moist soil; phytotelmata; dung
Suborder - **Brachycera**	
Infraorder Tabanomorpha	
Superfamily Stratiomyoidea	
Stratiomyidae	(soldier flies)- streams & rivers, esp. margins; littoral zones of ponds & lakes, esp. around submerged & emergent macrophytes; hot

Family	Distribution and Habitat
	springs
Superfamily Tabanoidea	
Rhagionidae	(snipe flies)- moist soil & moss in woodlands
Pelecorhynchidae	small, foothill streams, on sand substrates
Tabanidae	(horse & deer flies)- wetlands; littoral zones & margins of ponds & lakes; damp soil; slow-water regions of streams & rivers; tree holes; marine beaches; estuaries
Athericidae	streams & rivers
Infraorder Asilomorpha	
Superfamily Empidoidea	
Empididae	(dance flies)- streams & rivers, esp. in detritus; littoral zones of ponds & lakes; wet soil
Dolichopodidae	margins of ponds, lakes, rivers & streams; leaf-miners in aquatic macrophytes; marine intertidal; estuaries
Infraorder Cyclorrhapha	
(Section Aschiza)	
Superfamily Phoroidea	
Phoridae	(humpback flies)- burrowers; predators on Psychodidae
Superfamily Syrphoidea	
Syrphidae	(rattail maggots, flower flies)- pond & lake margins, esp. in fine particle detritus & on water plants; shallow marsh & bog pools; tree holes; polluted water
(Section Schizophora: Subsection Acalyptratae)	
Superfamily Sciomyzoidea	
Coelopidae	(seaweed flies)- breed in decaying seaweed around the high water mark
Dryomyzidae	moist places, including the seashore
Sciomyzidae	(marsh flies)- marshes; margins of streams, ponds & lakes, esp. near emergent macrophytes; temporary ponds; salt marshes; larvae predators or parasites of aquatic & terrestrial snails
Sepsidae	(black scavenger flies)- decaying organic matter; terminal drying phase of temporary pools; dung
Superfamily Heleomyzoidea	
Sphaeroceridae	(small dung flies)- decaying organic matter; terminal drying phase of temporary ponds; dung; septic tanks; wet waste disposal sites
Superfamily Drosophiloidea	
Ephydridae	(shore flies, brine flies)- littoral zones & margins of lotic & lentic habitats, often near or within stems of aquatic macrophytes; temporary waters; saline lakes & pools; salt marshes; marine intertidal; pools of crude petroleum; hot springs
Canaceidae	(beach flies)- on algae in intertidal zone
(Section Schizophora: Subsection Calyptratae)	
Superfamily Muscoidea	
Scathophagidae	(dung flies)- burrowers in tissues of aquatic macrophytes in lakes & ponds; in rotting seaweed; damp soil; sewage treatment beds
Anthomyiidae	(root maggot flies)- littoral zones of lakes & ponds, often those that have been enriched by organic wastes; tree holes; a few species in streams
Sarcophagidae	(flesh flies)- semiaquatic; burrowers in macrophytes

Feeding

The dietary diversity of aquatic dipteran larvae parallels the habitat diversity. Some families are shredders of coarse particulate detritus (Tipulidae); others are specialized for filter feeding (Simuliidae). Some families are specialized scrapers (Blephariceridae), consuming periphyton and associated materials from the surface of the substrate of fast-flowing streams. Other families are predaceous. Representatives of every functional feeding group have been reported among the aquatic dipterans.

References

- Hutchinson, G. Evelyn 1993. A Treatise on Limnology. Vol. IV, The Zoobenthos. Ed. Y.H. Edmondson. John Wiley & Sons, Inc. Xx, 944pp.
- Narf, R. 1997. Midges, bugs, whirligigs and others: The distribution of insects in Lake "U-Name-It". Lakeline. N. Am. Lake Manage. Soc. 16-17,57-62.
- Peckarsky, Barbara L., Pierre R. Fraissinet, Marjory A. Penton, and Don J. Conklin, Jr. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell Univ. Press. xii, 442pp.
- Wetzel, Robert G. 1983. Limnology. Second Edition. Saunders College Publishing. Xii, 767pp., R81, I10.
- Williams, D. Dudley, and Blair W. Feltmate. 1992. Aquatic Insects. CAB International. xiii, 358pp.

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