BIOE 155
Freshwater Ecology

Larger Invertebrates (read 107-113)

BACKGROUND

Allochthonous—energy produced outside of ecosystem (e.g., leaf litter fall).

Autochthonous—energy produced within the ecosystem (e.g., phytoplankton, periphyton).

Functional feeding groups
Different taxa perform different functions in aquatic systems. They form an important component of the food web. For example, shredders break down leaves that fall into streams while scrapers use primary production.

Different streams will have different balances of these functional feeding groups, which can indicate the primary source of energy to the system.

Functional groups include:

- Scrapers—scrape off algae (many mayflies)
- Shredders—shred organic matter like leaves (many caddisflies)
- Collectors/filterers—collect fine organic particles (many diperans)
- Predators—eat other invertebrates (such as dragonflies)

LARGER INVERTEBRATES

There is a long history in stream ecology of studying benthic invertebrates. Benthic invertebrates are to streams what zooplankton are to lakes.

Types of larger invertebrates in lakes and streams.

MALACOSTRACAN

Includes:

- Crayfish—omnivorous (generalist) feeding habits.
- Shrimp (e.g., *Neomysis*)—can be zooplanktivorous, as observed in the Lake Washington example.
- Amphipods and Isopods—omnivorous.

These crustaceans can be important to food webs of both streams and lakes. In the U.S., they are important native and invasive species (e.g., crayfish). They can be both pelagic (such as *Neomysis*) and benthic (such as crayfish).

Life cycle: Separate sexes, no adult terrestrial phase, no diapausing stage. Can be long-lived.

BIOE 155
Freshwater Ecology

INSECTS (ARTHROPODA)

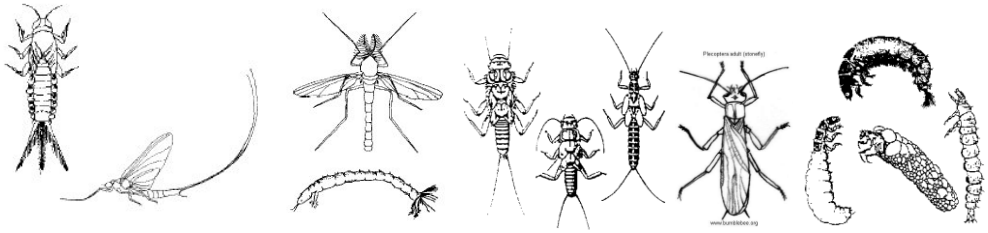
This is a diverse group. >5000 spp in the North America. Not surprisingly that they have a lot of different adaptations, feeding habits, and use lots of different habitats. Most of these are benthic, but there are numerous pelagic species, especially in lakes.

Important Orders:

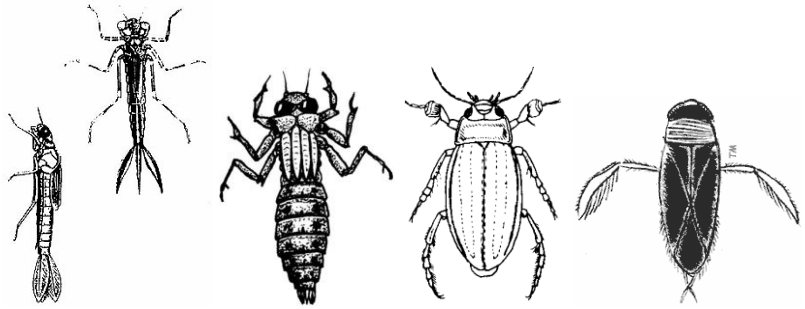
- Coleoptera—beetles. Often predatory. Adults have hard and shiny carapace.
- Diptera—flies and midges. Collector-gatherers, usually. (e.g., chironomid). Fairly tolerant to pollution and low O_2. Thin bodied, adults have delicate single pair of wings.
- Ephemeroptera—mayflies. Grazers often. Sensitive to pollution. Have two-three tails, adults have long tails, upright wings.
- Hemiptera—bugs (e.g., water strider, water boatman). Often predatory. Wings cross over forming a "V".
- Odonata—damselflies and dragonflies. Predatory. Often found in slower moving water and lakes. Shorter tails, as adults have 2 pairs of wings, adult wings either horizontal and perpendicular to body (dragonflies) or pointed back along abdomen (damselfly).
- Plecoptera—stoneflies. Often predatory. Found in fast, high O_2 water. Sensitive to pollution. Have two prominent antennae and two prominent tails and two pairs of wings. Adults have wings held tight along their abdomen.
- Trichoptera—caddisflies. Grazers and shredders. Sensitive to pollution. Grub-like as larvae, and sometimes live in houses they make. As adults, they look like moths with long antennae.

Some visual examples of key aquatic insect taxa:

Mayfly **Dipteran** **Stonefly** **Caddisfly**



Damselfly **Dragonfly** **Coleopteran** **Hemipteran**



Pictures from the web, mostly from: http:life.bio.sunysb.edu

Life cycle: Generally aquatic insects are sexual reproducers. Most of these groups have aquatic immature stages as larvae or nymphs, and adult stages that are terrestrial. The aquatic larval stages are usually longer-lasting than the adult terrestrial phase. For example, in mayflies the adults only live 24-48 hours and don't eat during this period. Many species lay diapausing. Because many of species have both terrestrial and aquatic life-stages, they connect aquatic and terrestrial habitats (see below).

MOLLUSKS

Bivalves (class)—clams and mussels
270 species
Gastropoda (class)—snails
500 species

Feeding: Bivalves and gastropods are generally scrapers/grazers as well as filterers.

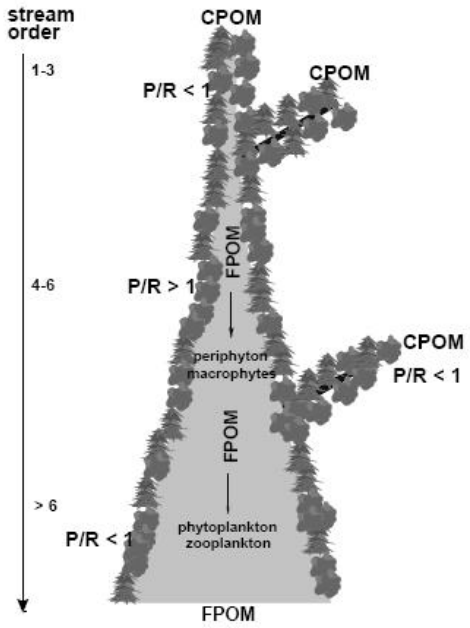
These contain important native and invasive species.

- Mussels are some of the most endangered taxonomic groups in North America.
- The New Zealand Mudsnail is invading North America, including local streams such as the San Lorenzo River. This is a tiny snail that can have large impacts.
    - It can reach extraordinarily high densities (100,000/m2)
    - Consume much of the available primary productivity.
    - Change nutrient cycling (excrete N)
    - Can survive being eaten by trout.

INVERTEBRATES--CONCEPTS AND APPLICATIONS

River Continuum Concept

A framework that describes how streams systematically as they change from small headwater streams to lowland rivers. As the river grows larger, the dominant source of energy systematically changes as well as the invertebrate community.
(Vannote et al. 1980)
(figure to the right is modified from Institute of Watershed Studies).
Given the different sources of energy across stream networks, which functional feeding groups would you expect in the different reaches?



BIOE 155
Freshwater Ecology

Benthic invertebrates as indicators of ecosystem health
Benthic invertebrates like caddisflies, mayflies, and stoneflies are extremely susceptible to degradation in water quality. In contrast, many dipterans are tolerant to low water quality. Thus, sampling the benthic invertebrate community is commonly used to monitor water quality.

Roles in food webs
Benthic invertebrates are critical in linking basal sources of energy (leaf fall, primary production) with upper trophic levels like fishes. Different invertebrates perform different functional roles (see above), and these different groups control different aspects of stream and lake ecology. For example, shredders are important in controlling the processing of organic matter.

Habitat coupling
The connection between two adjacent habitats, for example, aquatic insects connect freshwater and riparian ecosystems. Aquatic insect hatches are often important for riparian consumers such as spiders and birds.