Aquatic invertebrates & stream ecology
(Schlemon course March 2004)

PART 1.

I. Prologue: how inverts get into streams

- A. Fly
- B. Crawl (stream capture ,as for fish)
- C. Carried by birds
  - feet
  - resting stages in feces (also fish)
- D, Maintain upstream pops- same methods
  - Insects esp good- flying adults

II. Ways to classify stream invertebrates

- Taxonomic
- Habitat
- Functional groups
- Fish food vs non-fish food

III. Taxonomic

- A. Insecta
  - Ephemeroptera
  - Plecoptera
  - Trichoptera
  - Diptera
  - Coleoptera
  - Hemiptera
- B. Crustaceans
  - Amphipoda
  - Isopoda
  - "Zooplankton"
    - Cladocera, Copepoda
  - Decapoda
    - Crayfish (none in Skeena)
- C. Mollusca
  - Pelycepoda
  - Gastropoda
- D. Others

IV. Habitat

V. Habit

VI. Functional Groups

Part 2: Trophic relationships - themes from Chapter 6 in Allen (*Stream Ecology)*

I. Species-oriented food webs of limited value in understanding streams
- A. Most animal species, but esp. fish, feed at several levels, either as individuals or as life history stages
- B. On other hand, herbivore-carnivore-detritivore distinctions too general to be of much use
  crayfish: love to scavenge dead things, but will graze on algae and prey on small inverts and fish. Theo Light- crayfish may depress sculpin pops through combination of competition and predation
- C. Easier to talk about trophic guilds
  groups of species that feed on about the same things at the same time or feed in the same way - play the same trophic role.
  Not rigid- species can be in one guild at one time of year, on another later on.
  Crayfish- early in season may be primarily a grazer but become more of a predator when aquatic inverts become abundant.

II. Energetics approach useful for understanding trophic relationships
- A. R. Lindemann- Trophic-dynamic Concepts of ecology [in lakes]
- B. Producers vs Consumers

III. Producers - sources of energy for stream ecosystems
- A. Allocthonous sources
  1. Terrestrial veg
     Eaten directly?
  2. Bacteria “The microbial loop” p. 132
  3. Salmon carcasses

- B. Autochthonous sources
  1. Algae
     A. Periphyton
        Make rocks slippery
     B. Macroalgae
     C. Relatively few critters graze directly on these sources
        1. Plant walls hard to penetrate, cellulose hard to digest
        2. No native fishes in Skeena
           E USA - stoneroller, *Campostoma anomalum*
           Tropics- many fishes

  2. Macrophytes
     A. Fully aquatic to emergent

B. Surprisingly few aquatic critters eat them directly but major substrate for periphyton; important in detrital pool.
C. Lower river

III. Consumers of Coarse Particulate Organic Matter (CPOM)
A. CPOM major source of fuel for streams
1. Most of the carbon in forest stream ecosystems
2. Mostly leaves and wood
salmon?
3. Moving downstream- must be captured
1. Physical- debris jams, leaf jams
Depends on gradient, roughness, flow regime
2. Biological- insects

B. Major question: how does this happen? Leaves and wood hard to break down.
1. Shredders
A. Break up material into pieces
B. Chewers, scrapers, gougers
C. Chewers- grab on to leaf and chew all parts of it up
1. Usually larger sp. with low mobility: Tipulidae, limnephilid caddisflies- best known; often very abundant
D. Scrapers,
More mobile species that mainly eat the softer parts of the leafs, skip the veins and stems. Amphipods, some stonefly nymphs, midge larvae, snails
E. Gougers- eat wood. Wood, including twigs etc major potential source of carbon (up to half of material that falls into stream). Yet breaks down slowly, but does eventually- insects that can gouge out pieces and burrow into the water-logged wood
2. But how do insects manage to break down the material into energy and carbon?
1. Many aquatic inverts do not have gut laden with symbiotic protozoa like cows do. But some do. Tipulidae. Curiously, among the most efficient are amphipods *(Gammarus and Hyalella*.). Acidic foregut, basic hindgut with microbes for digestion.
2. As understanding grew, assumed that shredding breaks up material and increases surface area for optimal habitat for bacteria and fungi. Main food source is actually the bacteria and fungi. (Ken Cummins- Peanut butter and cracker analogy). Fecal material can be repeatedly processed. Turns out to be only partially true and fungi generally more important than bacteria.
3. But much of the energy actually comes from leaf material itself. How?
A. exozymes
B. self-manufactured cellulase- snails
C. Other methods- poorly understood

IV. Consumers of fine particulate organic matter (FPOM)

A. Detrital particles < 1mm; fragments of larger particles

B. Many sources, from fecal material of scrapers, to periphyton scraped from rocks, skin cells of swimmers, algae cells from lakes, etc.

Lakes can be major source-Babine River from Babine Lake

C. Two types: suspension feeders and deposit feeders

D. suspension feeders -AKA filterer-collectors

1. Stationary, Have capture method for removing FPOM from current

A. filtering apparatus- Simuliidae

Much known about blackflies because major pest and spreader of disease

B. Webspinners

Hydropsychidae- caddisflies

Often abundance is very high below lakes; then gets less in a downstream direction

C. Many other techniques, special nets, sticky lines, etc. See 6.7 in Allen.

2. Worth noting that webs catch lots besides FPOM so webspinners hard to classify in reality- coarser the net, more selective for other organisms (predators)

E. Deposit feeders: AKA collector-gatherers

1. Browsers on soft material on bottom

2. Burrowers

Burrower- e.g. Ephemeridae- burrowing mayflies

Midge larvae (Chironomidae)

Lamprey larvae (ammocoetes)

Create current across surface of deposits, catch material on mucous produced by cells in gills

3. Scrapers

Small mayflies, scrape FPOM from rocks, using mandibles

F. How FPOM gets converted to carbon and energy poorly understood

varies widely in quality

Presumably a mixture of highly digestable material, e.g. bacteria, small inverts, and poorly digestable material (e.g., pieces of wood).

But very important- contributes to cycling nutrients

Nutrient spiraling, p 295-303

More times a carbon atom gets used, the more productive the stream

V. Grazers (“Consumers of autotrophs”)

A. Broader term used to separate scrapers from piercers
Piercers- tiny caddis that pierce algae cells, insect larvae (bugs, mainly) that pierce aquatic plants.
B. Grazers
Scrapers- scrape off algae
Caddisflies, snails- hard part for scraping (radula on snails)
Often abundant in fast water - excludes predators and algae grows well

C. Brushers
Scrapers that using setae like a brush- Heptageniidae
FPOM as well

D. Pickers- mainly fish
Swim around and pick off strands of algae or clumps of diatoms
Sri Lanka barbs
Barbus nigromaculatus vs *B. dorsalis* feeding on same rock

VI. Predators
A. Most inverts opportunistic or inadvertent predators
Like the vegetarian who insists on organic food; may get some protein from small inverts.
Hydropsychidae caddis- mostly FPOM but below a lake, mostly zooplankton.

B. But many spp specialize in eating other critters, esp stoneflies.

C. Perlid stoneflies classic roving predators in stream world
Coleoptera- biting mouth, even take fish
Hemiptera- sucking/piercing mouth
D. Odonata- ambush predators

VII. Remember functional groups have limits in terms of explanation- critters flexible

VIII. Fitting this in to conceptual models of stream ecology
A. River Continuum
Diagram

B. Serial Discontinuity
1. Dams ‘reset’ rivers
Decreased flow, decreased temps
The greater the distance downstream, the greater the recovery.
Fish fauna appears to shift in way expected (trout>coolwater fishes>warmwater fishes

2. Is it really a reset? Differences:
    - CPOM - source?
        - Lots of collectors below dams
        - Often lots of grazers (why?)
    - Substrate armored
        - No gravel recruitment
    - All fishes found throughout
        - Communities not ‘clean’

C. Flood pulse concept

- RCC presents picture of stream as rather stable system, strong elev gradients
- FPC emphasizes importance of big flood flows in resetting things
    - Upper reaches: Scouring substrates, changing geomorphology
        - Fish and inverts must be able to adapt, recolonize
        - May account for high diversity of insects etc.
            - Intermediate disturbance
    - Lower reaches: high flows needed to inundate flood plains
        - Major source of energy but highly seasonal
        - Exports large amounts of energy to main river
            - Sources *lateral* rather than coming from upstream
        - Inverts: lots of filter-feeders on FPOM (chironomids)
            - Zooplankton
        - Fishes: opportunistic detritivores, omnivores, insectivores