



Ecología de invertebrados acuáticos y su manejo



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II Taller para el Manejo y conservación de las aves acuáticas y su hábitat en México
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Invertebrates account for 70% of all known species and 96% of all known animals.

Aquatic Invertebrates

- All aquatic insects evolved from terrestrial ancestors.
- Adapted to lower oxygen levels and fluctuating water levels



Why Invertebrates?

- "…egg-laying hens, ducklings, and molting adults cannot obtain their necessary protein (and specific amino acid) requirements entirely from aquatic plants" (Krull 1970:708)

Inverts are a good source of protein and calcium

(and also lipids)

PROTEIN

- Inverts contain up to 72% protein
  - Much higher than most plants

- High quality proteins and essential amino acids
  - Provide essential amino acids not found in agriculture grains
- Rapid digestion compared to seeds
  - Skewed ideas about waterfowl foods until 1970s
  - BWTE 10 min. after consumption → All scuds, 82% snails, and 24% fly larvae digested beyond distinction
- Efficient conversion of animal proteins to eggs and feathers

CALCIUM

- Invertebrates
  - Snails – 26.1% Ca with shell, 4.2% without
  - Crustaceans - Cladocera 11.8%
  - Clams
- Plants
  - Horsetail (Equisetaceae) – Roots 4.2%, Rhizomes 1.7%
  - Sago pondweed (*Potamogeton pectinatus*) – 2%
  - Duckweed (*Lemna spp.*) – 1.2%
  - Some algae & tubers
- P, Na, K, Mg – rarely deficient
  - Get sufficient amounts from natural foods

Krapu and Reinecke (1992)

LIPIDS

- Lipids = The most concentrated energy source
  - 37.7 – 39.8 kJ/g
  - Easily put into energy reserves

- Average energy/invert = 5100 - 5900 calories (5.1 – 5.9 kcal)
  - Inverts w/more calories ➔ more energy due to higher lipid content
    - Adult ♀, Larvae close to pupation, Eggs, Onset of winter

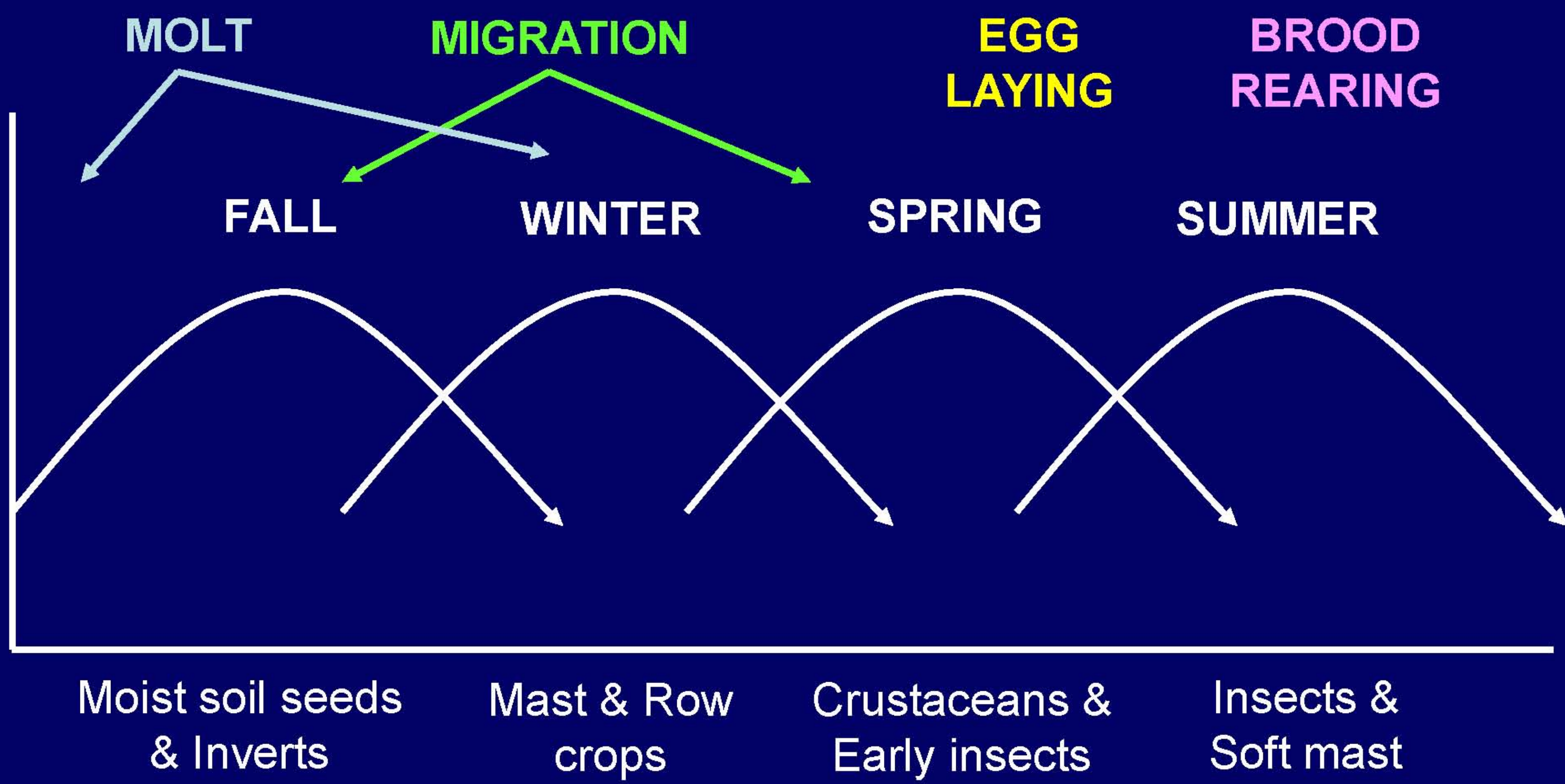
- Lipids generally higher in moist-soil seeds, mast , and corn
  - Most seeds lower in protein, thus good complement to inverts
  - Lipids can be limiting factor if:
    - Inverts abundant and seeds/mast scarce
    - Standard, year-round diet items are inverts

Baldassarre & Bolen (1994), Driver et al. (1974), Fredrickson & Reid (1988)

SEASONAL FORAGE VARIATIONS

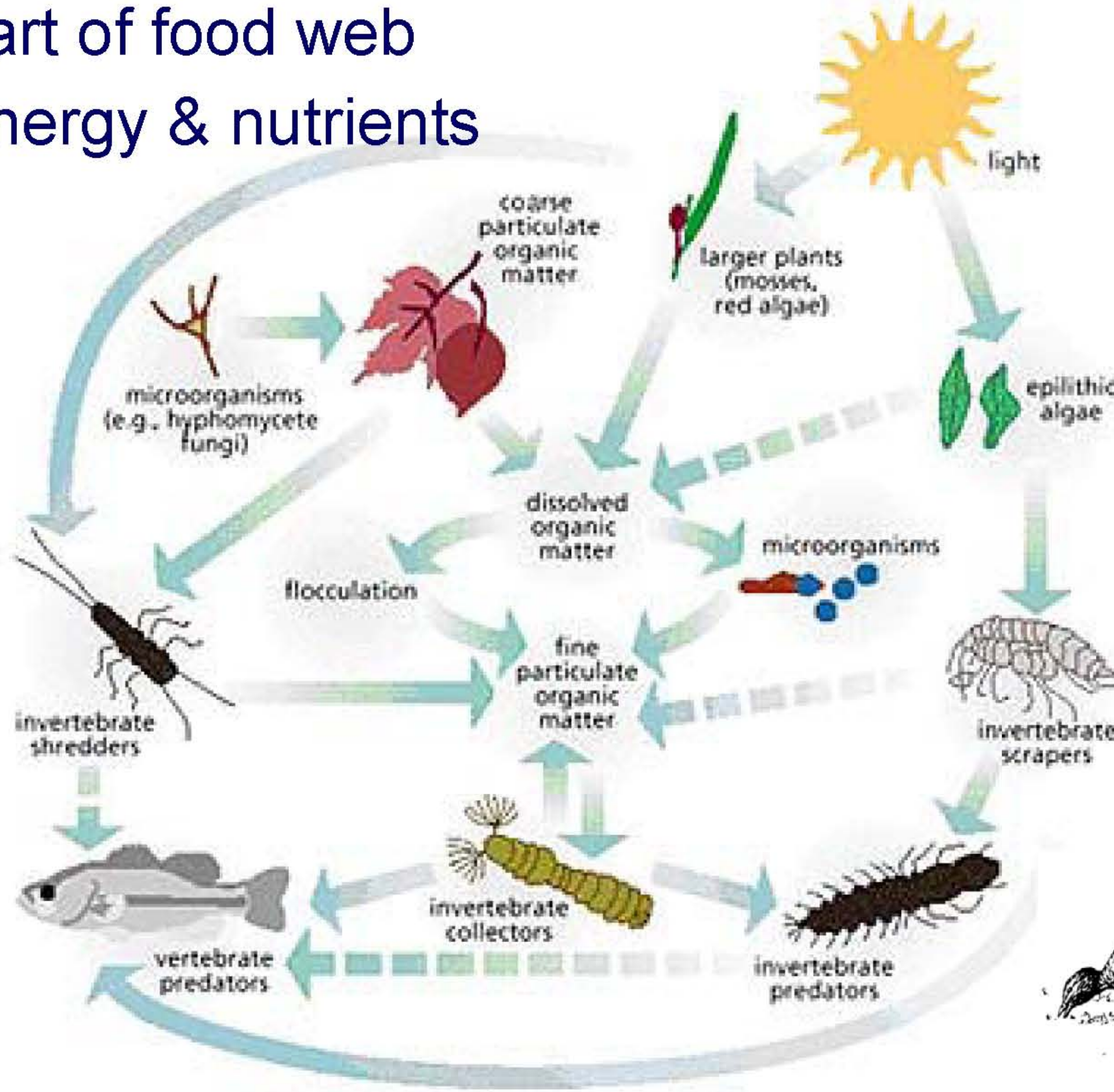
- "Waterfowl exploit a greater variety of food resources than any other family of aquatic or semiaquatic birds" (Krapu & Reinecke 1992:6)

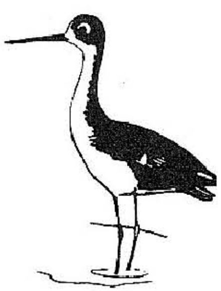
WATERFOWL LIFE HISTORY STAGES



Aquatic Invertebrates (con't)

- Major part of food web
- Move energy & nutrients





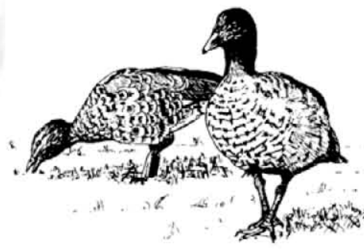
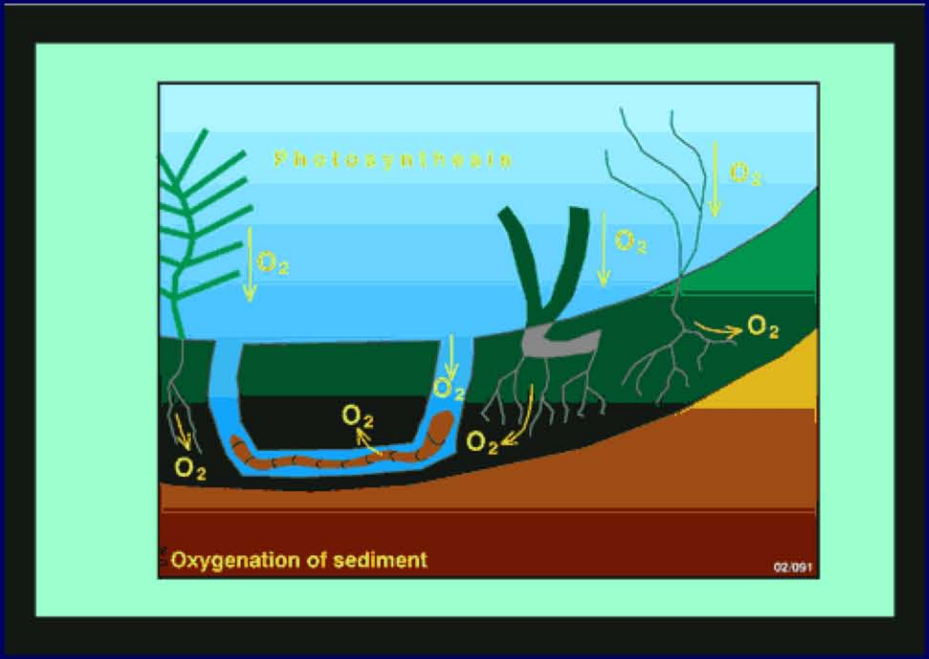


Diagram courtesy of Washington State University

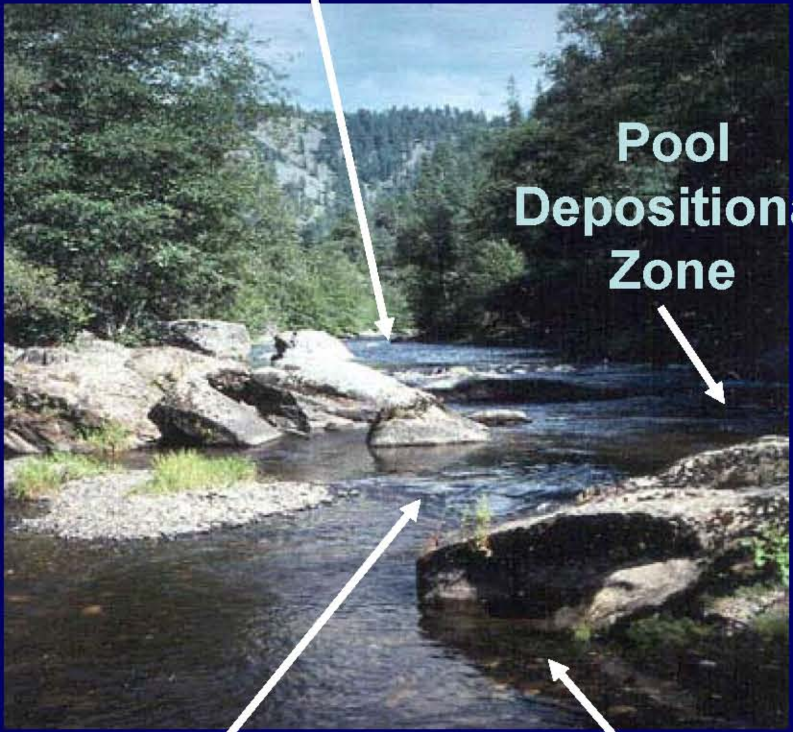
Aquatic Invertebrates (con't)

- Influence soil properties by
  - Mixing soil
  - Creating channels where water and air can move
  - Transporting organic residue to lower horizons
- Bio-indicators of
  - water quality
  - toxicological impacts
  - ecosystem conditions



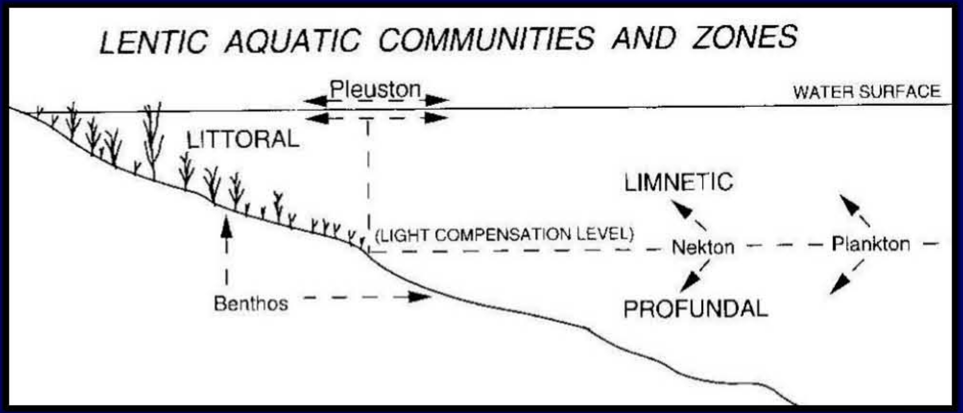
Lotic (running water) Habitat and Inverts

- Stream/river Habitats
  - Erosional: water velocity carries small particles in suspension
  - Depositional: slower water velocity so particles fall out of suspension
- Highest invert diversity in erosional zones with loose cobbles and pebbles, and a few boulders
  - Irregular composition provides array of hiding places and attachment sites
  - Provides surfaces for algae growth and edges to catch coarse debris
  - Inverts also live in hyperheric zone below stream bottom erosional zones



Lentic (standing water) Habitat and Inverts

(Includes Lakes, Ponds, Marshes, Bogs, and Swamps)



- Littoral: edge to limit of rooted aquatic plants
- Limnetic: open water from surface to where light does not penetrate
- Profundal: deep water from limit of light penetration to bottom substrate

- Greatest diversity of invertebrates in lentic habitats occur in the littoral zone
  - Plants provide structure for attachment sites and hiding places.

Aquatic Invertebrate Taxonomy

8 Freshwater Invertebrate Phylums

Porifera (sponges)

Cnidaria (hydra & jellyfish)

Nematomorpha (hairworms)

Platyhelminthes (flatworms)

Ectoprocta (moss animals)

Annelida (aquatic segmented worms, leeches)

Mollusca (snails, clams, mussels)

Arthropoda (spiders, crayfish, insects, etc)

Phylum Annelida

Segmented Worms

- Body wall is soft, muscular and covered with a thin skin
- Bodies are segmented, but no differentiated function
- Respire aerobically through skin but can respire anaerobically

Aquatic Earthworms (oligiocheates)

Lack suckers

Eat dead organic matter

Leeches

1 or 2 suckers

Parasites or predators

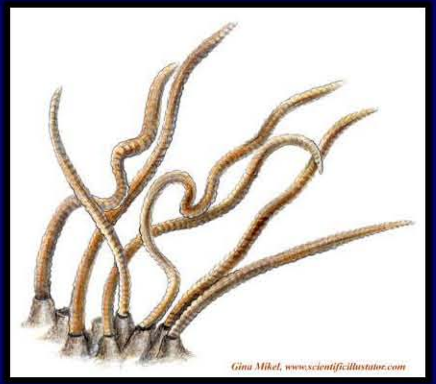
Branchiobdellidans (crayfish worms)

1 sucker

Live commensally on crayfish

Omnivores

PHYLUM ANNELIDA
"Leeches & Oligochaetes"



OLIGOCHAETES – Aquatic Earthworms"

- Ingest sediment, extract organic material, algae & bacteria
- Can survive low O2 conditions
  - Hemoglobin to aid O2 uptake
  - Respire through posterior "tail" by "waving"
- Most important animals in mixing sediments, releasing N & P

LEECHES

- Forage method
  - Mostly predators (Midges, oligochaetes, amphipods, molluscs)
  - Some parasitic (blood-feeding)
    - Leech dispersal either on animal host or as cocoon on invertebrate host
- Some can stand >60 days of anoxia

Eldridge (1990)

Phylum Mollusca

Planorbidae Snail

Phylum Mollusca

Molluscs

- 800 species in North America
- Hard shell that encloses body
- Soft bodies; irregular sections
  - Muscular foot
  - Head region
  - Main body (visceral mass)
  - Mantle (fleshy tissue that covers body and secretes the shell)

Snails (Class Gastropoda)

- Caenogastropod (Prosobranchs)
  - Internal gill
  - External operculum
- Pulmonate
  - Psuedo-lung
- Southeast US: some of the highest freshwater snail diversity in the world

Mussels and Clams (Class Bivalvia)

- Pearly mussels (naiads)
- True mussels
- Pill, fingernail, & pea clams

MOLLUSKS

Snails, Clams, and Mussels (Mollusca Phylum)

Adapted to seasonal, semi-permanent, and permanent wetlands

- Snails
  - Most have 1–3 generations per year
  - Live for 2 – 5 years; can lay up to 100s of eggs
  - High associated with aquatic vegetation
  - File-like radula to scrape algae, periphyton, etc
  - Lunged snails hibernate in mud (freeze-up or drying)
  - Need calcium carbonate for shell production

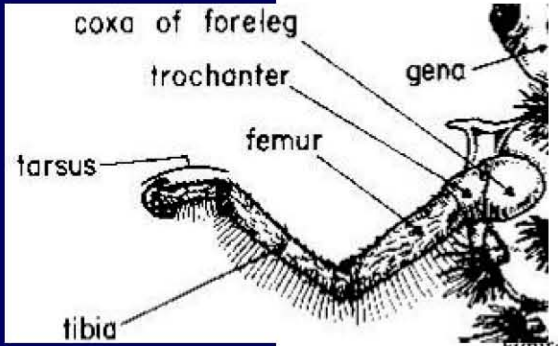
- Clams and Mussels
  - Female mussels incubate up to 1 million eggs for 1–10 months; larvae are parasitic on fish for dispersal
  - Female clams incubate eggs; larvae not parasitic
  - Most common in 2–7 ft of water with enough current to keep DO high and decrease sedimentation
  - Important filter feeders: remove excess algae and suspended organic matter and make it available to other benthic organisms

Arthropoda Phylum (Subphylum Hexapoda)

Arthropoda Phylum

Morphology (insect example)

- Largest invertebrate phylum in terrestrial and aquatic habitats
- Extremely diverse, occupy most trophic levels & functional feeding groups
  - Parasitism rare
- Bodies are segmented & grouped for distinct functions
- Paired legs
- Bilaterally symmetrical
- Hard or soft skin acts as external skeleton
  - Good protection
  - Shed it as they grow – energetically expensive & vulnerable to predation
- Most are dieocious



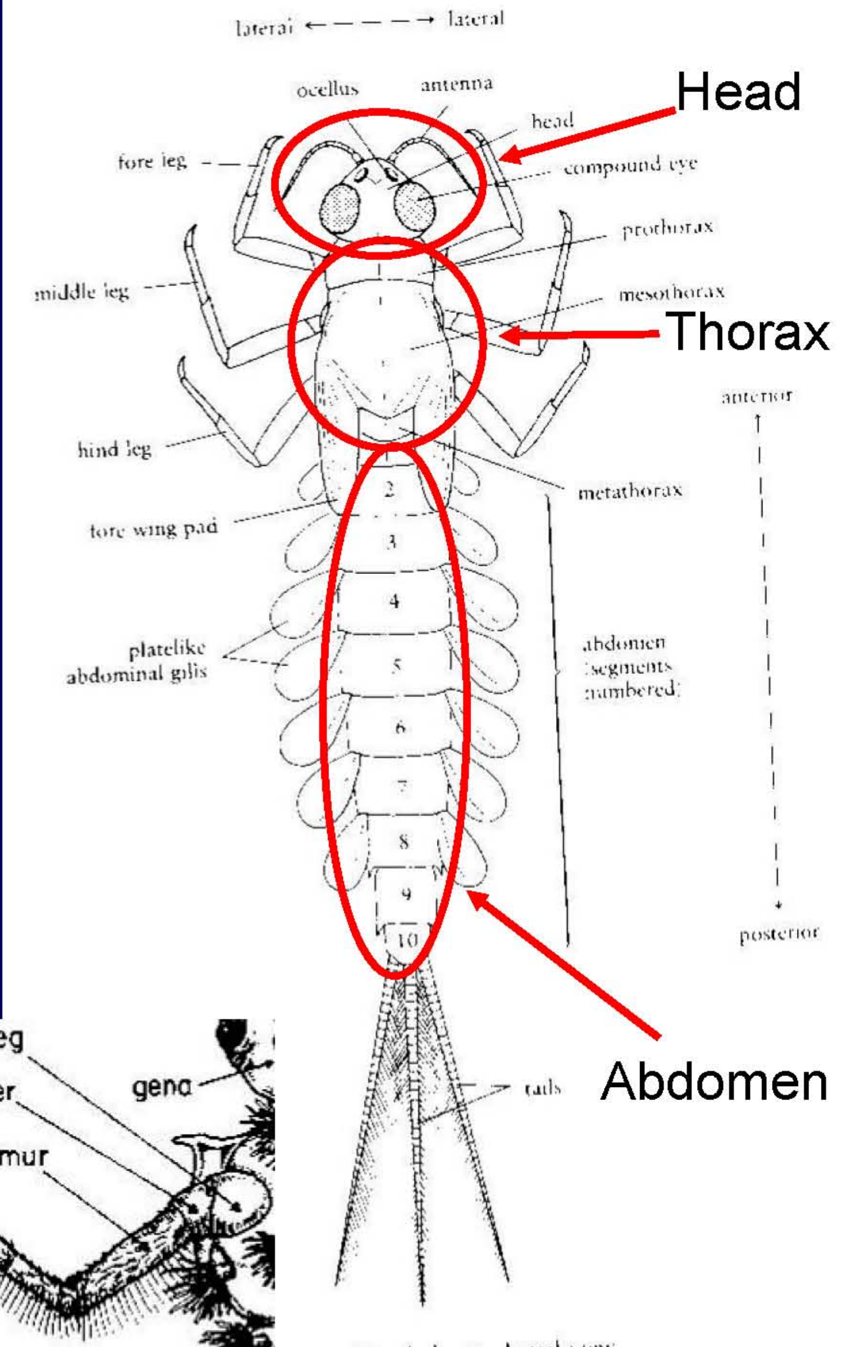


Figure 2.1. Mayfly larva, dorsal view.

McCafferty (1998)

Arthropoda Phylum

Spiders, mites
(Subphylum Chelicerata)
4 pairs of legs, no antennae
5,000 species

Shrimp, sow bugs, scuds
(Subphylum Crustacea)
Variously fused body parts
2 pairs antennae
1,500 species

Insects & near relatives
(Subphylum Hexapoda)
head, thorax, abdomen
May have 3 pairs 5-part legs
1 pair antennae
7,200 species

Chelicerata Subphylum
(Arthropoda)

Spiders

- Paired mouth parts
- Head & thorax fused; abdomen
  - Connected by stalk (pedicle)
- 4 pairs of legs, distinctive mouths, no antennae
- Quasi-aquatic predators
- Hydrophobic hairs allow them to run on water or dive for prey
- Very few species associated with water

Mites

- Mouth region with fused head, thorax, abdomen
- Larvae are ectoparasites
  - Parasitism can effect fitness and survival of host insects
- Nymphs and adults voraceous predators
- 5,000 aquatic species worldwide

Crustacea Subphylum

Fairy shrimp

- Extremely important in planktonic and benthic communities in almost every inland water system
  - Can be significant proportion of benthic biomass

Copepod

- Vital food link between primary producers (algae & plants) and higher trophic levels
  - Major consumers of phytoplankton, algae, bacteria, protozoans, detritus
  - Scrapers, filterers, gatherers, scavengers
  - Some carnivors
- Often have larval development within the egg/embryo

Seed shrimp

- Adults important prey for waterbirds
- 1,500 freshwater species in North America in 4 classes
  - Branchiopoda (fairy, tadpole, & clam shrimp: water fleas)
  - Maxillopoda (copepods and fish lice)
  - Ostracoda (seed shrimp)
  - Malacostraca (scuds, aquatic sowbugs, crayfish, shrimp & crabs)

Crayfish

DECAPODS

Crayfish, Crabs, & Shrimp

(Arthropod Phylum - Crustacea)

29,000 described species worldwide
500 freshwater species in NA , 90% are crayfish

CRAYFISH

- Live up to 7 years
- Molt their outer exoskeleton –energetically and physiologically demanding – may eat old exoskeleton for Ca; increased predation risk
- Eggs and developing young attach to female abdomen
- Opportunistic omnivores; prefer living/dead animal prey
- Higher abundance in shallow water where refuge from predators more common
  - Predators include other larger decapods, fish, waterbirds, snakes, turtles
- Also occur in upland habitats where they can reach the water table
- Threats: pollution, water extraction, and non-native decapods

AMPHIPODS

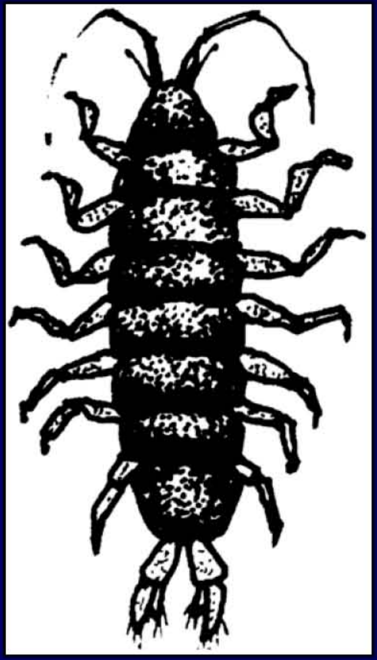
Scuds & Sideswimmers (Arthropod Phylum)

Generally found in seasonal to semi-permanent wetlands

- Most complete life cycle in 1 year
- In spring females brood up to 50 eggs for 1–3 weeks
- Bottom-dwellers in tangles of plants, roots, &/or detritus
- Water < 1 meter
- Most abundant in small, shallow wetlands, streams, and springs without fish.
  - Abundance as high as 10,000 scuds per sq. meter
  - Important in breaking down organic matter

ISOPODS

Aquatic Sowbugs, Crustacea (Arthropod Phylum)



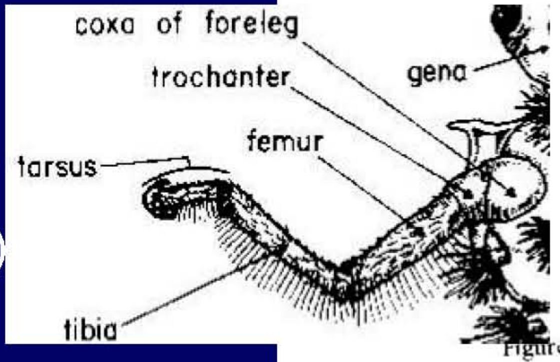
- Most complete life cycle in 1 year
- Females brood 20–250 eggs and hold newly hatched young for 4 weeks
- Molt (shed) 15 times before adults
- Most abundant in springs, seeps, & spring-fed streams
- Water < 1 meter
- A lot of hiding places = high abundance
  - Omnivores, but also important in breaking down organic matter

SUB-PHYLUM HEXAPODA
"Aquatic Insects"

Inland waters of North America
10,000+ species
(≈ 8,600 species in freshwater)

Aquatic Insect Orders

- Ephemeroptera (Mayflies)
- Plecoptera (Stoneflies)
- Tricoptera (Caddisflies)
- Odonata (Dragonflies & Damselflies)
- Megaloptera (Dobsinfies)
- Lepidoptera (Moths)
- Hemiptera (True Bugs)
- Coleoptera (Beetles)
- Hymanoptera (Wasps)
- Diptera (True Flies)
- Neuroptera (Spongillaflies)



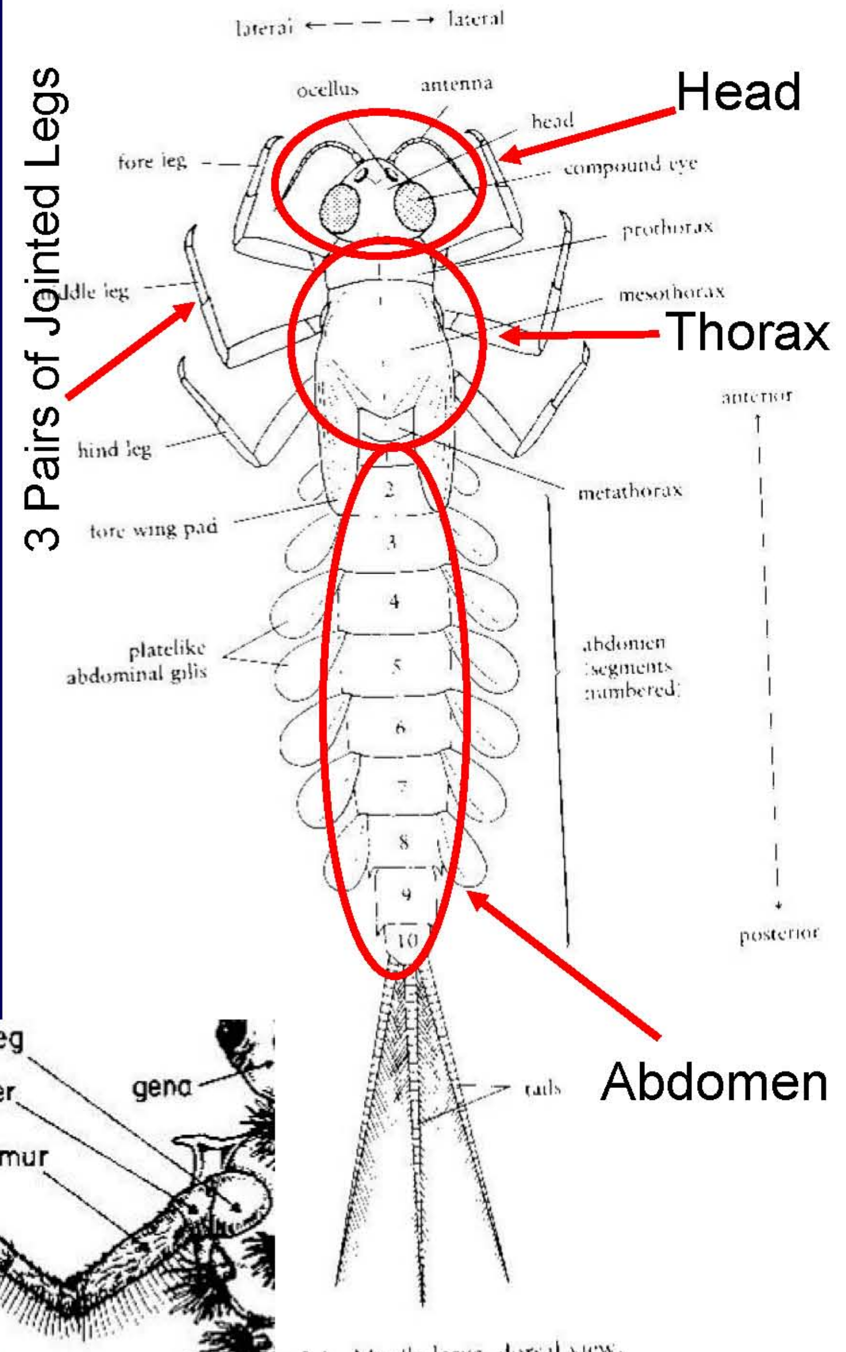


Figure 2.1. Mayfly larva, dorsal view.

McCafferty (1998)

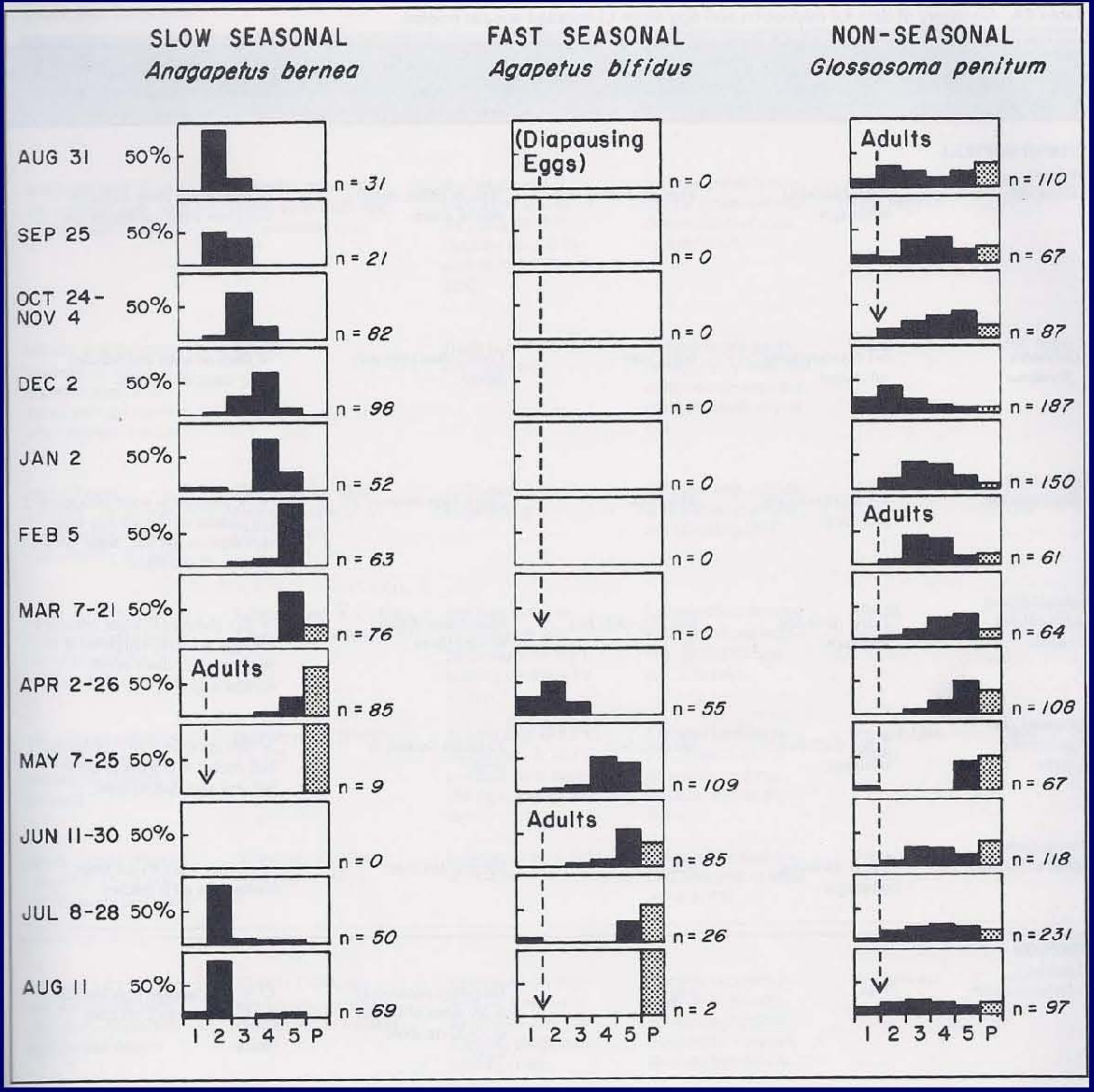
DRAGONFLIES & DAMSELFLIES

(Odonata)

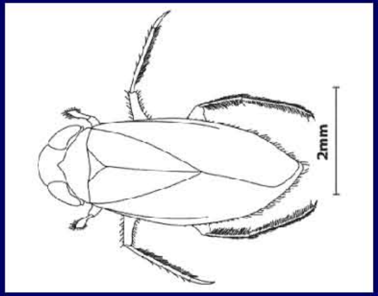
- Lifespan
  - Dragonflies 1-6 yrs
  - Damselflies < 1 yr
  - 1-2 generations per year, except in northern latitudes
- Females deposit eggs in water or above the water on other surfaces
  - Eggs stage 7-200 days (depending on species & temp.)
- 11-13 instar stages
- Predators – species vary by method and habitat
  - Sit & wait vs. stalking
  - Detritus vs. vegetation in water column

CADDISFLIES

Life History Examples



WATER BOATMEN (CORIXIDAE)



Aquatic Insect, True Bug (Arthropod Phylum)

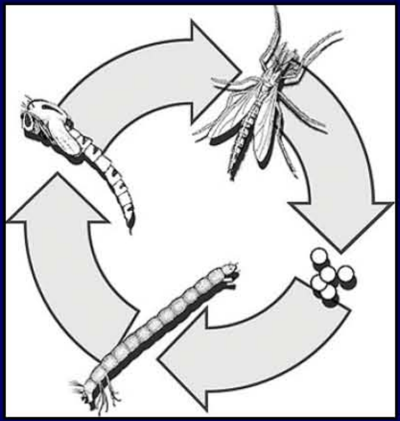
Life cycle adapted to Seasonally and semi-permanently flooded wetlands

- Strong association with wetland plants
  - Eggs deposited on vegetation in the spring
- Larval development 5–7 weeks
- Adults can hibernate in mud or remain active under ice
- Adults are strong fliers & capable of dispersing to new habitats and may overwinter in larger bodies of water that don’t freeze

MIDGES

True Flies (Diptera) (Arthropod Phylum)

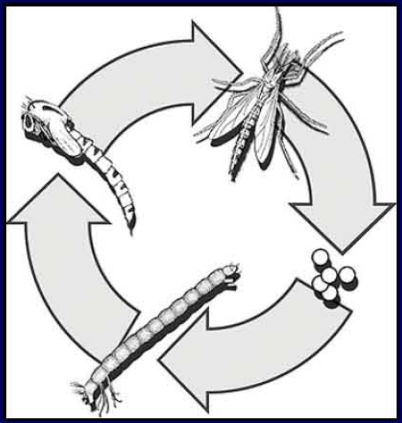
Chironomids: Most Diverse & Abundant Family of Aquatic Insects



- Generations range from 20 per year (mosquitoes in FL) to 7 years to complete 1 life cycle (Arctic tundra wetlands)
- Chironomid larvae can aestivate during dry periods (e.g., vernal pools)
- Diverse habitats range from
  - Temporary to permanent wetlands
  - Palustrine to riverine
  - Fresh to saline
  - “Pristine” to degraded
- Aquatic veg., rocks, course detritus, & fine sediment
- Often account for up to 50% of species present
- Abundance of chironomids can commonly reach 50,000 larvae per sq. meter

CHIRONOMIDS
Life History

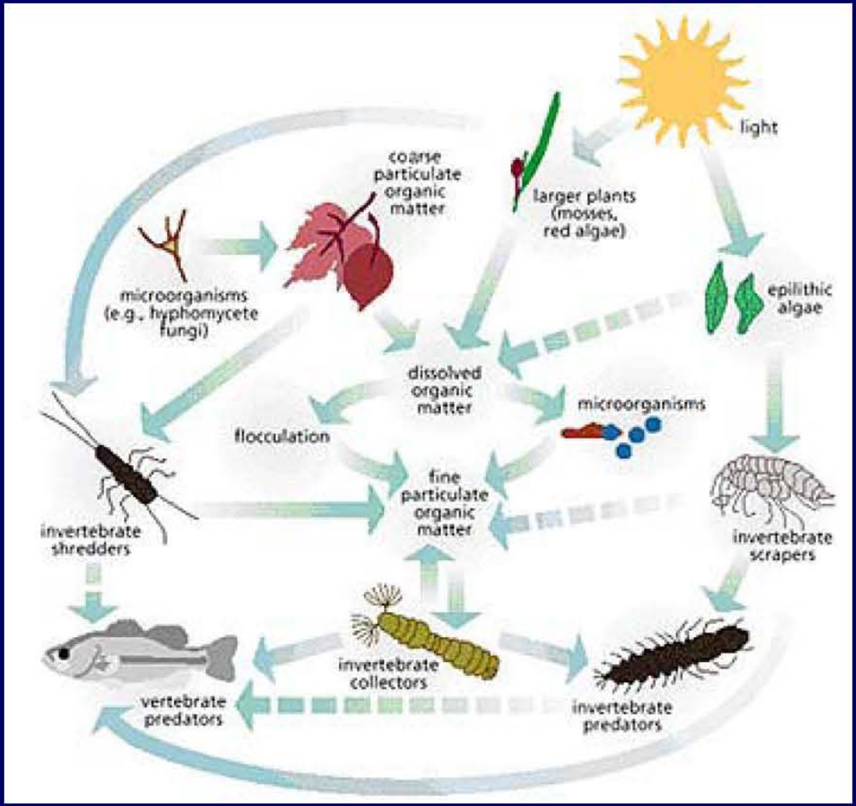
- Development
  - Egg – Larvae – Pupa – Adult
  - Spend most of time in larvae stage
    - 4 instar stages
    - Grow 2 to 24 mm
  - Forage on algae
  - Temperature dependent
    - More generations present at one time in southern lattitudes and/or shallower, warmer weather



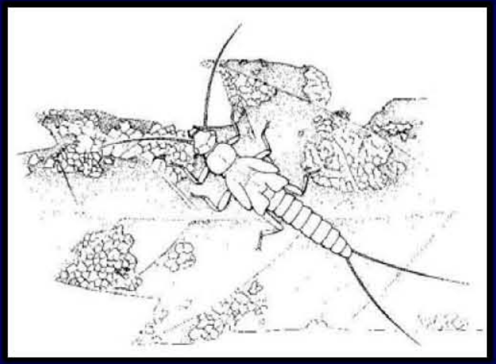
- Blood worms (*Chironomus* spp.)
  - Earliest colonizers of newly flooded wetland habitat
  - Early successional stages of moist-soil

Functional Feeding Groups

- Shredders
- Scrapers and Grazers
- Collectors
- Plant Piercers
- Predators
- Parasites



SHREDDERS



- Forage on plant material:
  - Herbivores - Living plants
  - Detritivores - Decomposing plants
  - Detritivores - “Coarse Particulate Organic Matter” (CPOM)
  - Gougers - Wood
- Convert to CPOM to “Fine Particulate Organic Matter” (FPOM)
- Stonefly nymphs

Pteronarcidae

Merritt & Cummins (1996), Fredrickson & Reid (1988a)

SCRAPERS/GRAZERS

- Scrape off algae & bacteria on plants
- Snails

COLLECTORS

- Decomposing FPOM from water column
- Foraging methods:
  - Filterers
    - Rows of tiny hairs
    - Constructed nets
      - Some caddisfly larvae
  - Gatherers
      - Springtails & Aquatic worms

Physidae

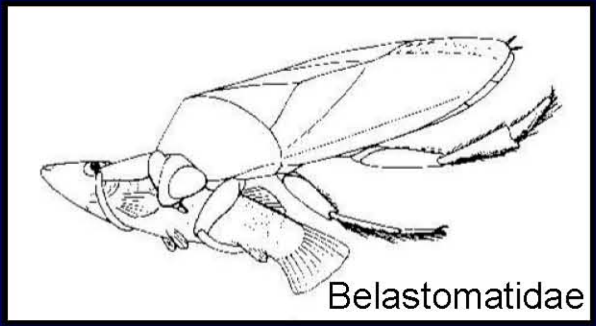
Hydropsychidae

Entomobryidae

Merritt & Cummins (1996),
Fredrickson & Reid (1988a)

PREDATORS

- Live animal tissue
  - Engulfers - Ingest whole animal
    - Dragonfly & Damselfly naiads
  - Piercers - Pierce & suck out fluids
    - True bugs



Belastomatidae

PLANT PIERCERS

Sisyridae

- Live plant tissue or algae
- Pierce & suck out fluids

  Spongillaflies

PARASITES

Braconidae

- On eggs, larvae, pupae, or adults
- Wasps & Flies

Merritt & Cummins (1996)

EXTREMELY DIVERSE

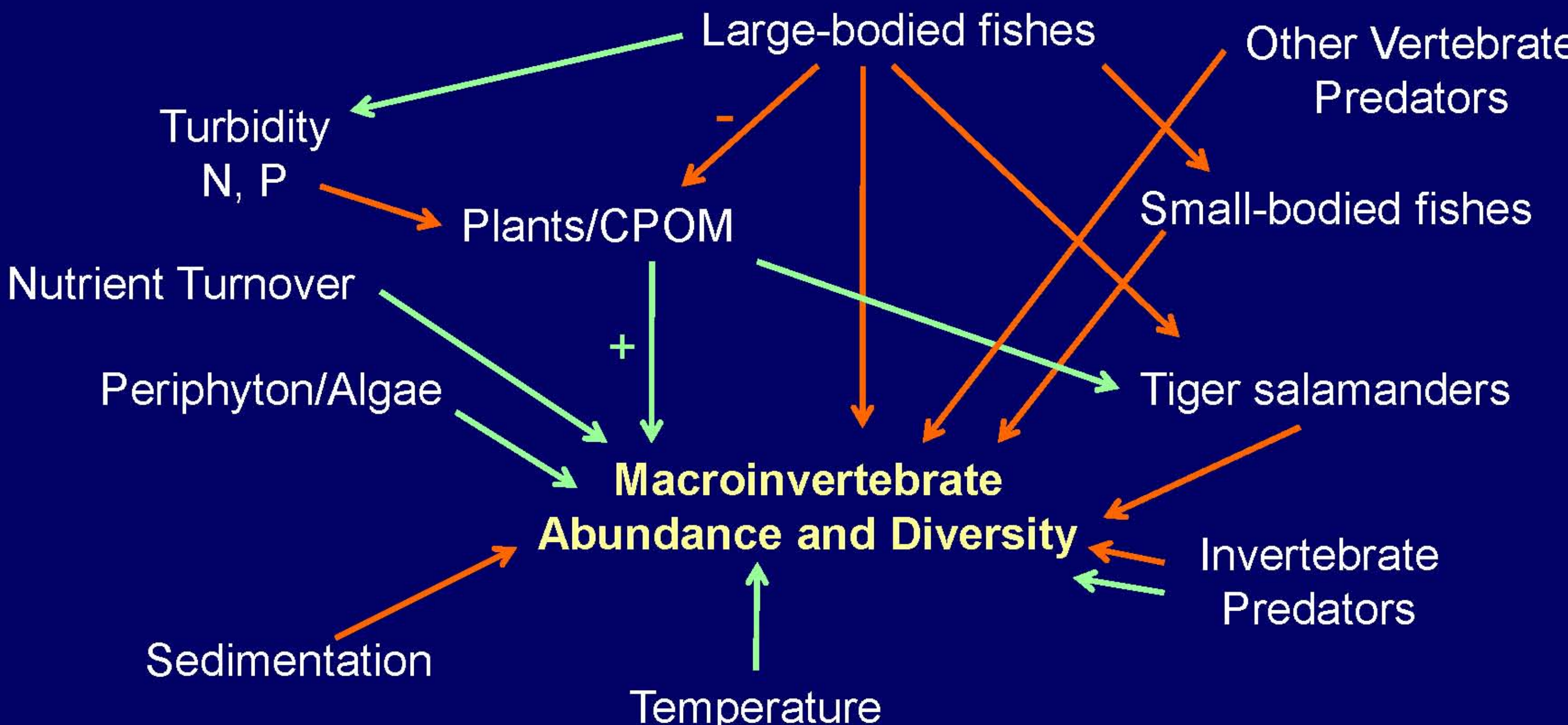
"The seemingly intractable ecological responses of invertebrates in North American wetlands"

A review by D. P. Batzer (2013) in Wetlands 33:1-15

- Most important controls on aquatic invertebrates
  - Hydrology
  - Plants
  - Anthropogenic disturbance
  - Predation
- BUT WHAT ARE THE MECHANISMS….
  - Distinct responses to environmental conditions, but we have not found consistent patterns
  - Interactions complex and difficult to predict

Aquatic Invertebrate Model

(modified from Hentges & Stewart 2010)



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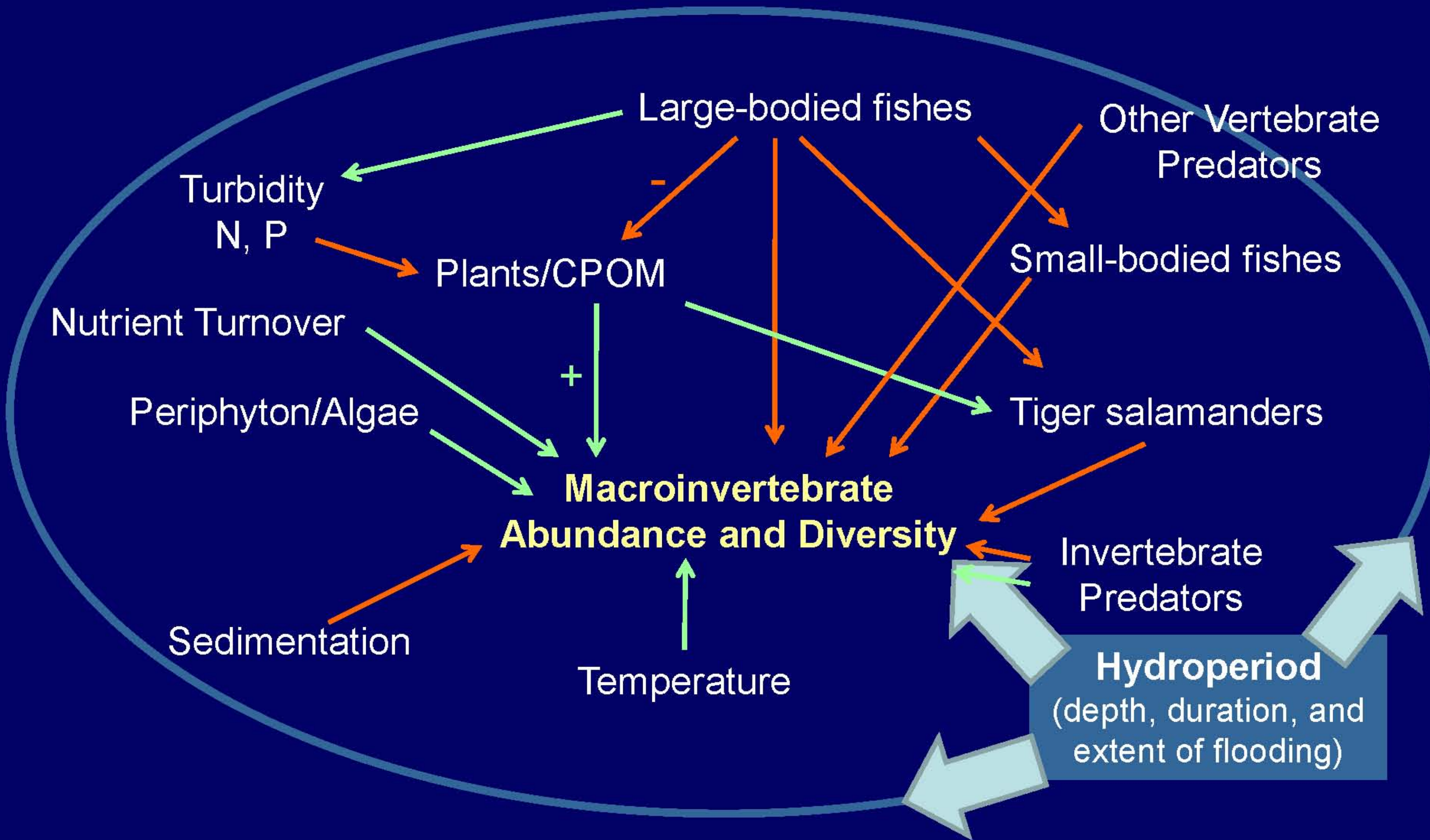


INVERTEBRATE HABITATS

Hydroperiod

↓

Vegetation

↓

Invertebrates

VEGETATION AND INVERTEBRATE ASSOCIATIONS

Lemna minor

67% zooplankton variation

55% amphipod variation

Ceratophyllum demersum

49% Gastropod variation

AQUATIC VEGETATION

- Structure
  - Height
    - High enough for emerging insects?
  - % Cover
  - Density
    - Dense clumps give protection/shelter

- Shape
  - Finely divided leaves give protection/shelter
    - Generally support larger invertebrate assemblages (Fredrickson & Reid 1988a)

- Surface area
  - More surface area ➔ More periphyton (algae & heterotrophic microbes)
  - More surface area ➔ More invertebrates (Krull 1970)

VS.

Polygonum spp. = GREAT INVERT HABITAT

Giant water bugs

Mayflies

Dragonflies/Damselflies

Mosquitoes

Midge larvae

Water scavenger beetles

Crayfish

Water mites

Crawling water beetles

Orb snails

Predaceous diving beetles

Backswimmers

Water boatmen

Water striders

Pond snails

(Fredrickson & Reid 1988)

Lotus spp. = NOT SO GREAT INVERT HABITAT

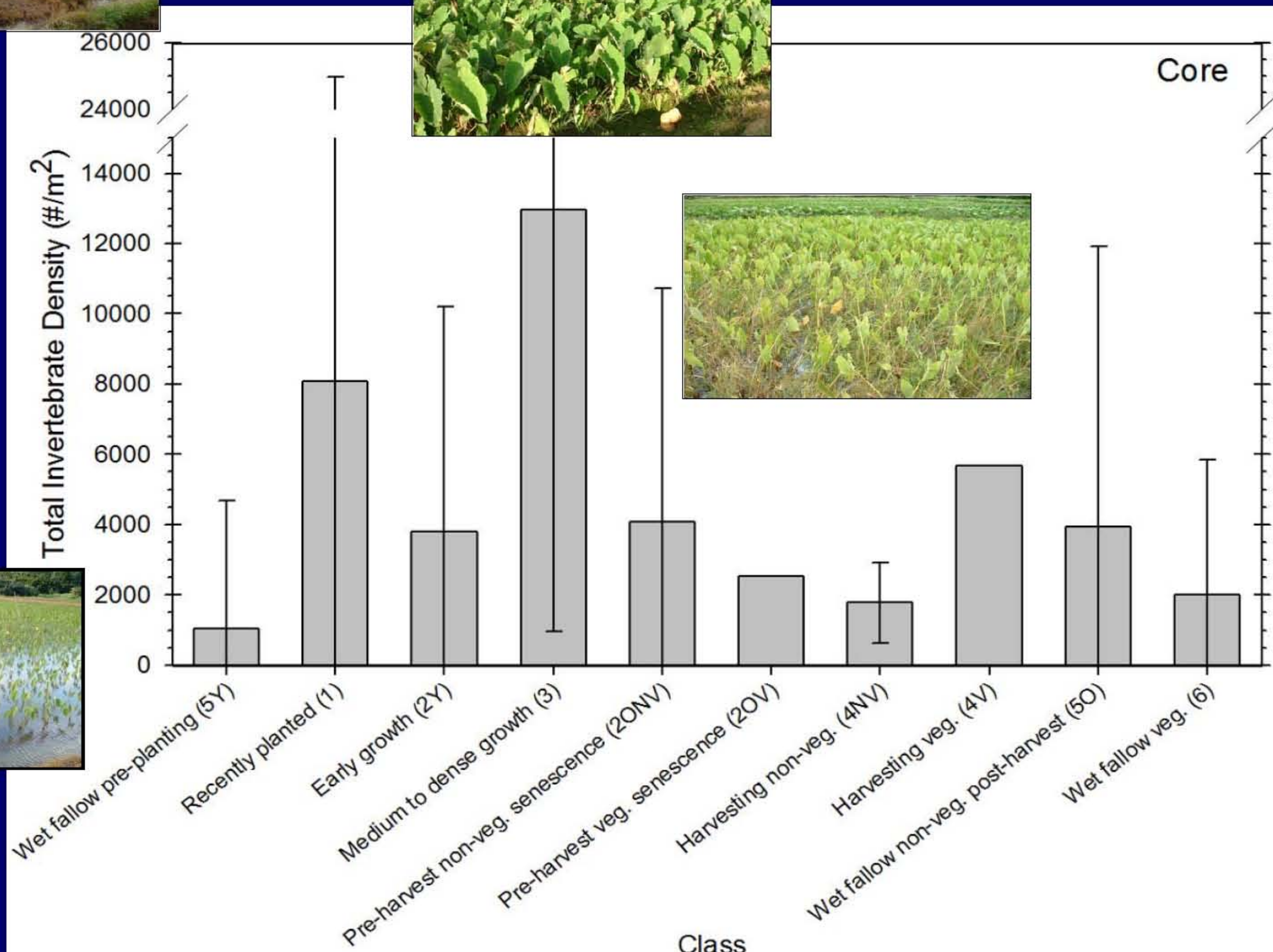
Dragonflies/Damselflies

Midge larvae

Water boatmen

(Fredrickson & Reid 1988)

INVERTEBRATE DENSITY BY GROWTH STAGE OF TARO



Krull (1970)

Vegetation	Common Name	Mean weight (g) inverts/100 g Plant material	# Inverts/ 100 g Plant material
Lemna trisulca	Duckweed	2.059	152
Heteranthera dubia	Water stargrass	1.530	103
Ceratophyllum demersum	Coontail	1.510	161
Elodea canadensis	American waterweed	1.117	58
Najas flexilis	Slender water-nymph	1.003	36
Najas marina	Spiny naiad	0.910	85
Stuckenia pectinata	Sago pondweed	0.786	101
Utricularia vulgaris	Bladderwort	0.761	80
Chara vulgaris	Stonewort	0.587	44
Potamogeton foliosus	Leafy pondweed	0.533	66
Rhizoclonium hieroglyphicum	Filamentous green algae	0.306	60
Myriophyllum spicatum	Eurasian water-milfoil	0.071	36

INVERTEBRATE RESPONSE TO HYDROPERIOD

- Spring Flooding
  - Earthworms emerge

- Temporary wetlands (inudated a few weeks) - Quick reproduction
  - Fairy shrimp
  - Mosquitoes
  - Water fleas

- Seasonal Wetlands - Longer inundation (1-3 months), Less fish
  - Damselfly & Dragonfly larvae
  - Backswimmers
  - Mayfly larvae

- Deeper, semi-permanent water
  - Peak inverts at peak growing season
    - LESC egg-laying correlated with peak in amphipods (Afton 1984)
    - Duckling hatch also timed with invert blooms
  - Amphipods
  - Chironomid larvae

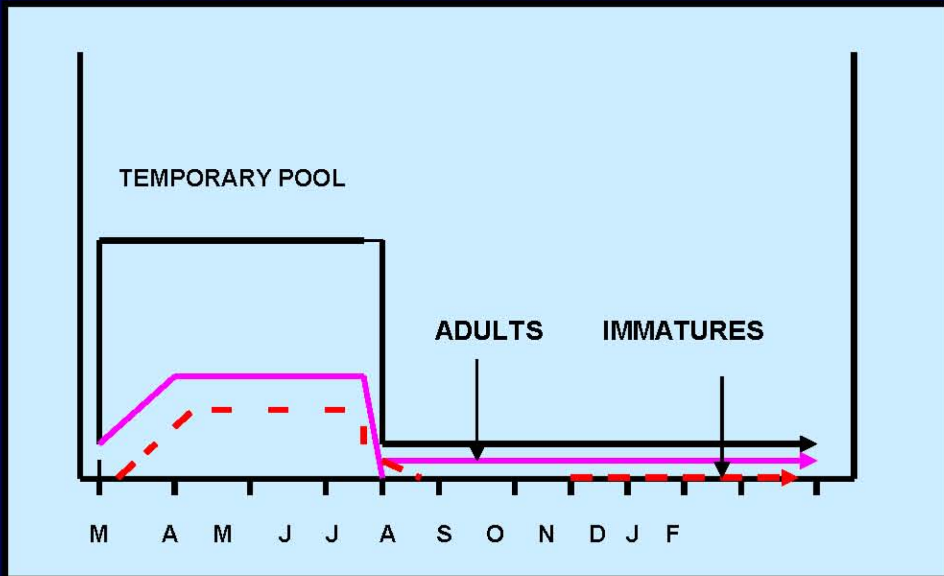
WHY LIVE IN A TEMPORARY ENVIRONMENT?

Especially with the threat of dessication!

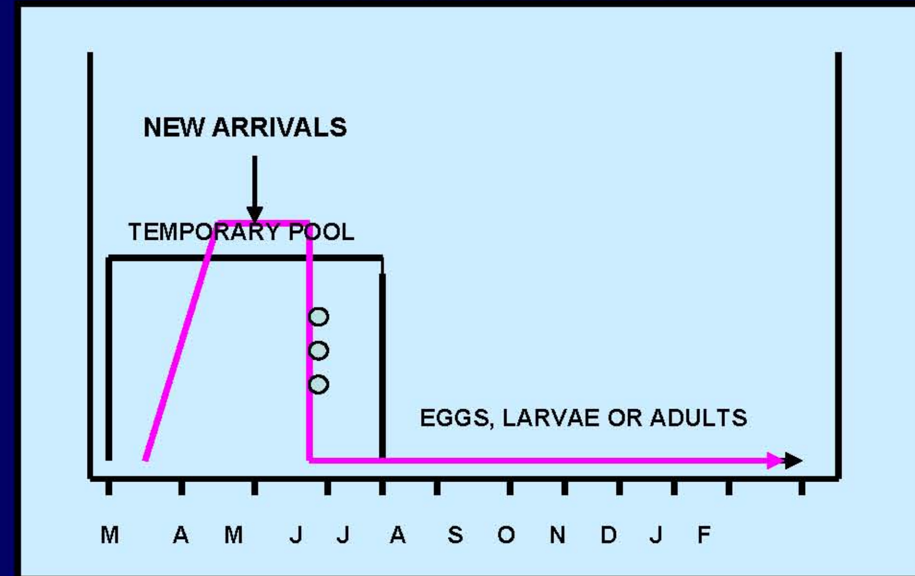
- Low predation by fish & other bugs early in wet phase
  - Fishless ponds → more diverse insect community than with fish
  - Fish reduce average size and abundance of macroinvertebrates
- Lower competition than permanent water
- High detritus decomposition rate → Faster nutrient turnover
- High productivity
- Water is warmer faster, so earlier growth

Culicidae

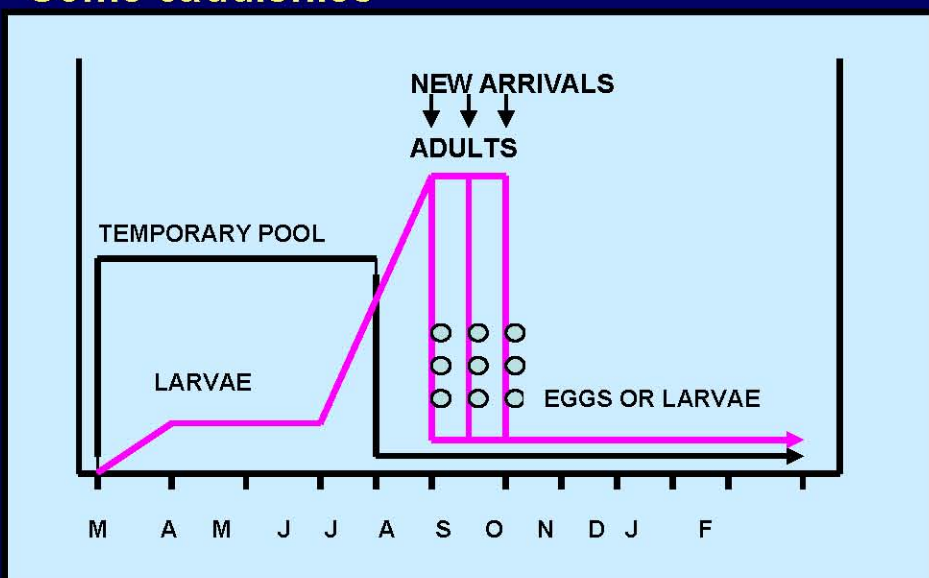
OVERWINTERING RESIDENTS



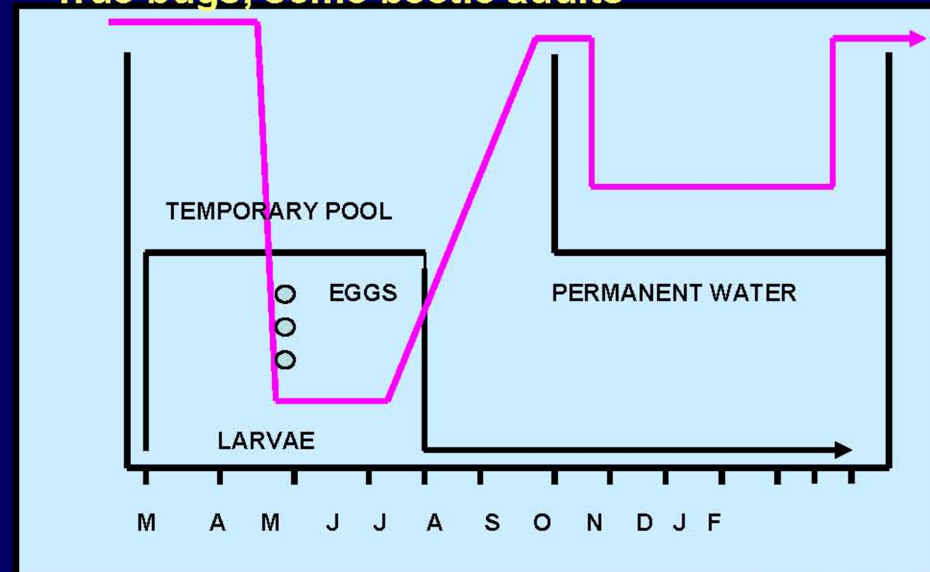
OVERWINTERING SPRING RECRUITS



OVERWINTERING SUMMER RESIDENTS
Some caddisflies



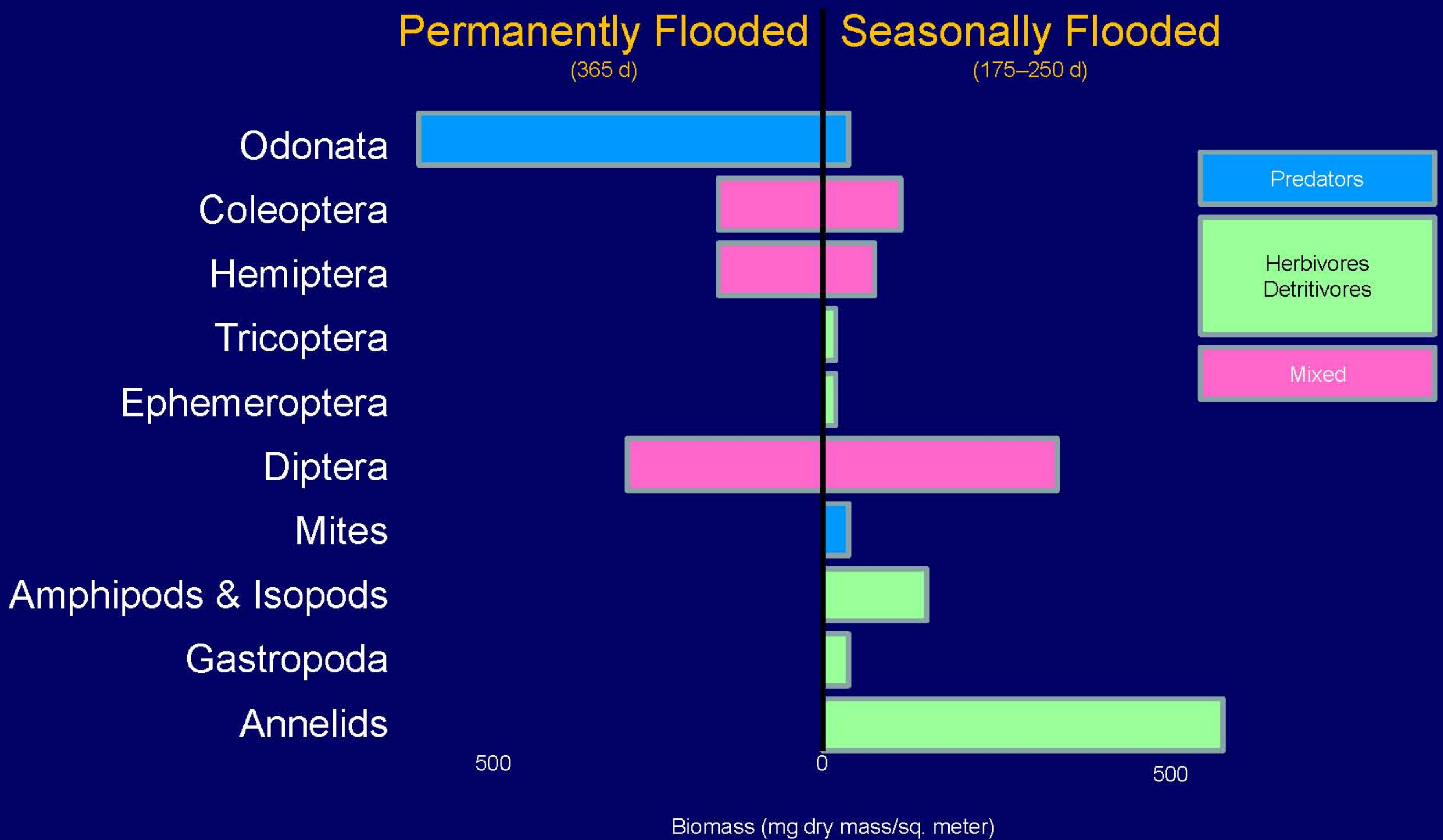
NON-WINTERING SPRING MIGRANTS
True bugs, some beetle adults



Ward (1992)

Comparing Different Hydroperiods

Carolina Bays, SC

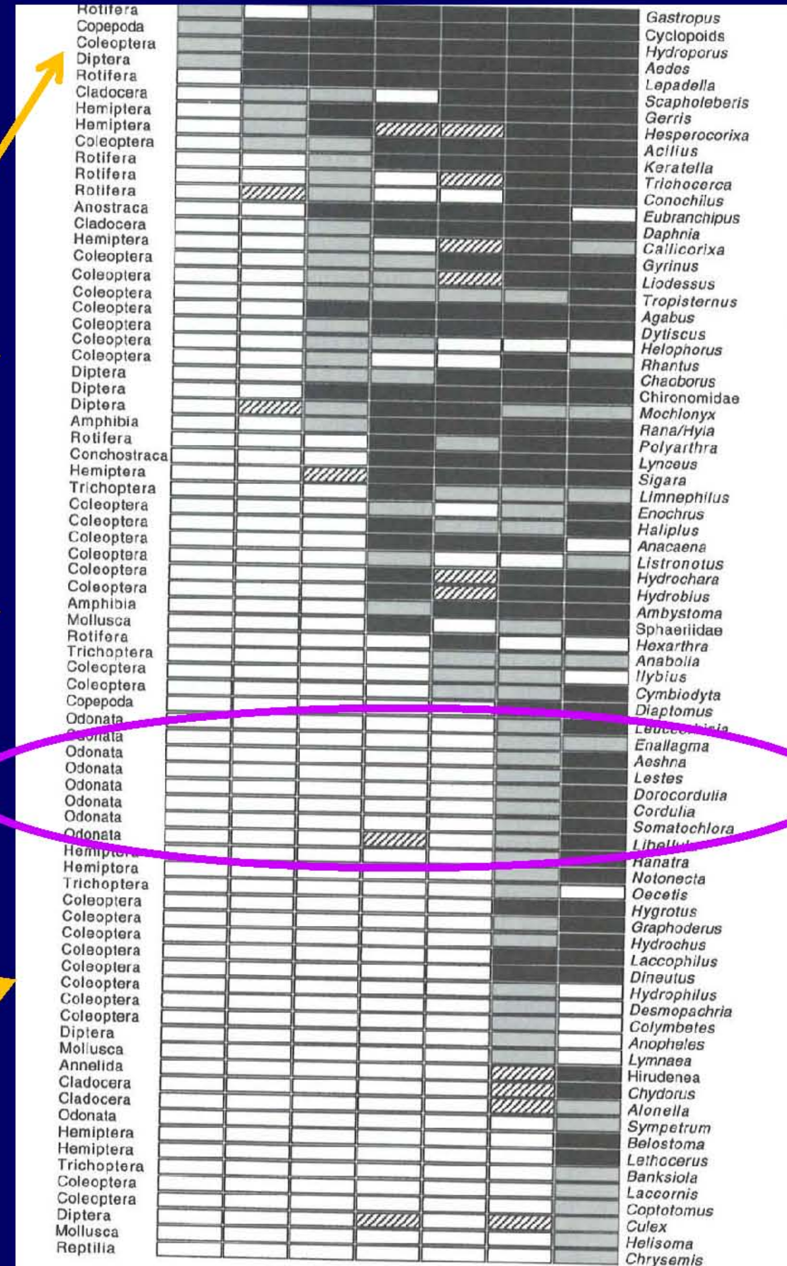


Invert Productivity

AQUATIC INVERTEBRATES AND HYDROPERIOD

WISCONSIN SNOW-MELT BASINS

TEMP → SEMI-PERM



MOLLUSKS

ODONATES

COLEOPTERA
Genera adapted to multiple flooding regimes

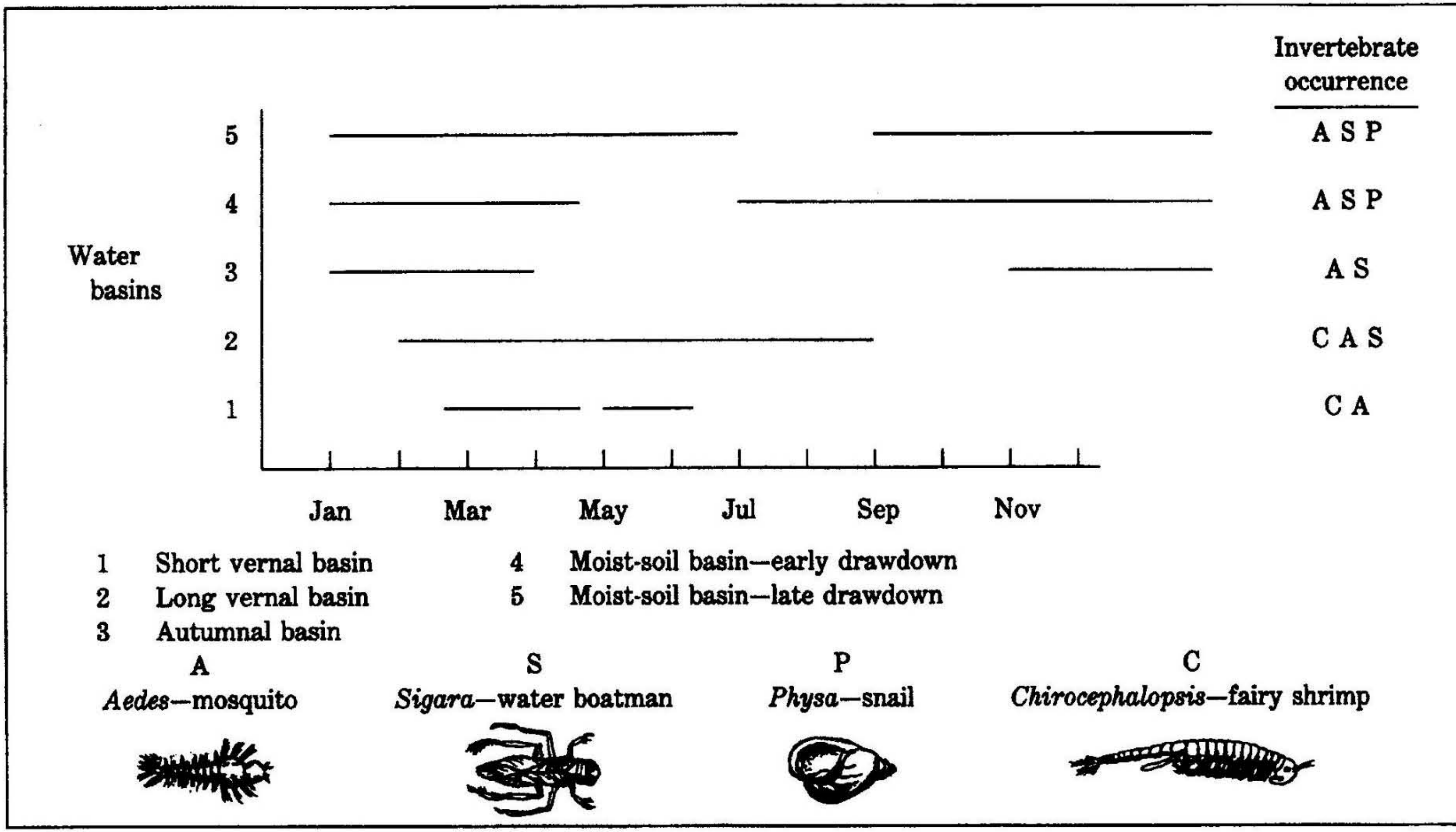


Figure 1. Occurrence of four common invertebrate genera relative to water regimes of five different seasonally flooded basins. Horizontal lines represent presence of water.

Basic Monitoring by Habitat

- Scuds (100's)
- Dragonfly larvae
- Back swimmers
- Water Striders
- Beetles

- Aquatic Earthworms
- Leeches
- Scuds (5)

OTHER FACTORS INFLUENCING INVERTEBRATE ABUNDANCE, DISTRIBUTION, & EVOLUTION

- Temperature
- Dissolved oxygen (DO) levels
- pH
- Salinity

WATER TEMPERATURE

(which is influenced by a variety of factors)

AFFECTS INVERTEBRATES'

- Geographic range
- Metabolism
- Growth
- Emergence timing and during
  - Earlier at lower latitudes
  - Earlier at lower elevations
    - Higher midday temps
      - Less emergence
      - Waterfowl forage in AM and PM
    - Low in excessive cold

Chura (1961), Collias & Collias (1963)

DISSOLVED OXYGEN (DO)

Temp. (Celcius)	O2 (Max % by volume)
0	4.9
10	3.8
20	3.1
30	2.6

Meyer 2006

- ↑ Water temperature ↓ ability to hold oxygen
- High organic wastes
  - Bacteria bloom consumes DO
  - Near-anaerobic environment
  - Insects must get O2 from the atmosphere
  - Encourages pollutant tolerant species
- Cold streams, waterfalls, rapids
  - Colder/High oxygen/high aeration
- Shallow lakes, ponds, wetlands
  - Warmer/Lower oxygen/Low aeration

pH

- Acidity can indirectly cause:
  - O_2 deficits
  - Ca deficits
  - Slow decomposition
  - Lower food quality
  - Reduced algae
  - Reduced plant productivity
  - Oviposition avoidance
  - Altered competitive interactions

Ward (1992)

INSECT TAXA IN STREAMS VARYING IN pH

	Nonacid Stream (6.8)	Acid Stream (4.8)
Insect orders (No. of spp.)		
Ephemeroptera (mayflies)	11	0
Plecoptera (stoneflies)	12	9
Megaloptera (dobsonflies)	1	1
Tricoptera (caddisflies)	15	7
Coleoptera (beetles)	7	2
Diptera (flies/midges)	10	4

Source: Modified from Otto and Svensson (1983)

- Acidic waters ➔ Lower species diversity
  - Crustaceans, snails, and clams hardest hit

Ward (1992)

INSECT FUNCTIONAL FEEDING GROUPS IN STREAMS VARYING IN pH

	Nonacid Stream (6.8)	Acid Stream (4.8)
Functional Groups (%)		
Shredders	25	48
Scrapers	28	4
Deposit feeders	15	11
Filter feeders	11	15
Predators	21	22

Source: Modified from Otto and Svensson (1983)

- Leaf litter decomposition lower at lower pH
  - CPOM persisted longer ➔ more shredders
  - CPOM ➔ FPOM ➔ more filter feeders
- Less algae ➔ fewer scrapers

Ward (1992)

SALINITY

- High evaporation in summer concentrates salts
  - Can make intolerable conditions for some invertebrate taxa
  - Increases more saline tolerant species

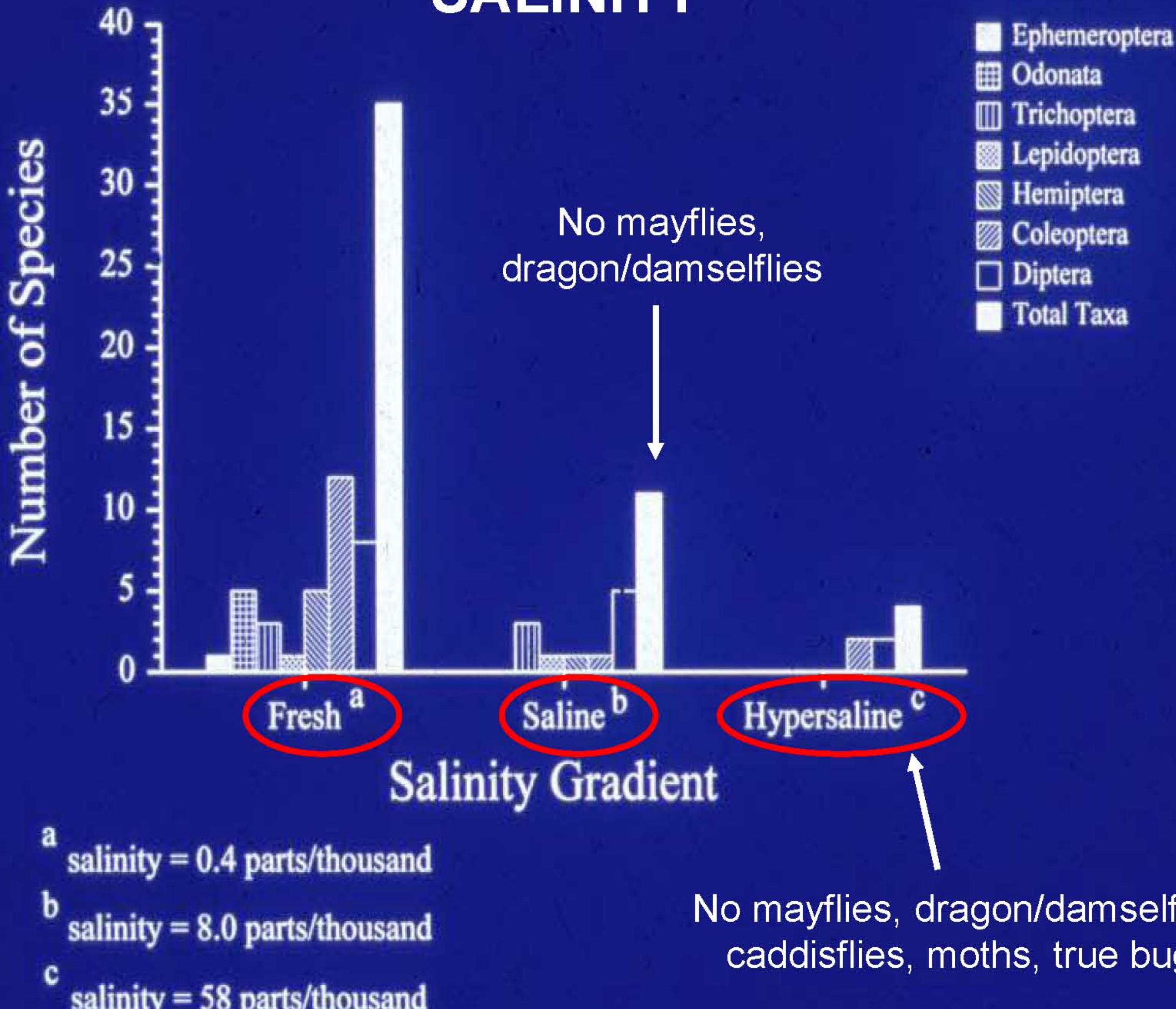
- Holding water to make temporary and seasonal wetlands more permanent results in long term salt accumulation

BRACKISH-SALINE TOLERANT FAMILIES

Order	Family	Common name
Hemiptera	Corixidae	Water boatmen
Coleoptera	Dytiscidae	Predaceous diving beetle
	Hydrophilidae	Water scavenger beetle
	Haliplidae	Crawling water beetle
	Gyrinidae	Whirligig beetle
Diptera	Dolichopodidae	Aquatic longlegged fly
	Ephydridae	Shore fly
	Chironomidae	Midge

Adapted from Ward (1992)

SALINITY



No mayflies, dragon/damselflies

No mayflies, dragon/damselflies, caddisflies, moths, true bugs

Some freshwater oligochaetes (worms) can withstand 10 ppt salinity

Adapted from Timms (1981) found in Ward (1992)

BIOASSESSMENT METRICS

- **Taxa Richness**
  - More distinct taxa ➔ suggests good habitat quality
- **Diversity**
  - High diversity ➔ suggests good habitat quality
  - Dominance by I or 2 taxa ➔ suggests poor quality
- **Density**
  - High density of benthic macroinverts ➔ suggests good habitat quality
  - Can be misleading if not used with % Pollution-Tolerant Organisms
- **% Pollution-Tolerant Organisms**
  - More individuals tolerant of various disturbances ➔ suggests poor habitat quality
  - Same species yields different tolerance values in different regions

Barbour et al. (1999)

Food Source for Other Animals

- The following forage on adult insects:
  - Birds: Falcons, Kingbirds, Kingfishers, Herons, Terns, Gulls, Sandpipers, Blackbirds, Swallows, Swifts, Martins, Grackles, Red-winged blackbirds
  - Fish
  - Amphibians
  - Bats


QUESTIONS?
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