

Limnology and Oceanography

Limnology: Biota of Lotic Systems



Learning Outcomes

To explore the organisms living in lotic habitats

To examine in detail a key lotic theoretical concept the River Continuum Concept (RCC)

Who are the Dominant Organisms Living in Lotic Habitats?

Key Biota

Characteristic biota:

Aquatic fungi, bacteria
& biofilm

Aquatic plants,
bryophytes & algae

Invertebrates (larvae):
Ephemeroptera, Plecoptera,
Trichoptera, Diptera, Odonata,
Coleoptera, Hemiptera,
Annelida, Mollusca,
Crustaceans

Fish

Amphibians & Reptiles

Birds

Mammals

Key Biota

Fast Flowing Waters

- Aquatic mosses (*Fontinalis*) and heavily branched filamentous algae **cling** to rocks by strong holdfasts while others grow in **cushion-like colonies** or form sheets
- *Hypnum palustre* – grows in the splash zone of rivers and lakes
- Leafy liverworts e.g. *Scapania* spp.



Key Biota

Organisms have evolved unique adaptations for dealing with life in the fast current

Ephemeroptera, Plecoptera, Fish

Streamlined bodies – offer less resistance to water currents
Fast swimmers

Plecoptera

Reduction in powers of flight

Ecdynourus spp, Gammarus spp. Flatworms

Flattened broad bodies and flat limbs – clinging

Trichoptera

- Protective cases that cements them to the stream bed
- Silk secretions
- Hooks on tarsi last segment of net-building caddis

Simulium larva

Silk secretions

Freshwater pearl mussel

Heavy shell

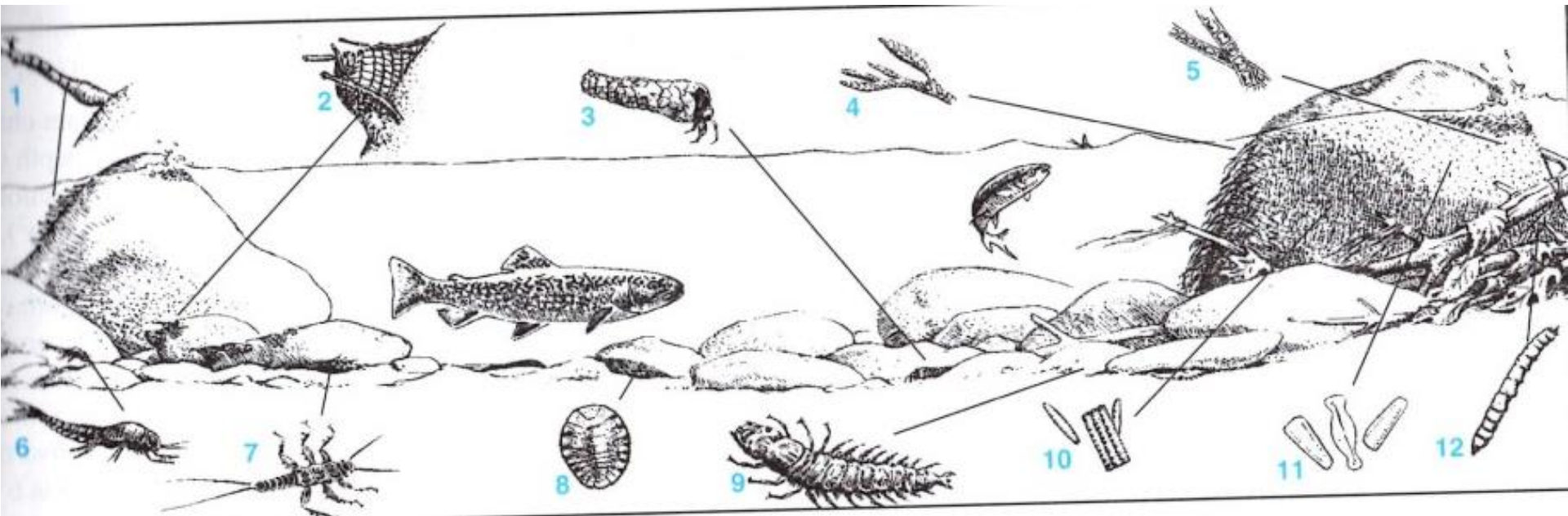
Molluscs

Sticky under surfaces help snails cling & move about

Key Biota

Animals in fast-flowing waters require:

- High/near saturation concentrations of oxygen
- Moving water to keep their absorbing and respiration surfaces in continuous contact with oxygenated waters



Key Biota

Slow Flowing Waters

Aquatic plants can root in sediments

Emergent plants

- *Phragmites australis* (**common reed**)
- *Typha latifolia* (**bulrush**)



Submerged plants

- *Myriophyllum spicatum* (spiked milfoil)
- *Ranunculus* spp. (**water crowfoot**)



Floating-leaved plants

- *Nuphar* spp. (**water lilies**)
- *Potamogeton* spp. (pondweeds)



Key Biota

Organisms tend to have specific retreats

Littoral Zone



☐ Grazing mollusca e.g.
Lymnaea spp., *Bithynia* spp.

☐ Ephemeroptera nymphs

☐ Plecoptera nymphs

☐ Dipteran larvae

☐ Beetle larvae & adults

☐ Water boatmen

☐ Odonata larvae

Profundal fauna



☐ O₂ can be in short supply

☐ Oligochaetes – tubificids

☐ Dipteran larvae –

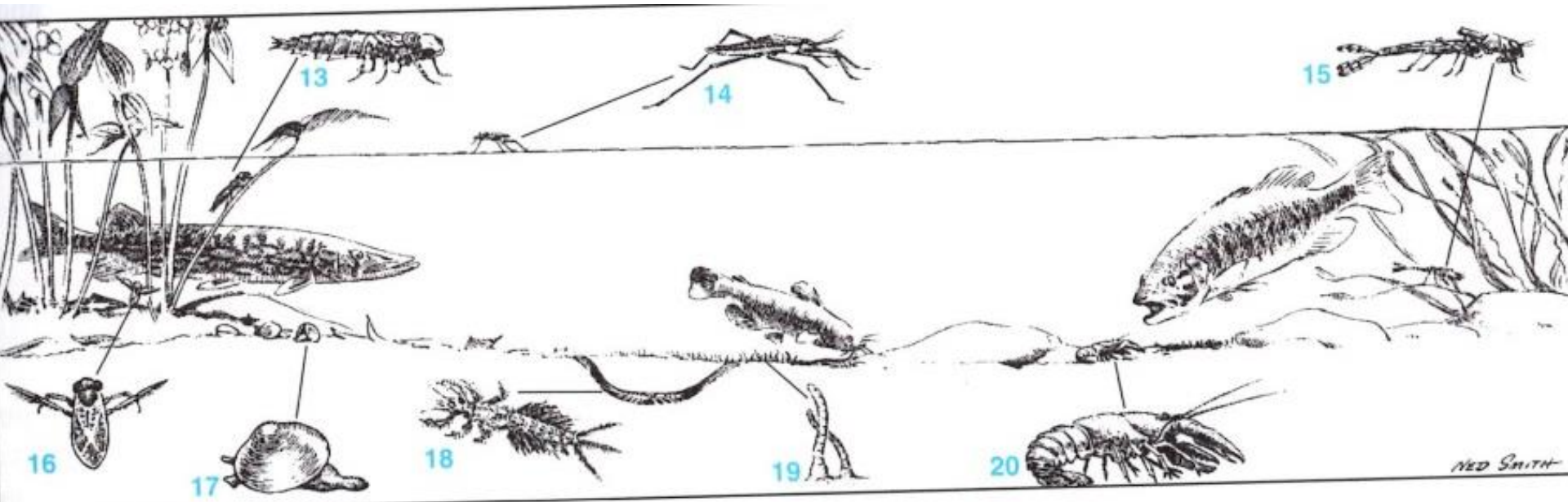
☐ *Chaoborus* larvae – migrate
up to surface at night to feed
on *Daphnia*

☐ Chironomid larvae – “blood
worms”

Key Biota

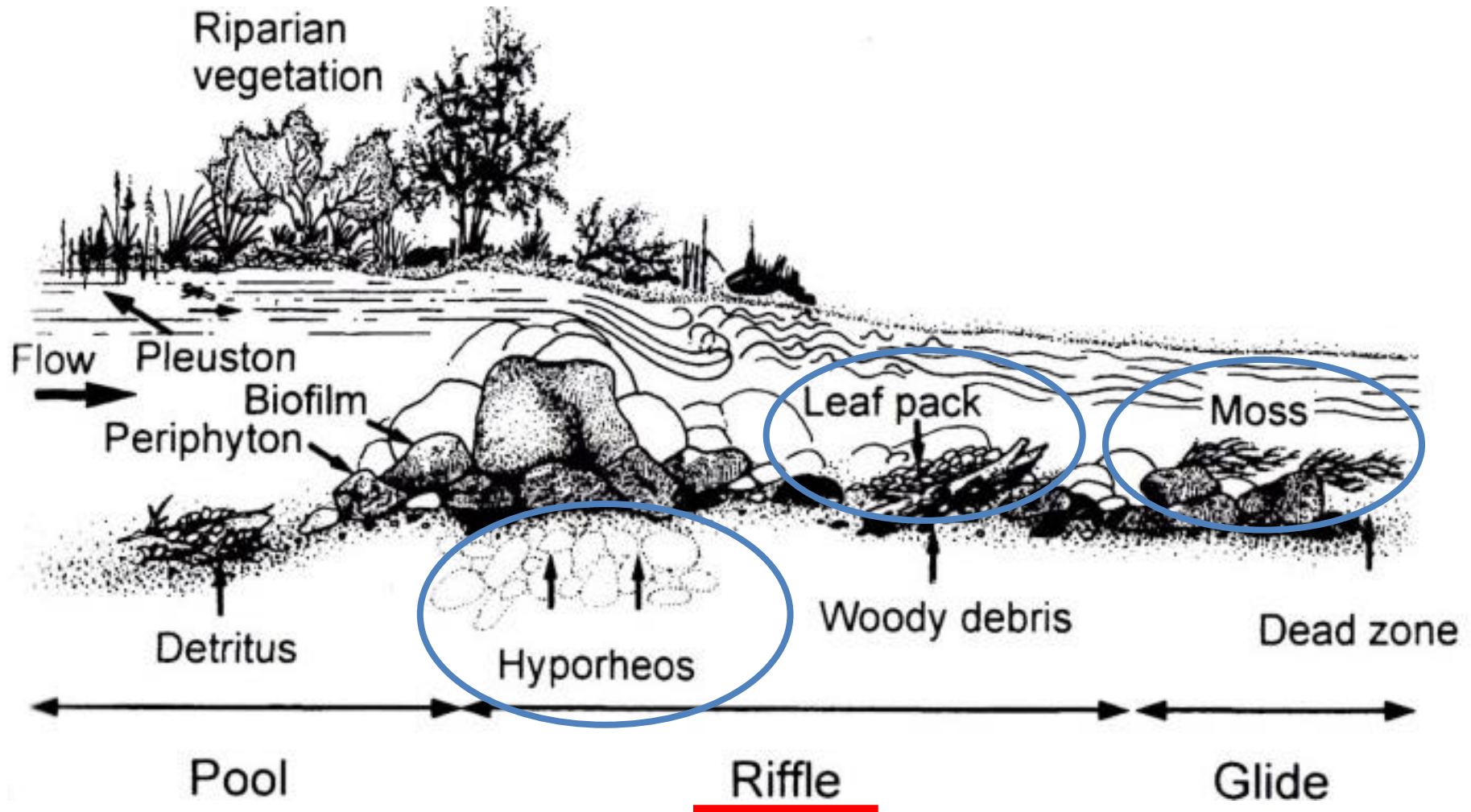
Animals in slow flowing (depositing) lotic environments tend to have:

- Compressed bodies
- Are bottom feeders
- Burrow into sediment



Macroinvertebrates

Macroinvertebrates are found hiding in the microhabitats of the stream bed – riffles, runs, glides, pools



Macroinvertebrates

Macroinvertebrates have a **functional role** in aquatic habitats

Directly and indirectly influence:

- **Decomposition** of organic matter
- **Transfer of nutrients** and materials through food webs
- Its **distribution** through the **aquatic food web**

Macroinvertebrates are classified into five major groups based on their feeding habits = **Functional Feeding Groups**

Functional Feeding Groups

1. Shedders (Gammarids, Plecoptera)

- Break down coarse particulate organic matter (CPOM e.g. leaves, twigs, woody debris) feeding on bacteria and fungi
- Assimilate 40% of ingested material and pass 60% as faeces = fine particulate organic matter (FPOM)
- FPOM drifts downstream, is picked up by filtering and gathering collectors, enhancing energy downstream



Functional Feeding Groups

2. Collectors

- a) **Filtering collectors** include Simuliidae (black fly larvae) with filtering fans and net-spinning caddisflies
- b) **Gathering collectors** e.g. larvae of midges pick up particles from stream-bottom sediments e.g. Chironomidae

Collectors obtain their nutrition from the bacteria associated with fine detrital particles (FPOM)



Functional Feeding Groups

3. Grazers

- Feed/scrape algal coatings, biofilm, periphyton and epiphytes on stones
- Excess material enters the stream as FPOM
- e.g. Beetle larvae, mobile caddis flies, snails



Functional Feeding Groups

4. Gougers

- Associated with woody debris
- Invertebrates which burrow into waterlogged limbs and trunks of fallen trees

5. Predators

- Feeding on the detrital feeders and grazers are predaceous insect larvae (Damselfly & Dragonfly larvae) and fish (trout)



River Continuum Concept – An Ever Changing Environment

River Continuum Concept (RCC)

Applies to **forested headwater catchments** in temperate zones

From the **headwaters to its mouth**, the flowing water ecosystem is a continuum of **changing environmental conditions** and **macroinvertebrate communities** in response to changes in food supply

Changes in functional feeding groups (macroinvertebrate communities) is determined by:

- Amount and type of **organic matter** (food) entering the river - called **allochthonous** material
- Amount of **primary production** (also food) in the river – called **autochthonous** material

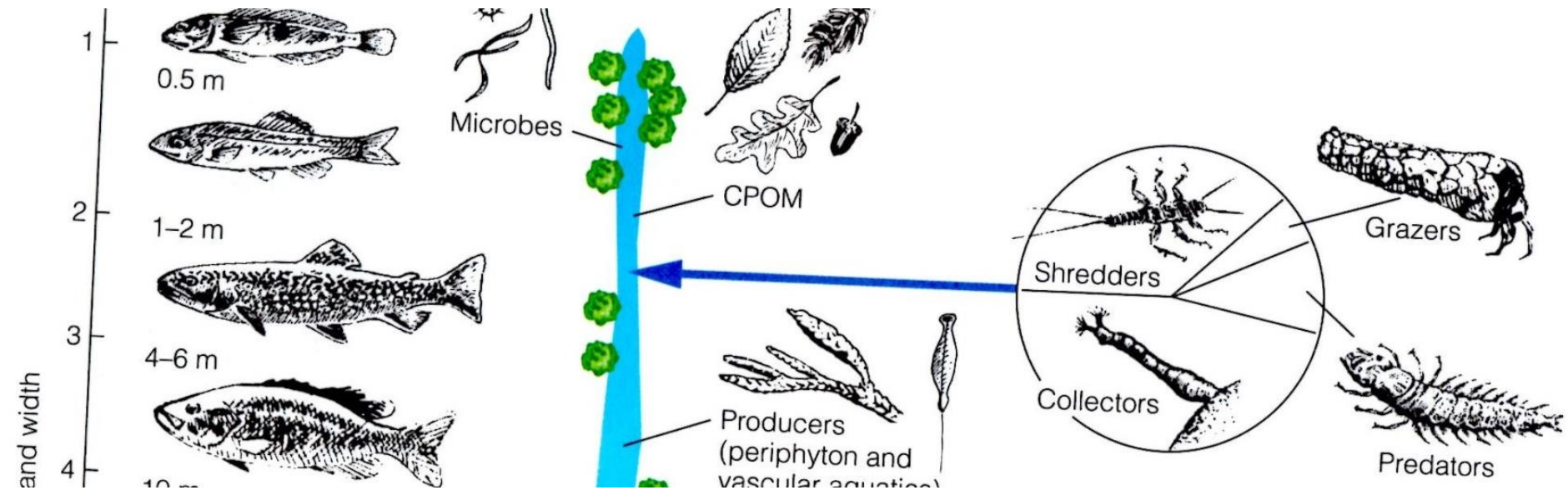
RCC is based on **stream order**, type of **organic matter** present and the **macroinvertebrates present**

River Continuum Concept (RCC)

Headwater streams (orders 1-3)

- Swift, cold, surrounded by native forestry
- Primary production is low
- Depend on **allochthonous material** - detritus and organic matter from riparian vegetation (contributes > 90% of organic input)
- **Shedders** – process and feed on CPOM
- **Collectors** – process and feed on FPOM
- Grazers are minimal – small amount of autotrophic production
- Predators are small fish e.g. trout

River Continuum Concept (RCC)



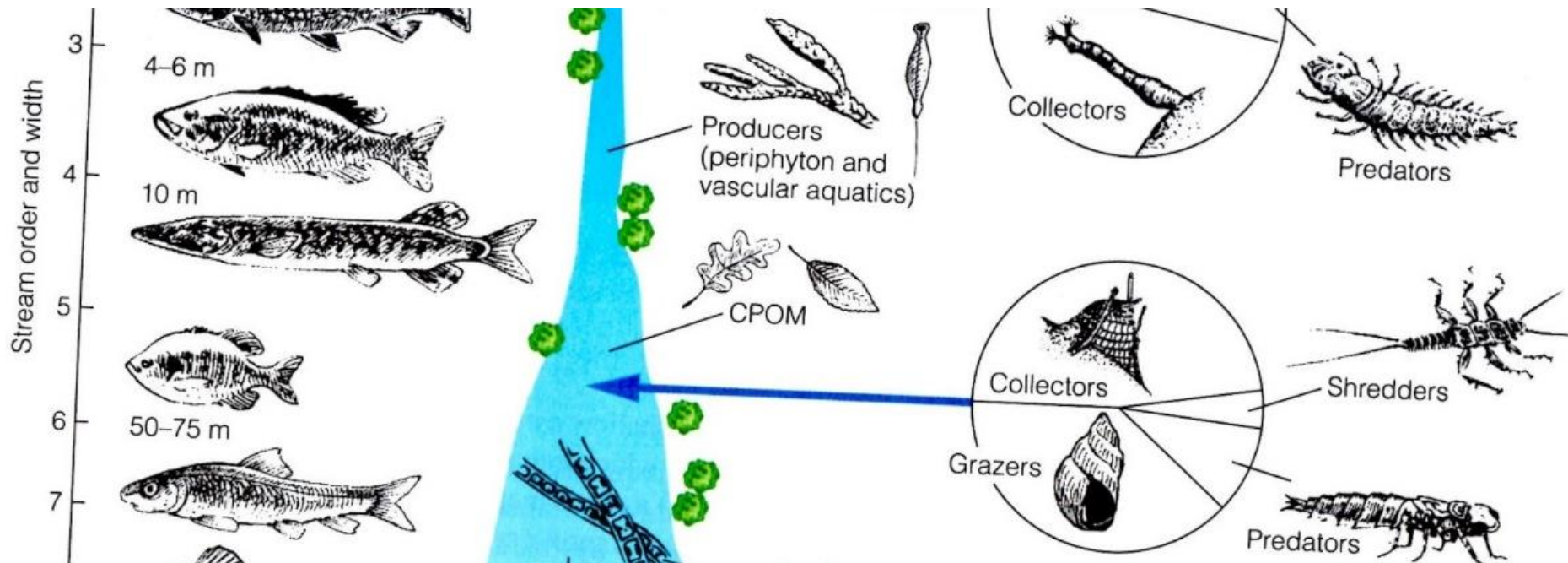
River Continuum Concept (RCC)

Medium-sized streams (orders 4-5)

- Increase in stream width
- Input of native riparian vegetation decreases
- Water temperatures increase
- Elevation gradient lowers
- Current speed increases
- In-stream primary production (**Autochthonous**) is by algae and aquatic plants (autotrophs)
- No CPOM = No Shedders
- **Collectors** – feed on FPOM

River Continuum Concept (RCC)

- **Grazers** – feed on autotrophic production (dominant consumers)
- Predators – shift to warm water spp. including bottom feeding fish e.g. suckers

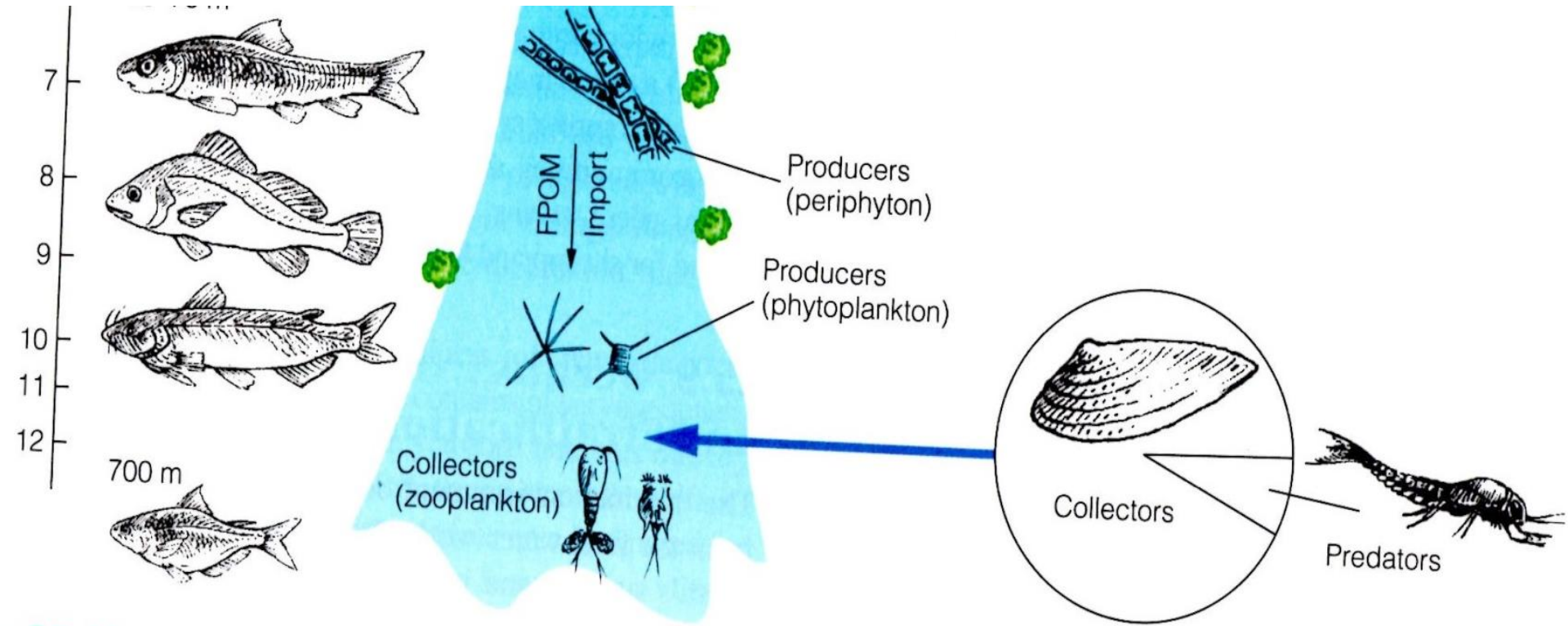


River Continuum Concept (RCC)

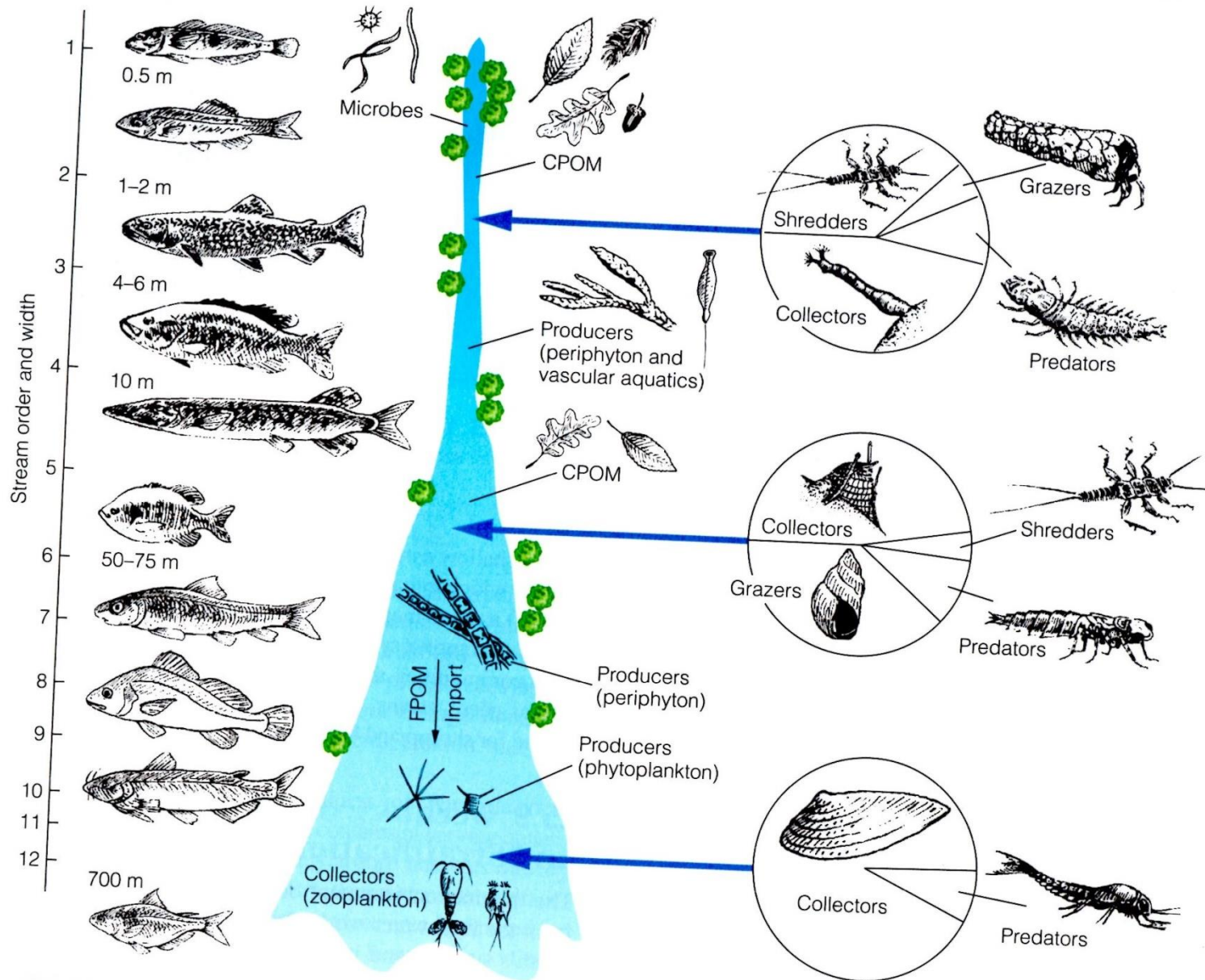
Rivers (orders 6-10)

- Channel is wider and deeper with increased flow
- Current velocity decreases
- Sediment accumulates at the bottom
- Riparian and autotrophic production decreases
- **FPOM & DOM** is the primary energy source by bottom dwelling **filter collectors** (dominant consumers)
- Support minimal phyto- and zoo-plankton population
- Communities capitalise on upstream feeding inefficiencies

River Continuum Concept (RCC)



River Continuum Concept (RCC)



River Continuum Concept (RCC)

System changes from **heterotrophic** (headwaters) to **autotrophic**

- Shredders expected to be common in lower order streams
- Grazers most abundant in middle order streams
- Collectors/Filterers present throughout the stream with abundance greatest in orders >5
- Predators relatively uncommon in general

Changes in type of organic matter (food) and the physical environment (stream order) = changing functional feeding groups (macroinvertebrates)

Key Points

Key lotic biota include: Microbes, aquatic plants, macroinvertebrates (larvae), fish, amphibians, reptiles, birds and mammals

Macroinvertebrates have various adaptations to survive in fast or slow flowing waters

Macroinvertebrates are divided into five functional feeding groups: shredders, collectors, grazers, gougers, predators

River Continuum Concept (RCC) is based on **stream order, type of organic matter** present and type of **benthic invertebrates present**

- Applies to forested headwater catchments in temperate zones

Reading List

Smith, T.M. & Smith, R.L. (2012). Elements of Ecology. Benjamin Cummings, London.

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Giller, P. and Malmqvist, B. (1998). The Biology of Streams and Rivers. Oxford University Press, New York, USA

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Freshwater Ecology and Limnology books in the library ;)

Thank you