Říční ekosystémy

Z4825

7. Potravní sítě

GEOGRAFICKÝ ÚSTAV
PŘÍRODOVĚDECKÁ FAKULTA MU

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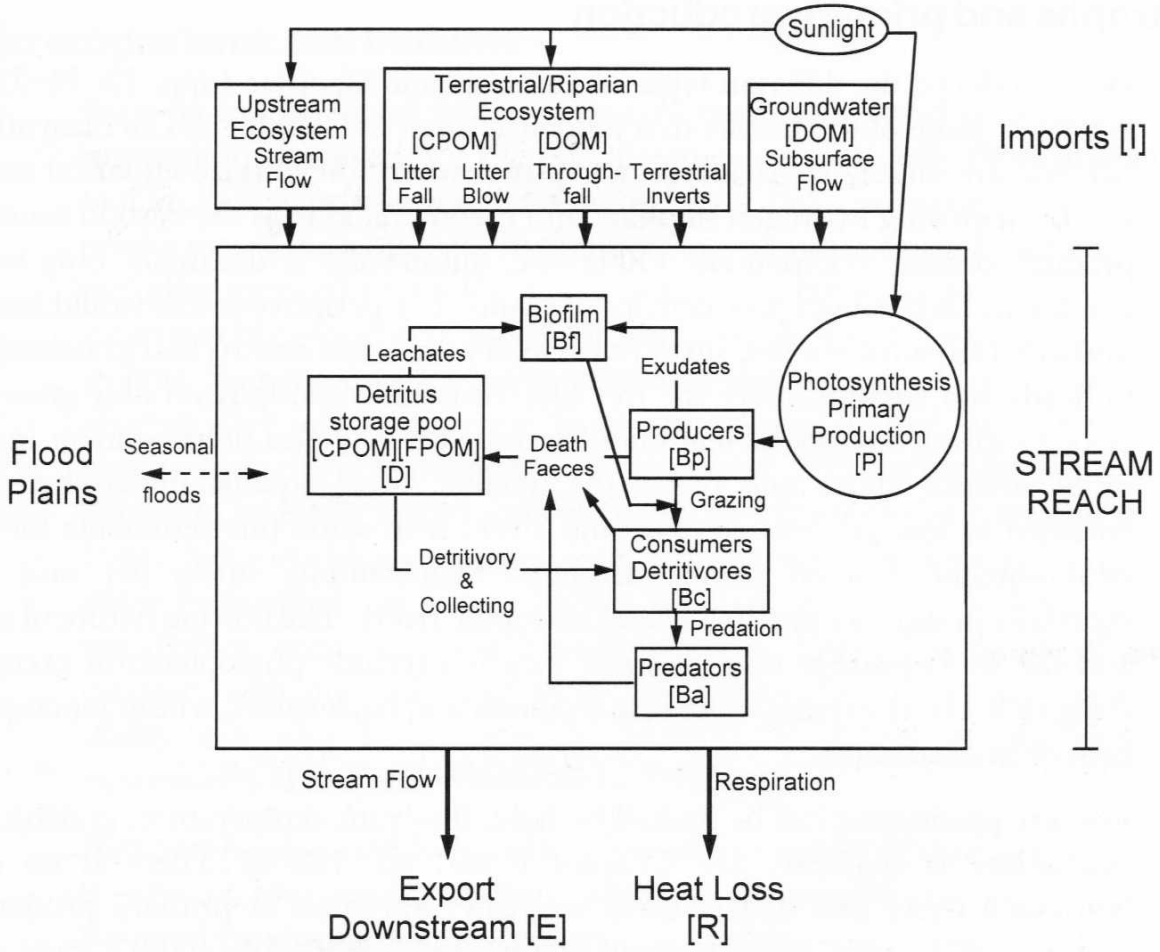
SYLABUS

1. Fluviální struktury a procesy, říční síť a krajina, fyzikální charakteristiky
2. Chemické charakteristiky, cykly látek
3. Sedimenty, hydraulické faktory, typy substrátu, organická hmota a procesy
4. Říční biota – mikroorganismy, řasy, makrofyta, produkce a dekompozice
5. Říční biota – bezobratlí živočichové
6. Říční biota – ryby a další obratlovci
7. **Potravní sítě, toky látek a energie**
8. Regulace a morfologická degradace vodních toků
9. Znečištění vodních toků a kombinace stresorů
10. Vodohospodářské strategie, hodnocení stavu vod
11. Ochrana a revitalizace říčních ekosystémů
12. Případové studie
13. Exkurze: regulovaný tok v městské krajině

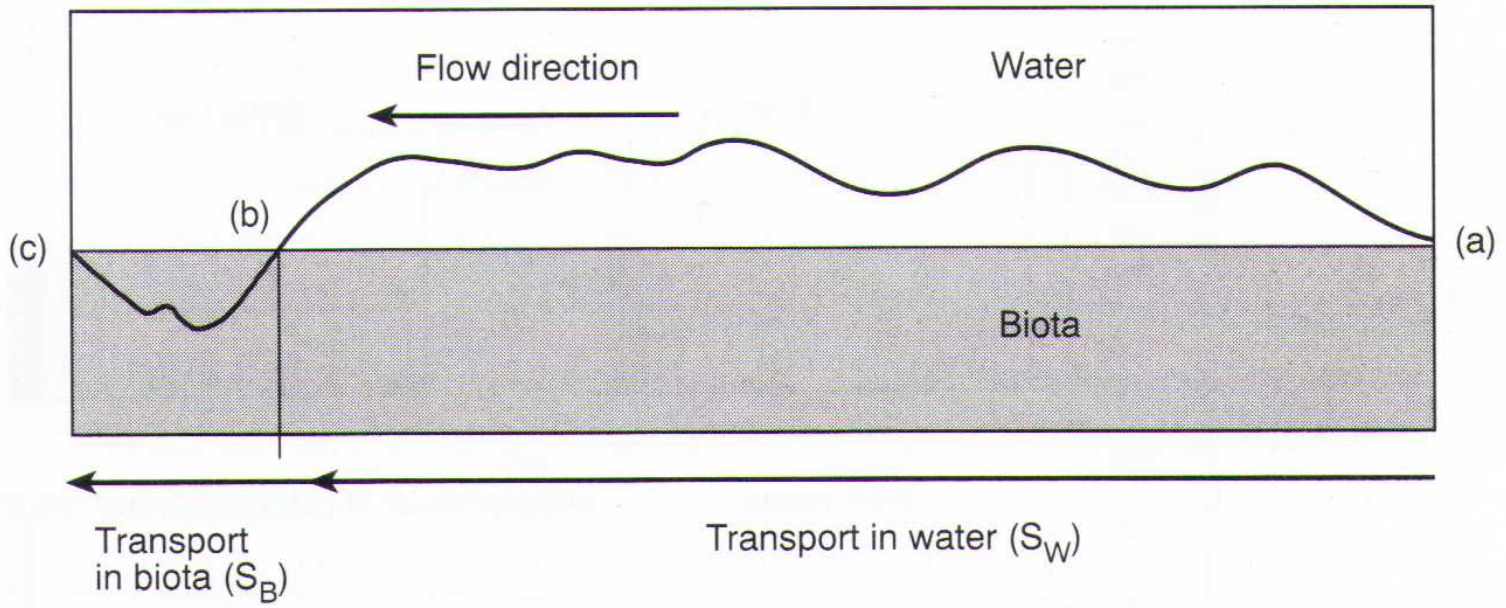
ENERGETICKÁ BILANCE V TOCÍCH

Fig. 6.2 Components of the energy budget of a stream reach. The budget is given by: Import (I) + Primary Production (P) = Export (E) + Community Respiration (R) + Change in Biomass of organic matter in the system [Δ(D + Bf + Bp + Bc + Ba)]. (Adapted from Fisher and Likens, 1973.)



SPIRÁLNÍ TRANSPORT LÁTEK

Fig. 6.6 A schematic figure of nutrient spiralling. The irregular line indicates the path of a dissolved nutrient atom that is regenerated from biota at point (a) and carried by the water downstream to a point (b) where it is taken up by an organism. The organism typically moves a short distance downstream before the atom is mineralized and returned to the water (c). The spiralling distance is the sum of S_W ('uptake length') and S_B ('turnover length'). (Modified from Newbold, 1992.)



SPIRÁLNÍ TRANSPORT LÁTEK

- délka spirály 190 m pro fosfor (Newbold et al. 1983)
- 165 m vodou
- 25 m v mikroorganismech vázaných na CPOM, FPOM a biofilm
- méně než 2 m v konzumentech

POTRAVNÍ STRATEGIE BEZOBRATLÝCH

TABLE 6.1 The feeding roles of invertebrate consumers in running waters. (Based on Cummins, 1973; Cummins and Klug, 1979; Anderson and Sedell, 1979; Wallace and Merritt, 1980)

Feeding role	*Food resource*	*Feeding mechanism*	*Examples*
Shredder	Non-woody CPOM, primarily leaves; and associated microbiota, especially fungi	Chewing and mining	Several families of Trichoptera, Plecoptera, and Crustacea; some Diptera, snails
Shredder/gouger	Woody CPOM and microbiota, especially fungi; primarily surficial layers are utilized	As above	Occasional taxa among Diptera, Coleoptera, Trichoptera
Suspension feeder/ filterer-collector	FPOM and microbiota, especially bacteria and sloughed periphyton in water column	Collect particles using setae, specialized filtering apparatus or nets and secretions	Net-spinning Trichoptera, Simuliidae and other Diptera; some Ephemeroptera
Deposit feeder/ collector-gatherer	FPOM and microbiota, especially bacteria, and organic microlayer	Collect surface deposits, browse on amorphous material, burrow in soft sediments	Many Ephemeroptera, Chironomidae and Ceratopogonidae
Grazer	Periphyton, especially diatoms; and organic microlayer	Scraping, rasping and browsing adaptions	Several families of Ephemeroptera and Trichoptera; some Diptera, Lepidoptera and Coleoptera
	Macrophytes	Piercing	Hydroptilid caddis larvae
Predator	Animal prey	Biting and piercing	Odonata, Megaloptera, some Plecoptera, Trichoptera, Diptera and Coleoptera

HRUBÁ PARTIKULOVANÁ ORGANICKÁ HMOTA (CPOM)

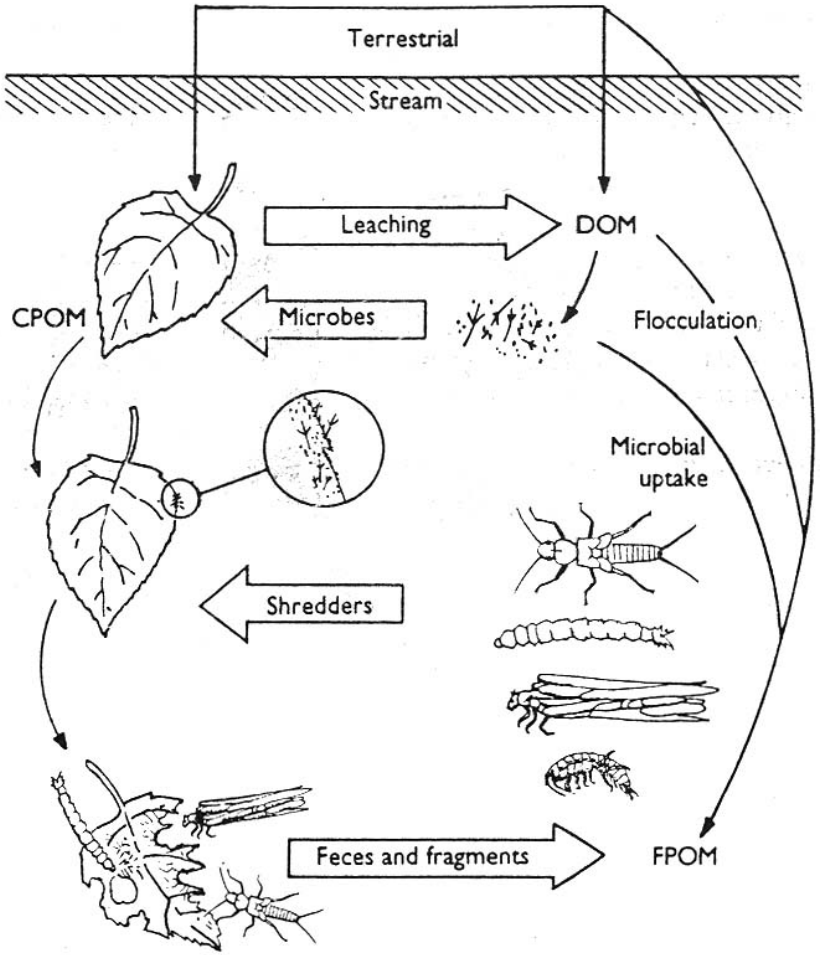


FIGURE 6.2 The links between shredders and CPOM, fungi and bacteria modeled for a small stream within a temperate deciduous forest. Physical abrasion, microbial activity (especially by fungi) and invertebrate shredders reduce much of the CPOM to smaller particles. Chemical leaching and microbial excretion and respiration release DOM and CO_2, but much of the original carbon enters other detrital pools as feces and fragmented material. (After Cummins and Klug, 1979.)

HRUBÁ PARTIKULOVANÁ ORGANICKÁ HMOTA (CPOM)

Trophic relationships

TABLE 6.2 The contrasting feeding strategies of two CPOM detritivores (Based on Barlöcher, 1983)

	Gammarus fossarum	*Tipula abdominalis*
Feeding mechanism	Scrapes at leaf surface	Chews entire leaf
Gut pH and digestive biochemistry	Anterior gut slightly acid	Foregut and midgut highly alkaline (up to 11.6)
	Its own enzymes and fungal exoenzymes attack leaf carbohydrates	Result is high proteolic activity but inactivation of fungal exoenzymes, thus little activity toward leaf carbohydrates
	Posterior gut is alkaline, would digest microbial proteins and some leaf proteins	
Efficiency	Highly efficient at processing conditioned leaves at low metabolic cost	Less dependent upon stage of conditioning, probably good at extracting protein, but at high metabolic cost
Other attributes of feeding ecology	Highly mobile	Low mobility
	Polyphagous	Obligate detritivore

JEMNÁ PARTIKULOVANÁ ORGANICKÁ HMOTA (FPOM)

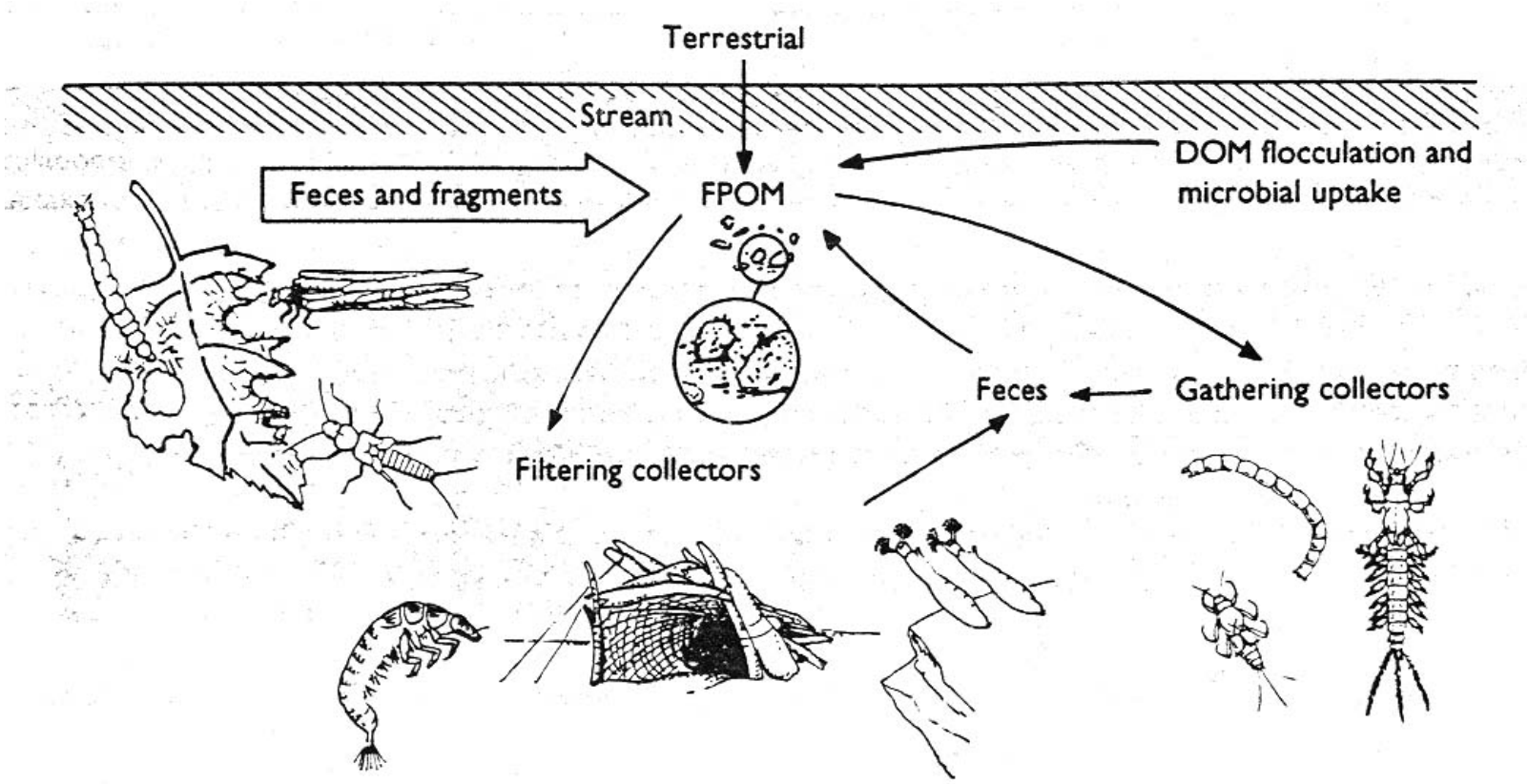


FIGURE 6.5 The collector–FPOM–bacterial linkage modeled for a small stream within a temperate deciduous forest. Detrital particles less than 1 mm produced by fragmentation of larger particles and from terrestrial inputs are surface-colonized by microorganisms. Additional carbon may accrue via flocculation and microbial uptake. Fecal matter, small animals and cells from the periphyton also contribute to FPOM. Suspension and deposit feeding are primary modes of FPOM acquisition, and further distinctions are made on the basis of particle size. (After Cummins and Klug, 1979.)

SUSPENDOVANÁ HMOTA

FIGURE 6.7 Diversity of suspension-feeding modes in running water. (a) Philopotamid caddis larva with tube-like net on the lower surface of a stone; (b) a hydropsychid caddis larva feeding on materials trapped on its capture net; (c) a chironomid midge larva, *Rheotanytarsus*, and its tube case; (d) a culicine mosquito larva in a discarded container; (e) a *Chironomus* larva in its J-shaped tube, better suited to deposit feeding. This larva also suspension feeds when U-shaped tubes are constructed; (f) the mayfly nymph *Hexagenia* in its U-shaped burrow; (g) the polycentopodid caddis *Neureclipsis* and its cornucopia-shaped net; (h) the larval dwelling and filtering apparatus of the hydropsychid *Macronema*, with its water intake opening projecting above the surface; (i) a *Brachycentrus* caddisfly larva in filtering position; (j) a black fly larva with extended cephalic fans; (k) the polycentopodid caddis larva *Phylocentropus* in its branched dwelling tube located in regions of finer sediments; (l) the mayfly *Isonychia* filtering with setae of its forelegs. (From Wallace and Merritt, 1980.)

SPÁSAČI / SEŠKRABÁVAČI

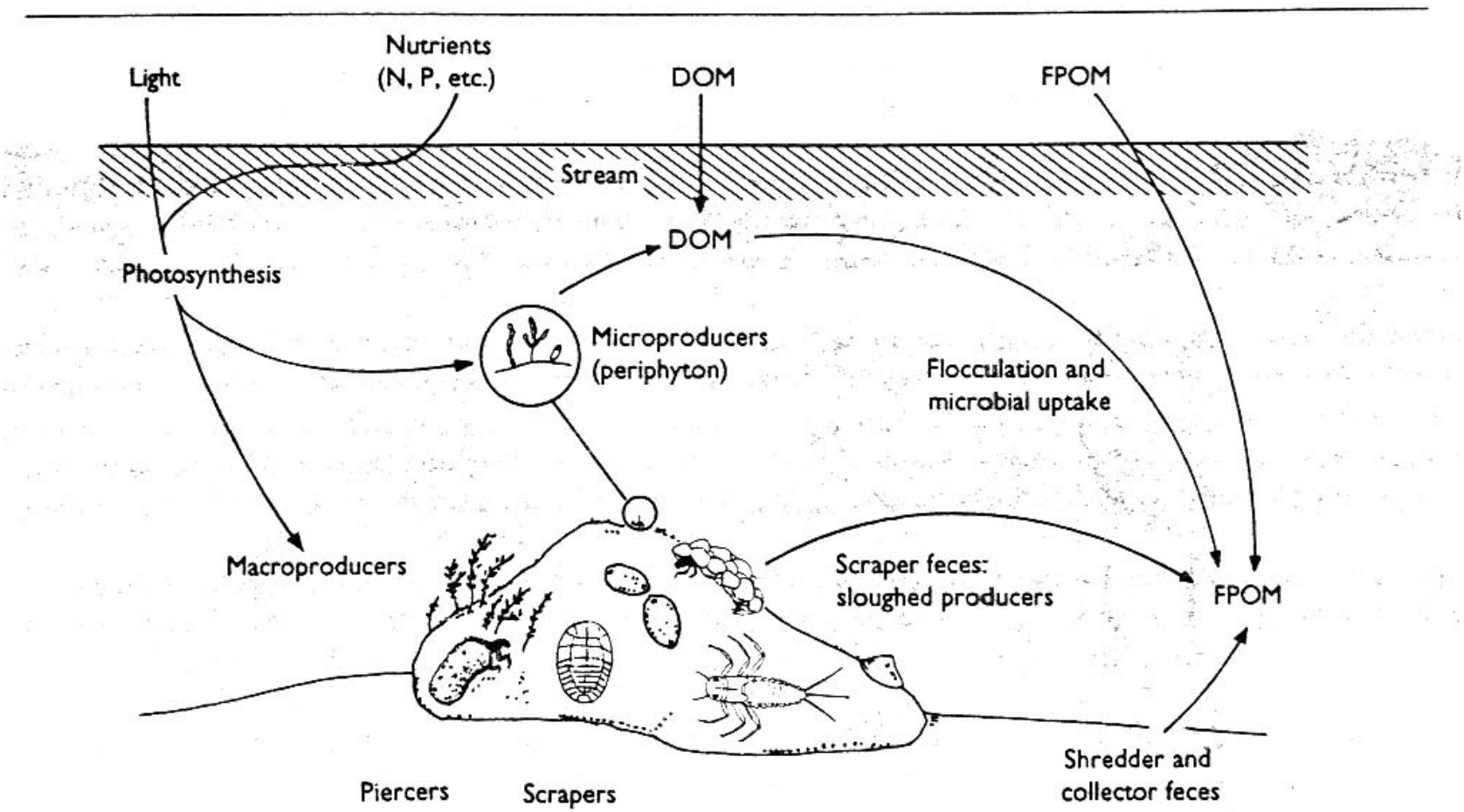


FIGURE 6.8 The grazer:periphyton and piercer:macrophyte linkages for a temperate stream. By a variety of mechanisms, the periphyton–bacteria–organic microlayer on substrate surfaces is scraped or browsed. Diatoms are a prominent constituent of this matrix. The contributions of the surface microlayer and associated bacteria, detritus and occasional very small invertebrates are difficult to quantify. Small caddis larvae (Hydroptilidae) pierce the cell walls of macroalgae and imbibe cell fluids. (After Cummins and Klug, 1979.)

PREDÁTOŘI

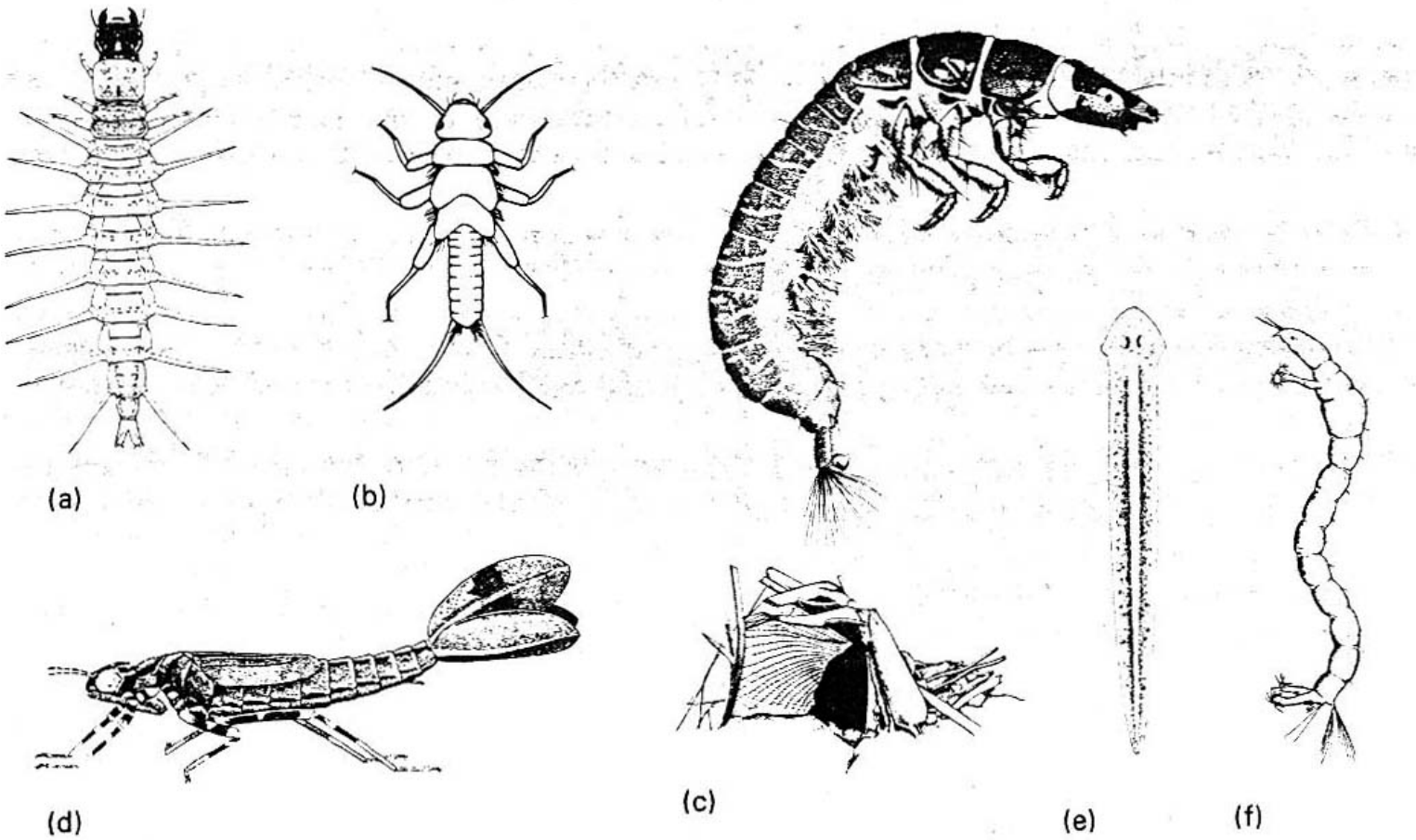
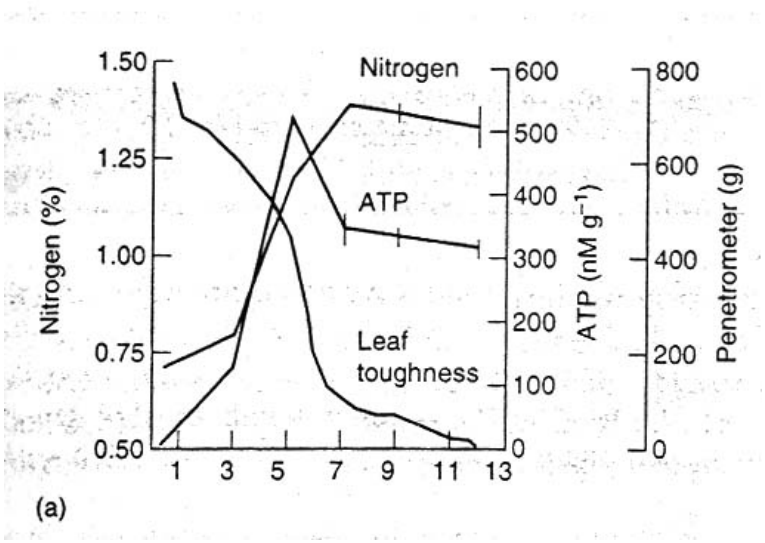
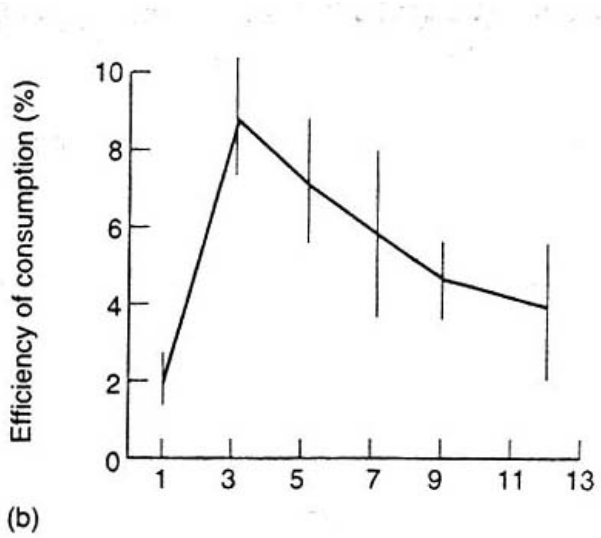


FIGURE 6.9 The predator:prey linkage for a temperate stream. Predaceous insects include those consuming large prey, illustrated by nymphs of (a) Megaloptera (Corydalidae) and (b) Plecoptera (Perlidae); those consuming prey of intermediate size, illustrated by (c) Trichoptera (Hydropsychidae) and (d) Odonata (Zygoptera); and those consuming small prey, illustrated by (e) Turbellaria (Tricladida) and (f) Chironomidae (Tanypodinae).

TRANSFORMACE ORGANICKÉ HMOTY





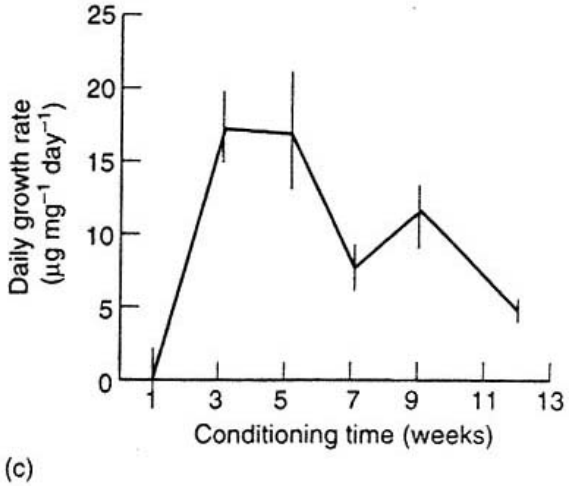


FIGURE 6.4 The influence of conditioning time of discs of hickory leaves on utilization by *Tipula abdominalis*. The food appears to reach peak condition in 3–5 weeks, as indicated by buildup of ATP (an index of microbial biomass), relative nitrogen content, and the progressive softening of leaf discs (a). Changes in efficiency of conversion of ingested material into consumer biomass (b) and daily growth rate (c) correspond to the time course of conditioning. The greater nutritional value of leaf discs at peak conditioning time apparently was due to peak digestibility of the leaf itself, rather than ingestion of microbial biomass. (After Lawson, Klug and Merritt, 1984).

LOTICKÁ POTRAVNÍ SÍŤ

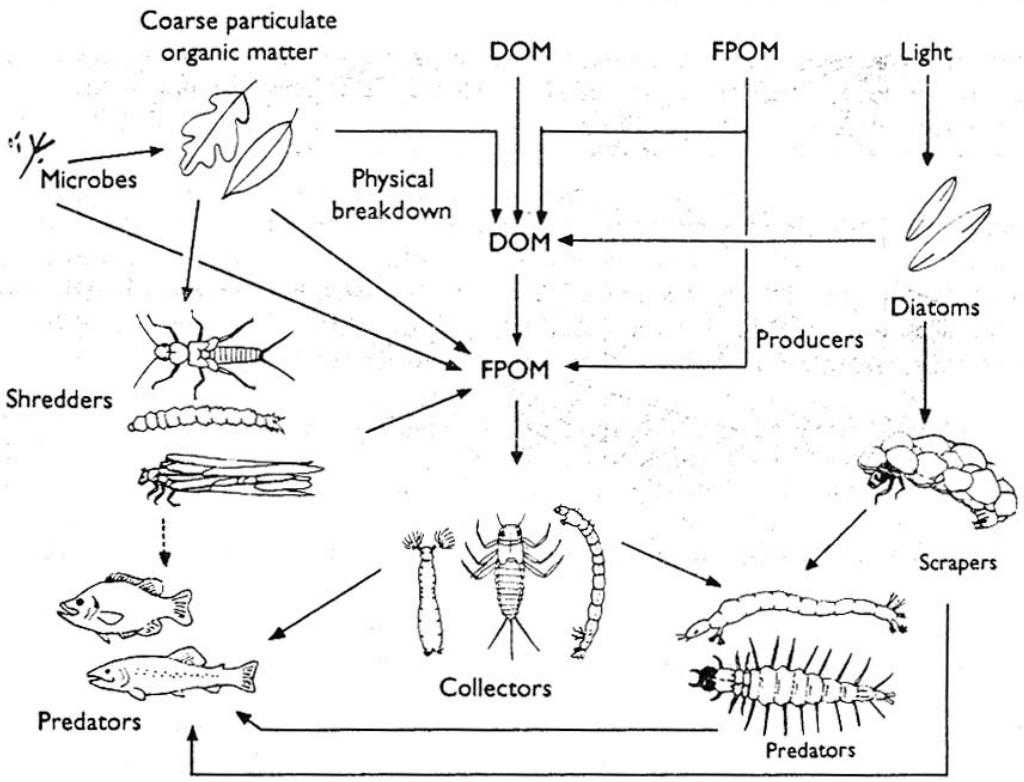
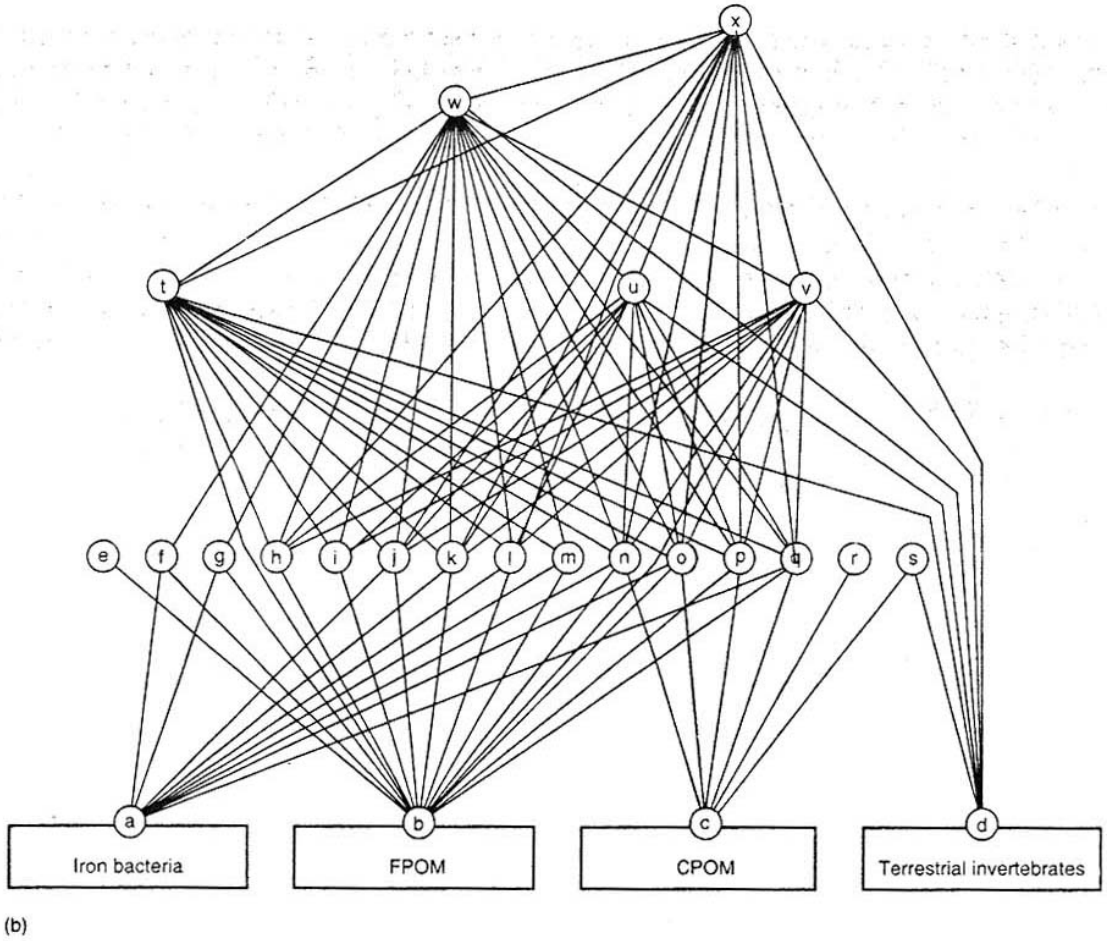


FIGURE 6.14 Lotic food webs. (a) A simplified view of a food web in a woodland stream. Energy inputs include fallen leaves, subsequently colonized by microbes; small autotrophs, primarily diatoms; and DOM and FPOM, originating from external sources and upstream. Feeding categories are based on divisions of Table 6.1: shredders include *Pteronarcys*, *Tipula* and *Pycnopsyche*; *Stenonema* is a deposit feeder, *Simulium* is a filter feeder and *Glossosoma* is a grazer. Examples of predators include *Nigronia* (Megaloptera) and two fish (*Cottus* and *Salmo*). (Modified from Cummins, 1973.) (b) Food web for a species-poor small stream in southern England. Primary consumers include: (e) *Psidium* sp., (f) Simuliidae, (g) *Niphargus aquilex*, (h) microcrustacea, (i) other microinvertebrates, (j) *Heterotrissocladius marcidus*, (k) *Micropsectra bidentata*, (l) *Prodiamesa olivacea*, (m) Oligochaeta, (n) *Leuctra nigra*, (o) *Nemurella picteti*, (p) *Brilla modesta*, (q) *Polypedilum albicornis*, (r) Tipulidae, (s) *Potamophylax cingulatus*. Predators include: (t) *Macropelopia goetghebueri*; (u) *Trissopelopia longimana*, (v) *Zavrelimyia barbatipes*, (w) *Plectrocinemia conspersa*, (x) *Sialis fulginosa*. Note that the predator *Sialis* can be four energy transfers removed from the base of the food web. (Modified from Hildrew *et al.*, 1987.)

LOTICKÁ POTRAVNÍ SÍŤ



(b)

(Modified from Cummins, 1973.) (b) Food web for a species-poor small stream in southern England. Primary consumers include: (e) *Psidium* sp., (f) Simuliidae, (g) *Niphargus aquilex*, (h) microcrustacea, (i) other microinvertebrates, (j) *Heterotrissocladius marcidus*, (k) *Micropsectra bidentata*, (l) *Prodiamesa olivacea*, (m) Oligochaeta, (n) *Leuctra nigra*, (o) *Nemurella picteti*, (p) *Brilla modesta*, (q) *Polypedilum albicornis*, (r) Tipulidae, (s) *Potamophylax cingulatus*. Predators include: (t) *Macropelopia goetghebueri*; (u) *Trissopelopia longimana*, (v) *Zavrelimyia barbatipes*, (w) *Plectrocinemia conspersa*, (x) *Sialis fulginosa*. Note that the predator *Sialis* can be four energy transfers removed from the base of the food web. (Modified from Hildrew *et al.*, 1987.)

POTRAVNĚ-FUNKČNÍ SKUPINY (STRATEGIE)

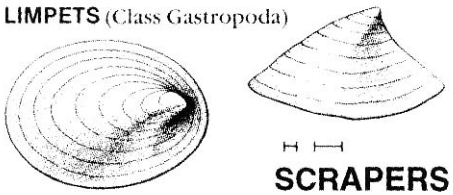
APPENDIX 21.1: SIMPLIFIED KEYS TO THE FUNCTIONAL FEEDING GROUPS OF LOTIC MACROINVERTEBRATES

KEY TO FUNCTIONAL FEEDING GROUPS

⊢⊣ ⊢——⊣ indicates size or range of sizes

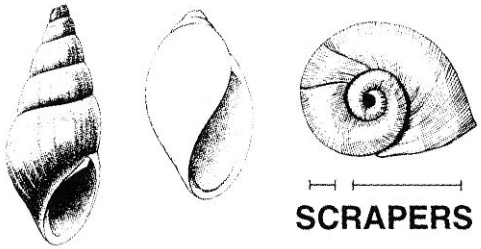
1. **ANIMALS IN HARD SHELL** (Phylum Mollusca)

a. **LIMPETS** (Class Gastropoda)



SCRAPERS

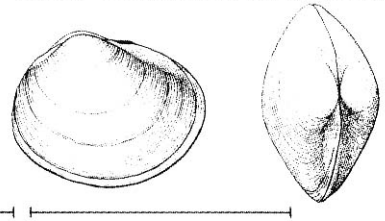
b. **SNAILS** (Class Gastropoda)



SCRAPERS

Snails are generalized (facultative) feeders and can also function as Shredders.

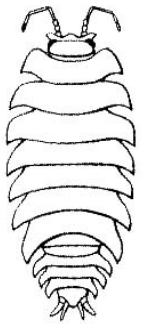
c. **CLAMS OR MUSSELS** (Class Pelecypoda)

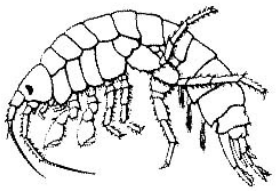


FILTERING COLLECTORS

APPENDIX 21.1—*continued*

2. **SOW BUG OR SHRIMP-LIKE ANIMALS** (Class Crustacea)





SHREDDERS

Generalized, can also function as Gathering Collectors.

3. **LARVAE IN PORTABLE CASE OR "HOUSE"**

Go to KEY 2

4. **LARVAE IN FIXED RETREAT WITH CAPTURE NET**

Note: Care must be taken when collecting to observe nets.

Go to KEY 3

5. **WITHOUT CASE OR FIXED RETREAT**

a. **WORM-LIKE LARVAE WITHOUT JOINTED LEGS**

Go to KEY 4

b. **NYMPHS OR ADULTS WITH JOINTED LEGS**

Go to KEY 5

6. **DOES NOT FIT KEY 5 EXACTLY. GO TO KEY 6**

POTRAVNĚ-FUNKČNÍ SKUPINY (STRATEGIE)

APPENDIX 21.1—*continued*

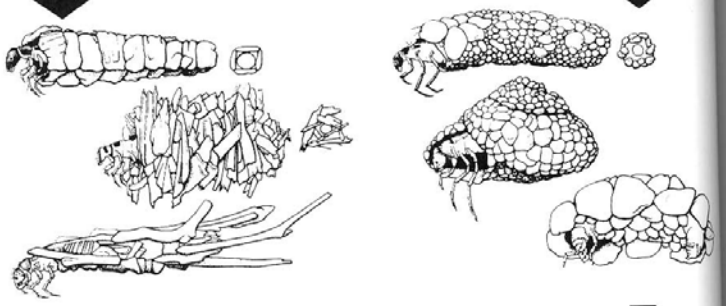
KEY 2

FIRST LEVEL OF RESOLUTION

LARVAE IN PORTABLE CASE
Caddisflies (Order Trichoptera)

CASES ORGANIC
Leaf, stick, needle, bark

CASES MINERAL
Sand, fine gravel



Families Limnephilidae (in part) Lepidostomatideae (in part) Phryganeidae, Leptoceridae (in part)

Families Glossosomatidae, Limnephilidae (in part), Helicopsychidae

SHREDDERS

SCRAPERS

SECOND LEVEL OF RESOLUTION considers a few fairly common caddisfies that would be misclassified above on the basis of case compositon alone.

CASES ORGANIC

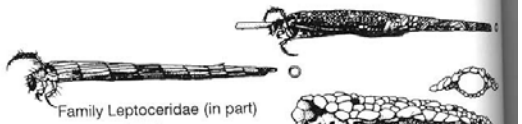
Cases square in cross section and tapered, with no bark or flat leaf pieces included. Front attached to substrate. Larvae extend legs and filter the current.

Foreleg with filtering hairs

Family Brachycentridae

FILTERING COLLECTORS

Cases long, slender, and tapered, made of plant material



Family Leptoceridae (in part)

GATHERING COLLECTORS

CASES MINERAL

Cases long, slender, and tapered (mostly fine sand or cases ovoid and very flat in cross section

Family Leptoceridae (in part)

GATHERING COLLECTORS

APPENDIX 21.1—*continued*

KEY 3

FIRST LEVEL OF RESOLUTION

LARVAE WITH FIXED RETREAT AND CAPTURE NET

Note: Care must be taken when collecting to observe nets.

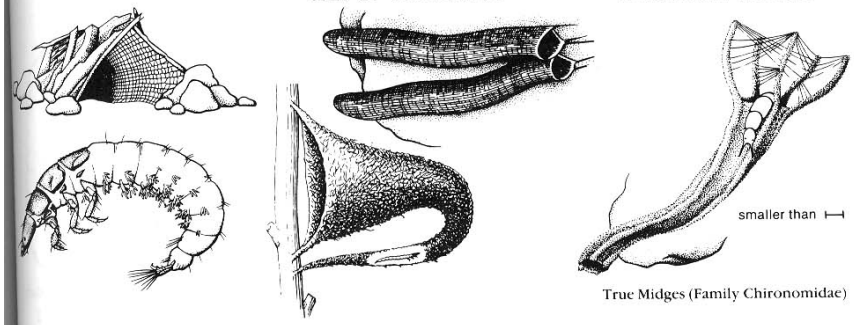
Caddisflies (Order Trichoptera)

True Flies (Order Diptera)

COARSE NET IN "SCAFFOLDING"

FLATTENED SOCK-LIKE OR TRUMPET-SHAPED NET OF FINE MESH

TUBE WITH SILK STRANDS STRUNG BETWEEN TERMINAL PRONGS



True Midges (Family Chironomidae)

Families Hydropsychidae, Philopotamidae, Polycentropodidae

FILTERING COLLECTORS

SECOND LEVEL OF RESOLUTION separates from free living larvae those net spinning caddisflies that may have been inadvertently collected without being associated with their nets.

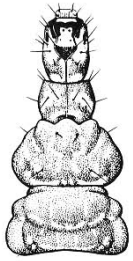
NET SPINNING CADDISFLIES
Frequently separated from their nets

HEAD AS WIDE AS THORAX

Especially Philopotamidae (bright yellow) and Hydropsychidae (bright green or brown)

ILTERING COLLECTORS

FREE LIVING CADDISFLIES
Non net spinning



HEAD LONG, SMALL, AND NARROWER THAN THORAX

Rhyacophilidae (often bright green)

PREDATORS

POTRAVNĚ-FUNKČNÍ SKUPINY (STRATEGIE)

APPENDIX 21.1—*continued*

KEY 4

FIRST LEVEL OF RESOLUTION

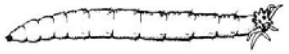
WORM-LIKE LARVAE WITHOUT JOINTED LEGS

LARGE — larger than —

SMALL — smaller than —

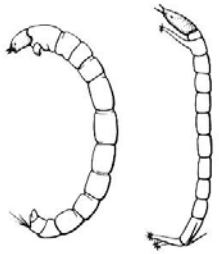
LONG AND SLENDER

Head retractile and poorly developed
Caudal lobes with eye-like spiracles



Craneflies (Family Tipulidae in part)

SHREDDERS



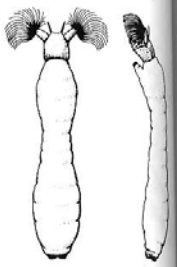
True Midges (Family Chironomidae)

Note: Subtract 10% of count for Predators.

GATHERING COLLECTORS

BOWLING PIN SHAPE

Bulbous base usually fastened tightly to substrate



Blackflies (Family Simuliidae)

FILTERING COLLECTORS

SECOND LEVEL OF RESOLUTION considers some common worm-like Predators that would be misclassified in the above key.

WORM-LIKE LARVAE WITHOUT JOINTED LEGS

LARGE

Family Tipulidae (*Eriocera* type)

Posterior segment swollen
Head retractile

SMALL

Prolegs poorly developed or absent
Jaws well developed
Very active

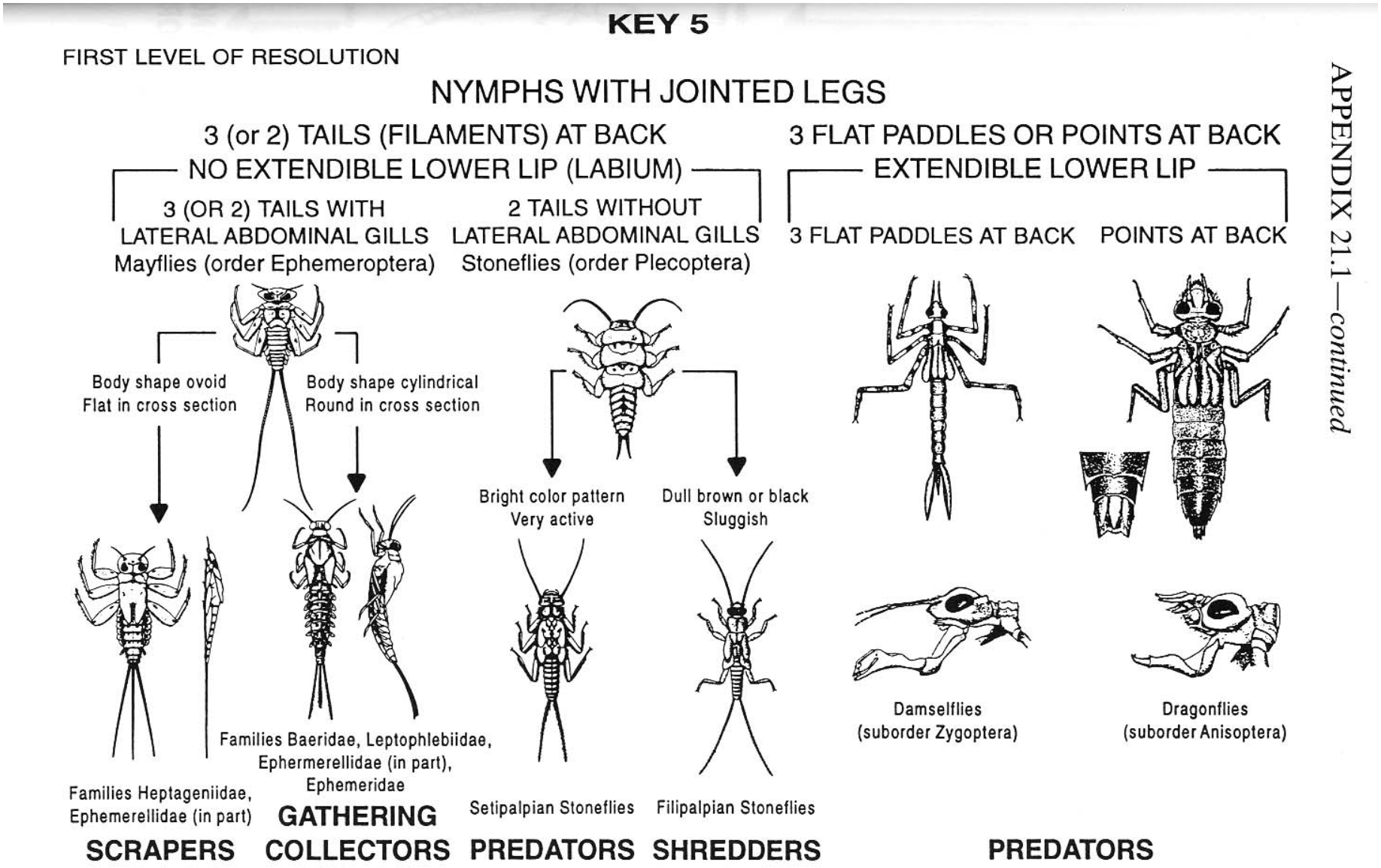
Prolegs along entire length
Head visible

Family Athericidae (*Atherix*)

Family Tipulidae (*Dicranota*)

PREDATORS

POTRAVNĚ-FUNKČNÍ SKUPINY (STRATEGIE)



APPENDIX 21.1—*continued*

POTRAVNĚ-FUNKČNÍ SKUPINY (STRATEGIE)

APPENDIX 21.1—*continued*

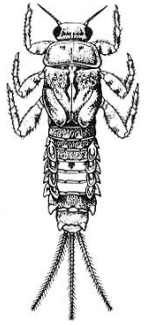
KEY 6

SECOND LEVEL OF RESOLUTION considers some fairly common insects that do not fit in the above key or would be misclassified on the basis of body shape alone.

LARVAE OR NYMPHS WITH JOINTED LEGS WITHOUT CASE OR FIXED RETREAT

WITH LONG TAILS
Mayflies (Order Ephemeroptera)

Body shape ovoid
Rear end often erected
scorpion-like when disturbed

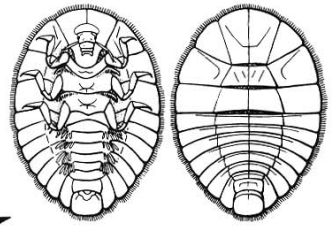


Families Ephemerellidae (in part), Caenidae, Tricorythidae

GATHERING COLLECTORS

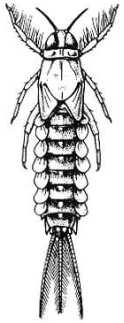
WITHOUT LONG TAILS
Beetles (Order Coleoptera)

Disc shape
Head and legs totally concealed beneath



Water Pennies (Family Psephenidae)

Body shape cylindrical
Long hairs on inside of front legs
Often with stripe down back



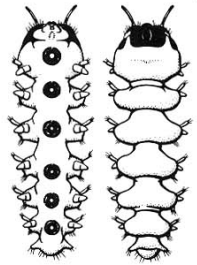
Family Siphlonuridae

FILTERING COLLECTORS

Slender
Triangular in cross section
Hard, yellowish brown covering

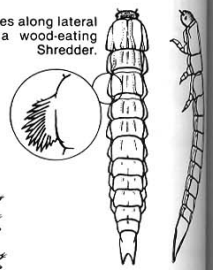
If larva has spines along lateral margins it is a wood-eating Shredder.

Lobed body
Ventral suckers



Family Blephariceridae

SCRAPERS



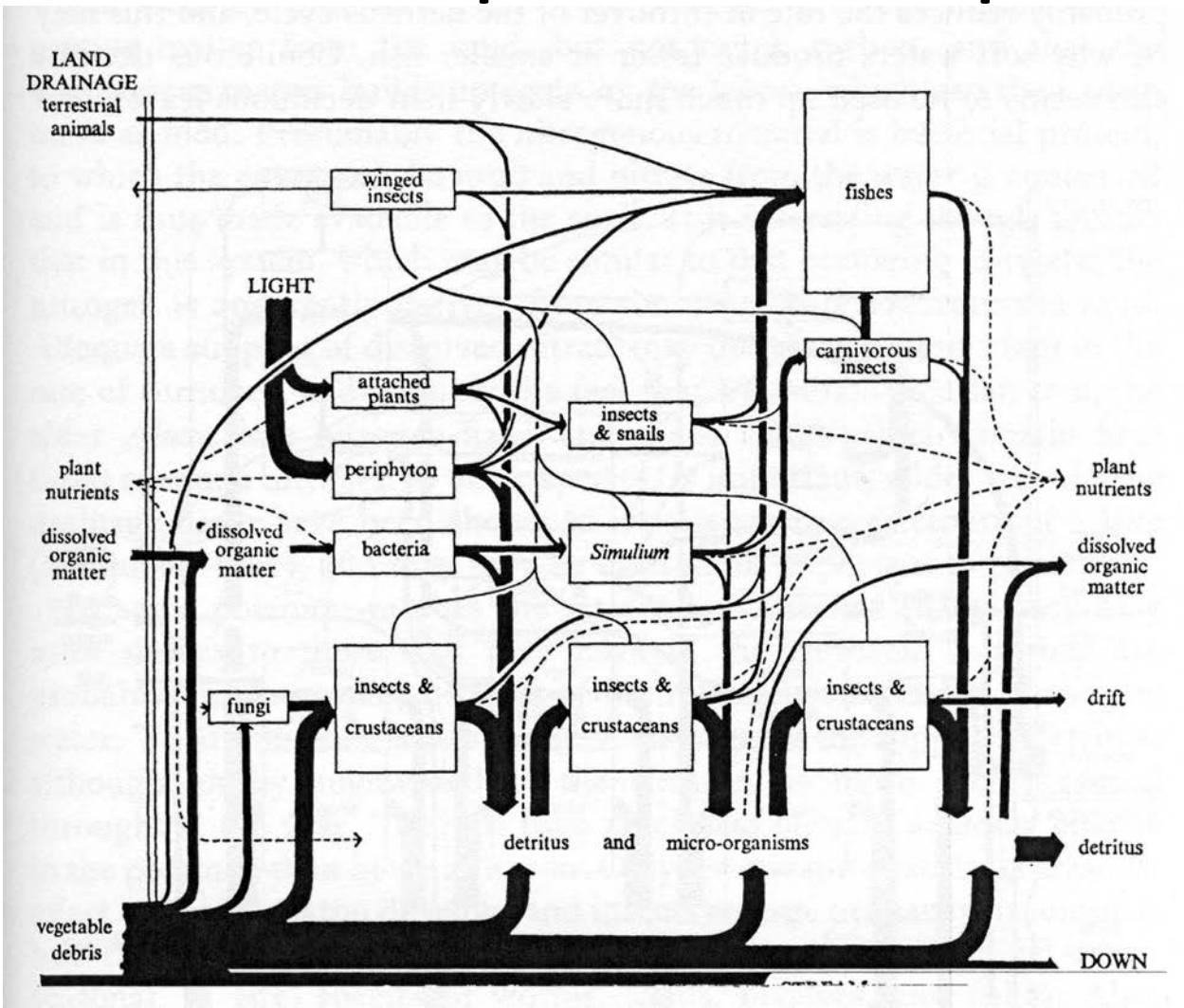
Riffle Beetles (Family Elmidae)

GATHERING COLLECTORS

METODIKY

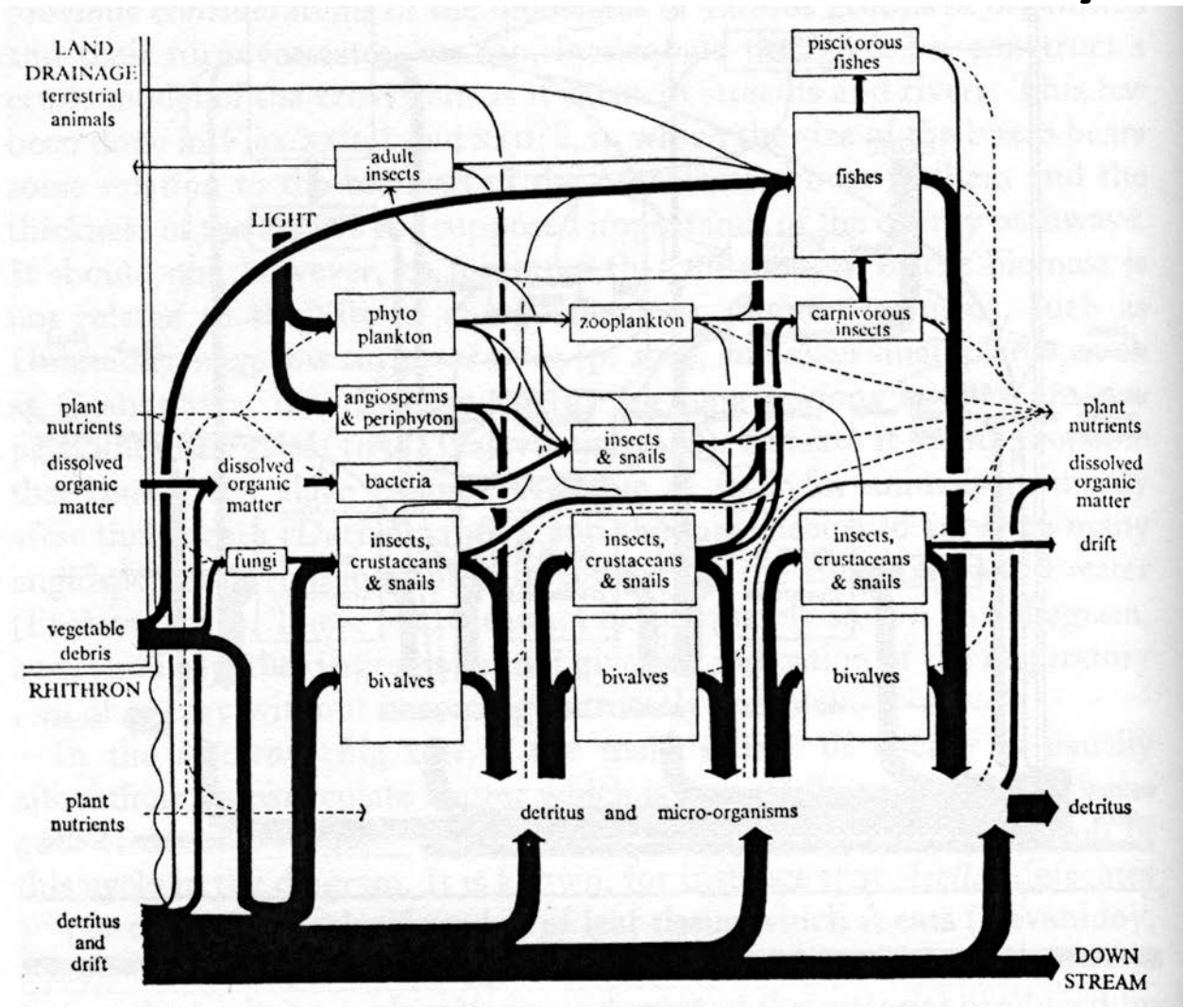
- analýza obsahu zažívacích traktů
- analýza stabilních izotopů
- radioaktivní značené izotopy
- databáze potravních strategií (feeding guilds)

Rhithron – podhorské potoky



Hynes, 1970: The Ecology of Running Waters

Potamon – nížinné řeky



Hynes, 1970: The Ecology of Running Waters