INVERTEBRATE’S DIVERSITY IN FRESHWATER ECOSYSTEM

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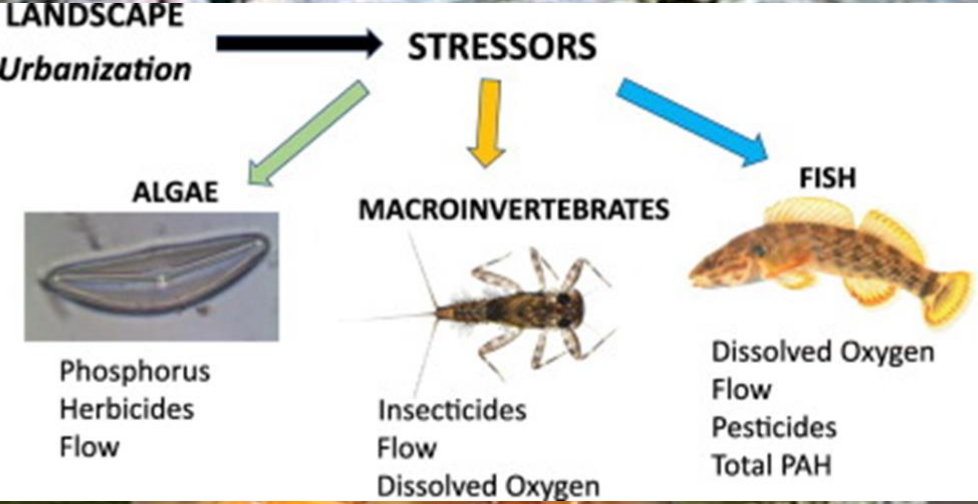
BENTHIC MACROINVERTEBRATES

Insecta	**Crustacea**	**Annelidae**	**Mollusks**
Plecoptera Ephemeroptera Odonata Coleoptera Diptera Caddishfly	Gammaridae Isopoda Ostracoda Decapoda	Hirudinea Clitellata	Dvigeldžiai Pilvakojai



WHY FOCUS ON INVERTEBRATES?

- **High Diversity**

- **Part of the Food Web:**
  Invertebrates are key consumers of algae, detritus, and leaf litter, and they in turn feed fish, amphibians, and birds. Their abundance and variety support the entire freshwater ecosystem.

- **Rapid Response to Change:**
  Different invertebrate groups respond predictably to changes in water quality, oxygen levels, and habitat structure. Because many have limited mobility and relatively short life cycles, their presence or absence reflects local, recent environmental conditions more reliably than mobile fish or seasonal plants.

- **Ease of Sampling and Identification:**
  Standard sampling methods—allow collection with **minimal disturbance**. Unlike fish surveys, no large equipment or permits are usually needed, and most organisms can be identified to family or genus on-site.

BENTHIC INVERTEBRATES: **HABITATS TYPES**

Hard substrate

Snags - Snags and other woody debris that have been submerged for a relatively long period (not recent deadfall) provide excellent colonization habitat.

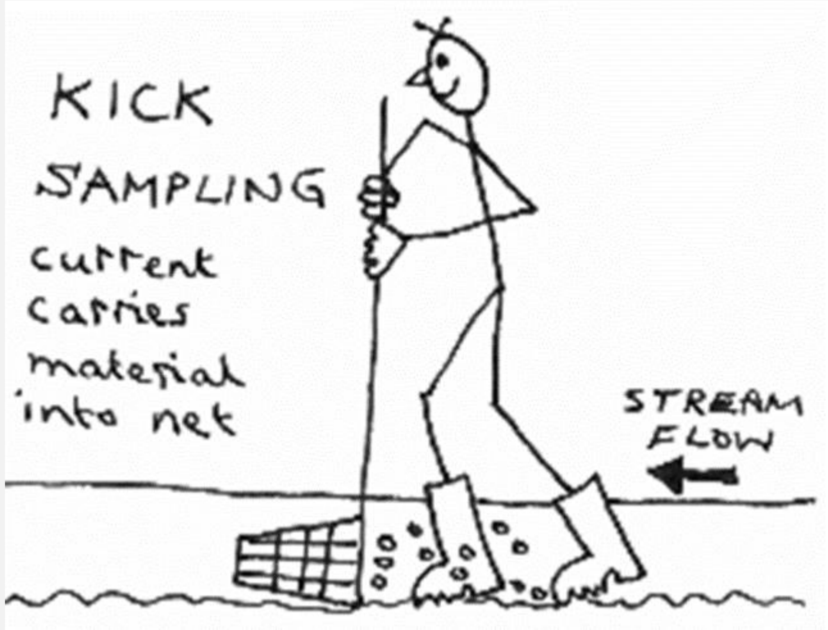
Vegetated banks

Submerged macrophytes

Sand (and other fine sediment)

SAMPLING

- Kick net in **shallow** waters (usually the **kick sample** should be conducted for three minutes).



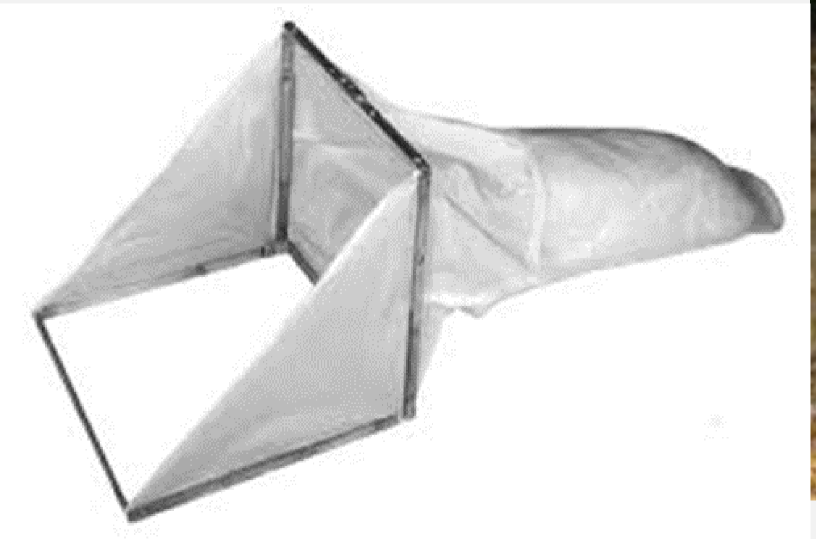
D-frame dip net

Kick net: 1 m2 area

D frame net common, useful in various habitats but not provide quantitave data

SAMPLING: SURBER OR HESS SAMPLERS

- **Quantitative samples**
- **Net (**250µm mesh)



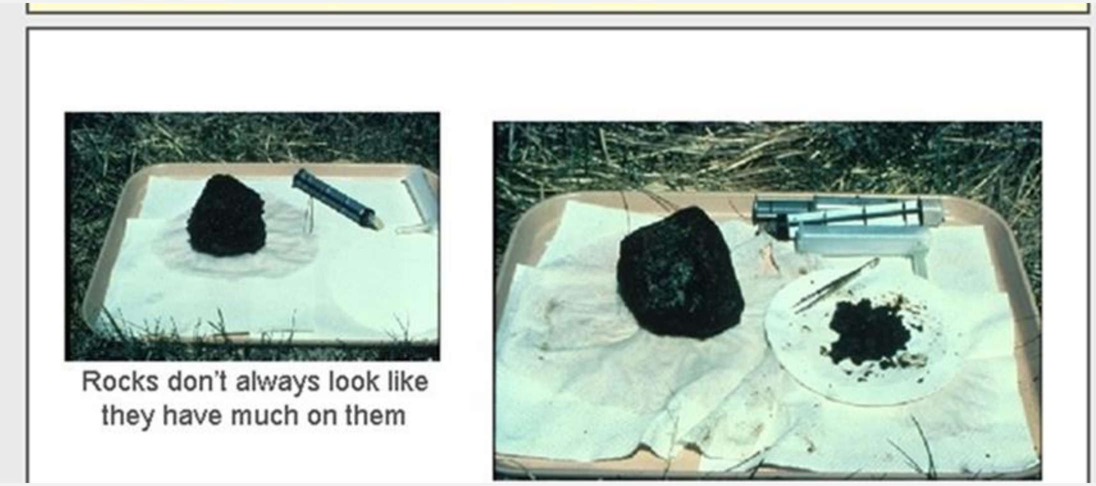
Surber: Dimensions of frame are 0.3 m x 0.3 m, which is horizontally placed on cobble substrate to delineate a **0.09 m2 area**. A vertical section of the frame has the net attached and captures the dislodged organisms from the sampling area. Is restricted to depths of less than 0.3 m.

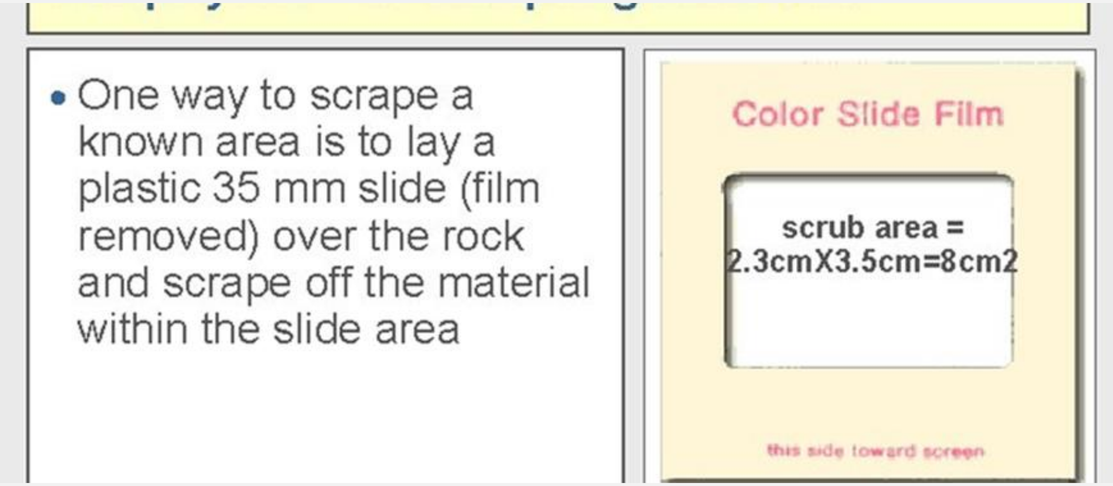
Hess: is intended to prevent escape of organisms and contamination from drift. Is restricted to depths of less than 0.5 m. Samples are collected from **0.8 m2 area**.

SAMPLING: (PERIPHYTON) FROM ARTIFICIAL SUBSTRATES

Hester-Dendy sampler. This method of sampling is used to collect aquatic invertebrates **over a period of time**.

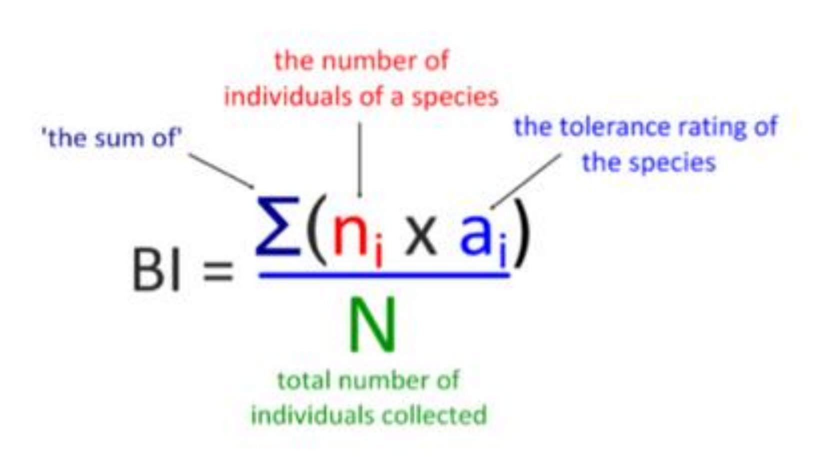
SAMPLING


Rocks don't always look like
they have much on them


• One way to scrape a known area is to lay a plastic 35 mm slide (film removed) over the rock and scrape off the material within the slide area
Color Slide Film
scrub area =
2.3cmX3.5cm=8cm2
this side toward screen

BIOTIC INDEX

IT ASSIGNS SCORES TO VARIOUS SPECIES GROUPS, AND HIGHER SCORES REFLECT BETTER WATER QUALITY.



Calculating the Index: The scores are averaged or totaled to generate an overall biotic index value, which indicates the health of the environment:

- **High biotic index**: Suggests healthy, clean water with a diverse array of sensitive species.
- **Low biotic index**: Suggests poorer water quality, where only tolerant species can survive.

SITE 1

DATA:

Species	n_i	a_i	$n_i \times a_i$
Stonefly nymph	8	9	72
Freshwater shrimp	2	5	10
Tubifex worm	0	1	0

WORKING:

$\sum(n_i \times a_i)$	82	Total (N)	10

ANSWER:

$\sum(n_i \times a_i) \div N = 82 \div 10 = \mathbf{8.2}$

*Water quality is **reasonably good** (low pollution)*

SITE 2

DATA:

Species	n_i	a_i	$n_i \times a_i$
Stonefly nymph	4	9	36
Freshwater shrimp	10	5	50
Tubifex worm	6	1	6

WORKING:

$\sum(n_i \times a_i)$	92	Total (N)	20

ANSWER:

$\sum(n_i \times a_i) \div N = 92 \div 20 = \mathbf{4.6}$

*Water quality is **moderate** (some pollution)*

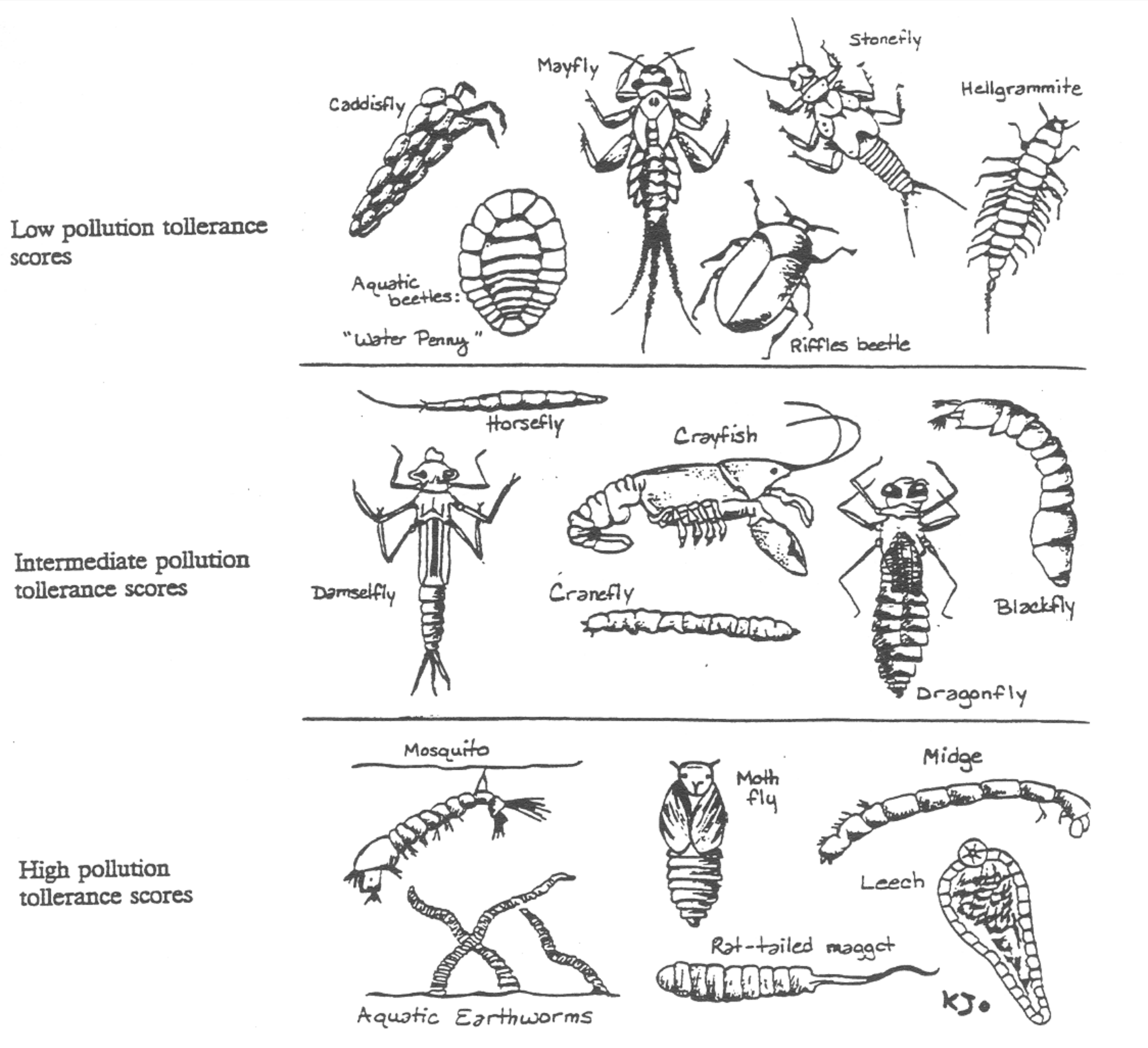
BIOTIC INDEX

MACROINVERTEBRATE TOLERANCE SCORES

BMWP Score table

Group	Families	Score
Mayflies, Stoneflies, Caddisflies, True Bugs (Hemiptera), or Sedgeflies	Siphlonuridae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Potamanthidae, Ephemeridae, Taeniopterygidae, Leuctridae, Capniidae, Perlodidae, Perlidae, Chloroperlidae, Aphelocheridae, Phryganeidae, Molannidae, Beraeidae, Odontoceridae, Leptoceridae, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidae	10
Crayfish, Dragonflies, Damselflies	Astacidae, Lestidae, Agriidae, Gomphidae, Cordulegasteridae, Aeshnidae, Corduliidae, Libellulidae	8
Mayflies, Stoneflies, Caddisflies or Sedge flies	Caenidae, Nemouridae, Rhyacophilidae, Polycentropodidae, Limnephilidae	7
Snails, Caddisflies or Sedge flies, Mussels, Gammarids, Dragonflies	Neritidae, Viviparidae, Ancylidae, Hydroptilidae, Unionidae, Corophiidae, Gammaridae, Platycnemididae, Coenagrionidae	6
Bugs, Beetles, Caddisflies or Sedgeflies, Craneflies/Black flies, Flatworms	Mesoveliidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Haliplidae, Hygrobiidae, Dytiscidae, Gyrinidae, Hydrophilidae, Clambidae, Helodidae, Dryopidae, Elmidae, Chrysomelidae, Curculionidae, Hydropsychidae, Tipulidae, Simuliidae, Planariidae, Dendrocoelida	5
Mayflies, Alderflies, Leeches Water mites	Baetidae, Sialidae, Piscicolidae	4
Snails, Cockles, Leeches, Hog louse	Valvatidae, Hydrobiidae, Lymnaeidae, Physidae, Planorbidae, Sphaeriidae, Glossiphoniidae, Hirudidae, Erpobdellidae, Asellidae	3
Midges	Chironomidae	2
Worms	Oligochaeta (whole class)	1

- Each organism is assigned a **sensitivity group** depending on the organism's **ability to tolerate stressors** such as pollution or lack of habitat within the stream.
- **Group I: Sensitive to pollution**. Large numbers of these types of organisms normally indicate GOOD WATER QUALITY.
- **Group II: Can exist under a wide range of water quality conditions**. Large numbers of these organisms, in the absence of Group I organisms, normally indicate MODERATE
- **Group III: Generally tolerant of pollution**. Large numbers of these types of organisms normally, in the absence of Group I and Group II organisms, indicate POOR WATER QUALITY.



INDICES / METRICS ARE USED / BEING DEVELOPED IN LITHUANIA

1.Lithuanian River Macroinvertebrate Index (LRMI)

This is a *multimetric macroinvertebrate index* relatively recent. It is intended to be compliant with WFD for assessing the ecological status of Lithuanian rivers. It includes several criteria: **richness** (kinds of species/families), **abundance** of sensitive taxa, possibly the proportion of tolerant species, etc.

Šidagytė-Copilas, Eglė & Arbačiauskas, Kęstutis. (2022). A multimetric macroinvertebrate index for the assessment of the ecological status of Lithuanian rivers. Limnologica. 97. 126010. 10.1016/j.limno.2022.126010.

Višinskienė, Giedrė and Bernotienė, Rasa. "The use of benthic macroinvertebrate families for river quality assessment in Lithuania" *Open Life Sciences*, vol. 7, no. 4, 2012, pp. 741-758. https://doi.org/10.2478/s11535-012-0052-1

2. EPT Index (Ephemeroptera (mayflies), **P**lecoptera (stoneflies), and **T**richoptera (caddisflies).
These three insect groups are sensitive to pollution.
The EPT index simply counts how many different types (species) of these three groups are found in a stream.
Higher EPT count = healthier water, because these insects only thrive in clean conditions.

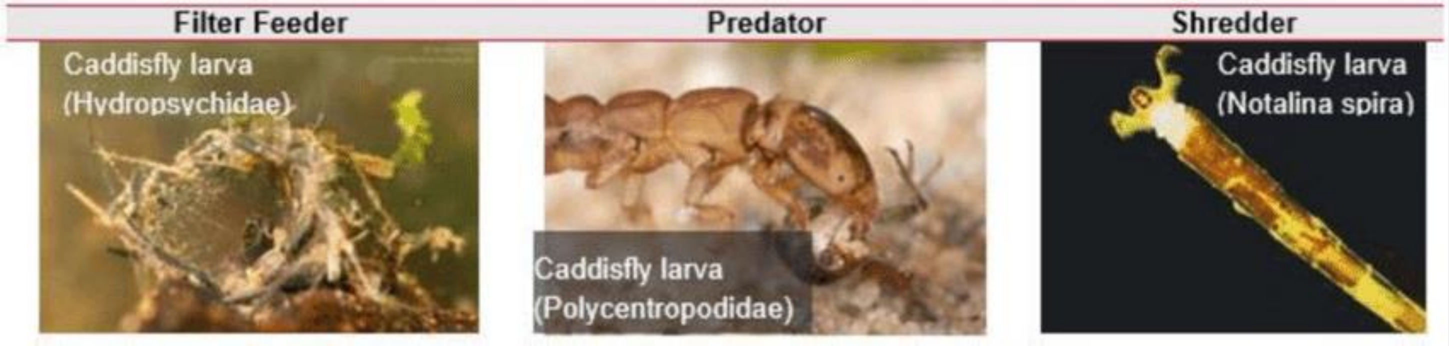
LITHUANIAN RIVER MACROINVERTEBRATE INDEX (LRMI)

Key Metrics

From *Šidagytė-Copilas & Arbačiauskas (2022)*, "A multimetric macroinvertebrate index for the assessment of the ecological status of Lithuanian rivers"

Metric	Description	What it indicates / Why it's useful
Danish Stream Fauna Index (DSFI)	A metric developed in Denmark based on macroinvertebrate fauna; sensitive to organic pollution and eutrophication.	It shows how much the fauna has shifted under nutrient enrichment / organic loads. If many sensitive species are lost, DSFI will drop.
Average Score Per Taxon (ASPT)	Each invertebrate family has a sensitivity/tolerance score; the ASPT is the average of those scores across all taxa present.	Helps measure how "sensitive" the community is. High ASPT = more sensitive taxa present; low ASPT = more tolerant taxa dominate.
Taxonomic richness of Trichoptera, Ephemeroptera, Plecoptera	Counting the number of distinct taxa from these three orders (Trichoptera, Ephemeroptera = mayflies, Plecoptera = stoneflies).	These orders are usually sensitive to pollution; if their richness is high, water is likely in better condition.
Difference between pooled relative abundances of Ephemeroptera, Heteroptera, Plecoptera vs. Crustacea & Hirudinea (expressed as **%EHP – %CrHi**)	%EHP = the combined relative abundance of Ephemeroptera + Heteroptera + Plecoptera; %CrHi = relative abundance of Crustacea + Hirudinea. Then you take the difference.	It compares abundances of more pollution-sensitive groups against more tolerant or different groups. A large positive difference means sensitive groups are doing relatively well compared to tolerant ones. If tolerant groups dominate, the difference will be small or negative.

FUNCTIONAL FEEDING GROUPS

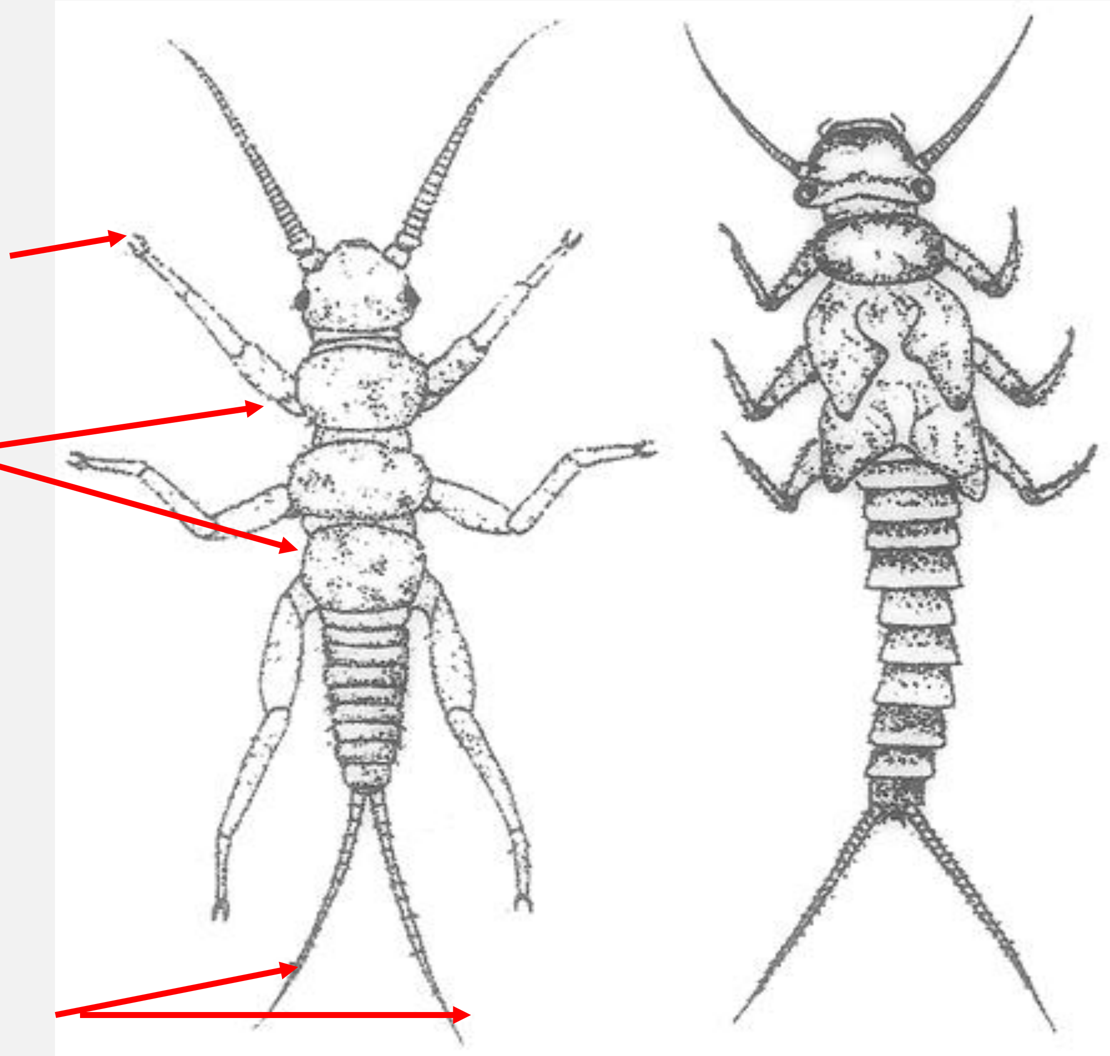


Individuals are categorized based on their **mechanisms for obtaining food and the particle size of the food,** and not specifically on what they are eating.

Group (examples)		Ecosystem service
Shredders (e.g. many stonefly and caddisfly larvae, some amphipods)	Chew and shred fallen leaves and coarse plant material into smaller particles.	Kick-starts **leaf-litter decomposition** and nutrient recycling, providing food for other organisms.
Collectors / Gatherers (e.g. some midges, worms)	Feed on fine organic particles that settle on the streambed.	Finish the breakdown of organic matter and **recycle nutrients**.
Filter feeders / Collectors–filterers (e.g. blackfly larvae, certain caddisflies, freshwater mussels)	Strain tiny particles and plankton from flowing water.	**Clarify water**, trap sediments, transfer nutrients from water to the food web.
Scrapers / Grazers (e.g. many snails, mayfly larvae)	Graze on algae and biofilms on rocks and plants.	Control **algal growth**, keep surfaces clean, and maintain oxygen production.
Predators (e.g. dragonfly and damselfly nymphs, beetle larvae)	Eat other invertebrates or small fish.	Regulate prey populations, maintain **food-web balance**.
Burrowers / Bioturbators (e.g. some worms, chironomids, bivalves)	Move through sediments.	**Mix and oxygenate sediments**, release nutrients back into the water column.

Group I: Sensitive to pollution

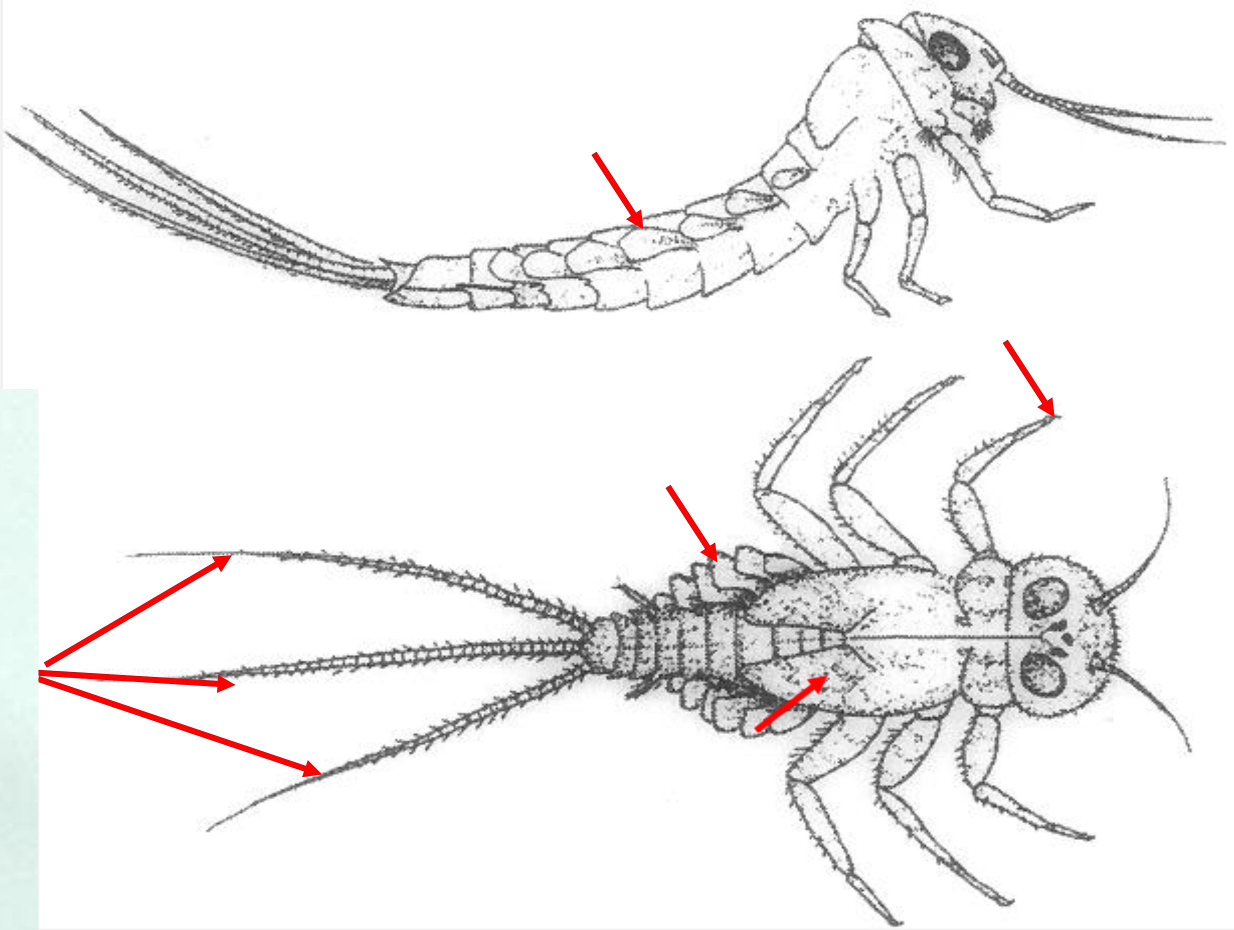
Ankstyvės (Stoneflies (Plecoptera)



Shredders, which consume leaf litter

Group I: Sensitive to pollution

Lašalai (Ephemeroptera)



scrapers (grazers), which consume algae and associated material

GROUP II: CAN EXIST UNDER A WIDE RANGE OF WATER QUALITY CONDITIONS

Dragonfly larva  15-50mm	Damselfly larva  10-50mm	Water beetle larva  2-6mm	Whirligig beetle  3-15mm	Riffle beetle adult  2-4mm
Dragonfly nymph  30-50mm	Damselfly nymph  10-50mm	Water beetle  3-40mm	Whirligig beetle larva  3-12mm	Water strider  10-25mm
Dragonfly adult  17-200mm	Damselfly adult  25-55mm	Backswimmer  5-16mm	Waterboatman  5-16mm	Cranefly larva  10-25mm
Scud (amphipod)  5-21mm	Crayfish  10-150mm	Water scorpion  20-43mm	Sowbug  5-22mm	Freshwater clam  30-270mm

GROUP II: CAN EXIST UNDER A WIDE RANGE OF WATER QUALITY CONDITIONS

Odonata: nymphs of damselflies, dragonflies

Crustacea: crayfish, amphipods, sowbugs (isopoda)

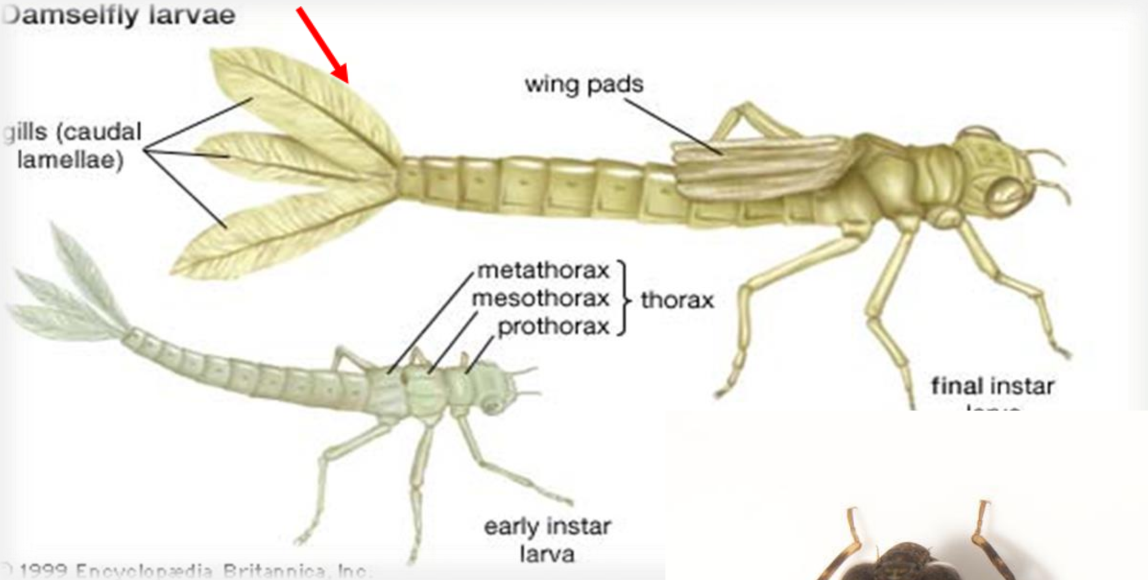
Caddisflies larvae (Trichoptera)

Cranefly larvae

Clams, mussels

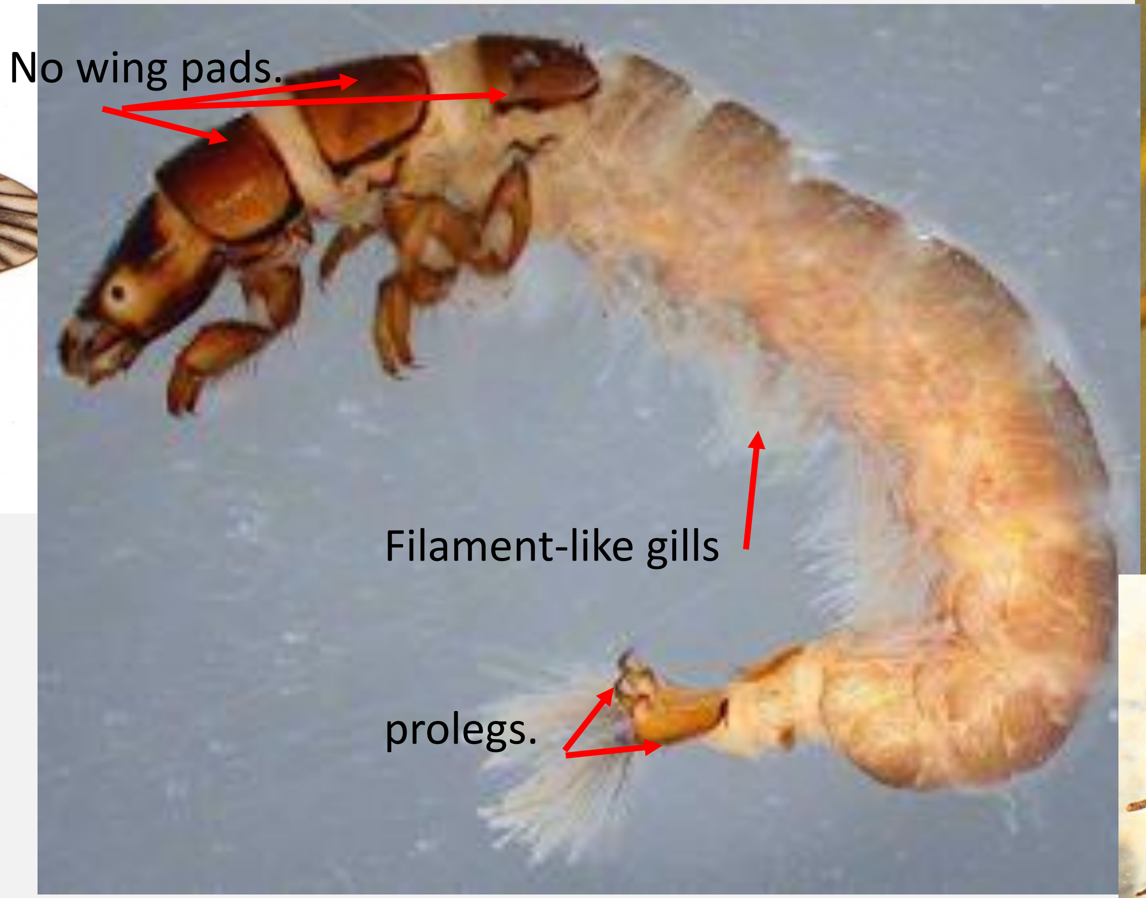
GROUP II: CAN EXIST UNDER A WIDE RANGE OF WATER QUALITY CONDITIONS

ŽIRGELIŲ LERVOS (ODONATA)



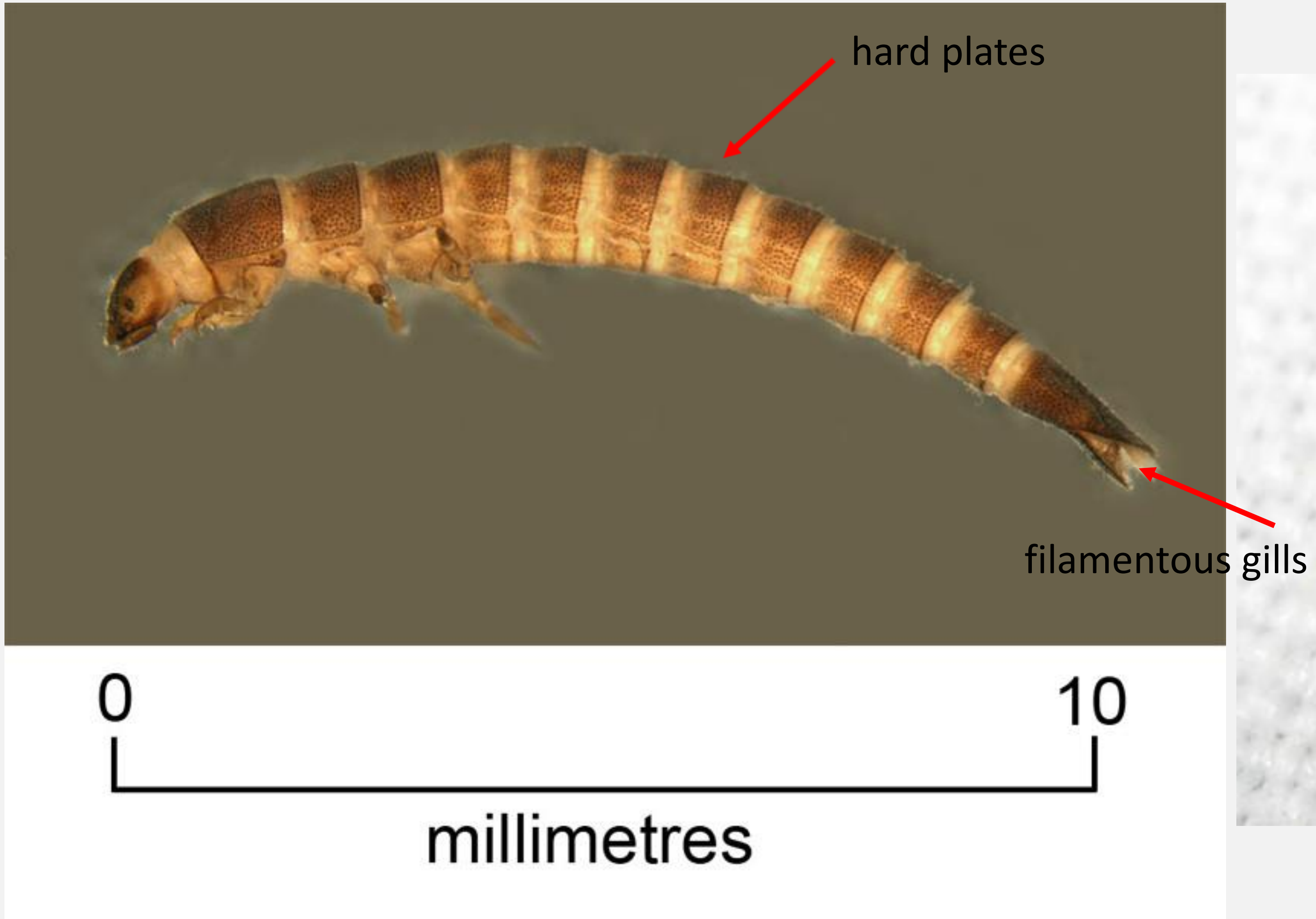
GROUP II: CAN EXIST UNDER A WIDE RANGE OF WATER QUALITY CONDITIONS

APSIUVŲ LERVOS (TRICHOPTERA)



GROUP II: CAN EXIST UNDER A WIDE RANGE OF WATER QUALITY CONDITIONS

VABALŲ (ELMIDAE) LERVOS IR SUAUGĖLIAI



DVISPARNIU LERVOS (DIPTERA):

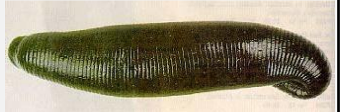
Tipulidae. The abdomen of larvae ends in several finger-like lobes. A smaller species of crane fly has an abdomen that ends in an enlarged lobe resembling a turnip shape.

GROUP II: CAN EXIST UNDER A WIDE RANGE OF WATER QUALITY CONDITIONS

MOLLUSCA: BIVALVIA: UNIO; ANADONTA.

Long-lived: some species may reach 70+ years.
Sedentary: juvenile and adult mussels move little during their entire lifetime.
Filter feeders: mussels obtain food and oxygen from the water column and via interstitial flow.
Fairly large: mussels contain ample soft tissue for chemical analysis. **Bioaccumulate metals.**

Group III: Generally tolerant of pollution

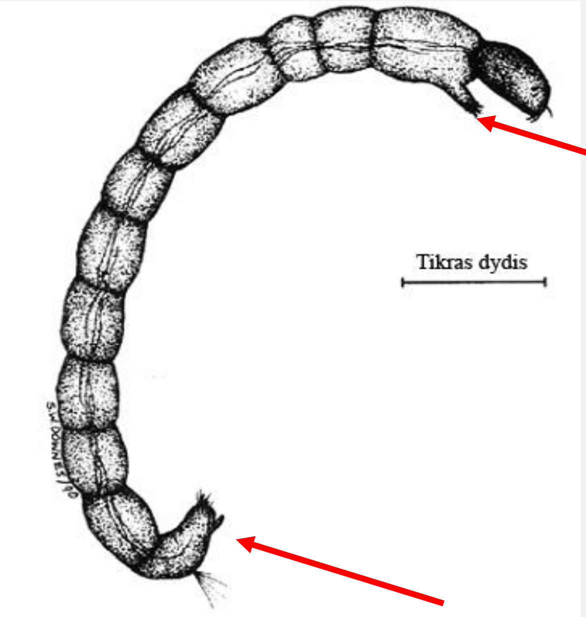
Blackfly larvae	Midge larva	Mosquito larva	Flatworm (planaria)	Freshwater worm
				
3-12mm	2-15mm	1-6mm	1-6mm	1-30mm
Blackfly adult	Midge adult	Mosquito adult	Leech	Water snail
				
2-5mm	3-4mm	6-13mm	5-40mm	2-70mm

Group III: Generally tolerant of pollution

UODŲ TRŪKLIŲ LERVOS (CHIRONOMIDAE (MIDGE FLY LARVAE))

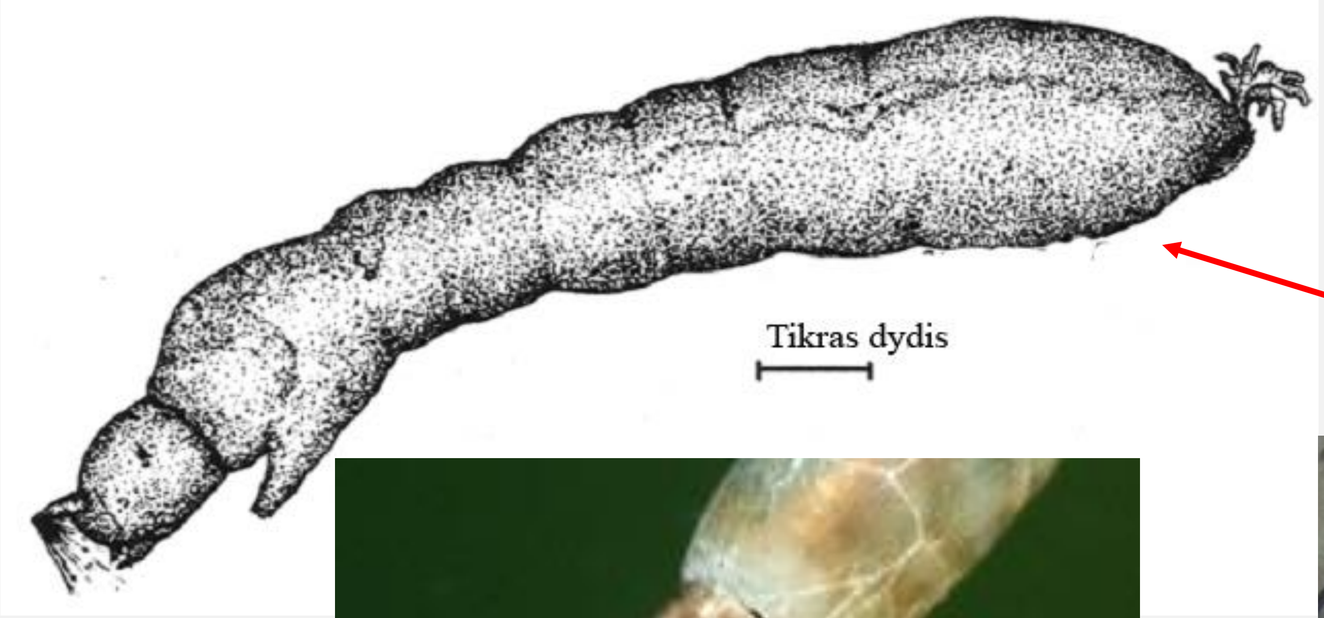
Distinguishing Features:

- Very small larvae, usually less than 1/4 inch in length.
- Head is visible when viewed with magnification.
- Presence of **two small prolegs** located **by the head** and at the **end of the abdomen**. Prolegs are not segmented.
- Slightly curved, **segmented body**.

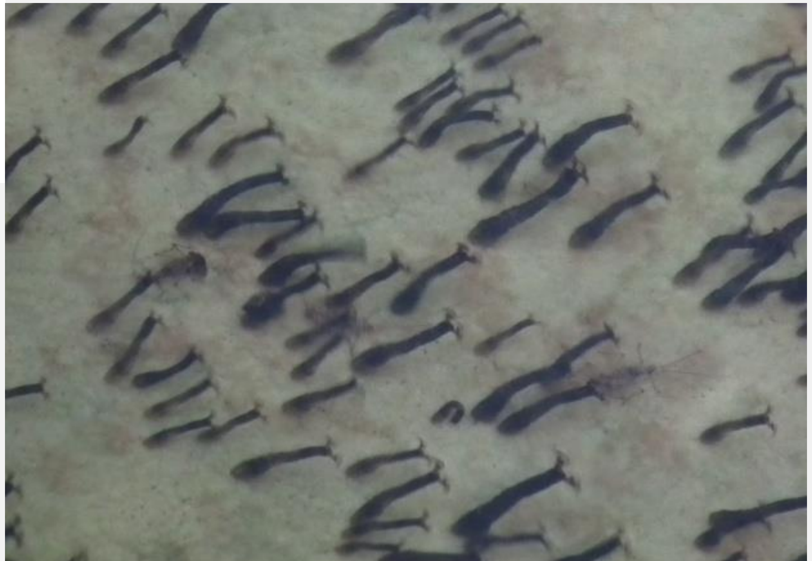


Group III: Generally tolerant of pollution

MAŠALŲ LERVOS (DIPTERA: SIMULIDAE (BLACK FLY LARVAE)



fan-like structures

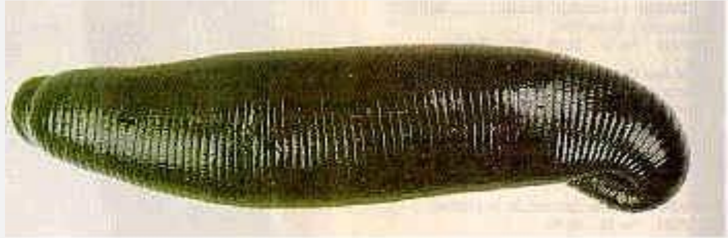


Group III: Generally tolerant of pollution

ŽIEDUOTOSIOS KIRMĖLĖS: DĖLĖS, TUBIFEKSAI.








are generally found in soft mud bottoms, and in high numbers are considered indicators of very poor water quality.

Group III: Generally tolerant of pollution

GASTROPODA

Radix sp.

Lymnea stagnalis

Bithynia sp.

Planorbis sp.

LAB SESSION

Objective: Refresh and deepen ability to identify and interpret the diversity of freshwater invertebrates using live specimens and discuss their ecological significance.

Field Collection – Split into small teams (2-3). Walk to the water body and collect invertebrates. Target different micro-habitats (bottom, leaf litter, submerged plants, wood, stones).

Laboratory: identification, report total richness and EPT richness per team. Optionally discuss functional groups (shredders/scrapers/filterers) and habitat notes.

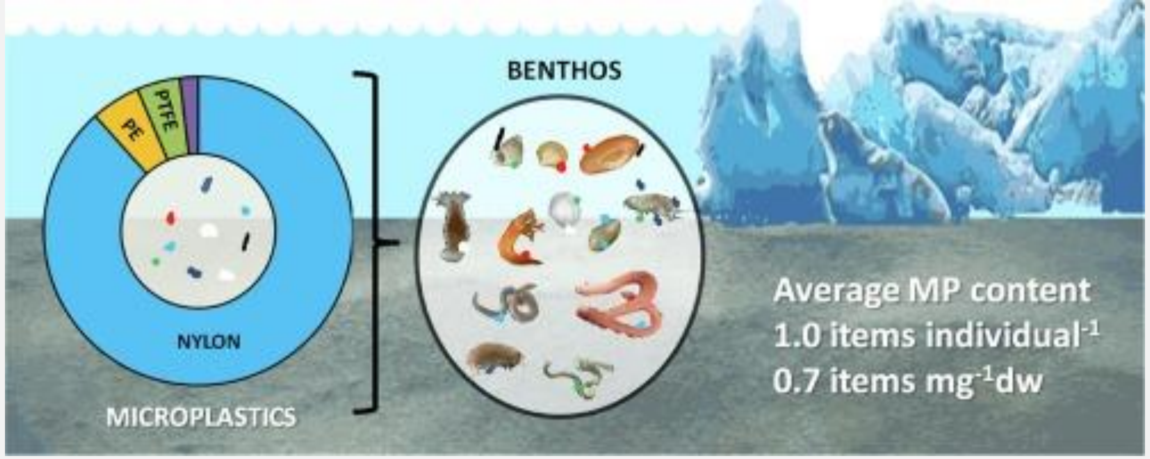
Total Richness: the total number of **distinct taxa** (families or genera) found in a sample or across the whole site.
*Remove duplicates so each taxon is counted **once** no matter how many individuals you found.*

Microplastic prevalent size ranges were between 50 and 100 µm.

The microplastic particles were mainly composed of nylon and polyethylene polymers.

•Bivalves displayed the highest microplastic contamination.

83% of the analyzed macrobenthic species contained microplastics (0.01–3.29 items mg−1).



Microplastic accumulation in benthic invertebrates in Terra Nova Bay (Ross Sea, Antarctica), Environment International,Volume 137, 2020, https://www.sciencedirect.com/science/article/pii/S0160412019335949

Microplastic accumulation in benthic macroinvertebrates is concentrated in urban parts of a freshwater river" Benthic macroinvertebrates in urban river sections had higher accumulation of microplastics. Some feeding modes (deposit feeders, filter feeders) had different levels of ingestion

Pace, G., Melfe, F., Rodrigues, C. *et al.* Microplastic accumulation in benthic macroinvertebrates is widespread, regardless of the river ecological status. *Hydrobiologia* (2025). https://doi.org/10.1007/s10750-025-05882-6

Problems and Gaps MP on the invertebrates

- Many studies are lab or mesocosm-based; field evidence is less numerous.
- Long-term effects and effects of very small particles (nanoplastics) are still not well understood.
- Effects can be species- or life stage-specific
- **Synergistic effects** with climate change, flow alteration, and habitat loss needs more study. Plastics may interact with other pollutants (heavy metals, pesticides) to worsen effects. Separating plastic pollution from other stressors (nutrients, sediment, chemical pollution) is hard.