With Bioindicators in Action

JANA SLEZÁKOVÁ | JIŘÍ KŘESINA

The Riverbed

Every organism has its place in nature. Including an ordinary mussel.
Or a more extraordinary, rare freshwater **pearl mussel**.

What makes this creature so interesting that it became the central figure of this publication and our guide on this riverbed journey?

Perhaps it is the fact that barely anyone has ever seen it. There are so few of them that they are nearly impossible to be spotted by the human eye, as they are scattered among the stones, gravel, and sand on the riverbed.

No wonder they are so difficult to find, given that they have survived to this day in only three Czech rivers; **Teplá Vltava**, **Blanice**, and **Malše**. What is more, their habitat does not stretch all the way from the river source to the mouth. In the old days they lived in river segments between the Šumava mountains and the city of České Budějovice, and a few other places in the Czech Republic, but nowadays they are found within the confines of only a few river kilometres, where the water is the purest and where there are trout and a rocky riverbed.

In fact, you might be better off not searching for them at all! This bivalve, the size of a hand, with a body resembling a black pebble, is hidden all too well beneath the little waves.

Its mysterious life, inconspicuousness, and effort to hide from pearl hunters turned the freshwater pearl mussel into a mythical chimera. Nowadays it is disappearing from our environment, silently and gradually, without anyone really noticing. However, its highly interesting story calls for more attention.

The goal of our story is to go through the process of discovering. A frog tadpole in a drying puddle can also be regarded a pearl. There are thousands of species in our rivers and ponds that are worth discovering and studying. Some of them have the unique property that they inform us about the specificities of the place and conditions they live in. These are called

Bioindicators

We can imagine them as a warning light that says: “Watch out! This water is not suitable for drinking, or swimming.” They scream “Be on alert! Pollution is pervading here.” On the other hand, they can also show us that a certain water source is safe.

For all of you explorers who want to learn how to “read” water, there is a special tool that you can cut out in the second half of this publication.

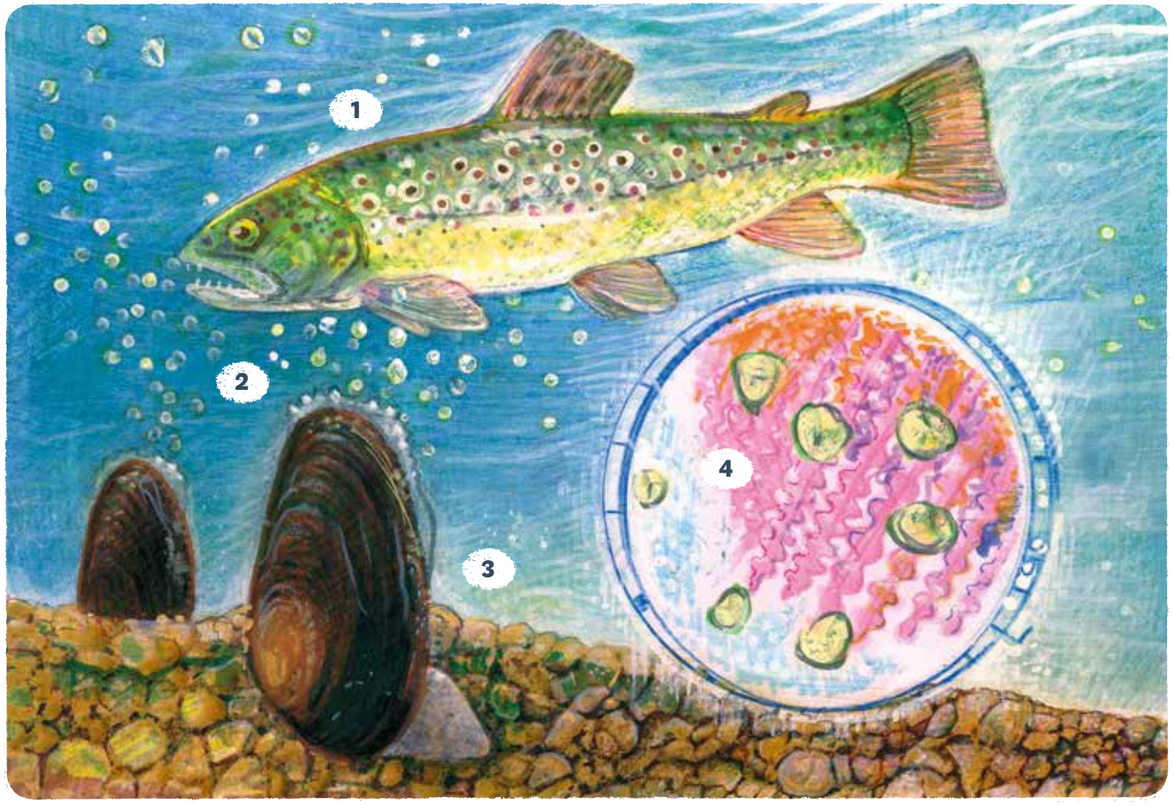
Nonetheless, let us not jump ahead of ourselves and get back to the story of our extraordinary guide, the freshwater pearl mussel.

The Record Holder of our Environment

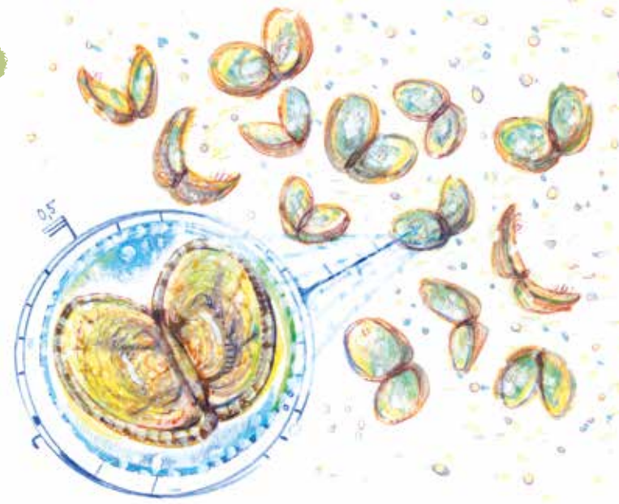
The water that it needs for survival must be as pure as our drinking water. It is hard to imagine for us to try to drink from a river, but our grandmothers could easily do it without any harm.

Many Offspring

Freshwater pearl mussels have separate sexes, i.e., there are males and females. Males excrete their sperm into water and females draw it in. After eggs are fertilized inside the female, larvae start to develop. When they are ready, the female discharges them into water in enormous numbers. About one percent of them will successfully latch onto the gill of a brown trout and continue their development.



1. Brown trout, **2.** Freshwater pearl mussel larvae, **3.** Colony of adult freshwater pearl mussels, **4.** Detail of freshwater pearl mussel larvae within a trout's gill



For the purpose of reproduction, freshwater pearl mussels form colonies. The more they are, the higher the chance of a successful transfer of the larvae onto trout. Obviously, males and females need to be in close proximity. Nonetheless, females can sometimes get by in a creative manner. They can become both mom and dad, as they are able to transform into a hermaphrodite and produce larvae on their own. This is a safety measure for lone, isolated individuals. Unfortunately, if the entire population becomes solitary in this way, it cannot go on forever and eventually dies out.

There are 1–4 million offspring all at once, which are smaller than the diameter of a human hair, so they are only visible under a microscope.

Common Minnow

These fish like to have a feast. They live together with freshwater pearl mussels and are patient. When the water warms up in the summer, freshwater pearl mussels treat them to a huge meal. The larvae are unable to escape. They cannot move willingly and are merely carried by the current. This is completely natural. Larvae are disseminated in large volumes so that there are plenty of them in the river. It is enough that only a few of them find their trout.

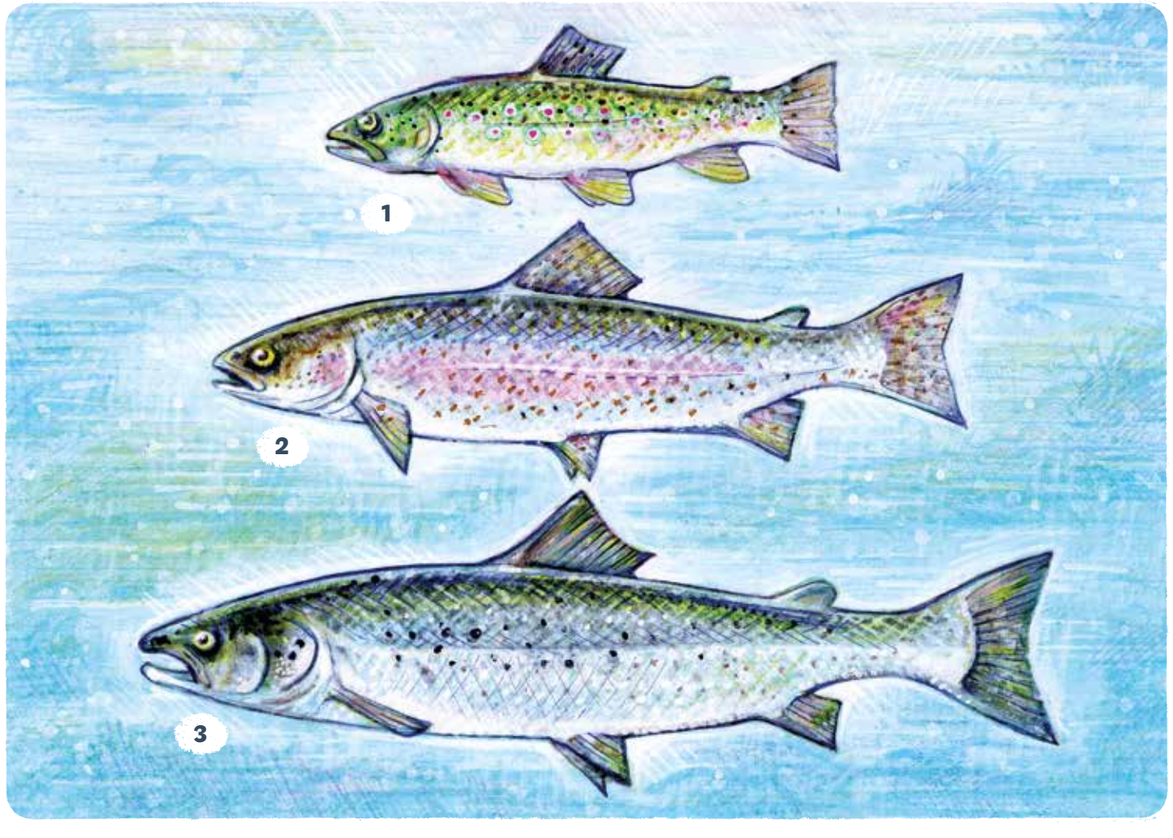
Common Minnow

The Record Holder of our Environment

The freshwater pearl mussel is named after its ability to produce pearls. In reality, this happens rather infrequently, when a foreign object or a parasite gets stuck between the body of the animal and the inner side of the shell, which is covered with a nacre layer. In this situation the mussel starts to coat the object in nacre to prevent it from scratching the host and assimilating it with its environment. It takes up to several years before a small oval or round pearl is formed. The colours of freshwater pearls range from white and creamy to pink and even pale purple.

Childhood Disease

The freshwater pearl mussel is a parasite. In order for a lava to become an adult mussel, it has to go through a metamorphosis. This process takes place in the gill of a fish species which has traditionally lived in rivers with freshwater pearl mussel colonies; the brown trout. Nowadays, natural populations of trout are scarce. As a result, some freshwater pearl mussels lack young trout for reproduction.



1. Small brown trout, **2.** Rainbow trout, **3.** Atlantic salmon

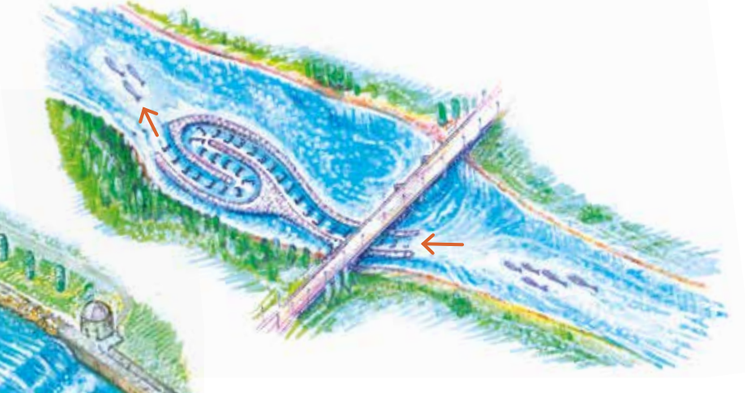
Brown trout

This fish has always been able to deal with the freshwater pearl mussel infection. The two interact similarly to children and lice, the difference being that once a young trout gets rid of freshwater pearl mussels, it is never infected by them again. It develops immunity defends itself the next time. So far as the artificially introduced rainbow trout is concerned, the larvae also attach themselves to it, but they die.

Atlantic salmon

Some of our freshwater pearl mussels already went through the loss of a host in the past. These were those that developed in the gill of the Atlantic salmon. This fish used to travel from the ocean upstream all the way to South Bohemian rivers to reproduce. However, its route was blocked off in the mid-20th century when dams were constructed on the rivers of Labe and Vltava. Thereafter, the brown trout assumed the role that had previously been held by salmon in the reproduction cycle of the freshwater pearl mussel and became its exclusive host.

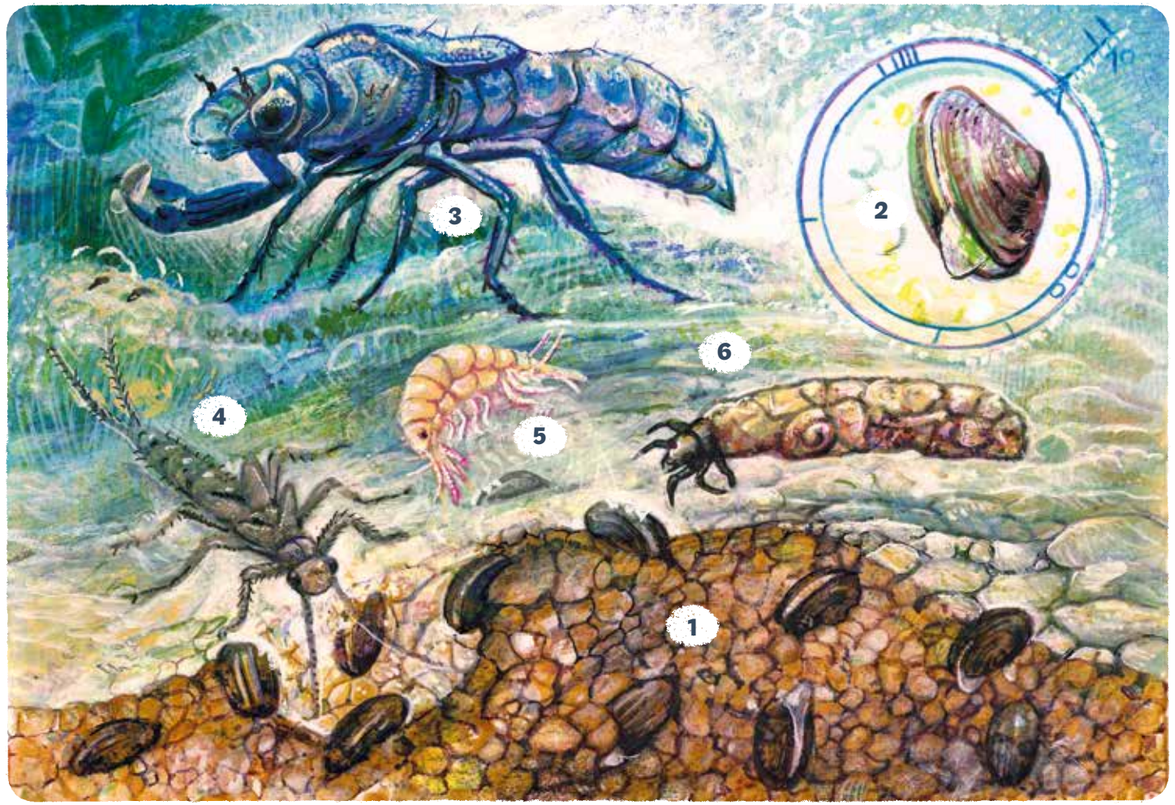
Weirs alter the character of a river, turning it into a stagnant water and stopping the incoming material. This is why there is usually a lot of mud just before a weir.



River barriers are nowadays neutralized concerning fish migration using **fish ladders**. However, this is still an emergency measure.

Young Freshwater Pearl Mussels

Approximately after a year of development, the mussels fall off the trout. Then they populate a new place where their host took them. Not always is it the right place. Freshwater pearl mussels cannot burrow themselves into mud, mud mixed with sand, or stay in a place where the stream is polluted. They require clean water and a riverbed made of stones, gravel, and sandy substrates.



1. Freshwater pearl mussel larvae, **2.** Detail of a freshwater pearl mussel larva, **3.** Dragonfly larva, **4.** Stonefly, **5.** Gammarid, **6.** Caddisfly

Food is plentiful. Initially they suffice with the finest algae growing on stones and pebbles. Anybody who has ever walked in a river barefoot, stepping on the slippery and slimy stones, is familiar with them. They are called a **biofilm** and young freshwater pearl mussels love it.

For animals living on riverbeds, the accessibility of oxygen is crucial. It may happen from time to time that there is a shortage of it.

This is detrimental, as the young freshwater pearl mussels live buried in the riverbed substrate and are unable to quickly move, even if only one meter away there might be enough running water with oxygen dissolved in it.

A year old, half a millimetre in size, and already needing to be self-sufficient. Burrow oneself into the riverbed, find a shelter from predators, find food, and avoid suffocation. None of that is easy to do. Especially when almost everyone around is larger and vegetarians represent a minority.

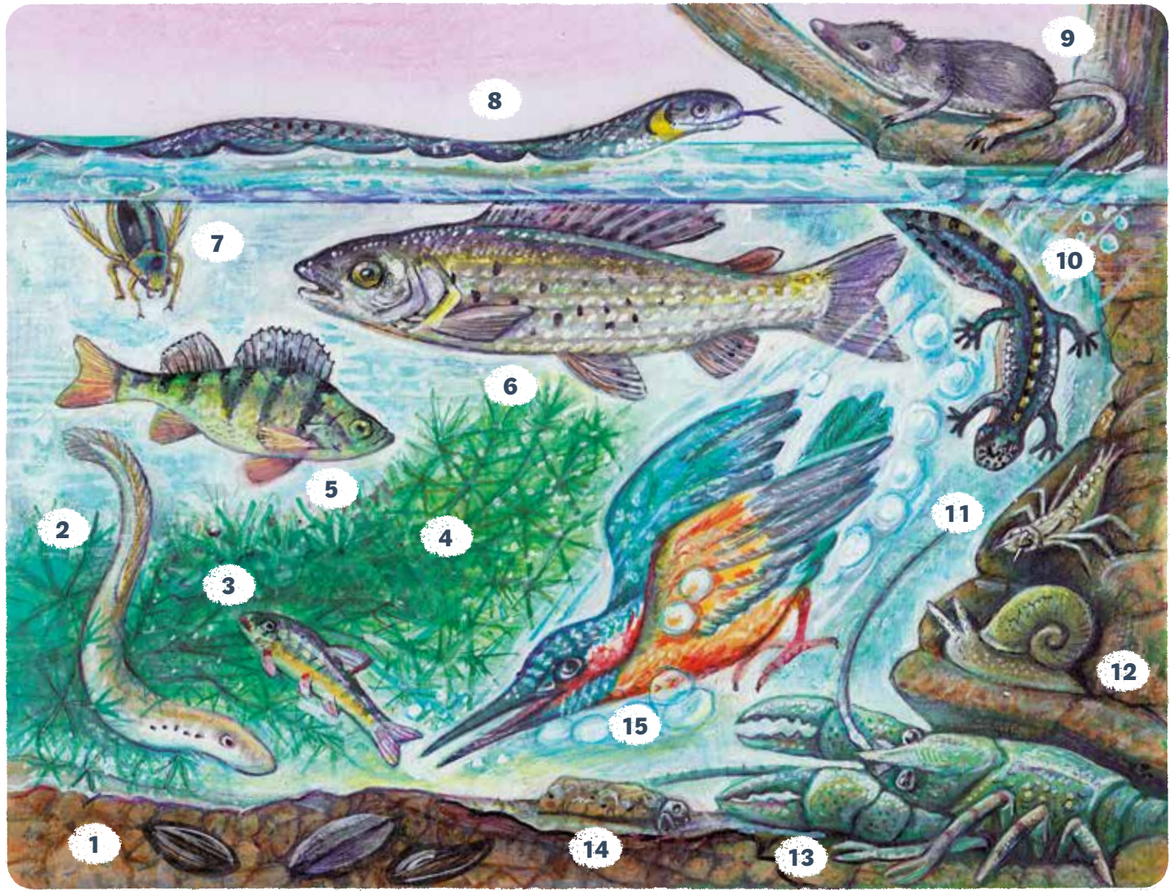
For instance, a **dragonfly larva** is 40 times bigger. A it is a true predator.

The **European bullhead** needs oxygen among the stones where it hides. Oxygenated riverbeds are found in fast-flowing and clean rivers. However, a single storm that brings mud from a nearby field can be enough for the bullhead to change places, or else it would suffocate. It is better if the river is surrounded by a meadow instead of a field because meadows are able to absorb long-lasting rains as well as cloudbursts.

The **crayfish** knows all too well that the hard shell houses a soft body of a mollusc. Its pincers are strong, it is tenacious and no bivalve can escape from it, however protected and rare. Even if it is rarer than the crayfish itself. The crayfish also lives in clean water. It does not necessarily need to be drinkable, but fresh, oxygenated water is ideal.

Inside the Riverbed up Until Adulthood

But above them, there is so much life



1. Freshwater pearl mussels, **2.** European brook lamprey, **3.** Common minnow, **4.** Water starwort, **5.** Perch, **6.** European grayling, **7.** Diving beetle, **8.** Grass snake, **9.** Eurasian water shrew, **10.** Alpine newt, **11.** Dragonfly larva, **12.** Great ramshorn, **13.** European crayfish, **14.** Caddisfly larva, **15.** Common kingfisher

Spring

Alpine flatworm

Flatworms are typical inhabitants of spring areas. The Alpine flatworm is a predator who is able to catch and swallow a relatively large prey. Even though it is called "Alpine" flatworm (*Crenobia alpina*), it lives in spring areas in lower altitudes. It requires high-quality water.

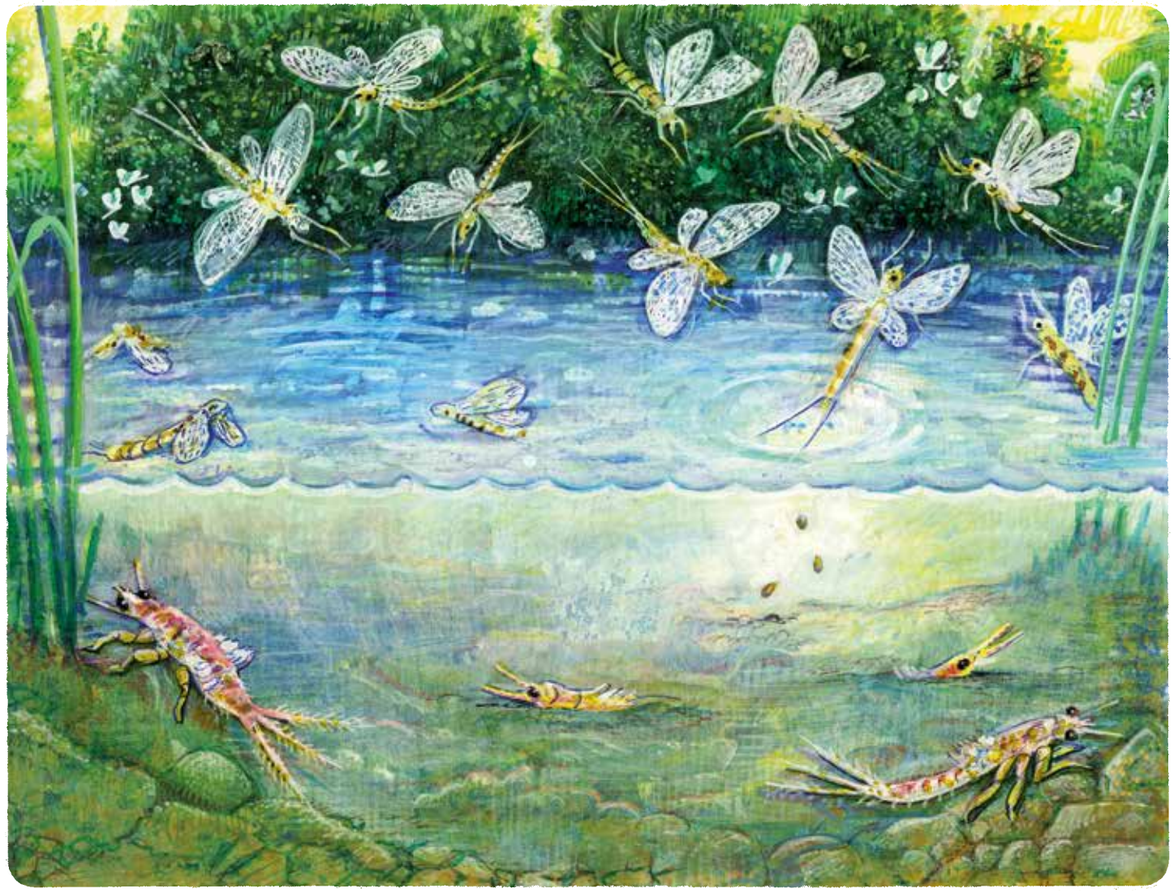
The Record Holder of our Environment

The freshwater pearl mussel is a very capable filter feeder. It filters approximately 50 litres of water a day. That amounts to a large beer keg or 33 plastic bottles of water. From the water it filters it extracts organic matter, such as plant remains or decomposed material. This is also called detritus. Freshwater pearl mussels absorb it like a sponge and let out purified water.

Stages of dragonfly hatching

A New Generation

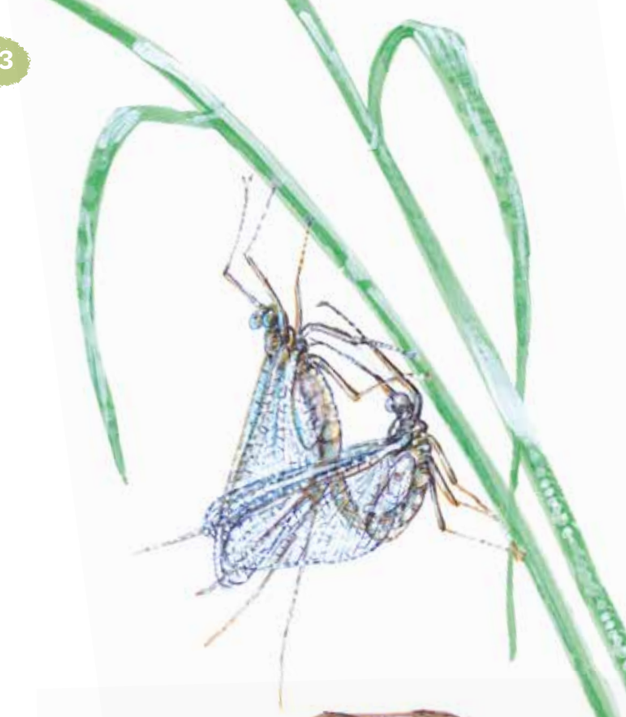
After ten, twelve, fifteen, or even twenty years, the already adult freshwater pearl mussels should start to resurface and begin a new chapter in their long life, i.e., produce offspring. Unfortunately, no new mussel has appeared this year, nor did it last year. In fact, no young mussels have been found for the last thirty to forty years.



From the 4 million offspring produced by one mother-mussel, none has reached adulthood. This holds true to the offspring of entire colonies across many localities. Only the very few individuals that have succeeded over the last half century are keeping the hope for the survival of the species alive.

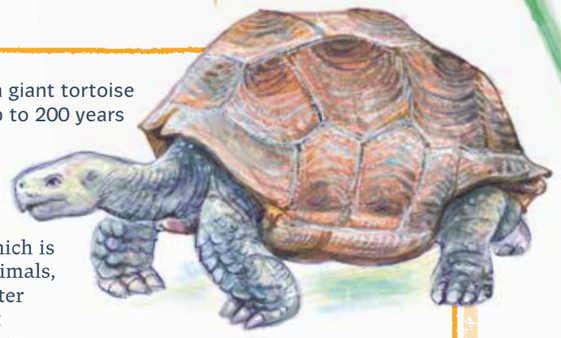
An Ephemeral Life

Mayflies, an ancient group of insects that have lived on the Earth since the Palaeozoic Era, are a symbol of a fleeting life. The life of a mayfly begins when a fertilized egg is laid into water. What follows is a year, or multiple years, of underwater life on plants or under riverbed stones in the larval stage. The maturing process takes place close to the water surface. Then it moults into an adult, leaves water, and fulfils its purpose through mating and laying eggs into water again. The life cycle comes to an end as the mayfly says farewell to its rather long life.



The Record Holder of our Environment

The freshwater pearl mussel is the longest living animal of our natural environment. It can live up to **150 years**, which is not much less than the absolute record holder among animals, the **Aldabra giant tortoise**. The majority of Czech freshwater pearl mussels is about 80 years old. During the time that they have been sitting in the same place, a lot of things have changed both in the river and in its surroundings. How can we tell the age of a mussel? The shell keeps growing throughout its entire life, leaving visible growth lines on the shell surface, much like tree rings. Therefore, upon discovering a shell, it is possible to determine the age of the dead bivalve.

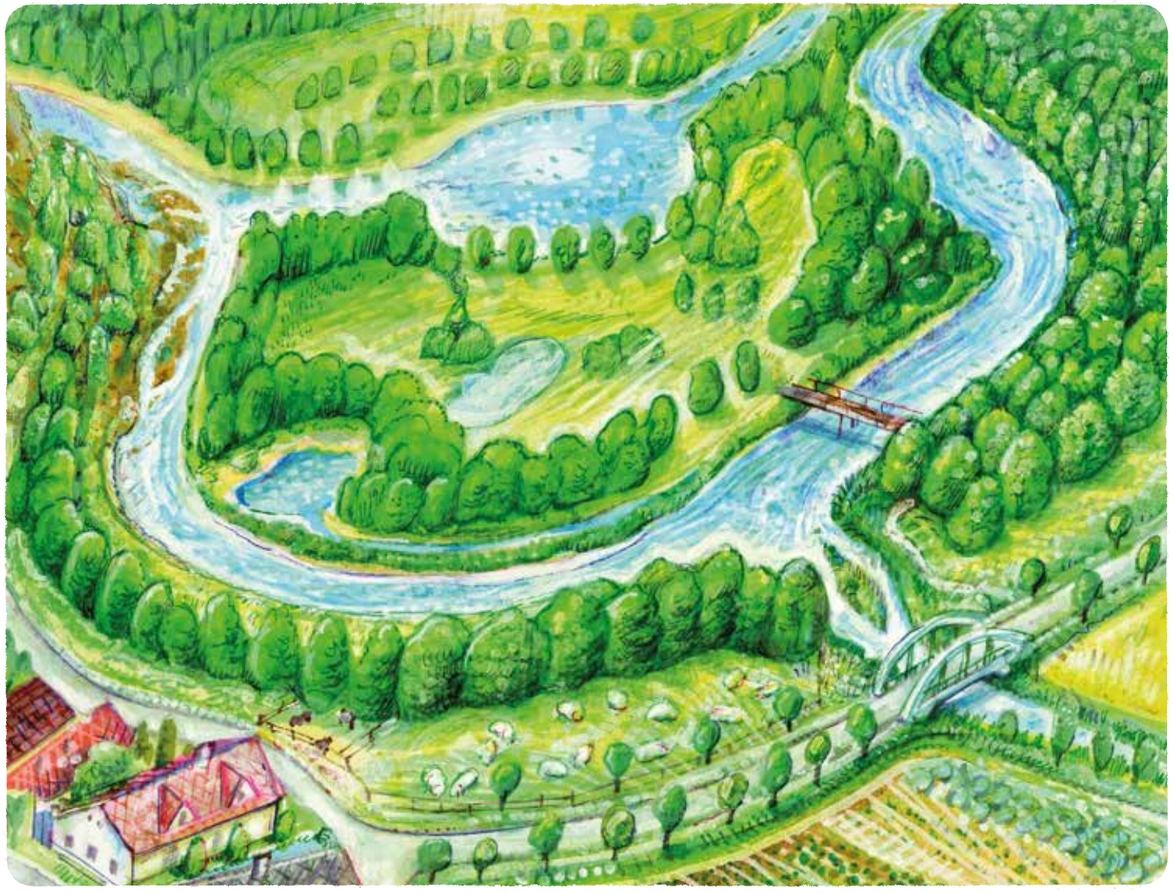


Aldabra giant tortoise
lives up to 200 years

Freshwater pearl
mussels
live up to 150 years

Towards Rectification

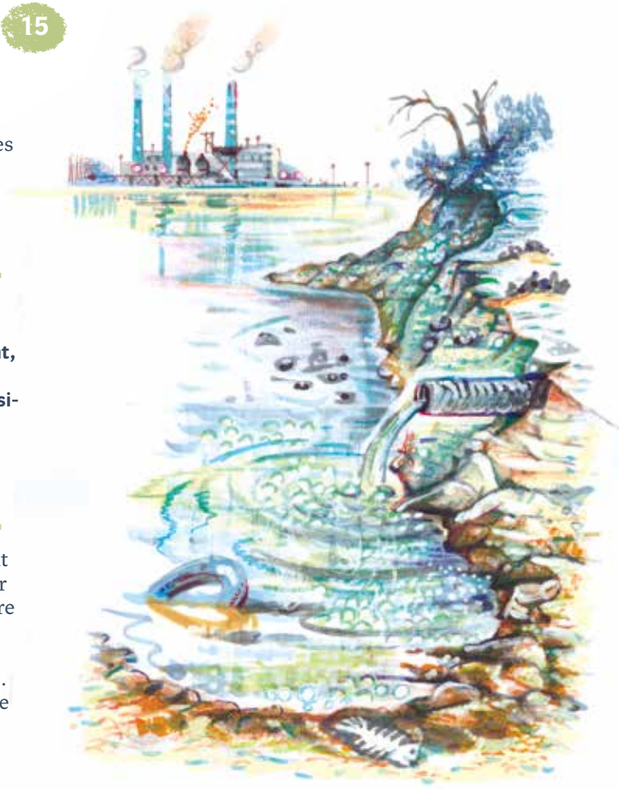
Experts have been trying hard to preserve this species in our environment for at least the last three decades. Thanks to this effort there remain a few last-standing mussels, a moderate number of their offspring, and also young individuals from artificial breeding that were introduced into rivers over the past few years.



The lack of new young individuals and the fact that the overall quantity of mussels has been steadily decreasing was noticed by people especially in places where they used to encounter them routinely. This is, for instance, in mill races, where the shortage of mussels meant that people could no longer use them to feed their poultry.

Putting young man-bred mussels into polluted or otherwise distorted river ecosystem is futile. Freshwater pearl mussels require quality environment, and their standards are high. This is concerning the composition of water, but also the shape and composition of the riverbed, as well as the waterflow characteristics. Everything has to meet their criteria. A single missing piece of the puzzle will doom the endeavour to failure.

Watercourses are nowadays being revitalised so that they could start to function properly once again over the entire catchment area. Meadows and marshes are starting to reappear along rivers, instead of fields. Wastewater is subjected to a thorough cleaning process. More deciduous trees are planted in forests. The state of river landscapes is directly related to the quality of water and to underwater life. This holds true to meadow springs, the tiniest runnels, creeks, streams, and large rivers.



The Record Holder of our Environment

This organism has inhabited the Earth since the Palaeozoic Era in an unchanged form. It is therefore a so-called living fossil, much older than dinosaurs, similar to nautili or tardigrades.

nautilus

tardigrade

An Adventure in Wellington Boots

The freshwater pearl mussel and its community live in places with the purest, cool, and running water. It is as demanding regarding water quality as us humans. Our lives depend on the same resource.

It does not matter if all there is nearby your house is a small pond, stream, or a temporary puddle. There is always something to discover!

Before you set off, approach an adult and ask for their approval or accompaniment, unless you are old enough to go on your own.

It is ideal to go in spring, summer, or autumn. In winter, the diversity of water organisms is lower. Besides, soaking oneself in ice cold water is definitely not for everyone.

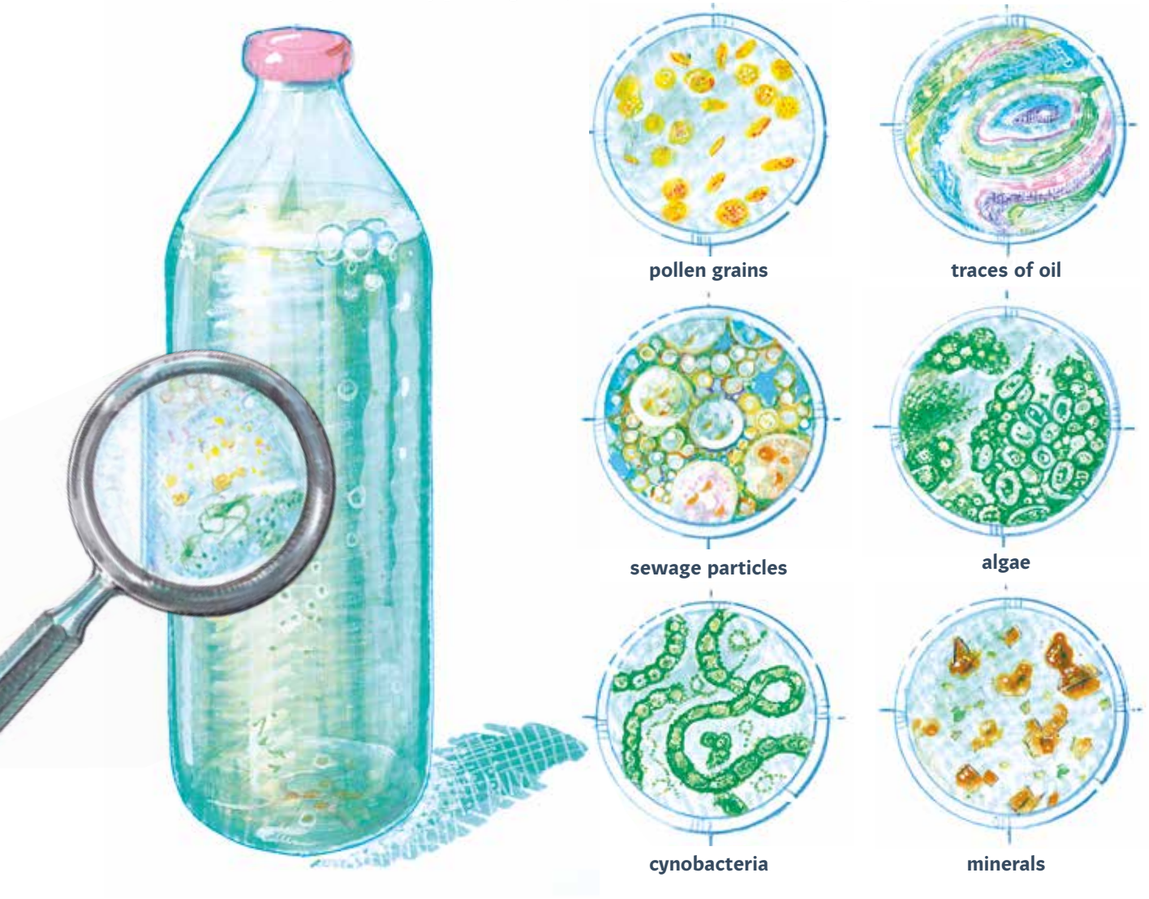
HERE ARE A FEW THINGS THAT WILL COME HANDY

- Bring our **book** with you, or at least the part with the **field guide**.
- Next, take a **transparent plastic bowl**. It should be large enough to accommodate your face. You can immerse it in water and observe what goes on underwater through the transparent material.
- Furthermore, take a **sieve** from your kitchen and put it into water for a while, or if you mom allows it, you can even dig into the riverbed.
- You will also need a **dish or bowl** to put your finds in, so that you could examine them later.
- It is also useful to have a **magnifying glass**.
- Next, have the **field guide** contained in this publication ready.
- Finally, having a **Secchi disk** may prove useful in case you go to a pond or a deeper river. It is used to measure water transparency and is easy to make.
- If you are an avid explorer and like to go on an adventure frequently, you might consider obtaining a **plankton net** and a **pair of tweezers**, which will help you to sort through your finds, and more **dishes or bowls**.
- It is prudent to take detailed documentation for a more thorough examination back home. **Take a picture of your finds** and put them back into water as soon as possible.

Transparency

Transparency is one of the most fundamental indicators of water purity. It depends on the colour of the water and its turbidity. It conveys information regarding the content of microorganisms and floating particles of substances such as clay or humus. Look through the transparent bowl and estimate how deep you can see.

What is the water colour? Scoop it into a transparent bottle and observe.
Does it contain algae and cynobacteria? Is it green, brown, etc.?
Can you see any pollen grains, traces of oil, minerals, sewage particles, etc.?



pollen grains

traces of oil

sewage particles

algae

cynobacteria

minerals

SECCHI DISK – INSTRUCTIONS

It is really easy to make a Secchi disk. All it takes is half an hour and a few items that you can find in your home or buy in a stationery shop.

YOU WILL NEED:

- a white plastic board (can be the bottom of a bucket or some kind of pad for modelling)
- a black marker pen (or a black adhesive tape, or a brush and waterproof black paint)
- weight – an eye bolt, two wide washers, and two nuts for tightening
- a strong 5-metre-long rope
- a pair of compasses, a ruler, a metre, and a red marker pen

1) First, we create a circular board with a diameter of 30 cm.
2) Then we divide it using a cross into four equal quarters, alternating between white and black. If our board is white, we will use black paint or a black adhesive tape to produce the black quarters.
3) The disk must be heavy so that it would sink towards the bottom. Therefore, it can be created from sheet metal. Alternatively, we can create a weight, consisting of a bolt and two nuts, placed in the middle of the board. Use an eye bolt to enable the attachment of a rope or a cable.
4) After fastening the rope, we mark it with a waterproof marker pen, using a rule as our length benchmark. The rope must be stretched and it is suitable to use different colours for the ranges of 5 cm, 10 cm, and 50 cm.

How do we measure transparency?

Given the fact that each of us has a slightly different perception, it is advisable to have at least two people conduct the measurement. Always perform the process in the shade. If there is no natural shade, it is necessary to create it using an umbrella or a piece of clothes.

When, where, and how to measure water transparency?

- During the growing season, i.e., between April and September, during the day (excluding twilight or dawn)… a special tip: repeated measurements taken in the same location allow for better evaluation.
- There where we cannot see the bottom of the water reservoir… always take the measurement from the dam, the outlet structure, or a boat as entering the shallow water would make it turbid, distorting the result.
- We sink and pull up the board repeatedly, around the limit of visibility. The board must float horizontally. The measured figure is taken in the moment when the contrast between white and black on the board becomes indiscernible.

Interpretation

In polluted fishponds with a lot of algae, transparency only amounts to a few dozen cm, up to one metre. On the contrary, in very clean lakes, the figure can prove to be 20 m or more.

Field Guide
for an indicative determination of water quality according to bioindicators

Observation

First, observe the water body and its surroundings. Even the sounds of birds or amphibians who are not visible can tell us a lot. If the locality is a place that is suitable for fish, take a look in the water and look for any movement. Only then should you start to search for other water animals.

Hunting for invertebrates

As far as hunting for invertebrates is concerned, they can be found on the water surface, underwater, in the bed, under the stones, among and attached to the local vegetation, and swimming in the current or just floating in still water. Your hunt should cover all the opportunities that the locality under examination offers.

The Field Guide will help you to recognise individual animals. You can write them down in your Field Guide using a pencil and, subsequently, evaluate your findings using the table found at the end of the Field Guide.

INSTRUCTIONS

Cut along this line

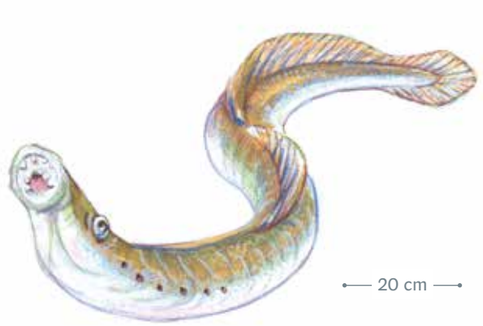
Fold along this line

Apply glue along this line

1) Follow the continuous lines to cut out all of the six parts.

2) With the help of a ruler, strike the dash-and-dot lines with the tip of your scissors to create little grooves in the paper. Next, glue the individual parts together following the yellow dots. Make sure that the succession of the pages is consistent with their numbering, i.e., 1–12.

3) Fold the newly created concertina book. The title page should come on top. Take the prepared Field Guide with you when you set out on your adventure. It might be a good idea to obtain a plastic cover to prevent your Field Guide from getting wet.



European brook lamprey

23

Field GUIDE

FOR AN INDICATIVE DETERMINATION OF WATER QUALITY ACCORDING TO BIOINDICATORS

Brown trout

21

European bullhead

22

APPLY GLUE

USING THE FIELD GUIDE

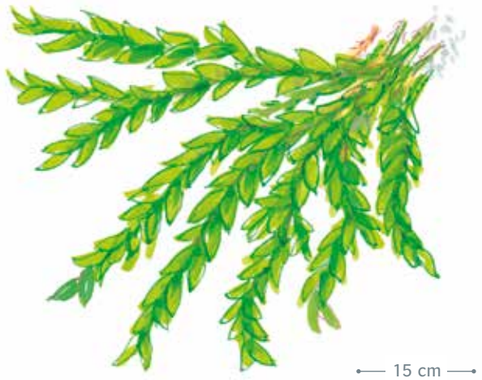
Consult the Field Guide to identify individual bioindicators. Then, note them down.

Use a pencil to make a tick next to the species that you found.

River Limpet — 6 — ✔

These numbers express the indicative value of the given species. You will find them useful when calculating the so-called biotic index, which can be used to derive the water quality.

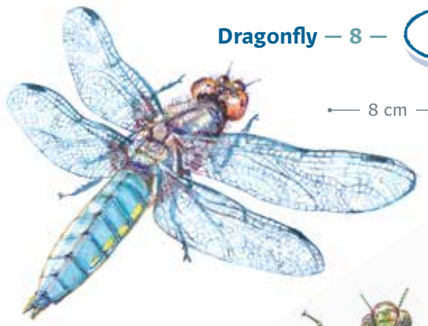
Water Moss



15 cm

APPLY GLUE ALONG THIS LINE

Dragonfly — 8 —



8 cm

5 cm

Dragonfly nymph — 8 —

Cranefly nymph — 5 —

4 cm

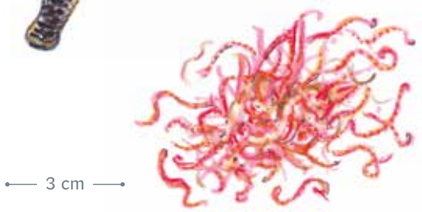
adult Cranefly

Damselfly nymph — 6 —

APPLY GLUE ALONG THIS LINE

Medicinal Leech — 3 —

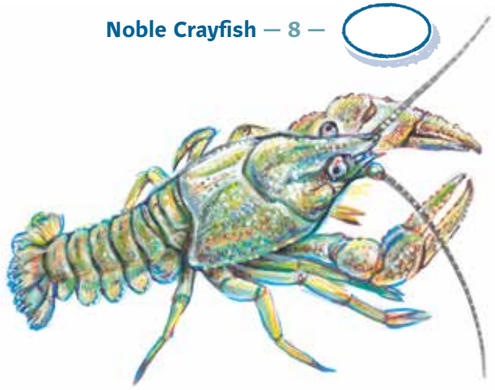
15 cm



3 cm

Sludge Worm — 1 —

Noble Crayfish — 8 —



20 cm

APPLY GLUE

5 cm

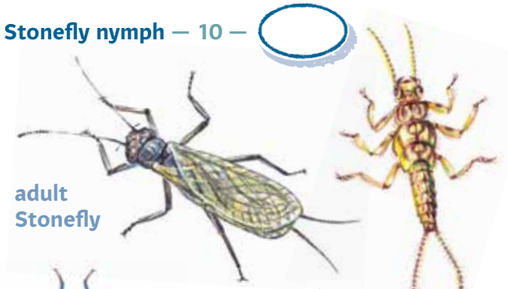
Great Pond Snail — 3 —

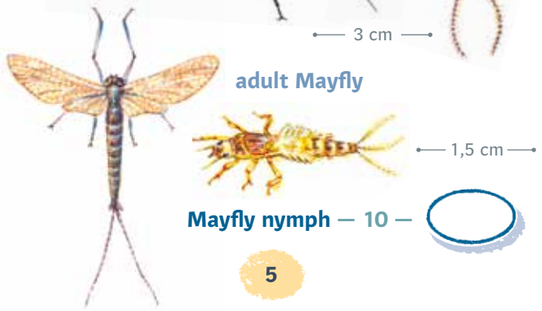
1,5 cm

Alpine Flatworm — 5 —

APPLY GLUE

Stonefly nymph — 10 —





Mayfly nymph — 10 —

5

Caddisfly larva
Caseless caddis — 6 —

Caddisfly larva
Cassed caddis — 9 —

6

APPLY GLUE ALONG THIS LINE

Lister's River Snail — 6 —

15

River Limpet — 6 —

Great Ramshorn — 3 —

16

APPLY GLUE

Nonbiting midge larva — 1 —

Blackfly larva — 5 —

7

Freshwater Shrimp — 6 —

Water Hog-Louse — 3 —

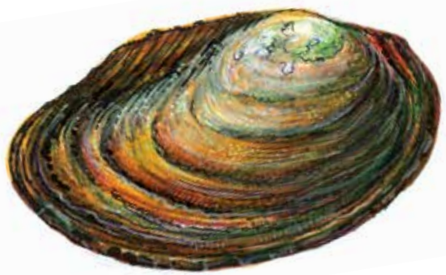
8

APPLY GLUE ALONG THIS LINE

Freshwater Pearl Mussel — 10 —

13

Duck Mussel — 6 —



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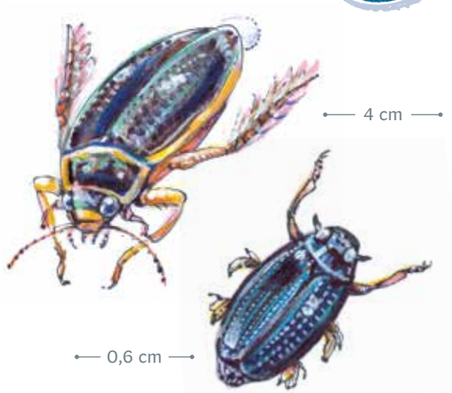
APPLY GLUE

Great Diving Beatle — 5 —



Whirligig — 5 —

9

Great Silver Beetle — 5 —

Water Scorpion — 5 —

10

APPLY GLUE ALONG THIS LINE

Water Measurer — 5 —

Pond Skater — 5 —

11

Water Boatman — 5 —

Water Cricket — 5 —

12

The numbers that can be found next to each species express the indicative value of the given species. Mark the values that you obtained in the table below. Calculate the average value (add up the indicative values and divide the figure by their total number), which is your resultant biotic index. Below you will find a table that will help you to determine the water quality using the measured biotic index. Water quality can also be estimated based on the prevalent groups of species. Record the result in your table.

Date	Name of stream / river / pond	Sum of indicator values	Total number of bioindicators found	Biotic index	Water quality
		:	=		
		:	=		
		:	=		
		:	=		

WATER PURITY CLASSES ACCORDING TO A BIOTIC INDEX

Modified according to POULÍČKOVÁ, A., RULÍK, M. Bioind kace kvality vodního prostředí – současný stav a perspektivy. Vlašim: ČSOP, 2000. Lampet a IV., Bull., 27–45 s.

Biotic index	Bioindicators	Purity class	Quality	Characteristics
1,0–2,5	Exclusively the larvae of nonbiting midges, sludge worms, larvae of hover flies, jelly-like white mats of sulfur bacteria, and white tufts of wastewater fungi	5	very low	heavily polluted, lack of oxygen, transparency lower than 0.5 m, very rich in nutrients; water body with a high proportion of wastewater, stabilization reservoirs, accumulative fish pond
2,5–4,0	Large numbers of nonbiting midges' larvae, sludge worms, leeches, great pond snail, almost no higher plants	4	low	heavily polluted, very low oxygen content, transparency up to 0.5 m, very rich in nutrients; artificially polluted water bodies (such as through wastewater)
4,0–5,5	Asellus aquaticus, river orb mussel, water beetles, water heteropterans, many water plants, leeches, Erpobdella octoculata, larvae of Stratiomys flies	3	medium	polluted, low oxygen content, transparency up to 1 m, rich in nutrients; fishponds, rivers, reservoirs
5,5–7,0	Larvae of mayflies and caddisflies, river limpet, Unio, duck mussels, Piscicola geometra, fine-lined pea mussel, many water plants, many fishes	2	good	slightly polluted, lower oxygen content, transparency up to 3 m, rich in nutrients; streams and lakes
> 7,0	Larvae of stoneflies, mayflies, and caddisflies, gammarid, European crayfish, freshwater pearl mussel, water mosses	1	excellent	unpolluted, rich in oxygen, clean, transparency 3–5 m, poor in nutrients; springs, upper courses of streams and rivers

A Few Facts About our Bioindicators

For this publication, we have selected species that point to a high quality of the water environment. What do freshwater pearl mussels, stone crayfish, European crayfish, and brook lampreys have in common?

Aside from the fact that they all are slowly disappearing from the environment, they indicate the properties of their habitats.

As these indicators are living creatures, we call them **“bioindicators”**. Preconditions for being regarded as a good bioindicator are met by those species and groups of animals that have well-known requirements concerning their environment and do not tolerate any deviations from the required characteristics very well. If a certain animal is able to live in both clean and polluted water, its tolerance, i.e., ecological valence, is too broad and it cannot be used as a bioindicator.

Throughout the year, the composition of an ecological community varies, especially in the cases of species with different stages of development, such as in insects, where larvae develop in water, while adult individuals can often fly far away from the native habitat.

It is convenient if a bioindicator can be easily classified into a group or, ideally, a specific species.

FRESHWATER PEARL MUSSEL

It can give us a picture about the course of the last century in the given locality. It is a significant bioindicator, thanks to its longevity, settled way of life, and strict environmental requirements. When their numbers decline, it is a testament to a changing environment, specifically a damage to the biotope or a disruption of ecological ties and relationships in the habitat.

If freshwater pearl mussels are present, it is a sign of a healthy river. In places where they live, other species thrive too, even if they are less sensitive to water purity or conservation of the environment’s natural characteristics, but still important for the ecosystem functionality. It is a so-called umbrella species, which means that protecting a certain species also indirectly protects other species, and that leads to an effective protection and conservation of the entire biotope.

EUROPEAN CRAYFISH

The European crayfish is a freshwater crustacean, one of two native species in the Czech environment. The European crayfish can be observed especially at night when it hunts for water animals. When there is shortage of prey, it can eat dead plants or animals too. Its numbers have been decreasing as a result of water pollution. This species is a so-called indicator of flowing water pollution. It is very sensitive to it, which is why it can only be found in the cleanest freshwater streams. Five pairs of segmented limbs are attached to its cephalothorax. The pincers are red from below. On its head, we can find an oral opening and a few long antennae, which are used as a tactile organ and a balance sensory system.

Aside from these, it also has shorter antennae, which is uses as an olfactory organ. Its eyes are mounted on movable stalks. The European crayfish can live up to 15 or even 20 years, which is relatively a lot. This is due to its high regeneration ability. Nowadays the most serious threat to our crayfish is a devastating infection called the crayfish plague, which is spread by invasive crayfish species, originally from North America, who inhabited Czech rivers as a result of unresponsible release of unwanted individuals from aquariums.

EUROPEAN BULLHEAD

The European bullhead is a bioindicator of natural and near-natural, well oxygenated, cold, fast-flowing segments of mountain and foothill streams. An important variable in the biotope character of the bullhead is a natural heterogeneity of the streambed and its properties, as it must provide enough opportunities for finding a hiding place. Regulation of streambeds and any barriers such as weirs, which block the spreading of species upstream, limit the occurrence of the bullhead. The bullhead does not have a swim bladder as most of other fish species. It moves along the streambed through small jumps generated by its pectoral fins. Spawning takes place at the turn of winter and spring. Eggs are attached to the bottom side of stones and are subsequently guarded by males for about three weeks, until the fry hatches. Bullheads live mainly on small insects and crustaceans. In the Czech Republic, bullheads can be found predominantly in mountain and foothill streams that are characterized by a good ecological potential, especially regarding water quality and the preservation of a natural streambed profile.

BROOK LAMPREY

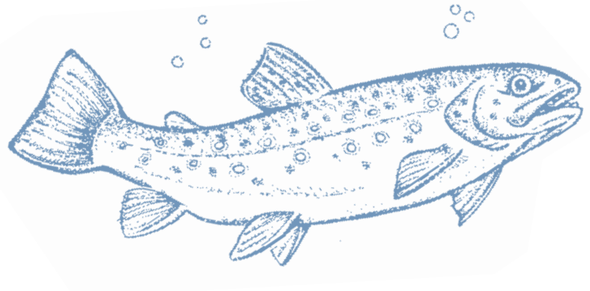
The brook lamprey, also known more specifically as the European brook lamprey, is a non-migratory and non-parasitic species, which sets it apart from the majority of other lamprey species. In the Czech Republic, the species of river lamprey is already extinct, while the Ukrainian brook lamprey survives in just one small stream, and its perspective is more than uncertain.

The lamprey spends most of its life, which spans 4 to 5 years, in the larval stage, when it is called the ammocoete. Their adulthood does not last long, and shortly after spawning they die. The larvae live buried in sandy and muddy sediments and are filter feeders, i.e., they feed on detritus that comes their way. After metamorphosing into adults, lampreys do not eat any more. This species is considered a bioindicator of clean foothill streams with natural conditions and preserved riparian vegetation. The flowing water of these streams carries material that is deposited in places where the current is slower, creating sediments of fine mud where ammocoetes can live. As a prerequisite, the sediment must contain adequate amounts of oxygen.

BROWN TROUT

The brown trout is a freshwater fish, from the Salmonidae family, which can be found basically all over Europe. A typical feature of salmonids is their adipose fin. In the Czech environment, the trout species lives in middle and upper courses of streams and in mountain creeks, including in higher altitudes. Important factors determining its occurrence include water temperature, its purity, and oxygen content. Trout eat mainly water insects' larvae, especially those of caddisflies, mayflies, and nonbiting midges. They also like to catch flying terrestrial insects on the water surface. Larger individuals can also eat smaller fish, amphibians, and small mammals. In our local conditions, they reach adulthood between the second and the third year.

They spawn in October and November, depending primarily on the water temperature in the given stream. They cover significant distances when they travel to their spawning grounds, being able to overcome relatively high barriers, such as waterfalls and weirs. The spawning grounds are characterized by a sandy or gravelly streambed, relatively slow-flowing water, and a depth not greater than 0.5 m. With their abdomen they pound against the streambed, creating oval holes that are up to 50 cm long. Into these holes, females lay yellow, relatively large eggs, which then males proceed to fertilise. During the process of spawning, both males and females swirl up sand and fine gravel, which cover the eggs. The lifespan of a trout in its natural environment ranges between 3 to 20 years.



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The authors of the texts are
Ing. Jana Slezáková a RNDr. Jiří Křesina
Contact: jana.slezakova@beleco, info@perlorodkaricni.cz

www.perlorodkaricni.cz | www.beleco.cz

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