THE SWEDISH 3Rs CENTER

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Aquarium furnishings for fish housed in a laboratory environment

A guide from the Swedish 3Rs Center

Photo: Reijo Juurinen

Contents

Background

This document has been produced by the Swedish 3Rs Center on behalf of the Swedish National Committee for the Protection of Animals Used for Scientific Purposes. The purpose of the document is to provide guidance to everyone working with fishes in a laboratory environment. This can for example be of use on how to live up to the requirements for housing and enrichment stated in chapter 26. § 5 in the Swedish research animal legislation (Statens jordbruksverks föreskrifter och allmänna råd (2019:9) om försöksdjur). The paragraph states that "An aquarium or corresponding space shall have an interior and a bottom substrate that corresponds to that found in the natural environment of each fish species". In this document, the Swedish 3Rs Center, with the help of experts in the field, has examined which fish species are housed in laboratories in Sweden and what needs of these species are. The document contains different ways of improving fish welfare by providing an appropriate environment, as well as tips on how furnishings can be replaced if it is necessary to avoid deterioration of the water quality. The material is based on scientific literature. The references used are listed at the end of the document, for further reading.

Experts who contributed to the compilation

- Erik Petersson, Swedish University of Agricultural Sciences
- Michael Axelsson, University of Gothenburg
- Svante Winberg, Uppsala University and Swedish University of Agricultural Sciences

Introduction

The results of an inventory of the fish species that are used as laboratory animals at Swedish laboratory animal facilities showed that 41 species are commonly used. The habitats and needs of these 41 species have been the basis for the recommendations in this document. The document contains cross-species recommendations as well as species-specific information about each of the identified species. The material is intended to be used as a guide when choosing aquarium furnishings for fishes that are kept in a laboratory environment in Sweden. Some information about other factors that need to be planned for when housing fish is also included in the document.

Our ambition is to increase the knowledge of researchers and animal care staff regarding the needs of fish that are kept in laboratory animal facilities. In Sweden, researchers are required to have knowledge of the animal species they are to use in an experiment.[1] The staff that takes care of the animals and decide how they should be housed also have to know about and have their species-specific needs in mind. There are several sources of information that can be used to make sure the fish are kept in accordance with current regulations and the most up-to-date knowledge. We recommend that researchers regularly return to these sources of information to ensure that they are working on the basis of the most recent knowledge. Such sources include:

- **Fishbase**
  https://www.fishbase.se/
- **The Swedish species database (Artdatabanken)**
  https://artfakta.se/
- **The Swedish Agency for Marine and Water Management (Havs- och vattenmyndigheten**)
  https://www.havochvatten.se/arter-och-livsmiljoer/fakta-om-arter-och-livsmiljoer/sok-arter-och-livsmiljoer.html
- **The Zebrafish Information Network (ZFIN)**
  https://zfin.org/

The word aquarium

In this guidance document , ‘the aquarium’ is mentioned on several occasions. By using this word, we mean different types of containers that fish are kept in. It does not necessarily have to be a traditional aquarium, but can be a trough or other container that is suitable to house fish in and that is approved as such.

[1] 6 kap. § 6 SJVFS 2019:9

Cross-species recommendations

Tens of thousands of fish species have been identified worldwide, and all species have their own specific needs. Nevertheless, there are also some collective needs and limitations when it comes to housing fish in a laboratory before, during and after experiments. In this part, we compile recommendations which are true for most of the species that we addressed in this material.

Aquarium furnishings during experiments

For fish that are kept as experimental animals, an aquarium or corresponding space must have an interior and a bottom substrate that corresponds to what is found in the natural environment of each fish species.[2] This paragraph has, since it was written, been clarified in a guide to the County Administrative Boards. In this clarification the Swedish Board of Agriculture states that the text should be interpreted to mean that it is the needs of the species that should control what furnishings are required. The wording should therefore not be interpreted as an absolute requirement for bottom substrate and other furnishings to be used.[3] If it is natural for the species that is being housed to have an interior or bottom substrate and you wish to waive the requirement outside of experiments, the Swedish Board of Agriculture needs to approve an exception for the facility.

Furnishings in the aquarium during ongoing experiments is regulated in the ethical approval of the experiment. In the application for ethical approval of an animal experiment, researchers must describe how they plan to house the fish during the experiment. That description should be based on the requirements and limitations that are set by the experiment. The regional animal ethics board examines both the experiment and the method of housing described in the application. Knowing and adapting the housing to the animals' needs is always important since it can affect both the welfare of the animals and the results of the experiment. For that reason, this support material can be a valuable aid in choosing the appropriate furnishings during experiments.

If you wish to exclude furnishings

Which aquarium furnishings that can or need to be excluded during experiments varies depending on the species that is being studied and the purpose of the experiment. It is up to the researcher to assess and apply for the possibility to exclude furnishings. Preferably, the assessment is done in association with animal care staff or the facility's responsible veterinarian. A common reason to exclude furnishing is hygiene-related problems, for example when using live plants. Replacing live plants with artificial ones could be a solution. If artificial plants also

[2] Chapter 26 § 5 SJVFS 2019:9

[3] Jordbruksverket. (2021). Vägledning för kontrollmyndigheter gällande bottensubstrat för fisk som är försöksdjur. Dnr 5.2.17-07557/2021.

obstruct the possibility to perform the experiment, these can in some cases be excluded as well. If the species housed has a need to hide, the plants should be replaced by other structures that offer protection. These structures can, for example, be dividing walls, more shading of the aquarium or halved clay flower pots.

Bottom substrate can also make it difficult to keep the aquarium clean. In scientific studies on zebrafish it has been shown to work with an image of bottom substrate under aquariums instead of bottom substrate inside of them. It is possible that this may be suitable for other species as well, but this has not been studied. It is also possible to paint the bottom in natural colors, since less contrast between the fish's own body and its surroundings can reduce stress for certain types of fish. If the species burrows into the bottom substrate, it is more difficult, and perhaps even inappropriate, to exclude it. If substrate is excluded anyway, the bottom substrate should be replaced with structures the fish can hide in and under, such as caves and halved clay flower pots.

General recommendations about furnishings and housing

Regardless of the type of fish that are housed and the type of aquarium they are housed in, there are certain general recommendations that should be considered regarding view protection, possibilities to hide, lid on the aquarium and safe furnishings. Also, other factors regarding handling and the environment need to be kept in mind.

View protection

Many fishes need some form of privacy protection, especially if they are kept in transparent aquariums. According to the existing animal welfare legislation, at least one side of the aquarium, or a corresponding surface, must be protected from view, unless the aquarium's interior provides the fish with such protection[4]. Experts generally recommend that transparent aquariums be kept opaque on three sides, as long as daily inspection of all individuals remain possible. The basis for that recommendation is the natural environment for the fish as well as experiences from researchers in Sweden. However, it should be noted that some people who work with fish feel that group-living fish who can see individuals in adjacent aquariums may perceive it as living in a larger group than what is in their own aquarium. In such circumstances, aquariums should not be covered quite as much.

Possibilities to hide

Most fish species prefer to be protected from above as well. This is easily done by covering approximately half the aquarium with an opaque material. Some species are particularly sensitive to disturbances from above and for them it is especially

[4] Chapter 26 § 6 SJVFS 2019:9

important to offer protection in this way. The recommendations for each separate species below indicate whether a species is particularly sensitive.

It is also important to remember that most fish species are prey for other animals that are found both in the water and on land. Therefore, they often need to be able to hide from people as well. Younger individuals may have an even greater need to hide since they often are exposed to predation even from their own species.

Lid or net over the aquarium

To cover, or put a lid on an aquarium is not always necessary or even recommended. Any cover must be adapted to the species that is being housed. For fish who are easily startled or tend to jump, it may be necessary to cover the aquarium to prevent the animals from escaping. When fishes attempt to escape, it can often lead to injuries and the risk of the fish dying. In addition to preventing fish from jumping out of aquariums, covering the aquarium can help to keep the temperature of the water at an even level, especially if the species needs a temperature that is very different from the surrounding air. Lids may also keep the humidity of the room down as it can lessen evaporation. If the fish tend to injure themselves, the cover should be made of a soft material, for example silicone covered fine mesh netting without knots.

Safe aquarium furnishings

Most fish have sensitive skin with a mucous layer that can easily be damaged. Therefore, it is important that furnishings are not pointed or have sharp edges. Even hard plastic plants can pose a risk of injuring some fish. Avoiding sharp edges also applies to the bottom substrate. Materials such as crushed gravel or stones should therefore be avoided.

In addition to posing a direct risk of injury, certain furnishings can give off harmful substances or form a breeding ground for pathogens (disease-causing substances). Certain materials, such as several types of plastics, risk releasing chemicals and microplastics into the water and should therefore be avoided. Such substances can impair the health of the fish and the results of the experiments. Nowadays, there are plastic plants that do not leak chemicals, which is preferable if you wish to use plastic plants. If glue is used to anchor or repair furnishings, it is important that this also does not release harmful substances.

When setting up water systems to keep fish in laboratories, a trade-off may have to be made between water quality and the needs of the animals. This is due to the fact that several types of furnishings risk worsening the water quality. The water may therefore need to be changed more often, and the furnishings cleaned more frequently.

Other factors to keep in mind

When housing fish, it is not only the interior of the aquarium and the safety equipment around that matters. Something that is also very important for fish are water parameters, access to daylight, health, catching and handling. Therefore, the following aspects should be reviewed before bringing fish into a laboratory, in addition to furnishing of the aquarium:

- Catching - should be handled as stress-free as possible.
- Handling – the majority of fish species are sensitive to air exposure.
- Endangered species – should be avoided in research.
- Acclimatisation – fish should be given the opportunity to get used to their new environment.
- Brightness – must be adapted to the species.
- Light cycle – natural light and dark cycle is preferred.
- Type of light – certain wavelengths and spectrums can be stressful.
- Type of water system – where some systems allow for a more varied furnishing.
- Water parameters – the needs of the species regarding temperature, pH, hardness and salinity, often measured as conductivity.
- Types of minerals in the water – different species may require different compositions.
- Predators and prey – predators and prey must not be kept within sight, smell or hearing distance of each other.[5]

[5] Chapter 16 § 22 SJVFS 2019:9

African lungfish, *Protopterus spp.*

African lungfish is one of three families in the lungfish subclass, and the only family that contains more than one species. The family includes four species, which in the wild can be found throughout Africa. African lungfish can be bought from suppliers in or outside of Sweden. None of the species is on the IUCN list of threatened species.

Biology

The African lungfish lives in fresh water at a depth of 0–60 meters. The species mostly eat animal-sourced foods such as molluscs, frogs, other fish and insects. They live near the edges of rivers and lakes, in swamps and in floodplains. African lungfish live close to the bottoms, which can vary from consisting of sludge or mud to rocks. They also like to live where there are floating plants and often hide in floating plant material. Young African lungfish usually hide under roots in shallow areas. This, combined with the fact that they often live in cloudy water, means that they are not often exposed to strong sunlight. As the name suggests, lungfish breathe with lungs similar to terrestrial animals and therefore need to come up to the surface to breathe air. In the wild, African lungfish live solitary lives and often show aggression towards conspecifics. They can become 40–200 centimetres long, depending on the species, and live for up to 70 years.

Housing in a laboratory environment

In aquariums, African lungfish requires fresh water, a temperature in the range of 25–30 °C and a pH between 6.5 and 8.0. They can be fed different types of protein, such as pieces of clams, shrimps and fish or whole dead such animals. Movements in the water should be kept to a minimum and pumps that create strong circulations should therefore not be used. On the bottom of the aquarium, African lungfish can have different types of substrate. An example of a bottom substrate that works is natural or pea shingle that is 8–12 millimetres in diameter. Since African lungfish have a long, narrow body shape and a need to hide, different types of pipes, such as clay pipes, can be used as furnishing. Due to the fact that they breathe air, there must be space between the surface of the water and any covering of the aquarium. This space must also be well ventilated. It is further important to ensure that the fish easily can reach the surface of the water, either by not having too great of a water depth in the aquariums or by furnishing with objects that allow them to easily reach the surface. African lungfish should be kept in dim lighting and given protection in the form of floating plants, such as water hyacinths, which give them the opportunity to hide. Given the species' aggressiveness towards conspecifics, they should be single housed to avoid them attacking each other.

African sharptooth catfish, *Clarias gariepinus*

The African sharptooth catfish, is a species in the family airbreathing catfish that belongs to the order catfishes. It lives in waters from South Africa to North Africa. It has also been introduced to Europe, the Middle East and parts of Asia. The species can be purchased via suppliers working both within and outside of Sweden. The species is not on the IUCN list of threatened species.

Biology

African sharptooth catfish is found in a range of different freshwater environments, at depths of 4–80 meters. They inhabit everything from calm waters such as lakes, ponds and pools to flowing rivers and rapids. They are potamodromous (migratory) and mainly migrate in streams and rivers. The African sharptooth catfish is highly adaptable to extreme environmental conditions and can, for example, cope with very muddy waters and large variations in temperature. In the water, the African sharptooth catfish prefers to reside at the bottom, where they can live on both sludge and rock bottoms. They often hide in floating plant material. As with water quality, the African sharptooth catfish is not picky when it comes to food and eats everything from plankton and molluscs to fruit, carcasses and small vertebrates. The species is nocturnal and breathes air, which means they need to come up to the surface to get oxygen. The African sharptooth catfish can grow up to 170 centimetres long and become 8 years old.

Housing in a laboratory environment

In aquariums, the African sharptooth catfish requires fresh water, a temperature in the range of 8–35 °C, but optimally 28–30 °C, and a pH between 6.5 and 8.0. Due to them breathing air, there must be space between the surface of the water and any covering of the aquarium. This space must also be well ventilated. Since they are omnivores, they should be given a variety of food. A study has shown that fine sand makes the best bottom substrate as it leads to higher growth and less aggression. Since the African sharptooth catfish readily hides among floating plants, it is a good idea to have such plants in the aquarium, for example water hyacinths. As the species is nocturnal, it may be a good idea to use a reversed circadian rhythm in the room where they are kept. If a reversed circadian rhythm is not possible, it is important not to disturb the fish too much during the day, as this is their natural resting time. Procedures and observations can also advantageously be carried out as late in the day as possible to be considerate of their circadian rhythm. The African sharptooth catfish shows less aggression to conspecifics if kept at higher densities.

Arctic char, *Salvelinus alpinus*

The Arctic char is a species in the salmonid family. It has been bred in captivity since the end of the 20th century. In the wild, it is found in northern Europe and the northernmost parts of North America. In Sweden, the distribution area previously consisted of mountain areas and deep waters in the south and middle of the country, but due to acidification and introduction of other species, it has disappeared in several places. However, the species is regularly reintroduced and has recovered at several locations. There are quite a few commercial farms that raise and sell Arctic char. These often sell fish of different sizes and ages. It is also permitted to catch Arctic char in the wild. The species is not on the IUCN list of threatened species.

Biology

The Arctic char mainly lives in fresh water. It resides in lakes or larger watercourses at a depth of 0–30 metres, where it inhabits coastal areas and lives pelagically, meaning it swims freely in open water and not often come in contact with the bottom. There are also northern populations that migrate out to sea. Small Arctic chars eat mostly bottom-dwelling invertebrates and plankton, while larger individuals mainly eat fish, including other Arctic chars. They usually grow to be 35–45 centimetres long, but there are populations that grow both larger and smaller. They have been reported to live for up to 40 years.

Housing in a laboratory environment

In the aquarium, the Arctic char requires fresh water, a temperature in the range of 4–16 °C and a pH between 6.5 and 7.5. It is also important to keep the water well oxygenated as the species is sensitive to a lack of oxygen. Since Arctic chars are bred in Sweden, there are commercial feeds available. These feeds are adapted to their various stages of development. For example, feed for newly hatched fry should be particularly high in energy. As the Arctic char often react strongly to disturbances from overhead, it is important to give them protection from above. Studies have also shown that dark sides of the aquariums reduce the aggressiveness of the fish. Stones that are 2-10 centimetres in diameter works well as bottom substrate in the aquarium. The Arctic char should be housed in groups.

Atlantic cod, *Gadus morhua*

The cod is a species in the *Gadidae* family. It occurs in the North Atlantic Ocean and from the northeastern United States to the White Sea. In Sweden, it occurs along the west coast, in the Sound (Öresund) and the Baltic Sea. There is a limited amount of breeding of cod in Sweden, but it can also be caught in the wild. The species has declined sharply and is listed as vulnerable on the IUCN list of threatened species.

Biology

The cod is found in saltwater environments where it usually stays close to the bottom of the sea or ocean down to a depth of 600 meters. Sometimes it also swims in the free water mass. Young individuals prefer a more complex environment and shallower water, that is 10–30 meters deep. Vegetation, boulders and rocks found in such environments can provide protection them from being eaten. Spawning takes place in the free water mass down to a depth of approximately 100 meters, and occurs at different times for different populations. Eggs and larvae are pelagic, meaning they float freely in the open water. The cod feeds on invertebrates and other fish, including smaller individuals of its own species. The species can become 31–74 centimetres long, but has been recorded being as long as 200 centimetres at the most. The cod can live for up to 25 years.

Housing in a laboratory environment

In aquariums, the cod requires salt water, a temperature in the range 0–15 °C and a pH between 6.5 and 8.0. In captivity, the cod can be fed commercial dry feed that are available from large feed suppliers, but it can also be fed mussel and fish meat. The species often reacts strongly to disturbances from above, and it is therefore important to provide it with structures to seek shelter under. It is often enough to cover half the aquarium with something opaque. Young individuals need a more complex environment with furnishings in the form of stones and live or artificial plants. Bottom substrate can consist of stones that are between 2–10 centimetres in diameter. The cod is not a distinctive shoaling fish, but sometimes gathers in shoals and can therefore be housed in groups.

Atlantic hagfish, *Myxine glutinosa*

The Atlantic hagfish, in some places simply referred to as hagfish, is a species in the family of hagfish which is a vertebrate that lacks jaws and a calcified skeleton. The species is found along the European and North African coasts of the Atlantic Ocean, the Barents Sea and the Mediterranean Sea. In Swedish waters it is found on the west coast. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The Atlantic hagfish lives at a depth of 20–600 meters in saltwater environments where it spends most of its time buried in fine gravel or mud on the bottom. There they lie curled up with their heads above the substrate. The species' main diet has been shown to consist of shrimp, but they also eat other invertebrates and carcasses when available. Atlantic hagfish usually reach 15–35 centimetres in length, but lengths up to 95 centimetres have been reported. It is difficult to determine the age of an Atlantic hagfish, but it has been estimated to become sexually mature at the age of 13 and is therefore predicted to become relatively old.

Housing in a laboratory environment

In aquariums, the Atlantic hagfish needs salt water, a temperature in the range of 2–13 °C and a pH between 6.5 and 7.5. For the species it is important that the temperature and oxygenation are kept at even levels. In aquariums, they should be fed pieces of shrimp, fish or other invertebrates, or whole dead such animals. Since Atlantic hagfish spend a large part of their lives buried, they need to be given access to a suitable bottom substrate, for example mud or sand with a maximum grain size of 3 millimetres. The bottom substrate also needs to be of such a quantity that they can cover at least 75 percent of their body. Atlantic hagfish are difficult to house in aquariums due to them producing large amounts of slime when they feel threatened. This slime is harmful to fishes as it can clog their gills. Options for keeping Atlantic hagfish in labs are to keep them in smaller aquariums that are cleaned frequently, if necessary daily, or in large open-system aquariums where flowing water is filtered or replaced quickly. It is especially important that Atlantic hagfish are not housed in the same water system as predatory fish, since this can lead to additional slime production. The Atlantic hagfish can be housed in groups. Since they often lie buried in groups, it is important that all individuals have enough surface area to lie buried at the same time.

Atlantic salmon, *Salmo salar*

The Atlantic salmon is a species in the salmon family. Naturally, it occurs throughout the northern Atlantic Ocean. In Sweden, the species occurs in the Baltic Sea and the Western Sea (Västerhavet), but there are also populations in Vänern. Atlantic salmon can either be caught in the wild or purchased from commercial breeders. The species is not on the IUCN list of threatened species.

Biology

The Atlantic salmon lives large parts of its adult life in salty seawater at a depth of 0–200 meters. When reproducing, they migrate up the freshwater river systems, where they were once born, to spawn. Young individuals then typically spend 2 to 3 years in this river system before migrating out to sea. The Atlantic salmon can spawn several times during its life, although most individuals only have time, or are able, to spawn once. The species spawns over gravel bottoms in watercourses. In their natural environment, young individuals stay close to gravel and stone or sediment bottoms. Once the Atlantic salmon have migrated out to sea, adult individuals no longer interact with the bottom substrate, but are pelagic, meaning that they live in open water. Juvenile Atlantic salmon feed on aquatic insects, molluscs, crustaceans and small fish, while as adults they mainly eat squid, shrimp and fish. Atlantic salmon naturally live solitary lives, but have for many generations been raised to feed humans in farms where they are kept at a high density. Despite their naturally solitary lives, this works as the high density has been shown to minimize aggressive behaviour. The species usually grows to be about 50 centimetres long with a weight of 2.5–9 kilograms, but it can grow up to 40 kilograms. Atlantic salmon can live for up to 13 years.

Housing in a laboratory environment

In aquariums, the Atlantic salmon requires a temperature in the range of 2–16 °C and a pH between 6.5 and 8.2. They are usually kept in salt water, but can be acclimated to lower salinities if the experiment requires it. If you do not plan to breed the Atlantic salmon, they should be kept in salt water. Young individuals, up to the smolt stage, must be kept in fresh water as they do not tolerate salt water. They can be fed pieces of fish and shrimp or whole dead such animals, but there are also commercial feeds made for salmonids at various stages of development available for purchase. For adult individuals, it is the open water volume that is important since they live in open water in the wild. In the wild, Atlantic salmon use the current in different ways depending on their life stage. Flowing water and circular water movements in a laboratory environment can therefore work well as enrichment. Younger individuals should also be provided with bottom substrate in the form of gravel. Natural or pea single that is 8–12 millimetres in diameter can work well for this. To keep aggression down, Atlantic salmon should be kept in high-density groups.

Atlantic silverside, *Menidia menidia*

The Atlantic silverside is a species in the family of neotropical silversides. In the wild it lives in the western parts of the Atlantic Ocean, from the Gulf of St. Lawrence in Canada to north-eastern Florida. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The Atlantic silverside lives in the upper parts of salt water at a depth of 1–3 meters. During spawning, they stay in shallower water where they attach the eggs to bottom substrate and aquatic plants. They live in large shoals that often stay close to the coast and in estuaries. The Atlantic silverside eats various types of crustaceans, such as copepods, opossum shrimps (*Mysida*) and shrimps, but also fish eggs as well as small squid and fish, even of their own species. The Atlantic silverside grows to be up to 15 centimetres long and has been reported to live for up to 2 years.

Housing in a laboratory environment

In aquariums, the Atlantic silverside requires salt water, a temperature in the range of 1–33 °C and a pH between 6.5 and 8.0. In captivity, the Atlantic silverside can be fed *Artemia* or artificial feed. Since the species lives in shoals, it is important to keep it in large aquariums that allow for it to be kept in groups of at least 10 individuals, but preferably more. It is not necessary to provide the Atlantic silverside with a bottom substrate or other furnishings other than during spawning. In order to stimulate breeding, the lights should also be on for 15 hours a day. Outside of breeding, the Atlantic silverside should have 12–14 hours of light per day.

Atlantic wolffish, *Anarhichas lupus*

The Atlantic wolffish, also referred to as many other names such as seawolf and Atlantic catfish, is a species in the wolffish family. It is naturally found in coastal areas to the east and west of the North Atlantic Ocean. On rare occasions it also occurs in the Sound (Öresund) and western parts of the Baltic Sea. Atlantic wolffish can be purchased from commercial breeders but may also be caught in the wild. The IUCN lacked sufficient data to evaluate the species' occurrence in 2023, and the Atlantic wolffish's status is therefore unknown.

Biology

The Atlantic wolffish lives in cold salt water at a depth of 1–600 meters, but is usually found at a depth of 18–110 meters. They live on rocky, muddy or sandy sea bottoms and thrive in low temperatures. The Atlantic wolffish eats smaller fish, crabs, lobsters, sea urchins and other echinoderms. The species mainly lives solitary lives but has also been seen living in groups, which is probably related to access to shelter. During spawning, adult Atlantic wolffish form pairs. Juveniles mainly stay on the bottom in spawning areas and become sexually mature when they are 50–60 centimetres long. Although Atlantic wolffish normally reach 50–60 centimetres in length as adults, they can grow to be up to 150 centimetres long. At most, they have been measured to weigh just under 24 kilograms and usually live to be around 20 years old.

Housing in a laboratory environment

In aquariums, the Atlantic wolffish requires salt water, a temperature in the range of -1–13 °C and a pH between 8.0 and 8.5. It can be fed pieces of, or whole dead, crustaceans, such as crabs and shrimps, or fish. The Atlantic wolffish needs bottom substrate, but has no need to burrow. Natural or pea single that is 8–12 millimetres in diameter is therefore a good alternative. Although the species is solitary by nature, it can be kept at a relatively high density in a laboratory environment. The fish density in captivity is considered to be an enrichment in itself based on studies made on growth and general health.

Black goby, *Gobius niger*

The black goby is a species in the family of gobies. It occurs along the eastern coast of the Atlantic Ocean, from Norway to Mauritania, as well as in the Mediterranean Sea and Black Sea. In Sweden, it lives along the west and south coasts and along the east coast up to Uppland. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The black goby lives in saltwater environments, but also occurs in brackish water, as it likes to live in estuaries, meaning where streams of fresh water lead into the salty sea. The species stays close to the coast and migrates out into deeper water during the winter, when it can swim down to depths of 75 meters. It prefers soft sea bottoms with vegetation, although it can sometimes also occur in rocky environments. The food mainly consists of small crustaceans, clams, snails, bristle worms (polychaetes), red mosquito larvae (chironomids) and small fish. The black goby, despite its name, is not completely black, but shifts in dark brown. The males become particularly dark during spawning. The black goby spawns repeatedly during the period of May to August. After spawning, the male guards the eggs until they hatch. Black gobies are usually 10–15 centimetres long, but have been reported to be as long as 25 centimetres. The species lives for about 5 years.

Housing in a laboratory environment

In aquariums, the black goby requires a temperature in the range of 8–24 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. In aquariums, the species can be fed small crustaceans such as *Mysis* and *Artemia*, but also mussels and snails. The black goby thrives the most if it is kept in small groups in large aquariums, that hold at least 200 litres of water. The aquariums should be furnished with live or artificial plants which provides the black goby with protection, but also stones, clay flower pots and brick pipes can give opportunities to hide. If the aquarium does not contain furnishings that allow the fish to hide, they should be disturbed as little as possible.

Broadnosed pipefish, *Syngnathus typhle*

The broadnosed pipefish is a species in the family syngnathids, which also includes the genus seahorses. It occurs along the eastern Atlantic Ocean, from Norway to Morocco, as well as in the Baltic Sea, the Mediterranean Sea and the Black Sea. In Sweden, it lives along the entire west coast, the Sound (Öresund) and along the east coast up to the Gulf of Bothnia. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The broadnosed pipefish occurs in both salt and brackish water at depths between 0 and 20 meters. It is a poor swimmer and usually inhabits coastal zones. The species prefers areas where there are soft sea bottoms with a lot of vegetation in the form of eelgrass which they can hide amongst. The broadnosed pipefish can also be found in estuaries. The food consists of plankton, small crustaceans and small fish larvae, and depends on the size of the individual. The species, like many other pipefish and seahorses, has reversed gender roles when it comes to reproduction. During spawning, which occurs from April to August, it is the female that courts the male and then she attaches eggs to a skin pocket on the male's abdomen in stages. The male spawns with several females and carry the eggs for about five weeks before they hatch. The broadnosed pipefish usually becomes 15–20 centimetres long, but can grow to be up to 35 centimetres long. There is currently no information on the lifespan of the species.

Housing in a laboratory environment

In aquariums, the broadnosed pipefish requires a temperature in the range of 8–24 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The species should be fed small crustaceans, such as *Mysis*, *Artemia* or *Neomysis*. It is suitable to feed them with both live and frozen food, but it is recommended to start with live food for newly captured individuals. Young greater pipefish requires small prey. Feeding should take place three times per day regardless of age. Greater pipefish thrive the best when living in groups in larger aquariums. They should be housed in aquariums that hold at least 500 litres of water. In such an aquarium, up to 50 individuals can be housed. In aquariums, the fish need something to hide among that also offers a rest for the tail, for example live or artificial plants, or other structure that gives the fish the opportunity to hide. The height of the aquarium, as well as the height of the plants, must be adapted to the actual size of the housed individuals, to make sure they can

swim upright, which they often do. If the aquarium does not contain furnishings that allow the fish to hide, they should be disturbed as little as possible.

Brown trout, *Salmo trutta*

Brown trout, also called sea trout, is a species in the salmon family. It can be found in streams, rivers, lakes and along coasts in almost all of Sweden. The species is otherwise found in northern and north-western Europe and has been released in several other parts of the world. The trout is bred commercially and can therefore be bought in several different ages and sizes. It can also be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The brown trout is a multifaceted and highly variable species. Different populations can differ significantly in growth, size and life history. Some populations of brown trout are sea-migrating (anadromous), but other populations spend their entire lives in fresh water. The species usually lives at a depth of 0–30 meters and does not interact with the bottom, except to spawn. In young individuals, the food mainly consists of insects and crustaceans, while larger brown trout switch to eating fish. Spawning generally requires flowing and oxygen-rich water, as well as a gravel bottom where the females can create spawning pits. The brown trout spawns in the autumn, from August to December, and the roe hatch in the following spring. The species can create hybrids with the Atlantic salmon. The brown trout is usually 40–80 centimetres long and live to be 5–10 years old. The maximum reported age is, however, 31 years.

Housing in a laboratory environment

In aquariums, the brown trout requires a temperature in the range of 4–20 °C and a pH between 6.5 and 8.0. The brown trout is a species that shows great flexibility in terms of its life cycle, where there are sea-migrating, lake-migrating and stream-stationary populations. In addition, different individuals within a population can behave differently, some stay in the same watercourse all their lives, and some migrate out into a lake or sea. The species is most commonly housed in fresh water in a laboratory environment, but you should mimic the salinity where the fish is obtained from. In captivity, the brown trout can be fed commercial feed specifically adapted to their different developmental stages and ages. The first feed given to newly hatched individuals should be particularly high in energy. The brown trout often react strongly to disturbances from above, it is therefore important that there are structures under which it can take shelter. Often, it is enough to cover half the aquarium with something opaque. Keep in mind that different ages may have different needs for protection and hiding places. Fry, in particular, have a greater need for protective furnishings. Stones that are 2–10 centimetres in diameter are recommended as a bottom substrate. The brown trout is not strictly shoal-dwelling, but are still advantageously housed in groups in aquariums. If you intend to breed the brown trout, it should be provided with finer distributed gravel that gives the fish opportunities to create spawning pits.

Burbot, *Lota lota*

The burbot is a species in the rockling family that is part of an order of cod-like fishes. It is found around the world between the latitudes 40 and 70 north. In Sweden, this corresponds to almost all freshwaters, except on Öland and the far south of Scania (Skåne). Along the east coast, it is found from the Bothnian Bay down to the Kalmar Strait. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The burbot mainly lives in fresh water at a depth of 1–700 meters, but can also be found in brackish water. It lives near bottoms among roots, fallen trees, rocks and dense vegetation. In its natural environment, the bottom may consist of either sand or clay. Their food consists of crustaceans and fish. As fry, they eat smaller plankton, *Rotifera*, before transitioning into eating smaller crustaceans, and finally end up eating mostly fish. The burbot is active at dusk and at night and communicates with the help of sounds. It can grow to be up to 150 centimetres long, but usually stays around 40 centimetres long. The burbot can weigh up to 35 kilograms and live for up to 20 years, but they usually live for 1–12 years.

Housing in a laboratory environment

In aquariums, the burbot requires a temperature in the range of 4–18 °C and a pH of 7.5. What they should be fed depends on their age, where fry should be given small crustaceans, such as newly hatched *Artemia*, and the adults almost exclusively should be fed pieces of fish or whole dead fish. Since the species can live in both fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. As a bottom substrate, it is appropriate to provide the burbot with natural or pea shingle that is 8–12 millimetres in diameter. Considering the natural habitat of the burbot, live plants, stones and pieces of wood are suitable as furnishing. Halved clay flower pots of appropriate sizes are also recommended. The burbot can be housed in groups at a fairly high density, which also promotes growth. However, care should be taken to make sure that they do not differ too much in size, since they also prey on fish of their own species. As the burbot communicates with the help of sounds, it can be sensitive to noise in a laboratory environment, but there is currently no scientific evidence for this. Since the species is active at dusk and at night, it may be a good idea to use a reverse circadian rhythm in the room where they are kept. If a reversed circadian rhythm is not possible, it is important not to disturb the fish too much during the day, as this is their natural resting time. Procedures and observations are also best carried out as late in the day as possible in order to be considerate of their circadian rhythm.

Common goby, *Pomatoschistus microps*

The common goby is a species in the family gobies. It occurs in the eastern Atlantic Ocean, from Norway to Morocco, as well as in the western parts of the Mediterranean Sea. In Sweden, it is found along the west coast, in the Sound (Öresund) and in the Baltic Sea, northwards to the Åland Sea and the Gulf of Finland. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The common goby lives in salt and brackish water environments at a depth of 0–30 meters, and often migrates into estuaries where the water shifts towards fresh water. They live on soft bottoms where they can burrow so that only the eyes are visible, such as deep mud and sandy bottoms. The diet consists of small invertebrates, such as copepods, annelids, bristle worms (polychaetes) and isopods. During spawning, the male digs a hollow under a suitable object, such as an empty mussel shell or a rock, in which the female lays her roe. The male stays with the eggs to guard and fan water over them for 8–10 days. The common goby can become up to 8 centimetres long, but is usually no more than about 6 centimetres long, with females slightly larger than males. The species has been observed to reach 2.5 years of age, but in the wild they rarely live more than a year.

Housing in a laboratory environment

In aquariums, the common goby requires a temperature in the range of 8–24 °C and a pH between 6.5 and 8.0. Since the species can live in both fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. Finely divided blue mussel meat works well to feed the fish with. Since the common goby spends a lot of time buried into the substrate, it needs a bottom substrate that allows for this, such as sand with a maximum grain size of 3 millimetres. The bottom substrate also needs to be of such quantity that the fish can cover itself up to the eyes. The common goby should be provided with halved clay flower pots of appropriate sizes to offer protection. If the aquarium does not have a bottom substrate, it is particularly important that the fish have access to different types of protection. When breeding, bottom substrate should be present in the aquarium and no more than one male should be kept per aquarium, as they are territorial in such situations. At other times, the common goby can be housed in same-sex groups in larger aquariums.

Eurasian minnow, *Phoxinus phoxinus*

The Eurasian minnow, sometimes simply referred to as minnow, is a species in the carp family. It occurs in almost all of Europe and east towards central Asia. In Sweden, it can be found throughout the country. The minnow can be obtained from commercial breeders but may also be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The Eurasian minnow occurs on the bottom of shallow, cold and well-oxygenated fresh and brackish waters. They can live in everything from small, fast-flowing streams to large Nordic lowland rivers and can survive in nutrient-poor environments. The Eurasian minnow is a shoaling fish that is omnivorous and feeds on, for example, algae, plant remains, molluscs, crustaceans and insects. It can live in a wide range of temperatures, but has high requirements when it comes to clean water and wants the water to be flowing. During spawning, Eurasian minnows stay in clean, flowing and well-oxygenated water with a gravel bed, where the eggs can fall down and be protected after fertilization. The Eurasian minnow is about 7 centimetres long, but can be up to 14 centimetres. It weighs 8–16 grams and can live for up to 6 years.

Housing in a laboratory environment

In aquariums, the Eurasian minnow requires fresh or brackish water, a temperature in the range of 2–20 °C and a pH between 6.5 and 8.0. Since the species can live in both fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. If the species is kept in natural annual cycles of light and temperature, they need deep pools of water with a low flow to hibernate. As the species is omnivorous, they can be fed a variety of food such as commercial feed, mosquito larvae and *Artemia*. They prefer feed that sinks to the bottom. The minnow wants a coarse-grained substrate on the bottom of the aquarium and the opportunity to hide. Bottom substrate in the form of natural or pea shingle that is 8–12 millimetres in diameter is a good alternative. Halved clay flower pots of appropriate sizes work well as hiding places. If you plan to breed the Eurasian minnow, it is important to provide them with a bottom substrate that protects the eggs, as well as clean, flowing water with high oxygenation. As Eurasian minnows naturally are shoal-dwellers, they should be housed in groups of at least 10 individuals.

European eel, *Anguilla Anguilla*

The European eel is a species in the eel family. It exhibits a complex distribution cycle depending on life stage. European eels are born in the Sargasso Sea and then carried to waterways in Europe through currents. In Sweden, the species occurs all over the country, mountain areas excepted. The European eel is commercially bred on a limited scale and can be purchased in a variety of ages and sizes. They are listed as critically endangered on the IUCN list of threatened species. The species has been protected in Sweden since 2011 and may not be caught in the wild.

Biology

The European eel undergoes a complex life cycle and is found in different waters depending on their age. Adults spawn in the Sargasso Sea where larvae then hatch. The larvae are carried north through currents. On the way, the larvae develop into glass eels and by the time they reach their final destination on the coasts of Europe, they have developed into yellow eels. Since they drift with currents and live in different types of water, the depth they live in varies from 8 to 700 meters. As adults, the European eel mainly reside in areas with soft bottoms where it digs passages and burrows. The eel then stays in the chamber during the day, either alone or together with conspecifics, and leaves in search for food at night. If the substrate at the bottom does not allow for digging, stones or vegetation can act as a hiding place instead of the chamber. The European eel feeds on animal-sourced foods, such as small fish and crustaceans. The species usually grows up to be 45–65 centimetres in length, but has been reported to grow as long as 130 centimetres. It has also been reported to live for around 20 years, but could probably reach a higher age. The oldest reported eel in Sweden became 88 years old.

Housing in a laboratory environment

In aquariums, the European eel can be housed in anything from salt to fresh water depending on its life stage. The salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions, with its life stage in mind. The species requires a temperature in the range of 4–20 °C and a pH between 6.5 and 8.0. It can be fed pieces of fish, whole small dead fish or commercial salmonid feed. Ideally, the eel should be given a finely divided bottom substrate to dig in and create its own passages and burrows. If it is not possible to provide a finely divided substrate, it is important to give the eel other structures to seek shelter in, such as artificial caves, pipes or halved clay flower pots. To offer options, such structures should be provided even if the eel has the ability to dig. As the species is nocturnal, it should be disturbed as little as possible during the day. Observation, handling or intervention should be done as late in the day as possible if reverse circadian rhythm is not used. As European eels sometimes share hiding places in the wild, they can be housed in groups begiven this opportunity in aquariums as well.

European grayling, *Thymallus thymallus*

The European grayling, also simply referred to as grayling, is a species in the salmonid family. It occurs in almost all of Europe, especially in colder areas. In some places, such as southern Finland and northern Italy, it has also been introduced. In Scandinavia, the species occurs in clear lakes and in the northern part of the Baltic Sea. The European grayling can be purchased from commercial breeders, but can also be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The European grayling prefers cold, well-oxygenated and fast-flowing fresh water with hard sandy or rocky bottoms. Although the species is not considered bottom-dwelling, they often live near the bottom in dens behind boulders. They also like to stay in shaded waters, under overhanging vegetation. The food consists of insects, crustaceans and other fish. It lives at depths of 0–30 meters but is usually found at a depth of 1–5 meters. The European grayling can grow to be up to 60 centimetres long, but is usually around 30 centimetres long. It can weigh up to 6.5 kg and at most become 14 years old.

Housing in a laboratory environment

In aquariums, the European grayling requires fresh water, a temperature in the range of 6–18 °C with a pH between 7.0 and 7.5. As the species largely feeds on insects, it can be fed with red mosquito larvae (chironomids), but also small crustaceans such as *Artemia*. Larger individuals may need to switch to a diet consisting of pieces of fish and shrimp, or whole dead such animals. With their preference for dens and hiding places, it is important to provide them with a dark zone by covering parts of the aquarium, as well as furnishings that can serve as protection. Halved clay flower pots of appropriate sizes work well as hiding places. A layer of pea shingle is recommended as a bottom substrate since the European grayling stays close to the bottom, but don't seem to interact much with it. As enrichment, the European grayling can be provided with running water, as they prefer it in the wild. The European grayling is a social species and should be kept in groups, preferably groups of at least 10 individuals, which make it possible for them to form a shoal.

European perch, *Perca fluviatilis*

The European perch is a species in the family Percidae. With few exceptions, it is found throughout Europe. In Sweden, it lives in lakes and waterways throughout the country, with the exception of the mountain region. In the coastal area, the European perch occurs throughout the Baltic Sea and the Gulf of Bothnia. In Sweden and surrounding countries, there is a limited breeding of the European perch and it can sometimes be available in aquatic pet stores. The species can also be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The European perch often lives in shoals in fresh and brackish water at a depth of 1–30 metres. During the summer, the European perch stays in vegetation close to the shire, while it lives near the bottom in deeper water during the winter. As fry, European perch eat zooplankton and then switch to a diet of insect larvae, crustaceans and small fish. When the individual is 10–20 centimetres long, it often switches to solely eating fish and crustaceans. The European perch can become up to 50 centimetres long, with females growing larger than males. They live to be, at the most, 25 years old.

Housing in a laboratory environment

In aquariums, the European perch requires a temperature in the range of 10–20 °C, but can be kept in anything from 4–28 °C. Even if they can handle a wide range of pH, this should be kept between 7.0 and 7.5. Since the species can live in both fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. In laboratories, European perch can be fed *Artemia* or mosquito larvae, but feed for pond fishes may also work. Adult European perch should also be fed pieces of, or whole dead, fish. As a bottom substrate, it works to use natural or pea shingle that is 8–12 millimetres in diameter. As European perches likes to reside among vegetation, it is advisable to furnish the aquarium with live or artificial plants. Halved clay flower pots that are adapted to the size of the individuals can also act as hiding places for the fish. The European perch should be kept in groups of at least 5 individuals.

European plaice, *Pleuronectes platessa*

The European plaice, also simply referred to as plaice, is a fish in the family of righteye flounders that is part of the flatfish order. It lives in the White Sea, along the coast of Scandinavia and south to the northwestern parts of the Mediterranean Sea, as well as around Iceland and the Faroe Islands. In Sweden, it is found on the west coast and in the Baltic Sea, up to the Gävle region. Since the 1940s, work has been done on breeding the European plaice in captivity. Despite of this, there is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The European plaice is a relatively hardy species that lives on clay and sandy bottoms at a depth of 0–100 metres. It is found in seas and estuaries, but rarely migrate into fresh water. As larvae, the European plaice lives free-swimming in the water, but when they are 12–14 millimetres in size, they take to the bottom of the sea, undergo a metamorphosis and live the rest of their lives there. As larvae, the European plaice eats plankton, but after settling on the bottom they switch to eating bottom-dwelling invertebrates. Large individuals can also eat fish. They usually grow to be 40–50 centimetres long and have been reported to live for up to 50 years.

Housing in a laboratory environment

In the aquarium, the European plaice requires salt water, a temperature in the range of 2–15 °C and a pH between 6.5 and 7.5. In captivity, the European plaice can be fed with various crustaceans and molluscs. Even pieces of fish, including fish wastes, whole dead fish or artificial food may work. The European plaice needs a relatively large area to move on, but it has no great requirements regarding water depth since it spends its life on the bottom. The larval stage differs from that requirement, as the species at that time is free-swimming. When raising European plaice, you need to take these different needs into account. Sand with a maximum grain size of 3 millimetres works well as a bottom substrate. The European plaice seems to feel safer when there is less contrast between the surroundings and its own body. If the aquarium does not have a bottom substrate, it may therefore be beneficial to paint the bottom in a colour that is natural to the species' home environment. The European plaice can be housed in groups, but does not seem to have a large need for social interaction. When group housed, it is important that all individuals have the opportunity to lie flat on the bottom of the aquarium at the same time.

Goldfish, *Carassius auratus*

The goldfish is a species in the carp family. It originates from the east parts of Asia, around China, Korea and Taiwan. From there it has been introduced to other parts of the world and is now also found in the USA, Canada, parts of southern Europe as well as South Africa, Madagascar and southern India. It is a very common fish species that can be obtained from both commercial breeders and from aquatic pet stores. It is also possible to catch goldfish in the wild. The species is not on the IUCN list of threatened species.

Biology

The goldfish mainly lives in fresh water at a depth of 1–20 meters, but can tolerate brackish water with up to 1.5 percent salinity. The species prefers to inhabit still or slow-moving waters, such as lakes, rivers, ponds, marshes and swamps. It lives in both open water and near the bottom, but mainly forages on the bottom and in vegetation. The goldfish is an omnivore that eats, for example, insects, eggs, plants and crustaceans. The species normally grows to be around 20 centimetres in length, but can grow to be as long as 48 centimetres long. They can weigh 0.1–3 kilos, but most commonly weigh around 2 kilos. Usually, they live to be 5–10 years old, but have been noted to live for up to 43 years.

Housing in a laboratory environment

In aquariums, goldfish generally requires fresh water, a temperature in the range of 18–25 °C and a pH between 5.5 and 8.0. However, the species can tolerate a pH as high as 10 and a temperature range from 0.3–43 °C. The species can be kept in water that has a maximum salinity of 1.5 percent. In captivity, goldfish usually eat fish food and small vegetables, such as peas. Younger individuals eat the same thing as the older ones, but in smaller proportions. The goldfish needs a bottom substrate that they can forage in, such as natural or pea gravel that is 8-12 millimetres in diameter. But more finely divided bottom substrate or even sand is preferable. Their environment should be enriched with live or artificial plants, preferably of a coarser nature since goldfish try to eat everything they can get into their mouths. Goldfish should be housed in groups of at least 5 individuals in aquariums that are at least 100 centimetres long.

The species is considered potentially invasive and it is therefore important to prevent its release into the wild.

Goldsinny-wrasse, *Ctenolabrus rupestris*

The goldsinny-wrasse is a species in the family of wrasses. It can be found along the coast of Europe, from Norway to Morocco, as well as in the Mediterranean Sea and the Black Sea. In Sweden, it is found in Skagerrak, Kattegat, The Sound (Öresund) and along the coast of Scania (Skåne), as well as sparingly up north to Bornholm and Blekinge. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species, but due to it being a target for fishing, an investigation into its status has been initiated.

Biology

The goldsinny-wrasse lives in salt and brackish water environments at a depth of 1–50 meters, where larger individuals often live deeper into the water than the smaller ones. The species also often swims out into even deeper waters during the winter, staying at a depth of up to 160 metres. The goldsinny-wrasse lives on rocky shores where there is underwater vegetation. It maintains permanent territories where it forages. During spawning, males maintain a smaller territory which they defend against others. The diet mainly consists of plant parts, crustaceans and molluscs. They also, like many other wrasses, eat parasites from other fish. As a result, they are often caught and used as cleaning fish on salmon farms. The goldsinny-wrasse grows to be up to 18 centimetres long, though usually is around 10–12 centimetres, and has been observed to live for up to 16 years.

Housing in a laboratory environment

In aquariums, the goldsinny-wrasse requires a temperature in the range of 8–24 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The species can be fed frozen shrimp. As a bottom substrate in the aquarium, it is appropriate to use natural or pea gravel that is 8–12 millimetres in diameter. In addition, the fish should be provided with stones that are 5-15 centimetres in diameter, which can offer the fish opportunities to hide. For additional protection, it works well to provide the goldsinny-wrasse with halved clay flower pots of appropriate sizes. As the goldsinny-wrasse is territorial, no more than one individual should be kept per aquarium. Alternatively, they can be given enough space to establish territories within the same aquarium.

Greater pipefish, *Syngnathus acus*

The greater pipefish is a species in family syngnathids, which also includes the genus seahorses. It lives along the eastern coast of the Atlantic Ocean, from Norway to Senegal, as well as throughout the Mediterranean Sea and the Black Sea. It also occurs along the southern coast of Africa, from Namibia to KwaZulu-Natal. In Sweden, it is found along the coast of the Western Sea (Västerhavet) and south towards the Sound (Öresund). There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The greater pipefish lives in saltwater environments at depths of 5–10 meters, but can be found at depths of up to 100 meters. They are poor swimmers and must therefore usually stay in the edge zones. They prefer areas where there are soft sea bottoms, with a lot of vegetation in the form of eelgrass, that they can hide amongst. The food consists of plankton, small crustaceans and small fish larvae, and depends on the size of the greater pipefish. The species, like many other pipefish and seahorses, has reversed gender roles when it comes to reproduction. During spawning, which occurs from May to August, it is the female who courts the male and then attaches eggs to a brooding pouch on his tail. The male carries the eggs for about five weeks before they hatch. The greater pipefish is usually around 40 centimetres long, but can grow to be up to 50 centimetres long. There is no information on the lifespan of the species.

Housing in a laboratory environment

In aquariums, the greater pipefish requires salt water, a temperature in the range of 8–20 °C and a pH between 6.5 and 8.0. The fish should be fed small crustaceans, such as *Mysis*, *Artemia* or *Neomysis*. It is suitable to feed them with both live and frozen food, but it is recommended to start with live food for newly captured individuals. Young greater pipefish requires small prey. Feeding should take place three times per day regardless of age. Greater pipefish thrive the best when living in groups in larger aquariums. They should be housed in aquariums that hold at least 500 litres of water. In such an aquarium, up to 50 individuals can be housed. In aquariums, the fish need something to hide among that also offers a rest for the tail, for example live or artificial plants, or other structure that gives the fish the opportunity to hide. The height of the aquarium, as well as the height of the plants, must be adapted to the actual size of the housed individuals, to make sure they can swim upright, which they often do. If the aquarium does not contain furnishings that allow the fish to hide, they should be disturbed as little as possible.

Halfbeaks, *Dermogenys spp.*

Halfbeaks are a genus in the family Hemiramphidae that is part of the order pike-like fishes. The species in this genus occur in many countries in southeast Asia, including Thailand, Malaysia, Singapore and Indonesia. There is no known breeder of the species in Sweden, but they can be found within the aquatic pet industry. The species can also be caught in the wild. No halfbeak is on the IUCN list of threatened species.

Biology

Halfbeaks live near the surface in fresh and brackish water environments. They eat small floating larvae and adult insects that drift past or land on the surface of the water. Halfbeaks can live in groups, in which the males often are aggressive, which they show by chasing and biting each other. During fights, they can also bite each other's mouths and lock jaws, but the fights rarely lead to injuries. Halfbeaks are viviparous, meaning they give birth to live young. At any one time, a female can produce up to 30 fry that are very similar to the adult animals. Halfbeaks grow to be 5–7 centimetres long, with females slightly larger than males, and can become up to 5 years old.

Housing in a laboratory environment

In aquariums, halfbeaks require a temperature in the range of 24–28 °C and a pH between 6.5 and 8.0, but can cope with pH as low as 3.8. They can be kept in fresh or brackish water and have been shown to thrive the best in water containing 0.7 percent salinity. As food, it is appropriate to give halfbeaks *Artemia*, red mosquito larvae (chironomids) or other small animals such as *Drosophila*, but they can also eat commercial fish food. Important to note is that they usually only eat from the surface and that the food therefore needs to float. Since halfbeaks live close to the surface, they do not interact with the bottom substrate and therefore do not need extensive coverage of the bottom. They also have no need for large depths in the aquarium, but instead prefer to have a large surface. However, they appreciate being able to hide in vegetation and floating plants are therefore a good furnishing. Furthermore, it is recommended to place plants around the outer edges of the aquarium. This reduces the risk of them swimming into the glass and damaging their sensitive beaks. Halfbeaks tend to jump out of aquariums and it is therefore important to cover the top of the aquarium properly. Floating plants, either live or artificial, or a darkened cover can also reduce their impulse to jump. In aquariums, males exhibit a dominance hierarchy where only the dominant male is allowed to stay near females. The composition of the group is therefore important to consider. In a group there should be either many males so that the aggression can spread out on several individuals, or the group should consist of one male and several females. It is also possible to have a group with only females.

Live-bearing toothcarps, *Poeciliidae spp.*

Live-bearing toothcarps is a family in the order toothcarps. The family includes many species of freshwater fish, including species common in the aquarium hobby, such as guppies, mollies, platys, and swordtails. The original distribution of the family is the south-eastern United States to Argentina and Africa, including Madagascar. Today, however, species have been introduced in a variety of subtropical and tropical locations. In this summary, we have chosen to focus on the guppy as it is a commonly occurring species in scientific studies. The guppy, like other species in the family, can be obtained from commercial breeders and in aquatic pet stores, but can also be caught in the wild. None of the species is on the IUCN list of threatened species.

Biology

The guppy normally lives in fresh or brackish water, but has a high tolerance for salt water. The guppy lives in small groups near the surface, at depths of 0–1 meter, where the bottom consists of sand or fine gravel. In the wild, the guppy eats zooplankton, small insects and dead organic material from plants and animals (detritus). All species in the live-bearing toothcarp family are viviparous, which means that they exhibit internal fertilization, where the eggs hatch just before birth and they therefore give birth to live young. The females are larger than the males and reach a length of 3–6 centimetres, while the males are between 1.5 and 3.5 centimetres long. They weigh 0.1–0.3 grams and usually live for 1–3 years, but can live for up to 5 years.

Housing in a laboratory environment

In aquariums, the guppy requires a temperature in the range of 22–28 °C and although they in the wild live at pH 5.5–8.5, in a laboratory environment it should be kept in water maintaining a pH between 7.0 and 7.8. Since it has a high tolerance for water with different salinities, it can be kept in both fresh and brackish water. However, the guppy should be housed in fresh water as a standard, even though it can be acclimatised to salt water. As the guppy is common in the aquatic hobby, there are several different commercially produced feeds that work well for the species. On the bottom of the aquarium a bottom substrate, such as natural or pea shingle that is 8–12 millimetres in diameter, alternatively sand or fine gravel, should be used. Either live or artificial plants are suitable as furnishing. Plants also provide protection for the fish. As the species lives in groups, it is important to house them in groups of at least 5 individuals also in a laboratory environment.

Ninespine stickleback, *Pungitius pungitius*

Ninespine stickleback is a species in the stickleback family. It lives in waters around the world at latitudes from the Netherlands to northern Russia. In Sweden, the distribution of the species is not properly recorded, but it probably occurs naturally along the coasts and in the inland below the High Coast (högsta kustlinjen). The ninespine stickleback have also been released in several places and is often found in bodies of water where other fish species are absent. The ninespine stickleback can sometimes be bought in aquatic pet stores, but more often needs to be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The ninespine stickleback has adapted to survive in several different environments and occurs in fresh water as well as brackish and salt water. In fresh water, it is found in lakes as well as slow-flowing streams. The ninespine stickleback lives at depths of 0–20 meters, but usually stays at a maximum depth of 2 meters. The species prefers to live in areas with dense vegetation. The diet mainly consists of small crustaceans. During spawning, the male builds a nest of plant parts that are attached in aquatic plants, above the bottom. The male stays with the eggs to guard and fan water over them until 3–4 days after the eggs hatch. The ninespine stickleback can grow to be up to 9 centimetres long, but usually do not get longer than 6.5 centimetres. It has been observed to become 5 years old at the most.

Housing in a laboratory environment

In aquariums, the ninespine stickleback requires a temperature in the range of 10–20 °C and a pH between 6.5 and 8.0. Since the species can live in anything from fresh to salt water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The ninespine stickleback can be fed *Artemia* or other small crustaceans. Potentially, feed for aquarium fish can be used. When setting up the aquarium, the natural environment where the fish were caught should be mimicked as closely as possible in terms of salinity and temperature. As furnishings, the ninespine stickleback needs sand with a maximum grain size of 3 millimetres and live or artificial plants to hide amongst. When breeding, it is important to maintain a natural circadian rhythm and that the fish have access to plants. Although the ninespine stickleback can build nests in artificial plants, they need organic plant parts to build with. Couples should be kept separated from other fish as the male becomes territorial in such situations. During this time, the female should also be housed separate from the male until she is ready to spawn. However, several females can lay eggs in the same nest so it is possible to replace the female

in order to get more eggs. Outside of spawning, the species lives in smaller shoals and should be housed in groups of at least 3 individuals.

Northern pike, *Esox Lucius*

The Northern pike is a species in the pike family. It lives in waters around the world at latitudes from northern Italy to areas of southern Murmansk in Russia. In Sweden, the northern pike is found in lakes all over the country, except in high mountain areas. It also occurs in the Baltic Sea, where it mainly lives in archipelago environments. Along the west coast it occurs in estuaries, but only exceptionally in salt water. The northern pike can be purchased from commercial breeders, but can also be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The northern pike lives in fresh and brackish water environments at a depth of 0–30 meters, but usually stays at a depth of 1–5 meters. The species occurs in both nutrient-rich and nutrient-poor lakes and rivers, and prefers access to open water. The northern pike often hides amongst vegetation and shows low activity levels during the day, but is more active at dawn and dusk when it hunts. The northern pike feeds on crayfish, frogs and fish as well as smaller mammals and birds. It is usually a solitary species that is highly territorial. The size of the northern pike varies greatly as it is usually 40–50 centimetres long, but can become up to 150 centimetres long. The females are usually significantly larger than the males. The northern pike can weigh up to 28 kilograms and usually lives for 10–15 years, but can live for up to 25 years.

Housing in a laboratory environment

In aquariums, the northern pike requires fresh or brackish water, and can live in temperatures from 0-29 °C, but should ideally be housed in the range of 10–19 °C and a pH between 5.0 and 9.5. Since the species can live in fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. As it is naturally carnivorous, it should be fed pieces of, or whole, dead fish and crayfish, and possibly parts of or whole dead small mammals and birds. The species should be given access to natural or artificial plants to hide amongst. Since the species does not directly interact with the bottom of the aquarium, it has no major need for bottom substrate, but for a natural interior, a thin layer of natural or pea shingle could be used. Northern pike tend to jump out of aquariums and it is therefore important to have lids on the aquariums that close properly, especially at dawn and dusk when the fish are the most active. Lids made out of plastic or a sturdy mesh are good choices. The northern pike's excrement contains alarm pheromones and is avoided by other fish. For this reason, housing and experimental setup should be designed so that other fish does not run a risk of being exposed to the northern pike faeces directly or indirectly, in accordance with what is described in the cross-species

recommendations above. Due to the species' solitary lifestyle, it should be housed alone in aquariums. If several northern pikes are housed together, some individuals risk not getting food and also being eaten by their conspecifics, even if the difference in size is small.

Oviparous toothcarps, *Cyprinodontiformes spp.*

Oviparous (egg-laying) toothcarps are a group of fish species that includes several families in the order toothcarps. The group is large and includes around 800 species. Oviparous toothcarps are also called killis and occur in tropical and subtropical areas on all continents except Australia. They can be purchased from aquatic pet stores and international suppliers. None of the species is on the IUCN list of threatened species.

Biology

Oviparous toothcarps is mainly found in fresh and brackish water. The species lives in different types of environments, some occuring in smaller bodies of water and swamps, while others live in flowing waters. Regardless of the environment, they usually live at a depth of 0–20 meters. Oviparous toothcarps mainly eat insects and larvae. Some of the most popular species live on tropical savannas, in small bodies of water that dry up during dry seasons. Such species only live for about 6–9 months. After breeding, the eggs dry into the bottom substrate and rapidly develop and hatch during the next wet season. Most species are colourful and have small bodies. In general, oviparous toothcarps grow to be 4–10 centimetres long and lives for, at most, 9 months, but this varies according to species.

Housing in a laboratory environment

In aquariums, oviparous toothcarps require a temperature in the range of 20–30 °C and a pH between 6.5 and 8.0. Since the species can live in both fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The fish should be fed live or frozen red mosquito larvae (chironomids), but there are also several suitable commercially produced fish foods for hobby fish. Oviparous toothcarps can be housed in the type of aquarium equipment used for zebrafish, meaning in plastic aquariums in racks. Such aquariums come in different sizes and should be adapted to the number of fishes housed. Fish density needs to be adapted to the behaviour of the species. In some species, the fish, especially the males, are very aggressive and should not be kept in groups. Family groups with one male and two to three females tend to work well, but generally also produce a lot of young. This can be avoided by keeping an eye out for, and removing, eggs. The aquariums should be furnished with living or artificial plants. Different species of oviparous toothcarps have different requirements regarding bottom substrate and require anything from clay or peat to sand or gravel. However, several species seem to prefer dark sand. Oviparous toothcarps attach eggs to plants or bury them in the substrate, and if breeding is

desired, it is important to have the correct furnishings for the species in the aquarium.

Painted goby, *Pomatoschistus pictus*

The painted goby is a species in the family gobies. It lives along the eastern coast of the Atlantic Ocean, down to the southern Bay of Biscay and in the Mediterranean Sea. In Sweden, the species is common along the northern Bohus coast and can also be found in the Kattegat and southward to the Sound (Öresund). There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The painted goby lives in salt water where it usually resides at a depth of 0–55 meters. There it lives on sandy, shell-gravel, stony or rocky bottoms covered with eelgrass or algae. It also lives in intertidal zones and can be found in tidal poles. In winter, the painted goby finds its way out into deeper water and can then reside at depths of up to 100 meters. The painted goby feeds on small crustaceans, where the main prey are copepods and amphipods. During spawning, the males dig nests in the sand. The females then attach eggs to threads on the underside of mussel shells. The species grows to be about 6 centimetres long with a weight of 1.5–3 grams. They can live for up to 2 years.

Housing in a laboratory environment

In aquariums, the painted goby requires salt water, a temperature in the range of 8–14 °C and a pH around 8, but no exact ranges for pH are currently known. It should be fed small crustaceans such as *Artemia*. The painted goby needs to be able to hide. Halved clay flower pots of appropriate sizes work well as hiding spots. If possible, the interior can be completed with eelgrass or other vegetation that can form hiding places. On the bottom, the species needs a finer substrate, such as sand, with a maximum grain size of 3 millimetres. In particular, the fish requires a material they can move with their mouths during breeding, as this is how the males build nests. When breeding, they should also be given access to mussel shells or similar structures to attach eggs to. If the species is kept without plans of breeding, they should be housed in small same-sex groups. Groups of 5–10 individuals have been shown to work, but they can probably be housed in larger groups if the size of the aquarium is adjusted accordingly.

Rainbow trout, *Oncorhynchus mykiss*

The rainbow trout is a species in the salmonid family. It originates from North America and eastern parts of Asia, but has been introduced to virtually every continent. The species has been bred in the north since the end of the 19th century. Today, there are several commercial farms that raise and sell rainbow trout in Sweden. These often sell fish of different sizes and ages. Occasionally, rainbow trout can be caught in Swedish waters as a result of them escaping from farms, as well as from them being released both legally and illegally. The species is not on the IUCN list of threatened species.

Biology

The rainbow trout mainly lives in fresh water at a depth of 0–30 meters. The species migrates between lakes and streams, but there are also populations that migrate into the sea. In natural waters, the rainbow trout often stands facing the current. Young individuals can hide between and under rocks or fallen branches. The species eats small fish and a variety of aquatic invertebrates, as well as terrestrial invertebrates that fall on to the surface of the water. The rainbow trout usually grows to become 50–60 centimetres long and has been reported to live for up to 11 years, but mainly live to be 3–5 years old.

Housing in a laboratory environment

In aquariums, rainbow trout generally requires fresh water, a temperature in the range of 2–18 °C and a pH between 6.5 and 7.5. If the experiment so requires, it is also possible to acclimatise the rainbow trout to salt water if this is done slowly. In captivity, rainbow trout can be fed commercial feed specifically adapted for their different developmental stages and ages. For example, feed for newly hatched fry should be particularly high in energy. As enrichment, the rainbow trout should be offered flowing water to swim against, as they do in nature. Since they often react strongly to disturbances from overhead, it is also important to give them protection from above. As a bottom substrate, it is appropriate to provide the rainbow trout with stones that are 2–10 centimetres in diameter. Young rainbow trouts need to be housed in separate water systems from potential predatory fish, while large rainbow trout do not have many natural enemies among fish kept in a laboratory environment. In aquariums, rainbow trout should be kept in groups.

Roach, *Rutilus rutilus*

The roach, also known as the common roach, is a species in the carp family, which in turn is the most species-rich group of freshwater fish in Sweden. In the wild it is found in the British Isles, in Continental Europe, the southern Balkans, the Caspian Sea and in large parts of Scandinavia. In Sweden, it is found throughout the country, except for in the mountain region. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

Roaches mainly live in shoals at a depth of 1.5–15 meters in lakes and larger watercourses, but can also be found in brackish water environments in addition to such freshwaters. Larvae and young fish live in coastal habitats, the so-called littoral. When the fish grows bigger, it can change its habitat to more open waters, so-called pelagic habitats. They mainly feed on bottom-dwelling invertebrates, zooplankton, plant material and detritus, which is dead organic matter. The shift from near-shore habitat to more free-swimming is controlled by the size of the fish, the availability of food and the risk of being eaten. Roaches are usually 15–25 centimetres long, but can become up to 50 centimetres long, and live to be at most 15 years old.

Housing in a laboratory environment

In aquariums, the roach needs a temperature in the range of 10–20 °C and a pH between 7.0 and 7.5. It is also possible to acclimatise the species to lower temperatures if it is required by the experiment. Since the species can live in both fresh and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. Roaches are very sensitive to low pH and it should therefore never go below pH 7.0. In aquariums, roaches are preferably fed *Mysis*, *Artemia*, *Neomysis* or red mosquito larvae (chironomids). Feeding should take place several times a day. Roaches like to hide in vegetation and hence should be offered live or artificial plants in the aquarium. As a bottom substrate, natural or pea single that is 8–12 millimetres in diameter works well. Bottom substrate is especially important for young individuals, that are under 15 centimetres long. Since the roach is a schooling fish, they should be housed in groups consisting of at least 10 individuals.

Round goby, *Neogobius melanostomus*

The round goby is a species in the family of gobies. It originated in the Caspian and Black Seas, but has spread through rivers and ballast water. In Sweden, it is an invasive species that occurs in the Kattegat and the southern Baltic Sea. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The round goby is a hardy species that can handle everything from fresh to salt water. The species occurs on different types of sea bottom, from 0 meters down to 20 meters deep. The species is mainly found in environments where there is an abundance of mussels and snails, as these constitute the species' main source of food. In addition, it eats other animal-sourced food. The round goby spawns repeatedly during the period of May to August. After spawning, the male guards the eggs until they hatch. The species usually grows to be 10–25 centimetres long, but can grow to be up to 35 centimetres long, and it can live for up to 6 years.

Housing in a laboratory environment

In aquariums, the round goby requires a temperature in the range of 4–20 °C and a pH between 6.5 and 8.0. Since the species can live in anything from fresh to salt water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. In aquariums, the round goby can be fed small crustaceans such as *Mysis* and *Artemia*, but also mussels and snails. The round goby thrives the most if it is kept in small groups in large aquariums, that hold at least 200 litres of water. The aquariums should be furnished with live or artificial plants which provides the black goby with protection, but also stones, clay flower pots and brick pipes can give opportunities to hide. If the aquarium does not contain furnishings in which the fish can hide, they should be disturbed as little as possible.

Sand goby, *Pomatoschistus minutus*

The sand goby is a species in the family gobies. It occurs along the eastern coast of the Atlantic Ocean, from Norway to Spain, as well as in the northern parts of the Mediterranean Sea and the western part of the Black Sea. In Sweden, it is found in Skagerrak, Kattegat, the Sound (Öresund) and in the Danish straits, as well as along the entire Baltic coast north to the Lule archipelago. But it is relatively uncommon north of the Åland Sea and the Archipelago Sea. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The sand goby lives in salt and brackish water environments at a depth of 0–20 meters and it often swims out into deeper waters during the winter. It lives on the bottom of the sea where it can burrow so that only the eyes are visible, such as in soft mud bottoms and sandy bottoms. The diet consists of small crustaceans and worms. During spawning, the male digs a nest under a suitable object, such as an empty mussel shell or a rock, in which the female then lays her rum. The male stays with the eggs for 8–10 days to guard and fan water over them. The sand goby is usually 3–9 centimetres long, but can get up to 10 centimetres long. It has been observed to live for 2.7 years, but in the wild the sand goby survives no more than two winters, and usually only one winter.

Housing in a laboratory environment

In aquariums, the sand goby requires a temperature in the range of 8–24 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. As feed, it is suitable to provide finely divided blue mussel meat. Since the sand goby spends a lot of time buried, it needs a bottom substrate that allows for this, for example sand with a maximum grain size of 3 millimetres. The bottom substrate also needs to be of such quantity that the sand goby can cover itself up to the eyes. To offer further protection, the sand goby should be provided with halved clay flower pots of appropriate sizes. When breeding, bottom substrate is especially important and there should be no more than one male per aquarium, as they are territorial in such situations. When keeping the sand goby without plans to breed, it should be housed in small same-sex groups consisting of 5–10 individuals per group.

Sand smelt, *Atherina presbyter*

The sand smelt is a species in the family old world silverside. It lives on the Danish side of the Kattegat, around the British Isles and all the way along the eastern coast of the Atlantic Ocean down to Morocco, as well as in the Mediterranean Sea. It has only been encountered in Swedish waters on one occasion. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The sand smelt lives at a depth of 10–90 meters and is a saltwater species that swims freely in open water in so-called pelagic habitats. They live in large shoals and prefer to stay at shallow areas along the coast where the salt water mixes with fresh water. Spawning takes place in shallower areas where they attach the eggs to bottom substrate and water-living plants. In the wild, the sand smelt eats crustaceans and small fish. The sand smelt can grow to be up to 20 centimetres in length and have been reported to become at most 4 years old.

Housing in a laboratory environment

In aquariums, the sand smelt requires salt water, a temperature in the range of 9–20 °C and a pH between 6.5 and 8.0. The sand smelt can be fed with, for example, *Artemia*. Since the species lives in schools, they should be housed in larger aquariums, where it is possible to keep at least 10 individuals. As the sand smelt is pelagic, it does not need a bottom substrate, except during spawning. If you want the sand smelt to spawn in a laboratory environment, the time exposed to daylight should be increased to around 14 hours per day.

Saulosi cichlid, *Chindongo saulosi*

Cichlids are a family of perch-like fishes that are found in Central and South America, Africa and parts of Asia. Cichlids is the most species-rich family of fresh water fish in the world. It is one of the largest families of vertebrates, with at least 1,300 classified species, but it has been estimated that there are around 1,900 species of fish in the family. The saulosi cichlid, which is the cichlid species we focus on here, is endemic to Taiwanee Reef in Lake Malawi. The species can be purchased from commercial breeders. It is also possible to catch the species in the wild, but as it is listed as critically endangered on the IUCN list of threatened species, this is not recommended.

Biology

The saulosi cichlid lives in fresh water at a depth of 7–15 meters. They inhabit reefs that contain rocky biotopes and flowing water. The saulosi cichlid mainly eats algae, but can occasionally also eat protein-dense food, such as shrimp. Males of the species are aggressive and territorial against other males of the same species. In the wild, males defend an area up to 2 meters in diameter. The saulosi cichlid grows to be about 8 centimetres long and live to be about 5 years old.

Housing in a laboratory environment

In aquariums, the saulosi cichlid requires fresh water, a temperature in the range of 23–28 °C and a pH between 7.4 and 8.4. As feed in aquariums, both frozen food and dry commercial feed made from vegetables is feasible, but so-called shrimp mix (a homemade frozen mix often made with shrimp, peas, gelatine and *spirulina*) is recommended, since it corresponds well to the natural food of the species. In aquariums, the saulosi cichlid wants flowing water and rock formations with hollows they can hide in. Ideally, the interior should be built so that it extends from the bottom to the surface, but halved clay flower pots that are adapted to the size of the individuals may also be appreciated by the fish. On the bottom, natural or pea single that is 8–12 millimetres in diameter works well as substrate. The saulosi cichlid prefers to live in groups of at least five individuals. As the males are territorial, space and hiding places are needed to prevent aggression between individuals. The species should be housed in larger aquariums, containing at least 150 litres of water.

Sea stickleback, *Spinachia spinachia*

The sea stickleback is a species in the family of sticklebacks. It can be found along the coast of the north-eastern Atlantic Ocean, from Norway to northern Spain, including around the British Isles and the Faroe Islands. In Sweden, it is found along the west and south coasts, as well as along the east coast up to Uppland. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The sea stickleback is a saltwater species, but it can also occur in brackish water. It lives at a depth of 0–30 metres. The species lives close to the coast where it resides in seaweed and other vegetation. The sea stickleback lives solitary, although young individuals may stay in small groups. The diet mainly consists of small crustaceans. The sea stickleback spawn during May to June, after which the adults die. The male builds a nest of plant parts, which the female lays her eggs in. After breeding, the male stays at the nest where he guards and cares for the fertilized eggs and the newly hatched young. The sea stickleback usually becomes 10–15 centimetres long, but can be as long as 22 centimetres. It lives to be around 1 year old.

Housing in a laboratory environment

In aquariums, the sea stickleback requires a temperature in the range of 4–20 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. In aquariums, the sea stickleback can be fed frozen *Mysis* or *Artemia*, but commercial feed for hobby fish might also work. For enrichment purposes, and for newly caught fish, it is recommended to feed live *Artemia*. Feeding should be done daily. The sea stickleback lives solitary and hence should be housed alone, but it may also be possible to keep it in small groups in large aquariums, that holds at least 200 litres of water. When studying spawning behaviour, the three-spined stickleback can be housed in smaller aquariums. To prevent aggression the male should be housed alone in the aquarium and the female only be moved in for a short while to spawn after the male has built his nest. The aquarium should then also be provided with plant parts that can serve as material for the male's nest building. Since protection is important for the species, especially during breeding when they want to protect their young, live or artificial plants are good to use as furnishing. If the aquarium does not contain furnishings that allow the fish to hide, they should be disturbed as little as possible.

Shorthorn sculpin, *Myoxocephalus scorpius*

The shorthorn sculpin belongs to the family of cottids. It occurs in the eastern and western parts of the Atlantic Ocean, as well as in the Arctic Ocean, the North Sea and the Baltic Sea. In Sweden, it is found along the coasts, especially on the west coast. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The shorthorn sculpin is a saltwater species that lives at a depth of 0–200 meters. They live among seagrass on bottoms consisting of stones and sand or mud. As larvae, they live free-swimming in the water. The shorthorn sculpin eats fish, large crustaceans, bristle worms (polychaetes) and amphipods. It usually grows to be 25–35 centimetres long, but can grow as long as 50–60 centimetres. The shorthorn sculpin has been reported to live for up to 18 years.

Housing in a laboratory environment

In the aquarium, the shorthorn sculpin requires salt water, a temperature in the range of 1–15 °C and a pH between 6.5 and 7.5. The shorthorn sculpin can tolerate lower levels of salt in the water, but the salinity of the water when first bringing the fish into the facility should nonetheless be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. In captivity, the shorthorn sculpin can be fed various crustaceans and larger individuals can also be given pieces of fish or smaller whole dead fish. The shorthorn sculpin wants access to live or artificial plants on an area corresponding to 30-50 percent of the bottom of the aquarium. On the bottom, it works to use a mixture of stone and sand. The shorthorn sculpin seems to feel safer when there is less contrast between the surroundings and its own body. If the aquarium does not have a bottom substrate, it may therefore be beneficial to paint the bottom in a colour that is natural to the species' home environment. In the wild, the shorthorn sculpin does not live in groups, however, it is also not naturally aggressive towards conspecifics. It may therefore be housed in groups in aquariums as long as the individuals are of similar size to prevent cannibalism.

Snake pipefish, *Entelurus aequoreus*

The snake pipefish is a species in the family syngnathids, which also includes the genus seahorses. In the wild it lives in the north-eastern Atlantic Ocean. In Sweden it occurs in the Western Sea (Västerhavet) and the Baltic Sea and, to some extent, in the Bothnian Sea. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The snake pipefish lives in salt and brackish water environments at depths of 5–10 meters, but can be found at depths of up to 100 meters during winter. They usually stay in edge zones where there are soft sea bottoms with a lot of vegetation in the form of eelgrass amongst which they can hide. In winter, they can also be found free swimming in the open water. The food consists of plankton, small crustaceans and small fish larvae, and depends on the size of the snake pipefish. The species, like many other pipefishes and seahorses, has reversed gender roles when it comes to reproduction. During spawning, which occurs from June to July, it is the female that courts the male and then attaches eggs to the male's abdomen. The male carries the eggs for about four weeks until they hatch. The snake pipefish differs in size depending on sex, with females being around 45 centimetres long, but can grow up to 60 centimetres, and males being around 30 centimetres long, but can grow up to 40 centimetres. They live for about 5 years.

Housing in a laboratory environment

In aquariums, the snake pipefish requires a temperature in the range of 8–20 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The snake pipefish should be fed small crustaceans, such as *Mysis*, *Artemia* or *Neomysis*. It is suitable to feed them with both live and frozen food, but it is recommended to start with live food for newly captured individuals. Young snake pipefish requires small prey. Feeding should take place three times per day regardless of age. Snake pipefish thrive the best when living in groups in larger aquariums. They should be housed in aquariums that hold at least 500 litres of water. In such an aquarium, up to 50 individuals can be housed. In aquariums, the fish need something to hide among that also offers a rest for the tail, for example live or artificial plants, or other structure that gives the fish the opportunity to hide. The height of the aquarium, as well as the height of the plants, must be adapted to the actual size of the housed individuals, to make sure

they can swim upright, which they often do. If the aquarium does not contain furnishings that allow the fish to hide, they should be disturbed as little as possible.

Straightnose pipefish, *Nerophis ophidion*

Straightnose pipefish is a species in the family syngnathids, which also includes the genus seahorses. In the wild, the species is found in the eastern parts of the Atlantic Ocean, from Norway to Morocco, as well as in the Black Sea and the Mediterranean Sea. Around Sweden, it is found in the Western Sea (Västerhavet) and the Baltic Sea, and to some extent in the Bothnian Sea. There is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The Straightnose pipefish lives in salt and brackish water environments, mainly at a depth of 1.5–4 meters, but can also be found in somewhat shallower and deeper waters. They reside at sea bottoms where there is a lot of vegetation in the form of algae and eelgrass. The food consists of plankton, small crustaceans and small fish larvae, and depends on the size of the pipefish. The species, like many other pipefishes and seahorses, has reversed gender roles when it comes to reproduction. During spawning, it is the female who courts the male and then she attaches eggs to the male's abdomen. The male carries the eggs for about four weeks before they hatch. Straightnose pipefish become 20–30 centimeters long, with females reaching the larger sizes, and live to be, at most, 4 years old.

Housing in a laboratory environment

In aquariums, the straightnose pipefish requires a temperature in the range of 8–20 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The species should be fed small crustaceans, such as *Mysis*, *Artemia* or *Neomysis*. It is suitable to feed them with both live and frozen food, but it is recommended to start with live food for newly captured individuals. Young straightnose pipefish requires small prey. Feeding should take place three times a day regardless of age. Straightnose pipefish thrive the best when living in groups in larger aquariums. They should be housed in aquariums that hold at least 500 litres of water. In such an aquarium, up to 50 individuals can be housed. In aquariums, the fish need something to hide among that also offers a rest for the tail, for example live or artificial plants, or other structure that gives the fish the opportunity to hide. The height of the aquarium, as well as the height of the plants, must be adapted to the actual size of the housed individuals, to make sure they can swim upright, which they often do. If the aquarium does not contain furnishings that allow the fish to hide, they should be disturbed as little as possible.

Three-spined stickleback, *Gasterosteus aculeatus*

The three-spined stickleback is a species in the family of sticklebacks. It occurs in the northern parts of Eurasia, North America and in Algeria. In Sweden, it occurs along the entire coast, in lakes and in waterways. The species is relatively easy to breed in captivity, however, there is no known breeder of the species in Sweden and it must therefore probably be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The three-spined stickleback lives in everything from fresh to salt water, and can also reproduce in different types of water. The species lives in shoals at a depth of 0–100 meters, both in open water and closer to shore areas. The food consists of plankton, small crustaceans, fish eggs and small fish larvae. In connection to spawning, which takes place from May to July, it stays in areas with vegetation where the males build nests and take care of the young. The three-spined stickleback grows to be about 6–7 centimetres in length and the lifespan is usually 1 year, but longer in some northern populations where sexual maturity does not occur until after 2 years. Most three-spined sticklebacks die after spawning.

Housing in a laboratory environment

In aquariums, the three-spined stickleback requires a temperature in the range 4–20 °C and a pH between 6.5 and 8.0. Since the species can live in anything from fresh to salt water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. In aquariums, three-spined sticklebacks can be fed with frozen *Mysis* or *Artemia*, but it may also be possible to feed them with flake food for aquarium fish. For enrichment purposes and for newly caught fish, it is recommended to feed live *Artemia*. Feeding should take place daily. Three-spined sticklebacks thrive the most if they are housed in larger groups in aquariums that contain at least 200 litres of water. When studying spawning behaviour, the three-spined stickleback can be housed in smaller aquariums. To prevent aggression the male should be housed alone in the aquarium and the female only be moved in for a short while to spawn after the male has built his nest. The aquarium should then also be provided with plant parts that can serve as material for the male's nest building. Since protection is important for the species, especially during spawning when they want to protect their young, live or artificial plants are suitable as furnishing. If there is no furnishing in the aquarium, the fish should be disturbed as little as possible.

Tilapia, *Oreochromis niloticus*

Tilapia is a species in the cichlid family. It naturally occurs in the Nile, but has spread widely through farming and is considered invasive in some areas. It is bred commercially and is available to purchase in different ages and sizes. The species is not on the IUCN list of threatened species.

Biology

Tilapia occurs in a variety of freshwater environments, from lakes and larger waterways to ditches and irrigation channels. It also tolerates brackish water and prefers to live in shallow waters, at a depth of 0–20 meters. The tilapia is diurnal and feeds mainly on algae from the bottom. In early life stages, it also eats animal-sourced foods, such as insect larvae and crustaceans. The species spawns all year round at 30-day intervals, as long as the water temperature is above 20 °C. During spawning, the females brood the eggs in their mouths and the males are territorial, defending a breeding pit. The tilapia grows to be 6–28 centimetres long, but can become up to 60 centimetres long. The reported maximum age is 9 years.

Housing in a laboratory environment

In aquariums, the tilapia requires fresh water, a temperature in the range of 13–33 °C, but preferably not below 20 °C, and a pH between 6.5 and 8.0. In captivity, the tilapia can be fed commercial feed that is specifically adapted to its different developmental stages and ages. The first feed given to newly hatched individuals, should be particularly rich in energy and protein. The tilapia often reacts strongly to disturbances from above, whereby it is important that there are structures where it can take shelter. Often, it is enough to cover half of the aquarium with something opaque. Halved clay flower pots of appropriate sizes can also be used as shelter. Ss a bottom substrate, stones that are 2–10 centimetres in diameter can be used. If you wish to breed tilapia, it is important to ensure that the water temperature does not fall below 20 °C. The male's behaviour in connection to breeding is also important to consider, and he should be given a bottom substrate of both type and quantity that enables the construction of a breeding pit. The tilapia often live in groups and should therefore be housed in groups also in a laboratory environment.

Two-spotted goby, *Gobiusculus flavescens*

The two-spotted goby is a species in the family of gobies. It is found in coastal areas along the north-eastern Atlantic Ocean, from Norway to Spain, as well as around the Faroe Islands and the British Isles. In Sweden, it is commonly found along the west coast and in the Baltic Sea, up to the Åland Sea. The two-spotted goby can sometimes be bought in aquatic pet stores, but typically needs to be caught in the wild. The species is not on the IUCN list of threatened species.

Biology

The two-spotted goby lives in salt and brackish water environments at a depth of 0–20 meters. The species often stays among seaweed and seagrass in coastal environments, alternatively near reefs or similar structures. The two-spotted goby is not as bound to the bottom of the sea as other gobies, and can be found in shoals in the higher layers of the water mass. The diet mainly consists of small crustaceans. During spawning, it attaches the eggs to aquatic plants or empty seashells. The male stays with the eggs for 8–10 days to guard and fan water over them. The two-spotted goby can grow to be up to 6 centimetres long and have been observed to live for up to 2 years.

Housing in a laboratory environment

In aquariums, the two-spotted goby requires a temperature in the range of 8–23 °C and a pH between 6.5 and 8.0. Since the species can live in both salt and brackish water, the salinity of the water when first bringing the fish into the facility should be similar to the salinity of where they are obtained from. The fish can then be acclimatised to other conditions. The two-spotted goby can be fed *Artemia* or other small crustaceans. Potentially, feed for aquarium fish can also be used. In order to hide, the species wants live or artificial plants in the aquarium. When breeding, natural circadian rhythms are especially important and, in addition, no more than one male should be housed per aquarium, as they are territorial in such situations. When keeping the two-spotted goby without plans to breed, it can be housed in groups.

Zebrafish, *Danio rerio*

Zebrafish is a species in the carp family. It occurs naturally in India, Pakistan and Bangladesh, in areas around the Ganges River. The species has quickly become one of the most common model organisms in biomedical research. There are a large number of different strains in use that often differ in behaviour. Zebrafish used for research must be bred specifically for this purpose, but if needed it is possible to apply for an exception from the Swedish Board of Agriculture. The zebrafish can be purchased from larger approved zebrafish breeders and zebrafish resource centres. The species is not on the IUCN list of threatened species.

Biology

The zebrafish lives in shallow freshwater environments at a depth of 0–20 meters. It lives in a variety of environments, from larger watercourses to smaller ponds and irrigation channels. The environments they live in also differ in terms of material on the bottom and vegetation. The bottom can consist of everything from mud or sand to larger stones and the vegetation differs according to the current species composition and quantity. The zebrafish mainly eat crustaceans, insects and other invertebrates. It grows to be 2–3 centimetres in length, rarely becomes more than a year old in the wild, and breeds close to the time of the monsoon. In captivity, zebrafish can live to be 3–4 years old and breed all year around after becoming sexually mature, which occurs at 3–4 months of age.

Housing in a laboratory environment

In aquariums, the zebrafish requires fresh water, a temperature in the range of 18–30 °C, where we recommend 24–29 °C which also is an interval that is commonly used, and a pH between 6.5 and 8.0. The zebrafish can be fed commercial feed for tropical hobby fish, but feed specially formulated for research zebrafish is recommended to facilitate reproducible data. Feed with a smaller grain size is needed for fry. Dry food should be combined with live food, such as *Artemia* and *Rotifera*. Zebrafish are usually housed in plastic aquariums of various sizes positioned in racks. The aquariums can be bought in different sizes and the size should be adapted to the number of fishes housed. Recommends to 26 ch. §4 in SJVFS 2019:9 state that fish under 5 centimetres in length should have at least one litre of water per individual, but new research indicates that 5 fish per litre of water is a suitable density in a laboratory environment. The aquariums should be equipped with furnishings in the form of live or artificial plants, alternatively other types of furnishings, that can ward off or interrupt aggression. As a bottom substrate, anything from sand to large stones work, but an image of bottom substrate placed under the aquarium has been shown to be a passable substitute. Note, however, that approval from the Swedish Board of Agriculture is required to exclude bottom substrate for zebrafish that are not included in experiments. Zebrafish should be kept on a cycle of 14 hours of light and 10 hours of darkness.

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The Swedish 3Rs Center
SE 551 82 Jönköping
Tel 0771-223 223
3Rcenter@jordbruksverket.se
www.jordbruksverket.se/3R