Carolina's Freshwater Aquarium Manual

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Carolina's Freshwater Aquarium Manual

Contents

Carolina Biological Supply Company, Burlington, NC

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Introduction

A freshwater aquarium kit from Carolina Biological Supply Company consists of a tank, supplies, and living materials. Upon receipt of a kit, unpack all the items and familiarize yourself with the components. Be certain that all the components are working prior to the arrival of the living materials.

The tank and supplies are usually shipped 7–14 days before the living materials are delivered. This allows time for proper setup and conditioning of the aquarium before the living organisms are introduced. The aquarium needs a break-in period of 2–3 days of operation before the living materials are added.

Our assortments and sets have been chosen to provide variety and interest in aquaria of any size. Animals and plants that are easy to maintain have been selected for these assortments. They can be purchased in many combinations and each item can be obtained individually for specific study. The availability of some living organisms may change in accordance with USDA regulations. In such cases, we will substitute organisms of equal quality and value.

If properly presented and cared for, an aquarium is a valuable asset for teaching. Many schools have aquaria that add color and life to the classroom but that are largely ignored as resources for study. With this manual, some background information, and a little experience in maintaining aquaria, students can gain significant insights into a living, interacting system. An aquarium can provide for studies of the biology and chemistry of aquatic systems and of the interactions among animals, plants, and their environment in a small unit.

Figure 1. A balanced freshwater aquarium with a variety of living organisms stimulates students' interest in living ecosystems.

Setting Up the Aquarium

Placement

When choosing the site for an aquarium, select an area where the temperature is fairly constant, preferably between 64°F and 77°F (18°C and 25°C). An aquarium needs diffuse light and should not be placed in direct sunlight or unusually bright artificial light. Excess sunlight encourages algal growth, and an aquarium receiving direct sunlight will have a daytime water temperature as much as 5°C higher than the temperature of the room. Furthermore, the overheated water cools rapidly at night, causing additional stress on the animals.

As with any living materials, it is best not to place an aquarium in an area where large amounts of volatile chemicals are stored or used, or in an area where the air is smoky or of poor quality. Atmospheric pollutants can enter the system and damage or kill animals and plants.

Once an aquarium is in position and filled with water, it should not be moved. The water in an aquarium exerts pressure on the sides and bottom of the tank. Moving the aquarium can cause it to leak or crack. If an aquarium must be moved, siphon as much of the water as possible into buckets and move the nearly empty aquarium.

Assembly

1. Wipe the new aquarium tank and lid with a wet paper towel to remove any dust. Do not use glass cleaner or detergents to clean the inside of the aquarium.
2. Fill the tank with clean water and carefully inspect the tank for leaks. When you are sure there are no leaks, siphon the water from the tank. Do not attempt to pour the water out.
3. Assemble the undergravel filter in the bottom of the aquarium according to the instructions included with the filter. For 20-gallon and larger aquaria, a second undergravel filter should be placed in the other back corner.
4. Carefully wash the substrate gravel under running water until all fine particles are removed and the water runs clear. A basket for washing filter gravel (and charcoal) can be constructed by bending a sheet of screen wire into the form of a box. After the gravel is washed clean, add it to the aquarium, covering the undergravel filter with 3–5 cm of gravel. The substrate should be deeper at the back of the aquarium than at the front. Gently slope the substrate from the back and sides to a point in the middle front area of the tank.
5. Add water to the tank by placing a heavy sheet of paper on the substrate and pouring the water slowly onto the paper. This keeps the substrate

from being disarranged. Next, add water to within 2 cm of the top of the tank. The water must be maintained near this level for the power filter to function. Remove the paper and then use water-conditioning tablets according to the manufacturer's instructions. Be certain to take into account that the space occupied by filter apparatus, gravel, and air reduces the actual volume of water to approximately 80% of the stated volume of the tank (e.g., a 20-gallon tank probably contains about 16 gallons of water).

6. Power filters are included with 20-gallon and larger aquarium kits. If your kit has a power filter, install the filter according to the instructions included with it.

7. Turn on both the power filter and the undergravel filter and place the aquarium cover on the tank. Operate the completely assembled system for 48–72 hours before adding plants and animals.

River Tank Ecosystems

River Tank ecosystems differ from traditional aquariums in that they provide both a pool of still water and a flowing stream of water. Furthermore, terrestrial plants can and should be planted in a River Tank.

Figure 2. The River Tank's ecologically balanced design requires very little maintenance and provides rich learning opportunities.

Setting Up a 20- or 30-Gallon River Tank

Set up your River Tank where it will not be exposed to direct sunlight, especially afternoon light. Some light is good, but too much can overheat the tank and stimulate the growth of algae. The location you choose should be stable and capable of supporting the weight of the tank and water.

1. Use tape to cover the end of the flexible plastic tube at the lower left section of the backdrop. This prevents gravel from getting into the tube. Do not crimp the tube.
2. Rinse the aquarium gravel under running water until the water runs clear.
3. Slowly add aquarium gravel to cover the bottom of the tank to a depth of 1½ to 2 inches (4–5 cm). Save some gravel for the plant pockets.
4. Remove the pump from the package. Identify the inflow and outflow ports of the pump. Cover the inflow port of the pump with the strainer from the pump parts package (see photo). This will prevent the pump from pulling in gravel when operating.

Figure 3. A pump with the strainer (to the right) in place over the inflow port. The outflow port is the cylinder extending toward the top of the photo.

5. Remove the tape from end of flexible plastic tube. Do not pull on the tube, as this can disconnect it from the back of the form. The tube can be cut shorter, if desired. Push the end of the tube over the outflow port of the pump.
6. Set the molded hollow rock over the pump. The larger slot fits over the plastic tube. Thread the power cord out through the smaller slot. Push the power cord into the back left corner of the tank.
7. Slowly add water to the tank until it just covers the top of the hollow rock housing the pump.
8. Insert the filter into the filter slot at the upper left of the backdrop.
9. Plug in the pump for a test run. The filter slot should fill, after which water will cascade down the right of the backdrop and into the plant pockets. Water in the tank will drop somewhat. If it drops too low, the pump may pull in air. If this happens, add water.
10. After the test run, unplug the pump.

Adding Plants to a River Tank

Aquatic plants are planted in the gravel if rooted or allowed to float if not. Tropical foliage plants are planted in the plant pockets molded into the backdrop of the River Tank.

1. Remove the plants from their pots. Shake off as much potting soil as possible.
2. Hold the roots of the plants under running water to wash away the remaining soil.
3. Place the roots of foliage plants in a plant pocket and add aquarium gravel to cover the roots. Do not completely fill the plant pocket with gravel. Do not drop gravel into the filter slot.
4. Turn on the pump and check for proper water flow.

Establishing the Plants

Parasites of aquatic animals can be introduced into an aquarium through the addition of unclean plants. Therefore, carefully inspect each plant that is to be placed in the aquarium and remove any unwanted pests found clinging to the leaves or stems. Most plants can be cleaned by holding them under running water. Handle the plants carefully so that their leaves and stems are not damaged.

In a new aquarium, establish the plants before any animals are put into the tank. To keep the tank from overflowing, siphon out some of the water before introducing the plants. Some plants are better suited to a new aquarium because of their food reserves, while others do not do as well because of the lack of nutrients in a new aquarium. When adding plants to an established tank, take care not to disturb the substrate too much. Otherwise, the water may become clouded.

Place taller plants at the back and near the sides of the aquarium; place shorter plants in the middle and front of the aquarium. Anchor the plants into the substrate using a side-to-side, sweeping motion. Bury all the roots, but leave the crowns above the substrate. Plants without roots can be placed using the same method, although the stems may have to be placed deeper into the substrate. Do not bury the leaves of aquatic plants, because they will decay and foul the water. Periodic removal of excess plant growth will keep the aquarium looking good.

For ease of identification and to facilitate aquarium maintenance, you may find it helpful to create a chart or draw a map indicating the names and positions of the plants in the aquarium. Other methods of identifying plants include taping labels to the outside of the aquarium and writing the names with waterproof ink on plastic stakes placed beside the plants. If you wish, students can discover where each plant can be found in the wild and identify each plant's special requirements. Adaptations of aquatic plants to life in the water include interesting modifications of structure and reproduction.

Plants should receive at least 12 hours of light each day. Most plants do best under fluorescent light. Incandescent lights are not recommended because of the amount of heat they release.

Acclimating the Animals

Next to proper conditioning of the tank, acclimation of the animals to the aquarium is the most important requirement to insure having healthy organisms. The stress of shipment will cause animals to become susceptible to diseases and parasites unless they are properly cared for when received.

When the animals are delivered, open the bag and fold the top down to form a sleeve. Place the open bag in the aquarium but do not allow any water from the aquarium to get into the bag. Do not let the aquarium overflow. Every 15 minutes, discard one-fifth of the water in the shipping bag and replace it with an equal amount of water from the aquarium. After an hour the animals can be netted from the shipping bag and placed in the aquarium. Return the aquarium to its proper level by adding clean springwater. This procedure allows the animals to adjust gradually to the changes in water chemistry.

Figure 4. To acclimate the fish, place the shipping bag of fish in or next to the aquarium and occasionally replace the shipping water with water from the aquarium.

Do not feed the animals the first day they are in the aquarium. They will be recovering from the stress of shipment and adjusting to their new environment. Thereafter, feed them on a recommended schedule (see "Feeding the Animals"). Watch the animals closely for the first few days. Any sick or dead animals should be discarded.

Aquarium Animals

A large variety of organisms can be put into a freshwater aquarium for study. Some classes prefer to study local organisms, and field trips can be organized to collect local aquatic plants and animals. If they are wild-collected, higher organisms such as fish must be acclimated to an aquarium. Most healthy plants and animals in a natural environment successfully cope with parasites and diseases; however, when organisms are placed in a stressful situation, such as adjusting to a new environment, their health can be drastically affected. Carefully examine all field-collected plants and animals, and hold them in a quarantine tank until it is evident they are healthy.

For best results, use plants and animals known to be acceptable freshwater aquarium inhabitants. Using established aquarium inhabitants reduces the amount of care and time necessary to maintain the aquarium. The chance of disease is also decreased. Standard aquarium organisms are also easier to obtain.

When choosing animals for an aquarium, select animals of similar size, keeping in mind both initial and mature sizes. Predators should be slightly smaller than their natural prey; for example, animals such as crayfish should be small enough that they will not eat the fish. Animals appropriate for aquaria include fish, snails, newts, mussels, small crayfish, tadpoles, neotenic salamanders, aquatic frogs, and turtles.

Mollusks

Snails and mussels are mollusks. Aquarium snails scavenge for food and help keep the aquarium clean. They reproduce readily and their transparent eggs clearly show early development. Mussels strain microorganisms from the water through a siphoning process. Mussels move and dig into the aquarium substrate by means of a muscular foot, which may tear up rooted plants in the process.

Figure 5. Aquarium snails feed on algae and uneaten food, and provide eggs for embryological studies.

Arthropods

Aquatic insects, insect larvae, and spiders are interesting subjects in the aquarium. These animals illustrate adaptations to aquatic life in their body structure, reproductive processes, and locomotion. Aquatic insects and spiders should be used with caution in a fish tank because they prey on small fish.

Figure 6. Dragonfly nymphs are common insects that illustrate adaptations to aquatic life. They should not be kept with small fish.

Crayfish are popular aquarium inhabitants. Use only small specimens, because larger ones might kill fish and other organisms. Smaller crayfish generally scavenge the floor of the aquarium for detritus, dead animals, and plants.

Figure 7. Small crayfish can be kept in an aquarium with fish, but large crayfish should be housed in a separate tank.

Freshwater shrimp are hardy scavengers, continuously roaming the aquarium for food. They are easy to maintain and help keep a freshwater aquarium clean. It is best to house them with nonaggressive fish and other compatible organisms. Small freshwater shrimp should not be kept in a tank with fish, especially those large enough to eat them. Conversely, large freshwater shrimp should not be housed with small fish, as they will eventually eat them. Ghost shrimp are transparent; they are peaceful scavengers well suited to life in a community aquarium. Many types of fish, especially smaller ones, will ignore ghost shrimp.

Amphibians

Newts, salamander larvae, tadpoles, and aquatic frogs are amphibians that are held in some aquaria. The larger aquatic amphibians are usually not suitable for fish tanks and should be placed in aquaria especially designed for them.

Figure 8. Newts are compatible with other animals in the aquarium.

Fish

Fish are the most popular aquarium animals. They come in a variety of shapes, sizes, and colors, and represent many native environments. They can be used for studies of reproduction, genetics, embryology, structure, and behavior. As with any animal placed in an aquarium, a careful study of the requirements and habits of each fish should be made before it is placed in the tank.

Temperate fish available from Carolina Biological Supply include bluegills, channel catfish, fathead minnows, gambusia (mosquito fish), largemouth bass, and several varieties of goldfish. For good health these fish require lower temperatures than tropical fish. They do best in the 64–70°F temperature range (18–21°C), but can tolerate lower or higher temperatures for several days.

Bluegills, members of the sunfish family, are popular game fish found in a wide range of freshwater environments. They are excellent organisms for physiological and ecological studies. Bluegills are reclusive, so any tank containing them should provide plenty of places for them to take shelter and hide. To keep them hardy and healthy, feed them a varied diet consisting of live worms, insects, tiny crayfish, and other small organisms. Because bluegills are game fish, a good filtration system and regular water changes are essential to minimize waste buildup.

Figure 9. Bluegills are small game fish used for aquaria and in toxicity studies.

Channel catfish are bottom feeders. When kept in a tank with other fish, they may not get enough to eat unless you use a heavy food that settles to the bottom.

Figure 10. Blue channel catfish are scavengers and grow well in large aquariums.

Gambusia, sometimes called mosquito fish, are hardy fish that can withstand a wide range of temperatures. These livebearers are commonly used to control mosquitoes, as they feed on mosquito larvae. Due to their aggressive nature, do not house them with other fish species in a community tank.

Figure 11. *Gambusia*, or mosquito fish, are not recommended for community tanks.

Largemouth bass are among the most popular game fish in the United States, and can be used in aquaria and outdoor ponds. Largemouth bass are predators and should not be housed with other fish species. Largemouth bass can become quite large, so an aquarium housing them should allow for significant growth. An aquarium filter that includes mechanical and chemical systems is essential.

Figure 12. Small largemouth bass can be kept in aquaria and in outdoor pools.

Goldfish were the first fish kept in aquaria. All varieties of goldfish belong to the same species, *Carassius auratus*, and have been developed by centuries of selective breeding. Fin and body structure, coloring, and eye shape are some of the characteristics that have been selected through breeding. Except for the most exotic forms, goldfish are extremely hardy, easy to keep (even in outdoor pools), and are excellent for study.

Figure 13. Although many varieties of goldfish have been developed over the centuries by selective breeding, all belong to the same species, *Carassius auratus*.

Caring for goldfish differs from caring for tropical fish. Because of their habit of nibbling on plants, you should put sturdy plants (such as *Elodea*) in the aquarium. Goldfish food and waste can quickly clog bottom and undergravel filters, so outside filters are recommended for use with goldfish. A heater is not required in the tank unless room temperatures are extremely cold.

Figure 14. The comet goldfish has several color varieties, but the most common is a deep orange.

Figure 15. The fantail goldfish has a double tail and is orange or orange and white.

Figure 16. Dwarf gouramis are beautiful fish that build bubble-nests at breeding time.

Figure 17. Guppies are prolific livebearers and are excellent for life cycle studies.

Tropical fish require higher water temperatures and are not as hardy as temperate fish. The tropical fish shipped by Carolina Biological are selected to live within the same range of temperatures and other habitat requirements, so our nonagressive tropical and temperate varieties can be kept in the same tank. The fish should be kept in the 70–80°F range (21–27°C) with a pH between 6.0 and 7.5. The water should be slightly soft.

Zebra fish (*Danio rerio*) are popular tropical fish because they are hardy, attractive, and nonaggressive. These fish are easy to breed in the classroom, and are widely used in molecular and developmental genetic engineering studies. Zebra fish coexist easily with other small, docile fish, and are an excellent choice for community tanks. Because they are schooling fish, keep them in groups of six or more; otherwise, they will display a fin nipping behavior. Provide them with a rich diet of live food (e.g., brine shrimp, insect larvae, bloodworms), fish flake food, or frozen food. They survive best in warm waters ranging from 72–81°F (22–27°C). Their optimal light cycle is 14 hours of daylight and 10 hours of darkness. Care and maintenance requirements are identical for all varieties of zebra fish.

Figure 18. The zebra fish is an excellent community tank specimen.

GloFish® are zebra fish developed when scientists removed the fluorescence gene from a sea coral and inserted it into a golden zebra fish embryo. The fluorescence gene became part of the DNA of the zebra fish. These fluorescent fish are fun and attractive, and they are excellent classroom organisms for introducing numerous topics, including genetic modification, fitness effects, ethics, and environmental science.

Figure 19. GloFish® fluorescent zebra fish are engaging and attractive, and they provide vivid classroom learning opportunities.

Casper fish are zebra fish that have been bred to be translucent, allowing observers to view their internal organs. Scientists at Children's Hospital Boston developed these ghostly zebra fish to help them study the development of cancer cells.

Figure 20. Casper fish are zebra fish that have been bred to be translucent, allowing observers to view their internal organs.

Feeding the Animals

People generally have a tendency to overfeed animals, which often results in poor health for the animals. Feed aquarium animals regularly, but only as much as they will eat in a few minutes. During the first 2 weeks, do not feed the animals more frequently than every other day. In an established aquarium, the animals can be fed daily. Excess food will tax the filtration system and contribute to pollution.

Fish need two or three small feedings a day. One large feeding has a disadvantage in that the fish may not be able to eat the food before it dissolves. The fish supplied by Carolina Biological may be fed prepared commercial fish foods; however, for best health, especially if they are to be used for breeding, fish should be fed living or freeze-dried foods at every other feeding. Fruit flies, *Tubifex*, whiteworms, brine shrimp, and daphnia are appropriate living foods.

Newts, neotenic salamanders, salamander larvae, and aquatic frogs should be fed small living animals according to the size of the animal being fed. Some good food organisms are daphnia, fruit flies, small worms, small tadpoles, and small crickets. Aquatic frogs also will eat dry, pelleted Xenopus food, which is available from Carolina Biological Supply Company. Canned dog food that is almost all meat is an excellent food for these animals. A drop of liquid vitamins and some bone meal mixed with the dog food provide supplemental nutrition. A small amount of food (i.e., of a size the animal being fed can handle) should be dropped into the water where the animal can get to it. Always feed the animals in the same place so they get used to feeding there. Remove any uneaten food after 5 minutes.

Most tadpoles are vegetarian and live on a variety of plant materials. Slightly boiled lettuce or spinach is a good food source, although tadpoles maintained exclusively on this may develop tumors. Carolina’s tadpole food and algae, supplemented with powdered egg yolk, are recommended diets.

Snails, crayfish, and mussels are scavengers and independently will find enough food to feed themselves. If an aquarium is especially barren, feed the crayfish a small strip of meat every few days.

Aquatic Plants

Aquatic plants are excellent additions to aquariums because they oxygenate the water, provide hiding places for animals, help maintain proper water chemistry, and serve as beautiful décor. Plants in an aquarium will only remain healthy with proper care. When selecting aquatic plants for your aquarium, it is important to know their ideal growth conditions and whether those conditions are compatible with those of the animals in the aquarium.

Proper lighting is critically important to maintaining healthy plants. Aquatic plants are grouped according to their light requirements and their placement in the tank (i.e., potted, floating, in the gravel, etc.). Generally, floating plants have a high, strong light requirement (4 watts/gallon), while those planted along the bottom of the tank have a low-to-moderate light requirement (1–3 watts/gallon).

Floating Aquatic Plants

Azolla

Commonly known as floating fern, *Azolla* is easily cultured in a shallow pan or terrarium containing a few centimeters of water or very wet mud. Standard aquariums are not suitable for propagation because they fail to supply the strong light that *Azolla* requires. Excess *Azolla* can be transferred from a culture dish to a standard aquarium. It has no special demands as to the chemical content of water, but grows best at a pH of about 7.0. Maintain temperatures around 65°F (18°C) in winter, and between 68°F and 77°F (20°C and 25°C) in summer.

Duckweed

Duckweed (*Lemna minor*) flourishes in a variety of environments and can be found in clear water as well as dark, brackish water. It has no special light requirements and can grow well in an aquarium. Duckweed propagates quickly in a vegetative manner and can potentially cover the entire surface of an aquarium. Periodically removing some of these small plants will help maintain balance with other plants in the aquarium. For best results, maintain the plants at temperatures between 65°F and 77°F (18°C and 25°C).

Salvinia

In nature, this lush floating fern is found in stagnant or slow-moving water that is heavily laden with organic matter. *Salvinia* is best cultured in an aquarium with shallow water that has a high content of suspended organic detritus. Covering the aquarium with a glass cover will increase the humidity of the air in the tank and prevent the plants from drying excessively. *Salvinia* does not grow well in direct sunlight but prefers a good amount of diffuse light. The water temperature should remain between 65°F and 77°F (18°C and 25°C) and the pH should be close to 7.0. *Salvinia* grows very quickly by the lateral growth of new leaves and can carpet the entire surface of the aquarium. Periodically remove some of the plants to prevent this from happening.

Planted Aquatic Plants

Elodea (*Anacharis*)

Elodea densa is an excellent plant for beginners because it absorbs nitrates, is a great oxygenator, and adapts to a diverse set of conditions. Also known as Brazilian waterweed, this aquatic plant is suitable for coldwater or tropical aquariums and has a wide pH tolerance (6.5–8.0). It can be floated on the surface or planted in the gravel at the bottom of the tank. Bright light is the key to maintaining healthy plants. *Elodea* is a fast-growing plant, so the upper portion of rooted plants should be periodically trimmed and replanted. Discard the bottom portion in the trash. It is an invasive plant and has been restricted in many regions. In states where restrictions apply, substitutes will be shipped. *Elodea densa* should never be introduced into open waterways, lakes, or ponds.

Elodea canadensis

Elodea canadensis is also known as American or Canadian waterweed. It is similar to *Elodea densa* but does not grow as large. This species can be floated on the surface or planted in the gravel, and is appropriate for coldwater tanks with temperatures between 50°F and 65°F (10°C and 18°C). *Elodea canadensis* requires bright light.

Figure 21. *Elodea* is one of the most popular oxygenating aquarium plants.

Chara

Also known as stonewart, *Chara* has a central stem with whorls of branchlets at the nodes. It is an excellent aquarium plant and substitutes well for *Elodea* and others. It is best to simply drop *Chara* into the water and allow it to float. Because it is an excellent oxygen producer, *Chara* can be substituted for *Elodea* in studying photosynthesis. A rough measurement of the rate of photosynthesis is possible by counting the number of gas bubbles produced per minute. *Chara* can also be confined in a volumeter for more quantitative measurements of photosynthesis. Cytoplasmic streaming can be observed in the branchlets and node cells. Unlike the case with *Elodea*, it is cytoplasmic bodies other than the chloroplasts that move, and the streaming is usually much faster.

Elodea canadensis

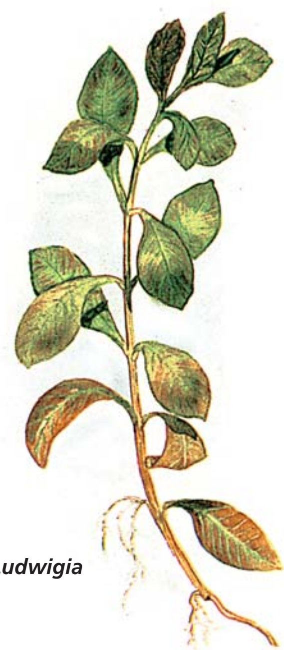
Myriophyllum

This hardy, adaptable plant is appropriate for garden ponds and coldwater or tropical aquariums. Depending on the species, *Myriophyllum* may be kept in water temperatures ranging from 40–78°F (4–26°C) and can tolerate pH levels between 6.0 and 8.0. It thrives in bright light, so provide the plant with 2–4 watts/gallon to keep it healthy. Regularly supply iron-rich fertilizer and carbon dioxide to promote healthy growth and development. Healthy *Myriophyllum* displays colors ranging from green to reddish-brown; however, discolored or pale plants indicate a deficiency of iron and/or other nutrients. Due to its rapid rate of growth, regular pruning is necessary. To prune this plant, cut off the top half, remove any leaves from the last node of the stem, and replant the tops in the substrate. *Myriophyllum* is an invasive plant and should never be introduced into open waterways, lakes, or ponds.

Myriophyllum

Ludwigia

Ludwigia palustris is an amphibious perennial herb, which means it is able to live both in and out of water. The color of the leaves may be olive green or red. When kept under high light (3–4 watts/gallon), the leaves become red. *Ludwigia* thrives when planted in a nutrient-rich substrate and when the water temperature is between 59°F and 77°F (15°C and 25°C). Maintain the pH of the water between 6.5 and 7.5.



Ludwigia

Ceratophyllum

Ceratophyllum demersum, or Hornwort, is a fast-growing plant and a great competitor with algae. It inhibits growth of algae by consuming nutrients in the water and releasing chemical substances that are toxic to algae. This adaptable plant can be used in coldwater or tropical tanks, may be planted or left to float, and grows well under moderate-to-bright light (2–4 watts/gallon). Under low light, the plant is thin and bright green; however, it becomes thicker and turns red as light intensity increases. This plant does best when the water temperature is between 50°F and 82°F (10°C and 28°C) and pH is between 6.5 and 7.5.

Ceratophyllum

Cabomba

Cabomba caroliniana, also known as Fanwort, is a hardy and fast-growing plant. It is an excellent oxygenator and provides desirable hiding places for small fish. *Cabomba* thrives in nutrient-rich environments with water temperatures between 72°F and 82°F (22°C and 28°C). The best pH range for this plant is 6.5–7.5. Moderate-to-bright light (2–4 watts/gallon) is necessary; otherwise, the plant will deteriorate. It is often fully submersed and rooted along the bottom of the aquarium, except for some floating parts. Free-floating plant parts can survive for a few weeks. *Cabomba* is restricted in some states due to its invasive nature. This plant should not be introduced into open waterways, ponds, or lakes.

Cabomba

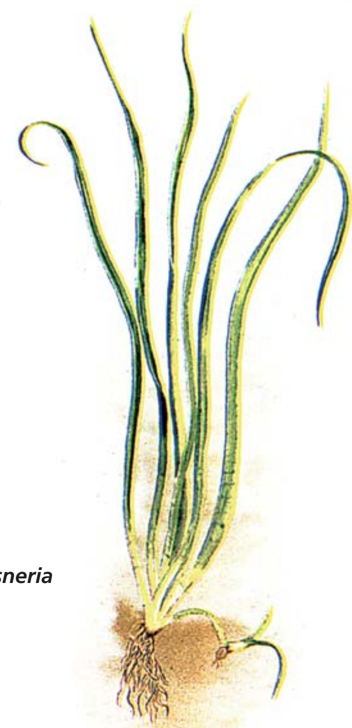
Sagittaria

Sagittaria subulata is an undemanding rosette plant that will adapt to almost any aquarium. It requires moderate-to-bright light (2–4 watts/gallon) and temperatures between 65°F and 82°F (18°C and 28°C). *Sagittaria* grows well in hard or moderately soft water with a pH level between 6.0 and 8.0. To promote strong growth, plant it in a nutrient-rich substrate that contains iron.

Vallisneria

Vallisneria americana is a tolerant, adaptable plant appropriate for large tanks. It is a superior oxygenator and a valuable addition to most aquariums. This plant grows rapidly and may reach a height of 12 inches. Its leaves may grow so long that they spread out on the surface of the water. Therefore, regular pruning is necessary so that the leaves do not prevent light from reaching plants rooted along the bottom of the aquarium. For optimal growth, *Vallisneria* should be planted in an iron-rich substrate and provided moderate-to-bright illumination (2–4 watts/gallon). This plant will tolerate a wide range of temperatures, but does best at temperatures between 64°F and 82°F (18°C and 28°C). It can withstand medium-to-hard water conditions and pH values between 6.0 and 9.0.

Sagittaria



Vallisneria

Maintenance

After the aquarium is set up and operating, general maintenance requires very little time. However, to maintain a successful and healthy aquarium, you must carefully follow the procedures outlined in the following text.

Daily Inspection

Every day, a person familiar with the aquarium and its operation should check the aquarium systems and the living organisms. All the fish should be inspected to see that they are healthy. Remove any dead animals immediately. The water temperature should be checked and the filtration system should be inspected to see that it is operating.

Keep a daily log of water temperatures, animal behavior, propagation, deaths, and other noteworthy information. A log can be invaluable for preventative maintenance and operational purposes, and can yield insight into problems should they occur. It also may be helpful when adding animals to the aquarium.

Periodically add conditioned water to the aquarium to replace water lost through evaporation. If the water level drops too far, problems will develop in operating the power filter.

Water Changes

It is necessary periodically to change some of the aquarium water to dilute chemicals that build up in the aquarium. Once each month, about one-fourth of the aquarium water should be siphoned out and replaced with fresher water that has been treated with water conditioner and allowed to stand overnight. This procedure will greatly assist in keeping the aquarium water at its highest quality. No more than one-fourth of the water should be changed at any one time, as a sudden change in the ionic balance and pH will stress the organisms.

During the water changes, unhook the power filter and replace the filter material. If algae are growing on the tank walls, they can be removed with a rough plastic sponge or razor blade. Do not use steel wool or any other material that will scratch the glass.

In a normal, well-managed aquarium there is a gradual accumulation of detritus (organic wastes) on the bottom. In reasonable amounts detritus is beneficial, but it can be siphoned out during the periodic water changes if it is unsightly. Detritus can also be picked up with the power filter by gently stirring the gravel while the filter is operating.

Disease Control

With a well-designed aquarium system, healthy animals, and good water conditions, disease rarely is a problem. Bacterial and fungal infections usually are the result of stress on the animals. Animals may be stressed by incorrect or fluctuating pH or temperature, poor water quality, too much food, too little food, attacks by other animals, or a breakdown of the filter systems. An animal under stress weakens, and its natural defenses to disease are reduced until pathogens (which are always present) overcome their defenses. At this point, the disease becomes apparent and the animal weakens further.

The first reaction of most people is to medicate the aquarium. Many medications cause more complications than benefits, and can create stress for animals that are not diseased. This is especially true for wide-spectrum antibiotics. The addition of antibiotics to the water affects the bacteria on the undergravel filter. If these bacteria are destroyed or greatly reduced, the nitrogen cycle is disrupted and toxic ammonia accumulates in the aquarium, thereby adding another stress to the tank in the form of ammonia poisoning.

If you must medicate an animal, do so in a separate small aquarium or "hospital" tank. Keep the hospital tank in semidarkness and do not use activated carbon when filtering, as it might remove the medication. The best way to handle a sick animal is to remove it from the aquarium and discard it.

The outbreak of an infection, especially if it affects most of the animals, usually indicates a malfunction in the aquarium system. Do not overlook this fact; otherwise you will continue to have problems as you add new animals to replace those lost. Check to see that the filters are functioning and that a dead animal or excess food is not decomposing. The water should have a biological odor but should not smell like rotting eggs or swamp ooze. Check the temperature and pH. Temperature, especially if it changes 2°C or more between night and day, is often a major contributor to illness. Look for possible stress conditions and, if you find any, correct them immediately. This is the best medicine you can apply to the animals.

Aquarium Science

Tanks

Probably the most important consideration in selecting an aquarium tank is the interface between water and air, which is the primary site of oxygen replenishment and carbon dioxide removal. The greater the area of water exposed to the air, the better the exchange of these gases. Fish require oxygen in sufficient quantity for a healthful existence. In comparison with nature, an aquarium is usually overstocked; animal biomass per liter of water may be as much as four or five times that found in a pond or stream. Therefore, when you choose an aquarium tank, make sure the water–air interface at least equals the width of the tank multiplied by its depth.

A second consideration is tank volume. As a rule, the larger the aquarium, the fewer the problems. This is true because the larger aquarium has more water to retard the effects of potentially harmful events such as pollution from a dead animal, rapid temperature change, or a shutdown of filtration during a power failure. The smaller the aquarium, the more care and attention it requires.

A third consideration is tank construction. Most aquaria today are either all-glass or all-plastic. In all-glass aquaria, pieces of glass are bonded to each other with a strong, flexible silicone sealer that does not dry out and that makes a sturdy, nontoxic aquarium. Plastic aquaria usually are molded and take the form of one or more interlocking pieces.

Filtration

Selecting the right filtration system is the key to providing your animals with a healthy habitat and saving yourself a lot of time and effort. In the wild, fish waste is quickly diluted; in aquariums, waste can quickly build to toxic levels. A filtration system cleans the aquatic environment by separating chemical toxins and particles from the water. An effective system also allows for a high biological loading, which increases the number of organisms you can keep in the aquarium. There are three major types of filtration systems that will help to accomplish these tasks: biological, mechanical, and chemical.

Biological Filtration

Biological filtration is nearly mandatory for a well-functioning aquarium. This filtration system relies on aerobic and anaerobic bacteria to convert toxic ammonia into less-harmful substances, nitrates. Generally, the bacteria are added when the fish or other aquatic organisms are introduced into the aquarium. The animals in an aquarium give off waste products, principally urea and ammonia, both of which are toxic to the animals even in very low concentrations. The urea, ammonia, and certain other organic wastes must quickly be converted into nontoxic substances; this takes place on the filter bed. Various bacteria attach to the substrate of the filter bed; these convert the toxic ammonia and urea to nitrite, and the nitrite to nitrate, a much less toxic end product. Because fish produce ammonia waste in large quantities, they should be introduced gradually. Doing so gives the bacteria time to establish colonies (in the same filter media used in mechanical filtration) that can convert the toxins quickly. In a freshwater aquarium, living plants assist in removing the nitrate from the water, thereby completing the nitrogen cycle.

Often, another means of nitrate removal, dilution, also is necessary. About once each month, one-fourth of the aquarium water is drawn off and replaced with fresh water that has been properly conditioned. This periodic dilution effectively holds the concentration of nitrate and other organic chemicals at nonlethal levels.

Figure 22. The male *Betta splendens*, known as the Siamese fighting fish, has been used extensively in behavioral studies. Males must be kept separate from other *Betta splendens*.

Mechanical Filtration

Mechanical filtration removes particulate matter from an aquarium, assists in keeping the water in circulation, and aids oxygenation. The media inside the filter trap particles while water flows through. Rate of water flow is controlled either by a pump or a flow of bubbles; the rate decreases as the water becomes free of particles.

There are a number of different types of mechanical filters. Perhaps the most useful is the power filter because of its high water-turnover rate. A power filter is simply a box containing a pump that circulates the water through filter material (usually activated carbon and polyester fibers or glass wool) and back into the aquarium. The fibrous material filters out particles, microorganisms, and organic colloids, while the activated carbon acts in a limited way as a chemical filter by absorbing organic molecules.

Chemical Filtration

Chemical filtration functions by removing ions and compounds from solution. Currently, the chemical filter most often used is activated carbon. Activated carbon has an affinity for and binds certain organic molecules and chemical compounds. The efficiency of the activated carbon is limited, however, to the number of potential binding sites; if these sites become loaded, the carbon's ability to adsorb molecules greatly decreases. In an average 20-gallon aquarium using 8 ounces of activated carbon, the carbon is effective for 7–10 days. If the aquarium water becomes cloudy, the addition of fresh activated carbon to the filter usually will clear the water quickly. Animal charcoal, sold as activated charcoal, has very little value as a filter and can even be detrimental to the aquarium.

Substrate

Any nonreactive granular material can be used on the bottom of an aquarium, but the choice of material should be based first on function and second on appearance. The use of fine sands and soils in an aquarium should generally be avoided, as they may allow anaerobic decomposition of waste material, which produces hydrogen sulfide and other toxic gases.

For use with an undergravel filter, substrate particles should be small enough to give the greatest surface area for bacterial attachment but large enough to permit water circulation. Usually, an optimal surface area can be obtained with rough-textured gravel the size of garden peas or slightly larger. Quartz and granite gravel are recommended. Limestone gravel should not be used, because it gives the water an alkaline pH. Epoxy-coated gravel may be toxic, and only high-quality brands should be used. There are some decorative glass gravels that work well for bacterial attachment.

Water

The water in an aquarium is not static; its chemical and biological components change continuously. Usually these changes take place slowly and are relatively small, thus allowing the animals to adjust. When a change in the water is rapid (for instance, due to siphoning out aged water and replacing it with fresh water, or the decomposition of dead animals), heavy stress is placed on the organisms. Under stress, an organism's natural resistance to bacterial, fungal, and viral infections is reduced, increasing the chance of an outbreak of disease.

Most fish do best in soft, slightly acidic water with few chemicals added. This kind of water is seldom available, as most municipal water supplies contain chlorine, fluorine, and other chemicals (such as chloramines). Tap water should be treated with a water conditioner that (1) removes chlorine, chloramines, and fluorine, and (2) softens, buffers, and adjusts the pH. Note that chloramines are not removed by aging tap water. Instead, you must treat the water with a dechlorinator specifically formulated to remove chloramines. If in doubt, contact your local water treatment plant.

Clean springwater and rainwater are excellent for an aquarium, but you must be certain that contamination by pesticides and other chemicals has not occurred. Rainwater may be acidic due to pollution. Distilled or deionized water can also be used, but it must be treated by adding synthetic marine salts at the rate of one-half teaspoon per gallon of water (600 mg/L). Never put fish in distilled or deionized water without adding these salts.

Although most tropical freshwater fish prefer soft, slightly acidic water, they will tolerate a fairly wide range of hardness and pH if the changes are gradual. Inexpensive test kits for hardness and pH can be useful in establishing an aquarium and keeping it in good chemical balance.

Hardness is the measure of calcium and magnesium ions in the water. To soften water, it is necessary to precipitate these ions. Water can be softened by the addition of noniodized table salt at the rate of one teaspoon per 5 gallons of water (250 mg/L), or by the use of peat as described below.

pH is the expression of the negative logarithm of the concentration of hydrogen ions present in water. A pH of 7 is neutral; pH values below 7 are acidic and values above 7 are alkaline. Most fish thrive in a pH range between 6.5 and 7.0. Once a suitable pH is established, natural buffers in the water tend to hold it stable.

If water is alkaline, the pH can be adjusted by using a good grade of commercial peat. A few tablespoons of peat placed in the power filter or suspended in the aquarium in a cloth bag will slowly adjust the pH toward acid. The peat also helps soften the water, but it should be removed when the desired pH is reached. The peat will give the water a light yellow color, but in moderation this does no harm.

If the water pH falls to 6, add a tablespoon of sodium bicarbonate; test the water again and adjust the pH further if necessary. Always adjust pH in increments of not more than 0.5 pH unit per 8 hours.

Biomass

Much has been written about the biomass capacity of aquarium systems, and there are many generalized rules about the suitable number of animals per gallon of water. The ability of an aquarium system to sustain animals is influenced by many factors, but the actual carrying capacity depends on the rate of conversion of toxic products (e.g., urea and ammonia) to nontoxic products. If the number of animals is such that the bacteria on the gravel substrate cannot convert the wastes quickly enough, toxic materials will accumulate and kill the animals.

A rule of thumb is to have no more than 1 inch of fish per gallon of water in an aquarium. For a healthy aquarium that requires less maintenance, it is better to have 1 inch of fish for each 2 gallons of water. This will provide a safety margin against a temporary power failure or other hazard that could kill the animals in an overstocked tank.

Temperature

Most temperate aquatic animals used in classroom aquaria do well at temperatures of 64–70°F (18–21°C), while most of the tropical fish available for aquaria thrive between 70°F and 80°F (21°C and 27°C). If you are stocking an aquarium with local native fish, the temperature may have to be adjusted accordingly. It is of the utmost importance to avoid sudden fluctuations in temperature. Water in aquaria as large as 100 gallons will change rapidly as the temperature of the room changes; the rate of change increases as the size of the aquarium decreases. Rapid, large fluctuations in the water temperature are stressful to the animals and increase the opportunity for bacterial and fungal attacks.

A good-quality aquarium heater with a thermostat and an aquarium thermometer will help control temperature. When using a heater, check the temperature each day, as the thermostat may malfunction and overheat the water.

Light

When lighting an aquarium, use a high-quality fluorescent or LED light hood. Incandescent lights use more electricity and produce more heat than either fluorescent or LED lights. Do not rely on natural sunlight, as there is no way of controlling the length of the day or the intensity of sunlight. The heat from direct sunlight can cause water temperature fluctuations of 5°C or more, which will stress the animals.

Fish do best in a regular cycle of light and dark. A cycle of 12–14 hours of light followed by 12–10 hours of dark is recommended. Many fish need even longer light cycles to breed, and cycles of 18 hours light and 6 hours dark are not detrimental. If you are growing plants in the aquarium, provide at least 12 hours of light each day.

Under conditions of long, relatively high light intensity and high nutrient concentration (as in cases of overcrowding or overfeeding), algal blooms may occur. Should an algal bloom occur, the best remedy is to change as much of the water as is practical, and keep nutrients to a minimum.

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