Growing Australian Tropical Water Plants in an Aquarium.

Using *Aquagreen* plants and fertilser

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Introduction

Part of the growing trend in keeping aquaria is to set up a mini habitat for selected species from the one place and call it a bio-type aquarium. The aquarist can select a number of plants from a location and attempt to put together a small community representing one particular place of interest.

An attempt will be made to describe a system that grows most of our tropical native aquatic plants that have submerged growth. There are plenty of plant growing systems around that you can follow, here is another one. It will concentrate on the physical conditions and chemical requirements to achieve the desired result. The article will be divided into sections and touch on basics but delve more deeply into light, substrates, water quality, nutrient addition, nutrient control, sub-gravel heating and the little things that get in the way, like algae. It will break up the system into each of the different components then describe the way each section operates and its management.

Aquarium Management Summary

Water flow sequence - after the pump, where slow bubbling CO_2 is introduced, to just in front of the pump impeller water travels to the heater chamber. Here, heated and co_2 charged water goes from the heater chamber through the under-gravel network of pipes then back up into the aquarium where the current is directed across the top of the aquarium toward the point most distant from the outlet.

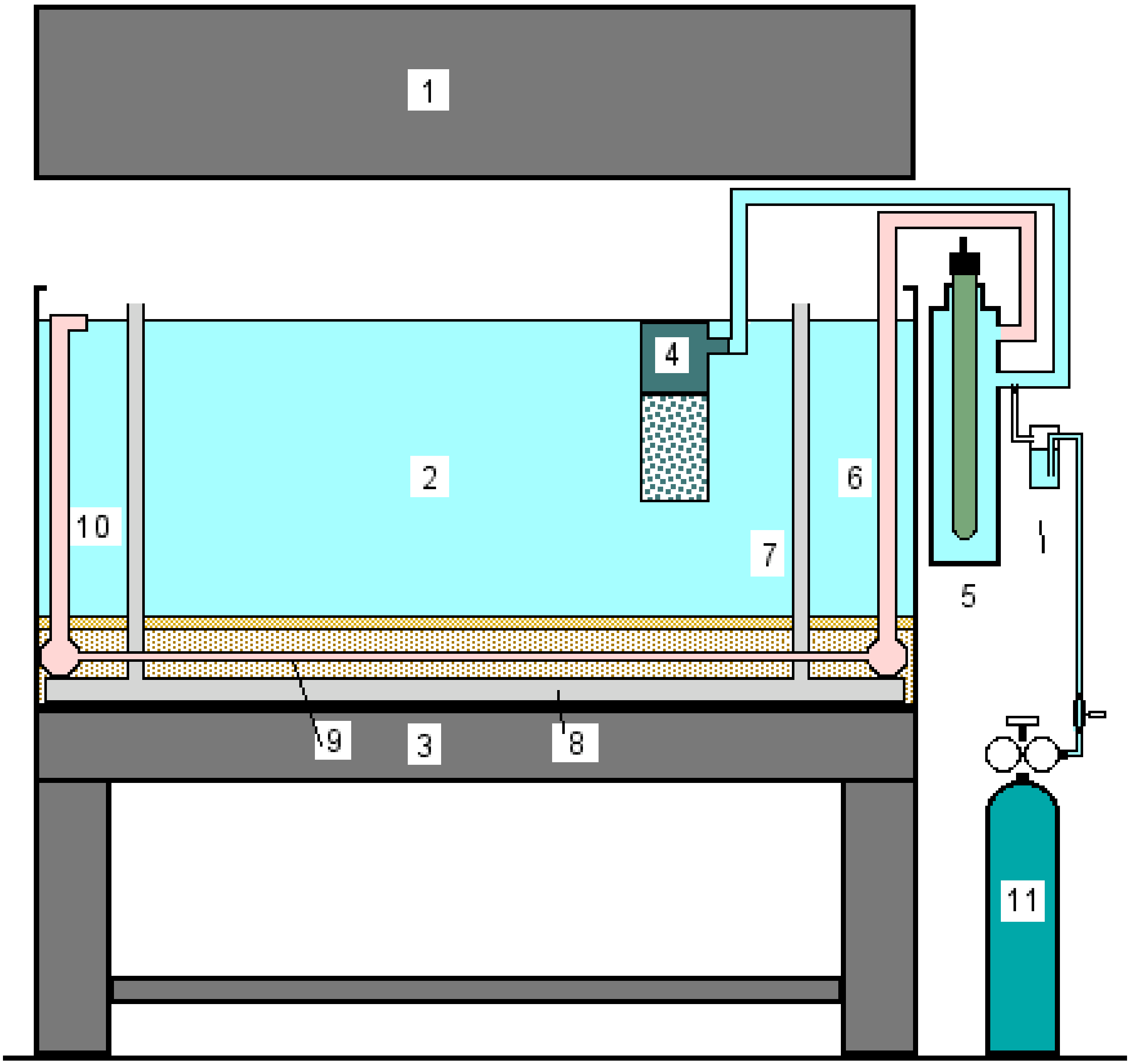
Daily, check all is working and looks good. Feed the fish.

Three times a week check pH, then adjust to neutral in soft water or 7.5 in hard water with CO_2 adjustment, more gas reduces pH. Temperature – adjust to 27 with thermostat on heater. Adjust hardness to over 50ppm with hardness generator, not necessary in very hard water. Adjust alkalinity up to level with the hardness or slightly higher with Potassium Bicarbonate. Make records of all your actions.

Once a week. Tip required amount of Gilbert's brew, sub gravel nutrient down plenum pipe. Siphon detritus and any loose material from substrate if accessible, draw 20/25% of aquarium capacity during operation, refill with good quality water. Remove extra plant material, nip stem plant off at base and replant as the tips grow out of the water. Take away extra plant material that overcrowds the smaller plants. Clean the glass.

Record Keeping

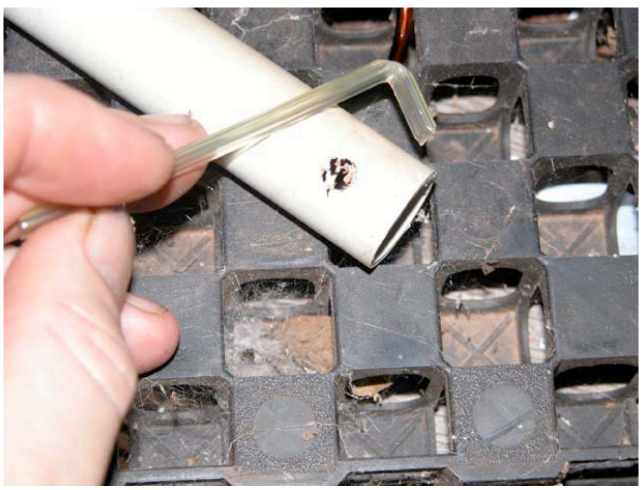
A pain in the you know where, but it is a very important part of Aquarium keeping. It is all about knowing what has happened and a major help in deciding what to do next. Without record keeping you can have success but you wont really understand what is happening. Make a chart or spreadsheet and name the columns date, time, aquarium number, temperature, alkalinity, hardness, pH, nitrate, phosphate, algae and comments. The comments section is where you write your actions that have been decided from the other parameters that have been measured. It is where you go back to when things are not going to plan. Your memory is not as good as you think. Some people even suggest that your memory's efficiency decreases with age.



1. Light hood
2. Main aquarium
3. Aquarium Stand
4. Submersible power-head pump on small sponge filter

5. 300 watt heater in heater chamber
6. Pipe to send warm water under substrate
7. Riser from under gravel plenum
8. Plenum under substrate
9. Series of small under-gravel pipes that warm substrate
10. Riser from sub-gravel heater to return water to Aquarium
11. Carbon dioxide pH and fertiliser control system

The plenum –
Description - A space under the substrate. A plenum is defined in the dictionary as a space entirely filled with matter, in this case the matter is water. You can use an old under-gravel filter and extend the tubes above the surface of the water. The tubes are left open at the top and are the place that Gilbert's Brew nutrient mix can be poured. A product from a Perth company called Atlantis drainage cell makes a good strong plenum when covered with 90% knitted shade cloth. Make sure the shade material overlaps over half the width of the plastic drainage cell so no substrate can work its way underneath. The risers for the drainage cell can be 15mm PVC potable water pipe that fits neatly into a drainage cell square where it can be pinned with plastic welding rod to prevent it being in advertently pulled out.



Pictured are the black drainage cell, white 15 mm PVC pipe and the plastic welding rod.

Management – if you get over zealous with the addition of sub-gravel fertiliser, the substrate goes black, the roots of the plants rot and the leaves fall off, this is a problem that can develop with attempts to grow plants faster and faster. A small airline tube can be sent down the plenum tube to the bottom of the substrate and a sample of the water from down there can be withdrawn. This sample will indicate the condition of the lower substrate. If it is discoloured grey and has a sulphurous odour then a revision of the amount of fertiliser going into the plenum is advised. Reduce the amount of liquid fertiliser administered by half for a few weeks then reassess the situation. Keep a record in your logbook.

Substrate heating -
Many of the native plants from the wet/dry tropics in the North of Australia are tuned into there being no water for 6 to 9 months of the year. To keep our plants growing through the year we can attempt to trick them into thinking it is wet season all the time. Keeping a warm bottom, regular light interval and constant nutrient supply will help achieve this objective.

Description - A network of warm water running under the substrate but above the plenum. Two 32mm pipes at either end of the aquarium that have a number of 12mm tubes running across the bottom of the aquarium. One of the larger pipes is attached to a heater chamber, the other side has an opening at the water surface that allows return warm water to enter the main part of the aquarium. A 300 watt heater will fit neatly in a 20mm PVC compression coupling fitting that can be plastic welded onto a 100 mm PVC pipe with a 20 mm valve adaptor welded onto each side of the chamber. The heater is hung on the outside of the aquarium and fed water from a power-head within the aquarium. Heater chambers are also available from commercially, Rainbow lifeguard has a model and is available from http://www.aquamail.com.au The exhaust water port is piped to the inlet manifold of the substrate heater under the gravel where the warmed water travels across the top of the plenum into the outlet manifold of the substrate heater. There is then a riser pipe from the substrate heater rising on he diagonal opposite side of the tank letting water flow into the main body of the aquarium. The substrate heater where water flows through the small pipes also acts as a CO_2 reaction chamber where all the CO_2 is completely dissolved before the water exits back into the aquarium. It is also possible to buy substrate heating cables from several companies.

Management - The heater is adjusted by turning the thermostat knob on the top as per any of the glass aquarium heaters. As the water passes under the substrate first then it is warmed. A warm substrate is said to be a benefit to the plants even in tropical climates. Heating the substrate with warm water pipes is a standard nursery practise. (Hartman et.al. 1990). Tropical plants from the top of the NT seem to do very well when the water temp is set at 27^{O} C.

The substrate - Place 75 mm of top soil, from an area in the yard that grows a nice lawn over your plenum and substrate heater. The soil could be mixed eight parts soil to two parts peat to one part fine shell grit. Place another 25 mm of coarse sand or aquarium gravel over the soil. Avoid prepared potting mixes for pot plants as they are usually fortified with fertiliser and go black and smelly when submerged.

Lighting - Sunlight is best, put your aquarium outside and under 70% shade cloth shade house but keep it from direct sunlight or it will probably get too hot. If that is not possible because you unfortunately live in a cool climate use either four to six by 37 – 40 watt fluorescent tubes or two 125 watt metal halides or one 250 watt metal halide light (in the 4 X 2 X 2). Ask for a lamp with a colour rendering index of 90 or over and a colour temperature around 6500 degrees Kelvin (between 5000 and 7000 deg K will be OK.

Management - the plants need a set photoperiod of around 12 hours. Install a timer and use the time you usually go to bed as a turn off time and twelve hours before as lights on time. Make a record in your aquarium management log book including the date you put the lights onto the aquarium and change the lamps every 6 months as they lose their efficiency quite quickly. You can also write the date you put the lamp into service on the metal part of the lamp with permanent texta.

Water quality and nutrients - Most people are familiar with pH, alkalinity (also called carbonate hardness), hardness and temperature. The system described here needs good control over these parameters which link in with the fertilisers required for good plant growth. A couple of others that can be measured are phosphate and nitrate. Fertilisers produced from feeding fish can be used and are calculated into the system but are usually in the wrong proportions for good plant growth management.

A fresh water planted aquarium does better with a 25% to 50% water change per week, test the water you use for the change to make sure that it is better than the water you have already. Consider town water supply additives such as chlorine or chloramine and take steps to remedy those problems.

Water quality parameters are qualities that we can measure. They are physical properties, dissolved gases and other chemical properties. None of the parameters on their own are worth much, but together they give you a picture of what the water is like. Measuring the properties are useless unless you use those measurements to make adjustments to the water that work towards what has been determined as the most suitable water quality for the plants you want to grow. Keep a record of the water quality management in a log book or on your PC spreadsheet. There are computer programs available as shareware that will help with this task. If you keep records, you will be amazed at how quickly your management knowledge of your aquatic system will grow.

Temperature is a measurement of how hot or cold the water. It is measured with a thermometer. The temperature of 27 degrees Celsius is a good place to start for tropical Australian native species. Wet season water temperatures may actually be lower than those in the dry season. Rainwater collected in Darwin during storms is about 22 deg C when it is falling. What generally happens is that the temperature in a coastal floodplain billabong could be as low as 25^0C during the coldest part of the year, then rise up to about 30^0C during October November December then drop suddenly to 27^0C or so when large amount of fresh water comes through. Rivers and springs are different.

Management - Temperature is managed with a thermostat dial on the heater where the desired temperature is below ambient but where the ambient temperature exceeds the aquarium temperature regularly for long periods of time a chiller may be required. In a very hot climate it may be necessary to buy and install a chiller. Chillers are adjusted by setting the thermostat.

Dissolved oxygen (DO), is the amount of oxygen (O_2) in the water as milligrams per litre (Mg/L) or expressed as a percentage of saturation. Water at a certain temperature can hold a finite amount of oxygen. This is called saturation. Plants have the ability to put more oxygen into the water than it can hold, this is called super-saturation and is not likely to be a problem. Lack of oxygen will never be a problem in a planted tank that is growing successfully. Aquaculture Technicians with large amounts of fish in ponds are very concerned with DO. If you want to measure DO, there are meters and reagent test kits available. Various types of aerators are available to help increase the amount of DO in the water. Some of the new high tech re-circulating aquaculture systems inject liquid oxygen into the water.

Management - The management of dissolved oxygen is hardly worth worrying about in a correctly run planted aquarium.

<u>Hardness</u> - Total or general hardness is a measure of the dissolved minerals in the water. In natural fresh waters these are usually the salts of calcium and magnesium (Moe 1992). The hardness is measured with a reagent test kit that will have operating instructions.

Management - Plants will use hardness and it may be necessary to increase the hardness of the water occasionally. You can make your own with a 50/50 mix by volume of calcium chloride and magnesium sulphate. This will give you a mix that is 4 to 1 calcium to magnesium ratio. About 20 grams in 1000 litres will raise the water hardness approximately 10 ppm. If you want to lower the hardness you can dilute the aquarium water with reverse osmosis processed water or other softer water.

<u>Alkalinity</u> - or carbonate hardness, or buffering capacity is a measure of the amount of carbonates and bicarbonates in the water. Alkalinity has a few extra substances but the majority of it is carbonate hardness so it is essentially the same for our purposes. This is one of the most important measurements for plants. Keep the alkalinity 10 ppm above the hardness measurement in softer water, below 70ppm hardness. Carbonate hardness is used up by plants. Adjust the carbonate hardness up with potassium bicarbonate. Tests performed in natural waters using reagent test kits over the years, have revealed that in most softer water (below 100 ppm hardness) the waters with the best submerged plants growth have an carbonate hardness the same or slightly above the hardness. Alkalinity is not exactly the same as carbonate hardness but using simple titration methods from a simple reagent teat kit the results are the same so for our purposes we can regard them as the same. Alkalinity is a term most used by swimming pool water quality technicians, aquaculture technicians and town water supply technicians.

Management - Add 20 grams of potassium bicarbonate to a 1000 liters of water to raise the alkalinity up by 10 ppm. Adding potassium bicarbonate will also increase the pH. To counter this you will need to increase the flow of carbon dioxide to bring the pH back down to near neutral. If you water is hard (over 200 ppm) it may be better to only bring the pH back to 7.5 or the amount of CO_2 in the water required to lower the pH will be too much for fish and may affect the fish respiration. There is a chart showing CO_2 levels relating to Alkalinity and pH that was first produced by Horst and Kipper in "The Optimum Aquarium". It is also reproduced on <u>http://aquaticconcepts.thekrib.com/</u>

<u>pH</u> - Indicates the waters acid or basic quality and it is usually the first water quality parameter we learn about with an aquarium. The ideal pH for plant nutrient uptake is 6.8 Hartman et.al. (1990) but if your water is hard and this pH level is achieved with the addition of CO_2, the amount of CO_2 injected into the water may be unsafe for fish. Check the chart mentioned earlier at <u>http://aquaticconcepts.thekrib.com/</u>

Management - pH is measured with a reagent test kit that shows different colours for different levels or with a meter that gives a number readout. It is managed in this system with carbon dioxide and the addition of potassium bicarbonate. pH is nearly as important as alkalinity. These two parameters are used to boost plant growth with the addition of carbon dioxide to lower the pH against the addition of potassium bicarbonate that increases pH. pH adjustment with carbon dioxide is monitored by counting the bubbles flowing into the system then increasing or decreasing the bubble rate in small amounts measuring the pH after a couple of hours. Soon the desired pH compared to the bubble rate will become instinctive. It could be said that you adjust the pH by experience. CONSULT THE pH / ALKALINITY / CO2 COMPARISON CHART REGULARLY at http://aquaticconcepts.thekrib.com/ . Watch the CO2 levels particularly with Banded Rainbowfish (*Melanotaenia trifasciata*) as they are usually from oxygen rich fast flowing water and don't suffer higher CO2 levels.

The nutrients and their management -
The water quality control means previously mentioned are achieved with minerals used by plants. The other nutrients namely nitrogen, phosphorus, sulphur and the micronutrients are supplied as a mineral supplement mixed and put down the plenum tube where they become available to plant roots and slowly diffuse into the water.

The average vascular plant is made up of the following minerals expressed as a fraction of the dry weight of the plant. Aquatic plants take or absorb the mineral nutrients they require from either the water through their leaves or from the substrate through their roots. If we provide ample of these nutrients in the right places, that is divided between the substrate and the water column, we can achieve vascular plant growth without much algae growth.

Macro nutrients	% parts per hundred
Carbon	44 %
Oxygen	44 %
Hydrogen	6 %
Nitrogen	1 to 4 %
Potassium	0.5 to 6 %
Calcium	0.2 to 3.5 %
Phosphorus	0.1 to 0.8 %
Magnesium	0.1 to 0.8 %
Sulphur	0.05 to 1 %

Micro nutrients	^{o}/ooo - parts per million
Iron	25 to 300 ^{o}/ooo
Chlorine	100 to 10,000 ^{o}/ooo
Copper	4 to 30 ^{o}/ooo
Manganese	15 to 800 ^{o}/ooo
Zinc	15 to 100 ^{o}/ooo
Molybdenum	0.1 to 5.0 ^{o}/ooo
Boron	5 to 75 ^{o}/ooo

Elements essential to some plants or organisms	
Cobalt	trace
Sodium	trace

Hartman et.al. (1990)

Fertiliser

Through photosynthesis the plants can change minerals into organic substances, sugars and starch that enable plants to grow - very basic stuff. If you look at the list of minerals and the percentages in a plant you can get an idea what is required in the way of nutrient imports into our managed ecosystem to support plant growth. The way we provide nutrients to the plants will be a major factor in the control over algae. Some nutrients can be provided in larger than required quantities. Potassium, calcium and magnesium are usually in much higher quantities in the water than phosphates or nitrates when compared to plant requirement levels of the same nutrient.

Management

Fertiliser addition - Terry Gilbert, of Brisbane came, up with an injectable substrate fertiliser a few years ago that has been slightly modified over time to a recipe that is easy to make and slightly more soluble. This substrate fertiliser is called Gilbert's Brew in recognition of the work done by Terry.

Gilberts brew contains Ammonium sulphate, Magnesium sulphate, Potassium nitrate, Monomonium phosphate, Chelated trace elements, extra Chelated iron, Vegemite and Seasol

Ammonium sulphate	670 grams
Magnesium sulphate	100 grams
Potassium nitrate	100 grams
Monomonium phosphate	30 grams (omit if phosphate present in water)
Chelated trace elements	50 grams
Chelated iron	50 grams
Vegemite	2 grams per litre of stock solution (vitamin B)
Seasol (seaweed extract)	10 ml per litre of stock solution

The made up fertiliser Gilbert's Brew is a diluted stock solution for ease of dosing and is available Aquagreen or you can make up your own. Add your stock solution to the upright pipes that allow access to the plenum. In your 440 litre aquarium with good plant growth add no more than 200 ml per week. If you add too much Gilbert's Brew the substrate goes black and smelly. If you draw some plenum water out with an air-line tube siphon you can check the status of things under the gravel. See the section on plenum management.

That will take care of most of the plant nutrients. There are other plant nutrient additions from the water quality management and fish feeding activities. The aquarium will get extra calcium and magnesium from hardness adjustments, extra potassium and carbon from alkalinity adjustment, carbon from CO_2 pH control, ammonia, phosphates from fish and their food. Aquagreen Dinosaur Pee will help with the daily nutrient supply to plants but may not be sufficient with the Aquarium that has good light and pH control.

The substrate will have a capacity to hold nutrients where plants can access them via their roots. This capacity is called a cation exchange capacity and it is high in clays and peat. To increase the cation exchange capacity and give large hungry plants such as water lilies a boost you can add Aquagreen Dinosaur Dung to the substrate

near the roots of the plants. Dinosaur Dung will add some other nutrients to the subatrate as well.
To allow optimum nutrient uptake there needs to be the right oxygen level and pH in the soil. These are about 1 ppm for the oxygen level and a pH of 6.8 (Sundstrom 1989). The reason growing plants in a correctly operating under-gravel filter is difficult is because the oxygen level around the plant roots is too high. Although some species of plant can grow in an under-gravel filter, these are the species that have the ability to get the majority of their nutrient needs through their leaves.

Algae

There are more than three thousand species of algae here in Australia (Entwisle et.al. 1997) and all of them have been in your aquarium at some time or other. People who try to manage planted aquaria have given the algae lots of names, some of which are very unkind. Without getting too serious we can lump the alga into various categories. These will include the blue-green, long green filament or hair algae, green water, the black hairy stuff that sticks to leaves and the little green spotty bits that get all over the glass.

Management

The theory behind algal control, and there are plenty of theories floating around, is to have
plenty of healthy growing plants to use up the nutrients but not limit the nutrients for the plants. If the management practises are followed then algae will be there but usually not a problem. I will go through some of the common types and suggest a remedy that may work. Norbert Grunwald of Wuppertal suggests that "If you have zee problem with ze algees, take ze valium zen zee algees is no longer a problem". Norbert substituted green cans of VB for valium when he was here in Darwin a few years ago.

Hair algae – this is the most common on start up of the planted aquarium, some suggest it is a sign of too much amonium nitrogen and or iron. The best remedy for this one is to let the plants catch up, keep dosing the nutrients but try adding something that will eat the algae. A very good example of a good algae eater is the members of the Atyiid shrimp family that has the species Caradina longirostris up north and other ones down south on the eastern sea board. Consult the ANGFA database for an atyiid near your location. ANGFA database http://db.angfa.com.au/. The atyiid made famous by Takashi Amano for algae eating is the *Caradina japonica* that are mentioned in his wonderful series of aquarium picture books. There are two common species around Darwin *Caradina longirostris* and *Caradina gracilirostris*.

Blue-green – the species that usually establishes in aquaria is from the family Oscillatoriaceae. It is dark green to dark blue-green and forms a matt over gravel and plants. This species is a sure sign that there is a nitrogen imbalance. Increase the amount of fertiliser you put in the plenum and make sure your hardness, alkalinity and pH are kept at the desired levels. Blue-green algaes can fix gaseous nitrogen and are advantaged in a nitrogen deficient area. If you add nitrogen that plants can use you give the advantage back to the vascular plants. When you go the other direction with the nitrogen the filament algae will probably take over from the blue-green.

Green Water - the most simple one to get rid of and this is achieved by adding daphnia or other filter feeder.

Spot Algae - on the glass and leaves of the plant. It can be scraped off the glass with a single sided razor and is usually on the older leaves of the plants. The older leaves can be removed if this algae is a bother.

The plants

There are many beautiful plant species native to Australia that are suitable for the aquarium. With the latest developments in water quality and nutrient control there are not too many species that can't be grown in the aquarium. Many of the Australian Natives are more difficult to grow than some of the common species available in the corner aquarium store but if you get into bright light, earthen substrates, water quality and pH control with carbon dioxide then results can be quite stunning.

Ask the staff here at your favourite pet store which plants are native. Aquagreen a local NT business promotes the use of native plants in the Aquarium.

There are pictures of many of these plants on the ANGFA database http://www.angfa.pracsol.com.au/

Aquascaping - Take a few photos of natural areas that are attractive and that you may be able to reproduce in a small box. Places that have beautiful aquatic plants growth usually have a dominant species with other species in small groups around the dominant species. Mock rock backgrounds and other layout techniques are beyond the scope of this article.

Aquariums and The Environment

The keeping of aquatic life in the aquarium correctly so the organisms display natural behaviour and good colours is a wonderful way to learn about our wonderful underwater world. Keeping an aquarium is a good way for parents to teach children responsibility by teaching them to do the daily and weekly chores necessary for the well being of the creatures.

If for some reason you no longer want the creatures in your aquarium under no circumstances release them into any natural water or put them in a pond that has access to natural waters by wet season rains overflow or flooding. Give your creatures to a friend with an aquarium, ask your pet shop proprietor what to do or call your Government Fisheries Department and ask how to safely dispose of the aquatic life in your possession.

If you keep aquatic life in a pond then you must be much more careful that the overflow or spillway does not allow any fish, seeds or other live things out into the drains. If your area is prone to flooding then only use aquatic life forms that have passed all the risk assessments from the Federal Government and are very unlikely to survive out there in the real world.

Some of the pet fish have escaped into NT waterways over the years and survived. The places they survive are mostly disturbed habitats without a full range of natural predators. There are guppies, platies and swortails in natural NT places as well as Cabomba in Darwin River. These aquatic life from other places can out compete our aquatic creatures and foreign plants like Cabomba can interfere with the free passage of boats, clog pumping equipment for irrigators and make the Darwin water supply taste different. Species that have passed a risk assessment process are much lass likely to survive outside their aquarium.

The Government is actively trying to reduce the amount of animals we can have in our aquariums and ponds in an attempt to keep the environment safe from invasive pests. Please make this unnecessary by being responsible with your aquatic life.

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