Tropical Australian Water Plants
Care and propagation in Aquaria

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Introduction

There is a growing interest in keeping native fishes and plants. Part of the developing trend in keeping aquaria and ponds is to set up a mini habitat for selected species from the one place and call it a biotope. Some enthusiasts have indicated that in recent times there is not much technical information for beginners about native Australian aquatic plant growing. Generally, if you can provide good conditions for the plants, the other inhabitants, fish, crustaceans and mollusc will be happy. This will set out water quality management, fertiliser and its management, describe an aquarium system that incorporates technology to achieve a nice aquarium. The fourth part will describe some native plants that can be trialled in the aquarium.

Soft water plants

Hard Water plants

Part 1 - Water Quality - Measuring and Management

Most people are familiar with pH, alkalinity, hardness, salinity and temperature. The system described here needs 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 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 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 share ware 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 cool the water is at the time of the measurement. It is measured with a thermometer. The temperature of 26^{o} or 27^{o} degrees Celsius is a good place to start for tropical species. Check the ANGFA database for the fish and plants you have to see what the temperature is where they live and remember that most collections in the wet dry tropics are carried out in the dry season when access is possible. Wet season water temperatures may actually be lower than those in the dry season. Rainwater collected in Darwin during storms is about 22^{o}C when it is falling. What generally happens is that the temperature in a coastal floodplain billabong could be as low as 25^{0} C during the coldest part of the year, then rise up to about 30^{0} C during October November December then drop suddenly to 22^{o}C 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 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. Another alternative in a hot climate is to air condition the room that contains the aquarium, this may be more economical than using a water chiller.

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. The meters are expensive and not usually owned or used by the average aquarium hobbyist.
Management - The management of dissolved oxygen is hardly worth worrying about in a correctly run planted aquarium. The plants will provide plenty of dissolved oxygen. If there is an emergency and oxygen becomes a concern there are 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.

Hardness - 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. Local Australian company Aquasonics manufactures a range of Test Kits that are good quality and have been used by the author to make water quality management decisions for many years.
Management - Plants will use hardness and it may be necessary to increase the hardness of the water. You can make your own hardness generator with a 50/50 mix by weight of calcium chloride and magnesium sulphate. This will give you a mix that is 4 to 1 calcium to magnesium ratio and will dissolve quickly. 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.

Alkalinity - carbonate hardness or acid buffering capacity is a measure of the carbonates and bicarbonates in the water. The alkalinity measurement used in aquariums, ponds and swimming pools is different to total alkalinity. Alkalinity for our purposes is an equivalent measurement of the resistance to water to the addition of an acid. The measurement is expressed as an equivalent. This is one of the most important measurements for plants. Carbonate hardness is used up by plants. A good value for money carbonate hardness test kit is available from Aquasonics. Keep the alkalinity to the level you have predetermined. Adjust the carbonate hardness up with potassium bicarbonate. Tests performed in natural waters using Aquasonics 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 a carbonate hardness the same or slightly above the hardness.
Management - to increase alkalinity add 20 grams of potassium bicarbonate ($KHCO_3$) to a 1000 litres of water to raise it by 10 ppm. Adding potassium bicarbonate will also increase the pH by a small amount. To reduce alkalinity, you can add soft demineralised water.

pH - 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 the pH level can be lowered by addition of Carbon Dioxide CO_2, the level of CO_2 in very hard water may be unsafe for fish if you try to lower it to 6.8, refer to the below chart for the safe use of CO_2. If there is ammonium in the water and the pH is high then a greater percentage of the ammonium will become the highly toxic ammonia. In a well run planted tank ammonium will not be a problem because it will be taken up by the plants.

Management - pH is measured with a reagent test kit that shows different colours for different levels or a meter that gives a number readout. It is managed by adding an acid to lower it and a base to raise it. 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, it is reproduced below. 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 very well.

Salinity - is a measure of the amount of salt in the water, sea salt is mostly Sodium chloride however in the sea there are many types of salt as well. Salinity is measured with a hygrometer by specific gravity with 1.000 being pure fresh water at 4^{o}C and 1.0264 sea water. It is also measured by conductivity where the resistance for electricity to pass through the water is measured with more resistance in pure fresh water and less resistance in marine water. Sea water at 32 parts per thousand PPT has a specific gravity of 1.0241 and a conductivity of 48.994 mS/cm. The easiest one to use measurement is PPT, that means that sea water 32 PPT has 32 grams of salt in a litre of water. It is easy to use and mix waters of various salinities for fish that need some salt if they are marine or brackish species. Salt is also a good treatment of fish that are not well until you can get a better diagnosuis salt as a first treatment gives you more time to help your finny friend. Parts per thousand can be measured with a refractometer. Total Dissolved Solids TDS is also used to measure salinity and is usually a conductivity meter that has a mathematical conversion to change conductivity to a PPT measurement expressed as TDS.
Management - Salinity is usually not good in a freshwater planted aquarium although there are some plants that are OK in brackish water. If you want to decrease salinity change some water with demineralised or soft water, to increase salinity add salt, one gram per litre will raise salinity one PPT.

CO2 levels based on KH in ppm and pH

KH ppm \ pH	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7	7.1	7.2	7.3	7.4	7.5
36	32	25	20	16	13	10	8	6	5	4	3	3	2
54	48	38	30	24	19	15	12	10	8	6	5	4	3
72	64	51	40	32	25	20	16	13	10	7	6	5	4
90	80	63	50	40	32	25	20	16	12	10	8	6	5
108	96	76	60	48	38	30	24	19	15	12	10	8	6
126	111	89	70	56	44	35	28	22	18	14	11	9	7
144	127	101	80	64	51	40	32	25	20	16	13	10	8
162	143	114	90	72	57	45	36	29	23	18	14	11	9
180	159	126	100	80	63	50	40	32	25	20	16	13	10
198	175	139	111	88	70	55	44	35	28	22	18	14	11
216	191	152	121	96	76	60	48	38	30	24	19	15	12
234	207	164	131	104	82	65	52	41	33	26	21	16	13
252	223	177	141	112	89	70	56	44	35	28	22	18	14

Not enough carbon dioxide
Good level of carbon dioxide
Too much carbon dioxide

Part 2 Nutrients and their Management

The water quality control means previously mentioned are achieved with Calcium Magnesium, Sulphur and Potassium that are minerals used by plants. The other nutrients namely nitrogen, phosphorus and the micronutrients are supplied as a mineral supplement mixed then added to the water by various means. Fertilisers are produced from feeding fish but are usually in the wrong proportions for good plant growth. 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.

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. The NPK you see on commercial fertiliser packets refers to the ratio mix of Nitrogen (N), Phosphorus (P) and Potassium (K).

Macro nutrients expressed as parts per hundred - $^0/_0$
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 expressed as parts per million - $^o/_{ooo}$
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 submerged 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 than phosphates or nitrates. There are many different ways to fertilise your aquarium plants. Look up Estimative Index and Perpetual Preservation System, there is plenty of information on line about these methods. The method we propose is meant for native plants. Natives are not good with too much phosphate and de much better with ammonium as a nitrogen source. Most of the fertiliser systems propose a certain level of nitrates. This is not good for some sensitive natives. We propose the substrate injection method outlined by Terry Gilbert of Brisbane is best for native aquarium plant cultivation.

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 more soluble. This substrate fertiliser is called Gilbert's Brew in recognition of the work done by Terry. The below mix is one kilogram when mixed.

Ammonium Sulphate	610 grams
Potassium nitrate	100 grams
Chelated iron	100 grams
Magnesium sulphate	100 grams
Monopotassium phosphate	10 grams
Chelated micronutrients	80 grams

Stock Solution - 10.0 grams of the above is mixed with one litre of water thoroughly. Mix the solution just before use. Phosphate and iron don't mix well however they will be injected to a place most likely devoid of oxygen so the reaction that occurs in the presence of oxygen will not occur or may be reversed.

Dose Rate - 25 ml to 100 litres aquarium water, 250 ml to 1000 litres. The weak solution is injected into the substrate near plants. This is dosed once per week. In the aquarium outlined below there is a plenum where the weak solution can go under the substrate via the stand pipes.

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 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 usually 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 seem to end up 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, sadly now no longer with us, 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 for valium when he was here in Darwin quite 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 ammonium 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 *Caridina* sp. (NT near nilotica) one that Aquagreen has called Darwin Algae Shrimp does a good job eating many types of algae. 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 *Caridina japonica* that are mentioned in his wonderful series of aquarium picture books. There are fish that eat hair algae, the native species that come to mind are Blackmasts and flyspeck hardyheads.

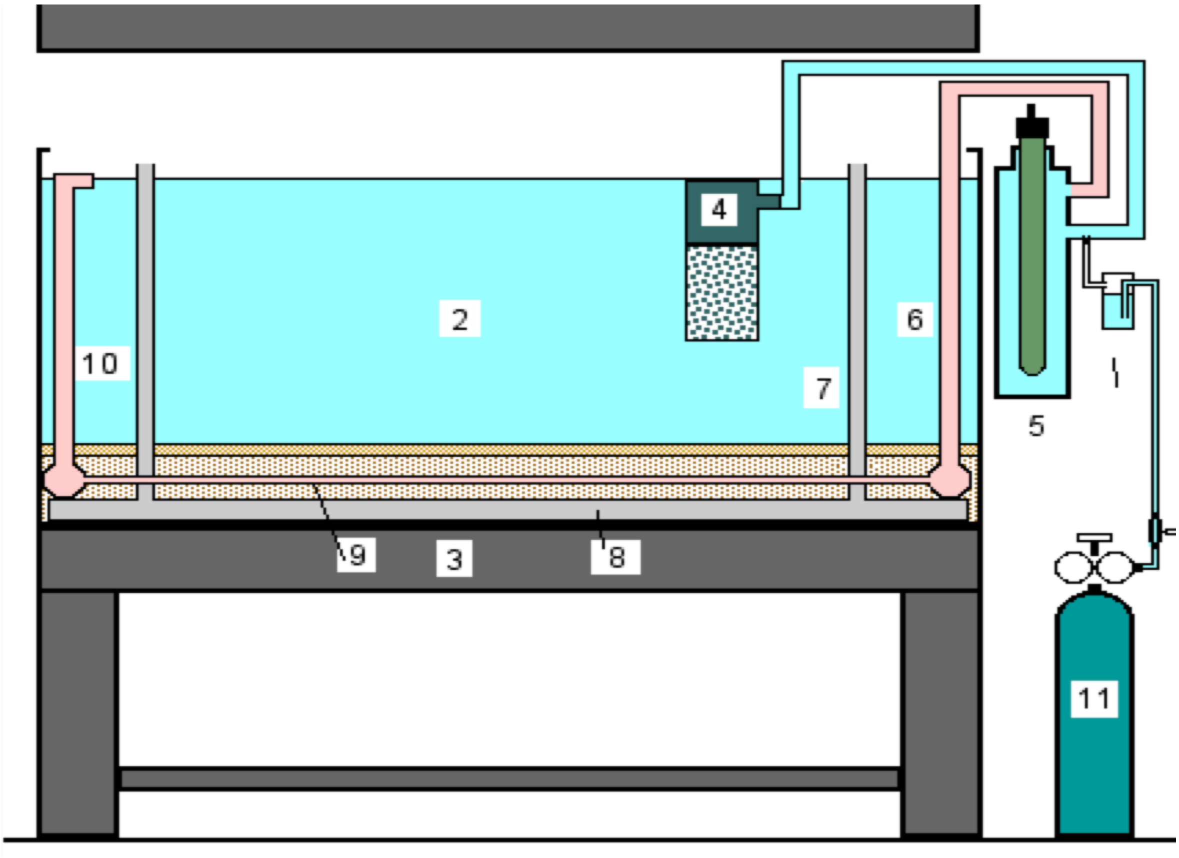
Blue-green algae – the species that usually establishes in aquaria is from the family Oscillatoriaceae. It is dark green to dark blue-green and forms a matt over gravel and plants. This species is a sure sign that there is a nitrogen imbalance. Increase the amount of fertiliser you put in the plenum and make sure your hardness, alkalinity and pH are kept at the desired levels. Blue-green algae 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. The local mussel from near Darwin *Velesunio angasi* Is a filter feeder and it will eat green water. The Waterhouse snail, Notopala waterhousei will also filter algae out of water turning green water clear.

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 alga is a bother.

Part 3 - An Aquarium System to Grow Plants

Below is a sketch plan of an aquarium, a 4 X 2 X 2 in feet, about 450 litres is a size that I have used as a photographic aquarium for many years. There is an explanation of the diagrams numbers further down.



A planted aquarium set up for native plants. 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, there is a bubble counter for a visual reference of the gas bubbles going to the aquarium.

Aquarium Management Summary

Daily - check all is working and looks good. Feed the fish. Clean the glass.

Weekly - Conduct 20% water change by siphoning away any loose detritus then replace it with water that has been treated for water supply additives such as chlorine or chloramine. Test water quality, check pH, then adjust to 6.8 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. Hardness - Adjust hardness to over 50ppm with hardness generator, not necessary in very hard water. Reduce hardness by adding soft water. Alkalinity - Adjust up to over 50ppm with Potassium bicarbonate. Reduce with addition of soft or demineralised water.

Pruning - 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. Fertiliser - Once a week. Tip required amount of nutrient down plenum pipe.

Record Keeping - is generally a nuisance but 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 won't really understand what is happening. Make a chart or spreadsheet and name the columns date, time, temperature, alkalinity, hardness, pH and comments. The comments section is where you write observations and 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. Below is an example.

Date and Time	Temp	GH	KH	pH	TDS	Comments, adjustments n 400 litre aquarium
target parameters	25 - 27	100 to 150	60 to 80	6.8 to 7.5	150 to 500	Record actions and appearances, problems and solutions.
9am 22/9/17	26	130	50	7.3	190	increased CO_2 flow slightly, added 0.4 X 40 grams, introduced 200 algae eating shrimps for hair algae reduction

1. **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 use either four to eight by 37 – 40 watt fluorescent tubes or two 125 watt metal halide lights with a colour rendering index (CRI) of 90 or over and a colour temperature around 6500 degrees Kelvin (between 5000 and 8000 deg K will be OK). If you can't get those figures for your lamps try going to lighting shops, or aquarium shops or look on line until you can find someone who will help. There are now also many outlets for light emitting diodes (LED). Suggest that only deal with providers of lamps that can give information on intensity, CRI, spectrum and colour temperature make up.

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 fluorescent lamps every 6 months as they lose their efficiency quite quickly, change metal halide lamps every 12 months. LED lamps are reported to run much longer times before they deteriorate.

You can also write the date you put the lamp into service on the metal part of the lamp with permanent marker pen. Record the details in your spreadsheet or aquarium diary.

2. **Aquarium** - generally an all glass box with braces available in an aquarium shop. It is also possible to make your own aquarium. The best shape is roughly a double cube, the aquarium that has been used as a model for this project is 122 cm wide, 61 cm deep and 61 cm front to back known in the past as a 4 x 2 x 2 (imperial length in feet). It holds 454 litres of water. There are other do it yourself aquariums, such as wood covered by fibreglass or other epoxy resin to make it water proof. An acrylic or glass panel is inserted for viewing.

3. **Aquarium Stand** - All glass aquariums will crack along the base or split the silicon join if the stand is not dead level and strong enough not to flex under the weight of water within the aquarium. Water weighs a bit more than a kilogram per litre, more if it is sea water. Glass weighs 25kg for one square meter 10ml thick. If a very large aquarium is being installed in a house on a wooden floor consideration must also be given for the strength of the floor. Some buildings with large aquaria need to have the floor braced underneath.

4. **Pump or Power Filter** - Any type of power operated filter that can move between one and four times the aquarium volume per hour. A powerhead, canister filter or any pump that can have return water directed through a pipe system past heat contact chamber then through the undergravel heating system back to the aquarium.

5 **Heater Chamber** - PVC plumbing fittings are used to make a space for the appropriate sized heater for the water of the aquarium.

6. **Under Gravel Heat Exchanger** - see the section on the heat exchanger

7. **Heater Return pipe** - see the section on the heat exchanger, water is directed across surface of aquarium to make current.

8 **The plenum** - Description, a space under the substrate. A plenum is defined in the dictionary as a space entirely filled with matter which 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 your 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 to prevent it being in advertently pulled out.
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 good notes in your logbook or records spreadsheet.

9. **Substrate heating - Heat Exchanger** Description - A network of warm water running under the substrate through small pipes 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 in a glass tube with element 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 powerhead within the aquarium. 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 the diagonal opposite side of the tank letting water flow into the main body of the aquarium. There is a commercial product is called an "in line heater housing". The substrate heater also acts as a CO_2 reaction chamber where all the CO_2 is completely dissolved before the water exits back into the aquarium.
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 terrestrial pot plants as they are usually made from bark mulch and fortified with fertiliser that go black and smelly when submerged.

Part 4 - Native plants for Aquaria and notes on their cultivation.

There are many plants out there in the rivers and billabongs of Northern Australia that have not been trialled as aquarium subjects. 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. Mock rock backgrounds and other layout techniques are quite simple if you do a bit of research before you start.

ACANTHACEAE
Hygrophila angustifolia R.Br. (Willow Hygro)
Nelsonia campestris R.Br.
Staurogyne leptocaulis Bremek.

ALISMATACEAE
Caldesia acanthocarpa (F.Muell.) Buchenau
Caldesia oligococca (F.Muell.) Buchenau
Caldesia oligococca var. oligococca

APONOGETONACEAE
Aponogeton euryspermus Hellq. & S.W.L.Jacobs
Aponogeton queenslandicus H.Bruggen
Aponogeton vanbruggenii Hellq. & S.W.L.Jacobs

ARACEAE
Colocasia esculenta (L.) Schott
Epipremnum amplissimum Schott
[Raphidophora australasica F.M.Bailey]
Pistia stratiotes L.
Typhonium flagelliforme (Lodd.) Blume

ARECACEAE
Corypha utan Lam.
[Corypha elata Roxb.]
Livistona benthamii F.M.Bailey
Nypa fruticans Wurmb
AZOLLACEAE
Azolla pinnata R.Br.

CAMPANULACEAE
Lobelia quadrangularis R.Br.

CERATOPHYLLACEAE
Ceratophyllum demersum L.
Ceratophyllum muricatum Cham.

CYPERACEAE
Cyperus sp (some species are suitable)
Eleocharis sp (some species are suitable)
Fimbristylis sp (some species are suitable)
Schoenoplectus litoralis (Schrad.) Palla
Websteria confervoides (Poir.) S.S.Hooper

DROSERACEAE
Aldrovanda vesiculosa L.

ELATINACEAE
Bergia pedicellaris (F.Muell.) F.Muell. ex Benth.
Elatine gratioloides A.Cunn.

ERIOCAULACEAE Eriocaulon setaceum L.
Eriocaulon willdenovianum Moldenke
Eriocaulon zollingerianum Korn.

GOODENIACEAE
Goodenia purpurascens R.Br.

HALORAGACEAE
Myriophyllum callitrichoides Orchard
Myriophyllum callitrichoides subsp. callitrichoides
Myriophyllum dicoccum F.Muell.
Myriophyllum filiforme Benth.
Myriophyllum muricatum Orchard
Myriophyllum trachycarpum F.Muell.
Myriophyllum verrucosum Lindl.

HANGUANACEA
Hanguana malayana (Jack) Merr.

HYDROCHARITACEAE
Blyxa aubertii Rich.
Blyxa aubertii var. aubertii
Blyxa aubertii var. echinosperma Cook & Luond
Blyxa octandra (Roxb.) Thwaites
Hydrilla verticillata (L.f.) Royle
Maidenia rubra W.Fitzg. ex Rendle
Ottelia alismoides (L.) Pers.
Ottelia ovalifolia (R.Br.) Rich.
Vallisneria annua S.W.L.Jacobs & K.Frank
Vallisneria caulescens F.M.Bailey & F.Muell.
Vallisneria nana R.Br.
Vallisneria triptera S.W.L.Jacobs & K.Frank

ISOETACEAE
Isoetes coromandelina L.f.
Isoetes coromandelina subsp. macrotuberculata C.R.Marsden
Isoetes cristata C.R.Marsden & Chinnock
Isoetes muelleri A.Braun

JUNCAGINACEAE
Triglochin dubium R.Br.

LAMIACEAE
Pogostemon stellatus (Lour.) Kuntze

LEMNACEAE
Lemna aequinoctialis Welw.
Lemna tenera Kurz
Spirodela polyrhiza (L.) Schleid.
Wolffia angusta Landolt

LENTIBULARIACEAE Utricularia aurea Lour.
Utricularia australis R.Br.

Utricularia fulva F.Muell.
Utricularia gibba L.
Utricularia muelleri Kamienski
Utricularia tubulata F.Muell.
LILIACEAE
Crinum angustifolium R.Br.
Crinum uniflorum F.Muell.

LIMNOCHARITACEAE
Butomopsis latifolia (D.Don) Kunth

LOGANIACEAE
Mitrasacme secedens Dunlop

LOMARIOPSIDACEAE
Bolbitis D65582 (NT herbarium number)

LYTHRACEAE
Ammannia baccifera L.
Ammannia multiflora Roxb.
Nesaea striatiflora Hewson
Rotala diandra (F.Muell.) Koehne
Rotala mexicana Cham. & Schltdl.
Rotala occultiflora Koehne
Rotala rosea (Poir.) Cook

MARSILEACEAE
Marsilea angustifolia R.Br.
Marsilea crenata C.Presl
Marsilea drummondii A.Braun
Marsilea exarata A.Braun
Marsilea hirsuta R.Br.
Marsilea mutica Mett.

MENYANTHACEAE
Nymphoides aurantiaca (Dalzell) Kuntze
Nymphoides crenata (F.Muell.) Kuntze
Nymphoides exiliflora (F.Muell.) Kuntze
Nymphoides furculifolia Specht
Nymphoides indica (L.) Kuntze
Nymphoides minima (F.Muell.) Kuntze
Nymphoides parvifolia (Griseb.) Kuntze
Nymphoides planosperma Aston
Nymphoides quadriloba Aston
Nymphoides spongiosa Aston
Nymphoides subacuta Aston

NAJADACEAE
Najas browniana Rendle
Najas foveolata A.Brown ex Magnus

Najas graminea Del.
Najas malesiana Willd.
Najas marina L.
Najas marina subsp. latior (K.Schum.) Triest
Najas pseudograminea W.Koch
Najas tenuifolia R.Br.

NYMPHAEACEAE
Nymphaea gigantea Hook.
Nymphaea hastifolia Domin
Nymphaea Nymphaea immutabilis S.W.L.Jacobs
Nymphaea immutabilis subsp. immutabilis
Nymphaea macrosperma Merr. & L.M.Perry
Nymphaea nouchali Burm.f.
Nymphaea pubescens Willd.
Nymphaea violacea Lehm.

ONAGRACEAE
Ludwigia adscendens (L.) H.Hara
Ludwigia hyssopifolia (G.Don) Exell
Ludwigia octovalvis (Jacq.) Raven
Ludwigia octovalvis subsp. octovalvis
Ludwigia octovalvis subsp. sessiliflora (Micheli) Raven
Ludwigia perennis L.

PARKERIACEAE
Ceratopteris thalictroides (L.) Brongn.

PHILYDRACEAE
Philydrum lanuginosum Sol. ex Gaertn.

POACEAE
Bambusa arnhemica F.Muell.
Hymenachne acutigluma (Steud.) Gilliland
Hymenachne amplexicaulis (Rudge) Nees
Isachne confusa Ohwi
Paspalidium udum S.T.Blake
Phragmites australis (Cav.) Trin. ex Steud.
Phragmites vallatoria (Pluk. ex L.) Veldkamp
[Phragmites karka (Retz.) Trin. ex Steud.]

PODOSTEMACEAE
Tristicha trifaria (Bory ex Willd.) Spreng.

POLYGONACEAE
Persicaria attenuata (R.Br.) Sojak
Persicaria barbata (L.) H.Hara
Persicaria D17952 Bulkine Billabong
Persicaria orientalis (L.) Spach

PONTEDERIACEAE
Monochoria australasica Ridl.
Monochoria cyanea (F.Muell.) F.Muell.
Monochoria hastata (L.) Solms
Monochoria vaginalis (Burm.f.) C.Presl ex Kunth

POTAMOGETONACEAE
Potamogeton crispus L.
Potamogeton octandrus Poir.
[Potamogeton javanicus Hassk.]
Potamogeton pectinatus L.
Potamogeton tricarinatus F.Muell. & A.Benn. ex A.Benn.

PTERIDACEAE
Acrostichum speciosum Willd.

SCROPHULARIACEAE
Bacopa floribunda (R.Br.) Wettst.
Glossostigma diandrum (L.) Kuntze
Limnophila aromatica (Lam.) Merr.
Limnophila australis Wannan & J.T.Waterh.
Limnophila brownii Wannan
Limnophila chinensis (Osbeck) Merr.
Limnophila fragrans (G.Forst.) Seem.
Lindernia cowiei W.R.Barker
Lindernia tenuifolia (Colsm.) Alston
Microcarpaea minima (Retz.) Merr.
Mimulus uvedaliae Benth.
Peplidium maritimum (L.f.) Asch.

XYRIDACEAE
Xyris indica L.

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