Chapter 4.

Water and water quality.

The hobbyist will be aware of the fact that the vast majority of aquarium plants originate from tropical regions of the world. Here for the most part, the water is typically somewhat soft, with a pH usually around 6.8 and sometimes even lower. This is the contrary of most of the Northern hemisphere where both in Europe, and N. America, so much of the aquarium hobby exists. I referred at the beginning of this book, that so many of us, in the Dublin Aquarium Society were able to produce beautiful planted aquariums which we proudly took to shows once or twice a year.

4-1 This easy to use and accurate GH/KH test kit by Aquarium Pharmaceuticals is excellent value, and the instructions are above average

What in those halcyon and innocent days was unknown to us, was the exceptional circumstance, that in South Dublin, where most of the Society members lived, the water was in fact unusually soft. In retrospect, it now seems no coincidence that all the prizes were won by persons who resided on the south side of the city. None of us realized then, that those few members from the north side of the city, where the water was entirely different, never seemed to be able to make their plants grow successfully. We just assumed they were no "green thumbs" among them as we put it.

4-2 A Reverse Osmosis unit like this one, is probably the most reliable way to reduce the hardness of your water. While they require an outlay of $120-$180, they will last indefinitely and can be used in fact to improve your drinking water quality.

I should like therefore to make it absolutely clear, that the water you use and it's quality is fundamental to the success of a Landscaped Aquarium. We need to know about the makeup of our water at the outset and in particular the Hardness values. Hardness is the measurement of the amount of the different minerals that are dissolved in the water.This means that the hobbyist must ascertain when using tap water, the hardness both of Calcium hardness (KH), and well as General hardness (GH).

For these many good test kits are offered in aquarium stores. Ensure that the kit you use is vouched for in quality by both the store owner, and write ups in aquatic magazines. Some test kits are better and more reliable than others. We will use in this book the measurements of Hardness in "German" degrees, as this was the original degrees measurement form used in the Hobby, and still extensively used worldwide.

For those purists among you, or those who prefer the scientific metric system, you can convert German degrees to ppm (parts per million) by multiplying by 17.9.

4-3 Want inspiration, this scene by Frode Roe won the large tank entry and best of show in 2001. The scene is not only beautifully proportioned , but allows plenty of space in front for schools of small fish, as well as hiding places. Note although there are about 16 differing plant species, the placing of same is very well thought out to give natural balance.

According to most of the serious growers in Asia and elsewhere, including our own experience, a general (total) hardness of between 5-7 GH coupled, with a carbonate (calcium) hardness of 3-5 KH is ideal. These measurements are given in the most commonly used German degrees of measurement.

At this point it is helpful to give a short outline of what the terms General Hardness (GH) and Carbonate Hardness (KH) mean. The two most common dissolved elements found in fresh water are Calcium and Magnesium. Both of these elements can in the presence of Carbonic acid form carbonate salts, and added together these are the Carbonate Hardness (KH).

There is in most natural waters a certain amount of Calcium carbonate, also often Calcium bicarbonate. .In the aquarium if we use a gravel which contains any limestone (Calcium carbonate), a reaction will take place which will create further amounts of bicarbonate salts. As bicarbonates can be removed by boiling (not practical in an aquarium), we term these salts the Temporary Hardness. Those salts which remain after boiling, such as Calcium sulfate and others, are termed the Permanent Hardness. The GH or Total Hardness is comprised of the sum of the Temporary Hardness + the Permanent Hardness.

In any of these scenarios the amount of either chemical you will need to add is dependent on the obtained values of your KH and GH, and of course the size of your tank. It is difficult to give a precise formula for these additions, as each water will vary in some way. However I prefer to make up a solution of either additive at a concentration of 50grams/litre, and add some 2-3 ml, to a tank of 50 gals. Wait for half an hour and measure again, repeating same until the desired values are reached.

Therefore we should be aware that Calcium and Magnesium can also combine with sulfur, nitrogen, and chlorine, to form sulfates, nitrates, and chloride salts, to constitute varying amounts, according to geography, of the total hardness of GH.
These latter salts are highly soluble and combined account for what is termed the permanent hardness. There are also a few other minerals that can form salts which comprise the GH, these others are most commonly Barium and Strontium, though from time to time there can be a few others. To all intents and purposes, the principal salts we have to concern ourselves with are Calcium and Magnesium.
It will now be apparent to the reader, that the KH will always be, either lower than the GH, or in a few and rare cases almost equal to it. This latter is where nearly all the hardness is only in the form of carbonate salts, which can be removed as we said by boiling. The writer has seen natural waters were the KH was 80% of the GH value, but never were it was 100%.
It is also vital when considering the question of hardness, to pay close attention to the type of gravel (substrate) you will select. (See more, in the chapter on gravel and substrate).
If the water is too hard, we can take steps to reduce it. There are a couple of different approaches to the preparation of suitable water for a planted aquarium, when this reduction is needed.
One method to reduce any excessive hardness after ascertaining the characteristics of your tap water, is by purchasing distilled water from a vendor. Garages, and several other outlets are available that can supply you with such. Most potable water vendors also offer a fully distilled quality. Of course you must ascertain that the reduction of the hardness will by “cutting it” in a straight line reduction, arrive at the ratio needed of GH to KH as shown above.
If for example the GH hardness was 15, and the Carbonate hardness was 10, then by adding distilled water to the tap water in the ratio of 2 parts distilled to one part tap water, would produce water with a GH of 5, and a KH of 3. This would be close to an ideal value.
Should however the GH be much higher than the KH, so that by obtaining a GH by dilution of the correct number of degrees, but now the KH would be too low, we must adopt another technique. We can supplement the KH by the addition of a suitable amount of baking powder added judiciously until the KH level is at the desired value.
It can also happen that one would obtain a value of GH and KH so that the relationship is of the KH as a percentage will be too high. When one would dilute the water with distilled or R.O. water to arrive at say 8 GH, the KH would be for example 7KH. This would be higher than desirable. To overcome this we can increase the Permanent Hardness of the water, by the addition of some salt (it must be non iodized or

one should by some of the mixes sold in aquarium stores for African Cichlids). One could increase the GH before dilution, or more easily afterwards. In both cases, one must use and record carefully measurements with a good quality hardness kit.
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Another method of "softening" your tap water is to use a deionization cartridge. This will take various ions out of water, using an exchange method. In Germany they use a double reactor system, often called "Kati" and "Ani". This is because the two reactors act differently. One exchanges Cations, or metallic salts, which "subtract" typically Calcium and Magnesium for Sodium, whilst the other removes Anions usually sulfates, nitrates etc replacing them with Chlorides. If you have an excellent knowledge of chemistry, and ensure that you ask all the right questions and obtain the precise modus operandi of the resin beds, this may work for you. Too often it makes a water quality that is unsuitable go from bad to terrible, and for the average Aquarist I do not recommend it. They also tend to be relatively expensive. One mixed bed model available in Aquarium Stores claim usually about 150 gallon of treatment, but most people I have spoken with say it treats far less than that.

As the replacement of evaporated water, as well as periodic water changes is needed, to maintain your Landscaped Aquarium, I feel there are better alternatives.

Possibly the best way is to use a Reverse Osmosis unit. Many types are now available, and these remove almost all dissolved solids from your water. The price depends on the amount of water the unit will treat in a 24-hour period. It is not necessary to purchase a unit that gives you the throughput equal to the size of your aquarium. When beginning, you can "save" the water treated until you have the right amount, and then dilute your tap water to make up the required hardness values.

In a most popular 55-gallon size tank, a Reverse Osmosis unit capable of producing as little as 5 gallons a day will be adequate. You may have to dilute your tap water by a factor of say two to one. Then by running and saving the output of the unit for about 7 days, you will have sufficient R.O. water.

As we will see later in the Chapter on Carbon Dioxide addition, there is a complex relation ship between the carbonate hardness, the amount of CO_2 and the pH value. Therefore it is necessary to be aware for optimum results a pH value of 6.8 –7.1 is in most cases the best. This is the ideal range for a typical assortment of plants that will be utilized by most hobbyists.

Those Hobbyists that wish to have a Landscaped Aquarium with Discus fish as their major attraction, often decide to keep a pH value lower than 6.8. This is of course possible, but will limit to some extent, the variety of plants which one can keep successfully in such Aquaria, and can also have some potential other problems with heavy metal toxicity. It is also IMPORTANT to note, that if your KH value is less than 3 KH, then it can be dangerous to add CO_2 to the Aquarium, as there will not be adequate buffering capacity in the water, to avoid the possibility of causing a dramatic and sudden drop in the pH value. Should this be the case ensure you increase the KH by addition of some $CaCO_3$ (calcium carbonate).

Heavy metal toxicity, is far more common than many of us may expect. This especially so, as we expect our local water boards to protect us against levels of contaminants, that could affect our health. Copper, Lead, and others however are often present, in amounts that may be life threatening to our fish and plants.

You can make a simple test that may help you to visualize the problems that can be encountered. Most houses have copper pipe which bring the hot and sometimes the cold water to the faucet. Most waters will interact with the copper and this will augment the dissolved copper, often to the level that can kill sensitive fish like Tetras very easily. Try testing with a reliable Copper Test Kit, the first water from your tap, early in the morning, when it has been lying overnight with no movement. Then test it again after running the water for a few minutes. We have observed differences of Copper levels from as little as 0.01 ppm(mg/L), to as high .3 ppm(mg/L) . It is a fact that levels above 0.1 ppm, can have an adverse effect on fish, and levels much above this will also effectively impact not only the fish but also many plants.

Should you observe this phenomena then it is incumbent to remember to run the water, when making water changes, or top ups, for a few minutes before taking the water one needs. This will bring the copper level to it's background level, which in most cases will not be a problem. We have seen aquarists, not aware of this, take healthy Neons, Catfish and others, from a store, introduce the fish to their new tank, (no plants present), and within a few minutes all were dead. It was eventually found out that the house was in a new housing estate, and the Copper pipes were new. Over time the copper pipes become less active as chemical reactions take place, but the potential for trouble never goes away completely.

Of course Copper is not the only heavy metal that can be present and cause toxic effects. Others are Cadmium, Chromium, Lead, Mercury, Nickel, Zinc, and more. The levels of these can often vary according to the time of year, drought, and other factors. It is not possible for the average Hobbyist to constantly monitor all these elements, and measure them to the levels that are required. It is much simpler, to use nature, to detoxify any excess levels by using plants, and adding humic factors to the water.

Although it is a fact that in nature most of our plants grow in a slightly acid and rather soft water, it is important to be aware, that the more acidic, and softer the water, the greater the potential for heavy metal toxicity. Harder waters and higher pH have usually more Calcium, and this tends to compete with the heavy metals for uptake, in a way that makes it less of a danger. It is therefore most important that the Discus fish lovers among you, who typically keep their pH and hardness values at a lower than average level, to be especially vigilant, in taking steps to ensure that these toxicities do not become a problem.

The oxygen that live plants emit during daylight hours, is beneficial to the fish, and helps under the right conditions, to keep the aquarium clear, as well as pathogen free. This occurs because oxygen can help reduce heavy metals, as well as providing the needed environment which assists in the growth of beneficial organisms, on the roots of the plants. It also assists in the uptake of other elements vital to the plants physiology.

The Nitrogen cycle is a part of our world Ecosystem. For many years it has been known, that the excretory products of fish, in the form of Ammonia (NH3/NH4) are converted in an active filter bed, by nitrifying bacteria to Nitrite(NO_2), and then further converted by another group of bacteria to relatively harmless Nitrate (NO_3). Unless this process is active in an aquarium, then fish will die from a combination of Ammonia and Nitrite poisoning. In a planted Aquarium however it has been found that the plants have a preference for the ammonium ion (NH_4). This preference can also help to ensure that the typical 'new tank syndrome', does not occur. New Tank syndrome is almost always caused by inadequate bacterial biomass, which is unable to handle the newly introduced excretions of the fish, plants by taking up the Ammonium ion, greatly help to ensure that this does not occur.

Some of you reading this book, may be fortunate in having tap water that fits the hardness and other specifications above. Those areas of the U.S. that tend to have water that is near the preferred values, are for the most part on the Eastern seaboard, also the Pacific Northwest. Regrettably in most of the rest of the country the majority of you, will find their tap water is much harder than the ideal. Often it will also have added chlorine and more, which the bodies charged with supplying us household potable water, deem fit to add. These additives are made even when the water is suitable for our plants so pay attention.

We sum up below the three major alternatives that are available to most Hobbyists, along with the advantages and drawbacks of each method.

For ourselves we find that the use of a good R.O. (Reverse Osmosis) unit, quickly pays for itself, and has less of a downside than the two other methods. For the average Hobbyist the size of the Aquarium will be a determinant in which system he/she decides upon.

WATER SOFTENING METHODS

	For	Against
1. Dilute with distilled water	Easy to use, readily available, inexpensive	Constant ongoing purchases
2. Demineralization with ion exchange resins	Can arrive at precise values desired , good units last a long time and show by color change when replacement is needed.	Chemistry not easy to undestand, As water quality differs, no one unit will suit all situations
3) Use Reverse Osmosis Unit **Editors choice**	Can be used constantly for original water and water changing. Quality with most units is excellent	There is an initial capital cost and a much smaller membrane replacement every 2nd year. Needs to be plumbed into your water supply .

It is astonishing to the writer that Chlorine is added ubiquitously, yet it is a well known carcinogen. It would appear sometimes as if we all have a death wish, as there are other alternatives, which can be adopted to ensure the safety of our water supply. As well as Chlorine in some states, Chloramine is also added to the municipal supply as well in some areas Fluorine.

The well being that plants bring to the fish in the aquarium is anything but theoretical. The writer had tried for many years without success to breed the Harlequin fish Rasbora herteromorpha , as well as the Cardinal Tetra Paracheirodon axelrodi. We have a very large personal tank in our home, some 220 gallon capacity. Into this very large numbers of plants which were in excess in the nursery were placed. Very little attention was given to the fishes, other than to feed them about 5 times a week. One day we suddenly observed very tiny fry swimming around the tank, and these turned out to be some of both species. We are convinced that the fish reproduced only because of the many complex factors in the water, which created a Biotope that was so conducive to their well being that they reproduced and in fact continue to do so. The amazing thing is that reasonable numbers survive and grow even though we added no special fry foods.

WATER CHANGES AND EVAPORATIVE MAKE UP.

The water which evaporates each day from the aquarium, needs to be replaced. It should be noted that this water contains no minerals, thus any replacement water needs to be ONLY distilled or R.O water. As the rate of evaporation is usually constant, the top up water can easily be made, by adding some simple type of drip feed over the rear of the tank. There are several automatic units for adding solutions to Reef tanks that are on the market and any of these could also be used.

As water “ages” due to the complex biological activity in the aquarium, it becomes somewhat polluted. Therefore once a week about 20% of the water should be exchanged. This will make a spectacular difference to the health of your plants, also the fish. The new water should obviously be prepared in the same manner as your original water, as in this instance, you will siphon away water containing a percentage of minerals. Remember always to remove any chlorine etc, that may be present in the tap water, before adding it to the aquarium, to avoid fatal results.

FILTRATION

It is necessary to filter the water, to prevent build up of toxic wastes, and keep the various biological processes working in harmony. A well planned Aquascape, however will provide a natural form of Filter, which tanks without live plants will not have.

There are many types of filtration units offered to the Hobbyist, and some will do a better job than others in providing the needed breakdown of waste matter, and keeping the water clear. It should be noted by the Aquarist that most plants prefer to take up the Ammonium ion $NH_{4,}$ rather than utilize NO_3 which is the typical result of the nitrification process. This can be one reason among many, that a well planted tank is far better for the health of your fish, than a bare tank, or one with plastic plants.

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4-4 A filter such as this one by Aquarium Landscapes, will provide aerobic and anaerobic filtration. It can also grow plants on the rough front surface(see right) , thus making it fit naturally into the Landscape.

Some important guidelines for selecting and using a filter.

The filter should not allow the water to splash back into the tank with highly aerated water. If a spray bar is a component of the filter, ensure that it is placed below the water surface. This will help to reduce the otherwise near certainty that algae will grow where the water splashes.

The volume of water turnover should be 1.5 to 2 times per hour.

Some more advanced filters today, have an anaerobic compartment, which assists in the breakdown of excessive Nitrates and possibly Phosphates. If one's budget will run to these types it is a good investment.

The filter medium should be washed or exchanged about every 2 months.

Ensure that one has check valves in the system if the filter is placed below the Aquarium so that in the event of a power outage one avoids the disaster of flooding of your living room, and also the draining of your tank by back siphoning action.

4-5 The same filter as shown in 4-4,, 3 weeks later, with profuse growth of Microsorium pteropus (Java Fern), on the front surface. This makes for a natural looking Aquascape.