pH Part 3 – pH Without tears – Part 3: Management in the Aquarium by Barry Moore from Tank Talk Volume 13 No. 2 1988

pH WITHOUT TEARS – Part 3: Management in the Aquarium

by Barry Moore

The first 2 parts of this series examined the concept of pH (TANK TALK 12(4), p.143) and the means of measurement (TANK TALK 13(1), p.16) so now it is time to look at the practical implications of pH in day to day management of an aquarium.

It is of course a general rule that fish or other animals do best in captivity when given living conditions as close as possible to those that they are accostomed to in nature. But not all creatures are equally particular: some are much more adaptable than others and this usually reflects the degree of stability or otherwise that they encounter in their chosen habitats.

Thus freshwater aquarium fishes, such as many of the Barbs, that come from regions that experience pronounced wet and dry seasons, or species from countries such as our own, where rainfall is erratic, are well adapted to cope with the large and often rapid changes in water chemistry that these conditions entail. Fishes that live in brackish waters are perhaps the most adaptable of all, for they can frequently move from the extremes of fresh to salt waters without any ill effects. The well-known Discus (*Symphysodon*) on the other hand, which lives in Amazonia, where the waters are reliable and very soft, is notable for its limited tolerances. Strictly marine fishes. too. live in a very stable (though chemically contaminated) environment and are quite unable to cope with relatively small changes in water composition. A good knowledge of the natural conditions under which one's fishes live in nature is therefore the best guide to their management in the aquarium.

The natural fresh waters of the world range in pH from about 4 to 7.5. At the low (acidic) end of this scale come the brown, discoloured waters of temperate peat-bogs and of certain 'black-water' rivers of the tropics. These contain high concentrations of humic acids, derived from plant detritus, but are low in nutrients and mineral salts. Such conditions are inimical to all but a few highly specialised forms of aquatic life and most aquarium plants and animals are therefore derived from sweeter waters. Thus although many of our fish (particularly the tetras and other Amazonian species) prefer slightly acidic water and a few (such as African Rift-lake Cichlidae and the cave-fish *Astyanax mexicanus jordani*) do best in slightly alkaline conditions, variations of pH in the fresh-water aquarium will normally be restricted to within the range 6-7.5. The marine aquarium, however, will need close control of the pH to match the remarkably narrow range of natural sea-waters, namely, 8.3-8.5.

The pH value of a body of water at a given moment results from a number of interacting, and sometimes opposing, factors. These include the nature and amounts of any dissolved substances (solids and gases such as carbon dioxide), the temperature and the level, if any, of biological metabolism. Of these, the first-mentioned is of paramount importance, for the presence of dissolved acids, such as humic acids derived from plant debris, or of alkaline salts, such as calcium bicarbonate, derived from limestone, will to a large degree over-ride the other influences, at least in the short term. It is also important to note that biological waters (including aquariums) usually show a daily rhythm and their pH can vary quite markedly with phases in the 24-hour cycle, depending upon whether carbon dioxide is being generated or absorbed.

Fortunately for us, the Canberra water supply is relatively low in both mineral and organic content. Its pH is usually 7.1-7.2, that is, slightly alkaline, but is sometimes higher in the newer suburbs, where the leaching of the concrete-lined reticulation system is incomplete. The salinity and hardness are quite low. Some free chlorine is often present as a residue from the deconatmination treatment, but this is soon dissipated on exposure and the water is ideal for aquarium use after 24 hours' storage in open containers.

Our problems with pH control at the setting-up stage are therefore small, in comparison with those elsewhere, but because an aquarium is a closed system, with a much higher than natural level of biological activity, the situation does not remain stable for long. The regular input of food, much of it with high-protein content, leads to production of fish wastes and other ammoniacal degradation products that are highly toxic. These need to be removed promptly, with the aid of nitrifying bacteria, if the fish are to survive for long, but the penalty is the production extra H+ ions:

$$2NH_3 + 4O_2 \rightarrow 2H^+ + 2NO_3^- + 2H_2O$$

So down goes the pH!

How do we counter this? Well, to some extent, regular water changes will help but it should be remembered that as the pH scale is a logarithmic one, in powers of ten, mere dilution with pure water will not produce a dramatic effect. To raise the pH from, say, 5 (an undesirably low level for an aquarium) back to 6 would require a 90% water change and this would unduly stress the fish. However, with slightly alkaline Canberra water, the effect is somewhat greater. Nevertheless, it will probably be necessary sooner or later to resort to chemical means for raising the pH and perhaps the most efficient and convenient way is to add considerable quantities of shell-grit. This readily available material consists essentially of calcium carbonate, which is virtually insoluble in pure water, but which dissolves slowly in weakly acidic media, with the consumption of H+ ions:

$$CaCO_3 + H^+A^- \rightarrow Ca^{++} + HCO_3^- + A^-$$

Because the shell-grit is normally present in great excess, it acts as a kind of buffer, preventing the pH of the aquarium water from shifting markedly and that is a valuable insurance. However, it suffers from the two small disadvantages of slowness to act and of hardening the water, although the latter is of little consequence under Canberra's conditions, except in the keeping of very sensitive fish, when water changes should be made frequently.

If, through neglect, the pH of a fresh-water aquarium has dropped alarmingly, and a 'quick fix' is needed promptly, small amounts of sodium bicarbonate, dissolved in plain water, may be added, along with adequate stirring and monitoring of the changing pH. Even in an emergency, immediate adjustments of pH greater than about 0.2 of a unit should be avoided and on no account should solid sodium bicarbonate be added as local temporary pockets of highly alkaline medium may result and greatly distress the fish. This same substance is also useful for control of the pH in marine aquariums which, with their much greater buffering capacity, are less likely to move so far out of range.

It is less often necessary to lower the pH of a fresh-water aquarium but for fastidious fish such as the Discus and some tetras, pre-treatment of Canberra water may be advantageous in the setting-up stages. This may be done by incorporating peat in the filter. Humic acids are thereby added to the water and Calcium and Magnesium ions are simultaneously withdrawn from it, giving the soft and slightly acidic medium that these fishes require. However, it should be remembered that softening of the water reduces its buffering capacity and therefore close monitoring of the pH and frequent water changes are even more important

The pH of a marine aquarium may well need adjustment downwards from time to time, to avoid the very dangerous liberation of free ammonia, and this is best achieved by a partial water change with, of course, new salt-water.

Postscript

Things (and particularly scientific things) are seldom as simple as they seem at first sight and this certainly applies to pH. So, in attempting to serve the constraint of my title, I may well have been guilty of some over-simplifications through this series. I have, for example, not mentioned before that Hydrogen ions are believed to exist only in their hydrated form, the so-called Hydronium ion (H_3O^+), but niceties such as that hardly matter to those of us who are concerned with the basics of maintaining healthy and attractive aquariums.

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