
The Scheel Letters, No. 12

Fry and the low values of pH

In one big tank with about 300 fry of Cynolebias (Cynopoecilus) melanotaenia, a few fry of Nothobranchius and some fry of Cynolebias whitei after some days had a few hydra possibly coming up from the bottom. This was treated with sulfuric acid in the way that the pH that was about 6.0 was decreased to about 4.0 (endpoint of brome cresol green) within one hour. All fry were apparently unaffected and so were daphnia and cyclops but all hydra next morning were white and died. In another tank I saw some green hydra and decreased the pH possibly far below 4.0 (water showed pure yellow color a few hours after using brome creol green, then I found lots of "white" fry dead on the fine peat mud but also I saw many fry swimming all over the tank. I added little tap water and no more fry died. Now there are many "calliurum" but no "labarrei" in this tank. Adding acid to the water of this tank indeed was made "by eye" and no doubt the pH was decreased far below 3.8. Another tank with breeding pairs of Epiplatys bifasciatus was infected by green and "red" hydra by large numbers. Fishes were transferred to another tank. The pH of the water was decreased to about 4.0. All hydra disappeared. None was seen during the following 3 weeks. Yesterday I lifted out 40 sound fry. The fry of this species always hide themselves and you only are able to estimate the number of fry from the consumption of food, just the way you do when breeding characins. Fry measuring 15-20 mm have distinct crossbars on the sides of their bodies and quite a number.

The Balanced Aquarium

Aeration using pure carbon dioxide

We all know that plants need a steady supply of certain elements if they shall live and grow bigger and bigger. These elements are primarily carbon (C), hydrogen (H), oxygen (O), nitrogen (N), sulfur (S), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) and iron (Fe). Secondary other elements may be of importance: boron (B), manganese (Mn), copper (Cu), zinc (Zn), molybdaen (Mo) and possibly also gallium (Ga). The secondary "nutrition elements" very often are very poisonous if present in concentration up to 1 ppm (mg/l).

In the balanced aquarium which possibly is of great importance when keeping the more feeble species of killies we want the plants to continue to consume all waste products which the fishes give away. Not only the carbon dioxide should be removed from the water by the activities of the plants, but also the nitrous components, possibly this being much more important.

If aquarists did not crowd fishes in their tanks, if they at least would give sufficient light, if they did not overfeed, possibly they would have a better aquarium keeping. The development of the inexpensive aquarium pump (diaphragm type) certainly has not made things easier to the fishes in the tanks. Certainly by this way he may get rid of the surplus carbon dioxide formed by the surplus of fishes in his tank, also he may to a certain degree increase the supply of oxygen to the tank. But he cannot blow out the nitrous waste products from the fishes.

Through the years I have acted (more or less involuntarily) as a sort of "fish doctor" to the aquarists of this country and from this service I conclude that most troubles in the aquarium keeping at level of the common aquarist comes from tanks far out of balance because of a much too high number of fish, insufficient lighting and cleaning of the bottom layer. I always wondered why people want so many fishes in their tanks. They never seem to have enough. Changing this bad habit is very difficult. People who more or less "live on the hobby" are in two ways interested in this matter because they think that they will sell more fishes primarily and secondarily more fish will die, but they do not take into consideration that they force many people out of this interesting hobby.

As a breeder by passion I certainly have faced these problems many times. As the fry grow up the previously so well established tank more and more comes out of balance. My best helpers -the "water ferns" (Ceratopteris)- loose their handsome live green color, they turn into a light green color, and at the same time the "algae pest", the blue green algae (Oscillatoria, etc.) appear. This is a warning, in particular to the man who keeps the feeble species of killies. Well you say, give more light and certainly sometimes this may help, but after some time the problem arises once more. Renewing the water only helps for a very short time. You have to lift out the fish, discard the water ferns, wash the sand or peat and reset the tank. Well, this is not a severe problem as long as you only deal with smaller tanks, but tanks that hold more than 100 liters (25 gallons) you do not want to reset every two months.

A month ago I had to reset my biggest tank - 320 liter that like all other tanks in my fishroom has a bottom layer of old peat and peat moss. This tank was far out of balance, caused by overfeeding, insufficient light during wintertime and so on. Also there was a lot of hydra all over the tank. Fishes were caught, plants removed and the whole dirty bottom layer of peat was stirred up. In order to kill the hydra, phosphorous acid and sulfuric acid was added until the reaction was pure yellow using bromo cresole green as indicator (pH bellow 4.0). Water now was very turbid indeed. Next day lots of daphnia were introduced. As usual they were not hurt by the low pH value. The daphnia gradually cleaned the water. Several times the bottom peat was stirred in order to help the daphnia in their cleaning work. The pH increased rapidly after each adding of acid caused by the buffer action of the peat, so more acid -much more indeed- had to be added in order to keep down the pH value between 4.0 and 5.0. As this tank is made of stainless steel and has the bottom sheet of stainless steel uncovered, this adding of acid to the peat could be dangerous. No doubt lots of metallic ions were liberated by the "regeneration process". As copper chloride had been used several times in this tank against hydra and Oodinium, the very poisonous Cu-ions absorbed by the peat may be liberated by the acid or certain heavy metallic ions from the stainless steel absorbed over years by the peat may go out into the water. This did not happen as the daphnia were not killed. After some days, the water and the peat seemed to be sufficiently clean and Cryptocorynes, Aponogetons and big water ferns were introduced. In order to increase the supply of carbon dioxide, I filled one liter bottle with 1/3 concentrated hydrochloric acid and 2/3 water. A rubber plug with a piece of glass tube, connected the carbon dioxide developer to the "aeration stone" of the tank (I never use "stones" because most material here used possibly will dissolve in the water, therefore I use a little piece of plastic hose with little pressed perlon inside for the formation of small bubbles). Pieces of marble and chalk were put into the "CO2 developer" and soon lots of fine bubbles of pure carbon dioxide were rising from the "aeration stone". Light was turned on during all nights and very soon a heavy growth of the ferns was easily seen. This proved that the water still held lots of nourishment for plants. Snails were introduced to clean the leaves of the Cryptocorynes and soon the tank was once more apparently balanced.

Since the "carbon dioxide developer" actually was at hand, why not use it in other tanks? A 260 liter, 2 meter tank had big males of Pterolebias peruensis, several smaller species of Aphyosemion and some Procatopus. The tank had been out of balance during the spring months but was now in apparently good order. Now I began to blow this tank with pure carbon dioxide in order to see how the fishes would behave. After a few hours (light on night and day) plants began to give away oxygen as fine bubbles and the growth of the water ferns increased. Possibly this tank, that was very overcrowded, had a need of more carbon dioxide in order to remove a surplus of plant food. The aquarist who for some time has used a demineralization filter or has used oxalic acid in order to prepare soft water, knows that a certain amount of carbon dioxide will kill his fish within a few minutes. Many fishes possibly have been killed when they were introduced into tanks with unaerated demineralized or dechalked water. Within a few minutes the fishes are paralysed, they seem to be dead, and if they are not at once put into normal water they surely will be dead in a short time. I know that outflow from my demineralization filter treating water with 5 degrees of alcality (SBV) will kill my fishes in that way. 5 degrees of alcality correspond to 5 milliequivalents of acid used to neutralize the temporary hardness (and/or "soda hardness") in one liter of water. 5 degrees of alcality correspond to 5.22 = 110 ppm (or mg/l) of CO2 liberated by the acid (or in the filter), but the tap water contains even more carbon dioxide. In order to keep a temporary hardness, corresponding to 5 degrees of alcality (that is 5 ml of 0.1 normal HCl in 100 ml of water) in true solution, a rather large excess of carbon dioxide is needed. To a temporary hardness of 5.2 = 14 German degrees corresponds about 34 ppm of CO2 and also that tap water normally holds about 20 ppm of free CO2. That will say that this water, after treatment that removed the temporary hardness, contains about 165 ppm of free carbon dioxide.

The well known books on fish diseases written by Schueperclaus and Reichenbach-Klinke do not give exact information on the values of free carbon dioxide that fishes will tolerate in very soft water. In his book "Diseases of Fish" van Duijn wrote about some experiments with a goldfish in water containing up to 300 ppm of carbon dioxide, but the pH during this experiment is not known and may play a role. Not long ago I read some paper which gave some values, but I do not remember where I read it, I only remember the value 50 ppm of carbon dioxide as critical.

Carbon dioxide resolves in water to a high degree. Water in contact with pure carbon dioxide will resolve about 1650 ppm at room temperature and normal barometric reading. (0 C = 3350 ppm, 10 C = 1688 ppm, 30 C = 1260 ppm). Normal air only contains about 0.035% of CO_2 by volume, that is about 1/3 cubic centimeter in each liter of air, that will say that normal air in contact with pure water will force this to take up about 0.5 ppm at 20 C. Freshy collected rain water normally contains 0.5-2 ppm of CO_2. Stagnant water in nature may have 2 ppm or more near the surface but the deeper water normally contains much more. In polluted rivers up to 50 ppm were found, but in normal rivers only 0-2 ppm of CO_2. Some years ago I measured the concentration of CO_2 free in my rain forest tanks. Rarely I found values up to 20 ppm.

The very high solubility of carbon dioxide in water makes the aeration, using pure carbon dioxide, rather dangerous when fishes are present in the tank. On the other hand this sort of aeration may be of value and, if used with care, I think it may be used without great risk. Estimate the critical value of about 20 ppm CO_2 in rain forest tanks with very soft and low conductivity water.

$CaCO_3 + 2\ HCl = CaCl_2 + H_2O + CO_2$

(40 + 60) 2(1 + 35,5) 40 + 71 44

100 73 100 44

100 grams of chalk or marble treated with 73 grams of HCl will form 111 grams of calcium chloride and 44 grams of free carbon dioxide. Common hydrochloric acid holds about 470 grams of HCl in each liter of acid. As I dilute 1/3 part of acid (by volume) with 2/3 parts of water, my solution holds about 157 grams of HCl in each liter. My bottle holds 1 liter of diluted acid. In order to use all acid this solution I have to add about 215 grams of water-free chalk or marble to the water and this will give me about 95 grams of carbon dioxide (about 50 liters of carbon dioxide). The calcium chloride formed will easily resolve in the water, as this salt resolves by 745 grams in each liter and here only about 240 grams are formed. Approximately 2 grams of chalk or marble produce 1 gram of free carbon dioxide. If in 100 liters of water I will not press more than 20 ppm of CO_2 that is 20.100 = 2000 mg or 2 grams. Put only 4 grams of marble in the bottle and keep light on until the plants do not give away any more bubbles of pure oxygen.

I will keep you informed on further experiments and experiences drawn from my future using of this method. Possibly the common method of aeration using common air does blow out much too much carbon dioxide from the water and the plants are not able to take up the other waste products formed by the fishes.

Aeration using Pure Oxygen

Not very often (I hope) you feel a need of blowing your aquarium water with pure oxygen, but breeders now and then must face the situation where polluted water forces the fishes to the surface and where lots of oxygen is needed to clear up the situation. A good "pure oxygen developer" is easily constructed. Hydrogen peroxide (H_2O_2) in contact with manganese (MnO_2) freely will liberate pure oxygen and this development may go on for more than 24 hours. Use a simple glass bottle. Place some pieces of manganese (MnO_2) in this bottle and fill it up with water. Add little liquid hydrogen peroxide and soon you will see minute bubbles rise from the manganese. When you are transporting fishes on journey such "oxygen developers" may be a great help. Do not try to plug the bottle if oxygen comes out, the bottle will explode.