Redfield Calculator

The Redfield ratio, which now has meanwhile not heard of the Dutch aquarium? In the February (2004) issue of "The Aquarium" has a whole article about the Redfield ratio stood. But developing fast. This page is also intended to give. The current state of affairs And it shows that there are still some snags down to this method.

What is the Redfield ratio?

We go to 1934. During this period the American Alfred C. Redfield (1890-1983) discovered that the ratio of carbon (C), nitrogen (N) and phosphorus (P) in zooplankton AND water in all the oceans each approximately the same was. This ratio C: N: P 106:16:1 turned back around to lie again. So 106 parts of carbon to 16 parts nitrogen to 1 part phosphorus.

Variations in the ratios were always less than 20%. That ratio of 106:16:1 is still named after its discoverer, the Redfield ratio. Abbreviated RR ratio.

This relationship can be more precise written as:
106C: 16N: 1P: 0.01 (Fe / Zn / Mn): 0,001 (Cu, Mo, Co, etc.)

As seawater plankton around 16x will contain sufficient nitrogen (N) and phosphorus (P)

Said ratio of carbon (C): Nitrogen (N): phosphorus (P), or C: N: P is expressed in mol. The Redfield ratio thus gives a molar ratio of.

Why the ratio 106:16:1

Why exactly this molar ratio occurs is still not clear. The reason why the Redfield ratio in the oceans is as constant as is explained by the stable water chemistry of the oceans and the nutrient-rich growth conditions of zooplankton in the oceans.

Redfield ratio and we aquarists

We aquarists would normally never noticed the Redfield ratio, what should we do with that knowledge that there is a fixed C: N: P ratio in the oceans occurs ... After all, we do have fresh water? and when I look at the list of food animals, I see food animals with N: P ratios range from a low 7.5:1 (much phosphate) to 55:1 (much nitrogen) and everything in between occupants. Ok .. fair amount of bugs that are around 16 ... but still?

Well that ratio of 16:1 of marine plankton is not very interesting in itself, but it appears that the cyanobacteria (blue-green algae) are rare in N from a large number of studies: P ratios> 29. So if there is a lot of nitrogen and phosphorus in low ratio.

The theory holds that green algae do better at high ratios. Ratios less than N: P / 5:1 (little nitrogen, phosphorus much) often give to cyanobacteria see a clear trend.

And it is precisely this fact makes the RR-theory (which have just overlooked it is seen that the N: P ratio by aquarists can not be measured and that there are different varieties are blue-green algae).

The RR ratio is about relationships

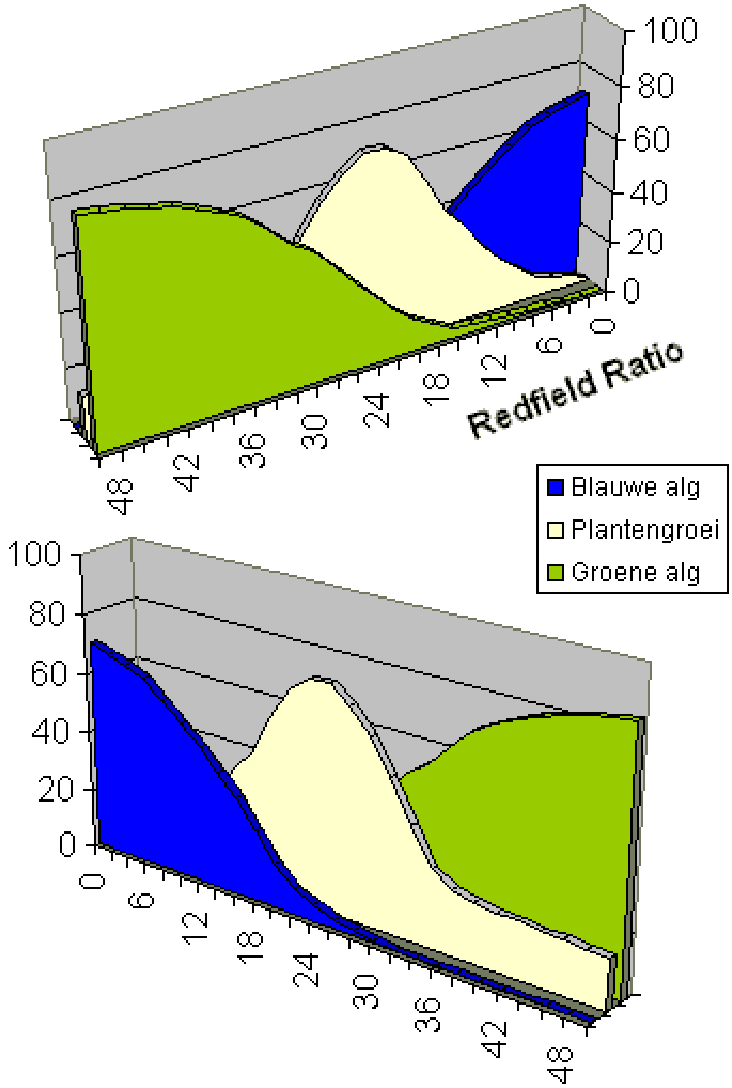
According to the theory, it is stated that the growth of algae is not only dependent on the number of nutrients is in the water, but also in what proportions these nutrients in the water.

If there is a lot of phosphate is present in water and very little nitrate than plants and algae can grow until the nitrate is on. There is enough phosphate present but because there is a lack of nitrate to algae and plants can not grow and record that phosphate. Nitrate has thus become a limiting factor for the growth.

Conversely, it might as well. If there are many little nitrate and phosphate is the phosphate will be the limiting factor. We now have the right balance of phosphate and nitrate phosphate and nitrate can then either be used by plants and algae until both phosphate and nitrate are exhausted.

Now, it is true to say that each plant species and also any algae species has its own optimum ratio has to include elements. Blue-green algae, the struggle for survival with other algae and plants is best if there is comparatively much phosphorus. Green algae do better contrast when comparatively much nitrogen present.

Blue algae do so well at low N: P ratios. Green algae do best at high N: P ratios. And in between there is a transition region in which our plants do especially well. The chart below is displayed graphically.



Redfield Ratio,
Mol or grams?

Redfield, the ratio of C: N: P is a ratio in mole of 106:16:1.
consists of 106, the ratio of carbon atoms 16, nitrogen atoms at 1 phosphorus atom

Then we can also view the Redfield ratio in grams:

Carbon weight = 12 g / mol
Nitrogen weight = 14 g / mol
phosphorus weight = 31 g / mol

Redfield molar ratio
C: N: P = 106:16:1

Redfield ratio in grams:
106x12: 16x14: 1x31

We share all the ratios by 31 and then find the Redfield ratio C: N: P in grams

41: 7.2: 1

Thus, 41 grams of carbon to 7.2 grams of nitrogen.
and 1 gram of phosphorus in every 7.2 grams of nitrogen.
the Redfield ratio of 16:1, in grams, is thus a ratio of 7,2:1

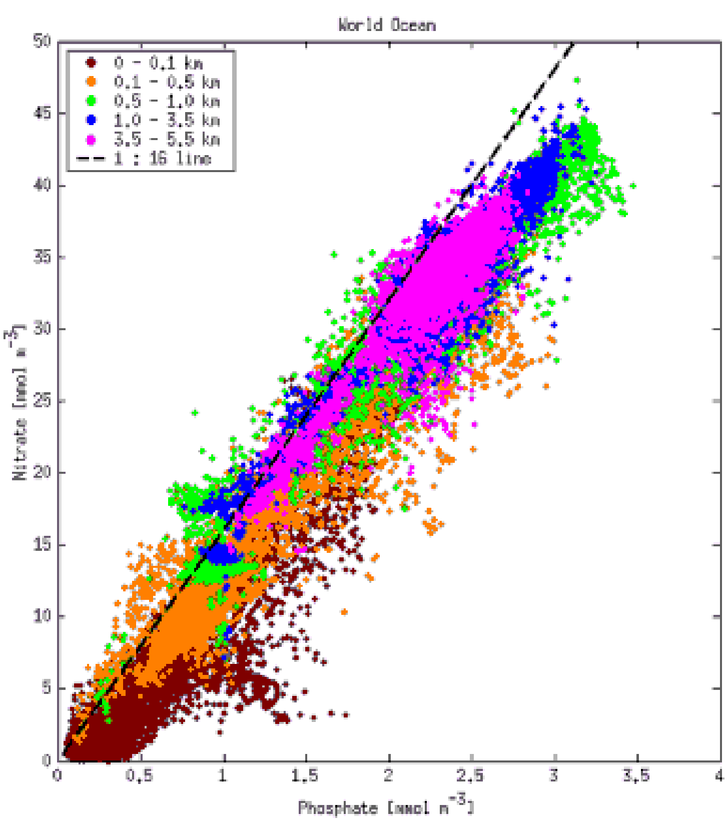
Algae fight with Redfield

Which is the method to fight according to the Redfield Ratio method algae based now? Well, the basic principle is simple. Make sure that the conditions for the algae bugging you've become less favorable.

So if you have blue algae, then there is a high proportion of phosphorus and low in nitrogen present (low N: P ratio) because in those circumstances they do best. If we produce less phosphorus and nitrogen (higher N: P ratio) than the conditions for the blue algae favorable to win the competition.

We now have green algae, then the reverse is the case. Doing the best with relatively little nitrogen and phosphorus little we Shifting the circumstances are such that we get less nitrogen and more phosphorus than the growth of green algae will be adversely affected.

The Redfield method is therefore means that algae are controlled by the proportions in which elements occur to shuffle. Simple principle is not it?. For blue and green algae, we can do this by the ratio of nitrogen / phosphorus (N: P) to go sliding. But we can also extract the same trick with other elements.



In the chart above for all major world oceans N:. P ratios appear
good to see that the ratio is always around the 16:1 / 15:1.
angled black line represents the Redfield ratio (RR) of 16:1 again.
It is also noticeable that the deeper you get, the more nitrate and phosphate are measured.
But the N: P ratio with increasing depth remains the same.

Redfield, only nitrogen and phosphorus,?

That's a more difficult question. The answer to it is no, the Redfield method also applies to other elements. As we could see, we influence the green and blue algae by sliding in the ratio Nitrogen: Phosphorus But other factors have an impact on algae growth!

Silicon

brown algae do the best example, if a high proportion of silicon is present and little phosphorus. Thus, at high Si: P ratio of brown algae do best. We think this is usually only at start-up bins wherein the silicon is present in the form of silicic acid in the water. Once the silicon is consumed move the brown algae on their return. Silicon is added very slowly from the bottom and the brown algae do not come back.

Iron

Large concentrations of iron can take care of unwanted algae growth in the water. Especially green algae do well at higher iron concentrations.

Calcium

Calcium is also an important element. Some algae need for their cell walls. More calcium That do so better in hard water than in soft water. A number of red algal species can be classified in this category limestone. Fighting Method? ... Apply soft water. Also, some green algae belonging to the limestone types. Those green wires are mainly found on the leaves of plants in biogenic decalcification. The formed on the leaves of calcium carbonate they can become good use.

Also in a saltwater aquarium, we know them well, the purple limestone algae.

Organic waste

It gets even more complicated ....
So far we are talking about elements such as nitrogen (N), phosphorus (P), iron (Fe), calcium (Ca), etc. But there are still more substances in water if these elements. Also, all the molecules, many of which are organic, are dissolved in the water and there are certain algae that are excellent in a position to make. Of the substances used Especially beard algae and brush algae for example are well able to be used for growth. Organic compounds (sugars, esters) So if there is a relatively high proportion of such substances than those algae will advance.

Beard Algae example, we therefore mainly seen as the plants lack a certain element. Photosynthesis goes on as the TL's fires, which they can not stop. But they can assimilation process is not entirely complete lack of elements. The plants will have no option than to discharge them. Organic component products The beard algae in turn can share that organic products fit well and grow good plants at or in the vicinity of the affected. Due to remedy the lack of elements in the plant conditions for baardalg be favorable and will decline or even disappear. A bin with a low organic load (low C: N ratio) will therefore less likely suffer from these algae have a container with a high organic load. And this explained immediately why this type of algae often on dead organic matter is found (driftwood).

Redfield and C: N ratio

We saw it in the beginning already at the Redfield ratio, we are not just talking about an N: P ratio, but also on the C: N: P ratio. The next logical question is, does the carbon present (C) also affect the growth of algae?

Well, yeah, so ... A high C: N ratio (> 15) appears in many natural waters indicate a lack of nitrogen and those waters before going even though the N tends to blue algae: P ratio as still unfavorable for algae formation!

That means a high organic load, many mulm in the bin, then a greater risk of blue-green algae. Here we have to do so with the algae variant that pops up when heavily loaded containers. Again, this is something more complicated like the Redfield thought theory.

Actually, we have the in the risk of blue-green algae, therefore, take into account the C: N ratio ..... problem with this is that the C: N ratio can not be measured by us hobbyists. We can estimate whether the C: N ratio is high or low. A soil that naturally stays clean usually indicates a low C: N ratio (good mineralization) A soil that collects mulm quickly indicates a low mineralization, so a high C: N ratio. The organic waste remain. These organic wastes bind phosphates and quickly spot the mulm so we get a lower N: P ratio than the surrounding water. So we can when testing the water conveniently Redfield Ratio have but just really suffer from blue-green algae on the bottom. The high C: N ratio can hereby thus be one of the factors to be seen.

So we see that the N: P ratio AND the C: N ratio both influence the occurrence of blue-green algae. What is the effect of adding extra nitrogen to an aquarium to fight the algae It does not matter whether this is done in the form of nitrogen-rich food, potassium nitrate or ammonium nitrate. What happens to all this? Well, the ratio of N: P changed unfavorably for the cyano's (cyanobacteria). The N: P ratio is increased by the administration of the nitrogen. But happened more ... The C: N ratio changed by the administration of nitrogen. Die C: N ratio is lower. This gives us a better mineralization. A better nitrifying operation, there will be more trace elements available to the plant that this also will do better and greater competition for the algae to form. And see the whole bin brightens up. Which will be contested for the algae? By changing N: P? or changing the C: N factor?. The truth is probably somewhere in the middle.

Can there as a phosphate or nitrogen deficiency also occur in the absence of carbon? Yes you can, but in nature it is very rare and in our aquarium, especially when baking with CO_2 on it, this will not occur.

No Redfield, but two blue-green algae conditions

We were able to distinguish a blue-green algae variant that does particularly well in low-load containers, the clean water variant with mostly very low nitrate levels. And we could distinguish one variation algae that especially does well with high C: N values, so a high organic load, whether there are many or few nitrate and / or phosphate is present.

Redfield and competition

We could all read it, by sliding concentrations and ratios of elements such as Nitrogen, Phosphorus, Silicon, Calcium, Iron, etc. We can algae quite get the hang of. We give the unwanted algae adverse living conditions, so they have to give. The On the other hand, we create conditions that other organisms which again has a positive influence that the weather is going to do better.

If we are going to fight to spend more nitrogen in the aquarium clean version of blue algae in overdose than the blue algae make way for green algae then we have achieved nothing. Just got a different kind of algae. We add the right amount of nitrogen to then get the cyanobacteria still unfavorable conditions, but the conditions favorable for the plants. The green algae has no chance because the plants have too little nitrogen. In this way, the plants are competing the algae off.

But what if we have no way of competing plants? Alga
Ehhh, then we have an ally in the fight algae, and not an insignificant too! Bacteria!

Bacteria as a competitor of algae

The fact is that not only plants and algae need nutrients but bacteria as well! In particular, for a good growth are much needed nutrients. And rapidly growing in it should take against bacteria. Both plants and algae

Especially the heterotrophic bacteria . these can double every 20 minutes. Especially phosphate is widely recognized by a growing bacteria colony! If growth is stabilized so does the phosphate recording. By a bacterial colony level is too thin it out (read regularly changing filter) there is a continuous growth and is slowly removed. But surely excess phosphate On the same principle, is also a sewage treatment steps to remove it from the influent. Phosphate

So in this way we see that bacteria by the inclusion of phosphate may take care that there is for the N: P (Redfield) ratio is higher.

Denitrification and the N: P ratio

By heterotrophic bacteria which is the Redfield ratio higher we have seen.
Vice versa is also possible. By denitrifying bacteria is nitrate (NO_3^-) is converted to nitrogen (N_2). This N_2 is gaseous and will escape from the aquarium. The more the more denitrification nitrate is removed from the circuit, and so we see that the N: P ratio is lower. So it turns out that a filter and the way we clean it (or not) may have an impact on the N: P ratio of an aquarium. Therefore, a filter is also a factor of significance in controlling algae or just a cause of algal infestation.

Redfield Ratio, tell the tale ...

Well we have it nicely on an N: P ratio and that at low N: P high probability of blue algae and high N: P high probability of green algae, but how do we make such a measure N : P ratio?

Well, basically it's pretty simple. We measured the number of moles of nitrogen in the water, we measured the number of moles of phosphorous in the water and on which parts of each other. So 8 moles of nitrogen to 0.5 moles of phosphorus gives an N: P ratio of 8/0, 5 = 16

The problem is that we now with a test set of the number of moles of nitrogen or the number of moles of phosphorus can not be read. Directly We first need to recalculate.

What test kits do we need to determine the nitrogen and phosphorus?
Basically four test sets namely:

- Ammonium / Ammonia
- Nitrite
- Nitrate
- Phosphate

Fortunately, in an aquarium concentrations Ammonium / Ammonia and nitrite are so low that they have little impact on the calculation. So we have to calculate only a test kit for nitrate and phosphate needed.

Example N: P calculation

Suppose we have nitrate, NO_3^- measured by the test set and we read 10 mg / l off.

With the phosphate, PO_4^{2-} test set we measured 0.5 mg / l

What kind of N: P (Redfield) ratio we have?

Determining the number of moles of nitrogen

Of the Periodic Table of the Elements:
1 mole of nitrogen (N) = 14 grams of
1 mole of oxygen (O) = 16 grams of
1 mole of NO_3^- has 1 mol of nitrogen and 3 moles of oxygen

The proportion of nitrogen in nitrate is then:
N / (N + 3xO) = 14 / (14 +3 x16) = 0.226 >> 22.6%

If we do so 10 mg / l nitrate than sitting there 10x0, 226 = 2.260 mg / l nitrogen.

1 millimol nitrogen weighs 14 mg.
Then there is therefore 2,260 / 14 = 0.161 mmol nitrogen.

Determining the number of moles of phosphorus (P)

Of the Periodic Table of the Elements:
1 mol of phosphorus (P) = 31 grams of
1 mole of oxygen (O) = 16 grams of
1 mol of PO_4^{2-} with 1 mole of phosphorus and 4 moles of oxygen

Phosphorus share phosphate is then:
P / (P + 4xO) = 31 / (31 +4 x16) = 0.326 >> 32.6%

So if we 0.5mg / l phosphate than sitting there 0,5 x0, 326 = 0.163 mg / l phosphorus.

1 millimoles of phosphorus is 31 milligrams.
Then there is therefore 0,163 / 31 = 0.005 mmol of phosphorus per liter.

Calculation of N: P (Redfield Ratio)

We have:
0.161 mmol Nitrogen
Phosphorus 0.005 mmol

The N: P ratio is: 0,161 / 0,005 = 32.2

Well, each to carry out such a calculation .... party for a measurement, that's quite a lot of work, of course. Therefore, we can draw a simple formula, which reads as follows:

Simple formula for the Redfield Ratio:

(Nitrate content x 1.5) / phosphate content

Example
We measure:
Phosphate 0.1 mg / l
Nitrate 5.0 mg / l

The N: P ratio is: (5.0 x 1.5) / 0.1 = 75

A quick check:

You know you're good when you nitrate phosphate 10x your content is about.
thus Measure a phosphate content of 0.5 mg / l.
then you are good if you have a nitrate concentration of 10 x 0.5 = 5 mg / l.

This formula has been a lot simpler if the whole mole calculation. But it can be even simpler. Before you can look in the table below.

Tabel N:P ratio (Geldt alleen als C:N<15)												
Fosfaat	Nitraat gehalte (mg/ltr)											
(mg/ltr)	0,0	1,0	2,0	3,0	4,0	5,0	7,5	10,0	15,0	20,0	25,0	50,0
0,00	--	--	--	--	--	--	--	--	--	--	--	--
0,01	0	150	300	450	600	750	1125	1500	2250	3000	3750	7500
0,10	0	15	30	45	60	75	113	150	225	300	375	750
0,20	0	8	15	23	30	38	56	75	113	150	188	375
0,30	0	5	10	15	20	25	38	50	75	100	125	250
0,40	0	4	8	11	15	19	28	38	56	75	94	188
0,50	0	3	6	9	12	15	23	30	45	60	75	150
0,75	0	2	4	6	8	10	15	20	30	40	50	100
1,00	0	2	3	5	6	8	11	15	23	30	38	75
2,50	0	1	1	2	2	3	5	6	9	12	15	30
5,00	0	0	1	1	1	2	2	3	5	6	8	15

- Minste kans op alg, gunstig gebied voor planten
- Gunstig gebied voor blauwe alg
- Gunstig gebied voor groene alg

Well, okay then, a Redfield calculator can also still off while I'm working once.

Simple Redfield Calculator

Nitrate content 5 mg / l phosphate content 0.2 mg / ltr

N: P ratio is: 0

Calculate Redfield ratio (RR) Begin waarden

A more detailed calculator can be found here The above table looks for Nitrogen only to the nitrate present. The program on the next page also takes into account the present nitrite and ammonia (k).