Ecology of Teleost Fishes: NITROGEN

Nitrogen is an essential nutrient for all living organisms, and is found in proteins, nucleic acids, adenosine phosphates, pyridine nucleotides, and pigments. However, nitrogen is required in relatively small quantities, and physiological needs are easily satisfied. Excess quantities then become nitrogenous wastes, and removal is necessary. The fish create and expel various nitrogenous waste products through gill diffusion, gill cation exchange, and urine and feces excretion. In addition to the urea, uric acid, and amino acid excreted by the fish, nitrogenous wastes accumulate from the organic debris of dead and dying organisms, uneaten feed, and from nitrogen gas in the atmosphere. Decomposing these nitrogenous compounds is particularly important in intensive ecological conditions because of the toxicity of ammonia, nitrite, and to up to some extent, nitrate. Ammonia is the major excretory product of fishes.

Ammonia

•Ammonia is the by-product from protein metabolism excreted by fish and bacterial decomposition of organic matter.

• Low level of ammonia can cause branchial hyperplasia.

•High levels of ammonia in water impair the excretion of ammonia from the fish into the water across its gills.

•As gills affected, the efficiency with which the fish can extract oxygen from the water through their gills also falls.

•Fish can tolerate 0.01 to 0.05 mg/l of unionised ammonia without a significant negative effect on production as long as levels of dissolved oxygen and water temperature are within the recommended range.

•They are able to withstand levels of unionised ammonia of up to 0.6 to 2 mg/l for only short periods

Ammonia/Nitrite/Nitrate

Nitrosomones Bacteria

$$2\ NH_4^+ + OH^- + 3\ O_2 \Rightarrow 2\ H^+ + 2\ NO_2^- + 4\ H_2O$$

Nitrobacter Bacteria

$$2\ NO_2 + 1\ O_2 \Rightarrow 2\ NO_3^-$$

Nitrifying Bacteria – Overall Reaction

$$NH_4^+ + 2\ HCO_3 + 1.9\ O_2 \Rightarrow$$
$$NO_3 + 2.9\ H_2O + 1.9\ CO_2 + 0.1\ CH_2O$$

•Ammonia occurs in two forms depending on the acidity of the water.

(a)The unionised form of ammonia (NH3) is more dominant when the water is alkaline and
(b)the ionised form, ammonium (NH4 +) when the water is acidic.

•In most cases, both forms occur, hence the term Total Ammonia Nitrogen.

•Total ammonia nitrogen is the combined measure of its two forms, unionised ammonia (NH_3) and ammonium ion (NH_4 +).

•The unionised form, ammonia, is the most toxic of the forms of Total Ammonia Nitrogen, to fish.

Ammonia - Nitrogen

Equilibrium Reaction - Ammonia

$$NH_4^+ + OH^- \Leftrightarrow NH_3 + H_2O$$

Increase in pH

Increase in temperature

Note: NH_4^+-N + NH_3-N $\Rightarrow$ TAN
NH_4^--N $\Rightarrow$ Ammonia - nitrogen

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Unionized Ammonia-Nitrogen

Percent unionized Ammonia-nitrogen

	pH					
Temp	6.0	6.5	7.0	7.5	8.0	9.0	
10	-	0.1	0.2	0.6	1.8	15.7
15	-	0.1	0.3	0.9	2.7	21.5
20	-	0.1	0.4	1.2	3.8	28.4
25	0.1	0.2	0.6	1.8	5.4	36.3
30	0.1	0.3	0.8	2.5	7.5	44.6