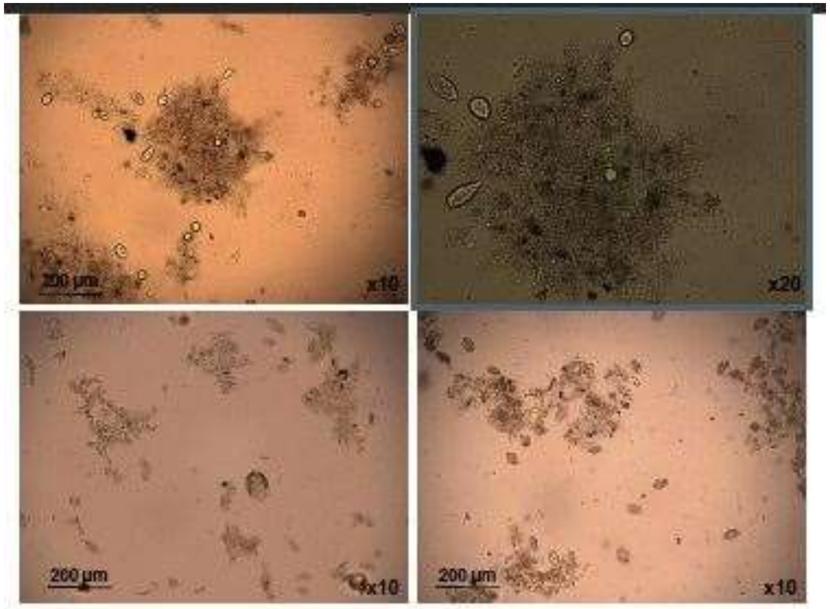

Nyan Taw, et al, GAA Sep/Oct 2008

Biofloc technology

Subject Name: Industrial Fish & Fisheries
1ST YEAR/IInd Sem
Paper: CC-4
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Important facts to be considered:

- Fish (shrimp) are fed with a lot of feed
- About 70-80% of it remains in the pond, in the water or the sediment.
- Ponds contain a high load of nutrients

It is an innovative and cost-effective technology in which toxic materials to the fish and shellfish such as Nitrate, Nitrite, Ammonia can be converted to useful product, ie., proteinaceous feed.

Biofloc systems were developed to improve environmental control over production. In places where water is scarce or land is expensive.

The basic technology was developed by "Dr. Yoram Avnimelech" in Israel and initially **implemented commercially in Belize by Belize Aquaculture.**

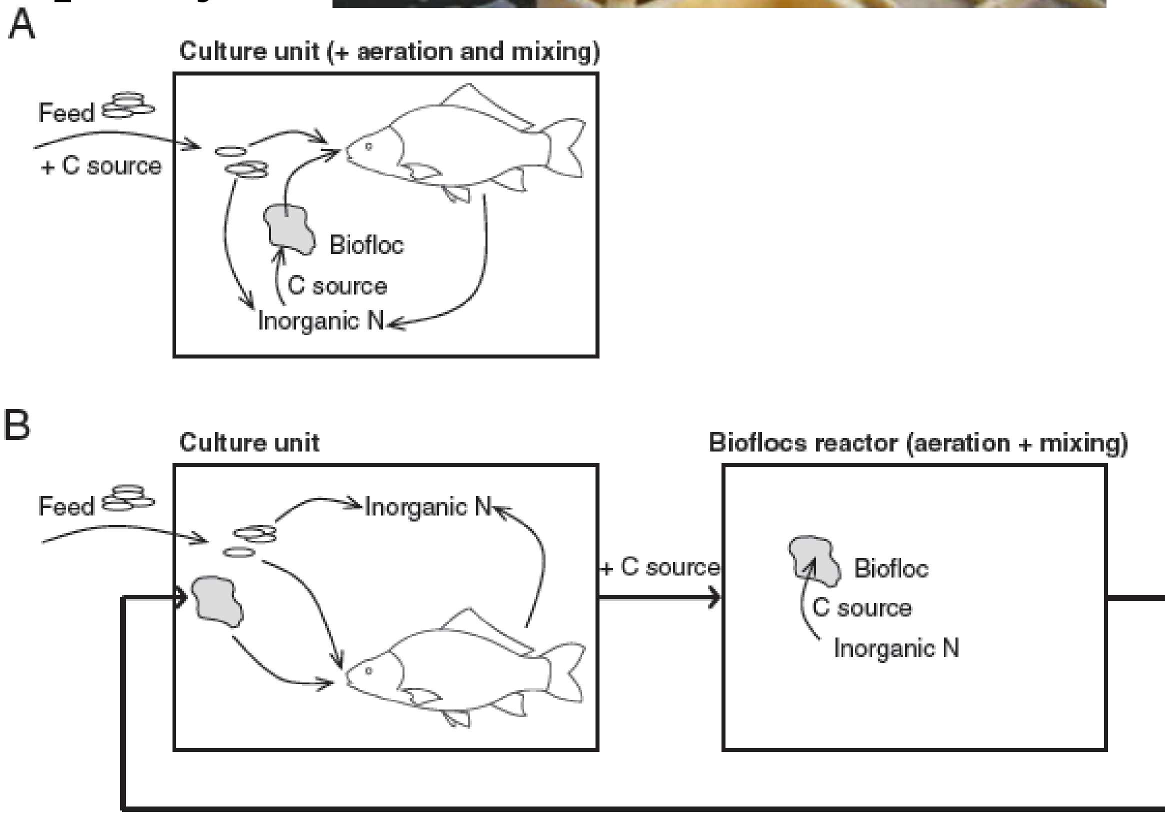
Definition:

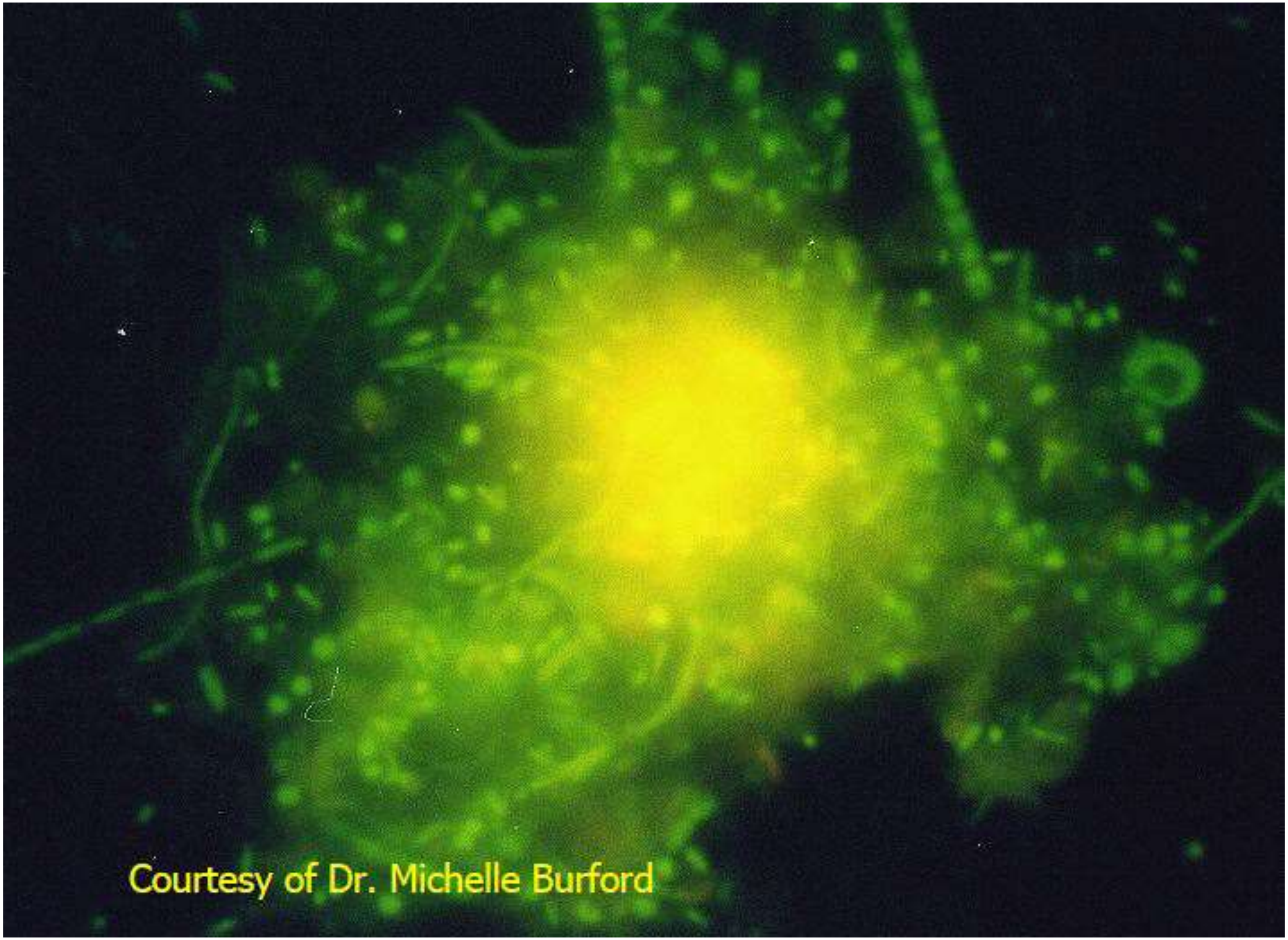
Defined as macro-aggregates of diatoms, macroalgae, fecal pellets, exoskeleton, remains of dead organisms, bacteria, protest and invertebrates.

Fish and shrimp use these microorganisms aggregated as additional feed source increases productivity, reduces FCR, possibly prevent diseases and consequently a sustainable production

What is BFT?

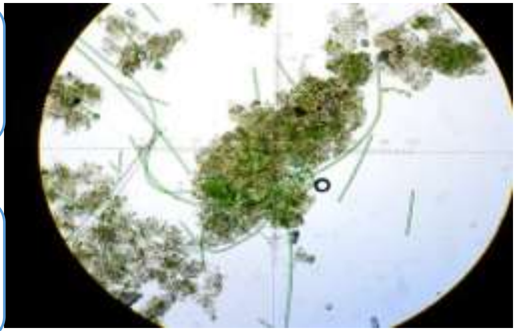
1. We limit water exchange
2. Organic residues accumulate
3. We mix and aerate.
4. Ideal conditions for bacteria
5. Bacteria control water quality.
6. Fish eat bacteria
7. Feed is recycled




Courtesy of Dr. Michelle Burford

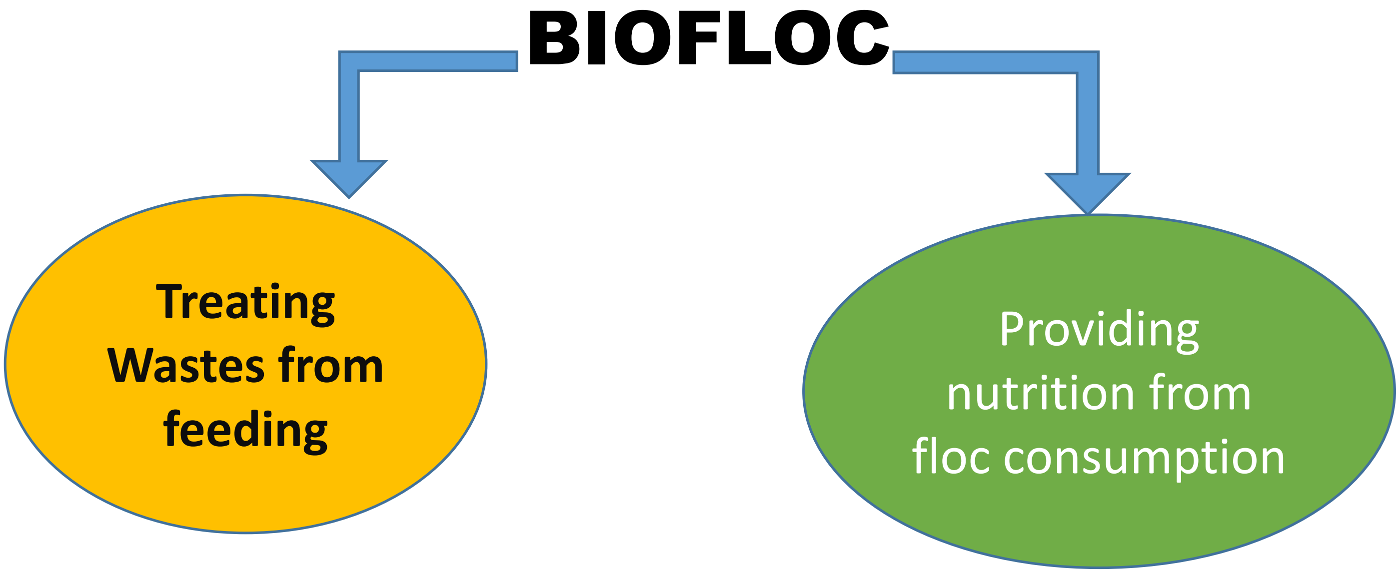
Composition and nutritional value :

- It is composed of microorganisms such as bacteria, algae, fungi, invertebrates and detritus, etc. (60-70%)



- A good nutritional value is found in biofloc. The dry weight protein ranges from 25 – 50%, fat ranges 0.5 – 15%
- Each floc is held together in a loose matrix of mucus that is secreted by bacteria.
- Large flocs can be seen with the naked eye, but most of them are microscopic. Floc size range from 50 – 200 microns.
- Good sources of vitamins and minerals, especially phosphorus. It may also have probiotic effects.
- Dried bioflocs have been proposed as an ingredient to replace fishmeal or soybean meal in aquafeeds.

Function :



- ✓Operate with low water exchange rates (0.5-1% /day).

- ✓A potential benefit is to **recycle waste nutrients** through **microbial protein** into fish or shrimp.

Heterotrophic bacteria feed on organic matter.

- **BUT Bacteria are made of protein so they need nitrogen.**
- They use the Chemical energy in organic substrates. Consume oxygen.
- Unlike algae, almost un-limited capacity.

Conditions for bacteria

- ❑There is a lot of available food for bacteria. The pond is loaded with organic residues.

- ✓The pond is fully aerated (needed for proper fish growth).
- ✓The pond is well mixed (typically 24 hours a day)
- ✓The number of bacteria in such ponds is 10^6 up to 10^9 Bacteria in one cm3

The pond becomes a biotechnological industry – Biofloc Technology

Manipulating bacteria

- Normally, there is enough nitrogen in ponds for new cell production.

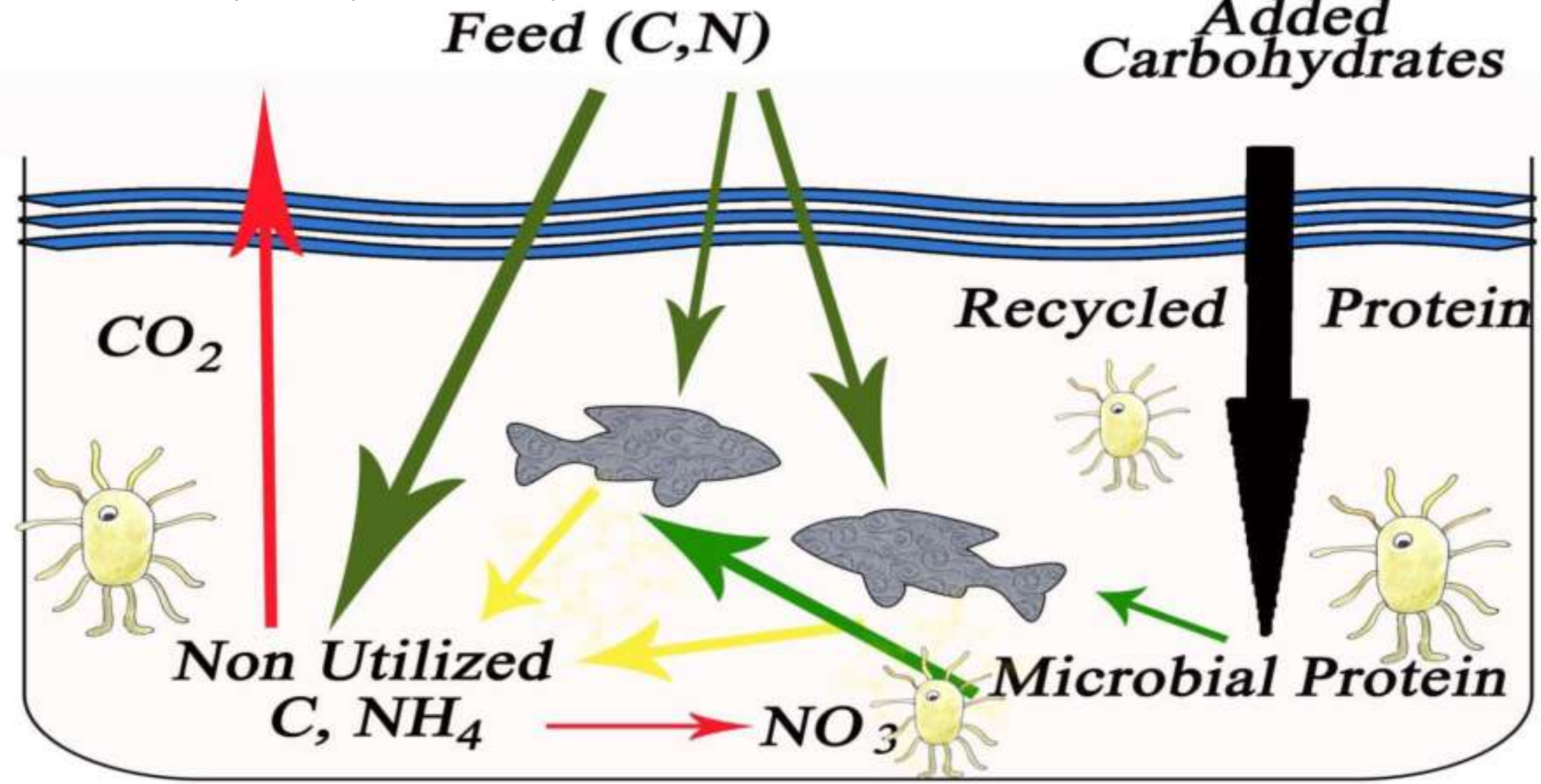
- 20 units of carbon to assimilate one nitrogen unit **So, we can add carbon rich and protein poor material (carbo-hydrate, CH), such as starch or cellulose (flour, molasses, cassawa etc).**

When this rate is adequate, bacteria that grow inside of the microsystem starts to use **organic carbon, ammoniac nitrogen, nitrates, nitrites, and phosphates** **(**toxic to the culture**)** as energy sources, oxidizing them so algae, fungi, and other bacteria and filtering organisms can use them.

► The way to adjust C/N ratio (>10)

- ✓The bacteria now take the nitrogen from the water and control water quality.
- ✓This promoted nitrogen uptake by bacterial growth decreases the ammonium concentration more rapidly than nitrification.

"Biofloc" system operation in a pond (Avnimelech, 1999).



Biofloc technology is a system that has a self-nutrification process within culture pond water with zero water exchange (Yoram, 2012)

Suitable culture species

species that can tolerate high solids concentration in water and are generally tolerant of poor water quality.

Species such as shrimp and tilapia have physiological adaptations that allow them to consume biofloc and digest microbial protein.

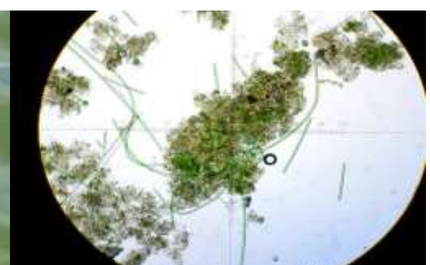
Nearly all biofloc systems are used to grow shrimp, tilapia, or carps.

Channel catfish and hybrid striped bass are examples of fish that are not good candidates for biofloc systems

Basic types of bio-floc systems

Exposed to natural light include outdoor, lined ponds or tanks for the culture of shrimp or tilapia and lined raceways for shrimp culture in green-houses.

A complex mixture of algal and bacterial processes control water quality in such “greenwater” biofloc systems. Most biofloc systems in commercial use are greenwater.



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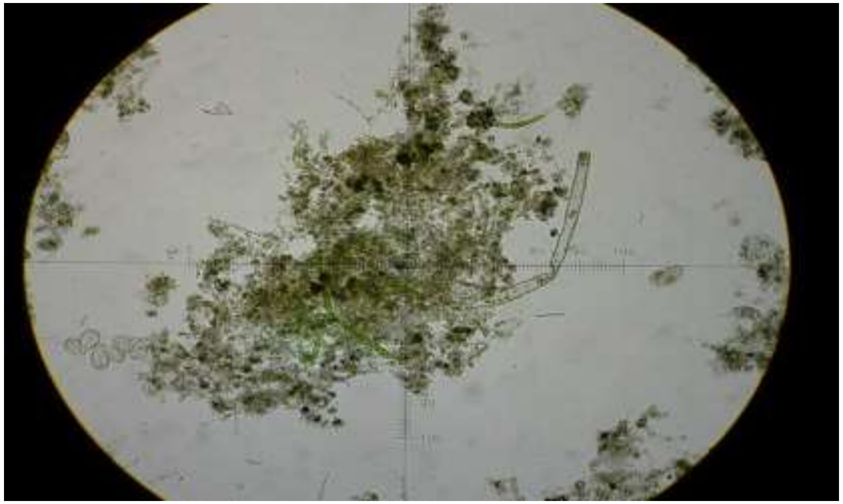
However, some biofloc systems (raceways and tanks) have been installed in closed buildings with no exposure to natural light. These systems are operated as "brown- water" biofloc systems, where only bacterial processes control water quality.



Super Intensive Methods

Mixing and aeration

Aeration is used to supply oxygen and provide mixing.

Although paddlewheel aerators supply oxygen efficiently, they are not ideal for pond mixing. Devices that provide only mixing are rarely used.

Feeding rate:

Feeding rate (kg/ha per d)	Water color	Dominant pathway
100	green	algae
200	green	algae
300	green	algae+bacteria
400	green	algae+bacteria
500	green-brown	algae+bacteria
600	brown-green	bacteria+algae
700	brown	bacteria
800	brown	bacteria
900	brown	bacteria

C/N ratios of feed materials

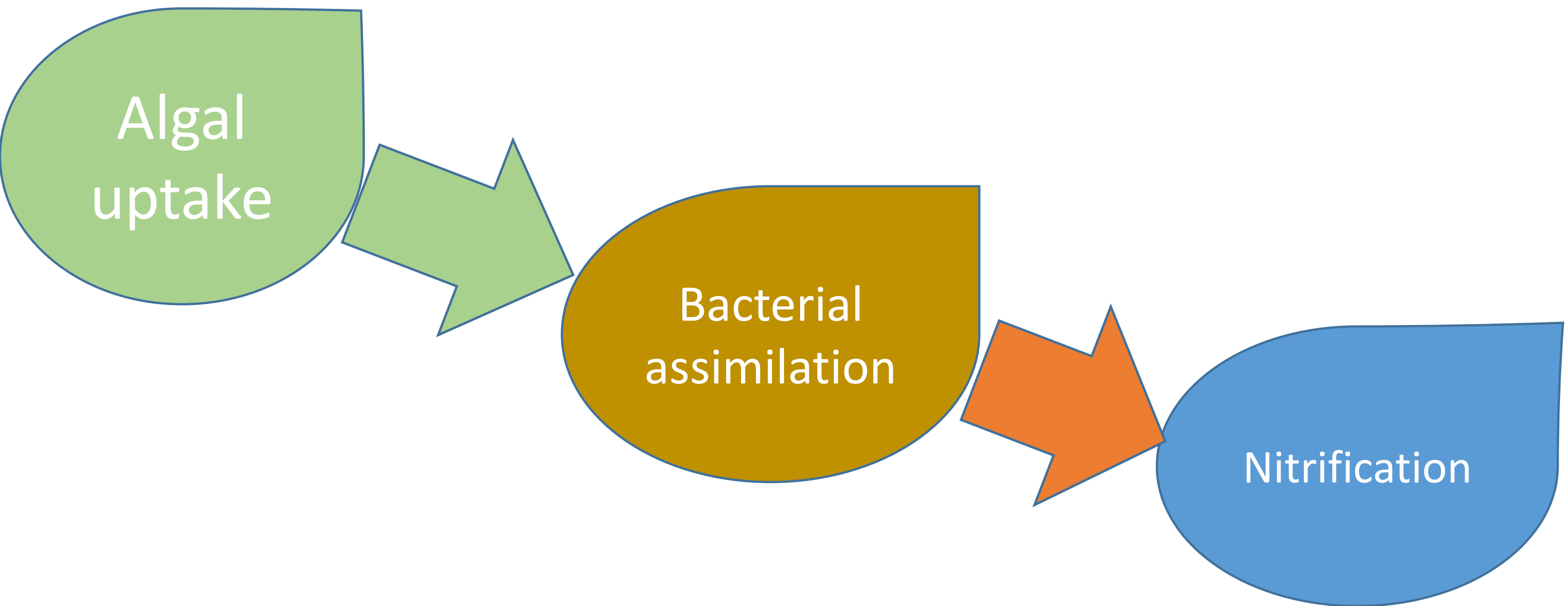
Protein content (%)	C/N
15	21.5
20	16.1
25	12.9
30	10.8
35	9.2
40	8.1

Ammonia dynamics:

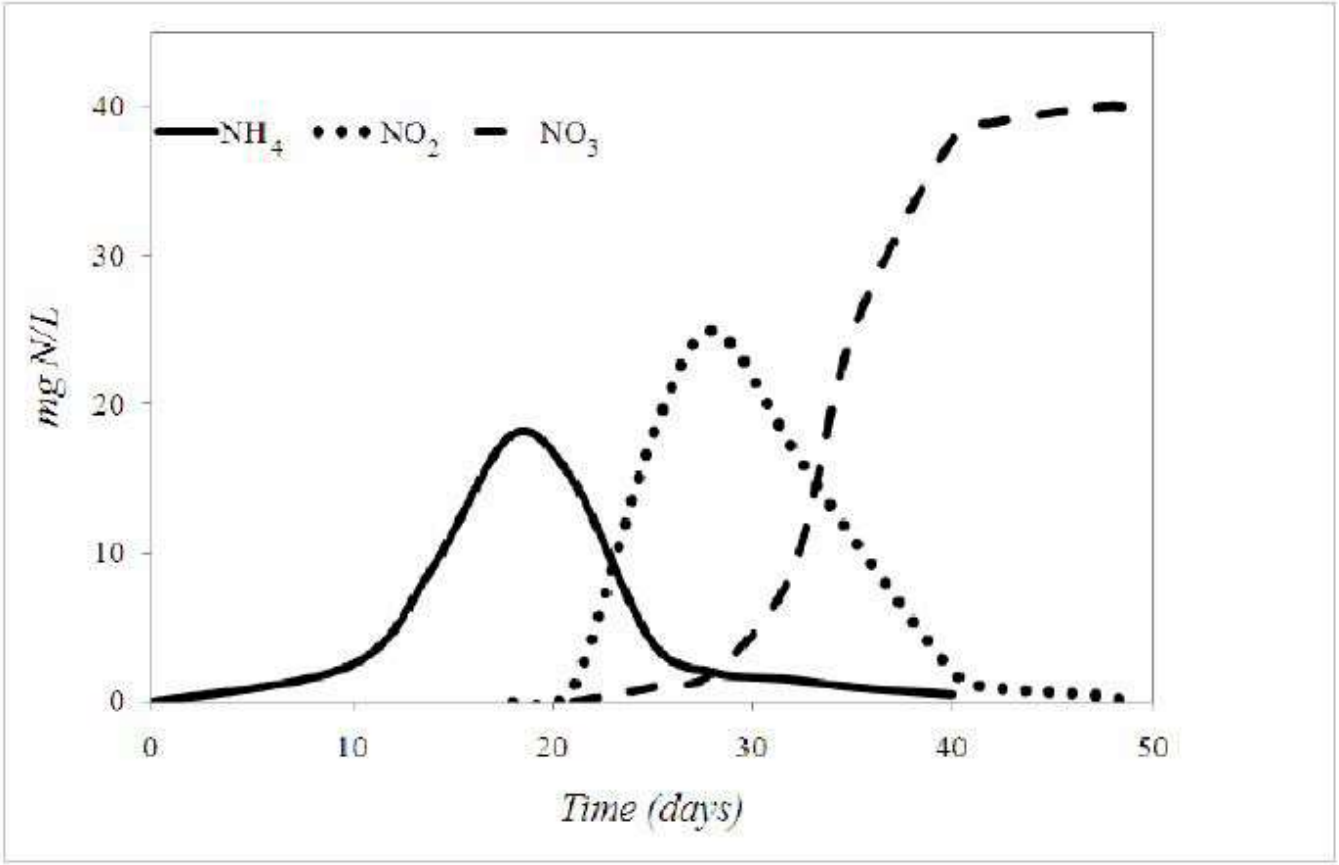
The Major problem: Inorganic nitrogen. Ammonia, NH_3 and nitrite, NO_2 are toxic.

- **Maximal safe NH_3 concentration for shrimp is= 0.2 mg/l**
- **At neutral pH maximal total NH_4 concentration= ~ 2 mg/l**

There are three main processes that control ammonia



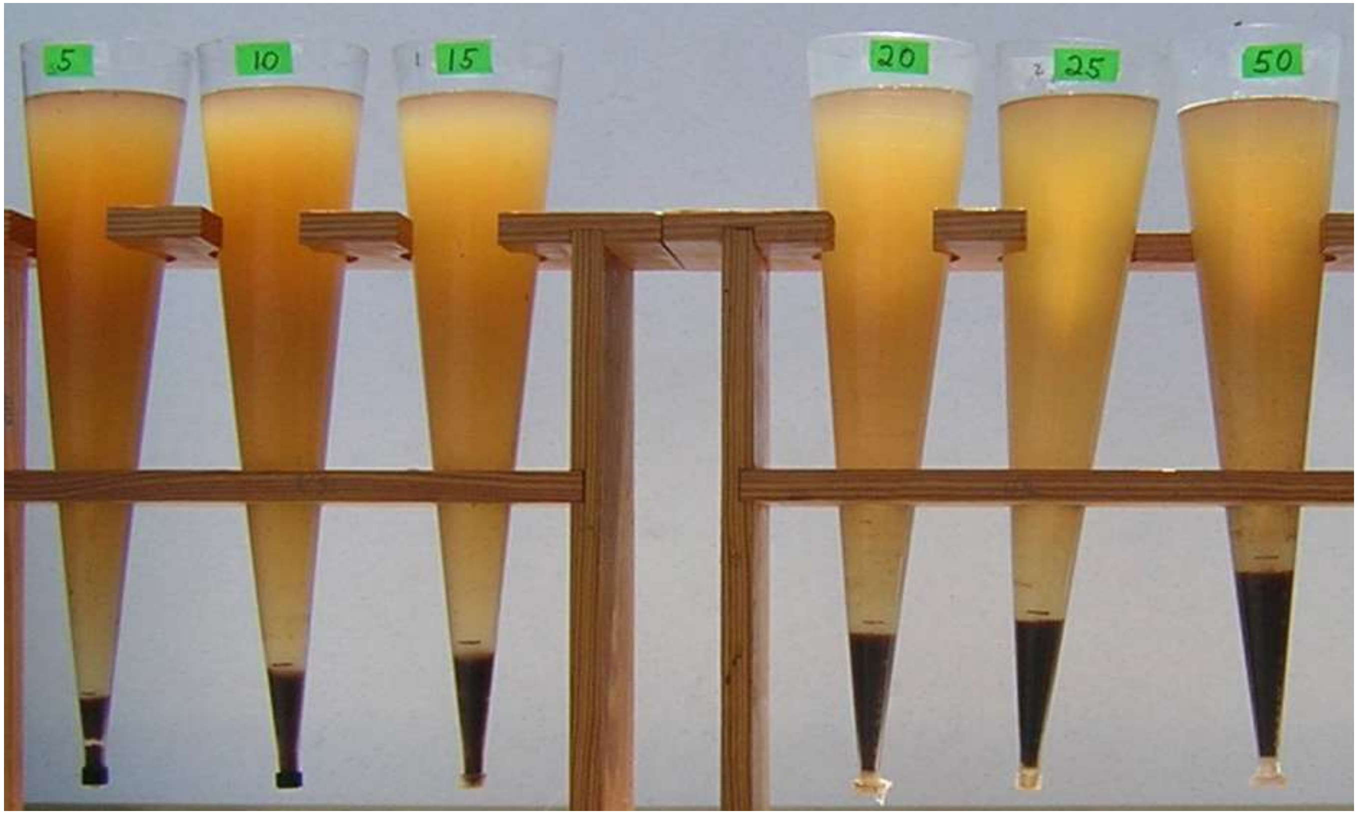
Nitrification sequence in BFT pond



Avnimelech et. at, 2012 (data from experimental pond Dor, Israel)

Bio-flocs evaluation

Imhoff or settling cones are a simple way to index suspended solids concentration. The cones have marked graduations on the outside that can be used to measure the volume of solids that settle from 1 liter of system water.



- Total suspended solids (TSS)- **200 to 500 mg/L is sufficient for good system.**
- shrimp raceway biofloc systems-100 to 300 mg/L.
- settleable solids concentration of 25 to 50 mL/L for fish.
- In lined biofloc shrimp ponds- 10 to 15 mL/L is the typical target range.
- Turbidity - 75 to 150 NTU

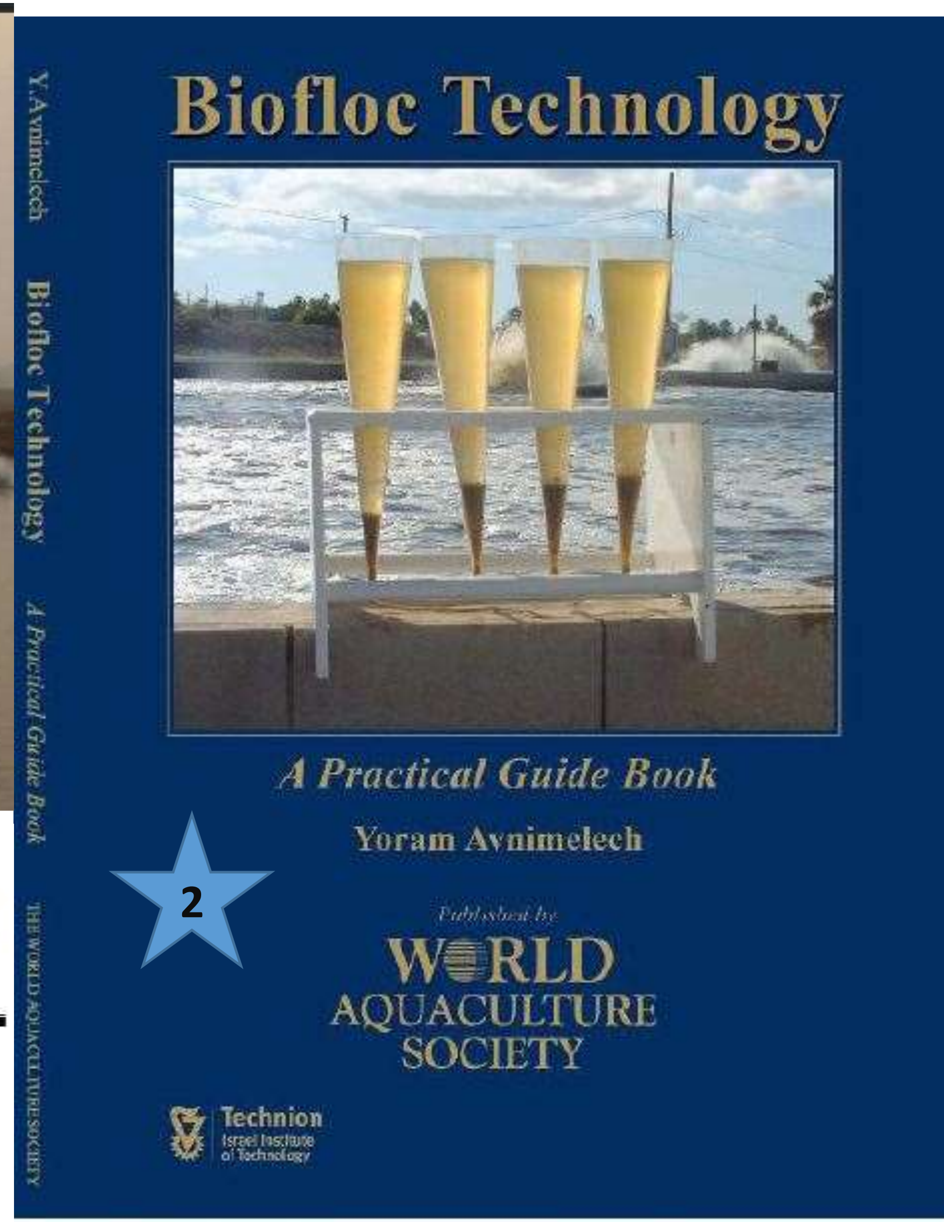
Advantages:

- Eco-friendly culture system.
- Improved biosecurity
- Improved feed conversion
- Improved water use efficiency
- Increased land-use efficiency
- Improved water quality control
- Reduced sensitivity to light fluctuations (weather)

Disadvantages:

- Increased energy requirement for mixing and aeration
- Reduced response time because water respiration rates are elevated
- Start-up period required
- Increased instability of nitrification
- Alkalinity supplementation required
- Increased pollution potential from nitrate accumulation
- Inconsistent and seasonal performance for sunlight-exposed systems

References:

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Biofloc systems: a technological breakthrough in aquaculture

[1]Castro-Nieto, LM*, [2]Castro–Barrera, T, [2]De Lara-Andrade, R, [2]Castro-Mejía, J, [2]Castro-Mejía, G.

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Biofloc Production Systems for Aquaculture

John A. Hargreaves[1]

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SHRIMP FARMING IN BIOFLOC SYSTEM: REVIEW AND RECENT DEVELOPMENTS

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