Professor Yoram Avnimelech (Yoram) Biofloc technology

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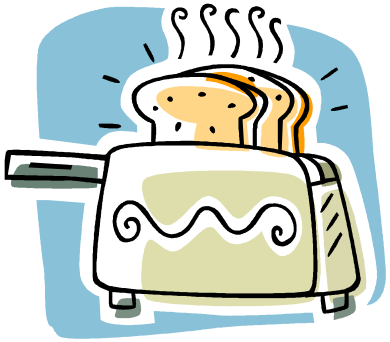
Biofloc technology

Important fact to remember



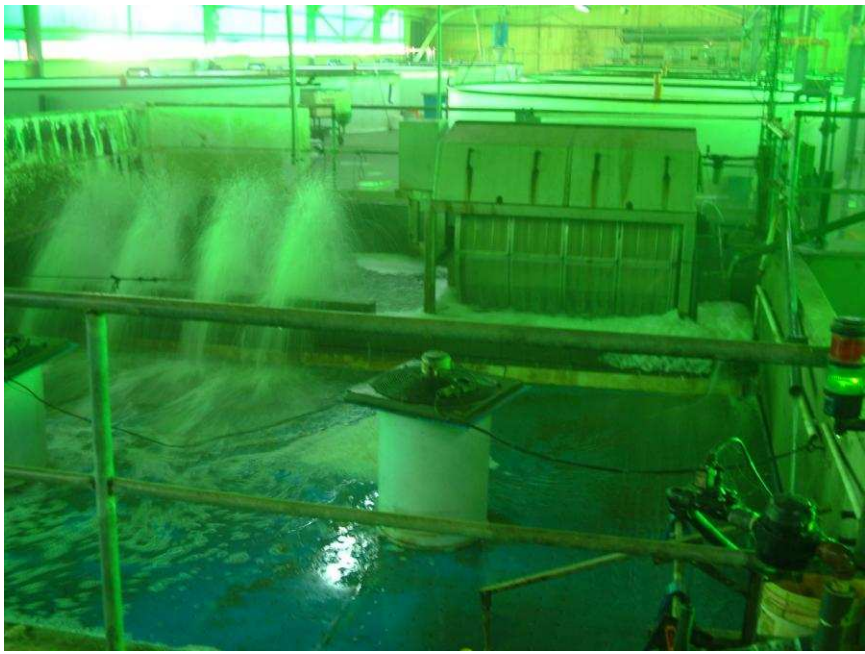
- Fish (shrimp) are fed with a lot of feed
- About 70-80% of it remains in the pond, in the water or the sediment.
- Ponds contain a high load of nutrients

What are the outcomes??

- 1. We waste Feed/Money **(Quite a lot!)**
- 2. Toxic residues (Sulphides, Ammonia etc) accumulate.
- 3. Fish growth is affected.
- 4. Intensification is limited.

What can we do??

- No Intensification (loose income, not being able to raise production).
- Use industrial RAS (Recycling Aquaculture systems) Quite expensive
- Use biofloc technology
- (BFT)



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

How does it work

- **Heterotrophic bacteria** feed on organic matter.
- BASICALLY
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6\ CO_2 + Energy$
- **BUT Bacteria are made of protein so they need nitrogen (We will discuss this later)**
- They use the Chemical energy in organic substrates. Consume oxygen (Though there are anaerobic bacteria).
- Unlike algae, almost un-limited capacity

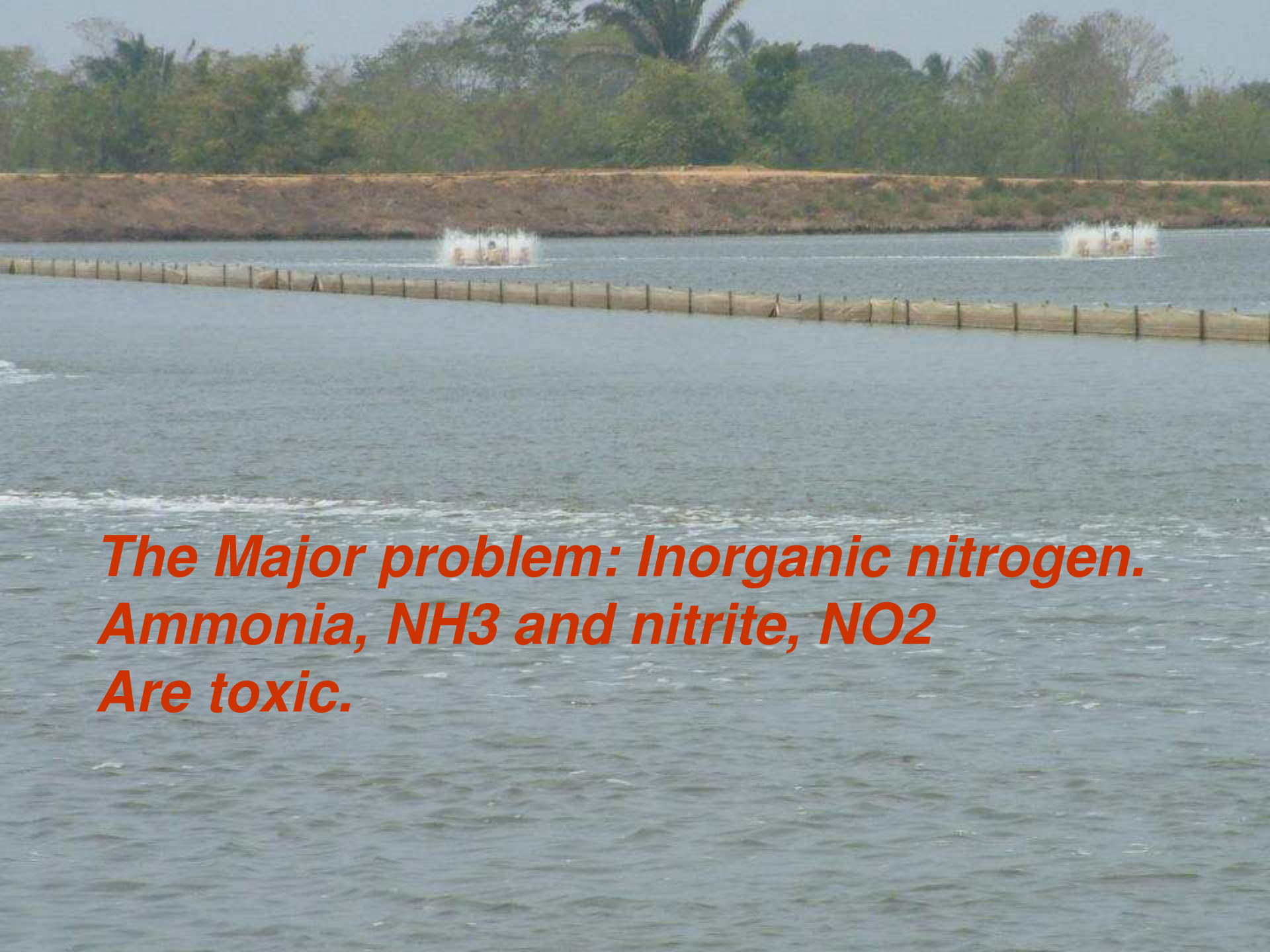
Conditions for bacteria

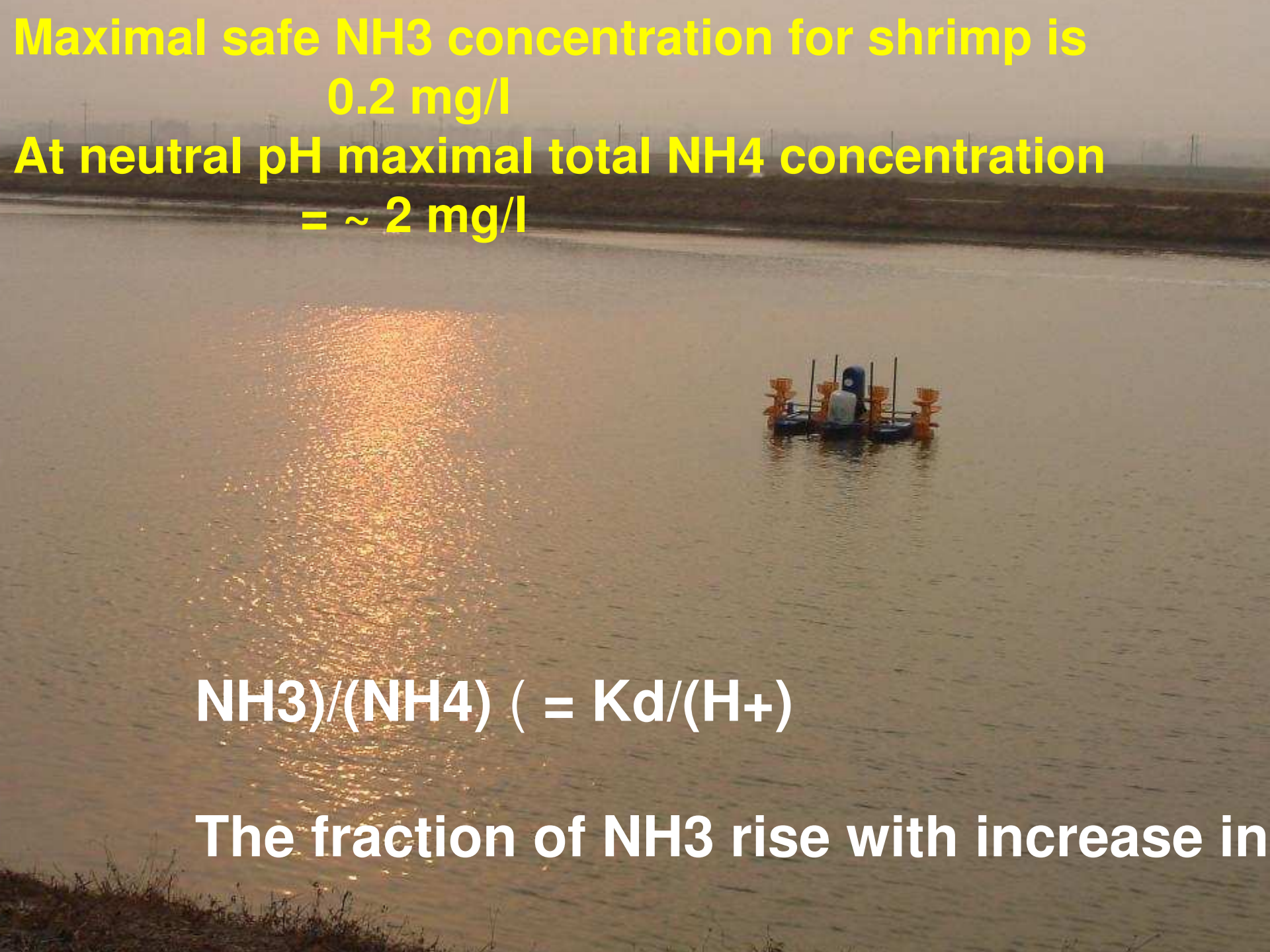
- 1. There is a lot of available food for bacteria. The pond is loaded with organic residues.
- 2. The pond is fully aerated (needed for proper fish growth).
- 3. The pond is well mixed (typically 24 hours a day)
- 4. **The number of bacteria in such ponds is 10^6 up to 10^9 Bacteria in one cm^3!!!!**
- The pond becomes a biotechnological industry – Biofloc Technology

The nitrogen syndrome

- **N**
- NH_3
- NH_4
- NO_2
- NO_3
- Organic N

- Ammonium is excreted by fish
- NH3 and NO2 are toxic


The Major problem: Inorganic nitrogen.
Ammonia, NH3 and nitrite, NO2
Are toxic.


Maximal safe NH3 concentration for shrimp is
0.2 mg/l
At neutral pH maximal total NH4 concentration
= ~ 2 mg/l
NH3)/(NH4) (= Kd/(H+)
The fraction of NH3 rise with increase in

Manipulating bacteria

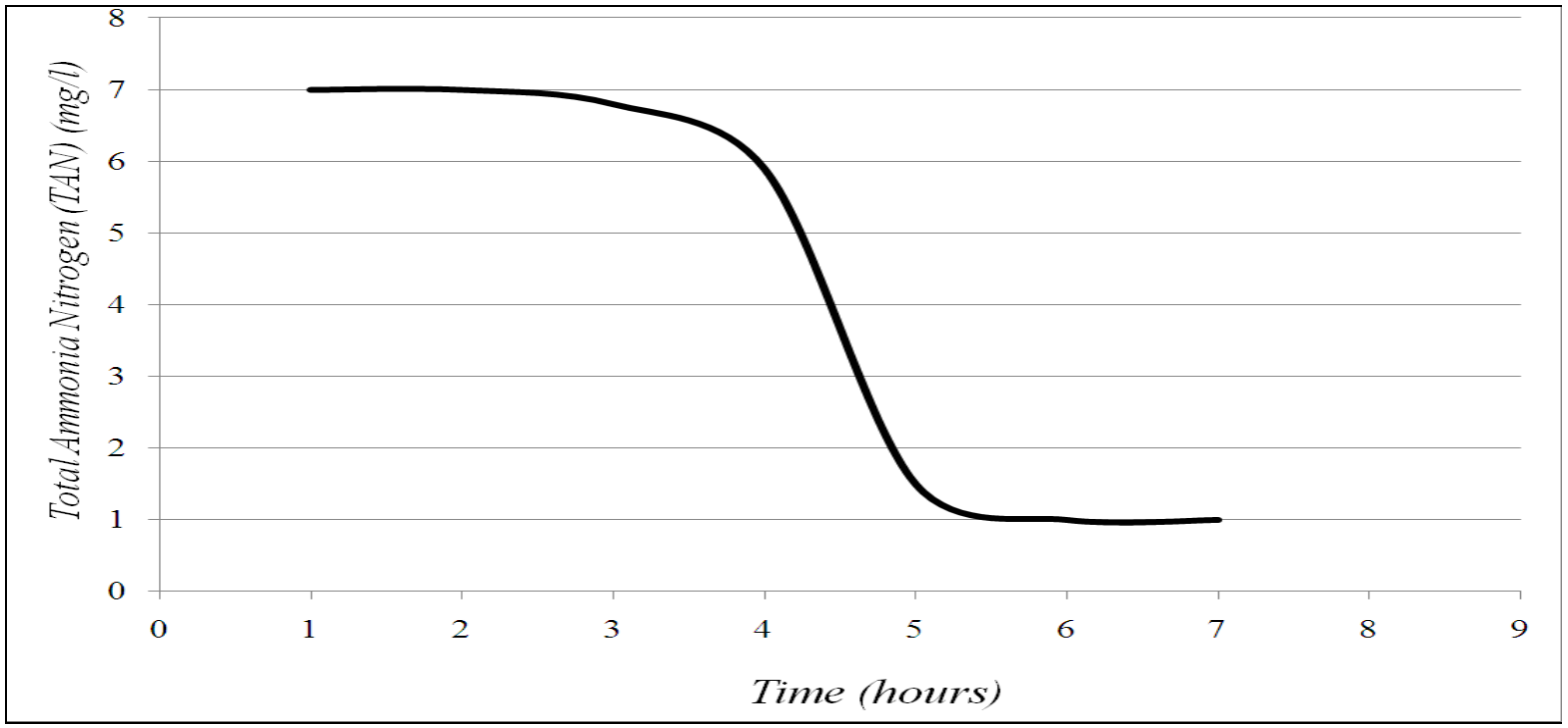
- Normally, there is enough nitrogen in ponds for new cell production.
- **BUT we can add carbon rich and protein poor material (carbo-hydrate, CH), such as starch or cellulose (flour, molasses, cassawa etc.**
- **Then, there is a need for nitrogen.**
- **The way to do it: Keep C/N ratio higher than 10**
- **The bacteria now take the nitrogen from the water and control water quality**

Table 6.1: 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

Bacteria have to produce protein. If the substrate is mostly carbonaceous, they need to take nitrogen from the water

Changes in TAN concentration in a suspension of pond bottom soil (2% dry soil) following the addition of glucose (TAN/glucose ratio of 1/20)*



*Avnimelech, 1999.

Inorganic nitrogen control is possible and predictable.

- EXAMPLES

Fish ponds in Israel

Over wintering of tilapia

Emergency treatment in shrimp ponds in Thailand

Shrimp ponds in Indonesia, many places

Summary till now:

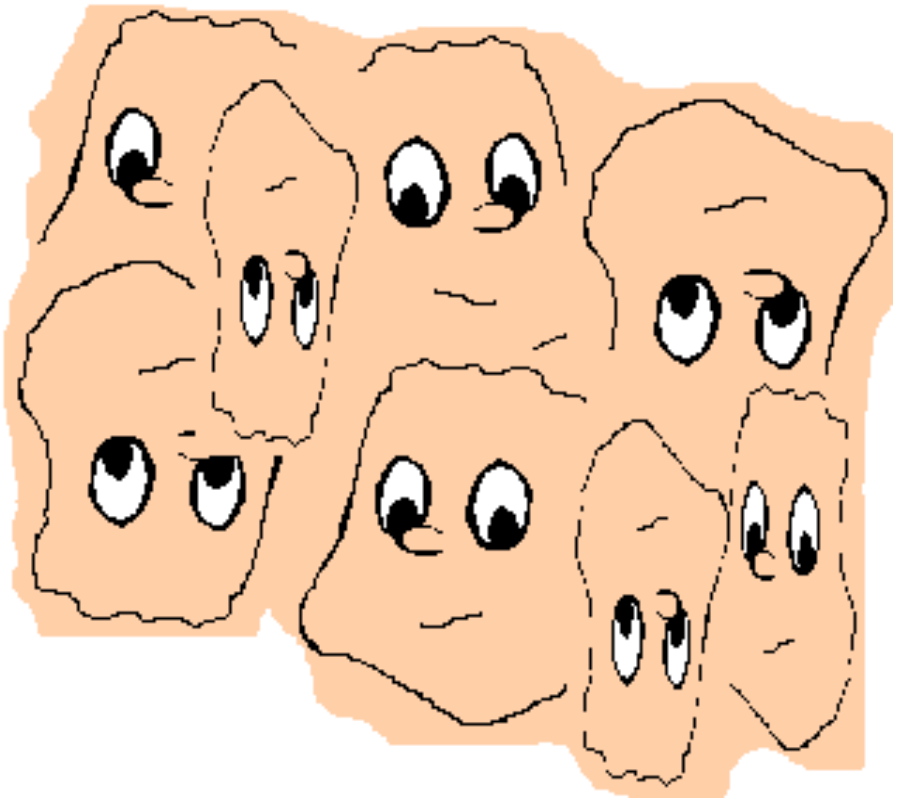
- 1. We know how to get active microbial system.
- 2. We know how to tell the bacteria to control water quality.
- 3. This enables to intensify production without the need to install special system.
- 4. As a by-product, bacteria produce large amounts of protein (ca 60 and 600 kg/ha per day for shrimp and tilapia culture).
- **CAN WE UTILIZE THIS PROTEIN???.**

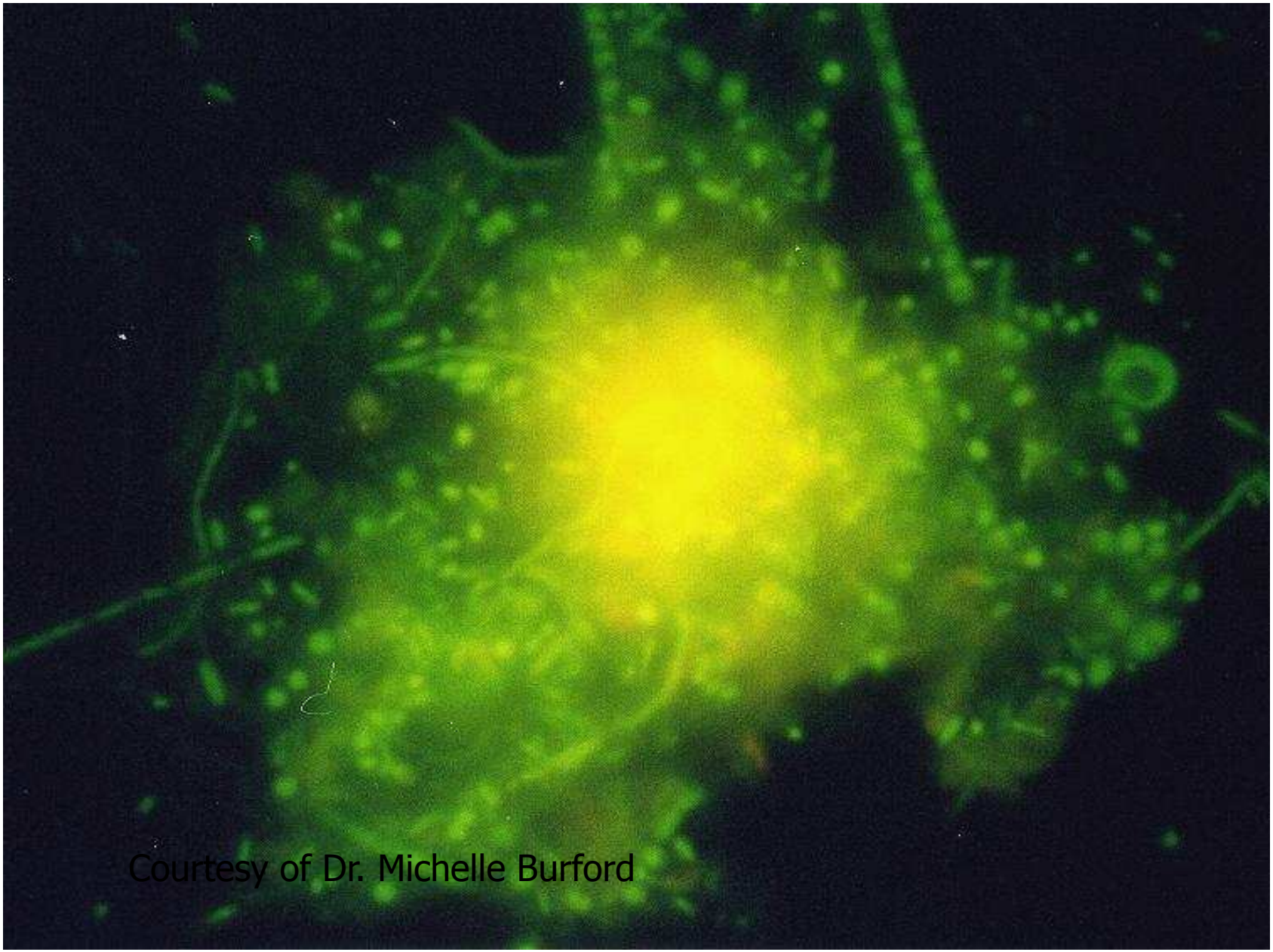
Can we feed fish or shrimp with bacteria

- Bacteria are very small.
- Luckily, when we have a dense culture,
- They tend to form bioflocs, containing bacteria, other organisms and organic particles.

BIOFLOC Systems

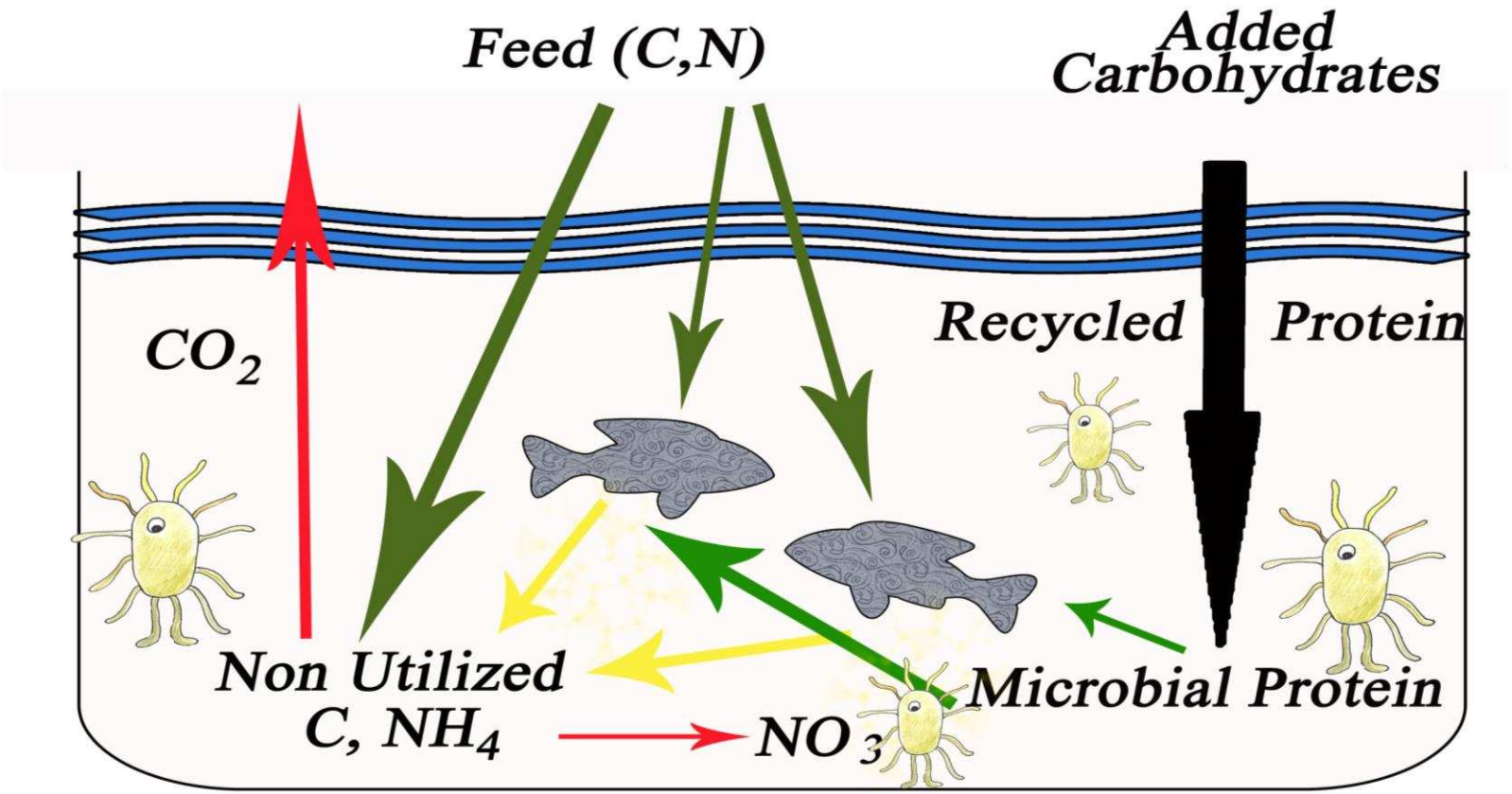
Let us floc together and keep company




Courtesy of Dr. Michelle Burford

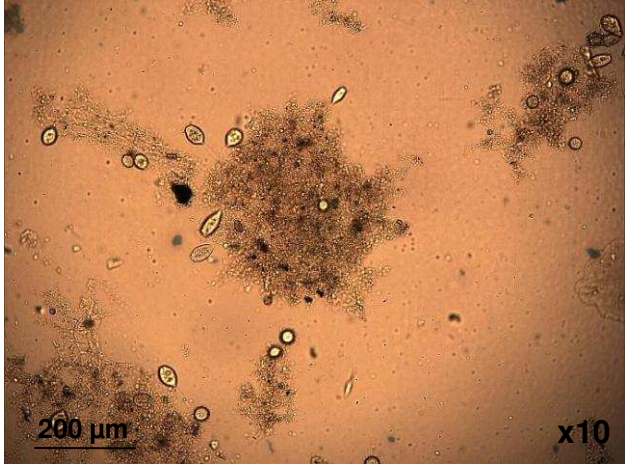

Each cm3 of floc plug contain 10-30 mg dry matter

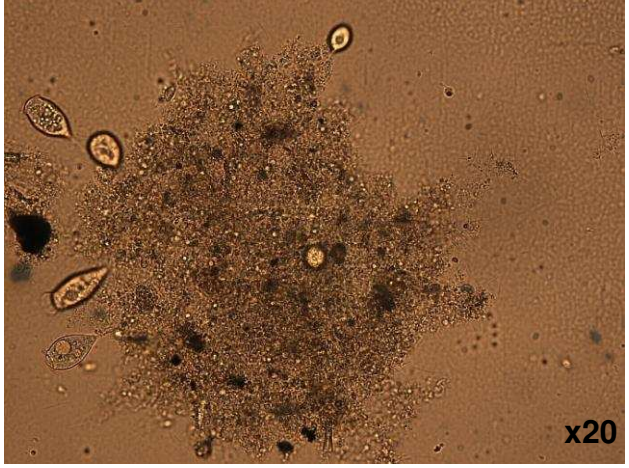
Scheme of Biofloc Technology pond



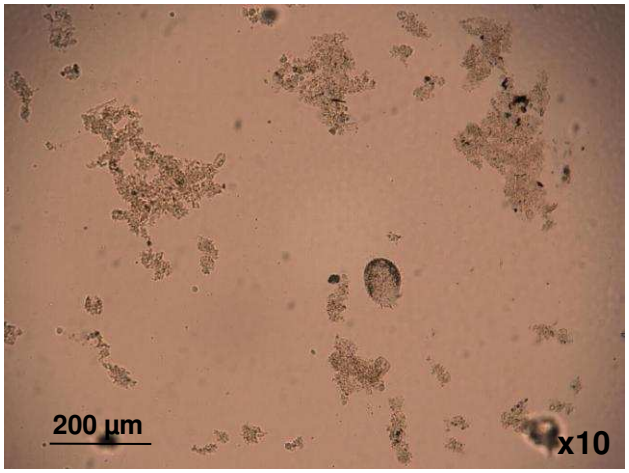
Can we use this microbial activity?

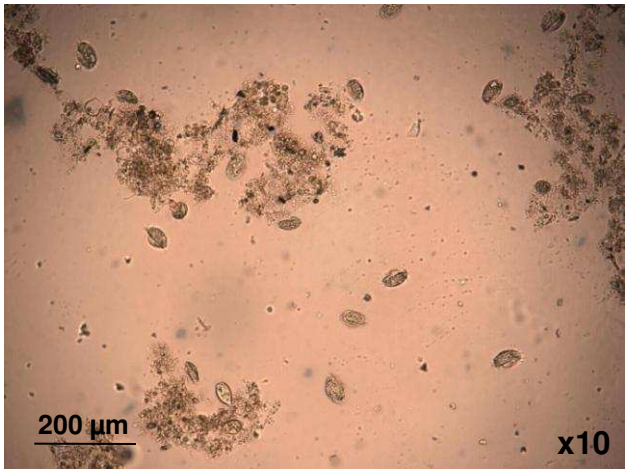
- We will deal with this extensively.
- The microbes degrade the waste, part of it to CO_2 and about 50% to microbial biomass.
- We can manipulate the microbial activity toward the control of nitrogen in the pond.
- The bacteria makes an important part of the food chain.
- They seem to improve disease protection.



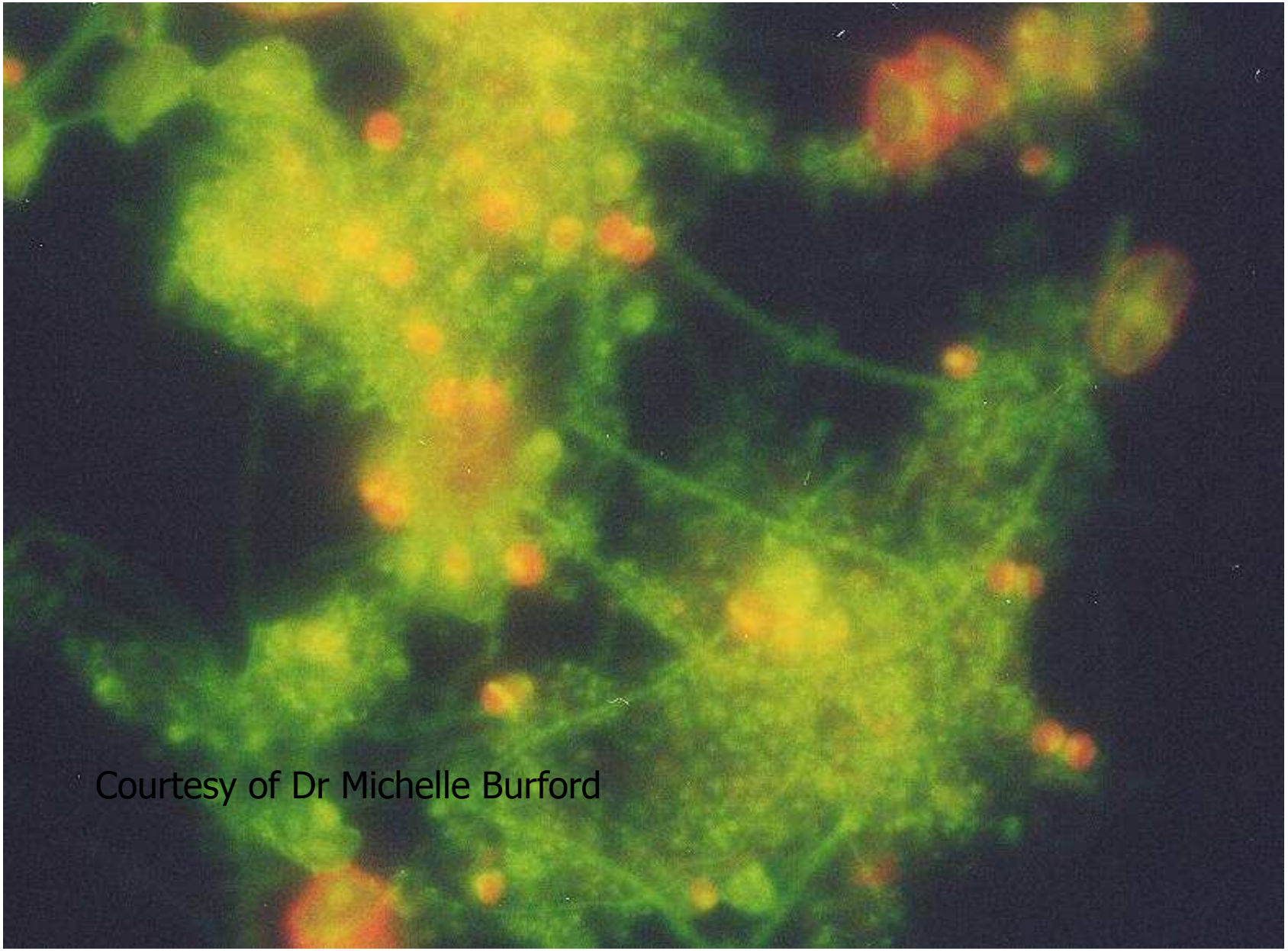


x40





Bio flocs are made of bacteria, protozoa, etc. Typicaly their diameter is 0.1-2 mm.


Courtesy of Dr Michelle Burford


Mixing and aeration are typical features of bio-technological industry
Biofloc technology is biotechnology


1. We need more research
2. Farmer has to understand the system

FARM MANAGEMENT

Starting

- Goal: Develop the biofloc system.
- In lined ponds, you start from almost zero.
- Before stocking, add organic matter (old feed, molasses, etc.)

Add N fertilizers, 0.5-2.5 mgN/l (5-25 kg/ha)

INOCULUM?

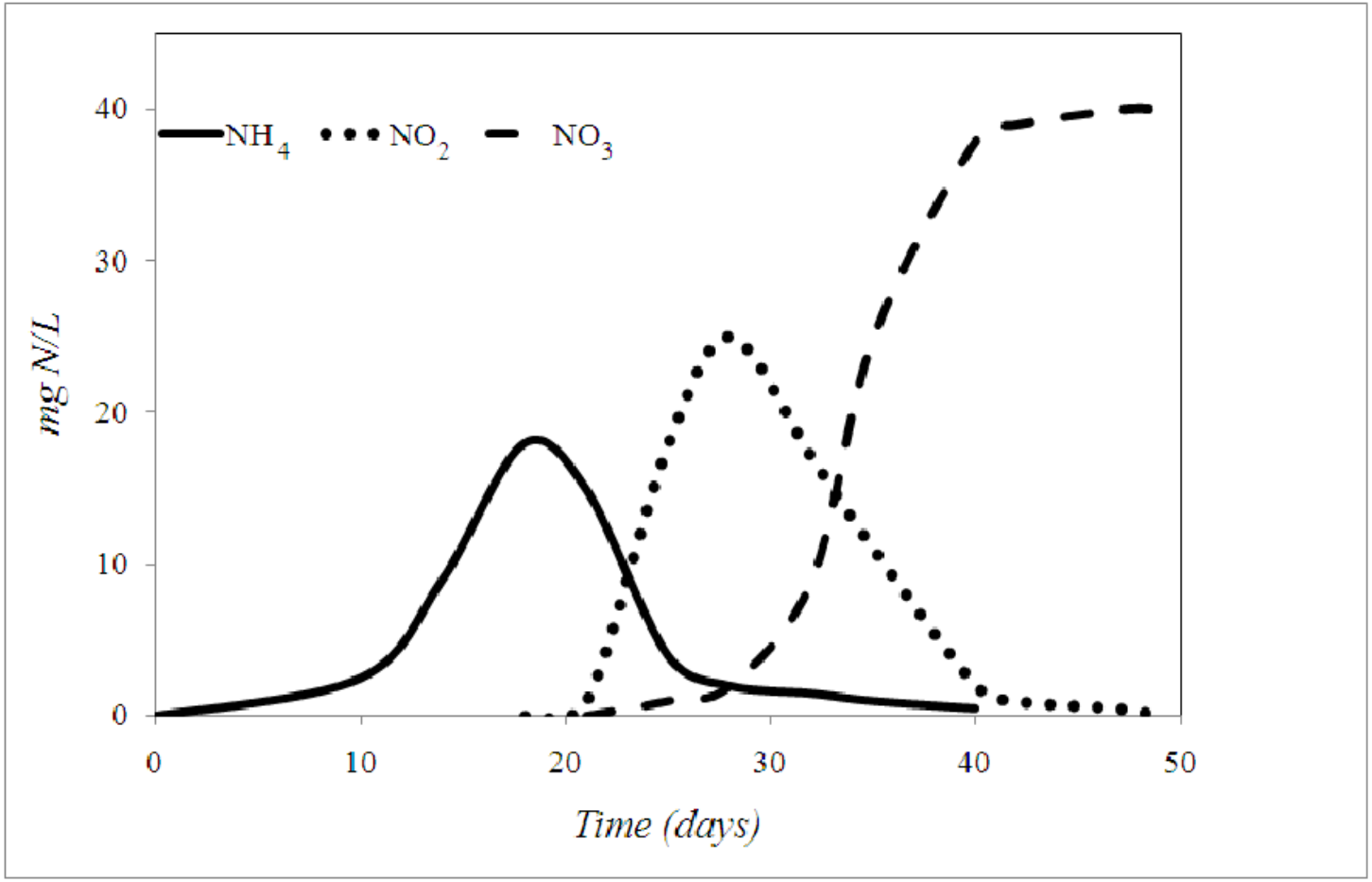
Often, just some soil from pond is enough (~50 kg/ha).

Commercial inuculum: Be careful

Development of biofloc system

- It may take a few weeks, depends on the biomass.
- First algae develop. Transition, foam formation then it get brown.
- Transition is fast with tilapia, longer with shrimp
- Add carbon if TAN is above ~2 mg/l
- **Adding clay, wheat bran etc. serves as seeding for biofloc formation.**
- **Best: Recycles water from good biofloc pond!!!!!!**

Nitrification sequence in BFT pond



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Feeding

- Feed C/N ratio ~ 15-25
- ADJUST ACCORDING TO TAN and NO_2 LEVELS
- The total C/N is important. Feed with low protein pellets or with High protein pellets + Carbon?
- Still not clear. Advantages and disadvantages in both. Need more experience
- In tilapia ponds, drain sludge 1-2 time daily. In shrimp ponds, end of season, drain weekly.

Monitoring

- Very important!!! This is your control
- Keep in computer and display graphs
- Normal aquaculture: Oxygen, T, pH, alkalinity, ….
- Ammonium, Nitrite and possibly nitrates.

Bioflocs: Imhoff cone

Bioflocs evaluation

- Imhoff cones: Measure following 15-20 minutes.
- In shrimp ponds 1-40 ml/l (Drain >15?)
- In fish ponds 2-100 ml/l (Drain >30?)
- Total Suspended solids, TSS:
- Not above 200-400 mg/l
- Volatile suspended solids, VSS
- Turbidity

Responses to monitoring

- High ammonium: Raise carbohydrates, reduce protein in feed. RESPOND QUICKLY.
- High nitrite: Check for low oxygen zones, sludge accumulation, aerator placement. Add carbon
- Low floc volume: you may add carbon
- Too high floc volume: Drain


1B
2B

Belize 1.6 Ha PVC lined ponds

Pay attention to distance of paddle wheel aerators from dykes
And to inner circle of aerators

Letter from a shrimp farmer in Indonesia

We are so lucky that we are applying biofloc technology, as it was suggested on your book.
All of our neighboring ponds were already harvested prematurely because of WSS.
So we are the only survivor on that area or region.
Thanks to your book- although we are still experimenting the quantity of molasses given for shrimps.
If we want to have C/N ratio of 20 then quantity of mollases needed are the same as the quantity of feeds.
Right now quantity feed of P3 & P4 are about 130 kg.
So right now we are targeting C/N ration between 12-15

Thank You

Yoram

Y. Avnimelech

Biofloc Technology

A Practical Guide Book

THE WORLD AQUACULTURE SOCIETY

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