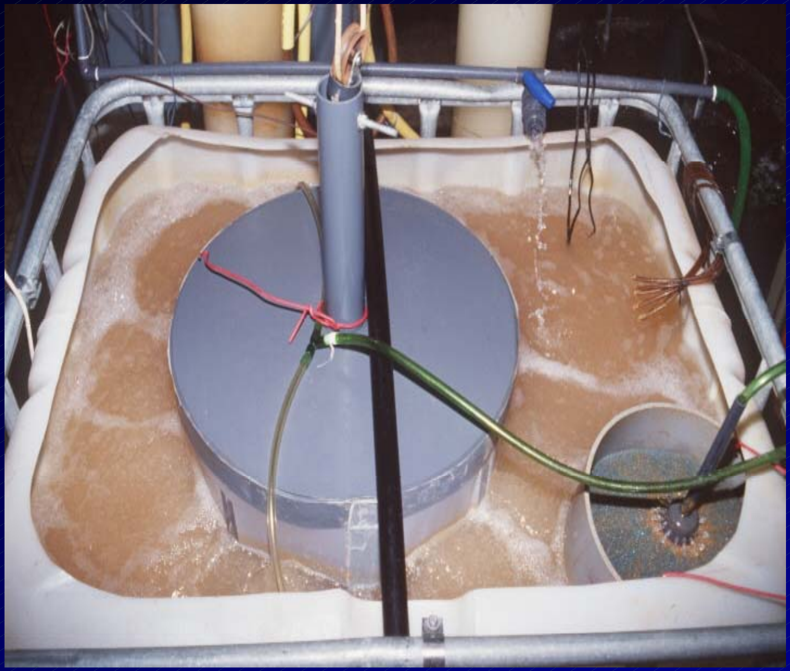
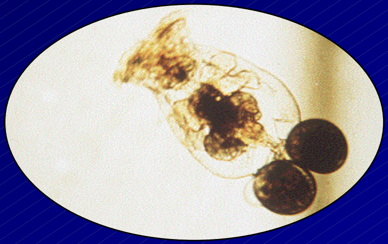
Biological, technical and economical feasibility of a rotifer recirculation system





G. Suantika, P. Dhert,
E. Sweetman, E. O'Brien
and
P. Sorgeloos

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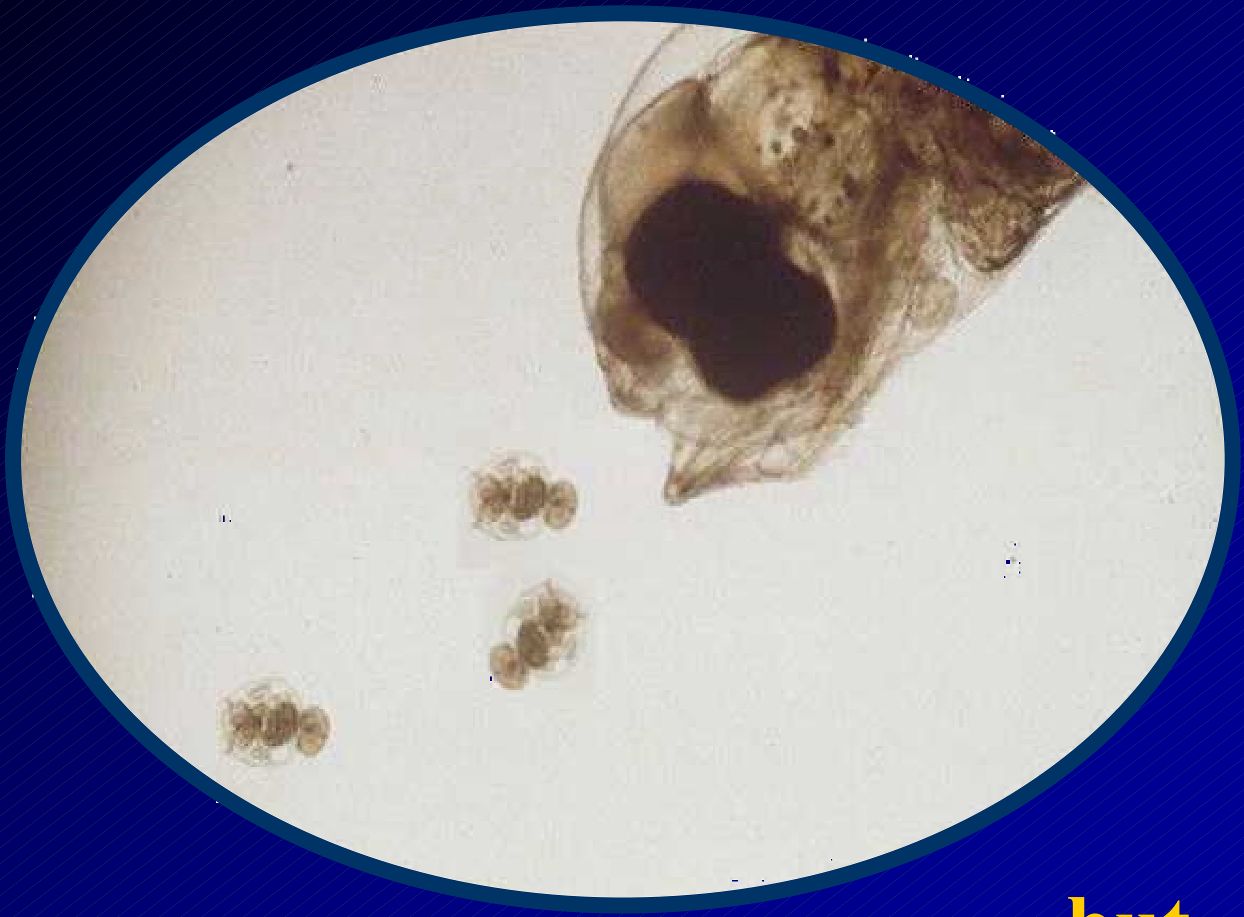
larvi 2001 - Ghent University, Belgium - September 3-6, 2001

Rotifers are an excellent first food for fish larvae



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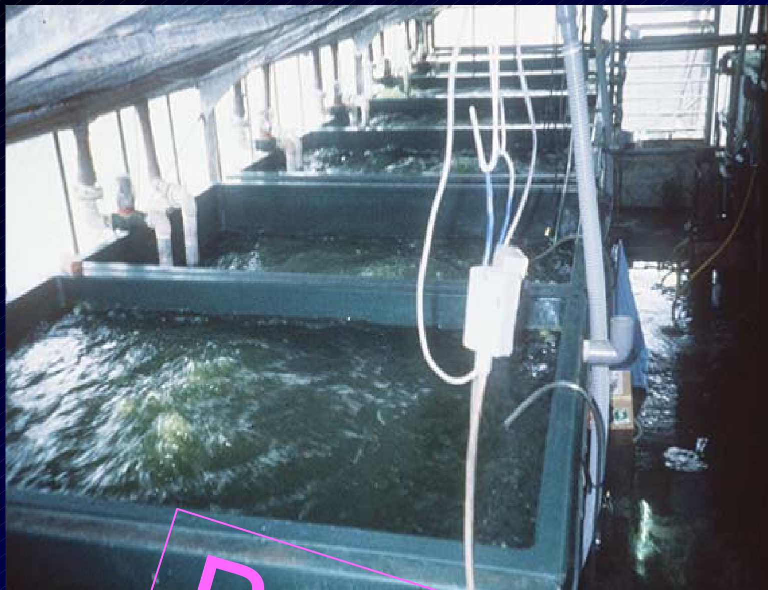
…a bottleneck for mass culture and industrial applications



- unpredictable in production
- source of contamination
- variable in quality
- high maintenance cost

Batch cultures

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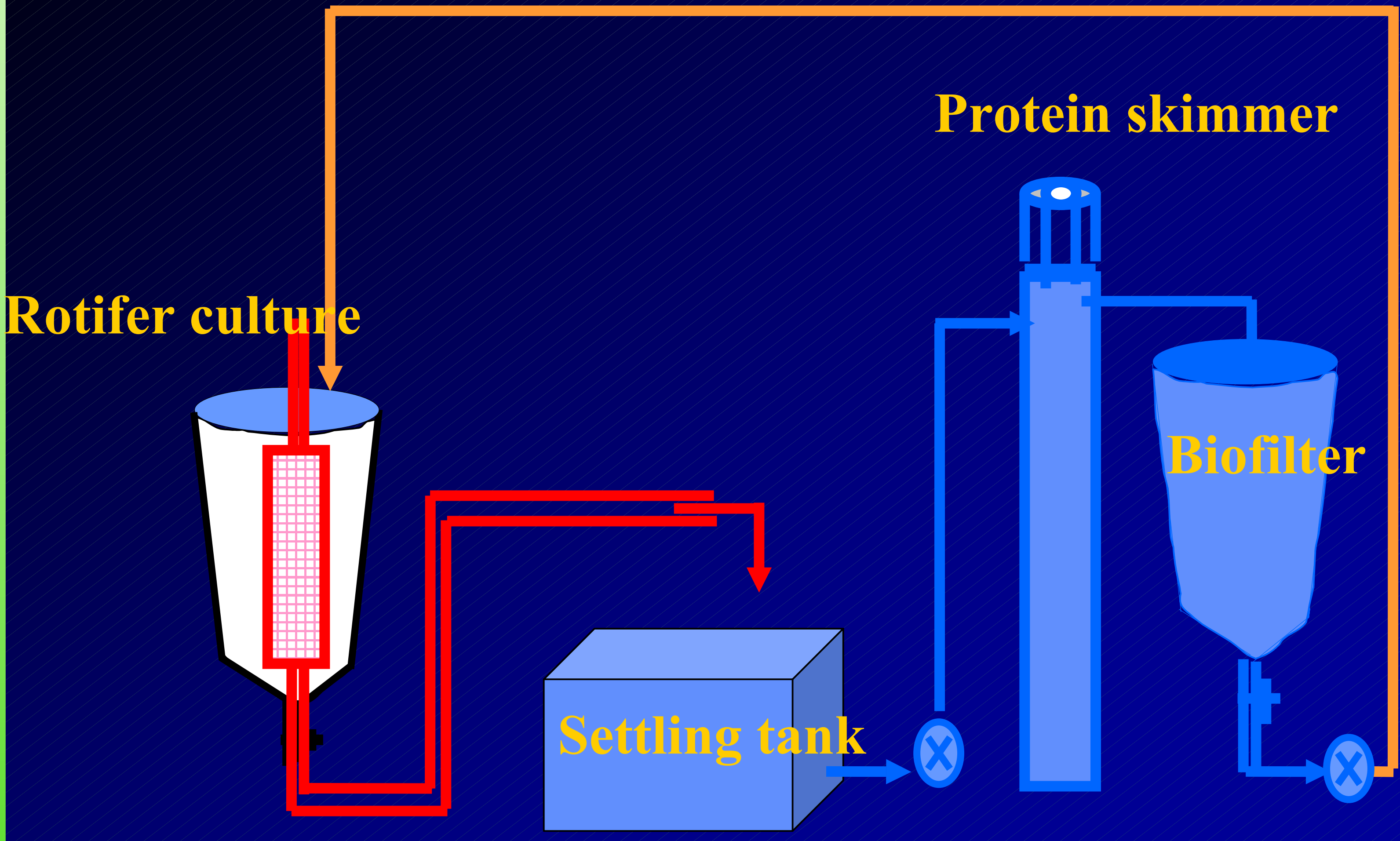
Recirculation system



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Recirculation system

Hydrology and food distribution

- Mesh size of the filter
- Determination of the optimal flow rate
- Determination of the feeding regime
- Improvement of the diet

Water quality

- Improvement of physical water quality parameters
- Improvement of biological water quality
- Technical improvement (more performant equipment)

Commercial applications and rotifer quality

- Upscaling for commercial application
- Effect on rotifer quality
- Cost estimation

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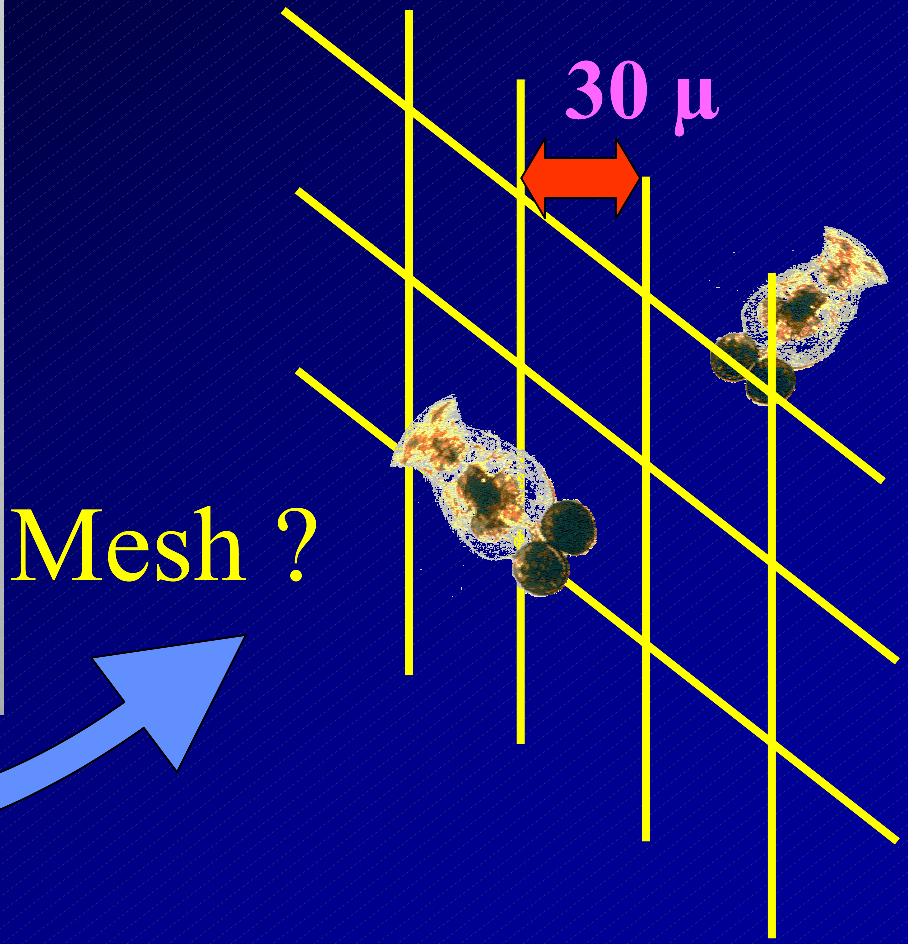
✓ Determination of a mesh size that retains rotifers



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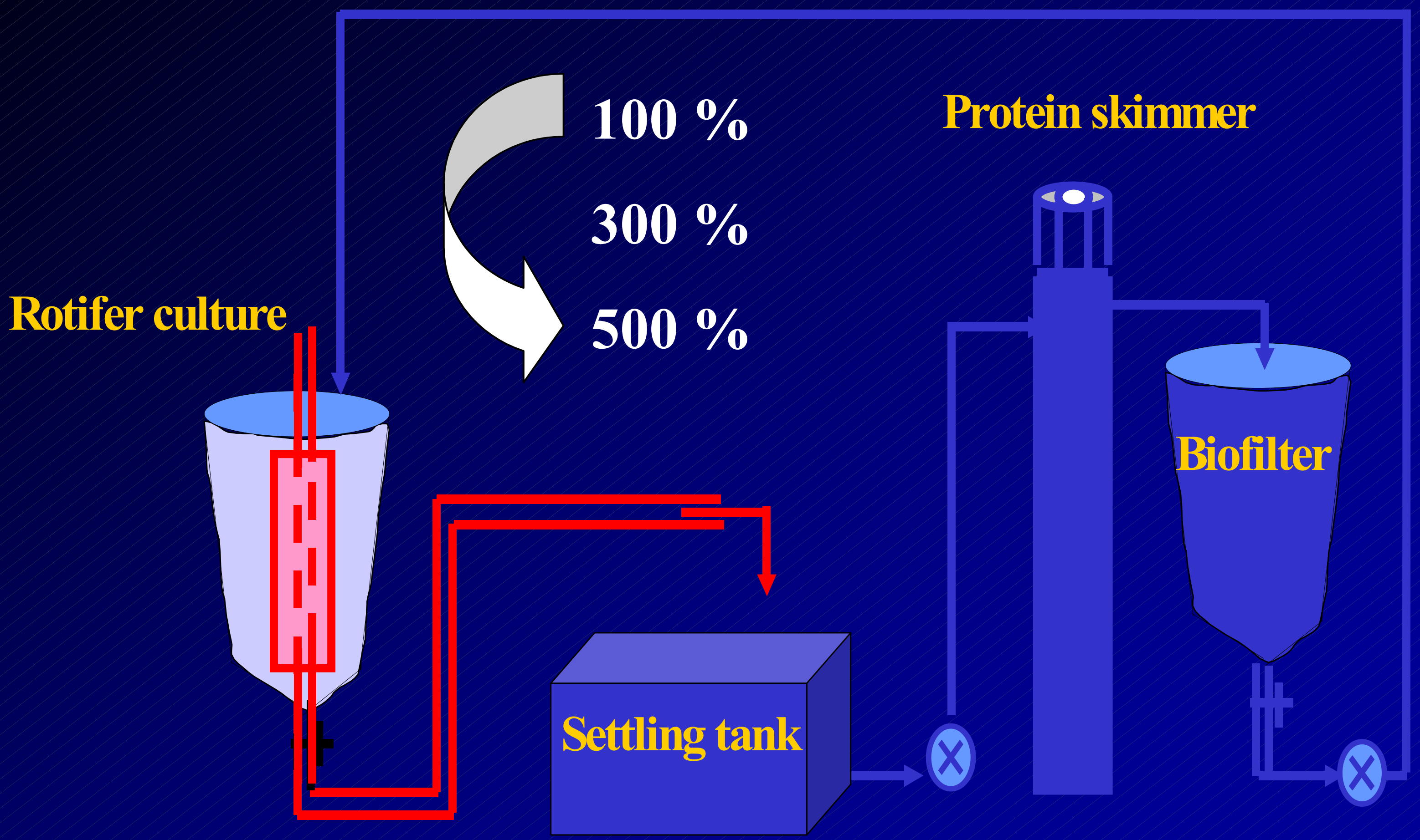
✓ Determination of the optimal flow rate



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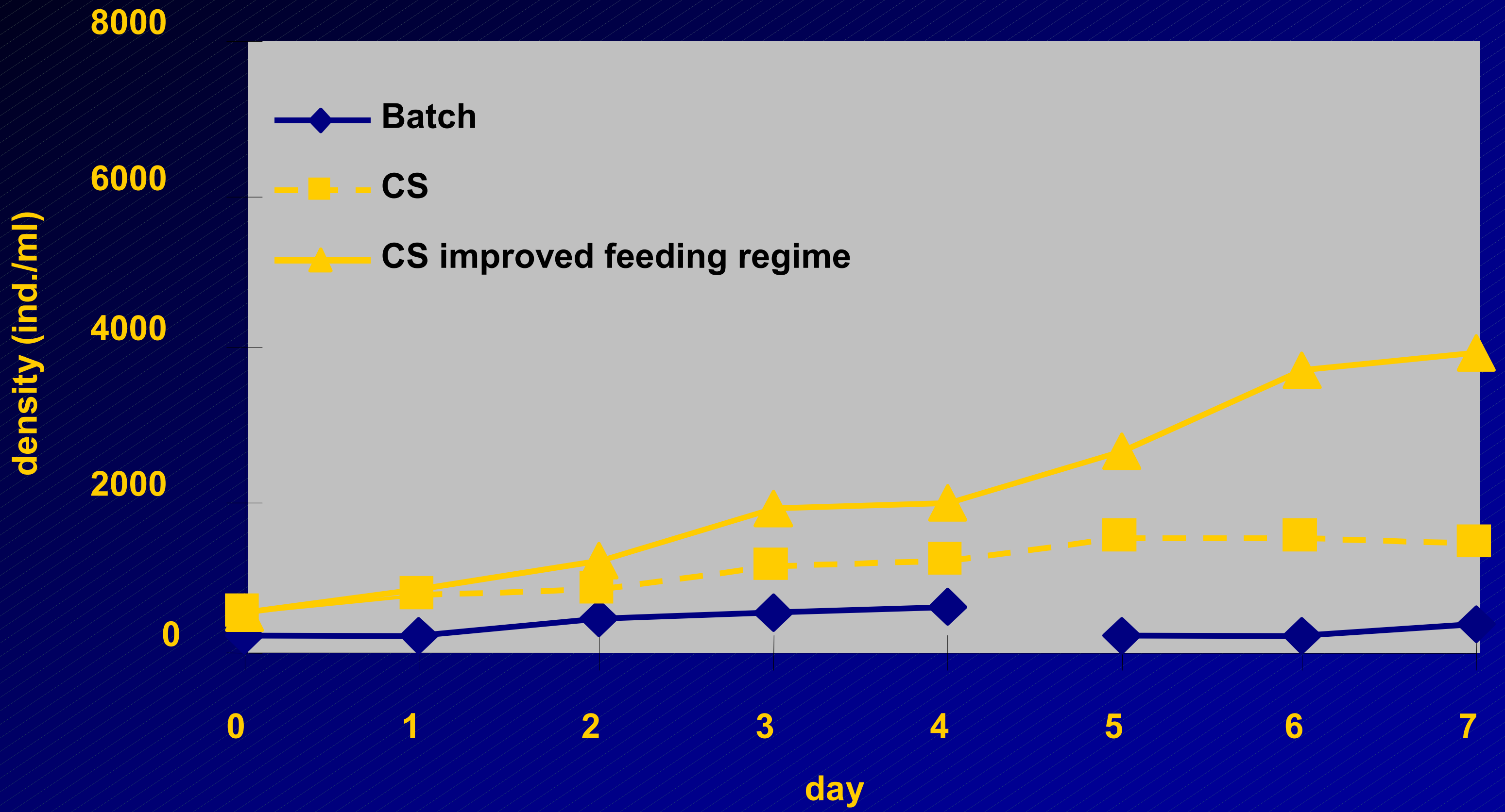
✓ Determination of the feeding regime



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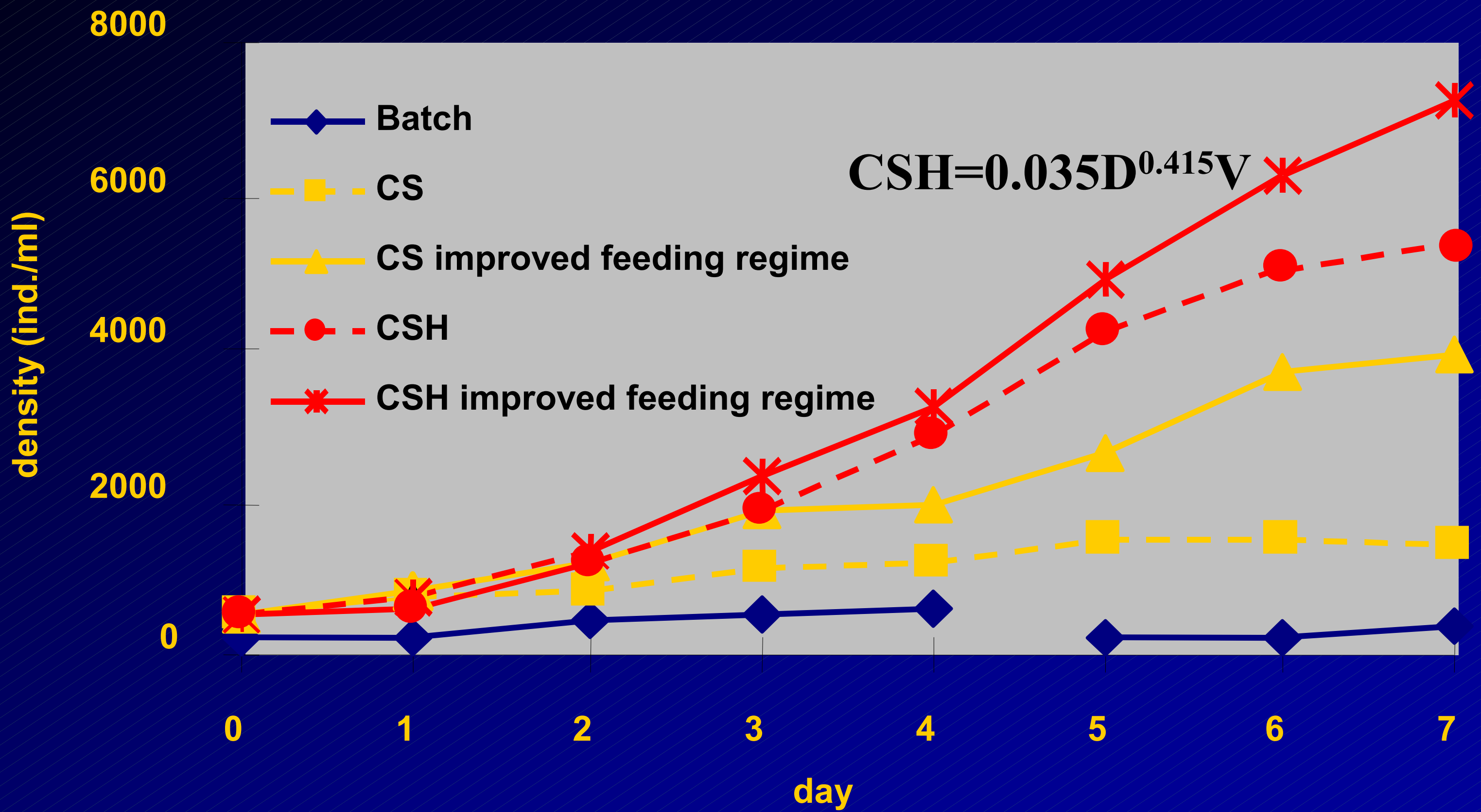
✓ Improvement of the diet



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Recirculation system

✓**Hydrology and food distribution**

- ✓ Mesh size of the filter
- ✓ Determination of the optimal flow rate
- ✓ Determination of the feeding regime
- ✓ Improvement of the diet

Water quality

- **Improvement of physical water quality**
- **Improvement of biological water quality**
- **Technical improvement**

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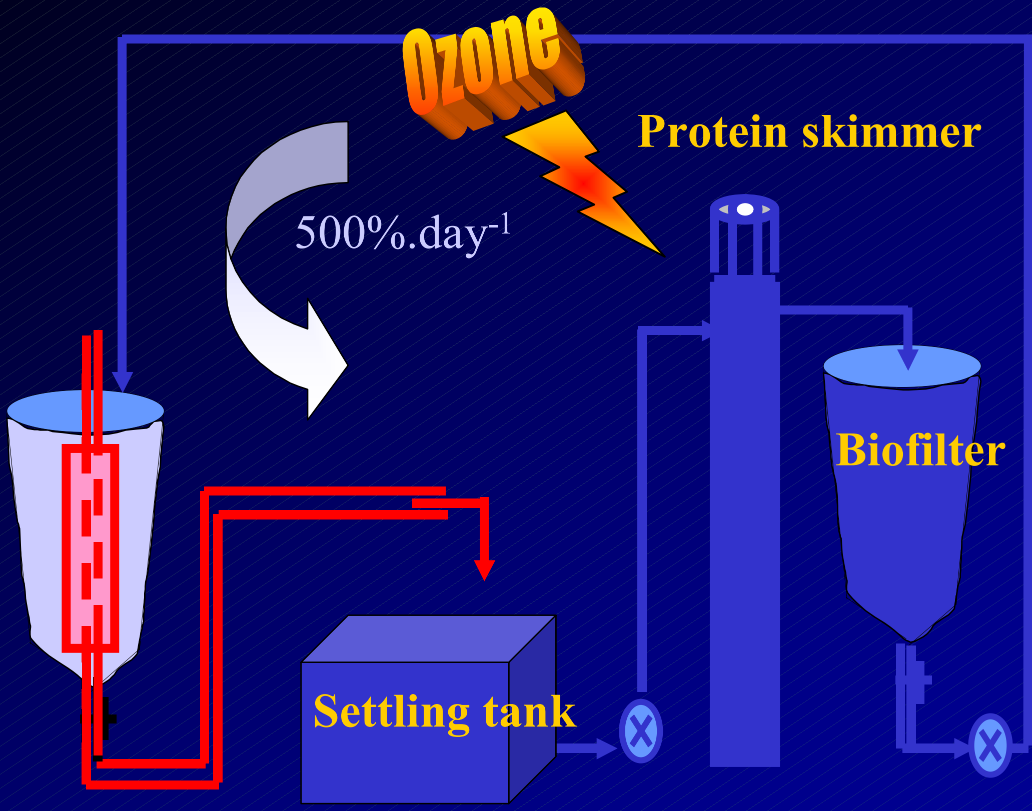
✓ Improvement of physical water quality parameters

Effect of ozone in the recirculation system?



- Strong oxydant
- Strong disinfectant
- Coagulation/floccul.

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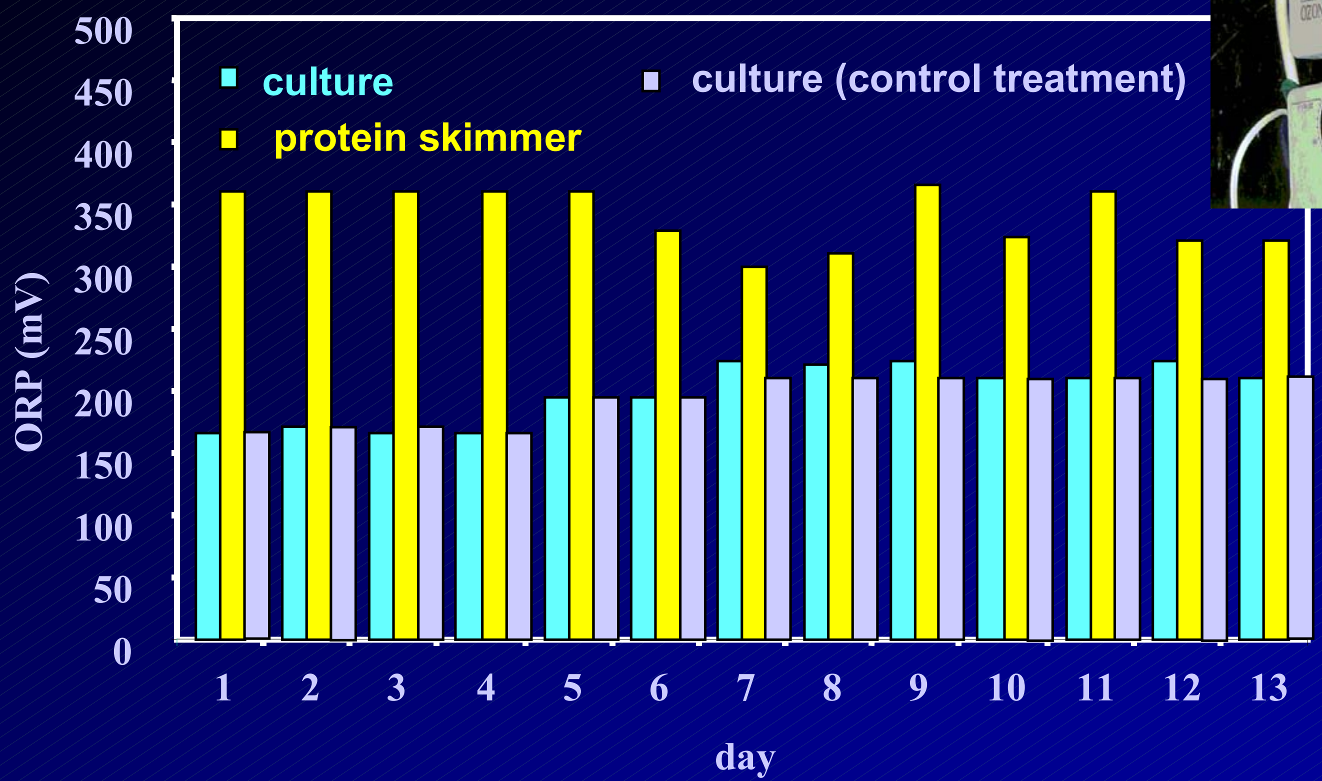
Oxygen Reduction Potential (ORP)



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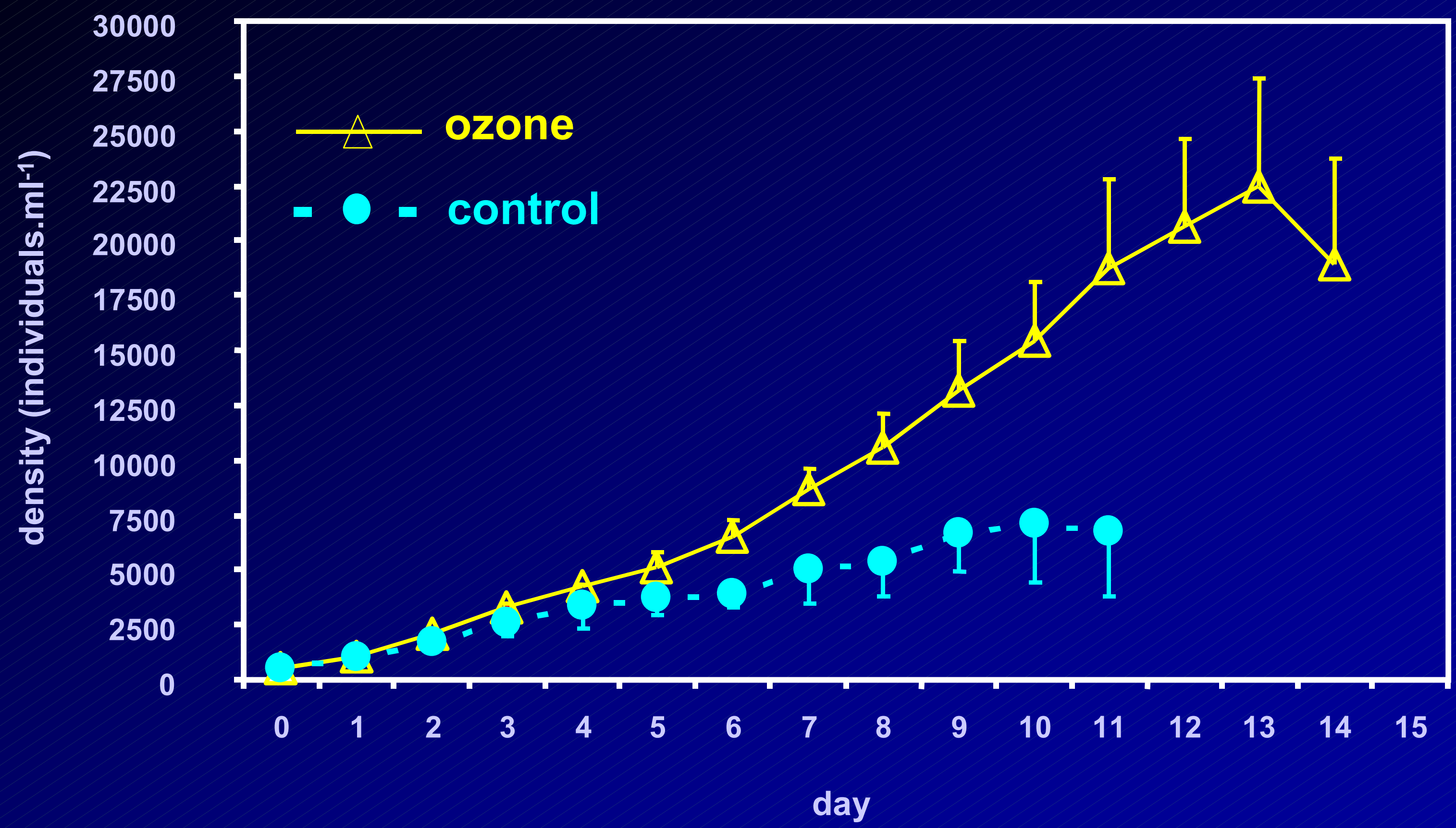
Effect of ozone on the production of rotifers



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Performance of the protein skimmer

Control

Ozone

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Performance of the protein skimmer

	control	Ozone
Effluent water (ml)*	730	2100
Dry weight of SS (gr)*	36	102
SS composition (particles/ml)		
- uneaten food	1.1×10^{11}	3.2×10^{11}
- organic wastes	4.1×10^{11}	5.7×10^{12}

* = average (10 days)

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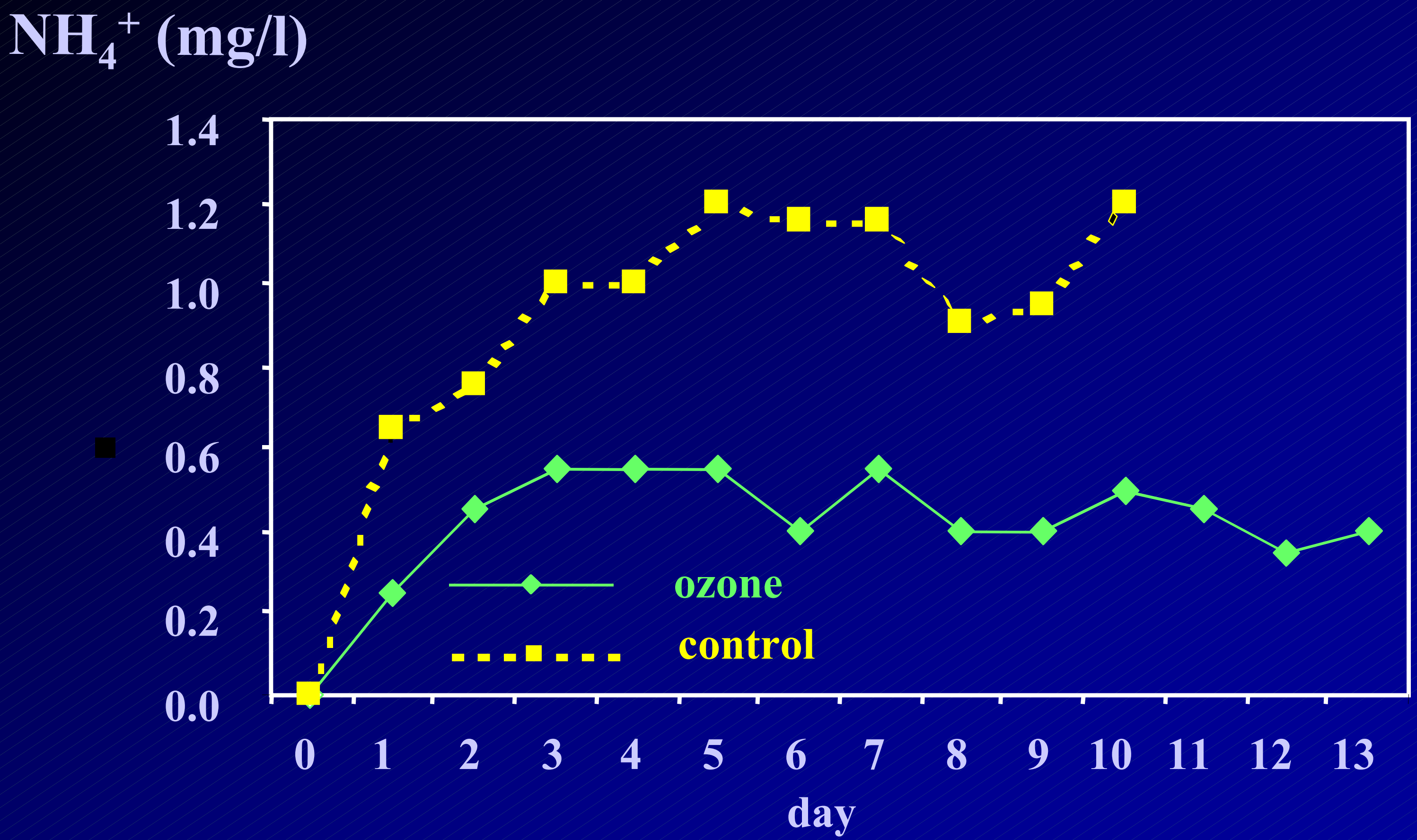
Physico-chemical parameters



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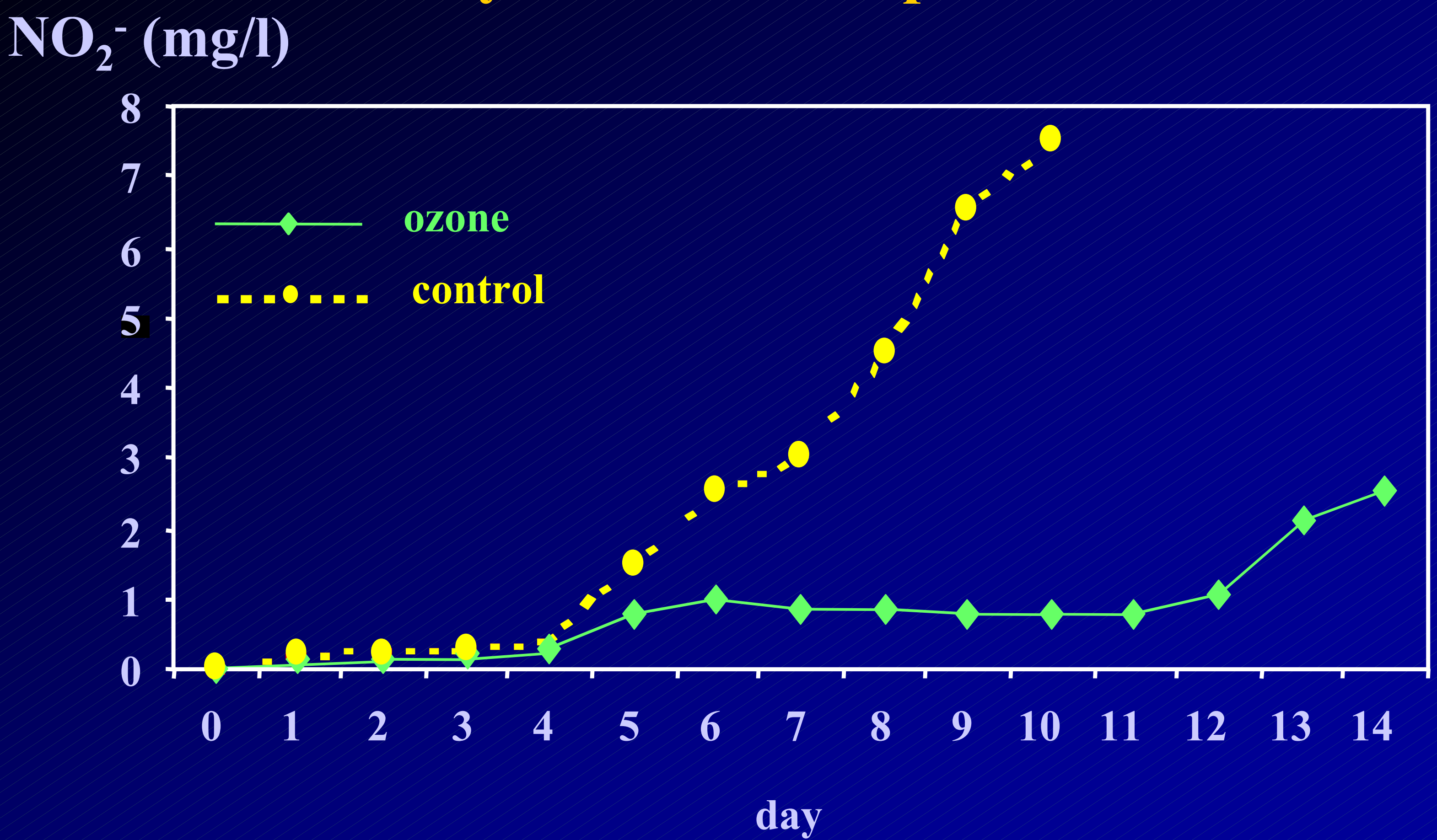
Physico-chemical parameters



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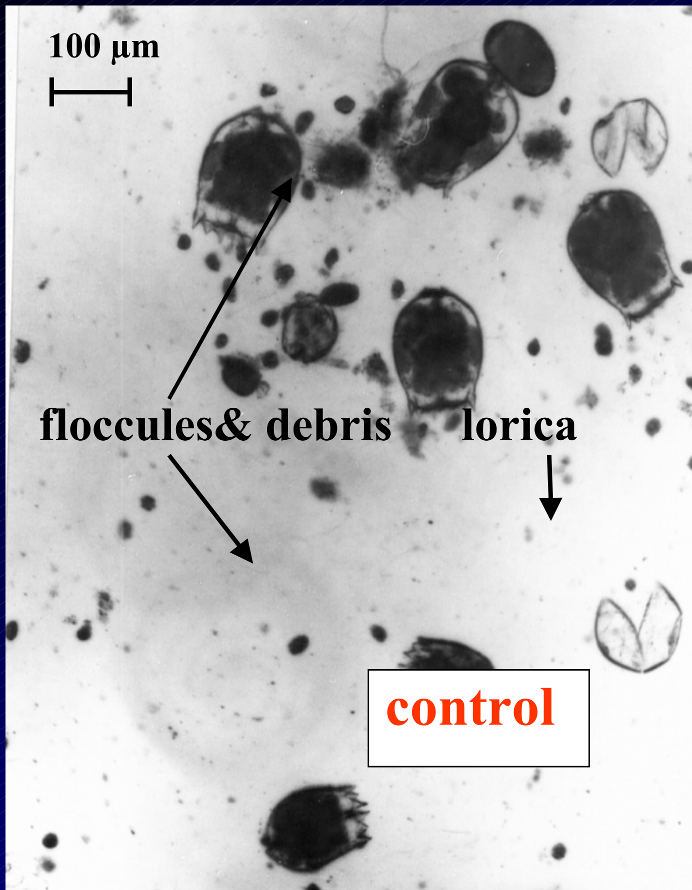
Effect of ozone on the rotifer culture water



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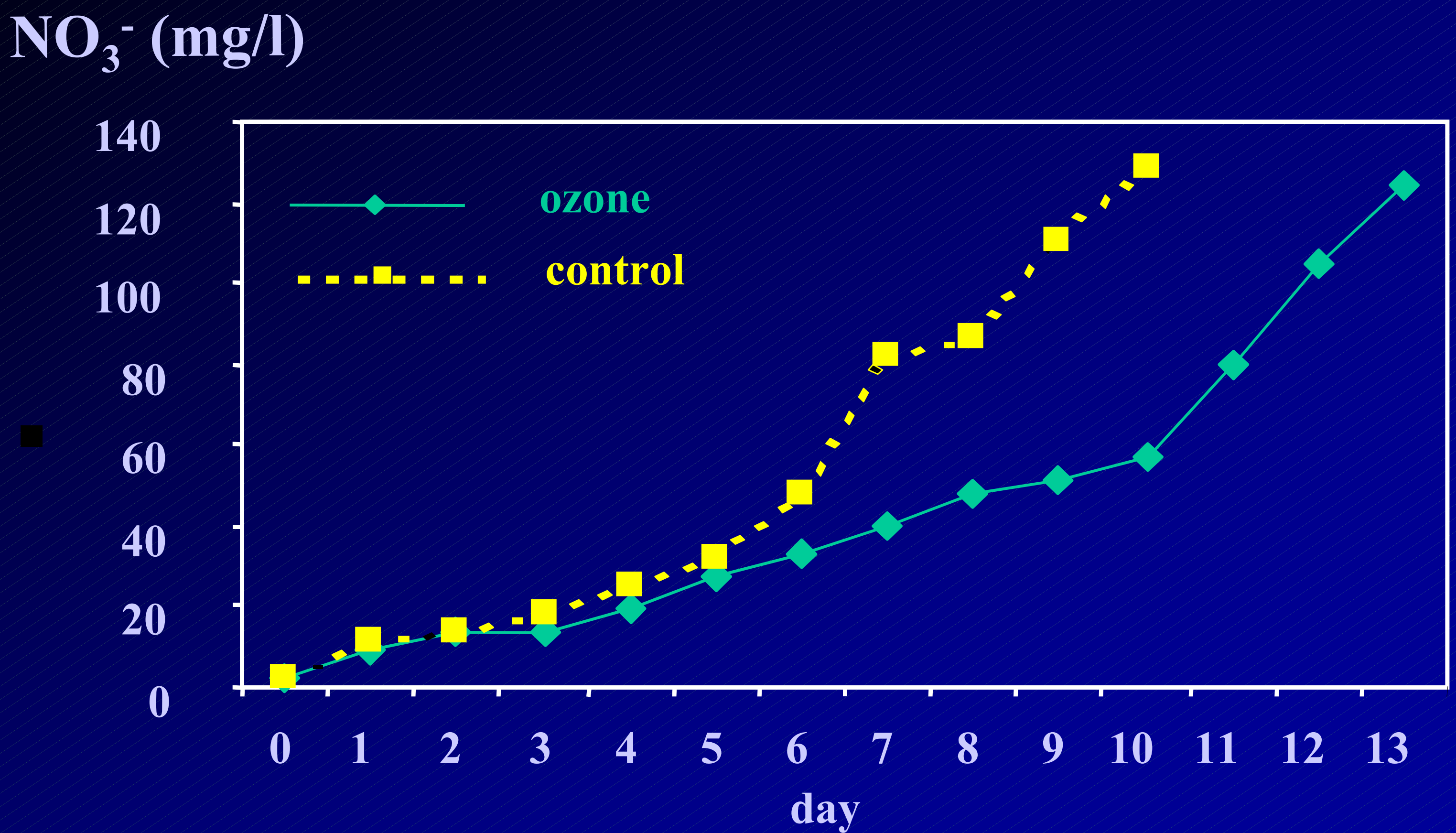
Physico-chemical parameters



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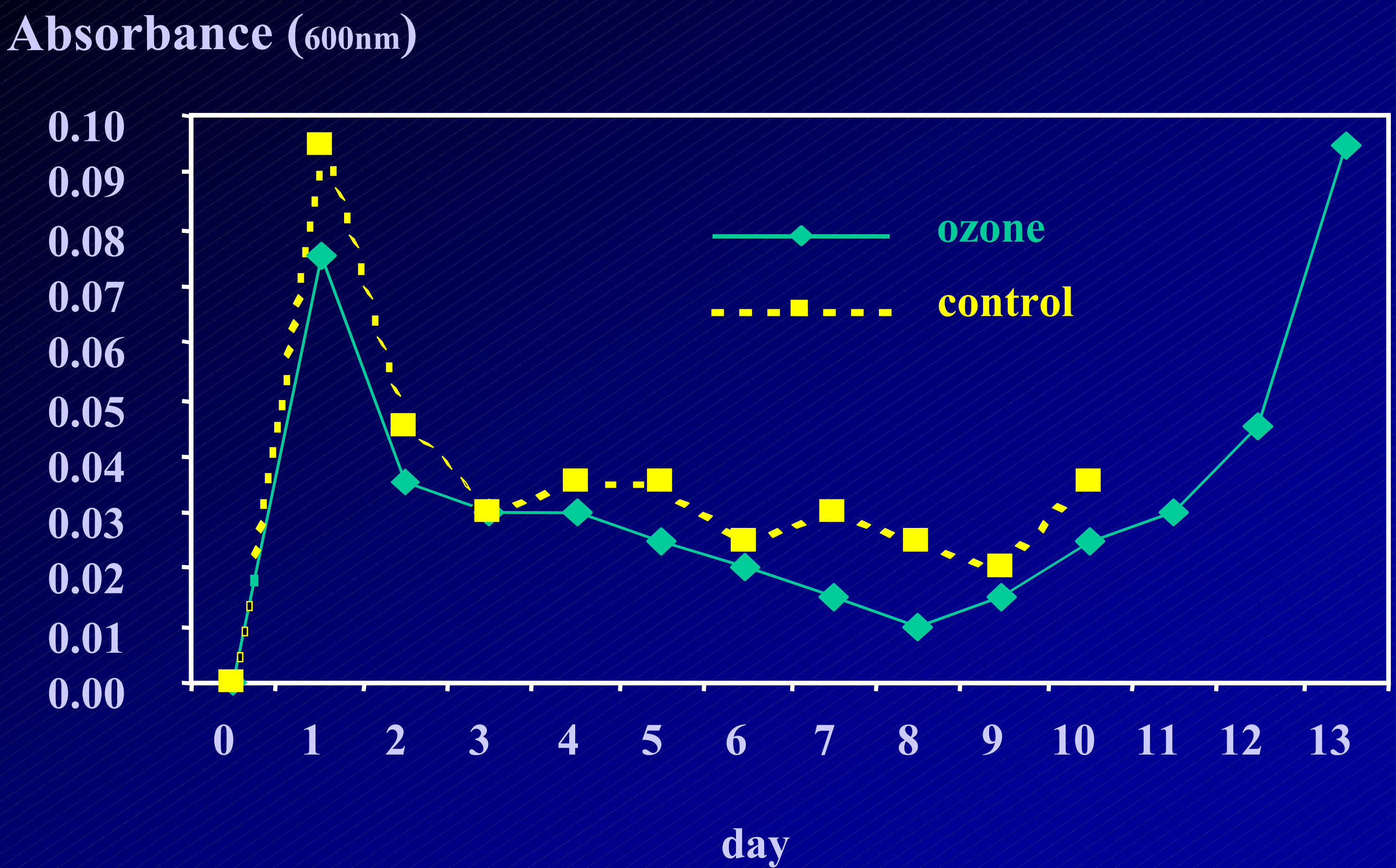
Physico-chemical parameters



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Bacterial counts on culture water (CFU ml^{-1})

	Control		Ozone	
	Marine agar	**TCBS**	**Marine agar**	**TCBS**
Rotifer culture	**9.0×10^4**	**1.8×10^3**	**2.7×10^4**	**1.1×10^3**
Protein skimmer	**1.0×10^5**	**5.4×10^2**	**<30**	**<30**

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CONCLUSIONS

Beneficial effects of ozone :

✓ improved water quality

- better removal of particles (oxydation, flocculation)
- lower level of ammonium, nitrite and nitrate

⇒ possibility to reduce the size of the biofilter

✓ improved rotifer production

- high rotifer density
- stable and longer culture period

⇒ possibility to reduce size of rotifer tanks

✓ cleaner rotifer production

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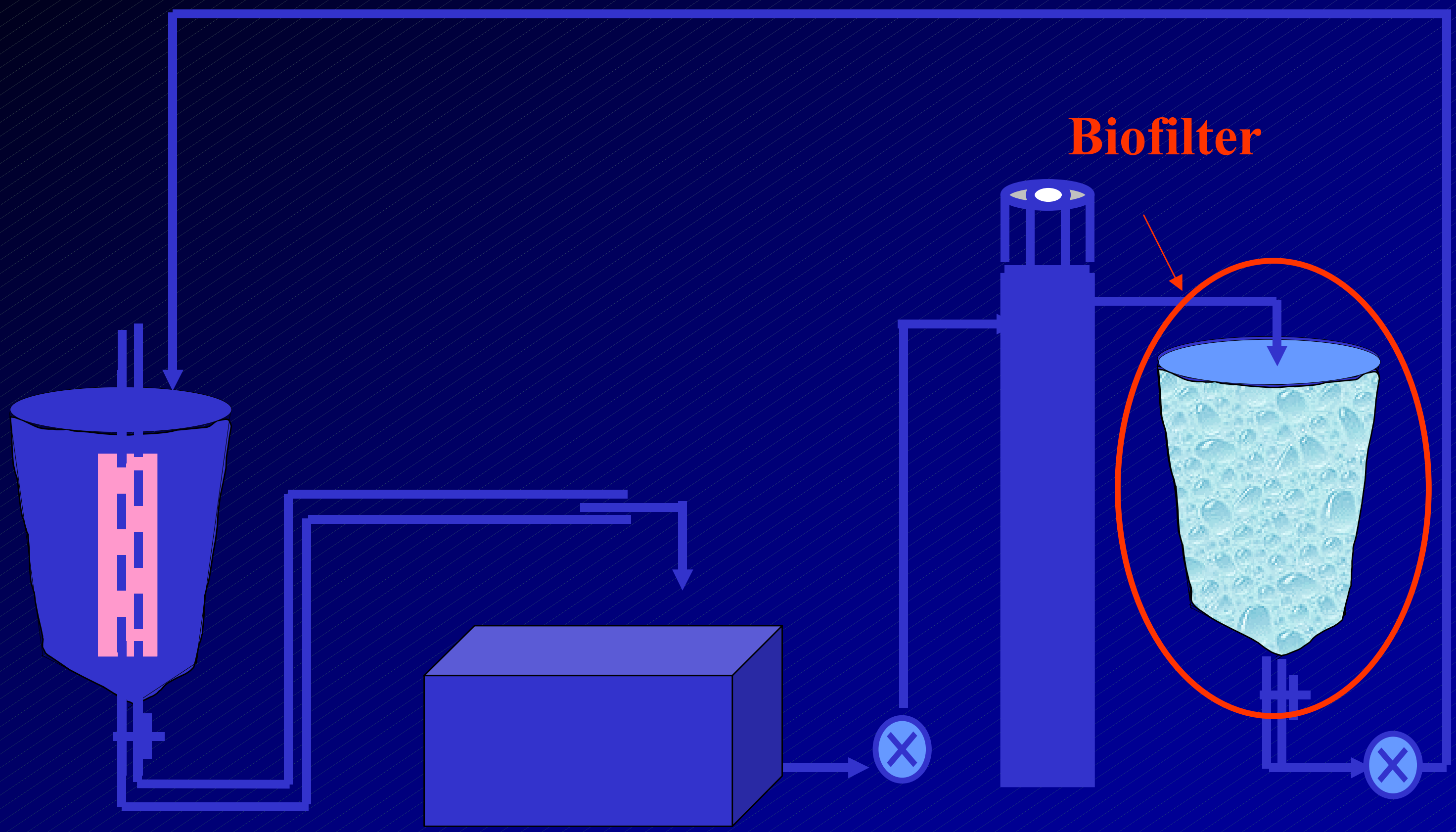
✓ **Improvement of the biological water quality**



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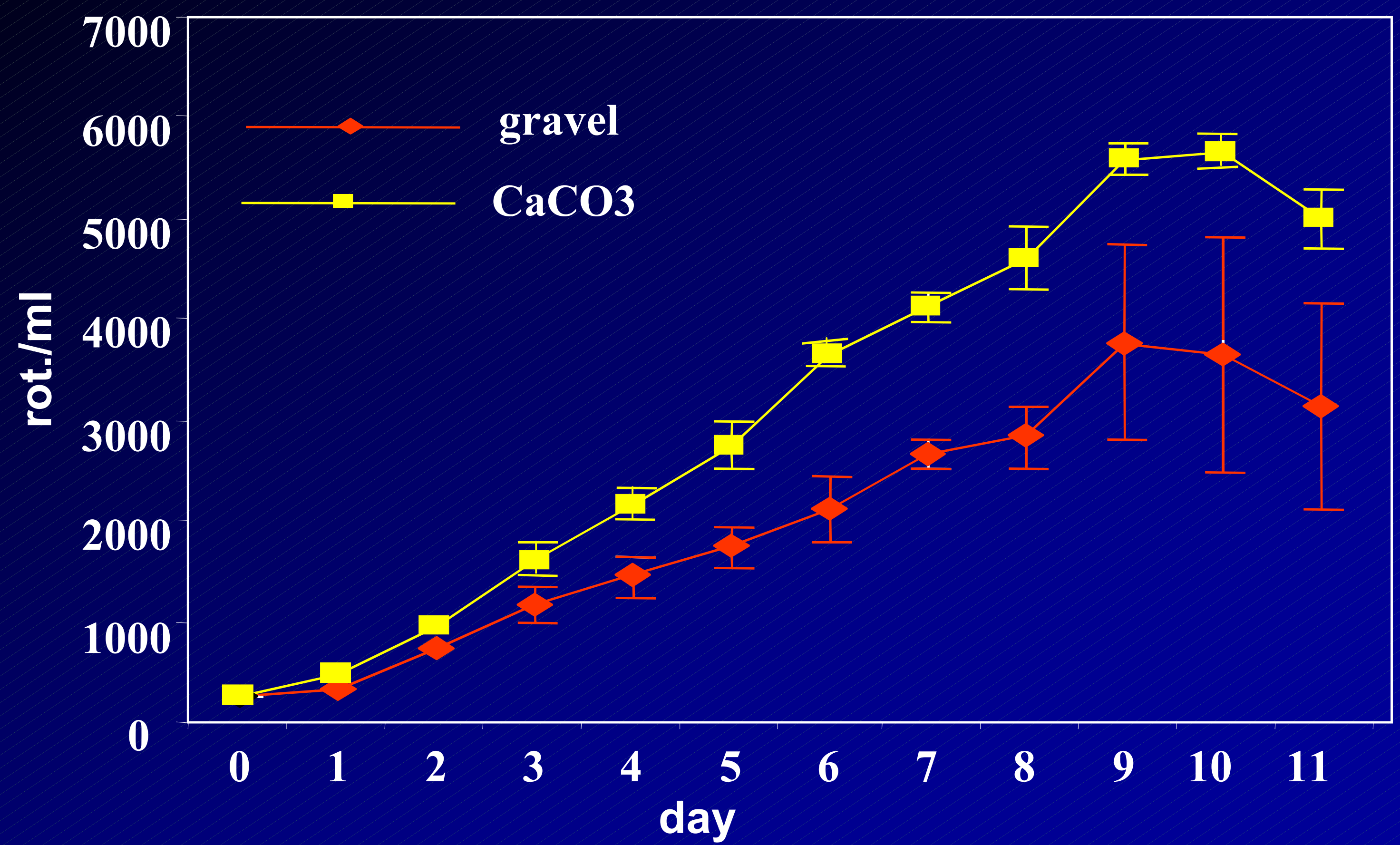
Effect of substrate of the biofilter on the growth rate of rotifers



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✓ Technical improvement (more performant equipment)

Floc traps

Sintered metal filters

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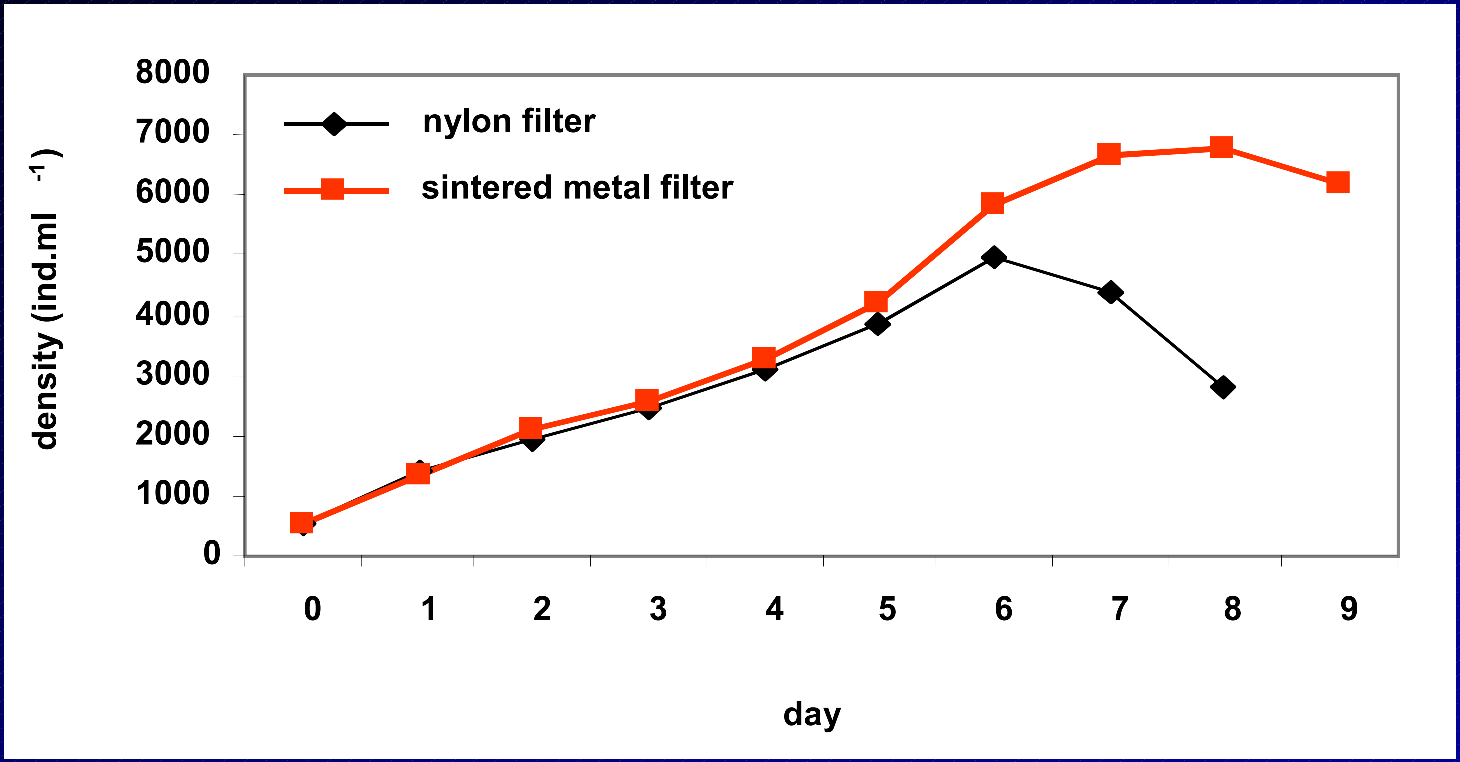
Sintered metal filters

Rotifer growth



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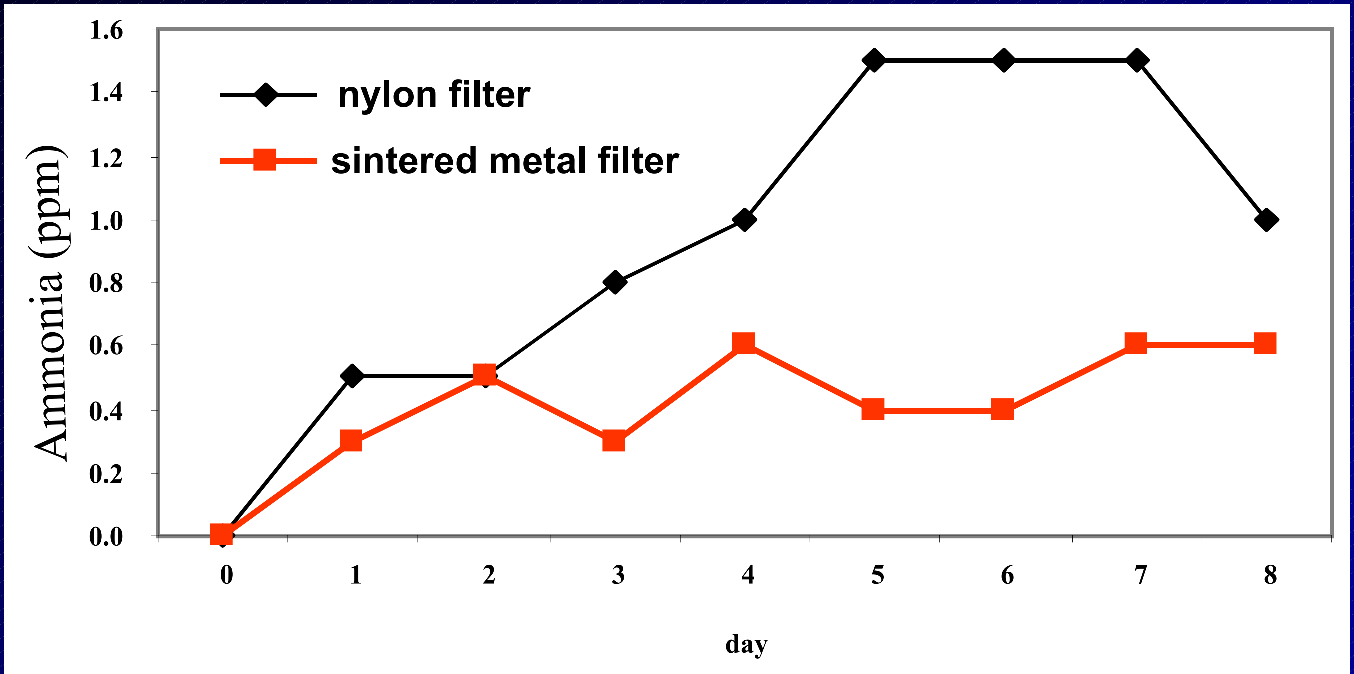
Sintered metal filters

Ammonia



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Recirculation system

Hydrology and food distribution

- ✓ Determination of the optimal flow rate
- ✓ Determination of the feeding regime
- ✓ Improvement of the diet

Water quality

- ✓ Improvement of physical water quality parameters
- ✓ Improvement of biological water quality
- ✓ Technical improvement (more performant equipment)

Commercial applications and rotifer quality

- **Upscaling for commercial application**
- **Effect on rotifer quality**
- **Cost estimation**

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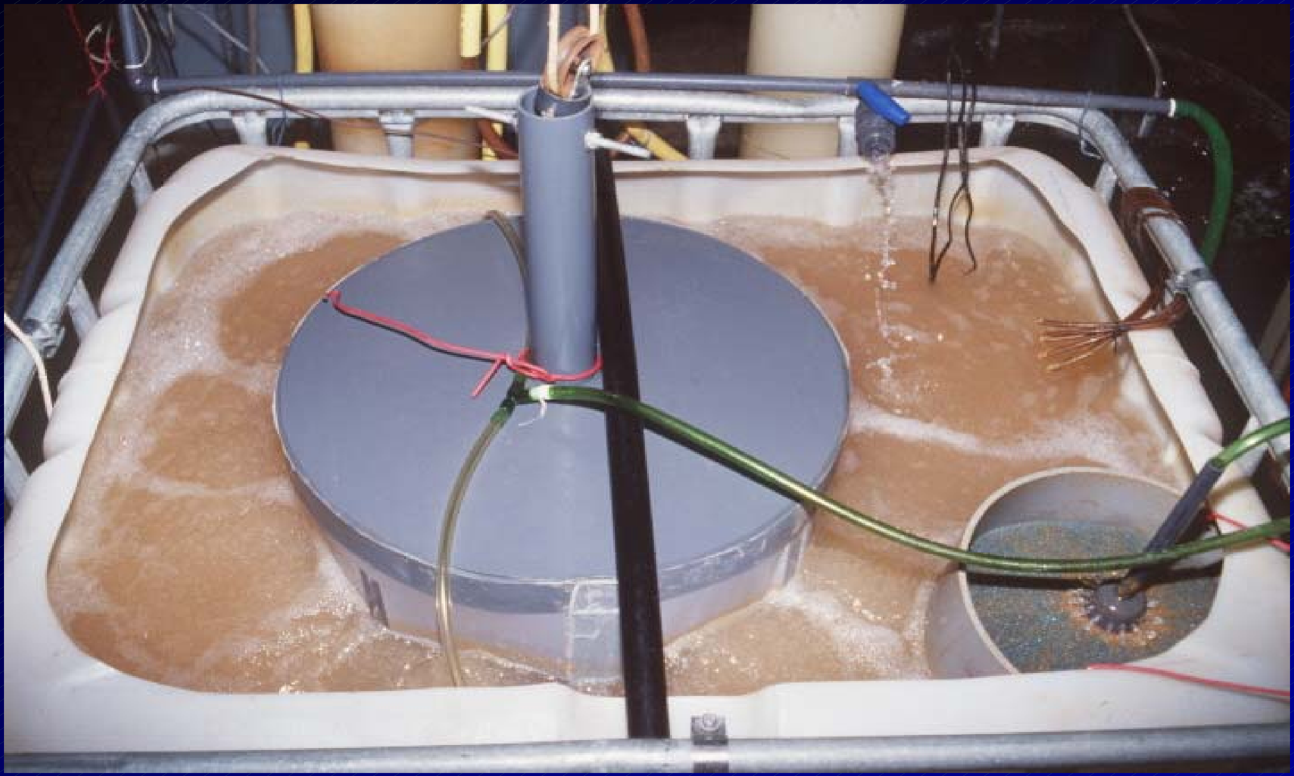
✓ Upscaling for commercial application



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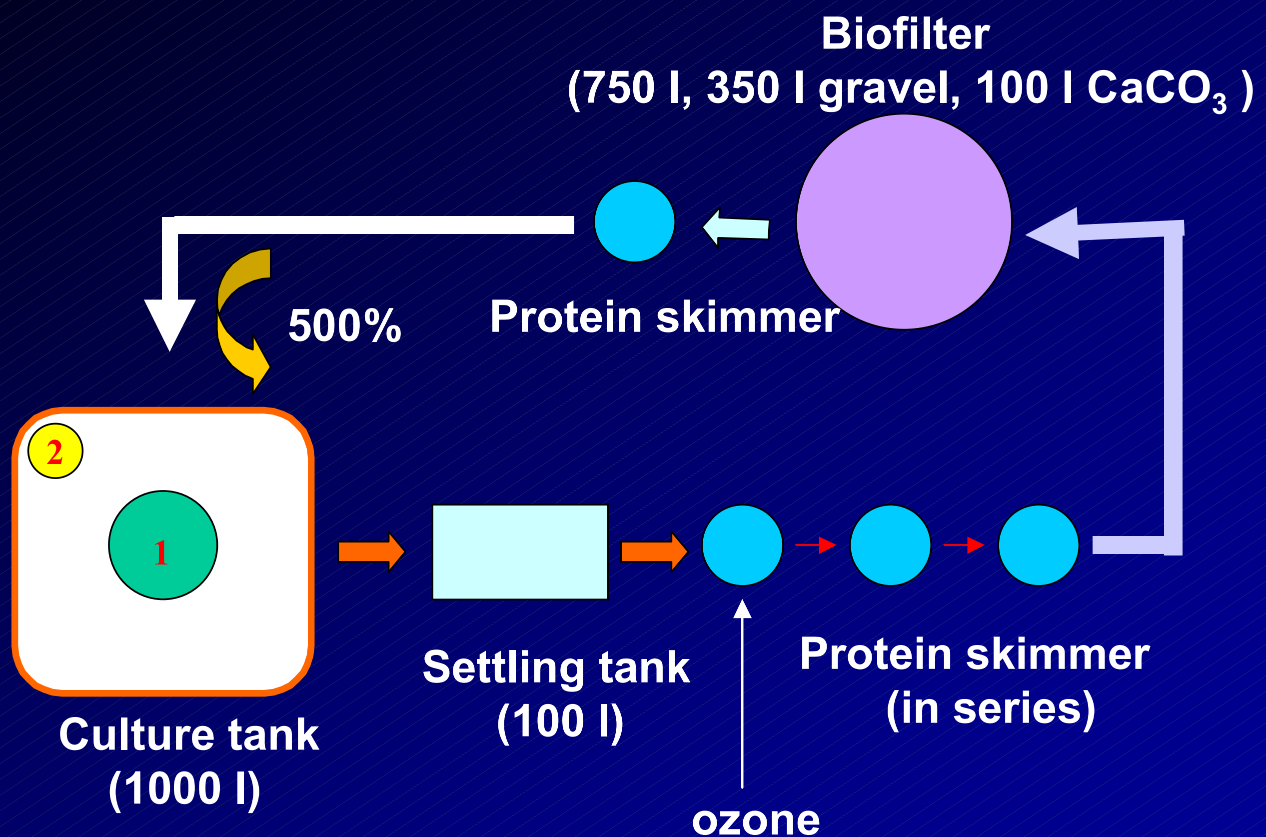
Schematic outline of the upscaling system



1 = filter (30 µm)
2 = air water lift

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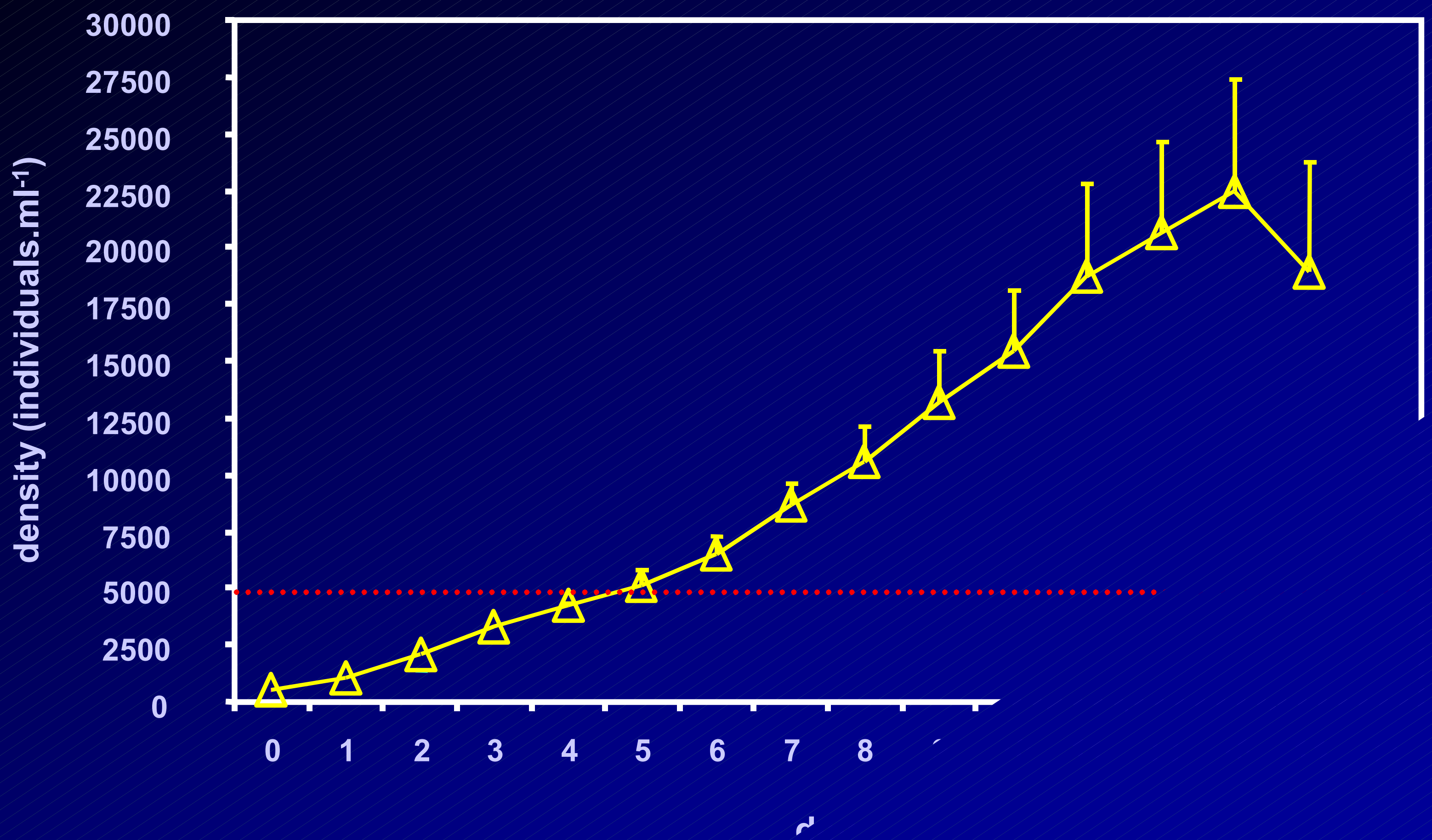
Rotifer production in recirculation system



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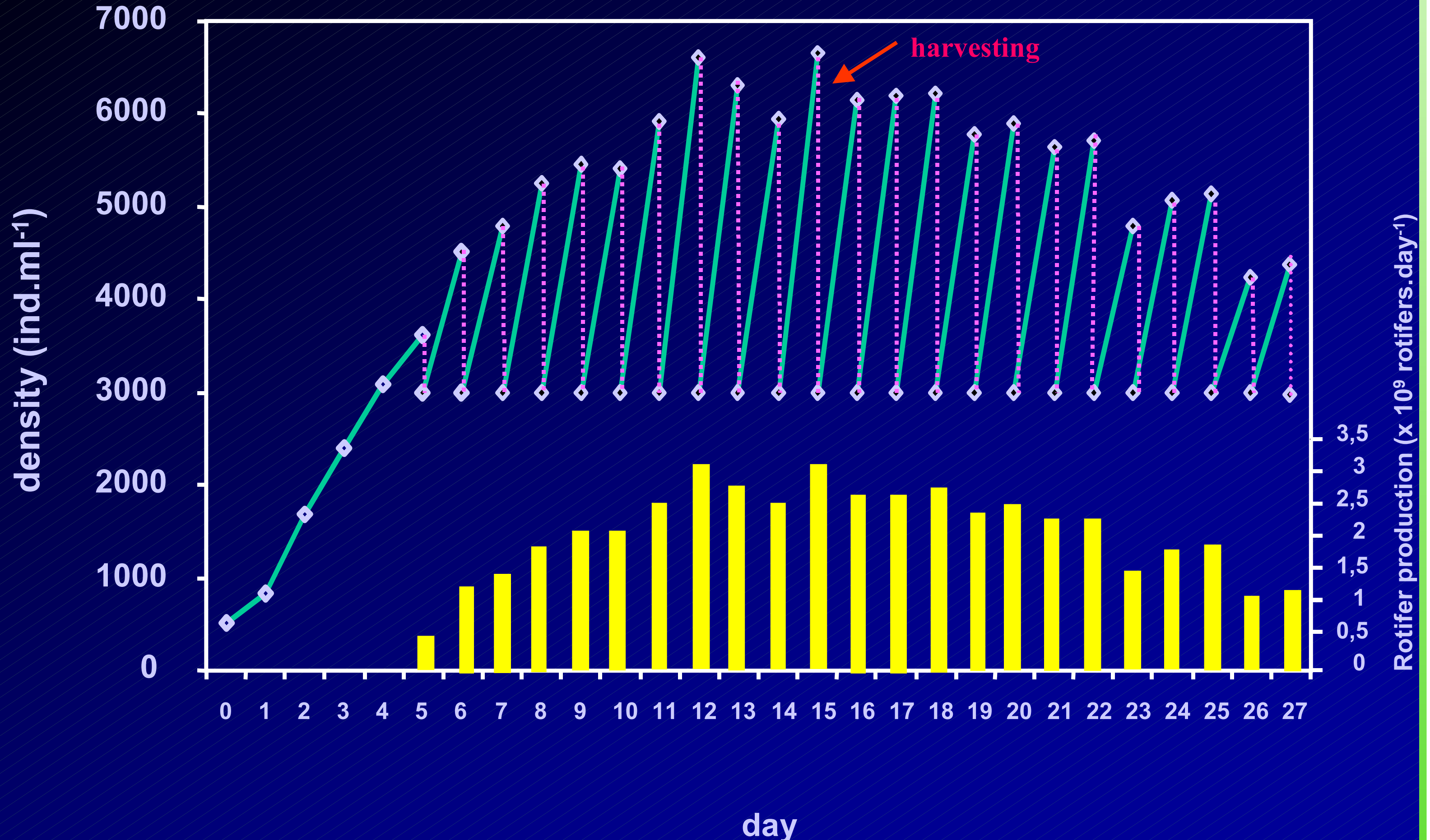
Rotifer production at 3000 ind./ml stocking density



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Comparison of rotifers production at three different stocking densities

	stocking density (ind.ml^{-1})		
	3000	5000	7000
Daily production (rotifers.day^{-1})	2.2×10^9 (45%)	2.1×10^9 (37%)	1.7×10^9 (21%)
SGR (µ)	0.6 ± 0.13	0.4 ± 0.07	0.3 ± 0.06
Σ water consumption (l)	9760	7850	4500
Σ food (kg)	21	25	28

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Bacterial count

Day	Sample	MA	TCBS
0	water	1.9×10^5	0
	rotifer	3.5×10^3 /rot.	3.3×10^2/rot.
7	culture	3.4×10^6	1.6×10^5
	after protein skimmer	1.8×10^5	2.2×10^4
	after biofilter	1.4×10^5	3.5×10^3
15	culture	3.4×10^6	3.8×10^4
	after protein skimmer	4.1×10^5	3.5×10^3
	after biofilter	4.9×10^5	0
23	culture	2.3×10^5	3.0×10^4
	after protein skimmer	2.8×10^5	5.5×10^3
	after biofilter	3.5×10^4	0

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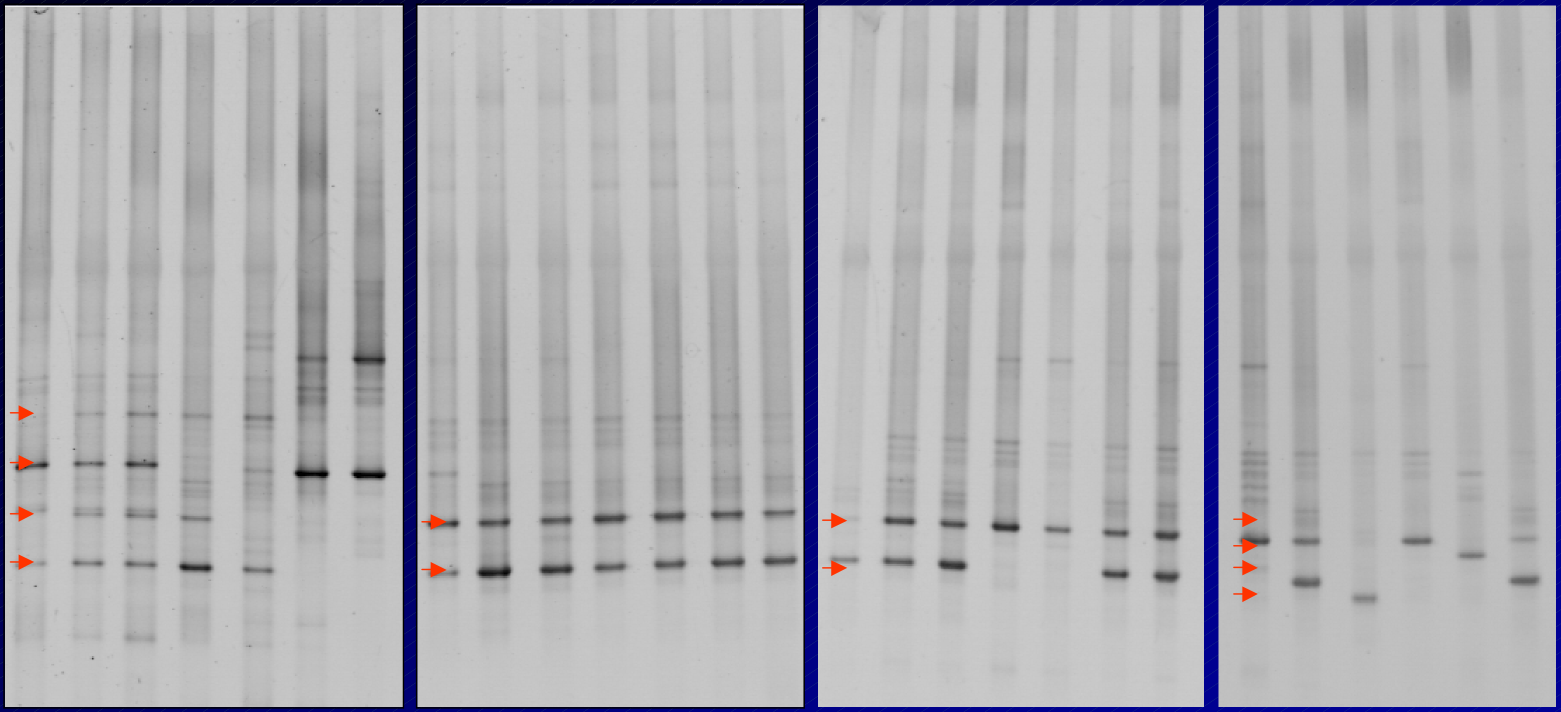
Changes in bacterial communities in rotifer cultures (DGGE)

recirculation technique



Week 1 Week 2 Week 3 Week 4

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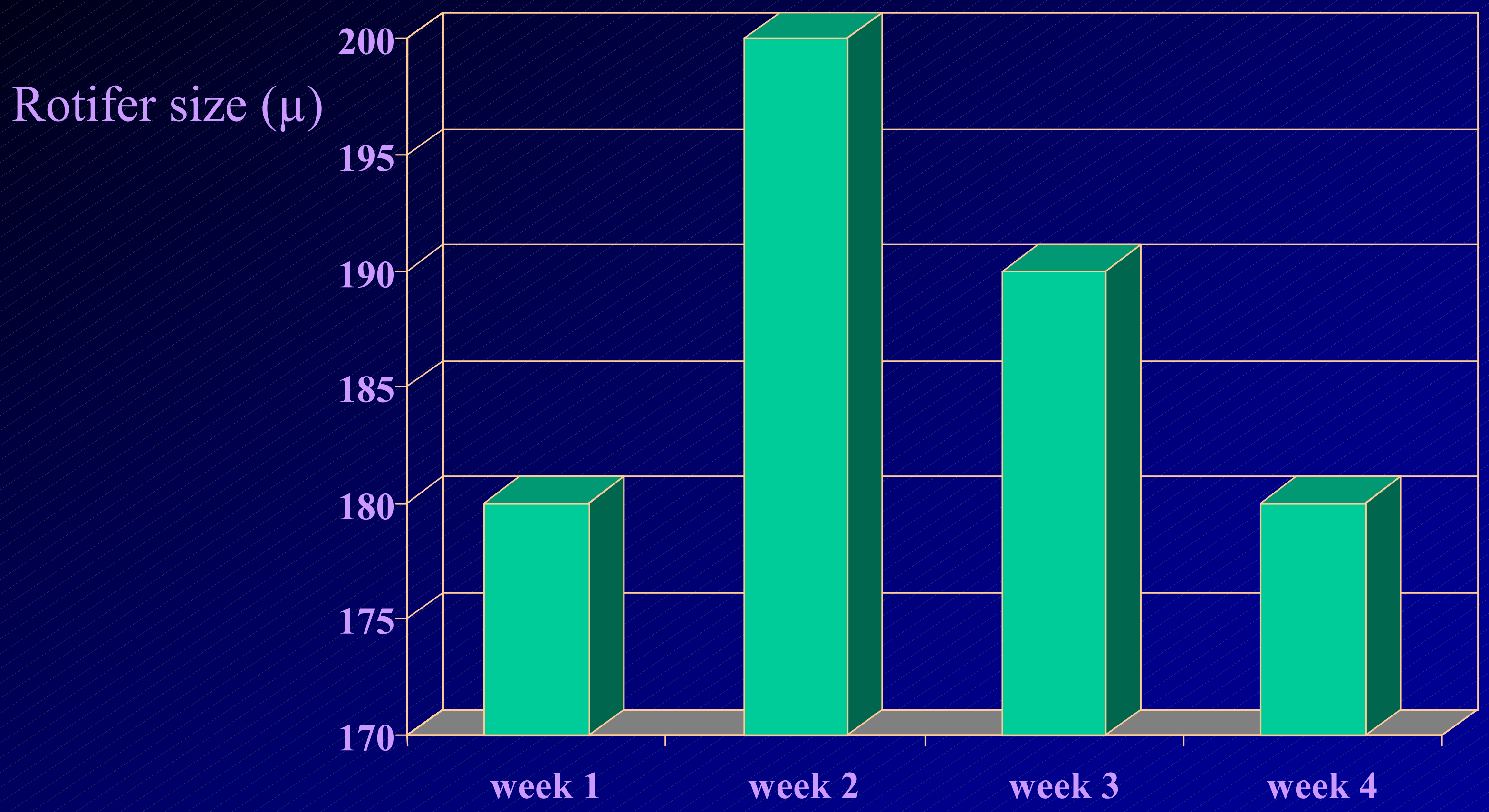
✓ Effect on rotifer quality



✓ Effect on rotifer quality

Formulation of an experimental DHA recirculation diet

Nutritional content of rotifers ($mg.g^{-1}$)

DHA :	10
EPA :	5
DHA/EPA :	2
Σ(n-3) HUFA :	19

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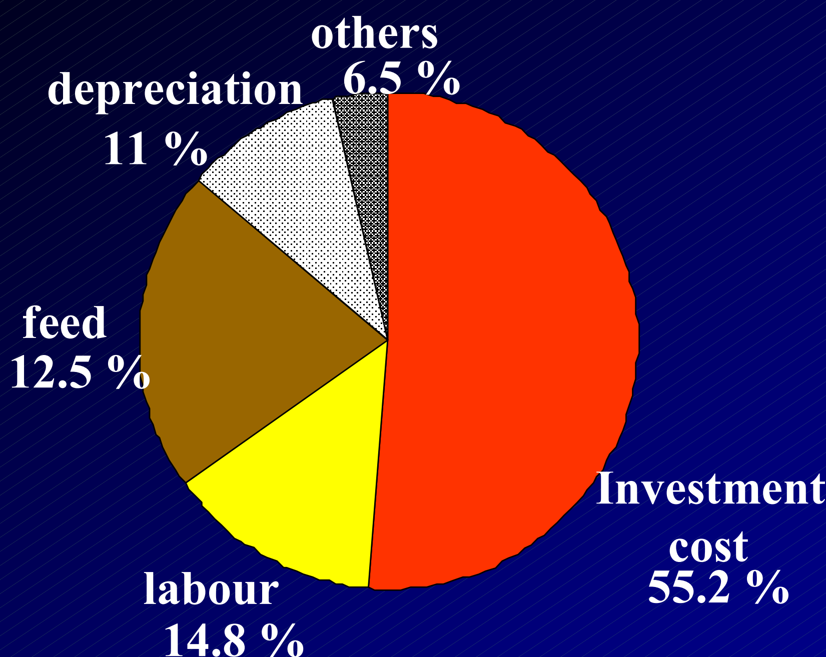
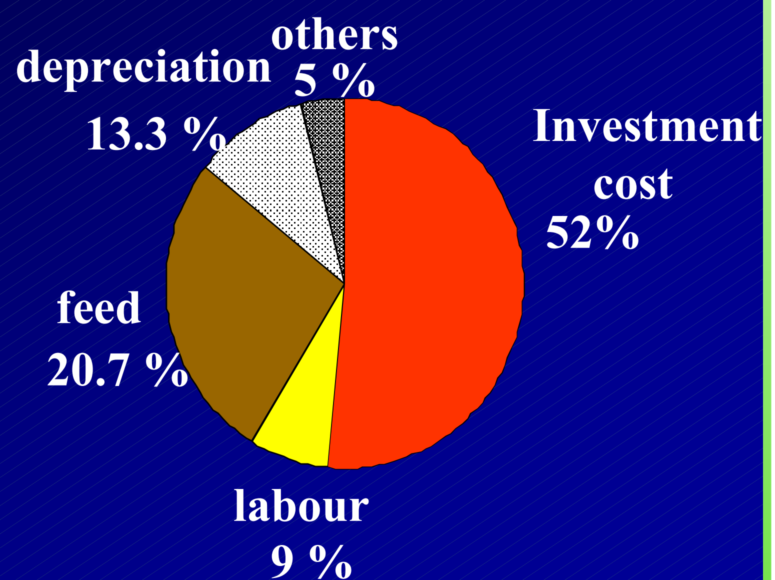
✓Cost estimation

batch system



Total cost : 94,396 €uro

recirculation system



Total cost : 54,000 €uro

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Conclusions

• Reliable daily production of 2.0×10^9 rotifers harvested from the recirculation system during long term culture period (3 weeks)

• More efficient production obtained at 3000 ind./ml stocking density due to a better food covertion rate and higher daily rotifer production

• Stable microflora during the culture period with control on Vibrio's

• Stable nutritional content of harvested rotifers, possibili rotifers with DHA during the rearing period no detri effect of ozone

• Cost efficient production method

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