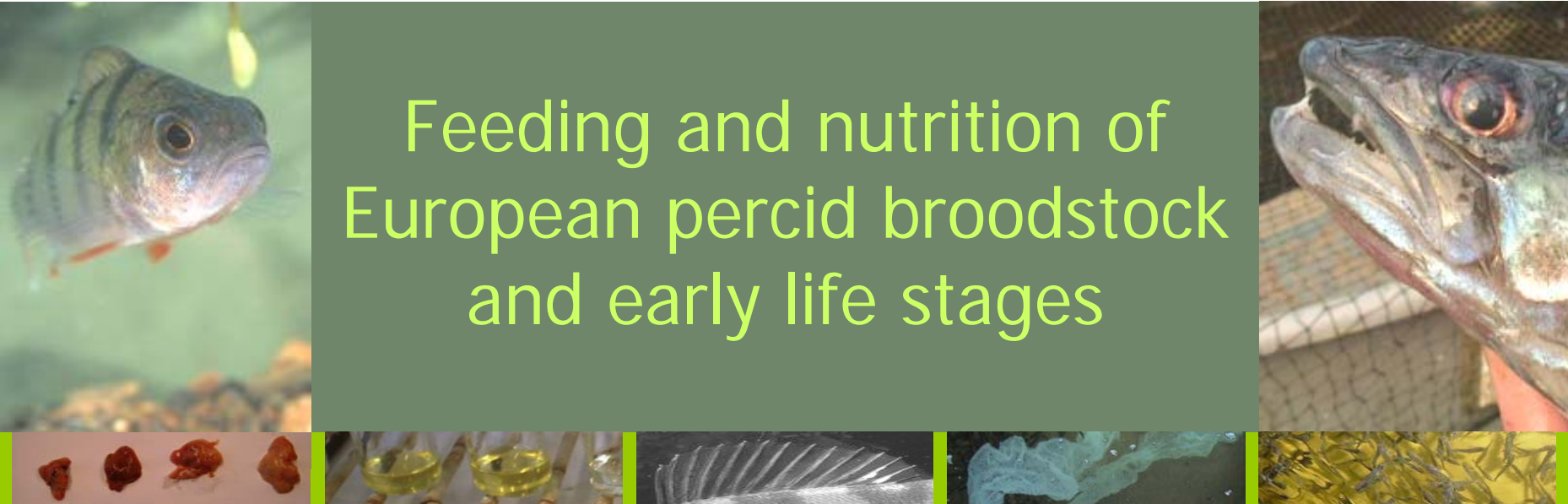


Percid fish culture

From research to production

Namur, Belgium, 23-24 January 2008

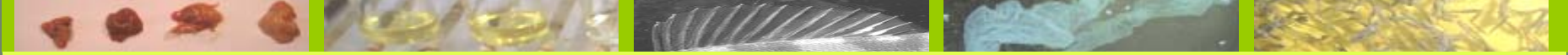


Feeding and nutrition of European percid broodstock and early life stages

P. Kestemont¹, E. Henrotte¹, N. Wang¹, R. Mandiki¹,
N. Hamza^{1,2}, H. Paulsen³ & J. L. Overton³

Design by Germaine Blanchard

1. University of Namur, URBO, Belgium
2. Institut National des Sciences et Technologies de la Mer, Tunisia
3. Danish Institute for Fisheries Research, Denmark



Major issues in European percid culture

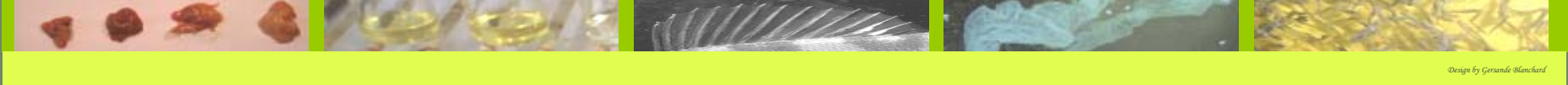
❖ Broodstock fed compound diets

- Low maturation and ovulation rates of breeders
- Reduced fecundity compared to wild breeders
- Low fertilization and hatching rates
- High variability in offspring quality and performances

❖ Larvae fed dry diets as starter feed

- Reduced survival and growth rates
- Increased occurrence of morphological deformities and cannibalism

Broostock feeding and nutrition



Design by Gerardo Blanchard

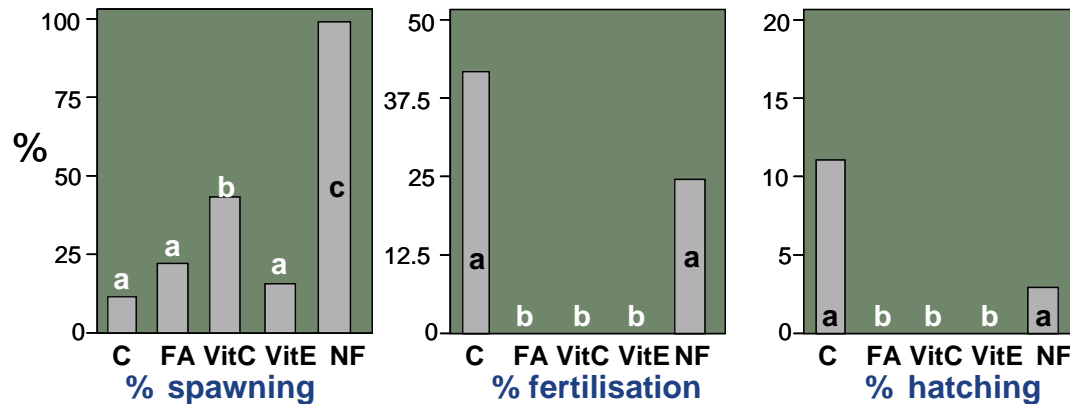
Eurasian perch breeders

Effect of diet on spawning and larval quality (ULG/FUNDP 2001)

- **Control group:** fish in ponds, fed natural preys
- **NF:** fish in RAS, fed «natural food»
- **FA:** fish in RAS, fed trout feed + fatty acid
- **Vit C:** fish in RAS, fed trout feed + vitamin C
- **Vit E:** fish in RAS, fed trout feed + vitamin E



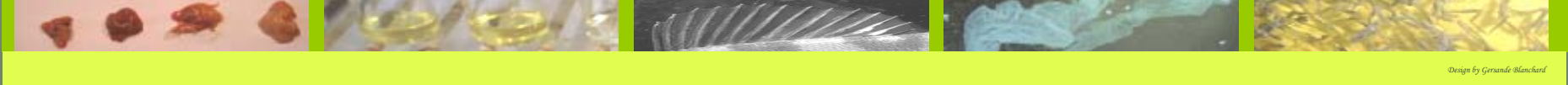
Recirculating system (ULG-CEFRA)



- Similar egg mass in all treatments
- Mass of larvae twice higher in control group
- Similar fatty acid composition of larvae in control and NF groups

Kestemont et al., PERCIS III (2003)

Broostock feeding and nutrition



Design by Gerardo Blanchard

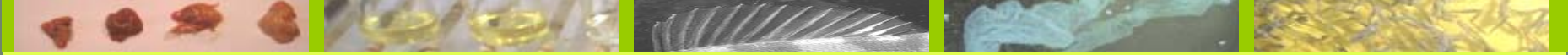
Eurasian perch breeders



What have we learned from this preliminary experiment ?

- Highly significant effect of diet (NF > FA, VitC, VitE)
 - Bad results with trout diet, regardless of nutrient supplementation
- Significant effect of holding conditions (pond > RAS)
 - Environmental factors ?
 - Nutritional factors ?
 - Stress ?

Broostock feeding and nutrition



Design by Gerardo Blanchard

Eurasian perch breeders



Effects of diet composition and holding conditions
(E. Henrotte, 2006-2007)

Diet composition:

- 2 experimental diets with different proportions of DHA/EPA/ARA (Exp diet)
- 1 commercial broodstock diet for salmonids (CDS, only tested in RAS)
- 2 types of forage fish diet (FF)

Holding conditions: pond versus RAS



Recirculating system (ULG-CEFRA)



Pond-based cages (FUNDP-URBO)

Broostock feeding and nutrition



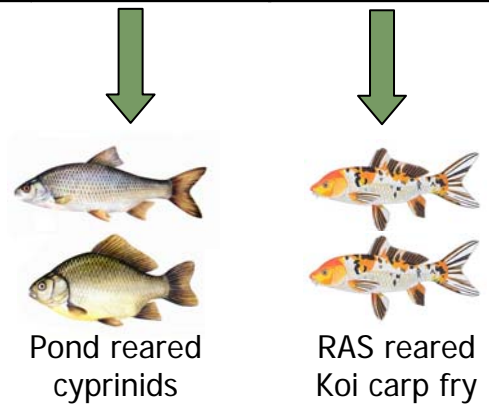
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Eurasian perch breeders



Fatty acid composition of diets

DHA/EPA/ARA	Exp. diet 1 3/2/2	Exp. diet 2 23/9/1	CDS 14/16/1	FF (pond) 2/1/1	FF (RAS) 10/10/1
Cod muscle meal (%)	50.5	50.5			
Menhaden oil (%)	0	16			
Sardine oil (%)	12	0			
Safflower oil (%)	3.2	0			
Vevodar oil (%)	0.8	0			

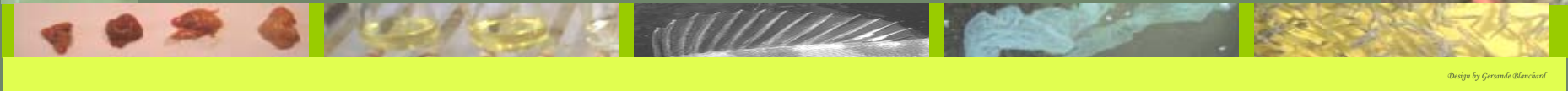


Perch feeding from Aug.06 to Apr.07 (spawning period)

2006						2007						
J	J	A	S	O	N	D	J	F	M	A	M	J



Broostock feeding and nutrition

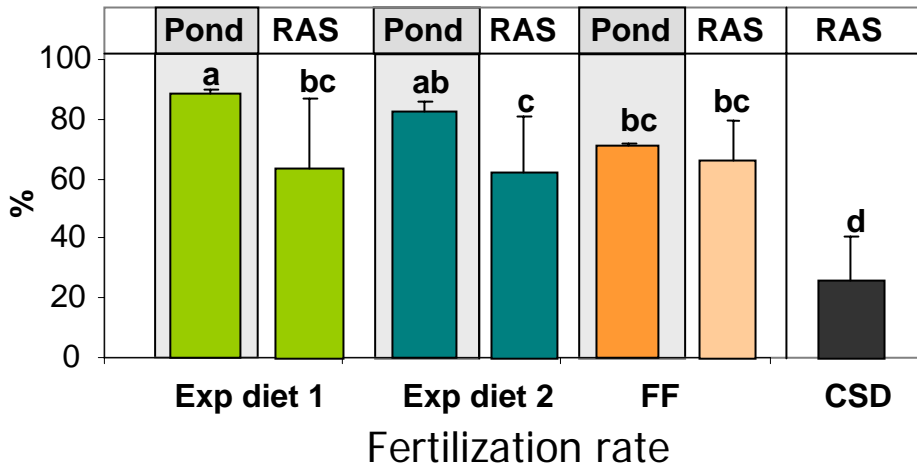


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Eurasian perch breeders

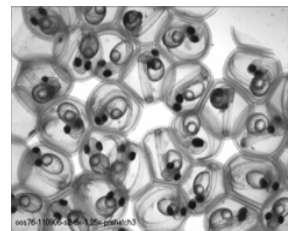


Reproductive performances



Main results

- Fertilization rate 20% higher in pond than in RAS
- Higher fertilization rate of Exp diet 1 than FF in pond reared perch
- No significant differences between Exp diets and FF in RAS
- Highly significant decrease of fertilization rate in perch fed CSD



Broostock feeding and nutrition

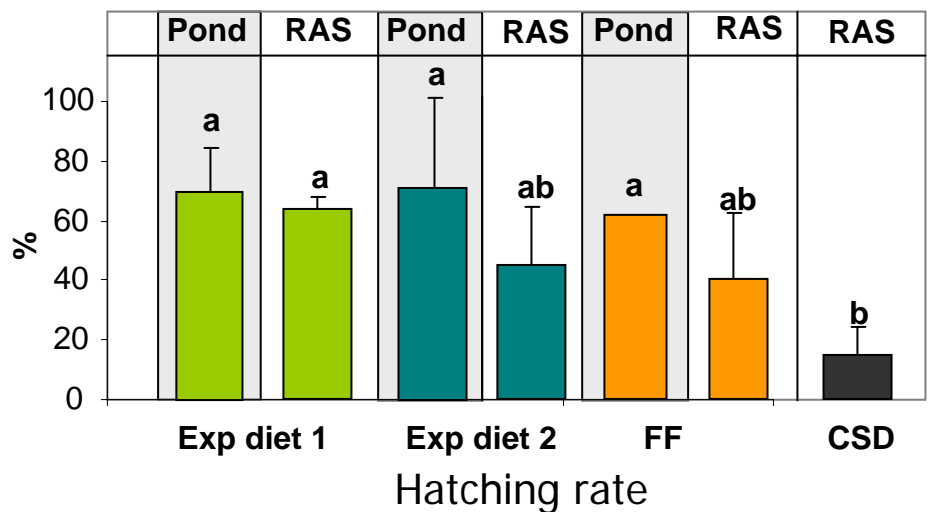


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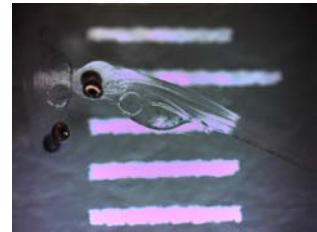
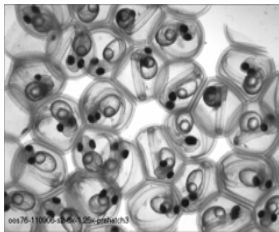
Eurasian perch breeders



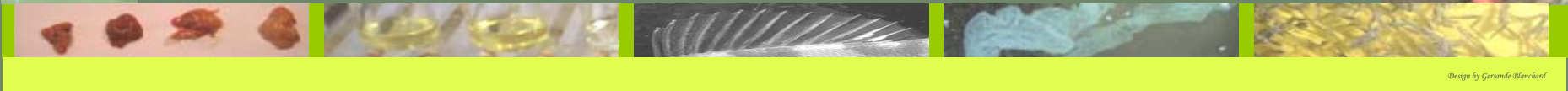
Reproductive performances



- #### Main results
- Higher hatching rate for fish held in pond than in RAS
 - No differences between Exp diets and FF
 - Highly significant decrease of hatching rate in perch fed CSD



Broostock feeding and nutrition



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Eurasian perch breeders

Egg quality : fatty acid composition



Fatty acids	Exp diet 1	Exp diet 2	FF-pond	FF-RAS	CSD
Saturated	18.5	17.5	17.4	18.9	18.1
18:0	0.4b	1.3a	1.2a	1.1a	0.8a
20:0	8.7a	5.0b	6.8a	7.2a	9.7a
Σ MUFA	13.2b	15.1a	15.4a	15.2a	14.0ab
18:1n-9	10.8b	12.6a	12.7a	12.4a	11.8ab
20:1n-9	0.8a	0.4bc	0.9a	0.3c	0.7ab
Σ PUFA n-6	18.6a	18.1a	22.1a	10.6b	16.1a
18:2n-6	17.7a	17.2a	21.1a	9.6b	15.6a
20:4n-6	0.9a	0.9a	1.0a	1.0a	0.5b
Σ PUFA n-3	29.5b	30.9b	26.5c	34.1a	26.7c
18:3n-3	0.3b	0.3b	0.7a	0.2c	0.3b
20:5n-3	2.9b	3.5ab	2.8b	5.3a	3.0b
22:6n-3	21.2a	23.1a	17.5b	22.5a	19.1b
n-3/n-6	1.8ab	1.8b	1.5b	4.4a	1.8ab
ΩHΔ / ΩDA	8.1	6.9	7.0	1.6	5.9
EPA/ARA	3.2b	4.0b	2.7b	5.3a	5.4a

Broostock feeding and nutrition



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Larval quality : resistance to osmotic stress

Stress test during 90 min (2g/L NaCl)

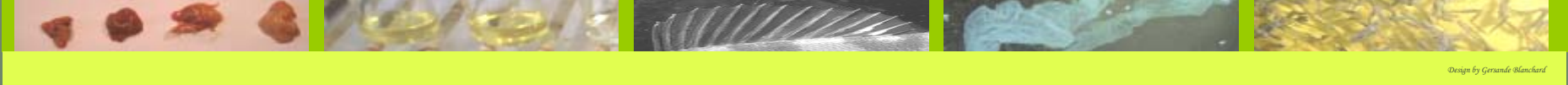
Survival (%)	Pond	RAS
Exp diet 1	55 ± 34	39 ± 25 a
Exp diet 2	16 ± 8	4 ± 3 b
FF	25 ± 5	10 ± 1 a
CDS		0 c

LT 50 (min)	Pond	RAS
Exp diet 1	85 ± 14 A	88 ± 26 a
Exp diet 2	34 ± 18 B	35 ± 1 b
FF	52 ± 11 AB	35 ± 7 b
CDS		18 ± 3 c

Main results

- Higher resistance in larvae from Exp diet 1
- 100% mortality of larvae from CDS after 60 min of stress test
- No significant differences between broodstock rearing conditions

Broostock feeding and nutrition



Design by Gerardo Blanchard

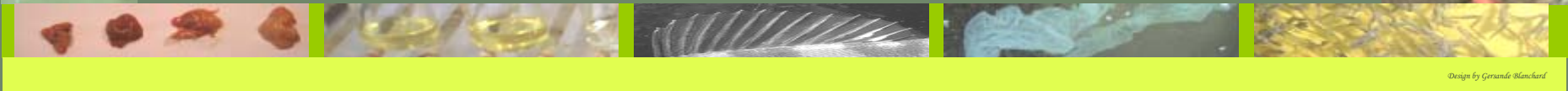
Eurasian perch breeders



What can we conclude from this recent experiment ?

- ❖ Reproductive performances significantly affected by dietary fatty acid composition
- ❖ Poor efficiency of commercial salmonid diet : imbalance in some EFAs
 - little amount of ARA and high level of EPA \Rightarrow inadequately high EPA/ARA
 - potential depressive effect on ARA-derived prostaglandins involved in maturation and ovulation processes
- ❖ High reproductive performances and larval quality with Exp diet 1 (lowest EPA/ARA)
- ❖ Very similar composition of ARA and DHA in eggs from fish fed Exp diet 1, Exp diet 2 and FF, despite significant differences of dietary levels
 - preservation of EFAs playing a major role in embryonic and larval development

Broostock feeding and nutrition



Design by Gerardo Blanchard

Pikeperch breeders

Partial or total replacement of forage fish by dry diet
(Luciopercimprove, 2005-2007)



Three diets in duplicate

- Forage fish FF (100% farmed Koi carp)
- Dry diet DD (commercial diet for salmonid breeders)
- Mix diet (alternately FF and DD)
 - 4 days/week of dry diet
 - 3 days/week of forage fish

Pikeperch broodstock (Excellence Fish, NL)

- Farmed fish produced in RAS
- 22 fish/tank (1 kg b.w.)



Flow through system
Natural temperature
and photoperiod



Broostock feeding and nutrition



Pikeperch breeders

Control of reproduction and spawning



Pikeperch feeding from Sept. 06 to April 07 (spawning period)

2006						2007						
J	J	A	S	O	N	D	J	F	M	A	M	J

One couple injected per treatment per week from 26/03 until end of April

Spawning on nest in 1m³-tank (one couple per tank)



HCG injection



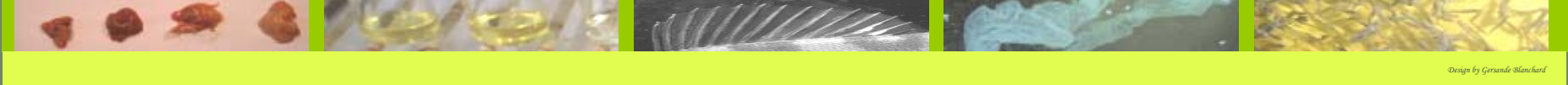
Spawning in tank

Incubation and counting of larvae



Incubation

Broodstock feeding and nutrition



Design by Gerardo Blanchard

Pikeperch breeders



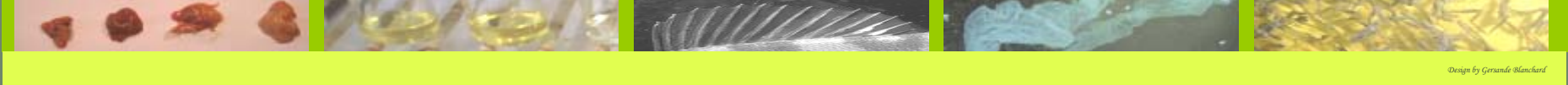
Spawning performances and larval production

Variables	FF	FF/DD	DD
Broodstock growth (%)	31.5	27.5	26.5
Broodstock mortality (%)	14	25	43
Injected couples (n)	8	8	7
Running males (%)	76	89	54
Spawning rate (%)	100	88	57
No hatching (n)	3	1	2
Low hatching rate (n)	2	2	1
High hatching rate (n)	3	4	1

Low hatching rate: <1000 larvae High hatching rate: >2000 larvae

❖ Larval composition (protein, lipid, FA) : similar in all groups

Broodstock feeding and nutrition



Design by Gerardo Blanchard

Pikeperch breeders



Conclusions and perspectives

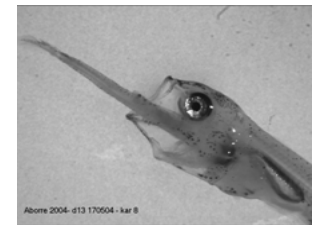
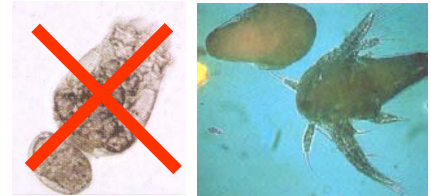
- Significant effects of broodstock diet on spawning performances and larval production
- No effects on larval size and biochemical composition
- Mixed diet, combining forage fish and dry diet, can be recommended in the mid-term
- Effects of fatty acid ratio (DHA/EPA/ARA) on gonad maturation under investigation

Larval feeding and nutrition



What we already know in perch and pikeperch larval feeding

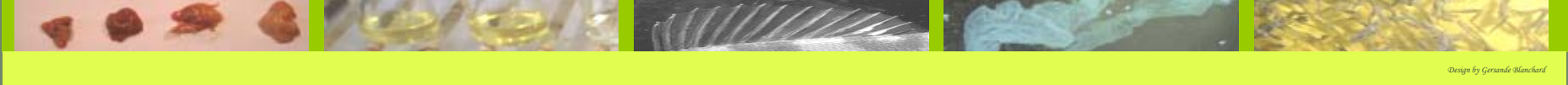
- Larvae are relatively small (5mm, 0.6-0.9mg at hatching)
- Most larvae (not all) accept *Artemia* nauplii from YSR
 - small-size nauplii recommended
 - no beneficial effect of 1st feeding with rotifers
- Dry diet accepted as starter feed but significant reduction of growth and survival (except Ostaszewska et al., 2005)
- High occurrence and impact of cannibalism (Kestemont et al., 2003)



Ostaszewska et al., Aquaculture Research, 2005
Kestemont et al., Aquaculture, 2003



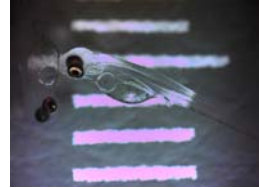
Larval feeding and nutrition



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Eurasian perch larvae

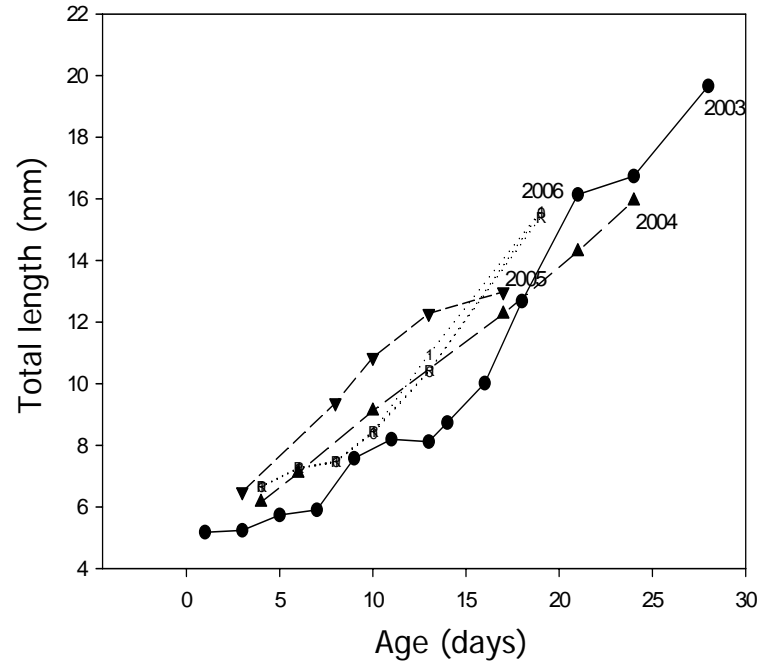
Larval rearing trials at Bornholms Hatchery (Denmark)



Incubation and larval rearing



Production of weaned juveniles



- High variations in larval growth between years
- No differences between newly-hatched, one-day old and HUFA enriched *Artemia*





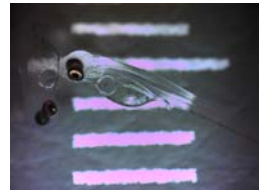
Larval feeding and nutrition



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Eurasian perch larvae

Start feeding : replacing Artemia with dry food



Length (mm)

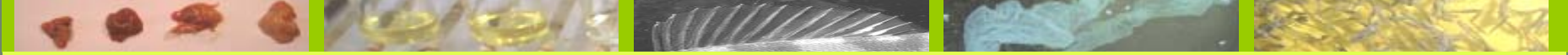
Year	days (p.h.)	Artemia	Partial D0	Partial D10	Full D0	Full D10
2004	24	15.5 – 16.4	13.6 – 13.8	14.2 – 15.2	9.4 – 10.3	12.8 – 13.1
2005	17	12.7 – 13.4	11.8 – 12.2		9.1 – 9.7	12.4 – 12.9
2006	19	15.6	11.3 – 12.1	14.6		

Survival (%)

Year	days (p.h.)	Artemia	Partial D0	Partial D10	Full D0	Full D10
2004	26	44.0 – 42.3	85.9 – 41.7	51.8 – 52.3	5.1 – 7.8	50.4 – 25.0
2005	17	69.1 – 76.5	57.8 – 88.7		13.1 – 22.7	72.1 – 74.7
2006	19	29.5	10.2 – 19.6	26.3		

- Marked reduction of survival and growth if full replacement of *Artemia* with dry diet from D0
- No or marginal differences if partial replacement from D0 or full replacement from D10

Larval feeding and nutrition



Design by Gerardo Blanchard

Pikeperch larvae

Effects of weaning time and diet composition
(Kestemont et al., 2007)



Optimal weaning time

- Control: *Artemia* nauplii from day 2 post-hatch (ph)
- Weaning time (days ph): 12, 18, 26 (triplicate)

Diet composition

- *Artemia* nauplii vs enriched nauplii
- Microdiets formulated for freshwater vs marine fish

Measured variables

- Growth, survival and cannibalism
- Malformation rate and type, body composition



Experimental larval recirculation unit
FUNDP/URBO

Kestemont et al., *Aquaculture*, 2007

Larval feeding and nutrition

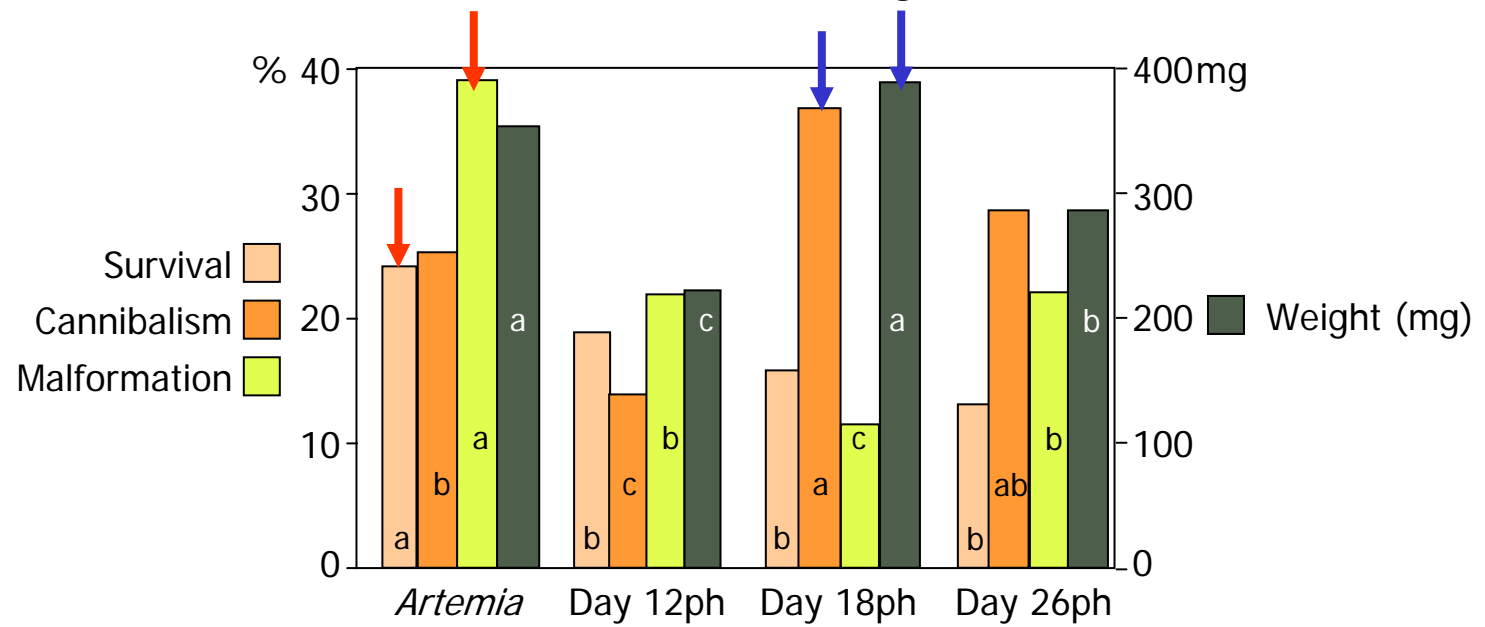


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Pikeperch larvae



Effects of weaning time



- • Highest survival with *Artemia* nauplii, but also highest malformation rate
- • Best growth rate when pikeperch weaned on day 18ph, but highest cannibalism

Kestemont et al., Aquaculture, 2007



Larval feeding and nutrition

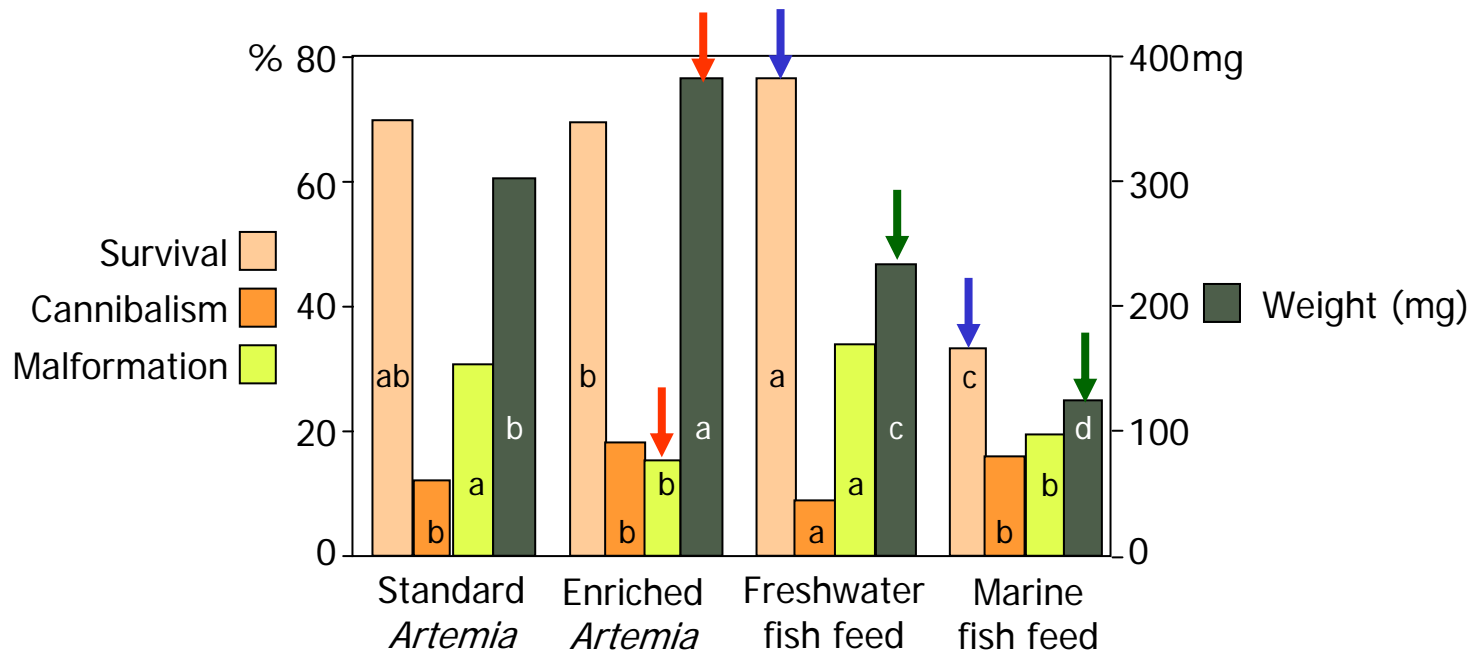


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Pikeperch larvae



Effects of diet composition



- ➔ • Highest growth and lowest deformity rates in pikeperch fed enriched *Artemia* nauplii
- ➔ • Survival and growth rates significantly higher in pikeperch fed freshwater fish feed compared to marine fish feed
- ➔

Kestemont et al., Aquaculture, 2007





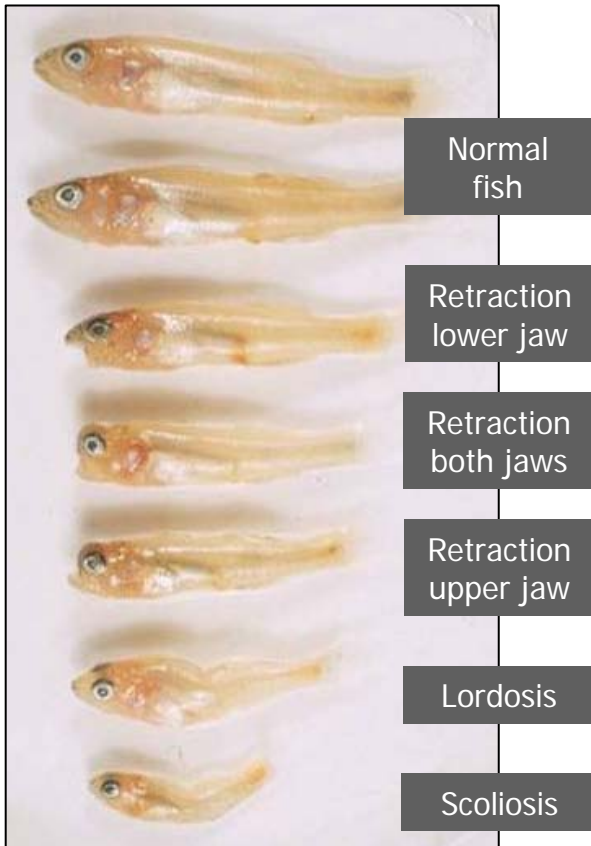
Larval feeding and nutrition



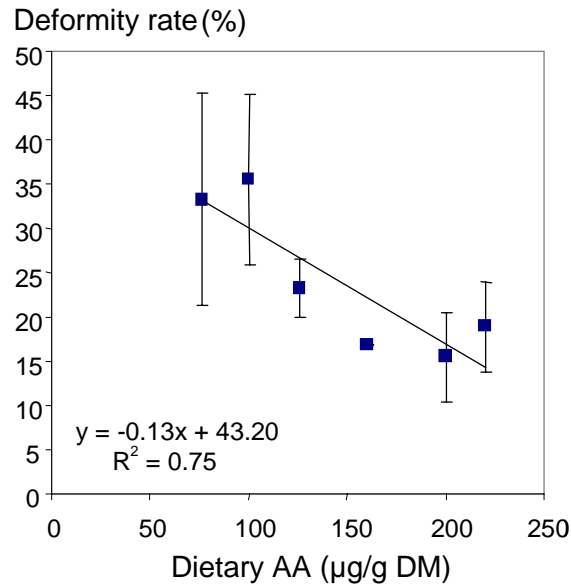
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Pikeperch larvae

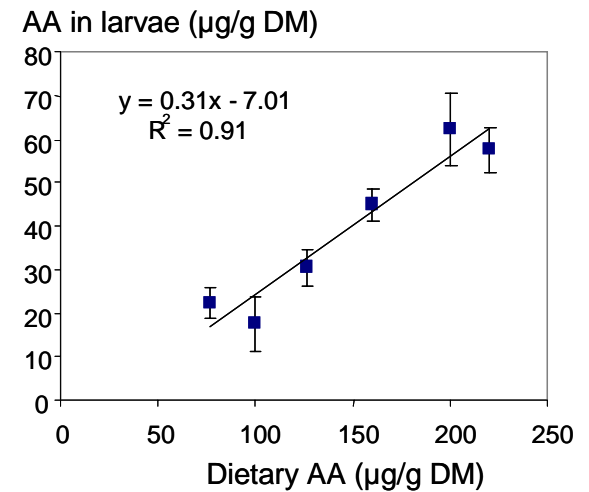
Malformations and dietary vitamin C enrichment



Relation between dietary ascorbic acid and deformity rate



Relation between ascorbic acid content in diets and larvae



Kestemont et al., Aquaculture, 2007





Larval feeding and nutrition



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Pikeperch larvae

Effects of dietary phospholipid level on larval performances (Hamza et al., 2008)



Three microdiets (IFREMER patent WO0064273)

- 45% crude protein, 18% crude lipid
- Different levels of soybean lecithin and cod liver oil
 - 1.5% phospholipids (PL1)
 - 4.7% phospholipids (PL5)
 - 9.5% phospholipids (PL9)
- Four tanks per diet



Larval RAS at INSTM (Tunisia)

Pikeperch larvae

- Produced in The Netherlands (Viskweekcentrum Valkenswaard)
- Shipped to Tunisia on day 2 post-hatch (ph)
- Reared in RAS and fed *Artemia* nauplii from day 3 to day 9
- Weaned on dry microdiets from day 10-14 ph



Viskweekcentrum Valkenswaard (NL)



Larval feeding and nutrition

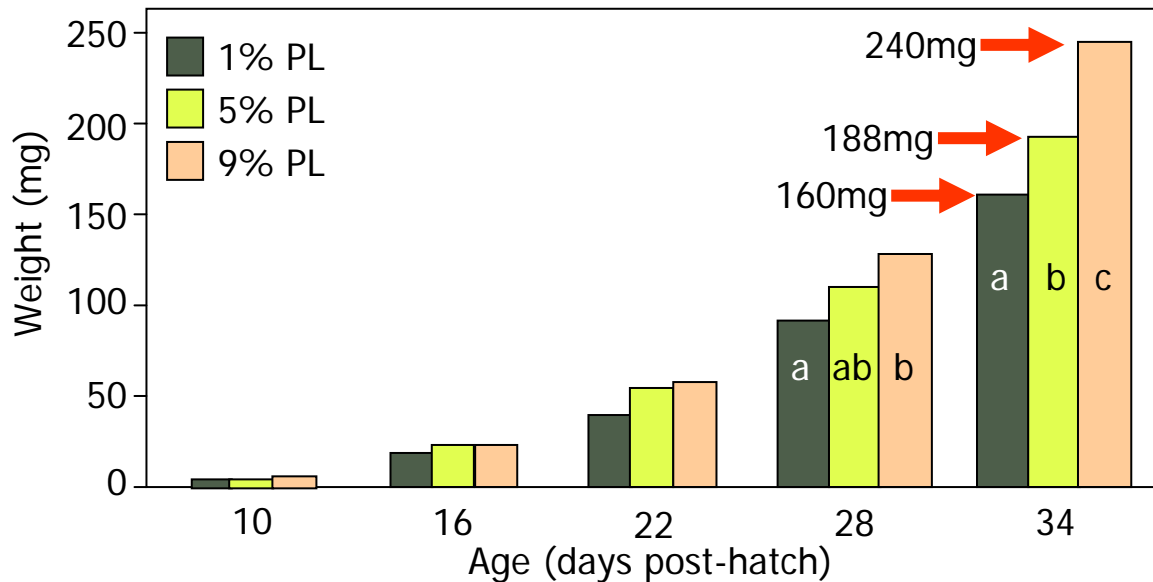


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Pikeperch larvae



Growth, enzyme activities and deformities

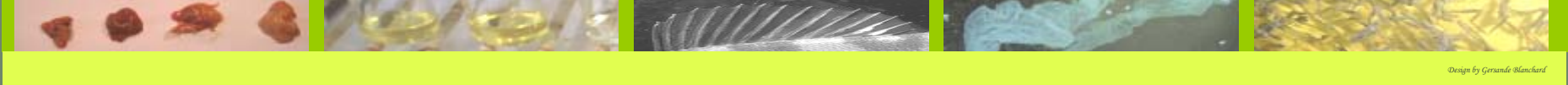


- No effects on survival (33-36% on day 34ph)
- Effects on enzymatic activities in cytosol and brush border membrane (gut maturation)
- No effects on skeletal deformities (7-12%) (non inflation of swim bladder)

Hamza et al., Aquaculture, 2008



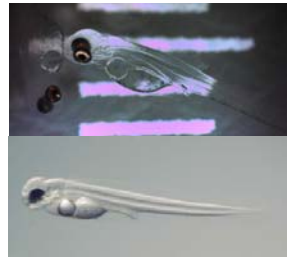
Larval feeding and nutrition



Design by Gerardo Blanchard

Perch and pikeperch larval production

Conclusions and perspectives



- Best performances when larvae are fed *Artemia* nauplii
 - Potential improvement by using *Artemia* enriched with HUFA and Vitamin C
- Weaning at day 10 (perch) to day 18 (pikeperch) without significant impairment of larval performances
- Fish feed formulated for freshwater species more suitable than marine fish diets
- Nutritional studies still needed but significant improvement with diets enriched with phospholipids