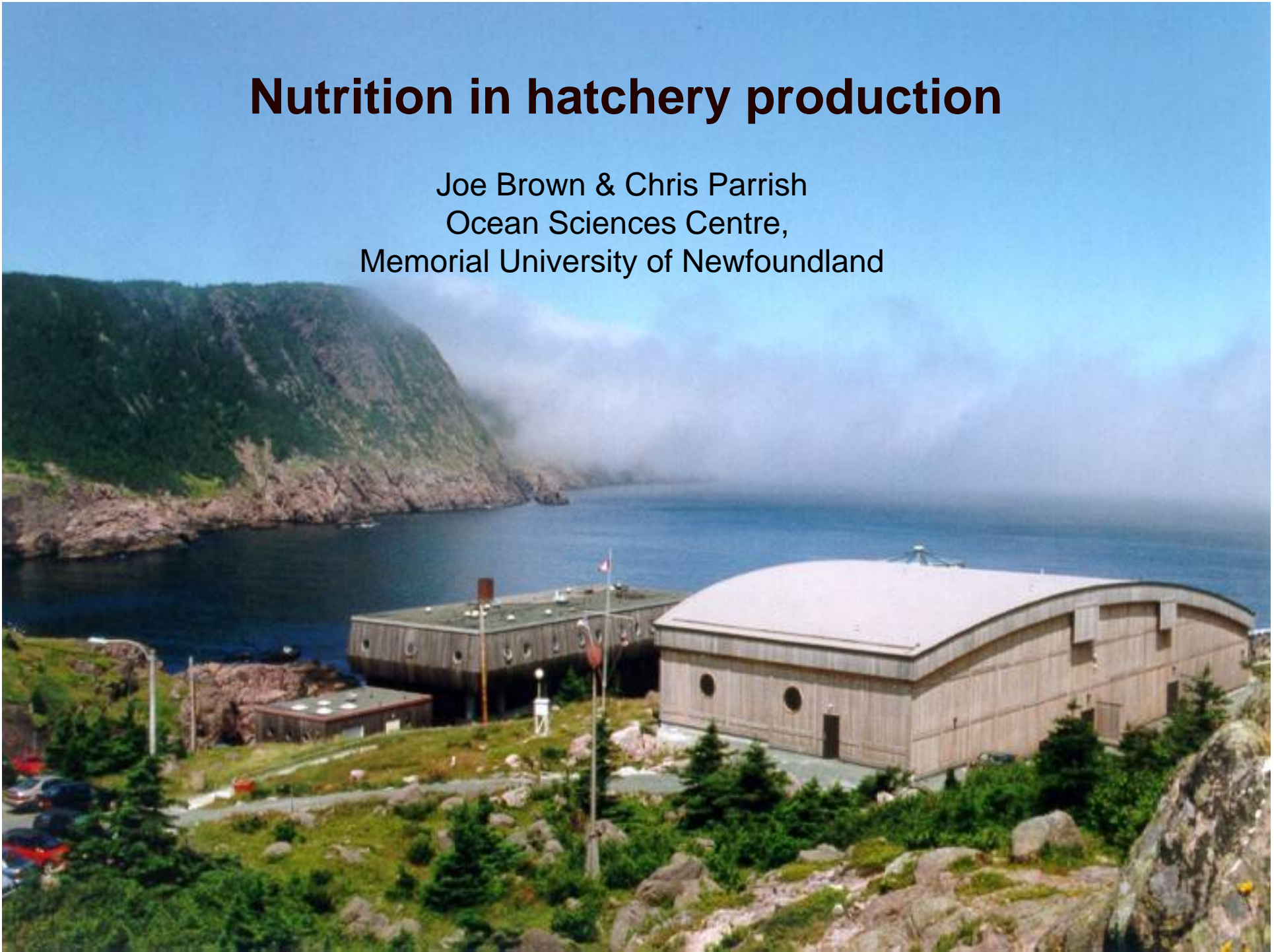


Nutrition in hatchery production

Joe Brown & Chris Parrish
Ocean Sciences Centre,
Memorial University of Newfoundland





Collaborators & students

Dr H. Park

Dr V. Puvanendran

Alexandre Garcia

Anne Kellett

Lynn Lush

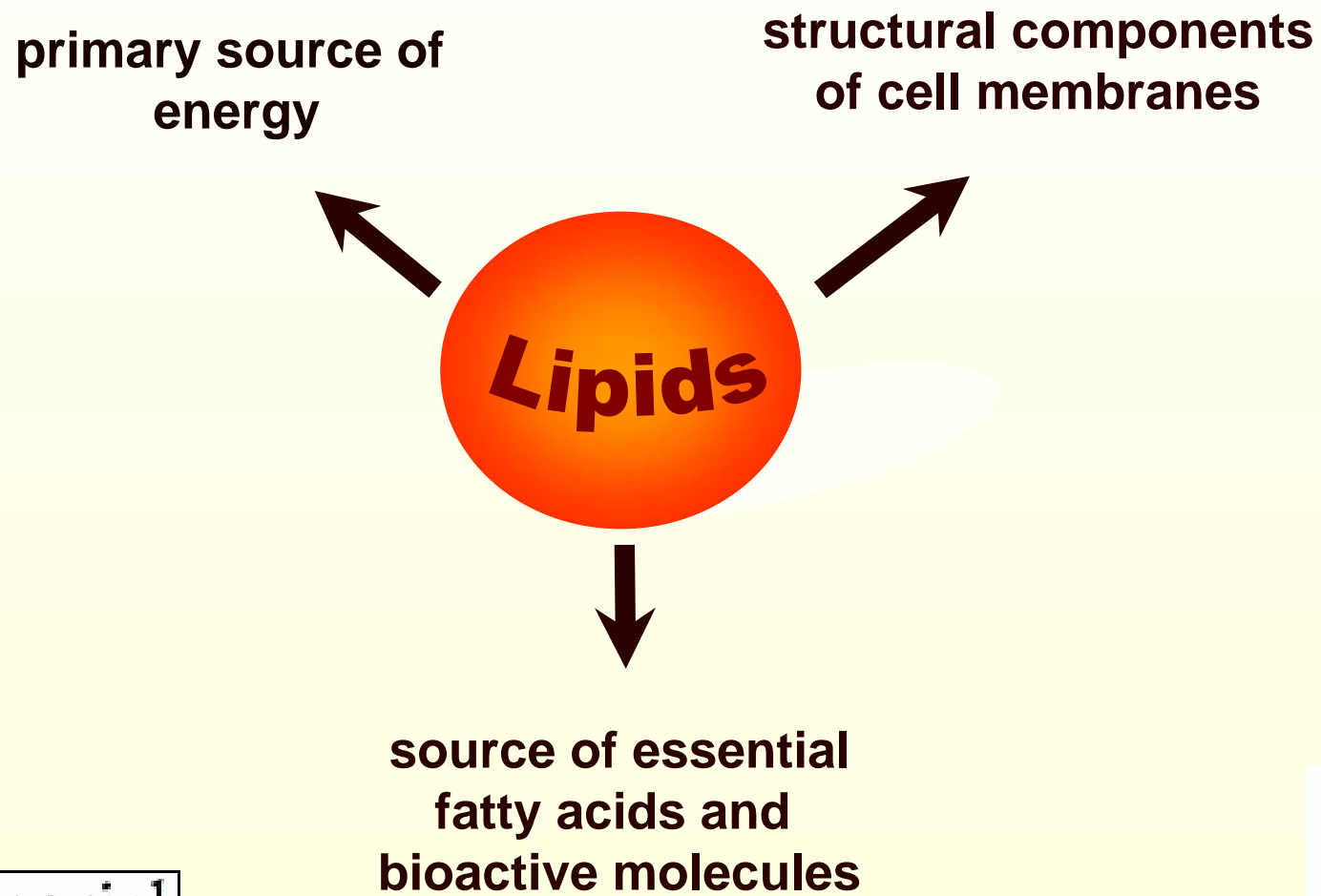
Kelly O'Brien-MacDonald

Joy Wade

Outline of presentation

- **Will present a series of three studies:**
 - **results of two are in press**
 - **third, analysis ongoing**
 - **all focus on performance of cod larvae and rotifer enrichment**

Introduction



Background



**Important starter
feed used in larviculture.**

Dhert *et al.* (2001)

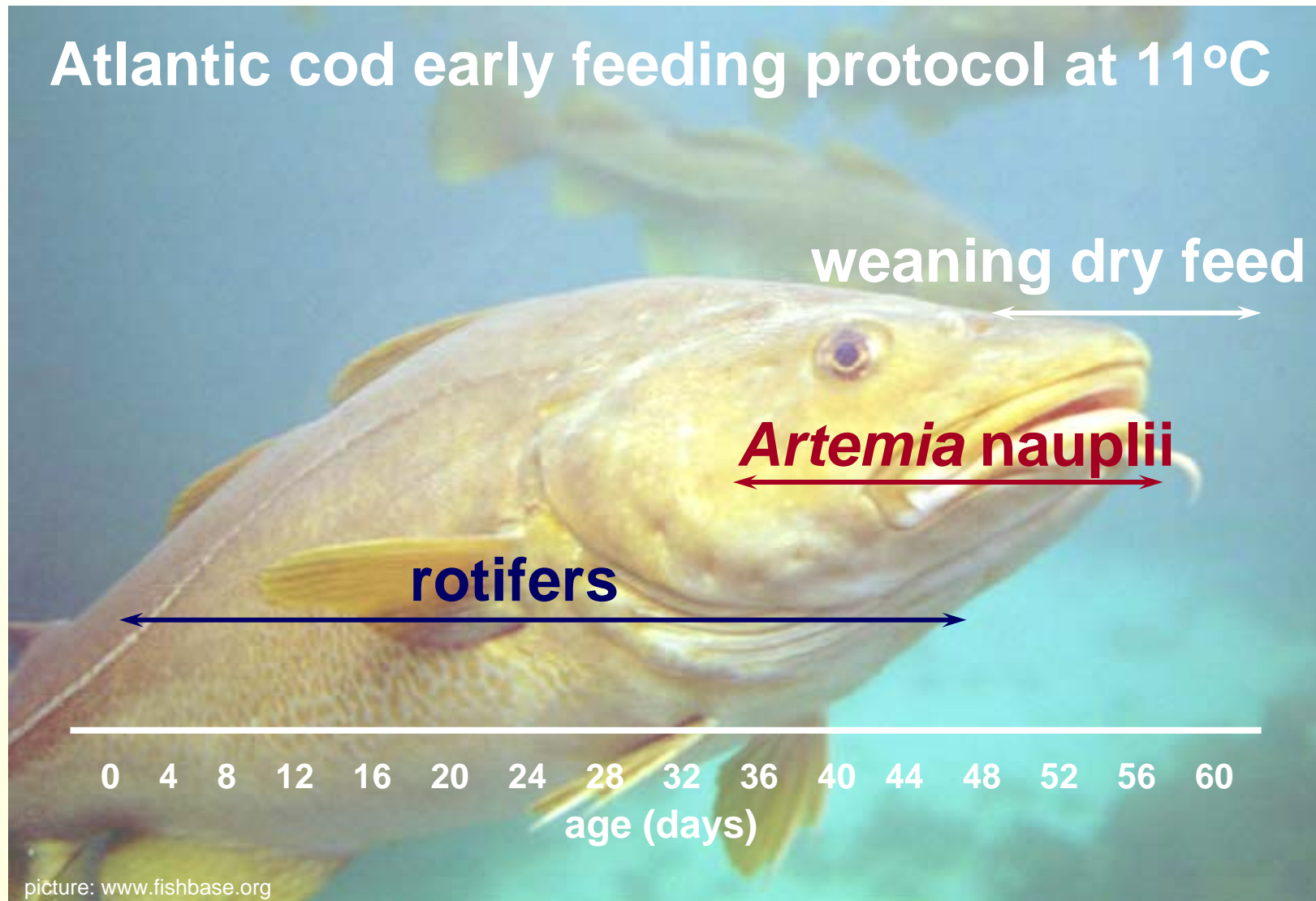


**40 % of the total aquaculture
demand for feeds for early stages**

Sorgeloos *et al.* (2001)

Background

Brown *et al.*, 2003



Background

*Bell *et al.* (2003)

**Sargent *et al.* (1999)



copepods*



rotifers*



*Artemia**



cod larvae**

	copepods*	rotifers*	<i>Artemia</i> *	cod larvae**
DHA‡	21.8 - 30.3 %	0.1 %	0.0 %	30.2 %
EPA‡	6.8 - 10.8 %	0.2 %	5.3 %	15.0 %
AA‡	0.8 - 1.8 %	trace	1.2 %	1.8 %

‡ % of total fatty acids

Materials and methods



first feeding tank



live-food enrichment tank

Integrating growth, behaviour and digestive enzyme activity in larval Atlantic cod (*Gadus morhua*): response to rotifer lipids.

O'Brien-MacDonald, Brown, Parrish ICES J Mar Sci in press

- Investigate the variability in digestive development in response to the quantity of lipid in the rotifer enrichment.
- Survival, growth, behaviour and digestive enzyme data from hatching to metamorphosis (0-450 dd [degree-days]) were measured.
- Four treatments were used in triplicate: high lipid rotifer enrichment, low lipid rotifer enrichment, green water and unfed.

Rotifer enrichments: *Brachionus plicatilis*

LL (T. iso) rotifers

7.1% DW lipid:

5.1% TAG

21.4% PL

HL (AlgaMac) rotifers

11.2% DW lipid:

20.6% TAG

21.6% PL

Lipid ($\mu\text{g}/\text{mg dw}$):

4.4

7.8

DHA:

0.1

12.0

EPA:

0.5

3.2

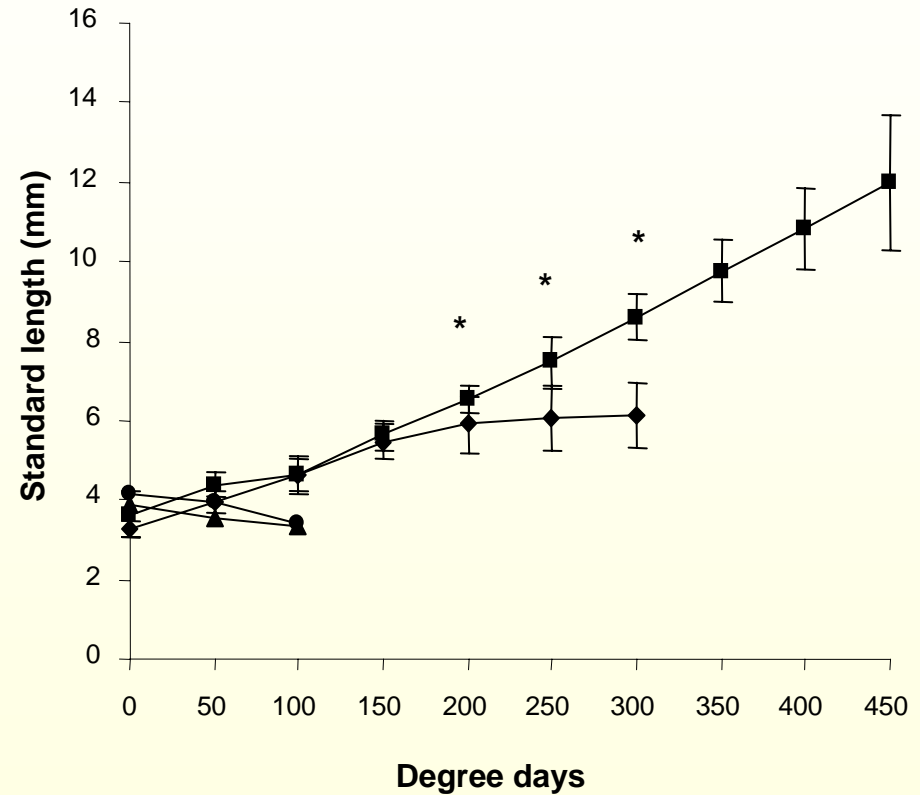
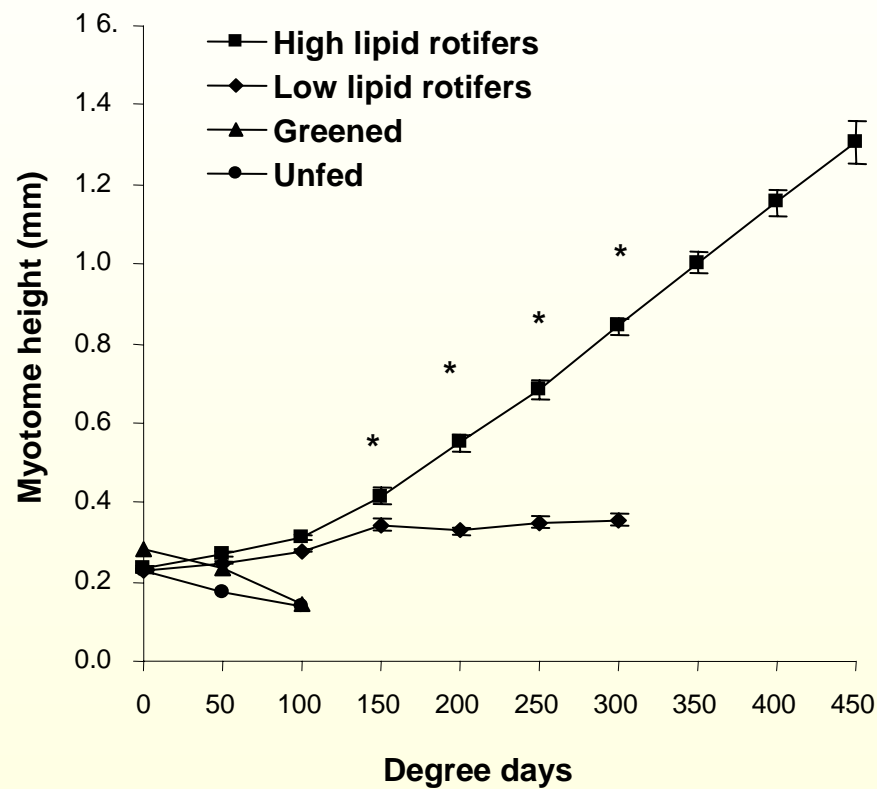
DHA:EPA

0.3

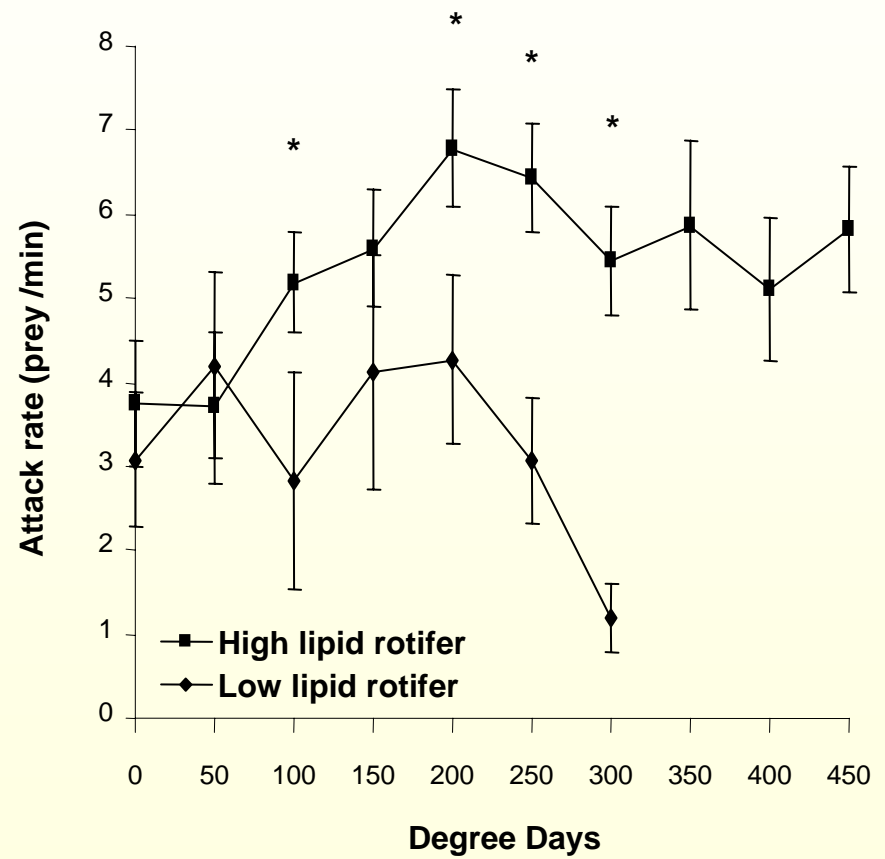
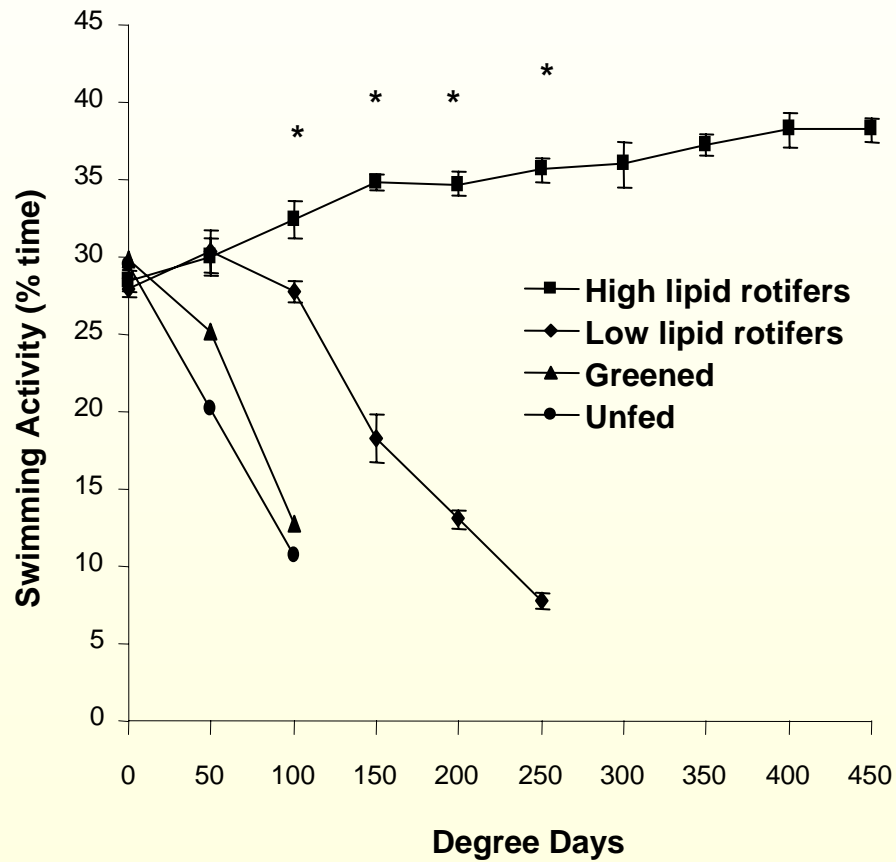
3.7



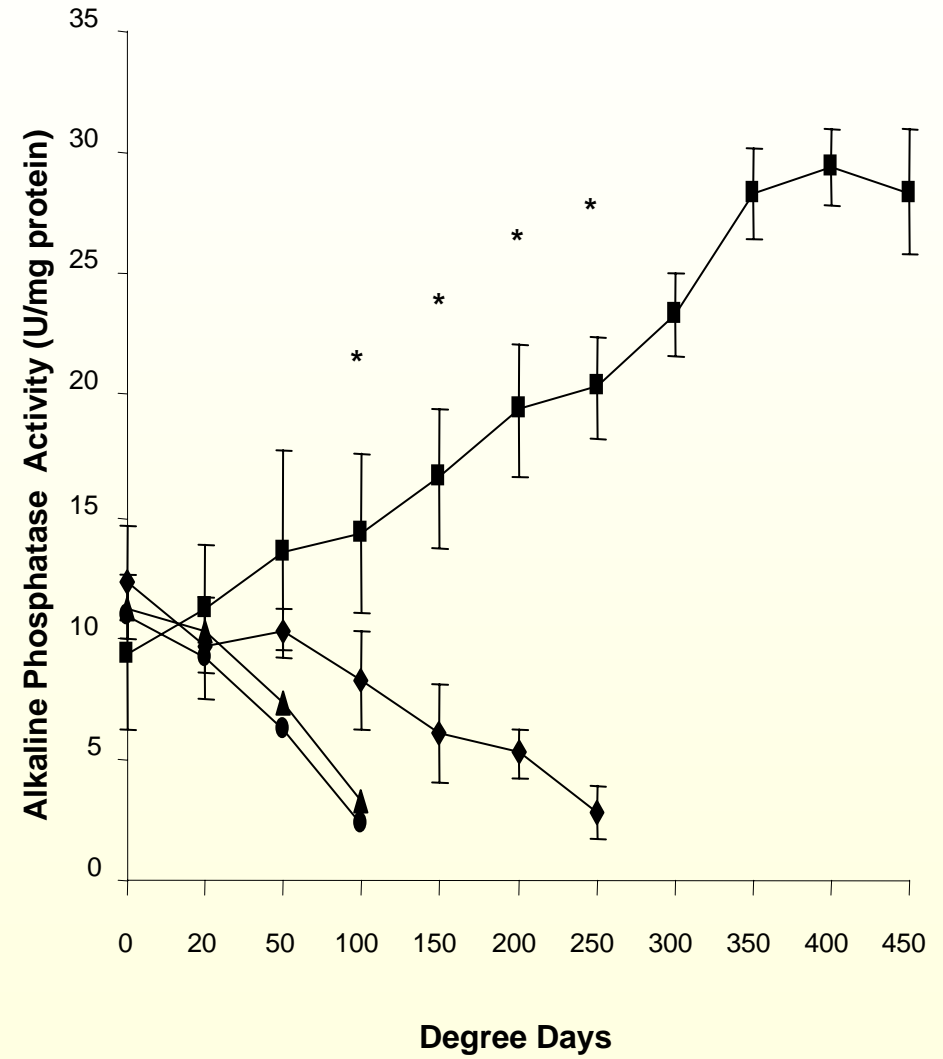
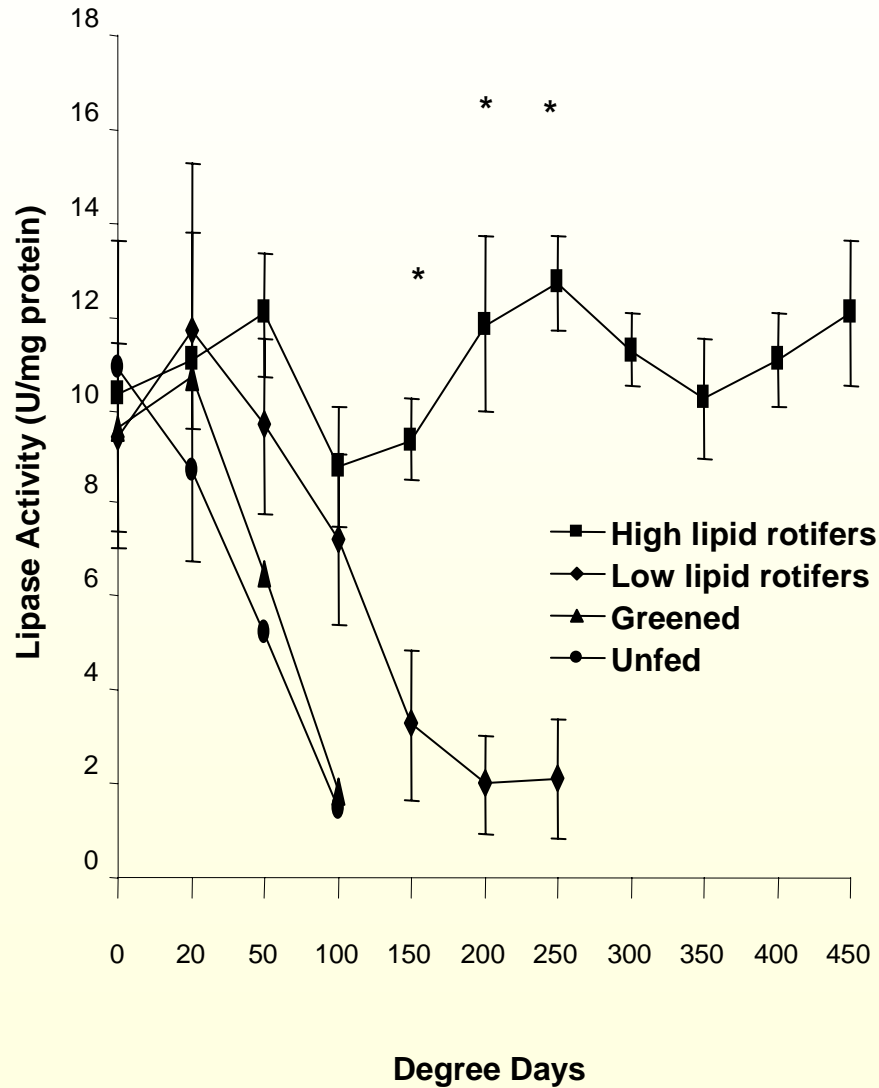
Myotome height and standard length of cod larvae



Swimming activity and attack rate (captures+misses)



General lipase activity and alkaline phosphatase activity



O'Brien-MacDonald, Brown, Parrish: Summary

- Swimming activity and attacks (captures + misses) on prey were higher in the high lipid group by 100 dd and increased over time.
- No differences between digestive enzyme activity for the unfed and greened treatments.
- Low lipid larvae had lower activity levels by 100-150 dd for all enzymes.
- Larvae in the unfed and green water treatments did not survive past 100 dd.
- Suggests that a higher quantity of lipid in the rotifer enrichment promotes higher growth and survival and provides more energy to allow larvae to capture more prey.

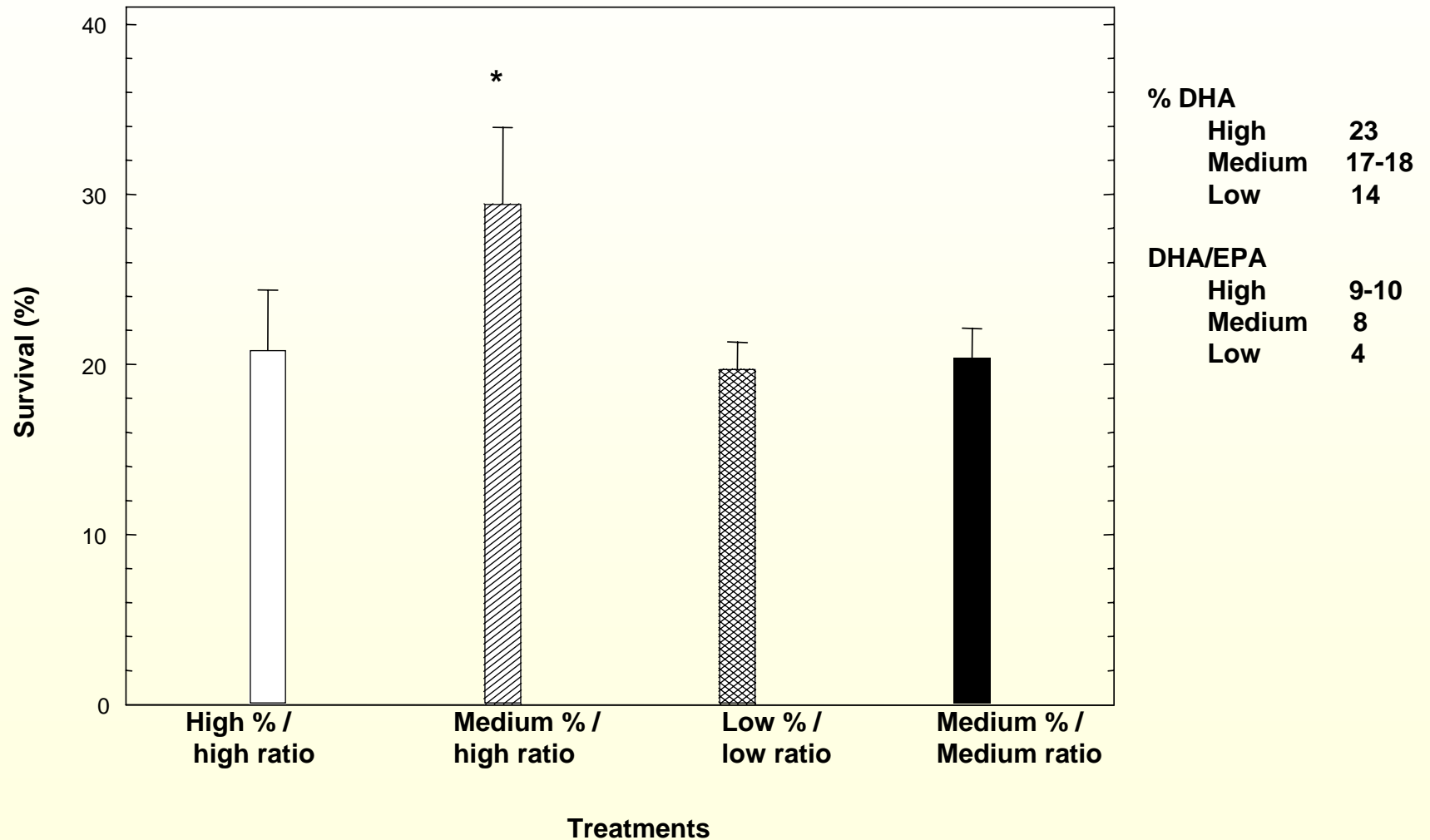
Effect of enriched rotifers on growth, survival and composition of Atlantic cod (*Gadus morhua*) larvae.

Park, Puvanendran, Kellett, Parrish, Brown ICES J Mar Sci in press

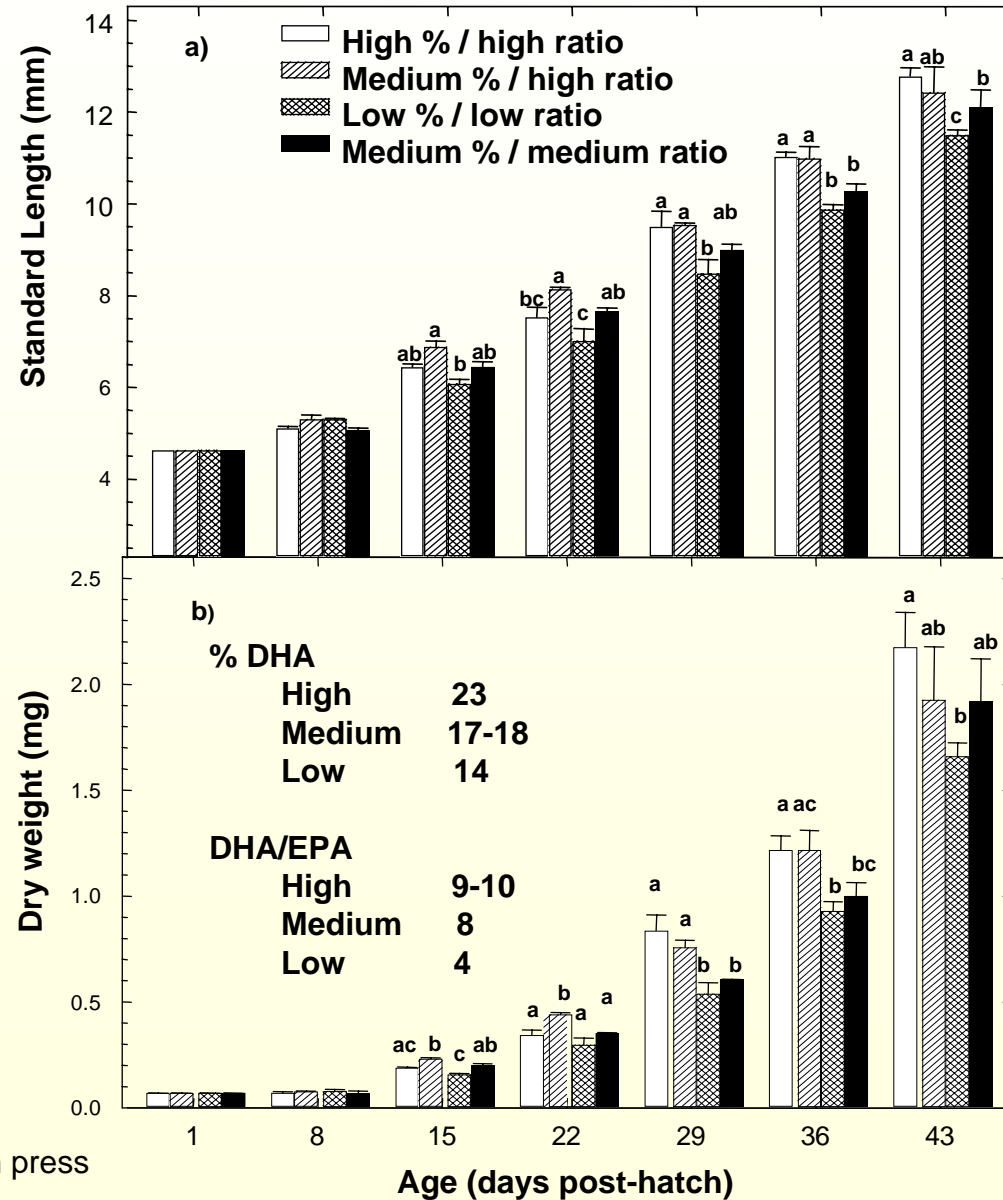
- Used three different commercial rotifer enrichment diets and a mixture of one diet with *Chlorella*.
- Cod larvae were fed rotifers with different proportions of docosahexaenoic acid (DHA) and ratios to eicosapentaenoic acid (EPA).



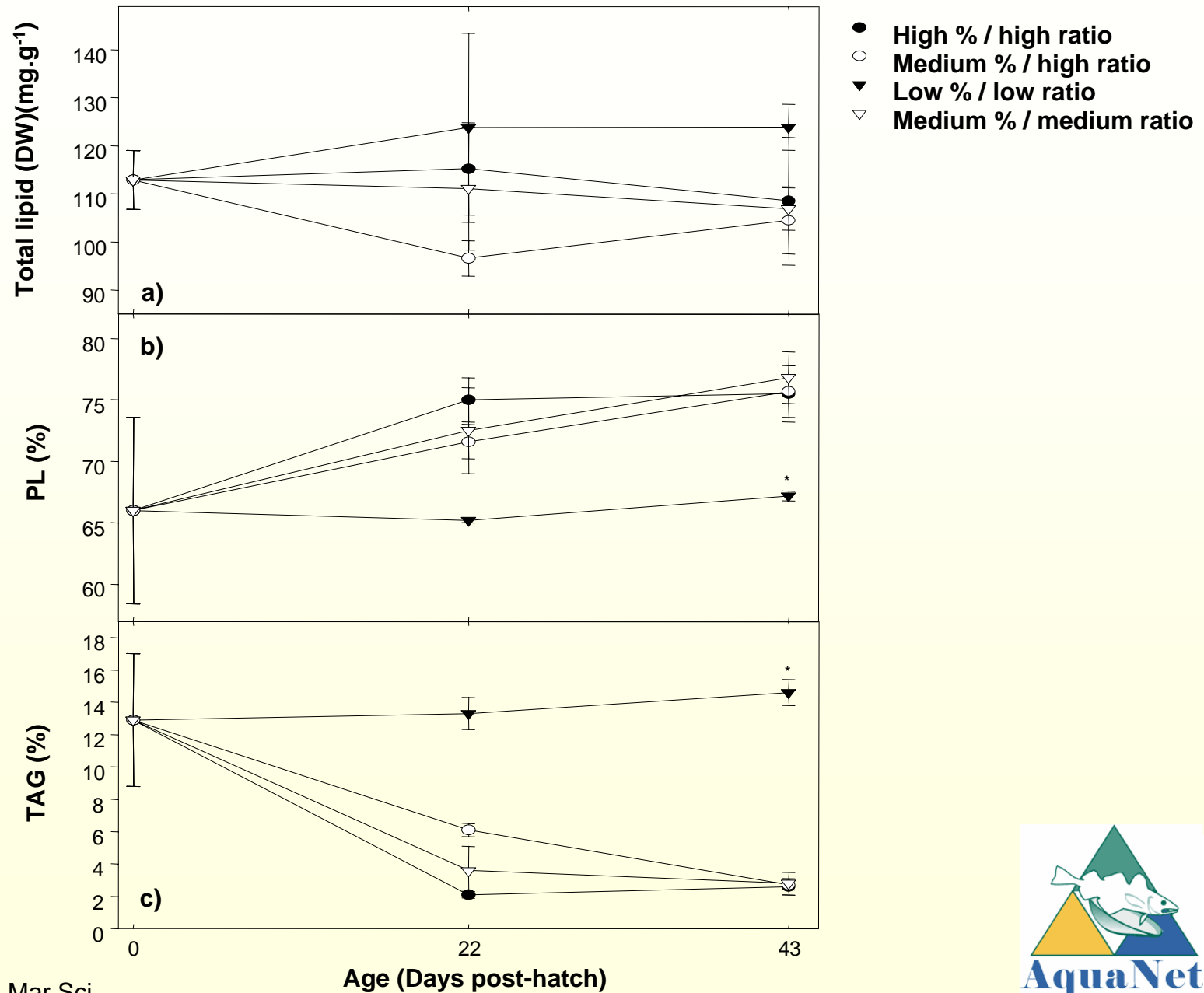
Survival of Atlantic cod larvae fed four differently enriched rotifers



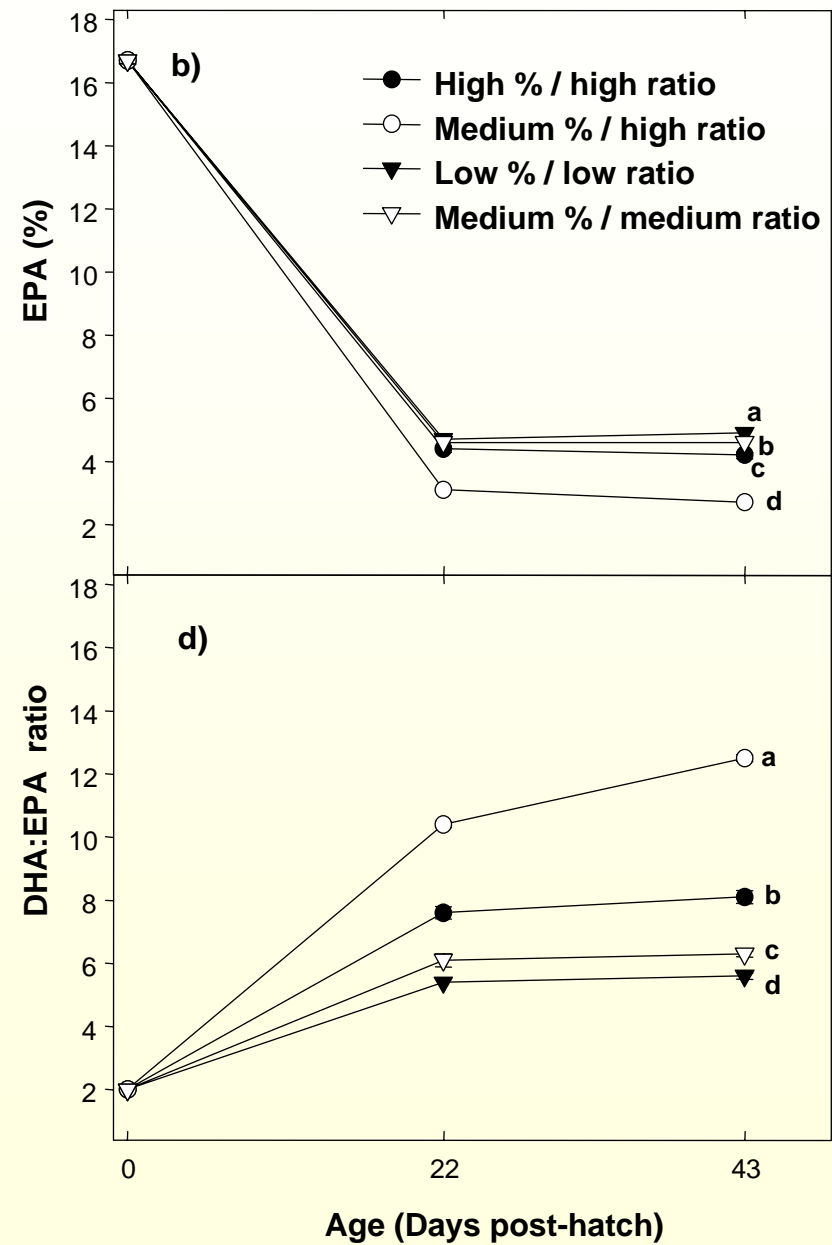
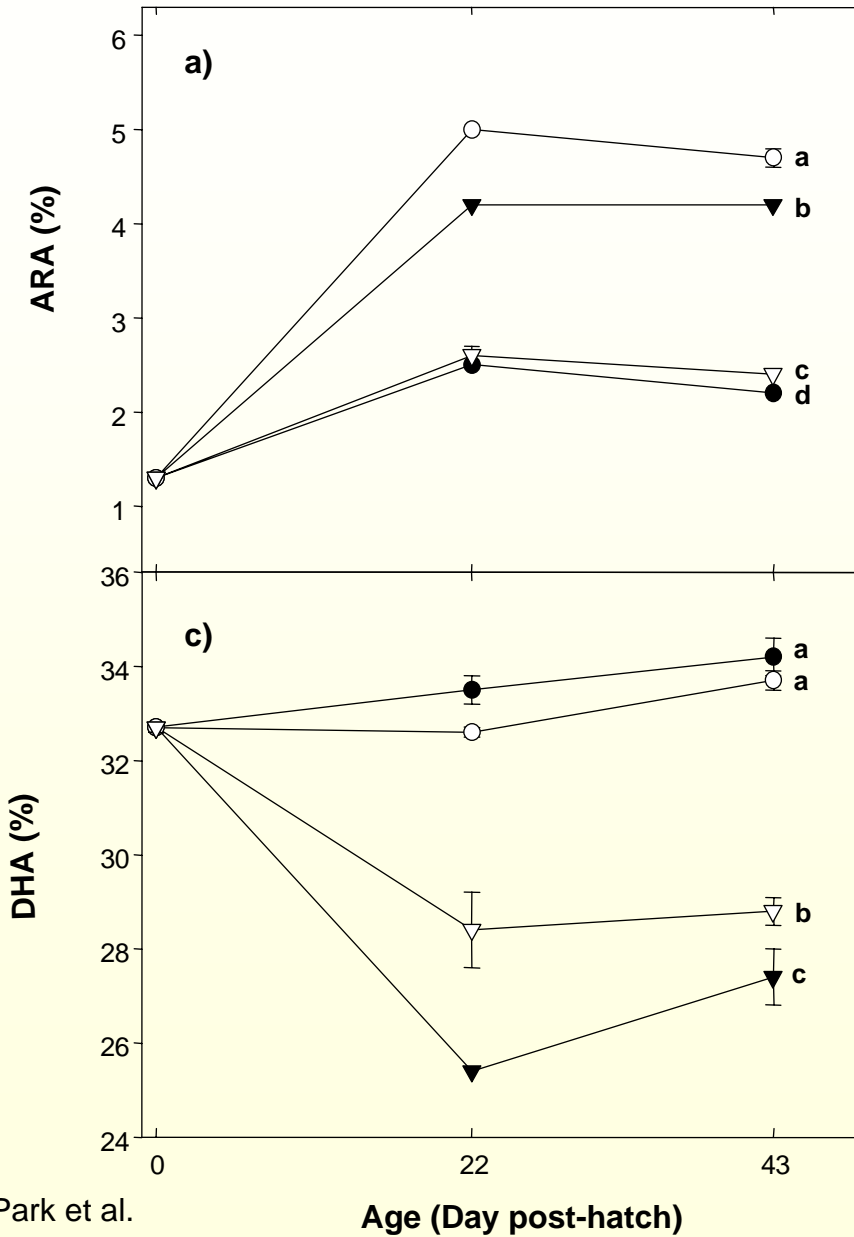
Growth of Atlantic cod larvae fed the differently enriched rotifers



Lipid content of Atlantic cod larvae fed differently enriched rotifers



Fatty acid content of Atlantic cod larvae fed differently enriched rotifers



Park, Puvanendran, Kellett, Parrish, Brown: Summary

- Results showed a positive effect of rotifer DHA proportions on growth and survival of cod larvae.
- Demonstrated that Atlantic cod larvae require a high ratio of dietary DHA to EPA.

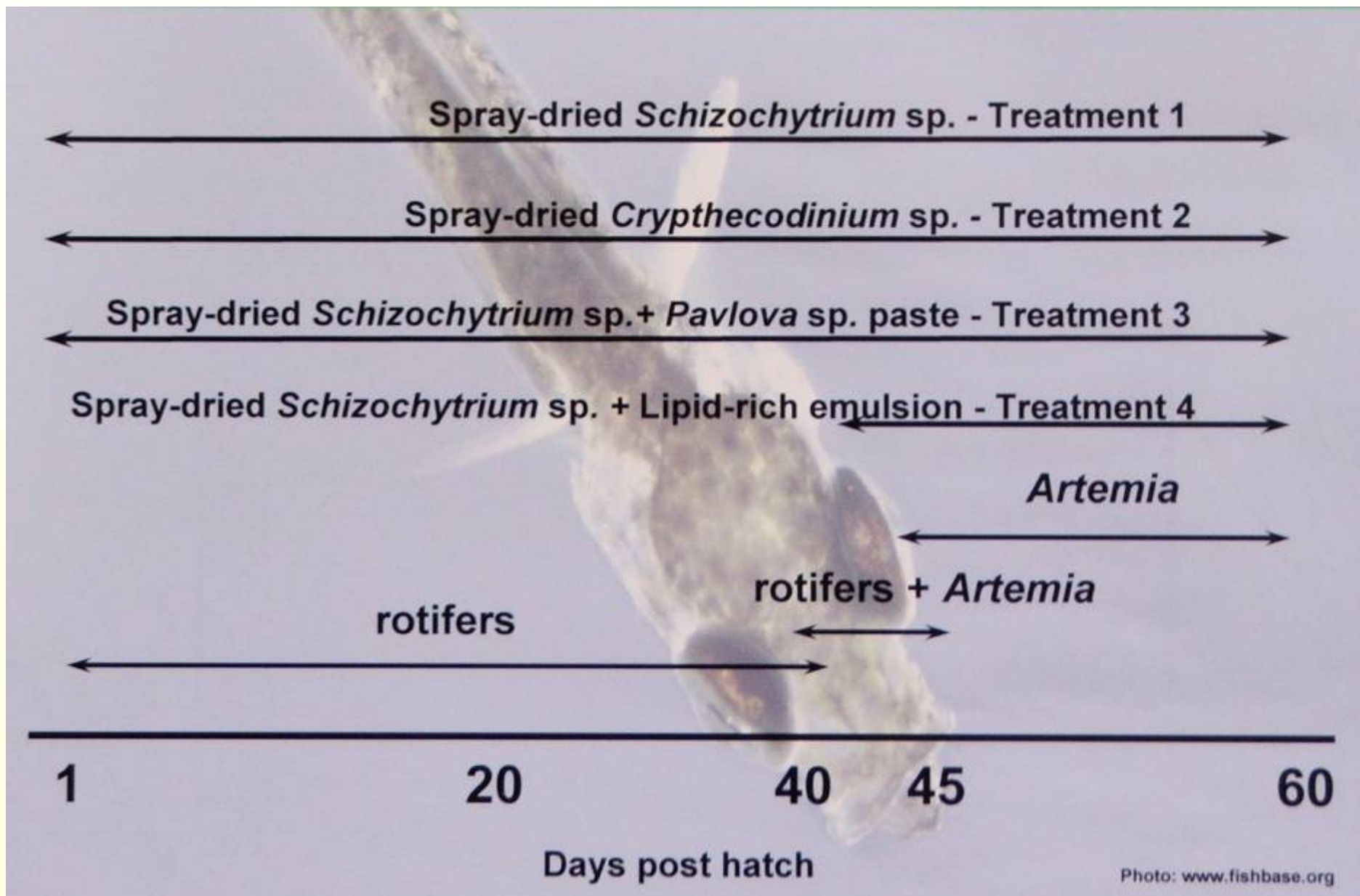
Final study (A. Garcia, PhD student)

Objective

To evaluate the effects of different commercially available enrichments on the early growth, survival, and lipid composition of Atlantic cod larvae



Materials and methods



Materials and methods

Lipid Classes (mg/g)	Algamac 2000[®]	Advantage[®]	<i>Pavlova</i> sp.	DHA Selco[®]
Total lipids	174.26 ± 4.82^a	82.10 ± 12.37^{ab}	37.54 ± 3.23^b	478.08 ± 73.29^c
Triacylglycerol	161.11 ± 5.28^a	38.60 ± 4.56^{ab}	16.56 ± 0.94^b	413.83 ± 61.29^c
Phospholipids	3.92 ± 0.15^a	4.70 ± 0.73^a	13.06 ± 2.21^a	26.89 ± 5.60^b

Materials and methods

- **tanks: 3,000 L, cylindrical, flat bottom**
- **2 replicates/treatment**
- **stocking density: 50 larvae L⁻¹**
- **prey density: rotifers - 4,000 rotifers L⁻¹**
- ***Artemia* - 3 to 12 million tank⁻¹day⁻¹**
- **feedings: between 9:00 - 10:00 am &
between 4:00 - 5:00 pm**
- **temperature: ~ 11 °C**

Materials and methods

- growth

dry weight, SGR

survival semi-quantitative (0-5)



- lipid composition

rotifers & *Artemia*/ before & after enrichment

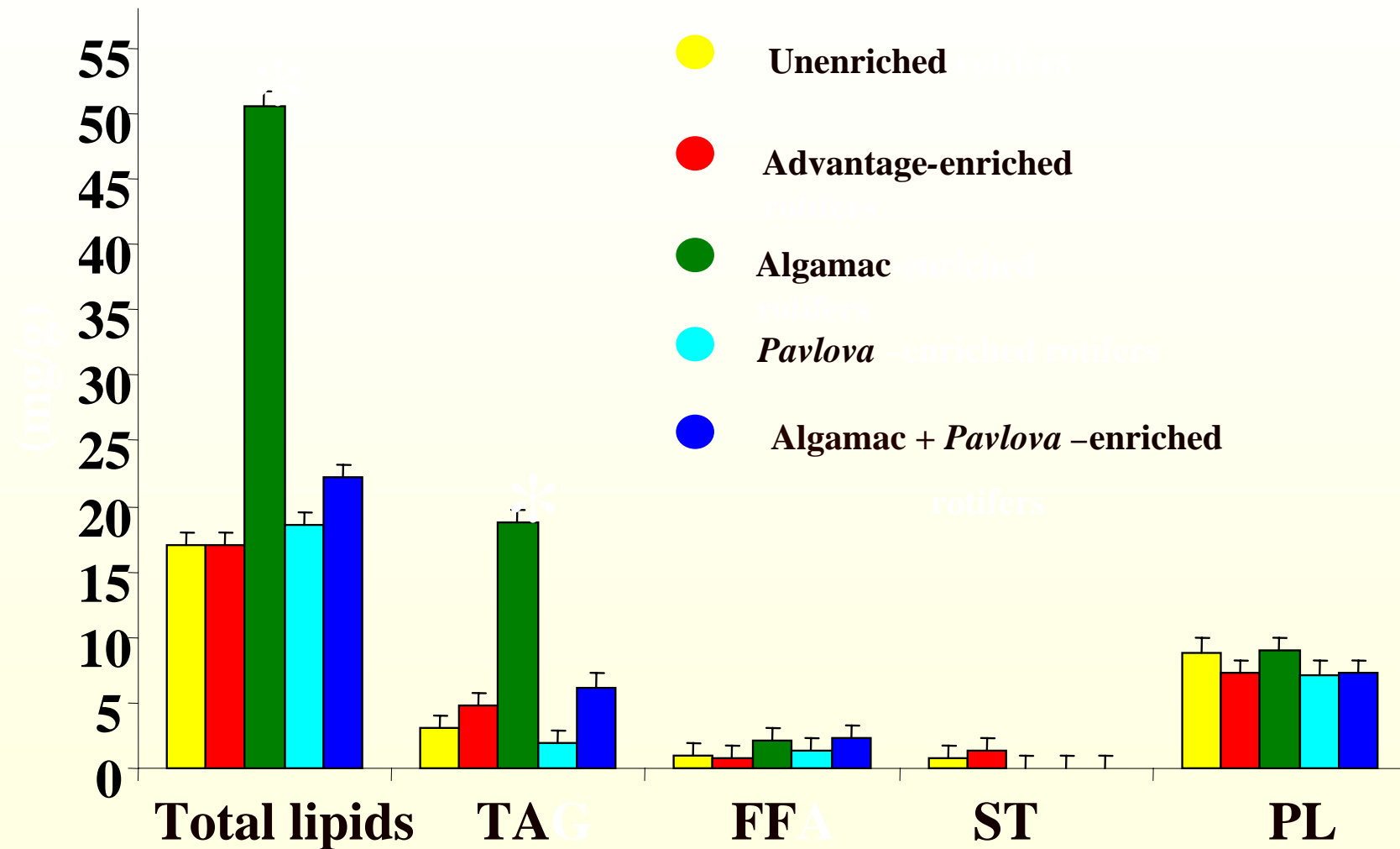
fish larvae – bi-weekly

enrichments

algae paste

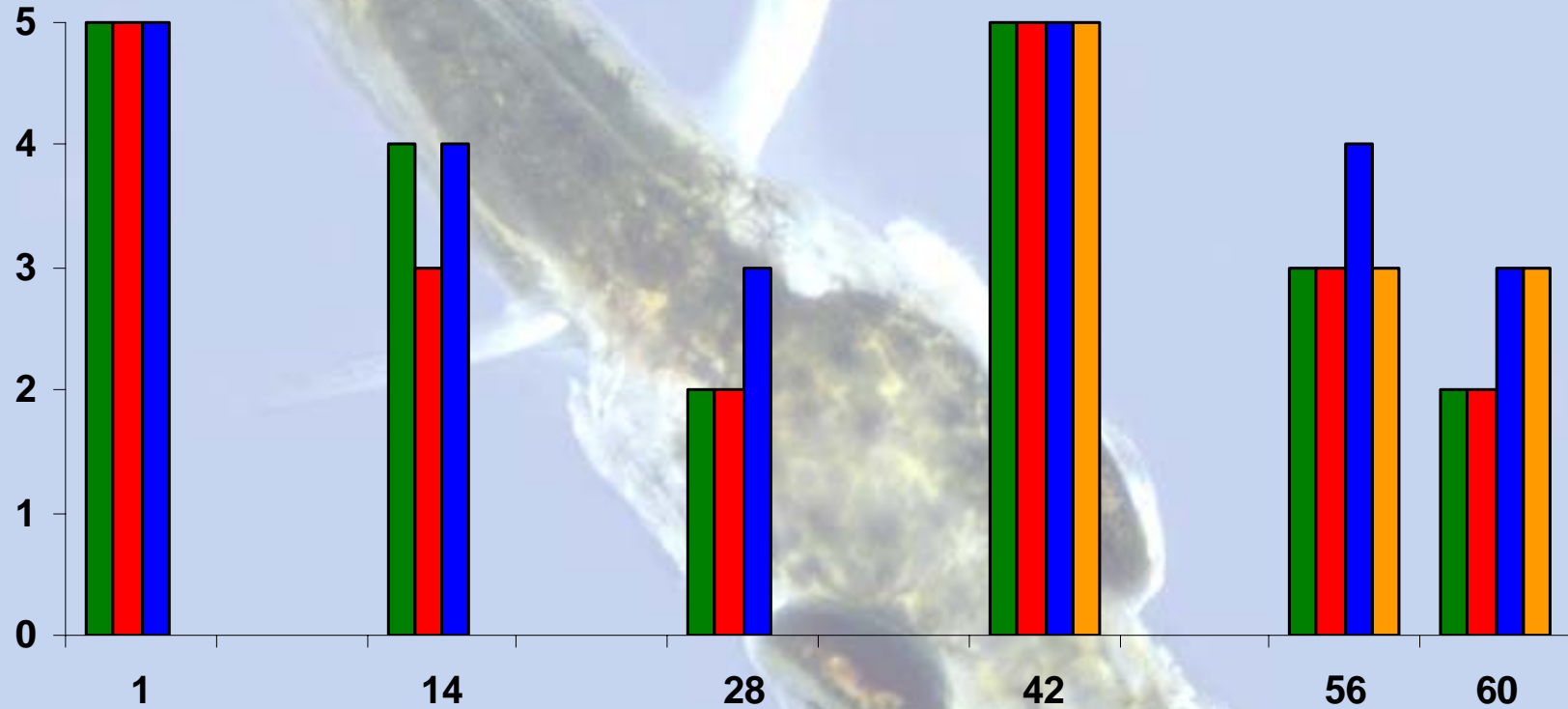


Results – Lipid classes in rotifers



Survival

picture: www.fishbase.org

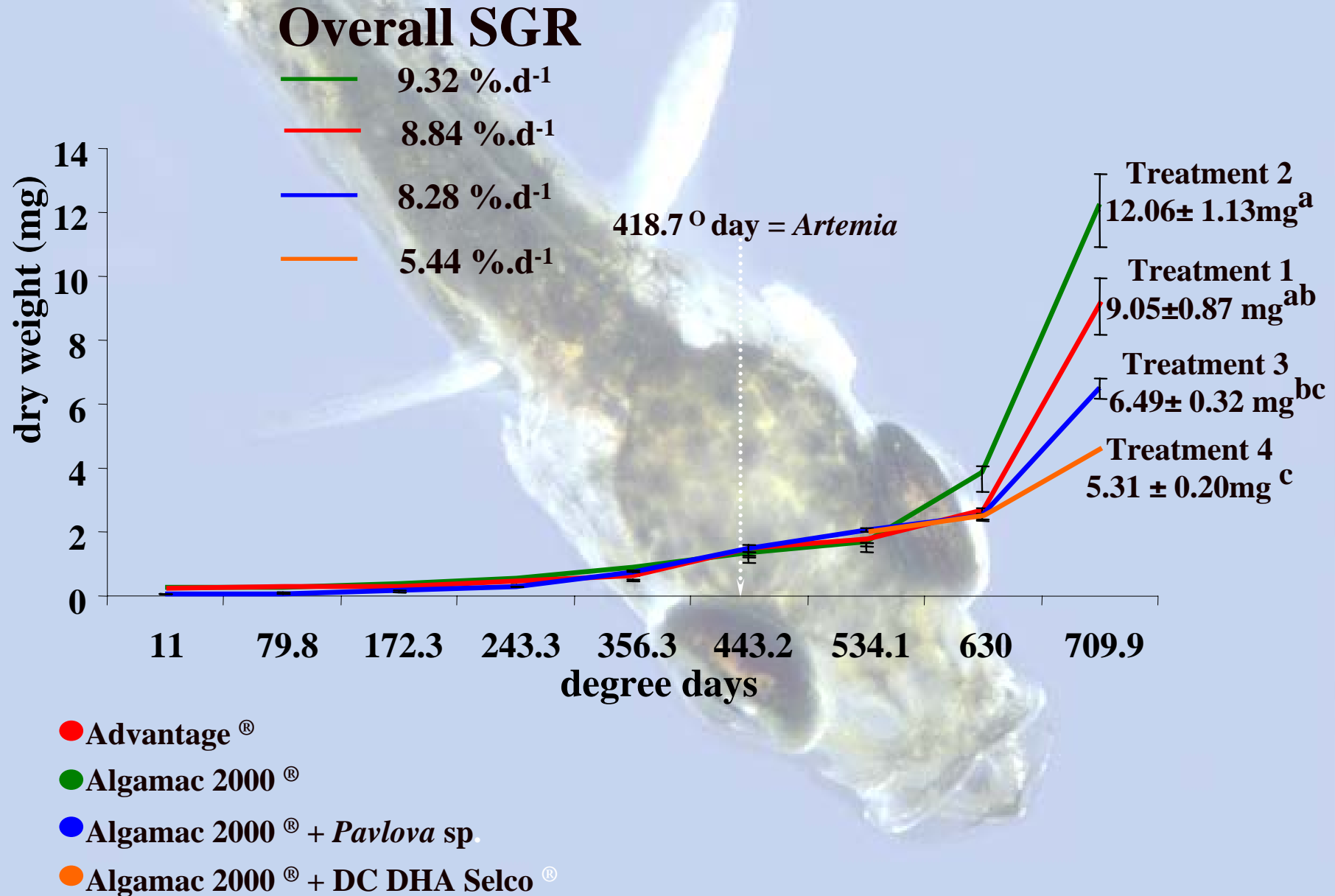


- Advantage[®]
- Algamac 2000[®]
- Algamac 2000[®] + *Pavlova* sp.
- Algamac 2000[®] + DC DHA Selco[®]

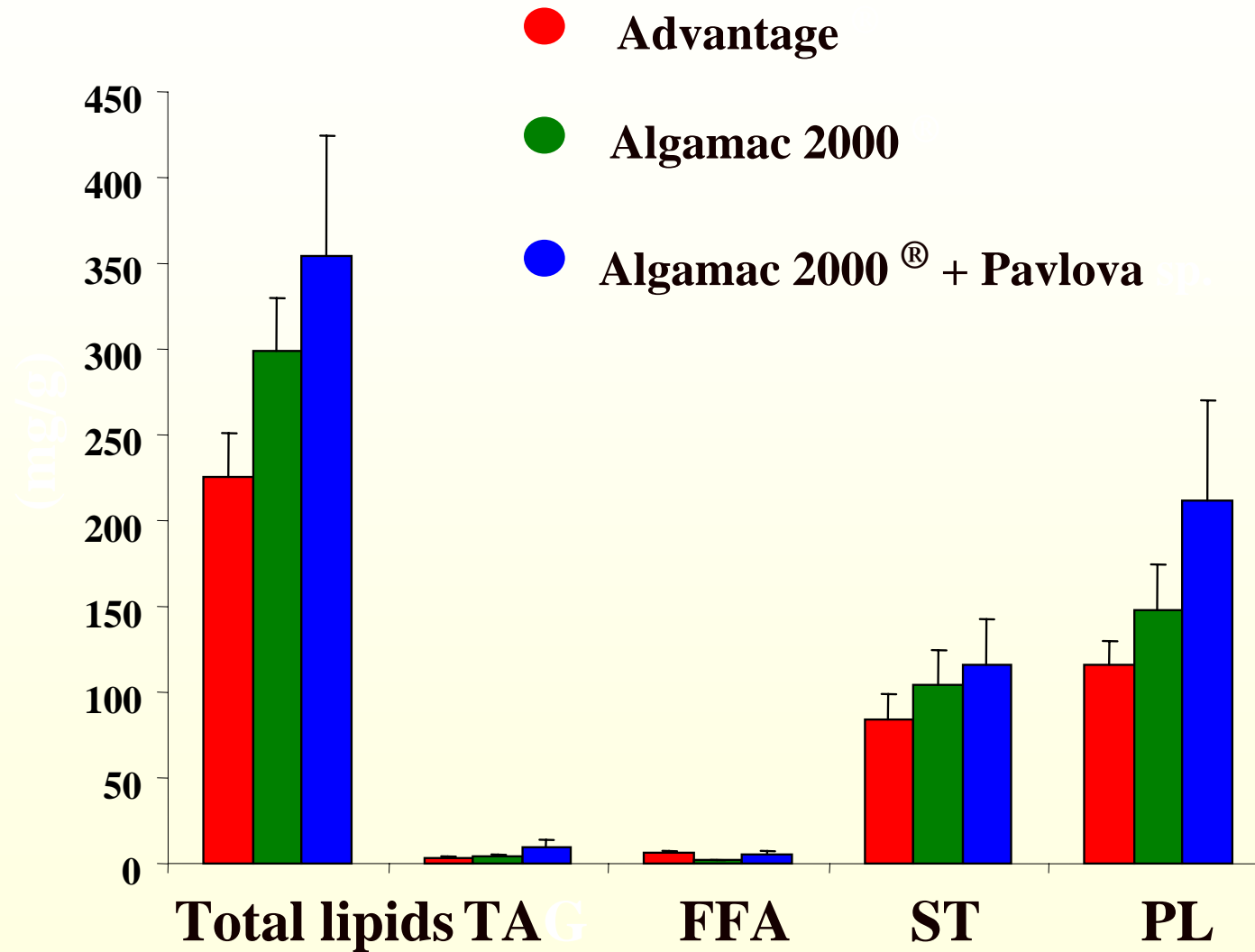
Days post hatch

Overall growth

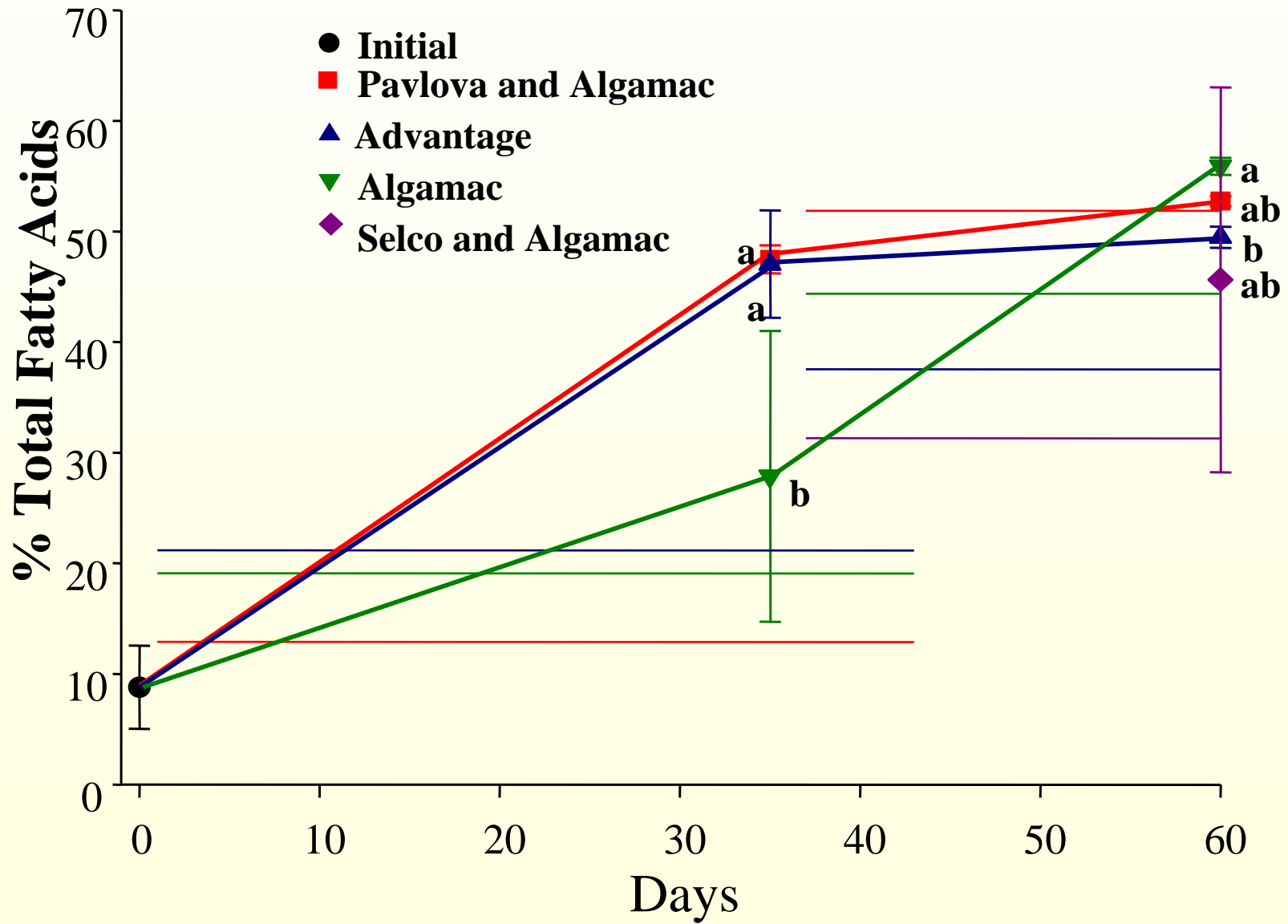
picture: www.fishbase.org



Lipid classes in cod larvae (37 dph)



PUFA





Take home:
High lipids, DHA & DHA:EPA = High growth & survival

Acknowledgments

- Danny Boyce and the Aquaculture Research Development Facility (ARDF) staff for their valuable help with live-food production and larval rearing.
- AquaNet – Canada's Network of Centres of Excellence for aquaculture research.
- Going Global Science and Technology Fund, International Trade Canada