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Larvi 2009 September 8-10th Ghent, Belgium

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CLOSING THE LIFE CYCLE OF *OCTOPUS VULGARIS* IN CAPTIVITY

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Partners in the research

- **Maricoltura di Rosignano Solvay** (MRS); Project coordinator and work on broodstock, live prey cultivation and larval rearing
- **Laboratory of Lagoon Ecology of Orbetello**; paralarval rearing with natural plankton
- **Arpat Livorno**; sampling campaign in the sea of wild Octopus paralarvae and associated zooplankton
- **CIBM** (Interuniversity centre of marine biology) – Livorno: analyses and classification of the material collected in the sea
- **UNIFI** Dep. Biotechnology; analysis and study of the algae associated with the paralarval rearing phase
- **UNIPI** Department of comparative Anatomy: histological study on the PL in different development stages
- **Artemia Reference Centre** (ARC); study of the nutritional characteristics of the live preys
- **Inve Technologies** (ITECH); development of inert feeds for paralarvae and special artemia ongrowing and enrichment feeds

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Structure

- Introduction:
  - Taxonomy
  - Potential of the species
  - Overview results paralarval rearing (literature)
- State of the art
  - Ongrowing juveniles
  - Broodstock maturation
  - Egg deposition
  - Paralarval and juvenile rearing

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Structure

- Paralarval and juvenile rearing
  - Importance of the rearing volume and rearing density
  - Importance of “green water”
  - Live preys and inert feeds
  - Survival
  - Histological studies
- Conclusions

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Introduction

Introduction
Taxonomy

- Phylum: Mollusca
- Class: Cephalopoda
- Family: Octopodidae
- Genus: Octopus
- Species: Octopus vulgaris, Cuvier

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Introduction

- Ideal candidate for industrial aquaculture
  - Easy adaptation to captivity
  - Extremely high growth rate
  - High market price
  - Lack of juveniles for ongrowing

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Introduction
Summary survival rates
(*Iglesias et al, 2007*)

Reference group	Live food Type	Survival (%)
ICM-CSIC (Barcelona)	Zoeae and Artemia	54% at day 20 0.8% at day 60
IEO (Vigo)	Zoeae and Artemia	31.5% at day 40
ICCM (Canary Island)	Zoeae and Artemia	11-27% at day 30
CEP (Spain)	Zoeae and Artemia	90% at day 20 3.4% at day 60
IFAPA (Spain)	Zoeae, Moina and Artemia	5-15% at day 35
YS (Japan)	Artemia + artificial	10-30% at day 30
FURG (Brazil)	Zoeae, copepods, mysids and Artemia	1-40% at day 40

State of the art

State of the Art Ongrowing of juveniles

Catch of juveniles from the wild

- Period: august - november
- Feed: crab, trash fish,…
- Natural thermo- and photoperiod

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State of the Art Maturation of Broodstock

- Separation of males and females before onset of spawning

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State of the Art Maturation of Broodstock

- Transfer of females to incubation tanks and acclimation

- Conditions:
  - Temp: 19-20°C
  - Photoperiod: 14L/10D

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State of the Art Hatching

- Hatching after incubation time of around 35 days at 20°C
- Asynchronical hatching (7-18 days)
- Mother animals die 18-30 days after hatching of the last egg

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- Amount of eggs: 20,000 – 300,000 per female
- Egg viability:
  - Maternal care: >95%
  - No maternal care: ± 60%

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Paralarval rearing
Rearing Volume

- Tank volumes: 100-500-1000-6000l
  => best survival in larger volumes

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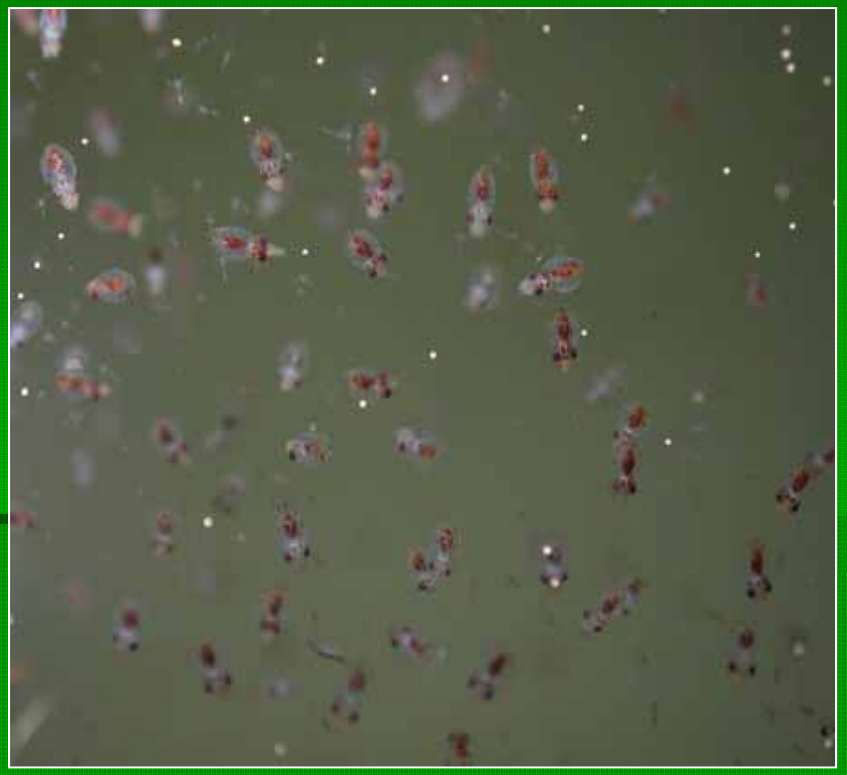
Paralarval rearing Densities

- Paralarval density: ranged between 3 and 35 paralarvae per l
  - Initial survival (up to day 15-20): not dependant upon stocking density
  - After day 20: best survival at low density (3ind.l^{-1})



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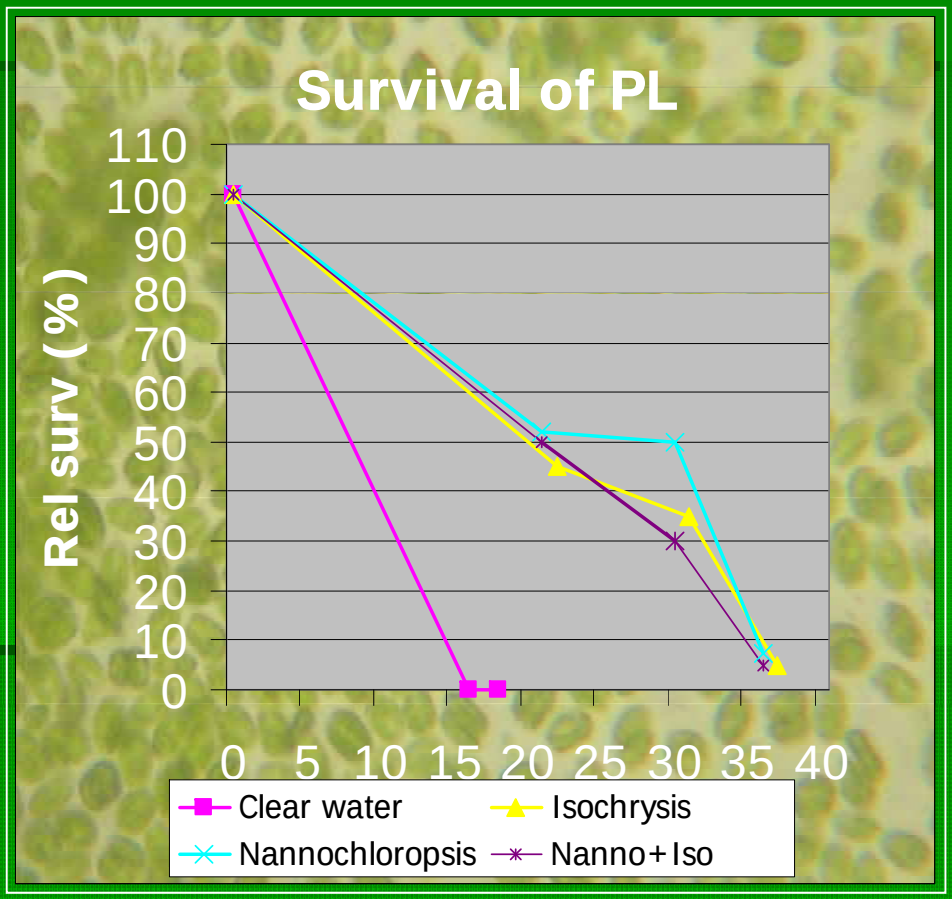
Paralarval rearing Green Water

- Comparison of:
  - Clear water
  - Nannochloropsis
  - Isochrysis
  - Nanno-Iso
- Role of algae:
  - Light diffusion
  - Bacteriostatic activity?
  - Feed complement?



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Paralarval rearing
Live prey – inert feeds




- Live preys:
  - Rotifers (*Brachionus spp.)*
  - Artemia nauplii, meta-nauplii and adults (enriched)
  - Mysids
  - Copepods
- Inert feed:
  - Moist, semi-moist, dry
  - White – reddish - brown

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Paralarval rearing
Live prey – inert feeds

- Live preys:
  - Preference for large Artemia
  - No better survival with addition of other wild zooplankton
  - Trials ongoing comparing enriched versus non enriched artemia
- Inert feed:
  - Preference for light coloured particles
  - Ingested?

State of the art: Paralarval and juvenile rearing

Major morphometric changes after day 20: armlength and nr of suckers, eye diameter

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State of the art: Paralarval and juvenile rearing

2 months

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State of the art: Paralarval and juvenile rearing

3 months

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State of the art: Paralarval and juvenile rearing

4 months

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State of the art: Paralarval and juvenile rearing

5 months

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State of the Art
First juvenile reproduced

"Gino" at
135 dph

- In 2007 we succeeded for the first time to reproduce in captivity Octopus juveniles using only on-farm produced plankton and dry diets
- This has been the first fundamental step opening the possibility of producing Octopus in aquaculture facilities

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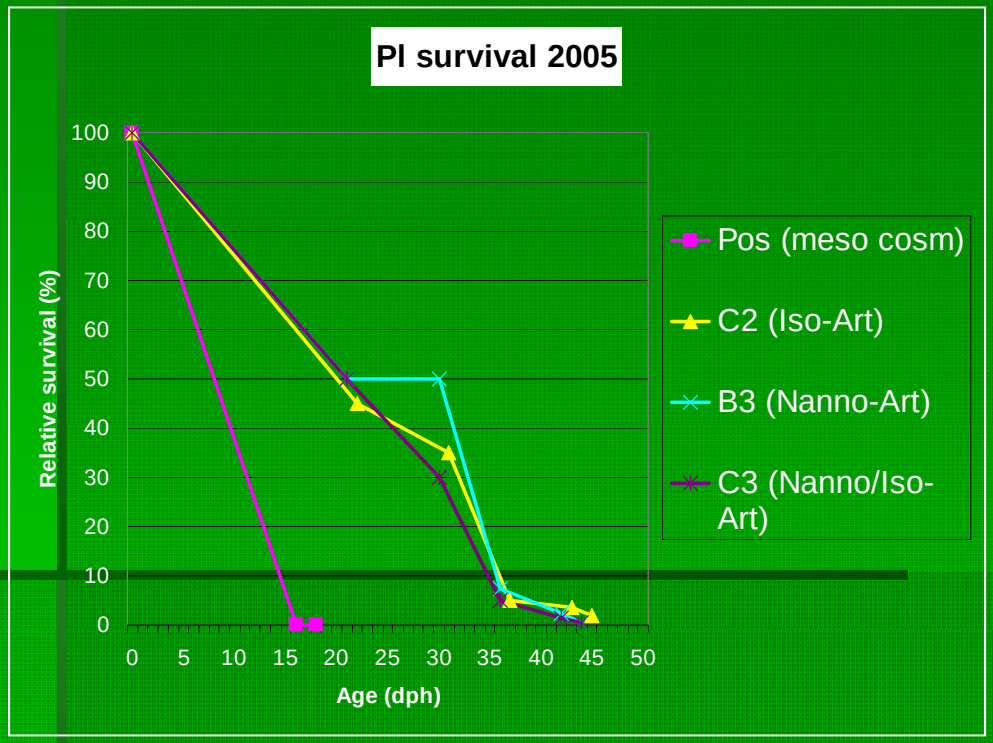
State of the Art Survival



- Avg at 30 dph: >35%
- Very high mortality during transition of planktonic to benthic phase
- Several thousand individuals are obtained of 45 dph
- Oldest "juvenile": 140 days

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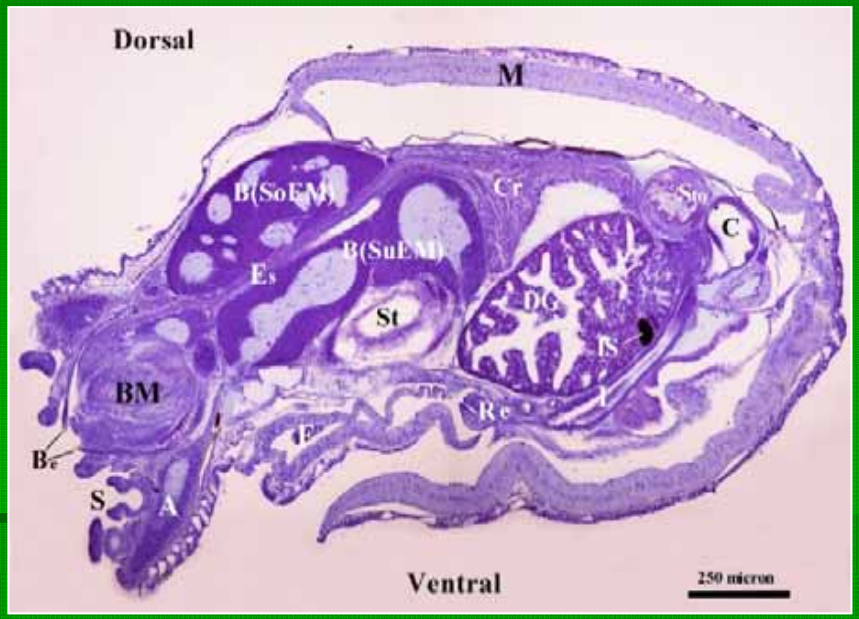
Paralarval rearing
Further studies



Histological studies

Sec. of Anatomy

Dept. of Animal Productions

University of Pisa

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Ongoing research

- Comparison enriched and non-enriched artemia as live prey and first results
  - GSL Artemia hatched and 24h enriched with Spresso®
  - Further ongrowing up to bigger Artemia with ideal size of 3mm – 1cm using algae and Prolon ®
  - Enrichment of the treatment group during 1-3h with experimental enrichment product (INVE), rich in HUFA

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Ongoing research

- Comparison enriched and non-enriched artemia as live prey and first results
  - Survival
  - Growth

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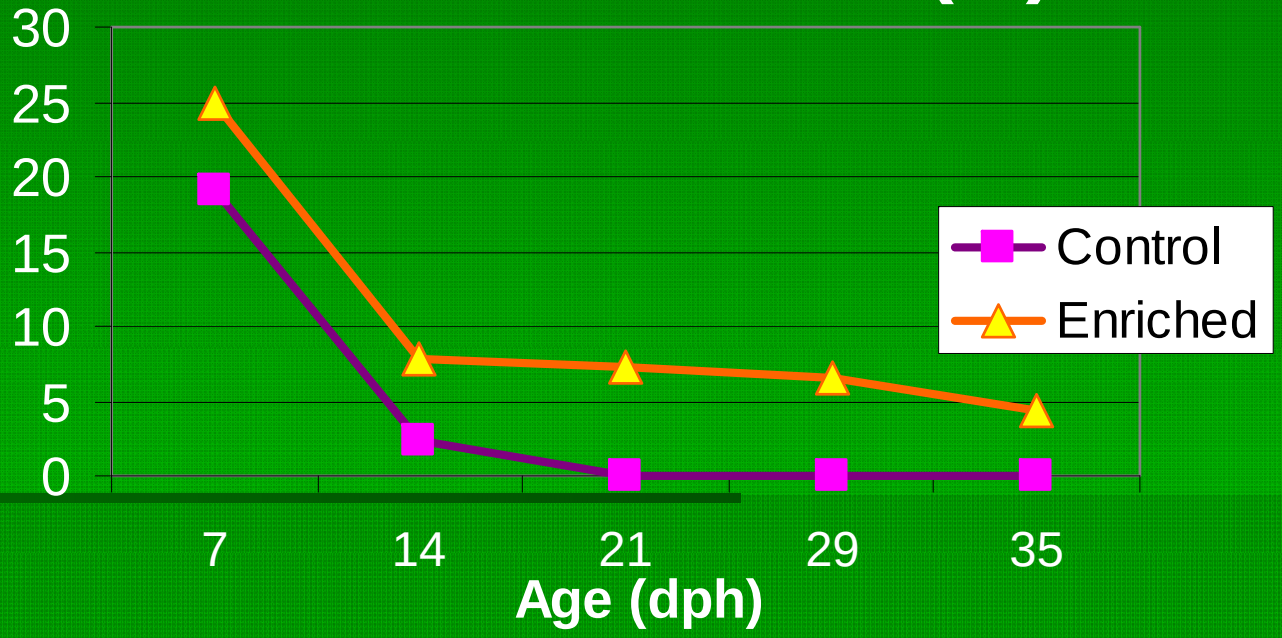
Ongoing research

- Survival



Higher survival in the enriched Artemia group

Ongoing research

- Growth: morphometrics at w1 post hatch

Parameters (mm)		Control		Enriched	
Total length	n	40		40	
	mean	3,15	B	3,36	A
	SD	0,250		0,246	
Mantle Length	n	40		40	
	mean	1,55	B	1,63	A
	SD	0,149		0,170	
Head Width	n	40		40	
	mean	1,11		1,14	
	SD	0,089		0,075	
Eye Diameter	n	40		40	
	mean	0,50		0,49	
	SD	0,044		0,025	
Arm Length	n	40		40	
	mean	1,16		1,21	
	SD	0,151		0,136	

Note: means with different letters differ per $P<0.01$

Conclusions

Conclusions
Potential for Large Scale Production

- Easy ongrowing of juveniles and maturation of broodstock in captivity
- A few hundred of thousands of eggs per female can be obtained with a high fertilization rate (>95%)
- High survival rates of paralarval up to 35-40 days
- First juveniles have been produced

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Conclusions
Suggestions for further research

- Continue paralarval rearing using “standard” aquaculture techniques
- Improve growth and survival rate by adjusting the nutritional profile of *Artemia*
- Attention towards other components besides HUFA, such as S and Cu

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Thank you for your attention

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