Nutrición en paralarvas de pulpo

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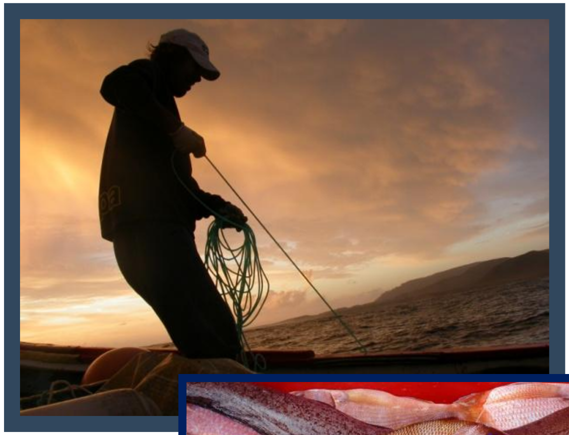
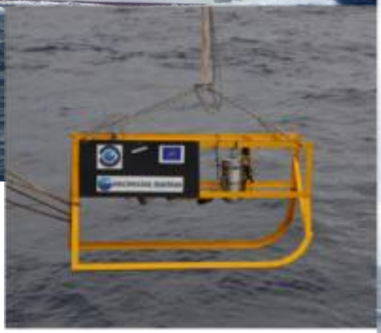
IEO-CSIC

Areas

- ✓*Pesquerías*
- ✓*Medio Marino y protección ambiental*
- ✓*Acuicultura*





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Grupo de investigación (CSIC)

Fisiología de la nutrición y bienestar en especies marinas

Pulpo común (Octopus vulgaris)

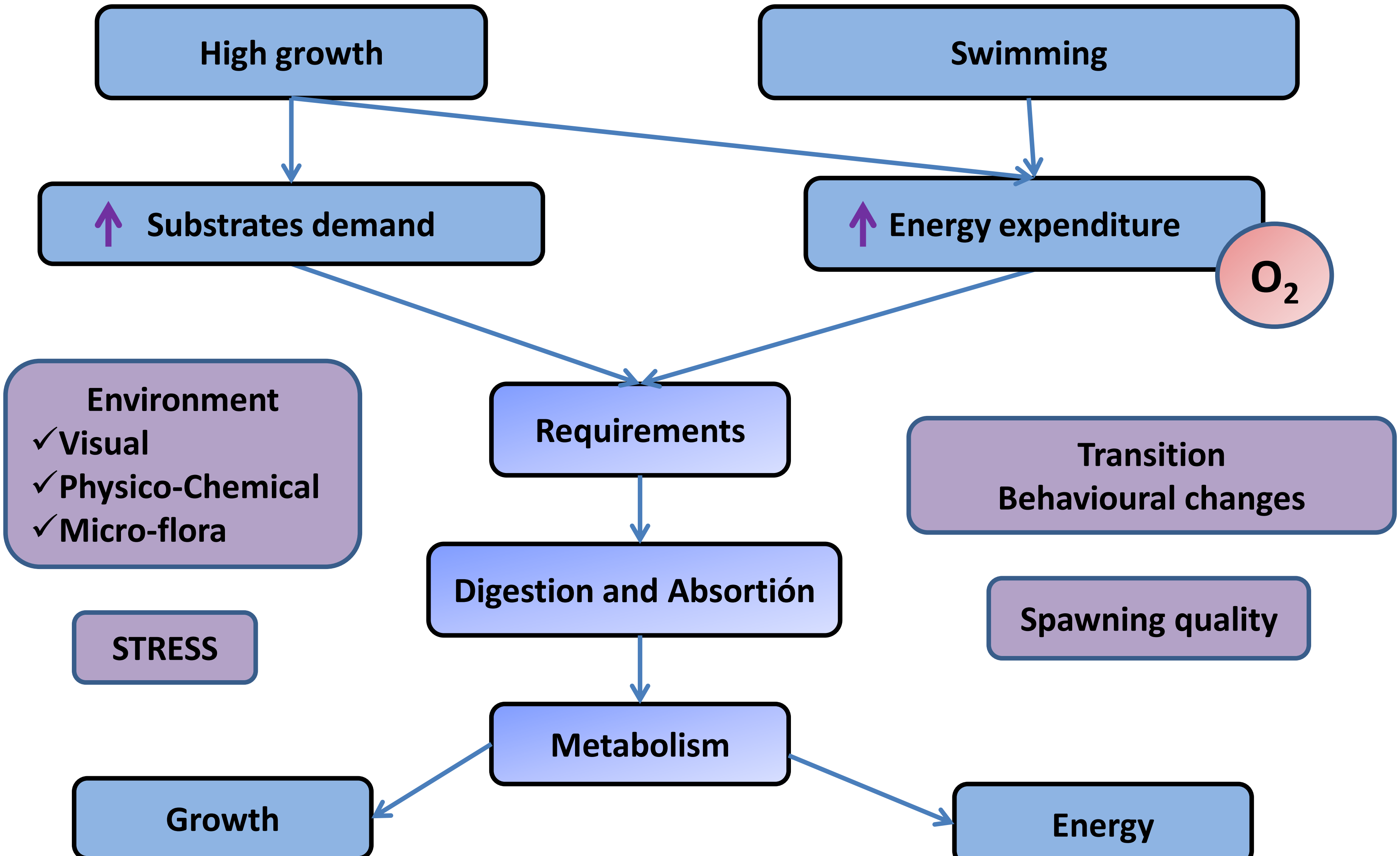
Objetivo:

Avanzar en el conocimiento de la biología del pulpo común a través de estudios multidisciplinares de nutrición y fisiología

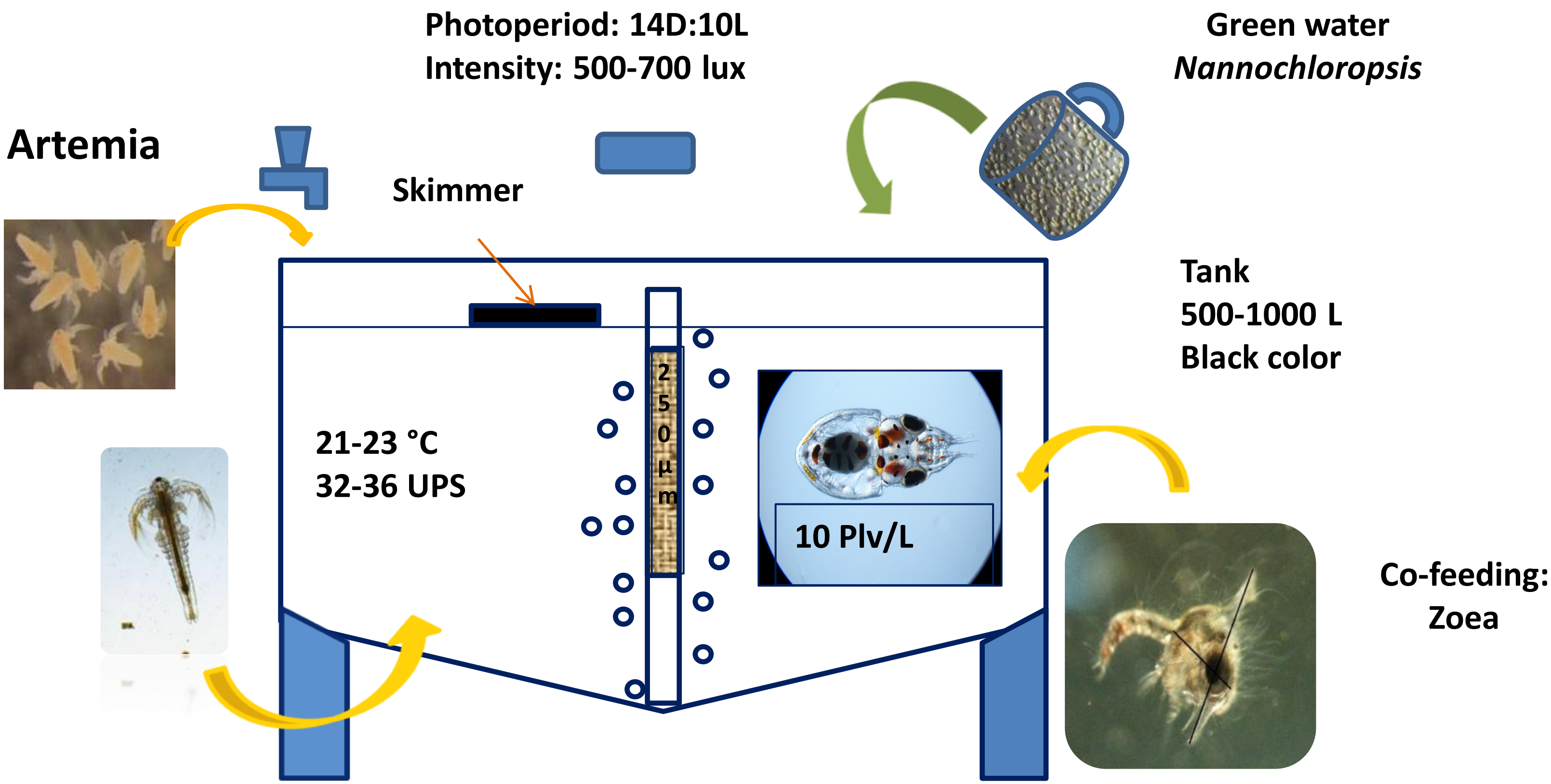
Areas de aplicación

- ✓ *Cría en cautividad*
- ✓ *Gestión de pesquerías*
- ✓ *Estudios de evolución y desarrollo*
- ✓ *Bienestar y salud animal*
- ✓ *etc.*

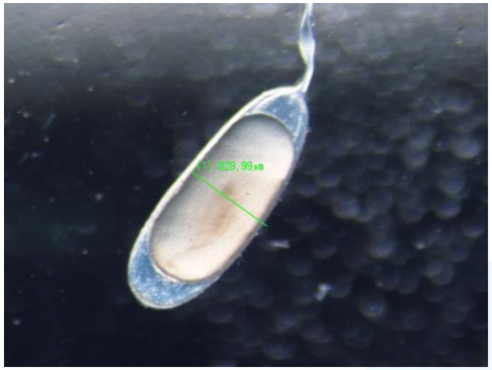
Paralarval development

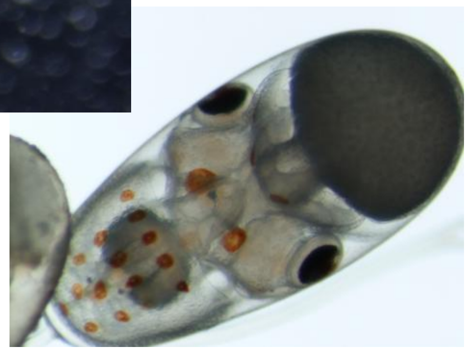


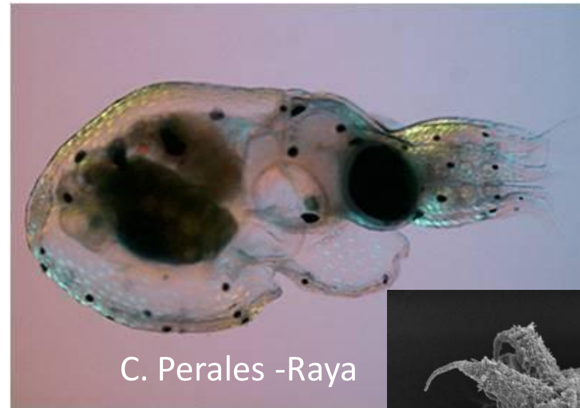
Environmental conditions

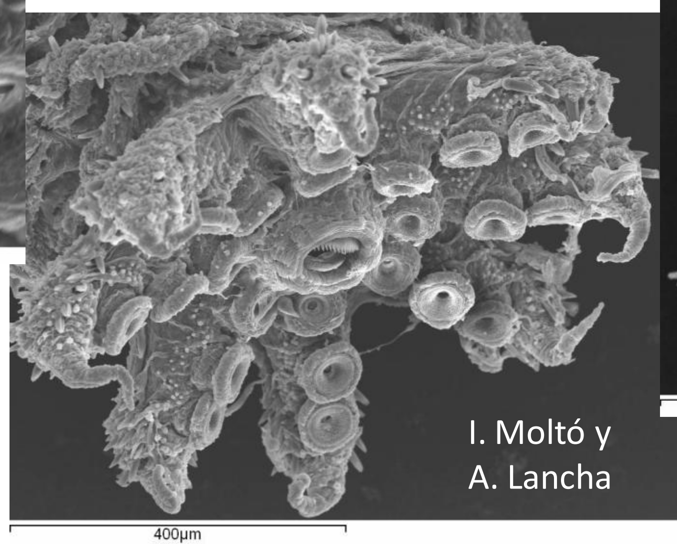


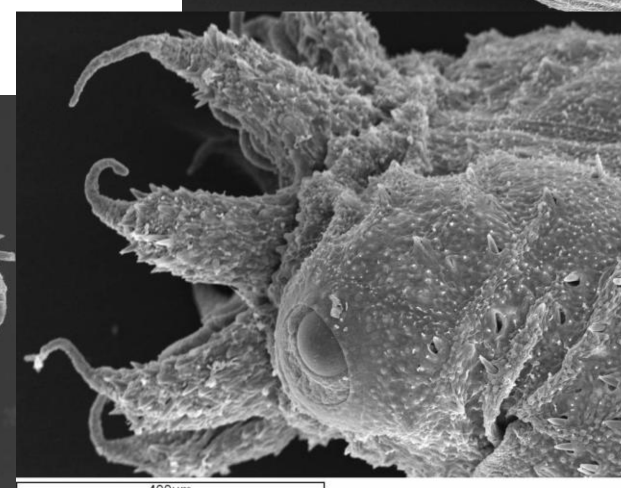
Eggs and paralarvae







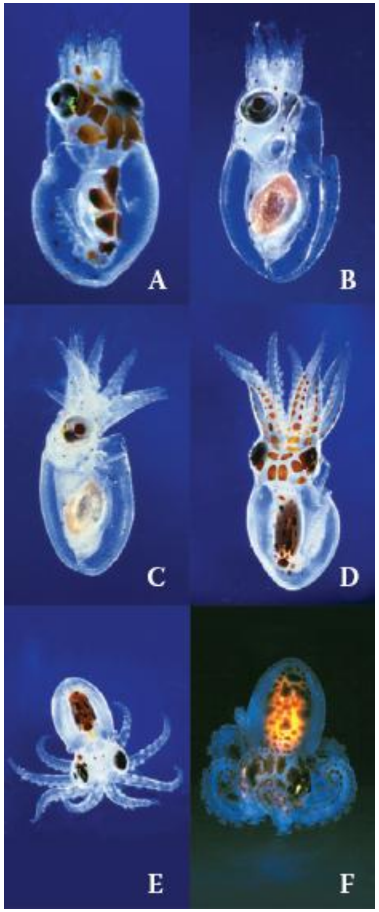




Development and feeding

0d
2 mm

20d
3 mm



30d
4,3 mm

42d
5,9 mm

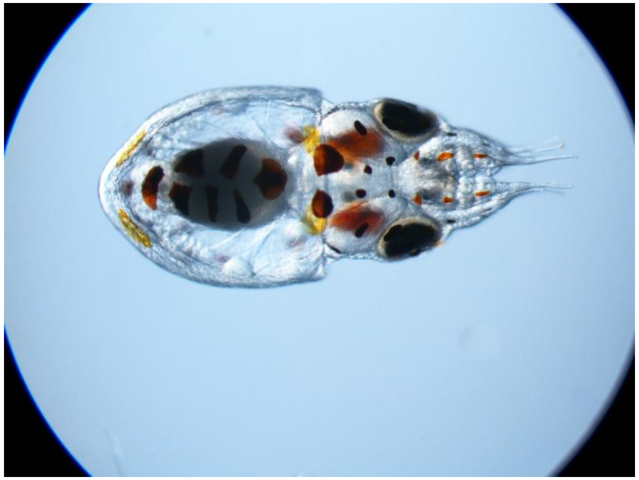
50d
6,6 mm

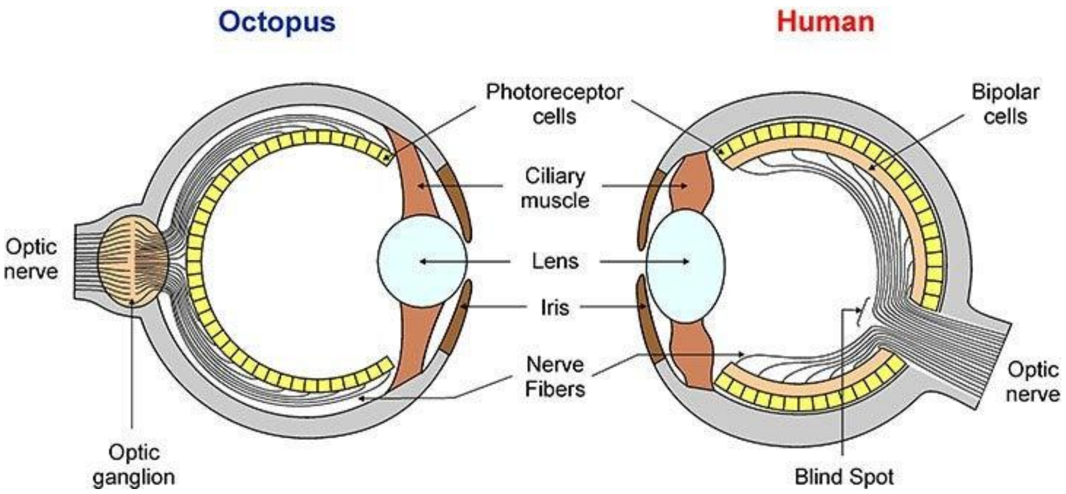
60d
8,5 mm

Edad (días) /LM (mm)

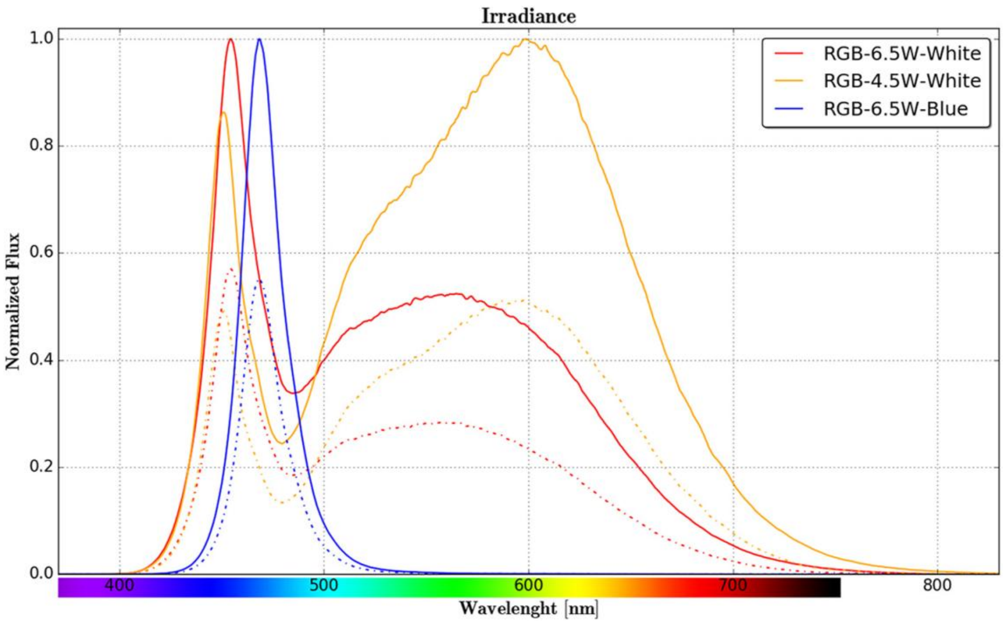
Fuente: Villanueva y Norman (2008)

Vision

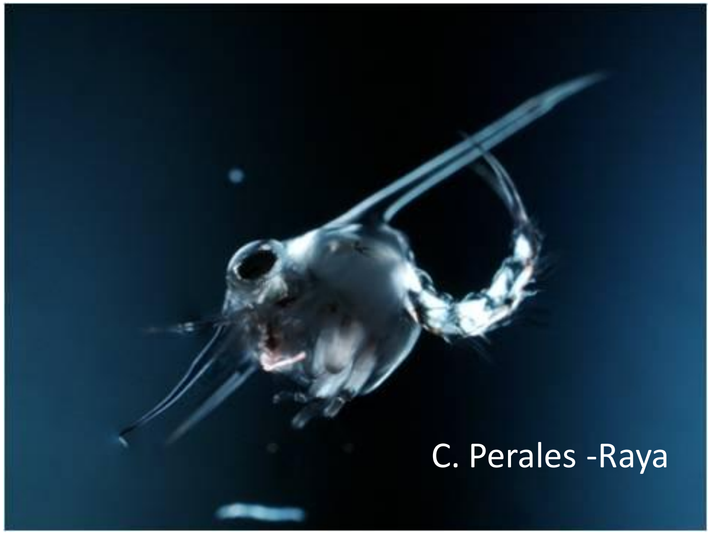




Octopus
Human
Photoreceptor cells
Bipolar cells
Ciliary muscle
Lens
Iris
Nerve Fibers
Optic nerve
Optic ganglion
Optic nerve
Blind Spot



Irradiance
RGB-6.5W-White
RGB-4.5W-White
RGB-6.5W-Blue
Normalized Flux
Wavelenght [nm]
0.0
0.2
0.4
0.6
0.8
1.0
400
500
600
700
800



C. Perales -Raya

Parlarval nutrition

Characterization of nutritional requirements and biomarkers

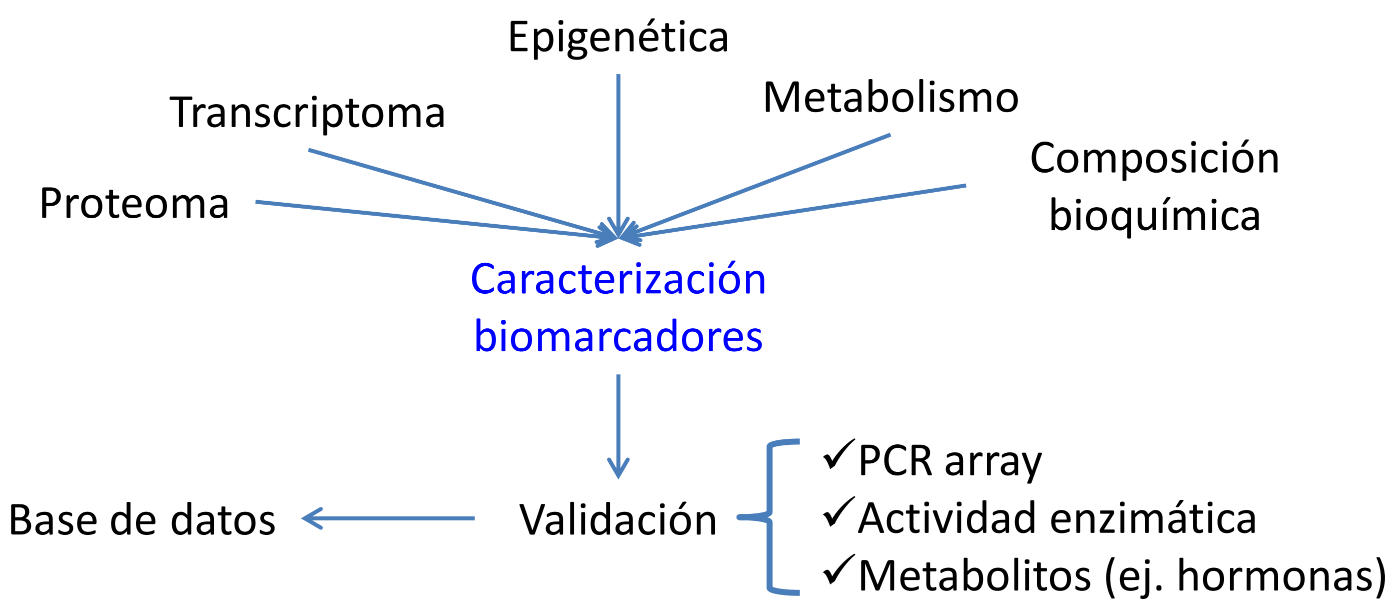
- ✓Metabolic pathways and nutritional requirements
- ✓Digestive physiology
- ✓Microbiome

Development of diets

- ✓Artemia enrichments
- ✓Alternative preys
- ✓Inert diets

Characterization of nutritional requirements and biomarkers

Identificar y validar biomarcadores de nutrición, estrés, salud y crecimiento que proporcionen una información fiable precisa y rápida sobre el estado de la paralarva

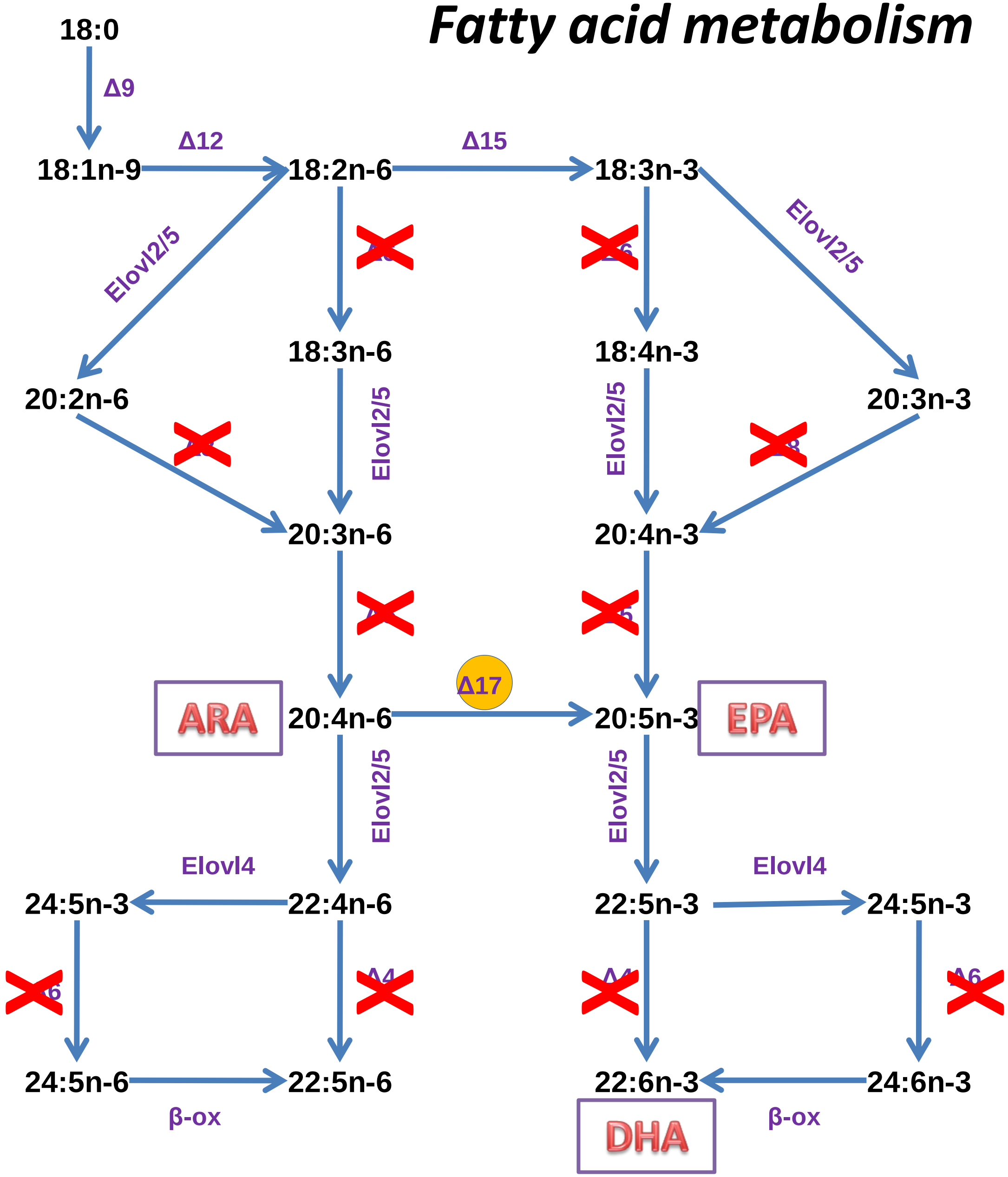


Metabolic pathways and nutritional requirements

Previous data

- ✓ **Different studies have showed the essentiality of long chain polyunsaturated fatty acids such as ArA, EPA and DHA. The presence of ω3 desaturase has been described**

Fatty acid metabolism



30% ácidos grasos pulpo

Metabolic pathways and nutritional requirements

Previous data

- ✓ Different studies have showed the essentiality of long chain polyunsaturated fatty acids such as ArA, EPA and DHA. The presence of ω3 desaturase has been described

- ✓ The pathways and biomarkers related with improved diet have been characterized and the results showed that most of the proteins and genes over-expressed are related to: cell cycle and replication, production of structural components, and development of the nervous system

- ✓ The nutritional regulation of genes and proteins confirms that proteins and carbohydrates as the preferred fuels for cephalopods. An increase in fatty acid oxidation would be indicative of an unbalanced lipid profile of preys

Metabolic pathways and nutritional requirements

Future challenges

- ✓ To study the essentiality of other nutrients such as amino acids, vitamins and trace elements.
- ✓ Further study of the requirements during the settlement phase
- ✓ To determine how is the digestive, metabolic and nutritional status of the octopus at tissue level

Key techniques

- ✓ Transcriptomics
- ✓ Proteomics
- ✓ Enzyme activities
- ✓ Pathway modelling
- ✓ Metabolomics

Digestive physiology

Previous data

- ✓ **Trajectory of food from mouth to stomach - crop - stomach - caecum – digestive gland**

- ✓ **Alkaline proteases mainly in the salivary glands; and cathepsin-type enzymes in gastric juice**

- ✓ **Enzymatic activity influenced by the animal size, temperature or feeding**

- ✓ **Characterization of the digestive system and digestive enzyme activity throughout development and under the effect of different diets**

Digestive physiology

Future challenges

- ✓ **Timing of digestion, absorption and assimilation of nutrients**
- ✓ **Gut transit times for different preys.**
- ✓ **Relationship between temperature and gut transit.**
- ✓ **Markers for absorption of different proteins and lipids.**
- ✓ **Protocols for determining nutrient digestibility.**
- ✓ **Measurement of pH along the digestive tube.**
- ✓ **Regulation of the secretion of digestive enzymes.**
- ✓ **Enzymatic profile of digestive organs throughout digestion.**
- ✓ **Factors affecting the activity of digestive enzymes.**

Digestive physiology

Key techniques

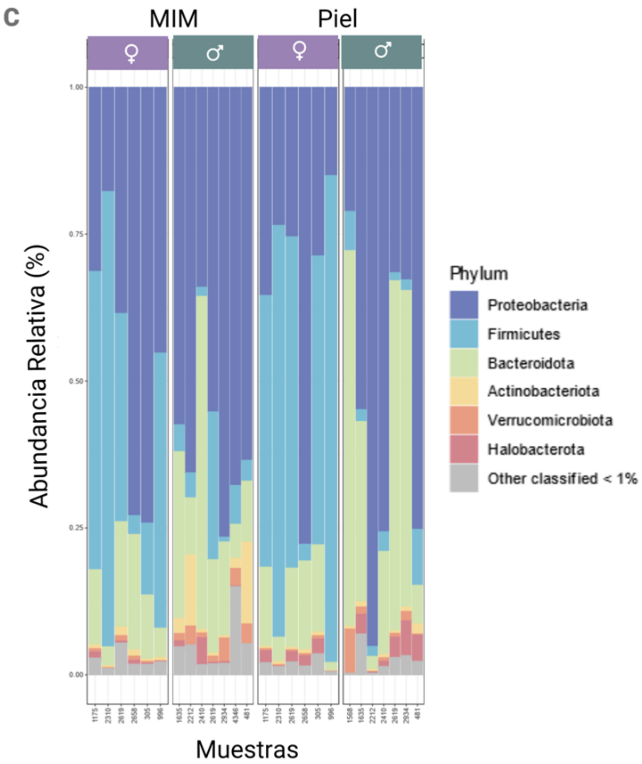
- ✓ **In vitro and in vivo digestibility.**
- ✓ **Histological and histochemical studies.**
- ✓ **Genetic expression of digestive enzymes.**
- ✓ **Nutrient radiolabelling.**
- ✓ **Diet fluorescence markers.**
- ✓ **Digestive enzyme assays.**

Microbiome

Previous data

- ✓ **A meta-analysis among different studies showed that there is no common microbiota for the different groups of cephalopods, but there could be a bias depending on the species**

- ✓ **Paralarvae reared in captivity with Artemia showed a depletion of bacterial diversity compared to wild paralarvae**



Microbiome

Future challenges

- ✓ **To understand how the natural microbiota of octopus may be affected under culture conditions and how these variations in turn affect the development of paralarvae and juveniles.**
- ✓ **Isolate, identify and select different microbial strains from biological samples of octopus with probiotic potential.**
- ✓ **To analyse the potential relationship between microbiota and immune system in cephalopods**

Key techniques

- ✓ **DNA metabarcoding of gut contents**
- ✓ **Bioinformatic analysis**
- ✓ **Metagenomic**

Parlarval nutrition

Characterization of nutritional requirements and biomarkers

- ✓Metabolic pathways and nutritional requirements
- ✓Digestive physiology
- ✓Microbiome

Development of diets

- ✓Artemia enrichments
- ✓Alternative preys
- ✓Inert diets

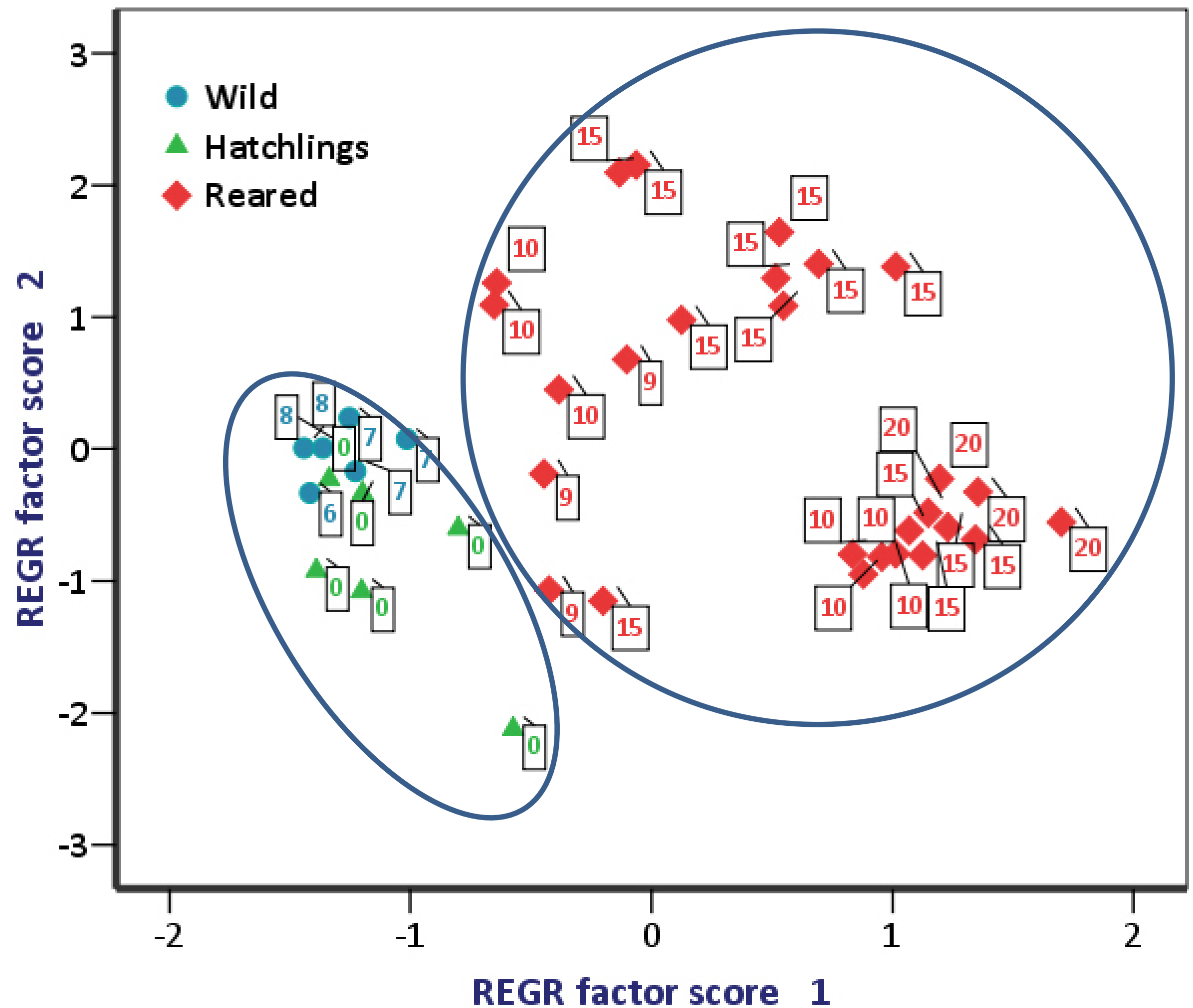
Fatty acid composition from wild, hatchlings and reared paralarvae

AGE: Numbers associated to individual scores

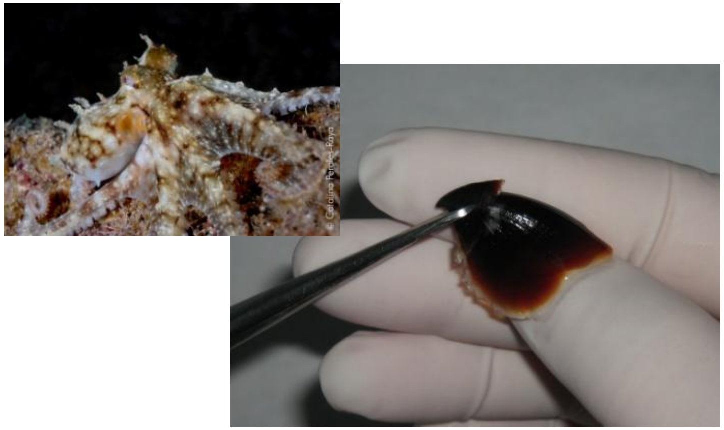
Ellipses represent different clusters for PC1 according to ANOVA results.

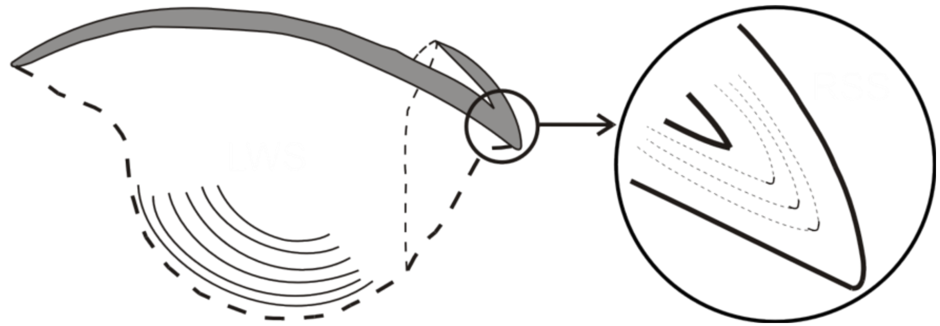
Fatty acid composition of reared paralarvae differs from wild and hatchlings

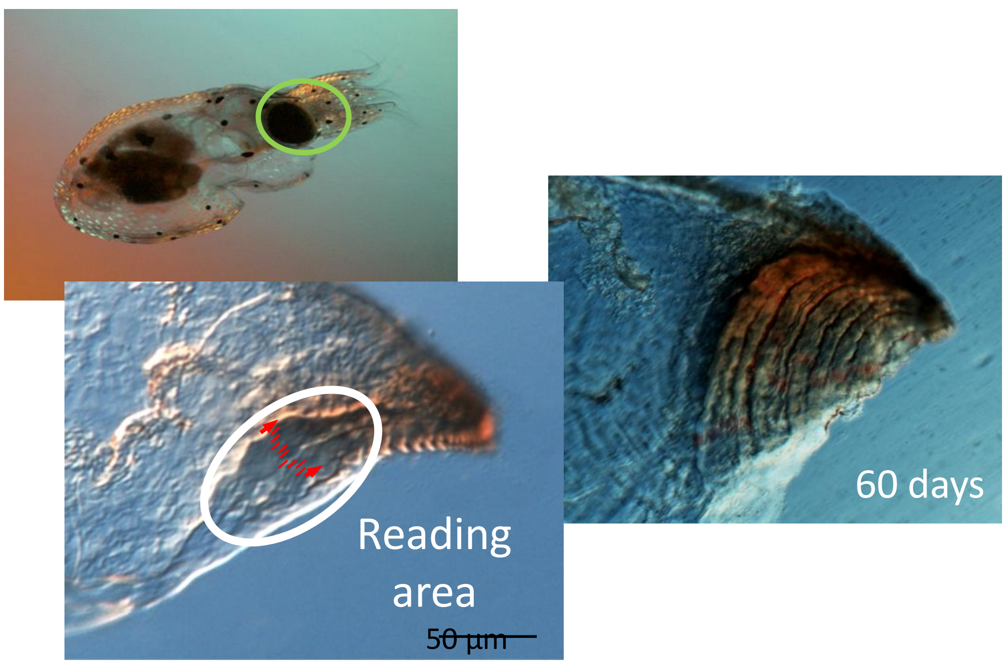
PCA

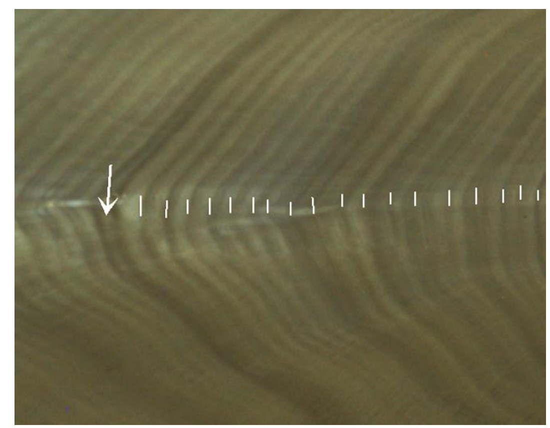


Age estimation







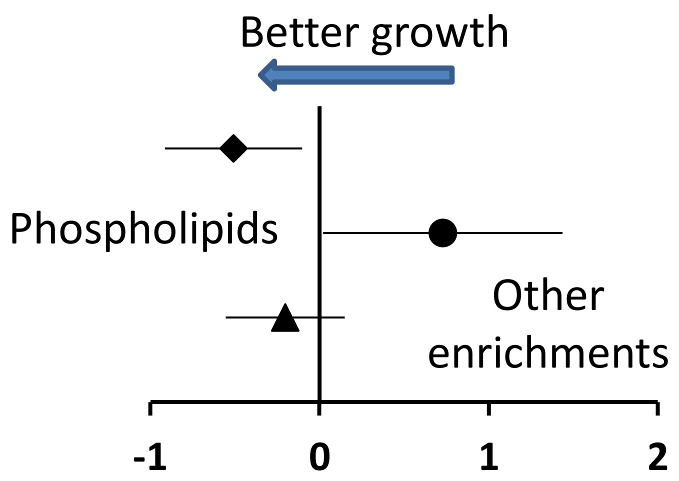


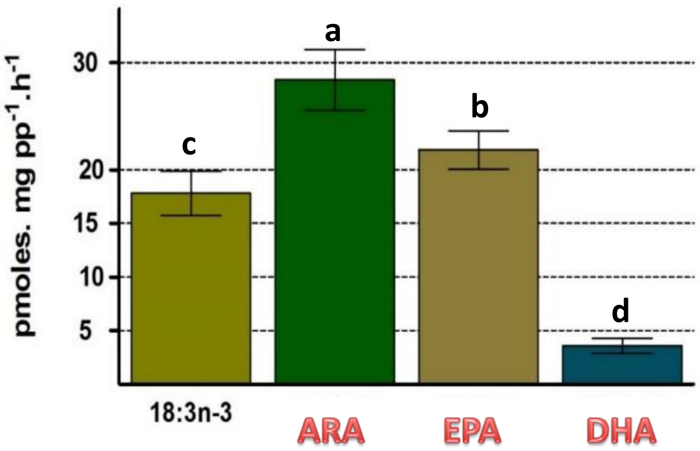
Artemia enrichments

Previous data

- ✓ **A meta-analysis showed that enrichment based in marine phospholipids improved the growth in *O. vulgaris* paralarvae**

- ✓ **A radiolabelling study showed that Artemia may not be the most appropriate vehicle to provide DHA to paralarvae**

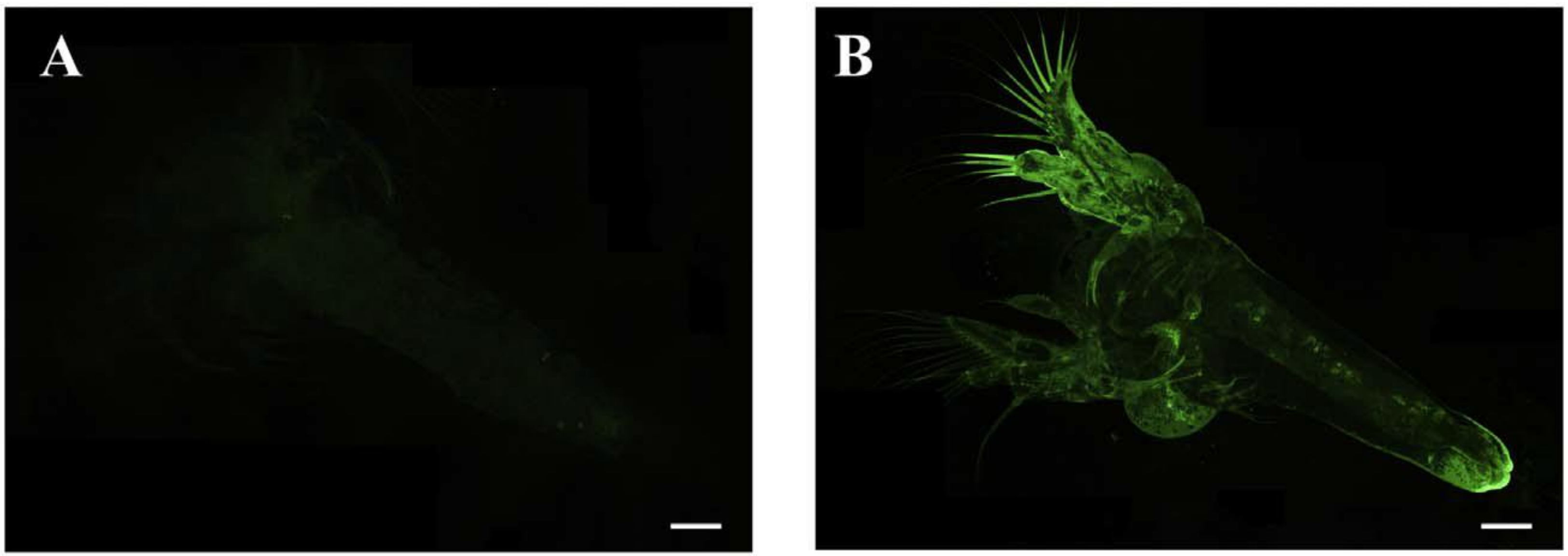




Artemia enrichments

Previous data

✓ **An alternative way to transport bioactive molecules bond to exoesqueleton through quitine binding domains ha s been developed**



Artemia enrichments

Future challenges

- **Design of new *Artemia* enrichment protocols, with phospholipids, n-3 HUFA, copper and antioxidants, for use in co-feeding with other live preys**

Foto Manuel Nande

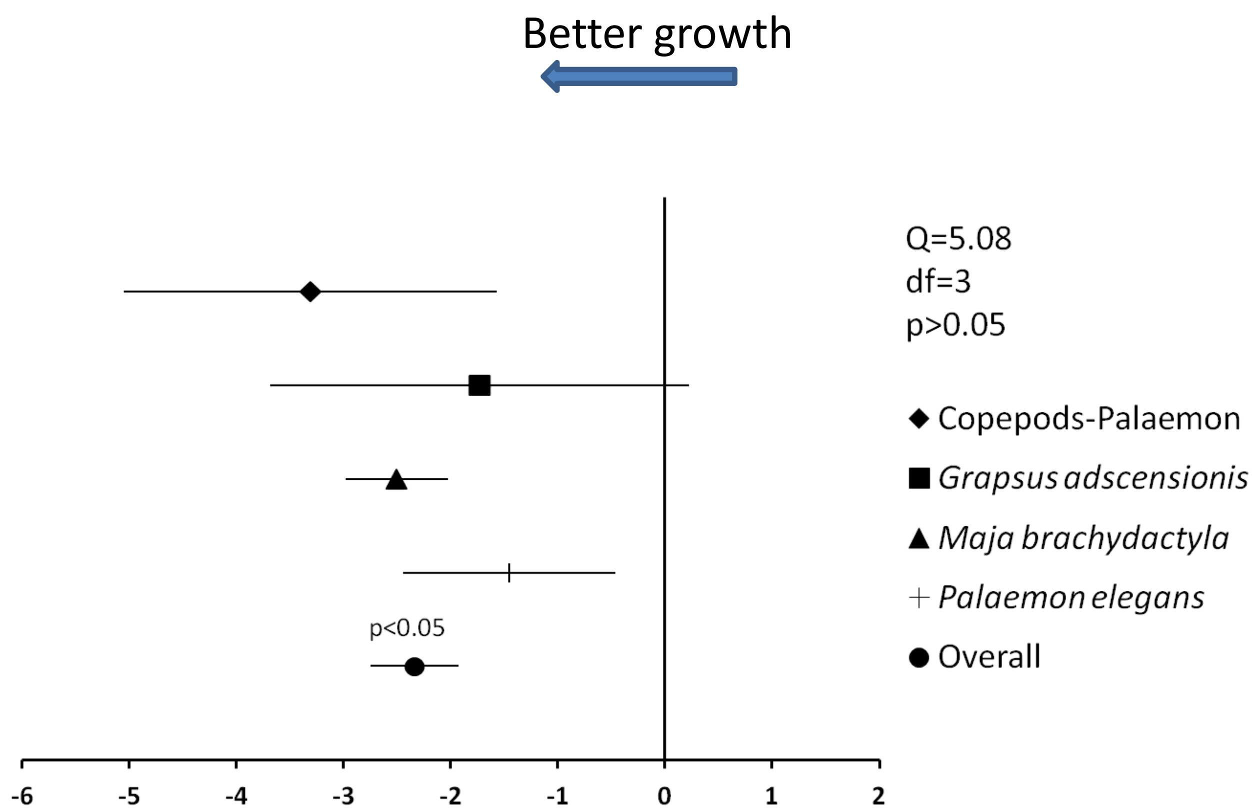
Key techniques

- **Design and formulation**
- **Biochemical composition**
- **Ingestion measures**

Alternative preys

Previous data

✓ **Decapod zoeae such as spider crab (*Maja* sp.) have showed the best results in paralarvae viability**



<u>Alternative preys</u>

Previous data

- ✓ **Decapod zoeae such as spider crab (*Maja* sp.) have showed the best results in paralarvae viability**

- ✓ **It is necessary to search for a live prey easy to obtain and maintain in the laboratory that meets the nutritional requirements of the octopus paralarvae and adapts to its predatory behaviour**

- ✓ **Paralarvae are specialist predators at least during the first weeks of their life cycle and showed seasonal and spatial variability in the diet**

Alternative preys

Future challenges

- ✓ **Search for alternative prey with an adequate nutritional profile, easy to capture and keep in captivity or commercially available**
- ✓ **Look for preys suitable for both the paralarval and settlement phases.**

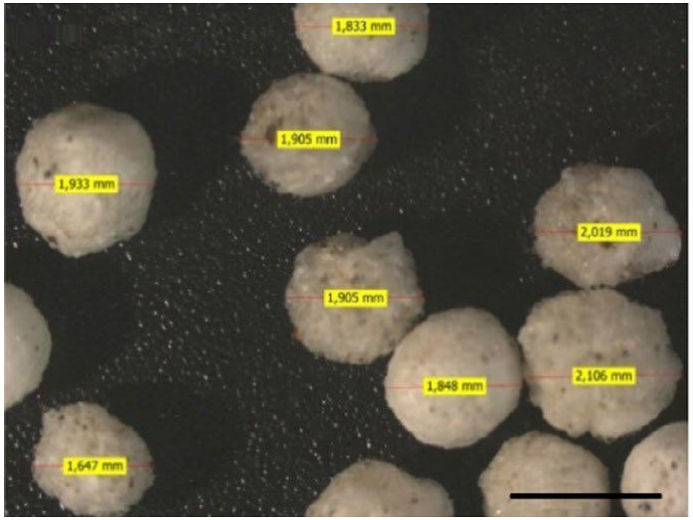
Key techniques

- ✓ **Prey selection**
- ✓ **Protocols for prey rearing**
- ✓ **Ingestion measures**

Inert diets

Previous data

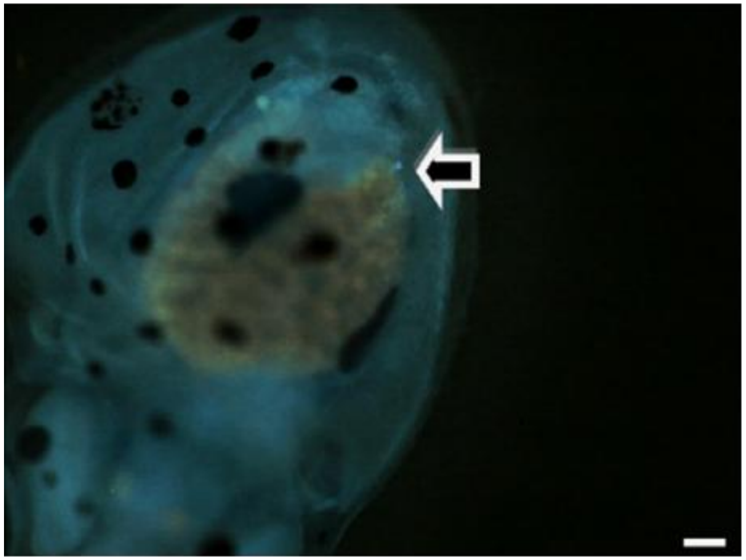
- ✓ **Paralarvae attack and ingest inert diets. Effective ingestion can be tested adding 10 µm fluorospheres to the inert diet.**
- ✓ **A gelatine based diet for *O. vulgaris* was patented by Estefanell *et al.*, 2018 (ES2599603)**
- ✓ **Alginate-crab diets increases average weight at day 14.**



Inert diets

Future challenges

- ✓ **Formulate inert diets with commercial ingredients**
- ✓ **Designing inert diets to assess nutritional requirements**
- ✓ **Effects of heated ingredients in growth rate**
- ✓ **Effects of exogenous enzymes and emulsifiers**



Key techniques

- ✓ **Design and formulation**
- ✓ **Biochemical composition**
- ✓ **Buoyancy**
- ✓ **Acceptability**
- ✓ **Ingestion measures**

Bienestar animal

European Directive 2010/63/EU

RD 53/2013-España

COST Action FA1301 "A network for improvement of cephalopod welfare and husbandry in research, aquaculture and fisheries (CephsInAction)"

3 R

- REPLACE
- REDUCE
- REFINE

✓**Establish cephalopod guidelines**
✓**Revise current information and produce new information**
✓**Exchange of information between scholars and institutions**

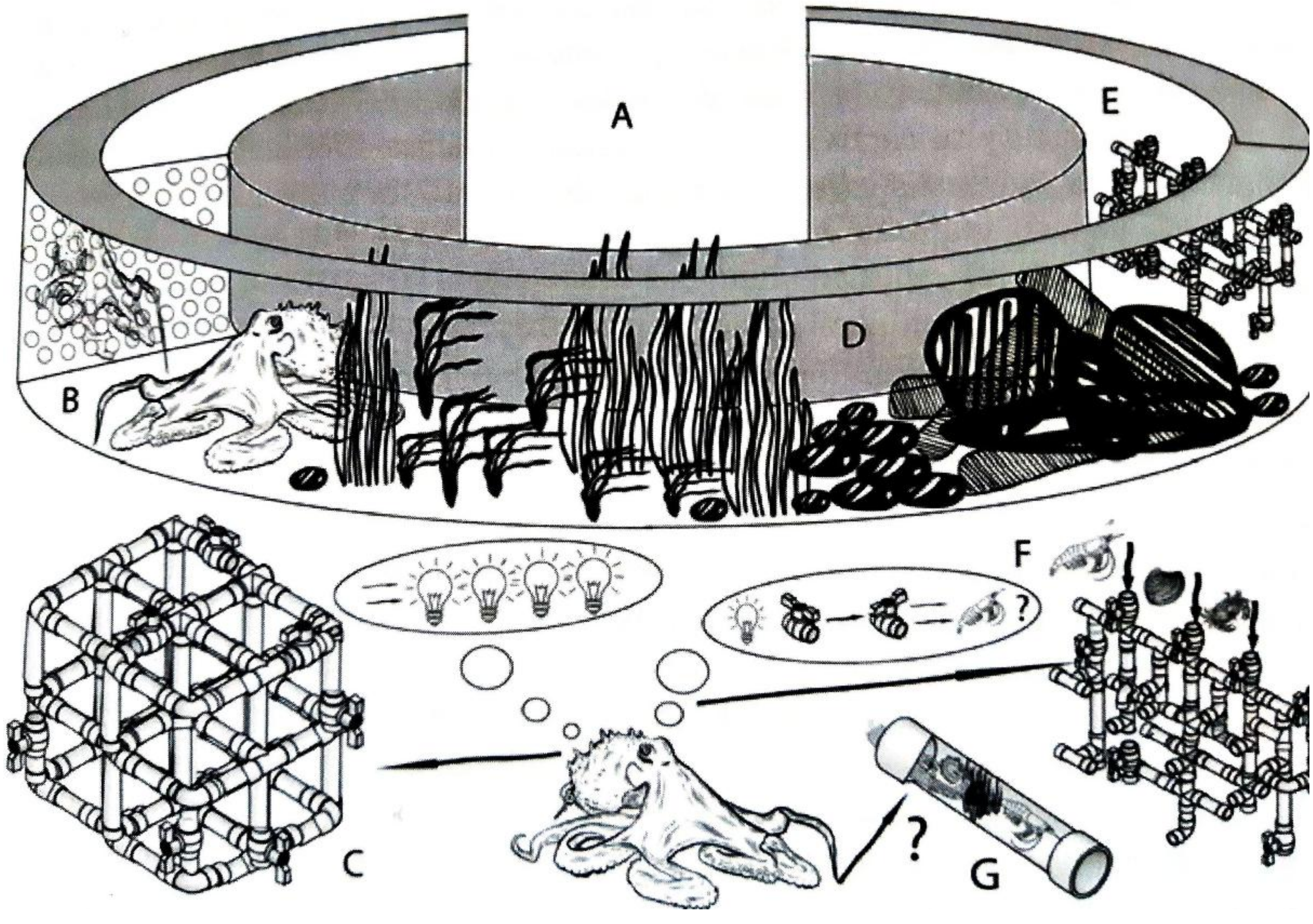
Anestésicos

Métodos no invasivos

Marcadores de estrés

Enriquecimiento ambiental

Bienestar animal



JENNIFER JACQUET, BECCA FRANKS,
PETER GODFREY-SMITH, AND WALTER SÁNCHEZ-SUÁREZ

The Case Against Octopus Farming

For ethical and environmental reasons, raising octopuses in captivity for food is a bad idea.

Octopuses stand out among invertebrates for their complex behavior. They are capable of problem-solving, mimicking their surroundings using color changes that take place on a scale of seconds, outwitting predatory sharks, discriminating individual humans, engaging in playful behavior, and hunting in response to cooperative signals sent by fish. As these patterns of behavior suggest, octopuses (as well as some other cephalopods) have sophisticated nervous systems and large brains.

Given their exceptional abilities, one might ask whether humans should be eating octopus at all, but here we want to raise a different ethical question. As global demand for octopus grows, especially in affluent markets, so have efforts to farm them. We believe that octopuses are particularly ill suited to a life in captivity and mass-pro-

cated by hu-
oats, cows,
tury, in tune
Revolution,
mals, which
ber of ani-
to concerns
s, including
ution.
stly exempt
xclusively

harvested from their natural habitats. Inter
ture became part of the global food system
half of the twentieth century and is now on
growing food industries. Aquatic animals a
id domestication, and approximately 550 di
animal species, from oysters and shrimp to
and even bluefin tuna, are raised in captivit
countries. Farmed aquatic animals now co
the seafood market in many industrialized

As with terrestrial animals, the intensive
aquatic animals is associated with animal w
ronmental concerns, but little is known abo
the welfare of farmed aquatic animals. Fish
develop traits not seen in the wild and tend
gressive, experience more chronic stress an
tract more diseases. Fish raised in intensive
tems may have lower immune function tha
more control over their lives. Even simple p
tank-wall color can have dramatic effects o
and aggression.

Feeding fish with fish

The environmental impacts of aquaculture
They include pollution from nitrogen and p
leased from feces and food decomposition;
from fertilizers, algaecides, herbicides, and
excessive use of antibiotics; interbreeding a

Co

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Review of the Evidence of Sentience in Cephalopod Molluscs and Decapod Crustaceans

Jonathan Birch, Charlotte Burn, Alexandra Schnell, Heather Browning and Andrew Crum

November 2021

GOV.UK

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3. Wildlife, animals, biodiversity and ecosystems (https://www.gov.uk/environment/wildlife-animals-biodiversity-and-ecosystems)
4. Animal welfare (https://www.gov.uk/environment/animal-welfare)

News story

Lobsters, octopus and crabs recognised as sentient beings

Amendment to Animal Welfare (Sentience) Bill following LSE report on decapod and cephalopod sentience

From:
Department for Environment, Food & Rural Affairs (/government/organisations/department-for-environment-food-rural-affairs), The Rt Hon Lord Benyon (/government/people/richard-benyon), and The Rt Hon Lord Goldsmith (/government/people/zac-goldsmith)

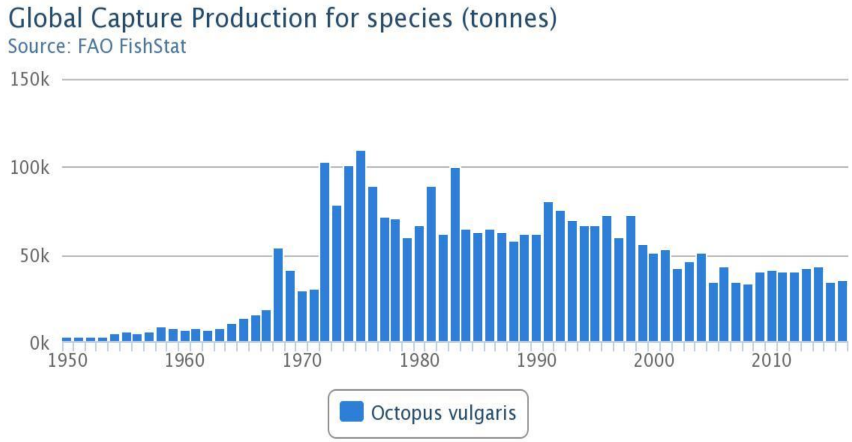
Published
19 November 2021

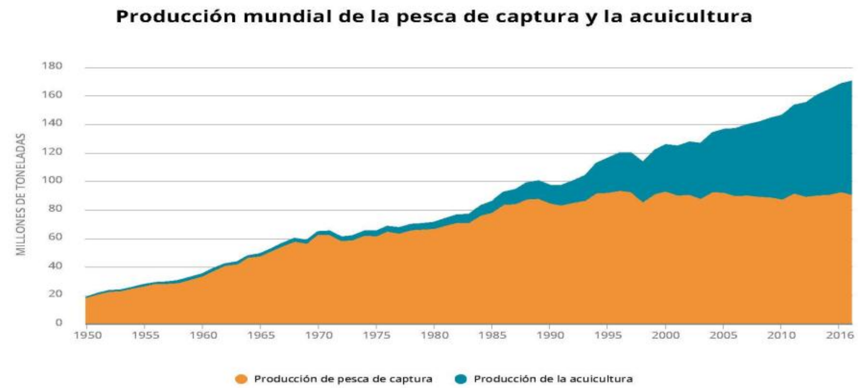
- Crabs, octopus and lobsters to be recognised as

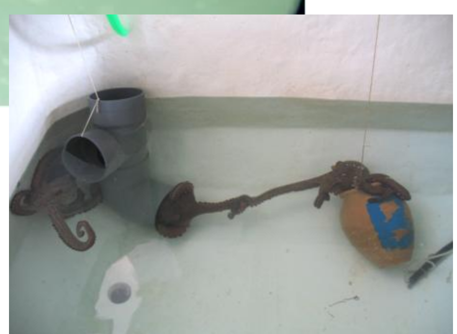
Related content

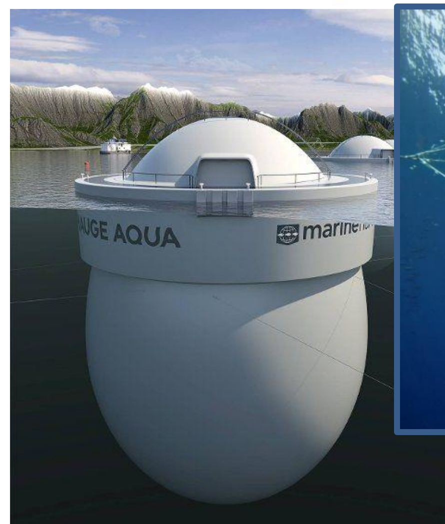
- Pet theft taskforce report (/government/publications/pet-theft-taskforce-report)
- Pet theft taskforce: terms of reference (/government/publications/pet-theft-taskforce-

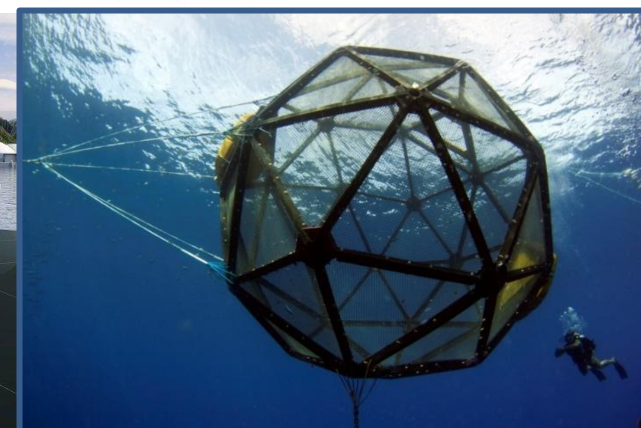
Producción pulpo











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Ministerio de Ciencia e Innovación
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"Una manera de hacer Europa"
Agencia Estatal de Investigación


MUCHAS
GRACIAS POR
SU ATENCIÓN

What is in an octopus's mind?

Jennifer Mather
Department of Psychology
University of Lethbridge

Abstract: It is difficult to imagine what an animal as different from us as the octopus 'thinks', but we can make some progress. In the *Umwelt* or perceptual world of an octopus, what the lateralized monocular eyes perceive is not color but the plane of polarization of light. Information is processed by a bilateral brain but manipulation is done by a radially symmetrical set of eight arms. Octopuses do not self-monitor by vision. Their skin pattern system, used for excellent camouflage, is open loop. The output of the motor system of the eight arms is organized at several levels — brain, intrabrachial commissure and local brachial ganglia. Octopuses may be motivated by a combination of fear and exploration. Several actions — a head bob for motion parallax, a 'Passing Cloud' skin display to startle prey, and particularly exploration by their arms — demonstrate the presence of a controlling mind, motivated to gather information. Yet most octopuses are solitary and many are cannibalistic, so they must always be on guard, even against conspecifics. The actions of octopuses can be domain general, with flexible problem-solving strategies, enabling them to survive "by their wits" in a challenging and variable environment.

Keywords: octopus, *Umwelt*, arm control, exploration, mind

Jennifer Mather is Professor in the Department of Psychology, University of Lethbridge. She has published many articles on cephalopod behavior and intelligence and is regarded as an authority on ethics with regard to cephalopods. Website