Investigación e innovación en el cultivo del pulpo Octopus vulgaris en el IEO-CSIC de Tenerife y sus implicaciones en el bienestar animal

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Científico Titular

Instituto Español de Oceanografía (CSIC)

IEO-CSIC

Areas

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

www.ieo.es

Grupo de investigación (CSIC)

Fisiología y bienestar de especies marinas

PHYSIS

IEO - Canarias

IEO - Murcia

IEO - Malaga

Línea de investigación

Nutrición y fisiología de cefalópodos

Pulpo común (Octopus vulgaris)

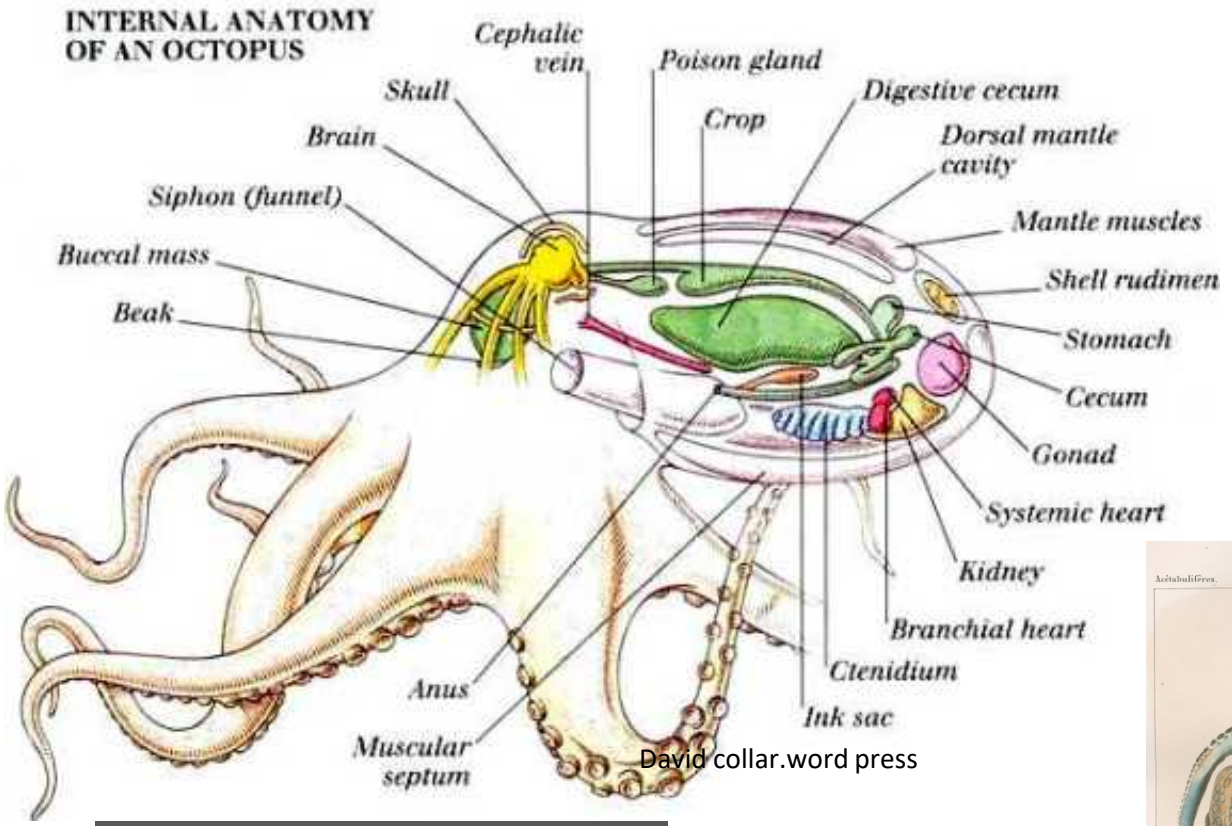
Objetivo:

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

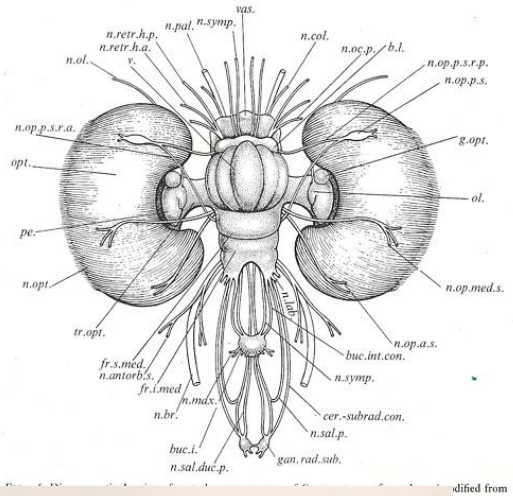
<u>Areas de aplicación</u>

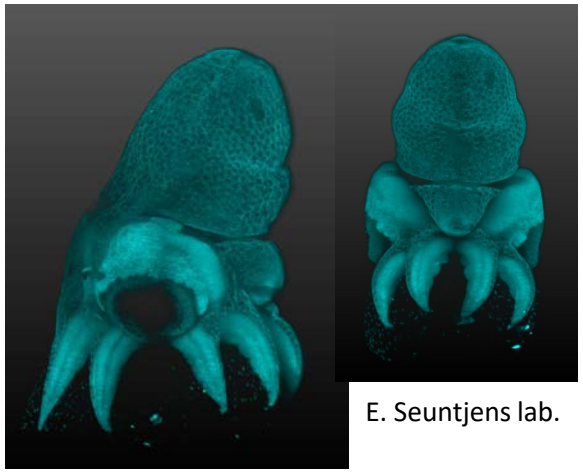
- ✓ *Cría en cautividad*
- ✓ *Gestión de pesquerías*
- ✓ *Estudios de evolución y desarrollo*
- ✓ *Bienestar y salud animal*
- ✓ *etc.*

ANATOMÍA Y EVOLUCIÓN



David collar.word press





E. Seuntjens lab.

Royal Society

Evolución y convergencia

- ✓ Ojos
- ✓ Cerebro
- ✓ Circulatorio
- ✓ Otros

Deuteróstomos

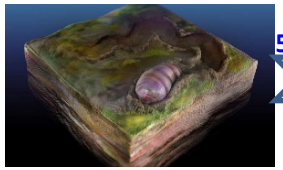
Primeros animales bilaterales

- ✓ Equinodermos
- ✓ Hemicordados
- ✓ Cordados

Vertebrados

Vertebrados

Convergencia evolutiva



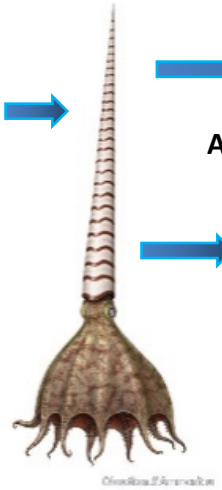
555 540 525 515 *Millones de años* 400 350 0

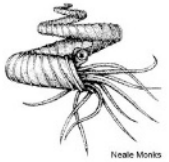
Cambrico | Ordovicio | Silúrico | Devónico | Carbonifero

Protóstomos

- ✓ Moluscos → cefalópodos
- ✓ Anelidos
- ✓ Artrópodos
- ✓ Nemátodos
- ✓ etc.

Ammonites



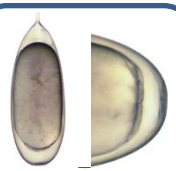


Coloideos

- ✓Pulpos
- ✓Calamares
- ✓Chocos

Desarrollo evolutivo embrionario - *EvoDevo*

Moluscos

	Moluscos	Cefalópodos
Segmentación embrionaria en espiral		
Larva trocófora		Desarrollo directo 

Bases genómicas de la innovación evolutiva

- Genomas grandes y repetitivos (≥50%)
- No parece basarse en la duplicación al contrario que en vertebrados
- Expansión de determinadas familias de genes (ej. Protocadherinas, ZNF, etc.)
- Cambios en el orden y la organización
  - ✓ Regiones cromosómicas
  - ✓ Cariotipo
  - ✓ Intergenes largos y repetitivos
- Elevada presencia de transposones
- Elevada edición de RNA

Cepahlopod Biology: At the intersection between genomic and organismal novelties.
Albertin and Simakov.
Annu. Rev. Anim. Biosci. 2020. 8:17.1-17.20

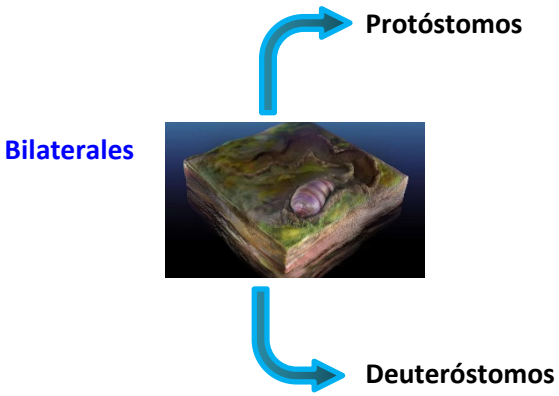
Spatially regulated editing of genetic information within a neuron.
Vallecillo-Viejo et al..
Nucleic Acid Research 2020. 2020. 8:17.1-17.20

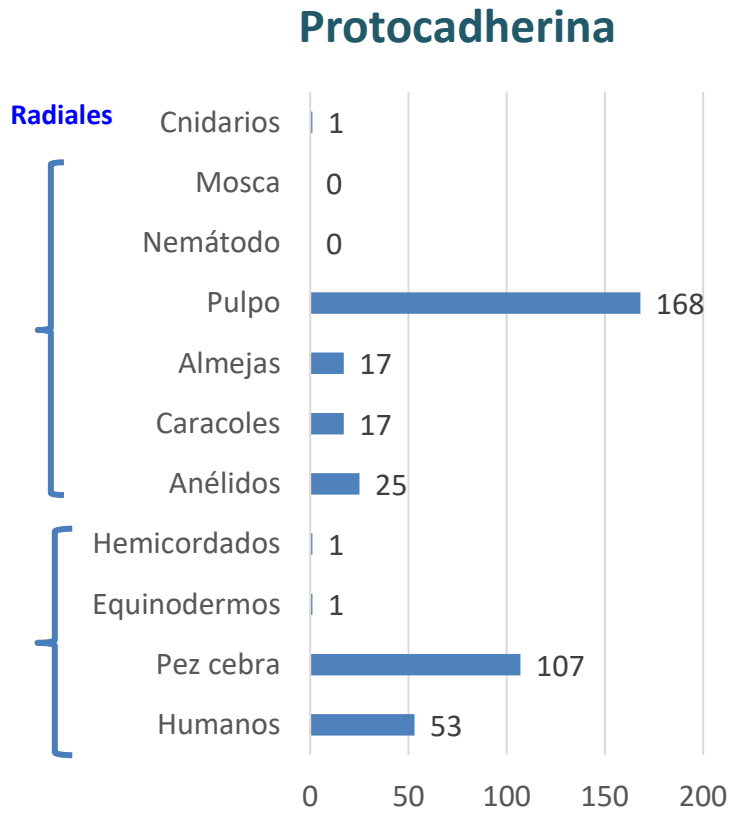
1ª descripción de edición de RNA fuera del núcleo en neuronas de calamar

Convergencia molecular

Protocadherinas

Moléculas relacionadas con la adhesión celular que juegan un papel fundamental en el desarrollo del sistema nervioso en vertebrados

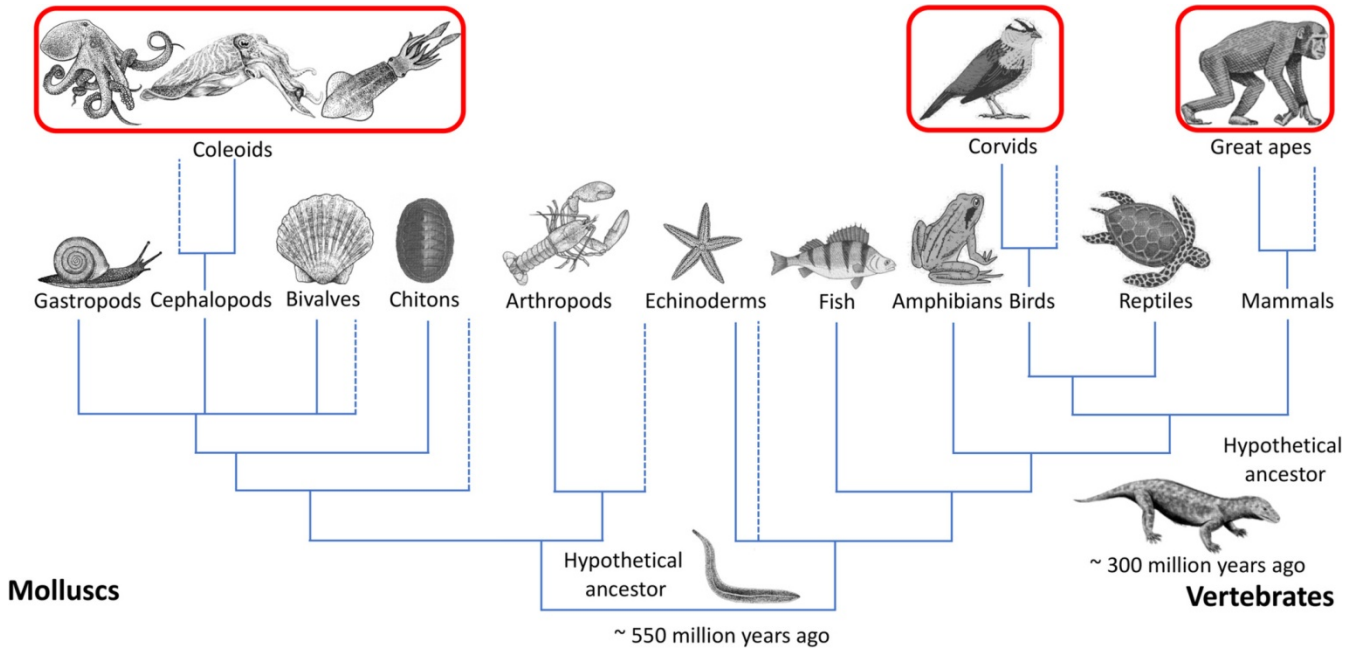




Otras familias moleculares

- **C2H2-ZNFs:** factores de transcripción
- **GPCRs:** transducción de señales

¿Como de inteligente es un cefalópodo respecto a otros animales?



Biological Reviews, First published: 06 September 2020, DOI: (10.1111/brv.12651)

Call for Commentary: *Animal Sentience* publishes Open Peer Commentary on all accepted target articles. Target articles are peer-reviewed. Commentaries are editorially reviewed. There are submitted commentaries as well as invited commentaries. Commentaries appear as soon as they have been reviewed, revised and accepted. Target article authors may respond to their commentaries individually or in a joint response to multiple commentaries.
INSTRUCTIONS FOR COMMENTATORS

What is in an octopus's mind?

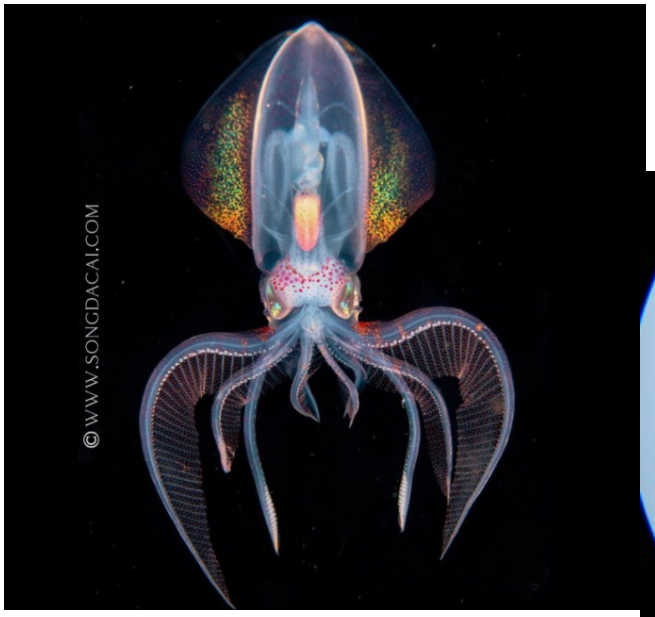
Jennifer Mather
Department of Psychology
University of Lethbridge

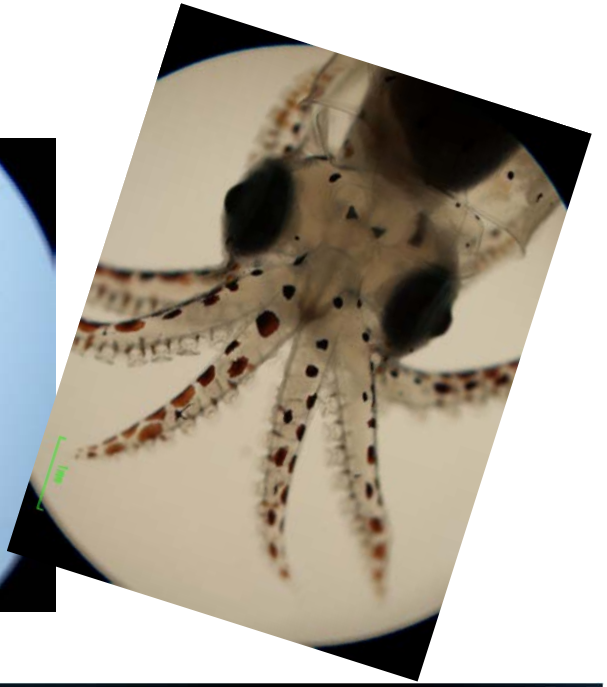
Abstract: It is difficult to imagine what an animal as different from us as the octopus 'thinks', but we can make some progress. In the *Umwelt* or perceptual world of an octopus, what the lateralized monocular eyes perceive is not color but the plane of polarization of light. Information is processed 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.

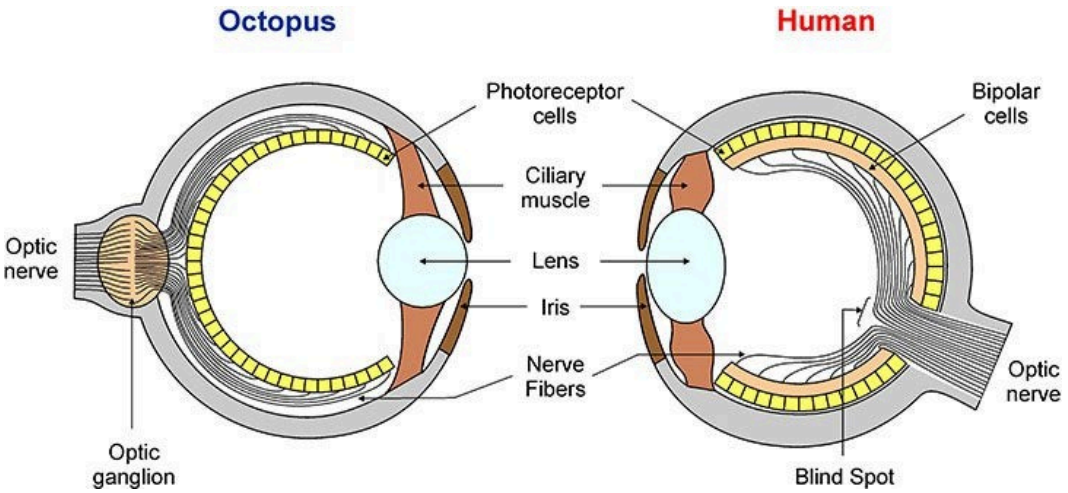
Keywords: octopus, *Umwelt*, arm control, exploration, mind

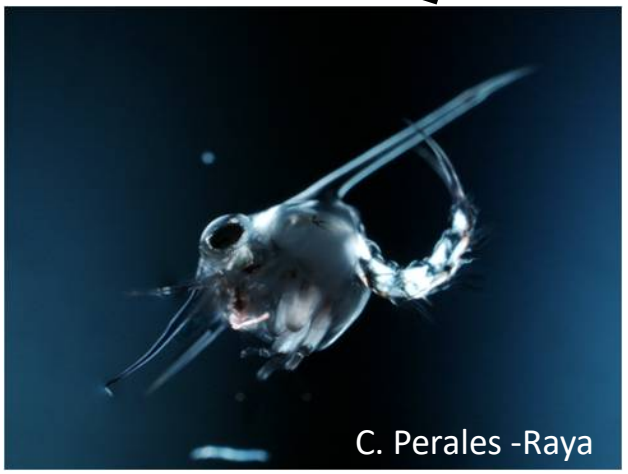
Jennifer Mather is Professor in the Department of Psychology, University of Lethbridge. She has published many articles on cephalopod behavior and intelligence and is regarded as an authority on ethics with regard to cephalopods. Website

Visión y pigmentación

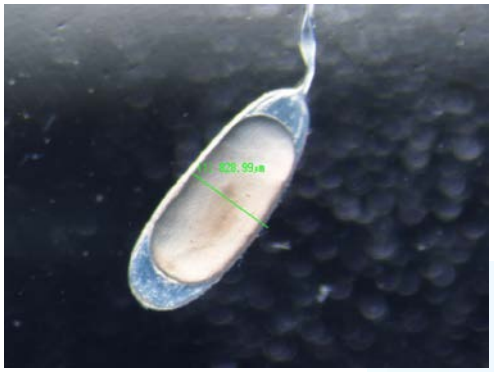


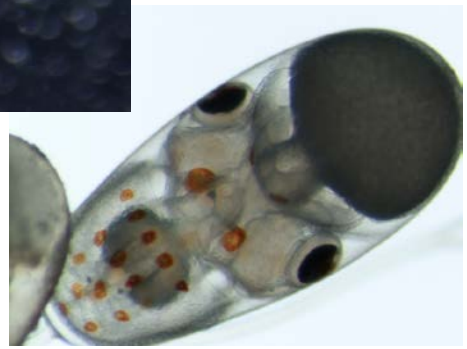


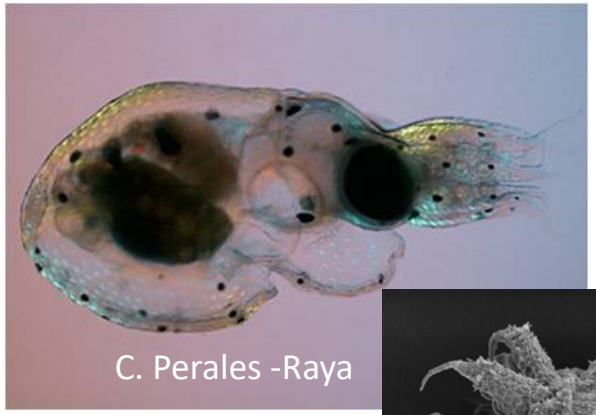




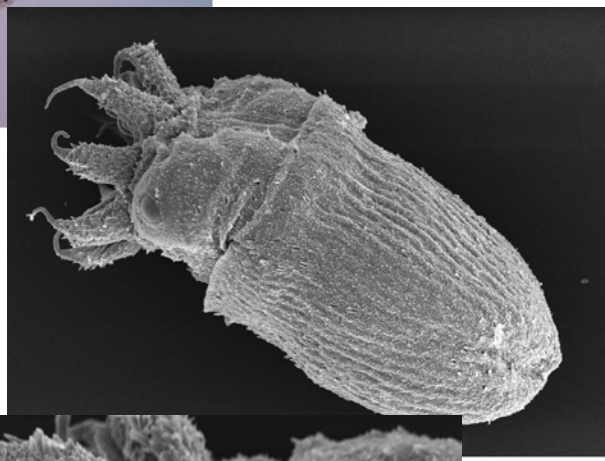
Huevos y paralarvas

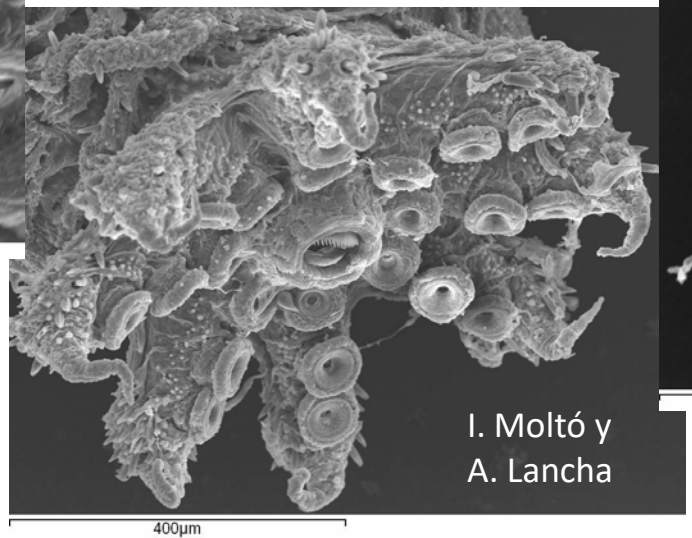


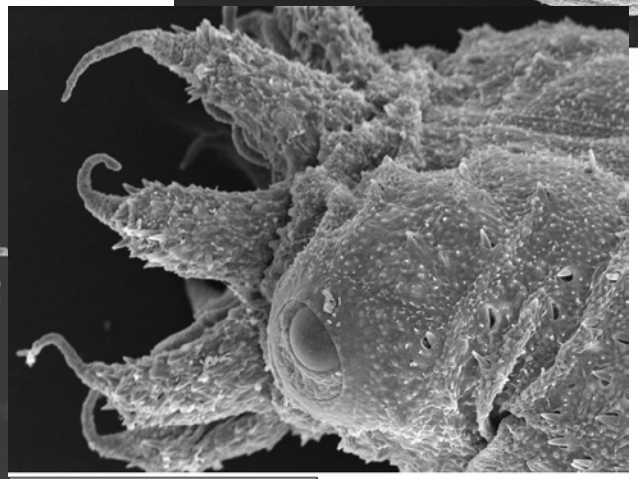




C. Perales -Raya

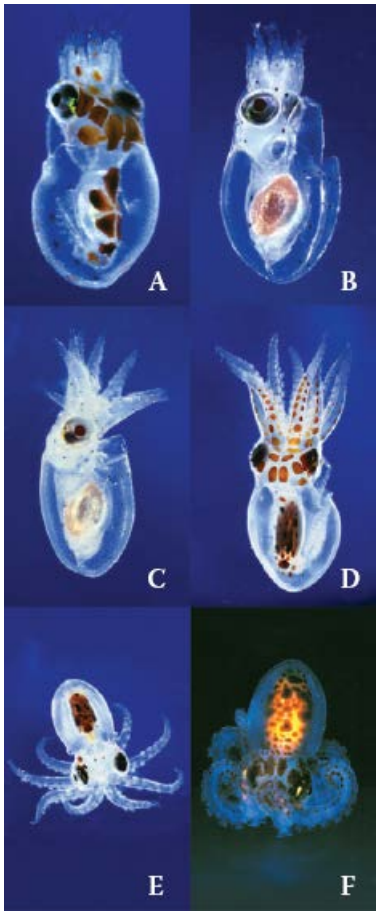






Desarrollo y alimentación

0d
2 mm



20d
3 mm

30d
4,3 mm

42d
5,9 mm

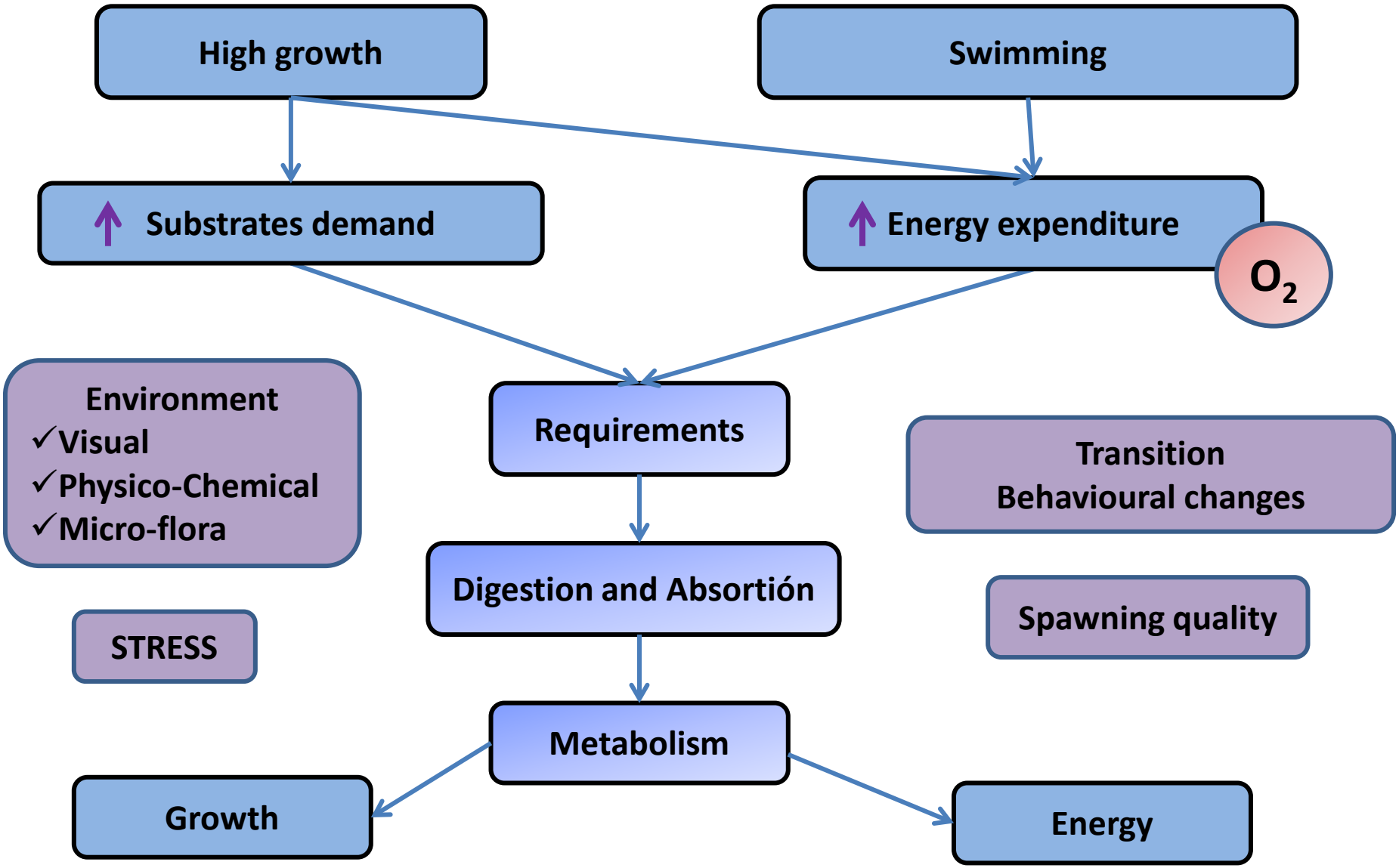
50d
6,6 mm

60d
8,5 mm

Edad (días) /LM (mm)

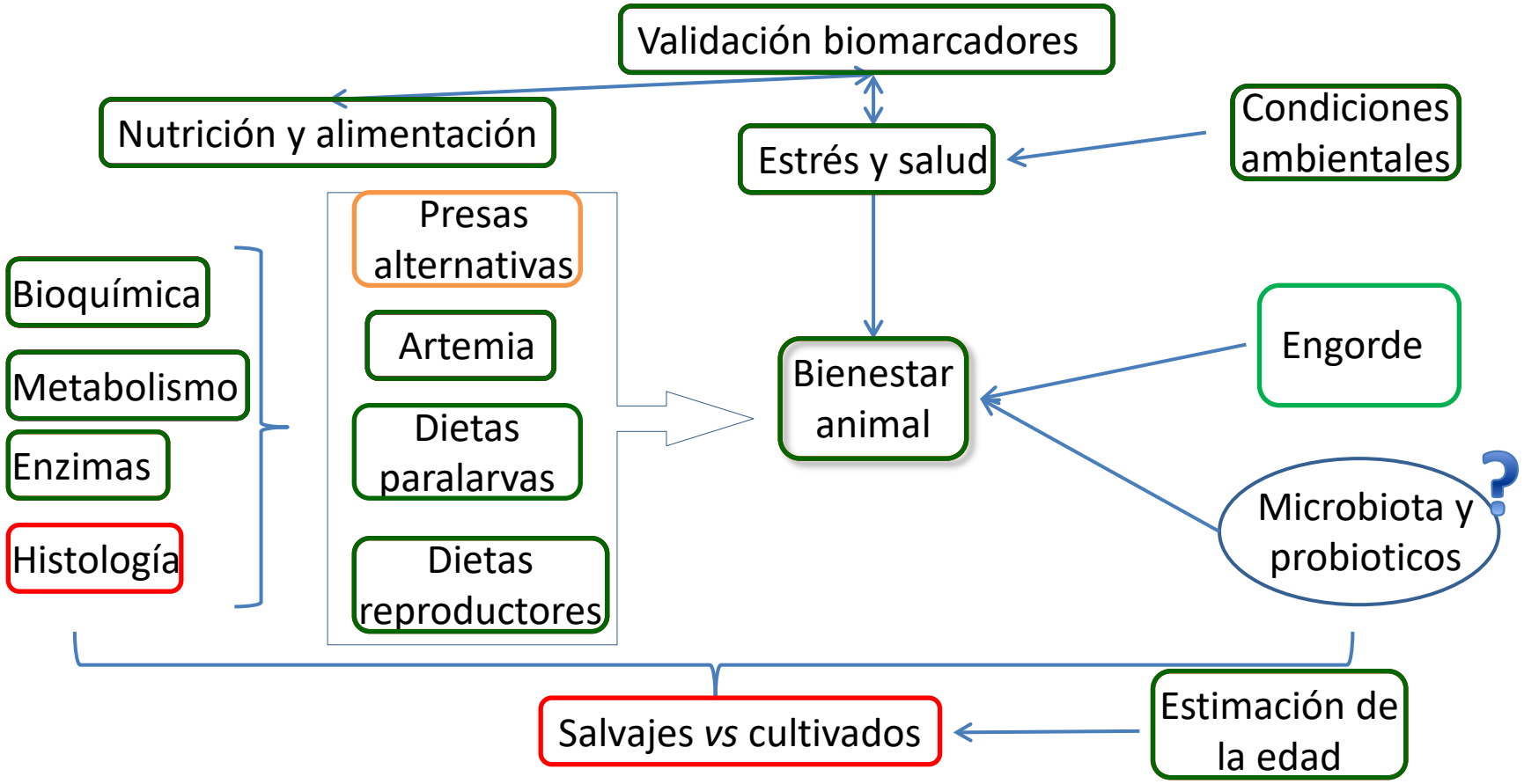
Fuente: Villanueva y Norman (2008)

Paralarval development



Acuicultura del pulpo común

- Incremento de la demanda por lo que se necesitan formas de producción alternativas



Proyectos pulpo 2004-2020

INIA (IFAPA+ULL)

PROFIT (CEDRA SL)

PRESAPUL (CIMA SL)

JACUMAR (8 grupos)

OCTOPHYS (CSIC+ULL+UGR+IRTA)

Red COST (21 paises)-***Representante nacional***

OCTOWELF (CSIC+ULL+UGR+Uvigo)

OCTOMICS (CSIC+ULL+UGR)

Engorde de juveniles

- ✓Estudios de viabilidad de jaula en aguas abiertas
- ✓Diseño de dietas
- ✓Estudios de salud y bienestar

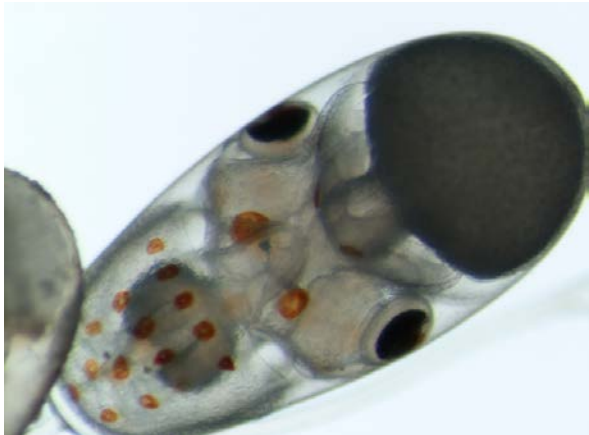
Reproducción de pulpo

Influencia de la dieta y las condiciones de cultivo de los reproductores en la calidad de puesta

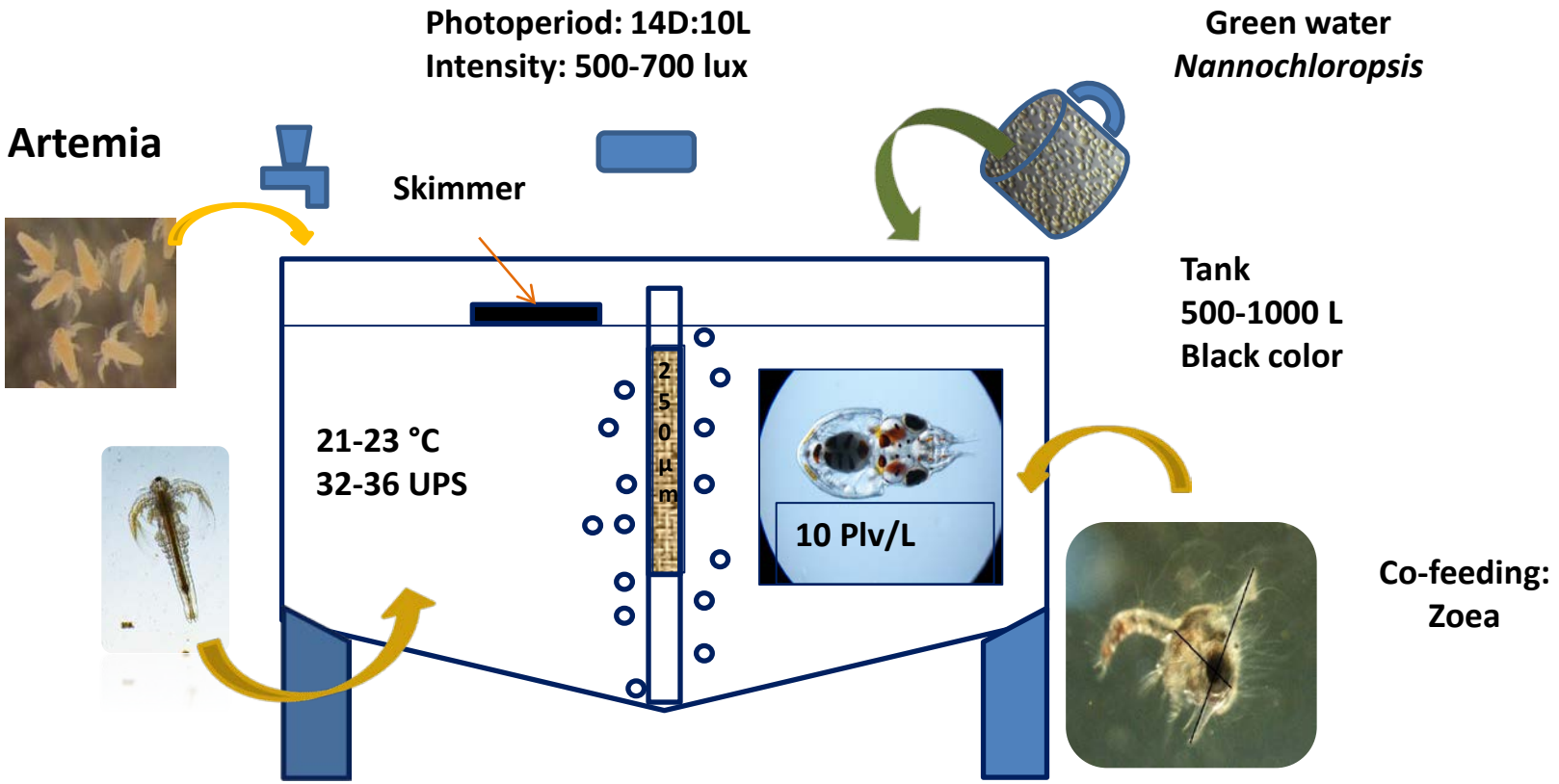
Variabilidad materna
- Individuos
- población

Mejorar la calidad de la puesta

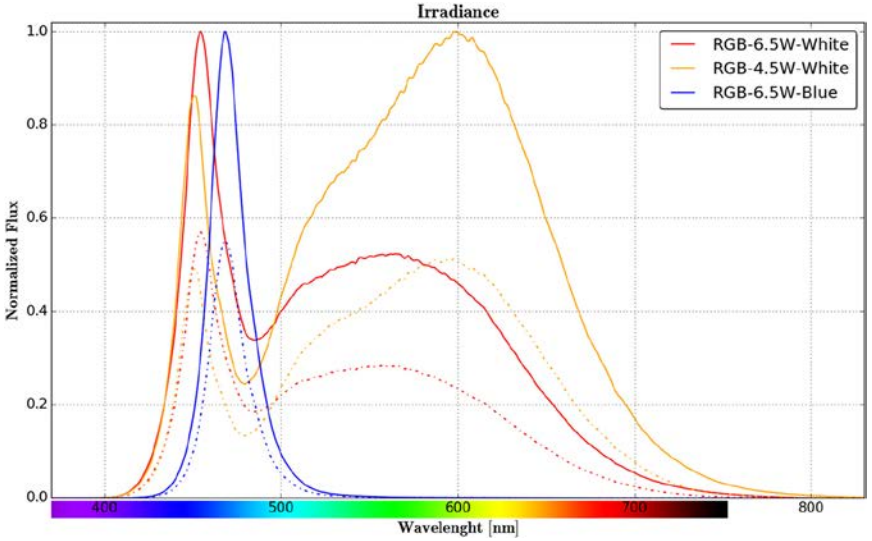
Validar marcadores de calidad de puesta

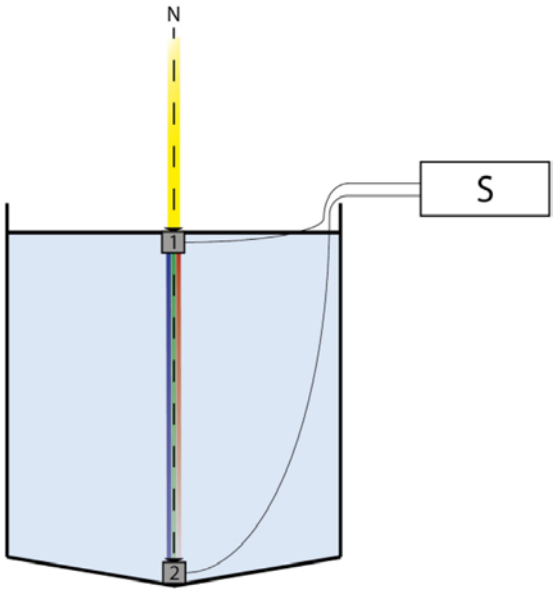


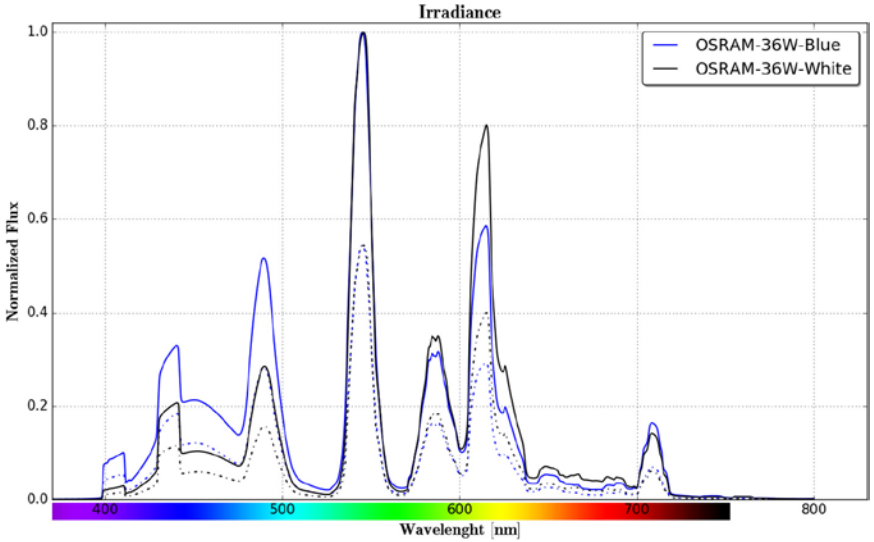
Cultivo de paralarvas

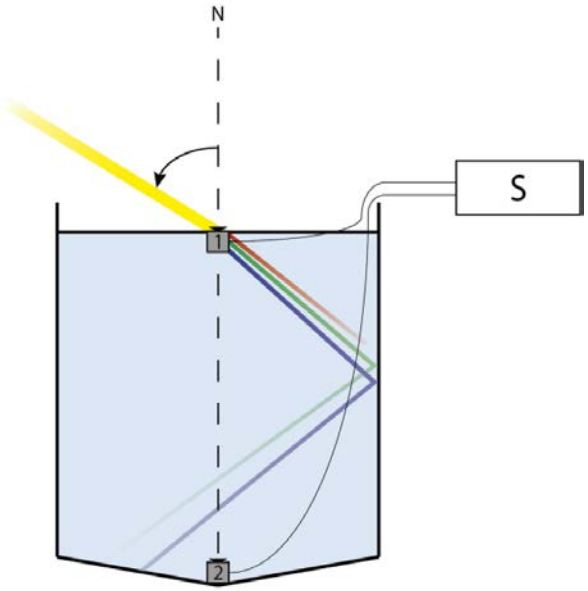


Iluminación en paralarvas









Tur et al. 2018

Nutrición de paralarvas

Caracterización de necesidades nutricionales y biomarcadores

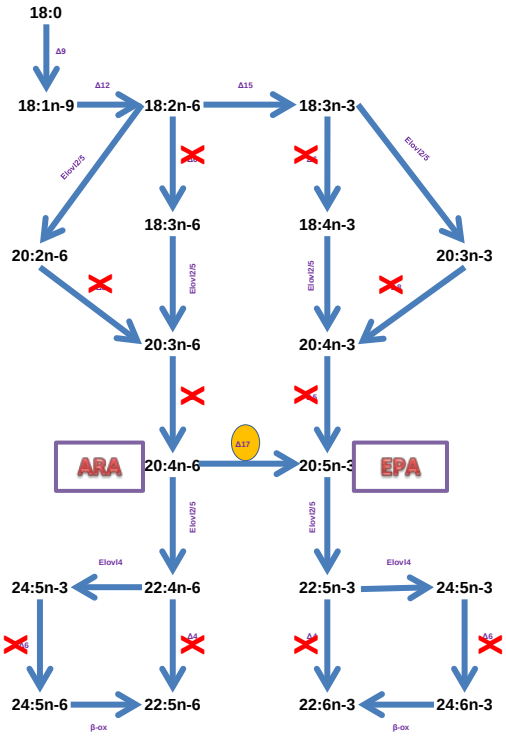
- ✓Vías metabólicas y necesidades nutricionales
- ✓Fisiología digestiva
- ✓Microbioma

Desarrollo de dietas

- ✓Enriquecimiento de Artemia
- ✓Presas alternativas
- ✓Dietas inertes

Vías metabólicas y necesidades nutricionales

- ✓ **Estudiar la esencialidad de los diferentes nutrientes .**
- ✓ **Estudiar las necesidades nutricionales durante la fase de asentamiento**
- ✓ **Estudiar la digestion y el metabolismoa nivel de tejido**



Técnicas

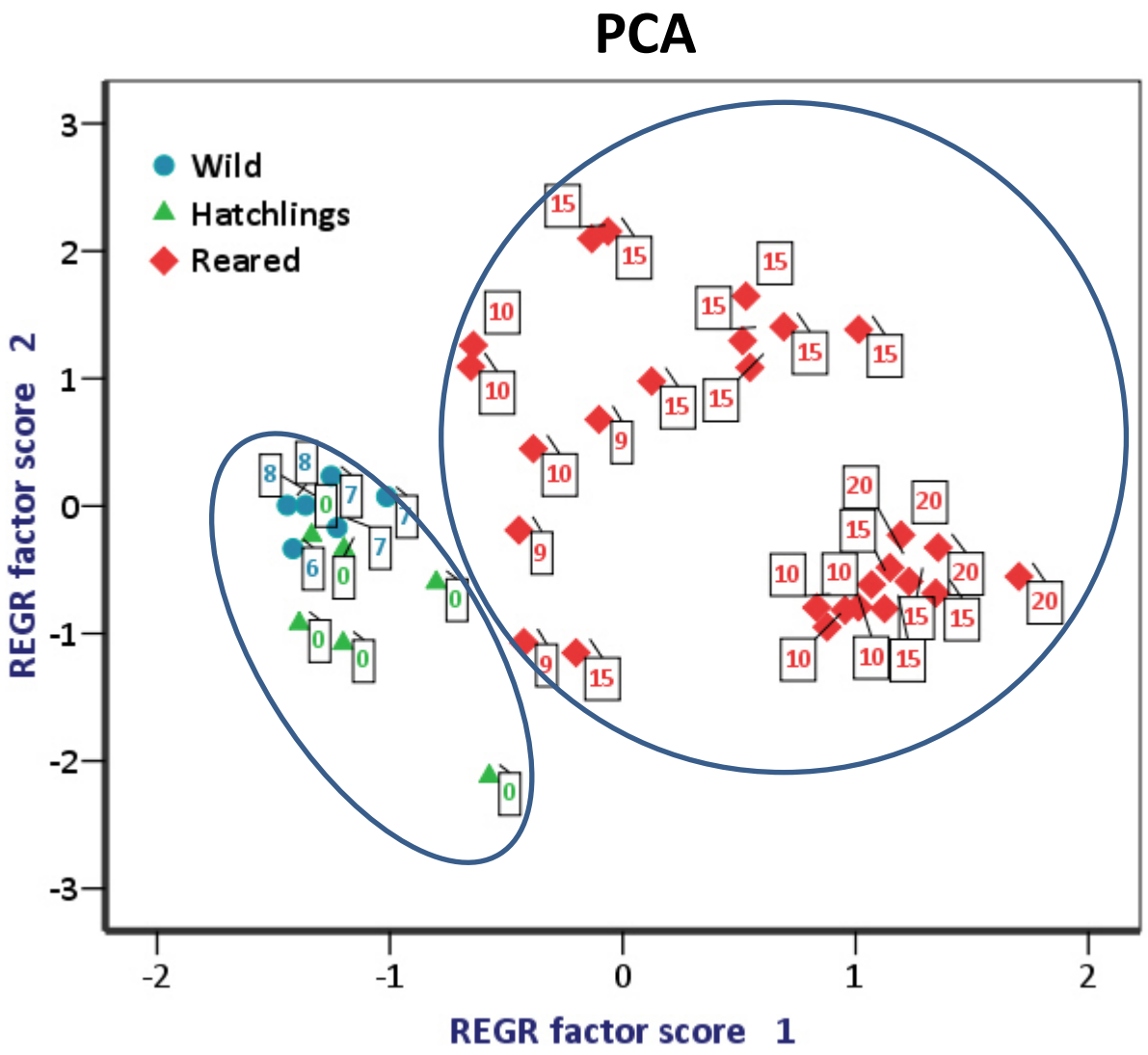
- ✓ **Transcriptomica**
- ✓ **Proteomica**
- ✓ **Actividad enzimática**
- ✓ **Modelización del metabolismo**
- ✓ **Metabolomica**

Composición en ácidos grasos en paralarvas salvajes y cultivadas

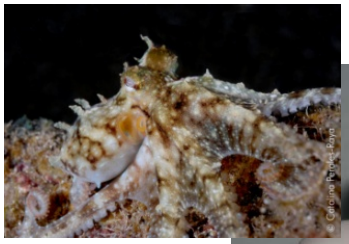
Edad: Indicada en los recuadros

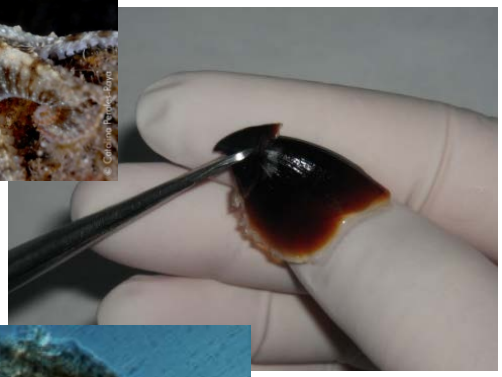
Las elipses representan agrupaciones según ANOVA

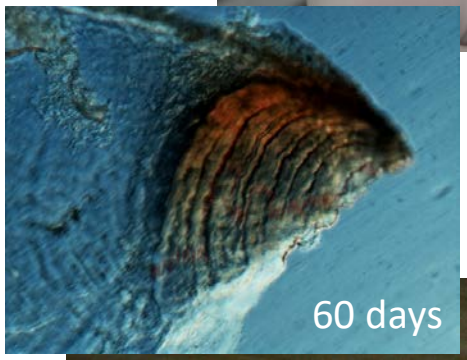
La composición de las cultivadas difiere de las salvajes y cultivadas recién eclosionadas

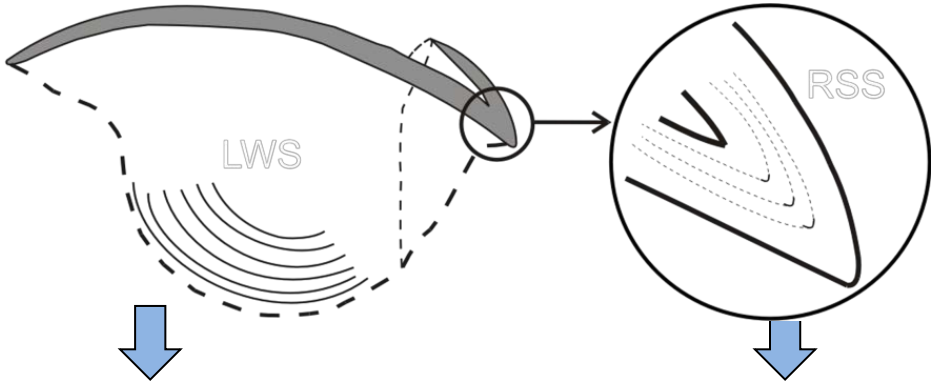


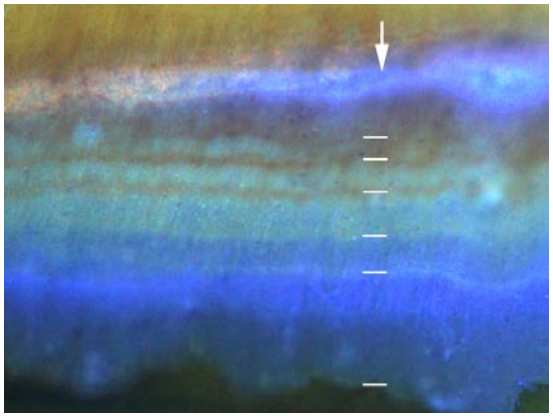
Pesquerías-Estimación de la edad

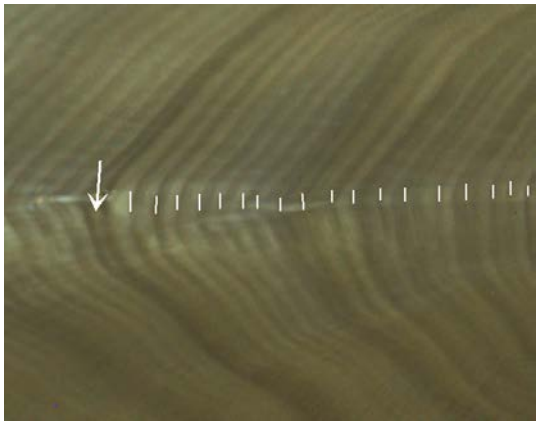












✓Validación de una técnica para estimar la edad
✓Validación de marcas de estrés en el pico

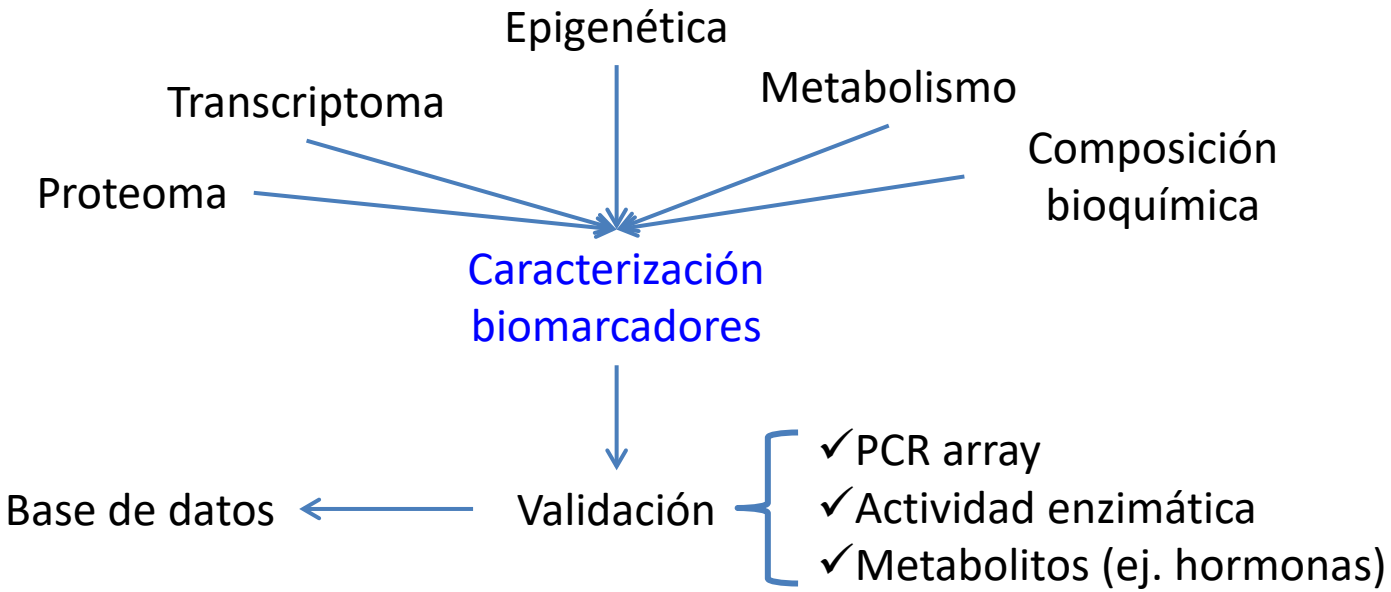
Colaboración Dra. Catalina Perales-Raya (Dpt. Pesquerías IEO-CSIC)

Fisiología digestiva

- ✓ **Digestión , absorción y metabolism de nutrientes**
- ✓ **Marcadores de absorción para nutrients**
- ✓ **Protocolos de digestibilidad**
- ✓ **Regulación de la secreción de enzimas digestivas**

Caracterización de necesidades nutricionales y biomarcadores

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



Microbiota y Probióticos

Objetivo:

Caracterizar y modificar la microbiota del pulpo bajo condiciones de cautividad con el objetivo de aumentar su diversidad y reducir la presencia de patógenos

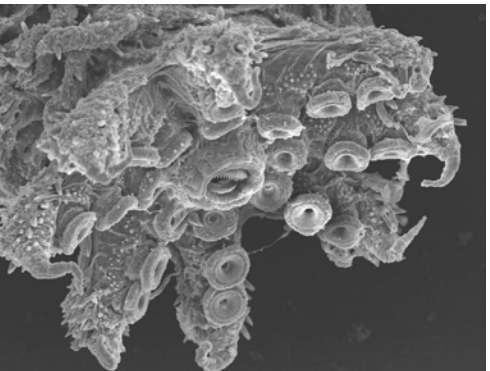
Diversidad de microbiota en paralarvas: Salvajes >> Cultivadas

Análisis de microbiota

- Secuenciación
- Cultivo bacteriano
- Citometría

≠ Estados de desarrollo

≠ Condiciones de cultivo

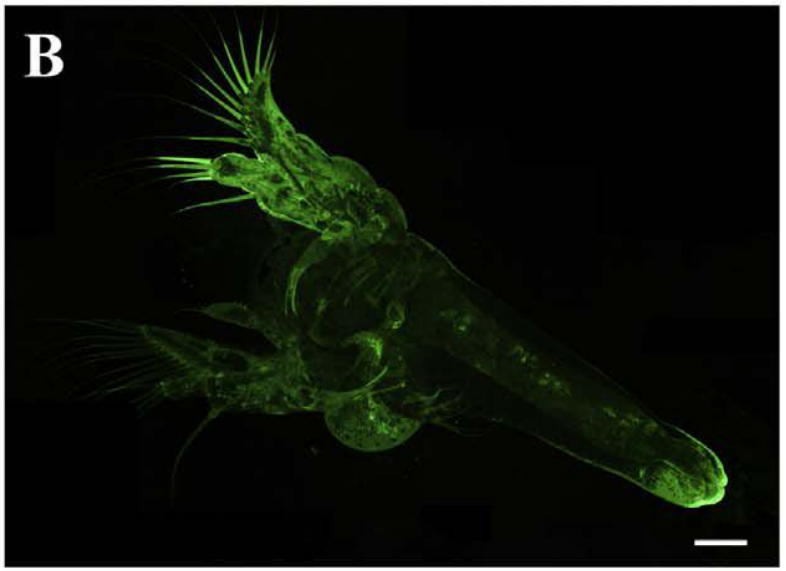


Técnicas para aumentar la diversidad

- ✓Probioticos
- ✓Biofloc
- ✓Presas alternativas

Enqriquecimiento de Artemia

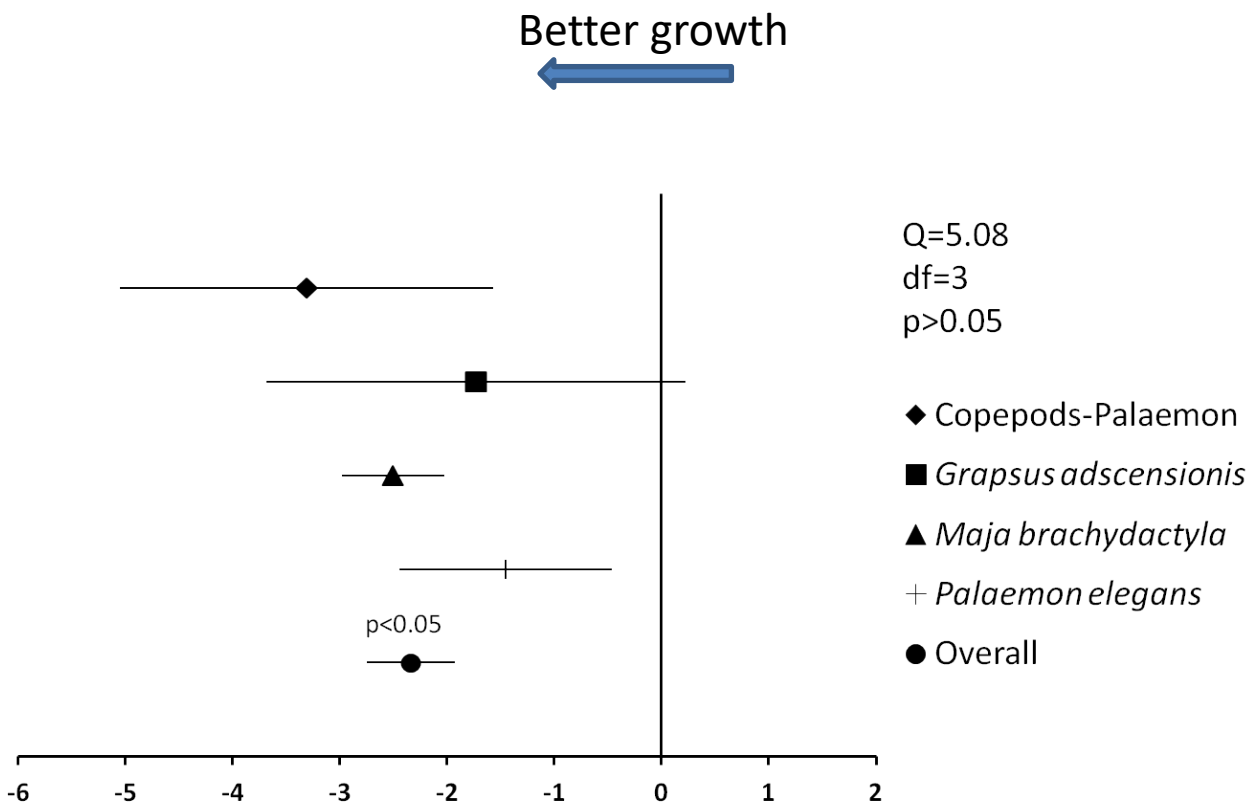
- ✓ **Forma alternativa de transportar moleculas bioactivas unidas al exoesqueleto**



- ✓ **Diseño de nuevos enriquecedores**

Presas alternativas

✓ **Los mejores resultados con zoeas de decápodos**

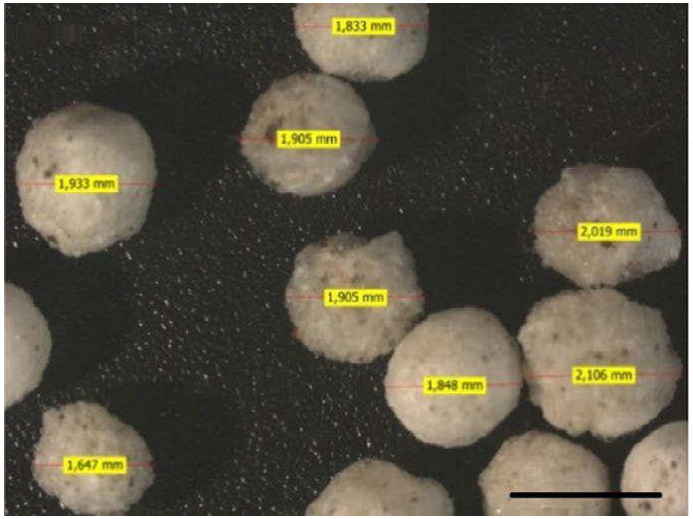


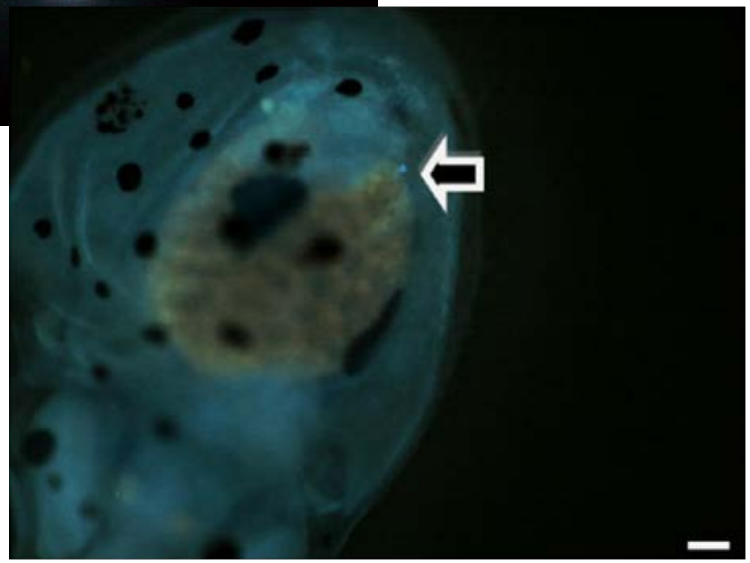
Presas alternativas

Técnicas

- ✓ **Selección de presas**
- ✓ **Cultivo de presas**
- ✓ **Medidas de ingestión**

Dietas inertes





- ✓ **Diseño y formulación**
- ✓ **Composición bioquímica**
- ✓ **Flotabilidad**
- ✓ **Aceptabilidad**
- ✓ **Medidas de ingestión**

Camino Gestal · Santiago Pascual ·
Ángel Guerra · Graziano Fiorito ·
Juan M. Vieites *Editors*

Handbook of Pathogens and Diseases in Cephalopods

Springer Open

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**

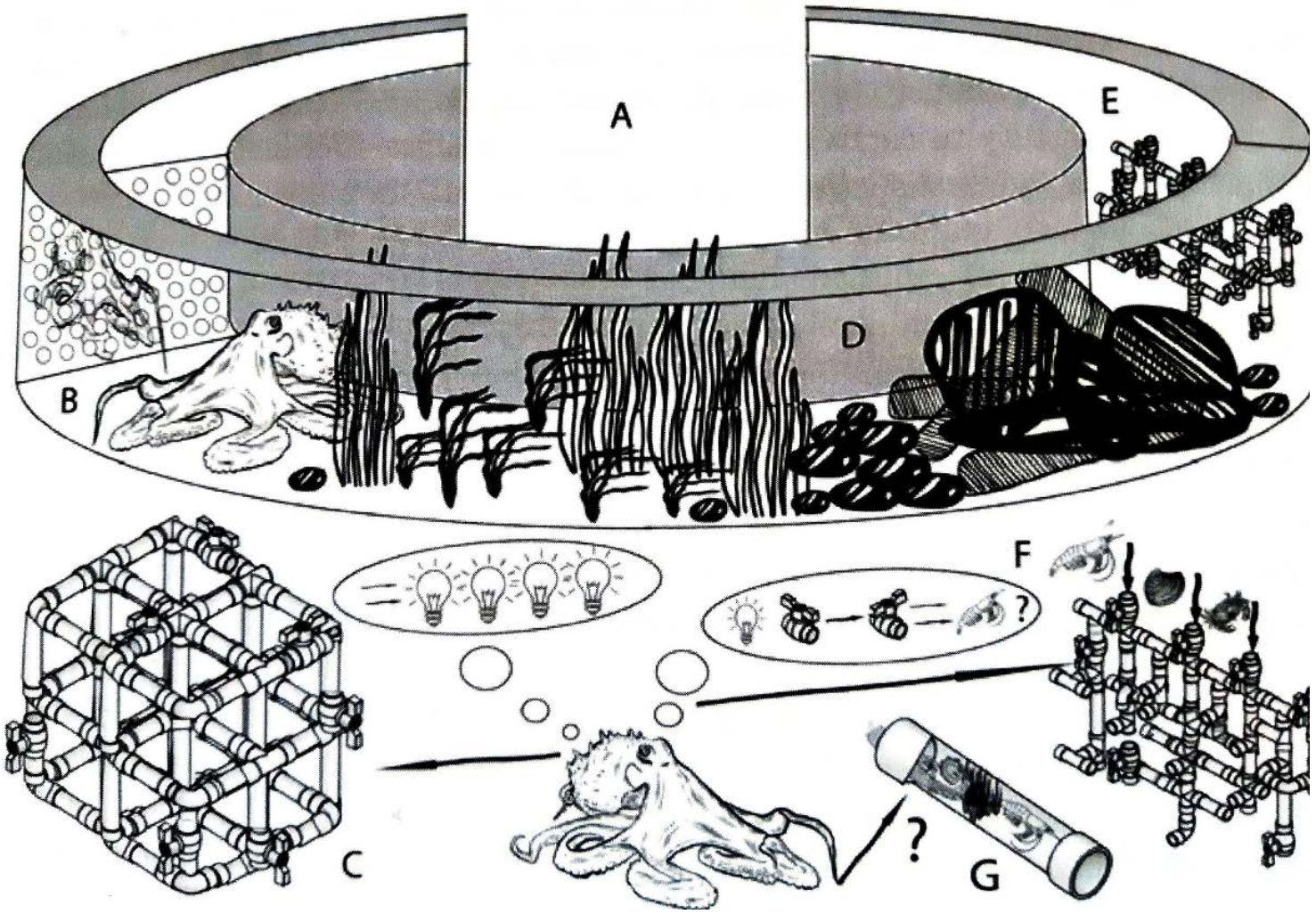
Anestésicos

Métodos no invasivos

Marcadores de estrés

Enriquecimiento ambiental

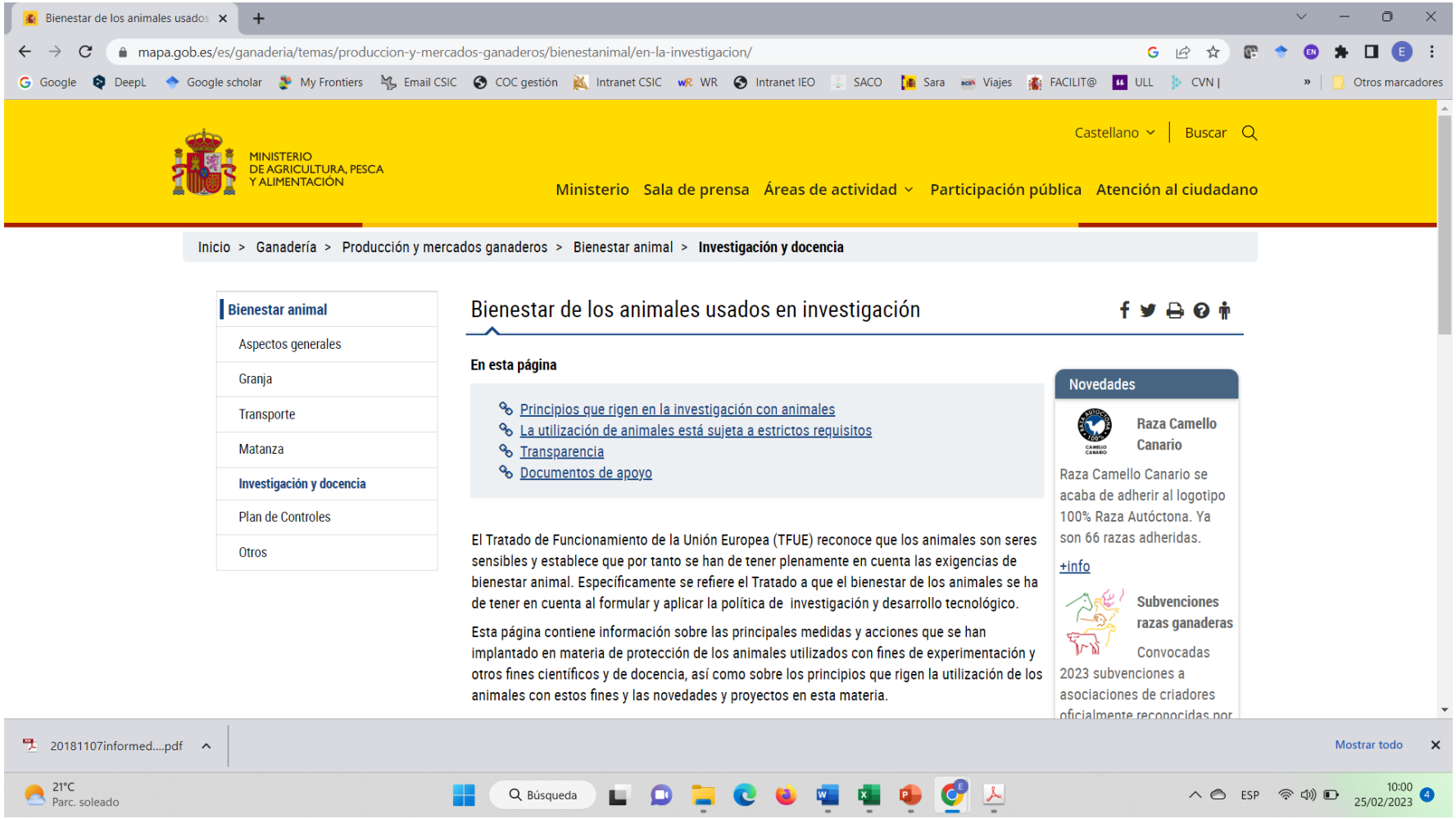
Enriquecimiento ambiental



Bienestar animal

European Directive 2010/63/EU

RD 53/2013-España



https://www.mapa.gob.es/es/ganaderia/temas/produccion-y-mercados-ganaderos/bienestanimal/en-la-investigacion/

ALURES: Animal Use Reporting-EU System

Environment

Home > Chemicals > Animals used for scientific purposes

- Animals used for scientific purposes
- Legislation and implementation
- The "Three Rs" and alternative approaches
- Statistics and Non-technical Project Summaries
  - Introduction to transparency
  - Legal basis

Animals used for scientific purposes

ALURES Statistical EU Database

This is the access page to the ALURES Statistical EU Database on the use of animals for scientific purposes. The data are collected by the Member States and submitted to the European Commission annually.

To progress towards the ultimate goal of full replacement, it is crucial to understand where, how and why animals are still required to be used for scientific purposes.

The ALURES Statistical EU Database

https://ec.europa.eu/environment/chemicals/lab_animals/alures_en.htm

Animales totales utilizados en la UE

Fuente Belen Pintado (Cursos formación CSIC)

Patente cultivo de pulpo

Centro Oceanográfico de Tenerife

Centro Oceanográfico de Vigo

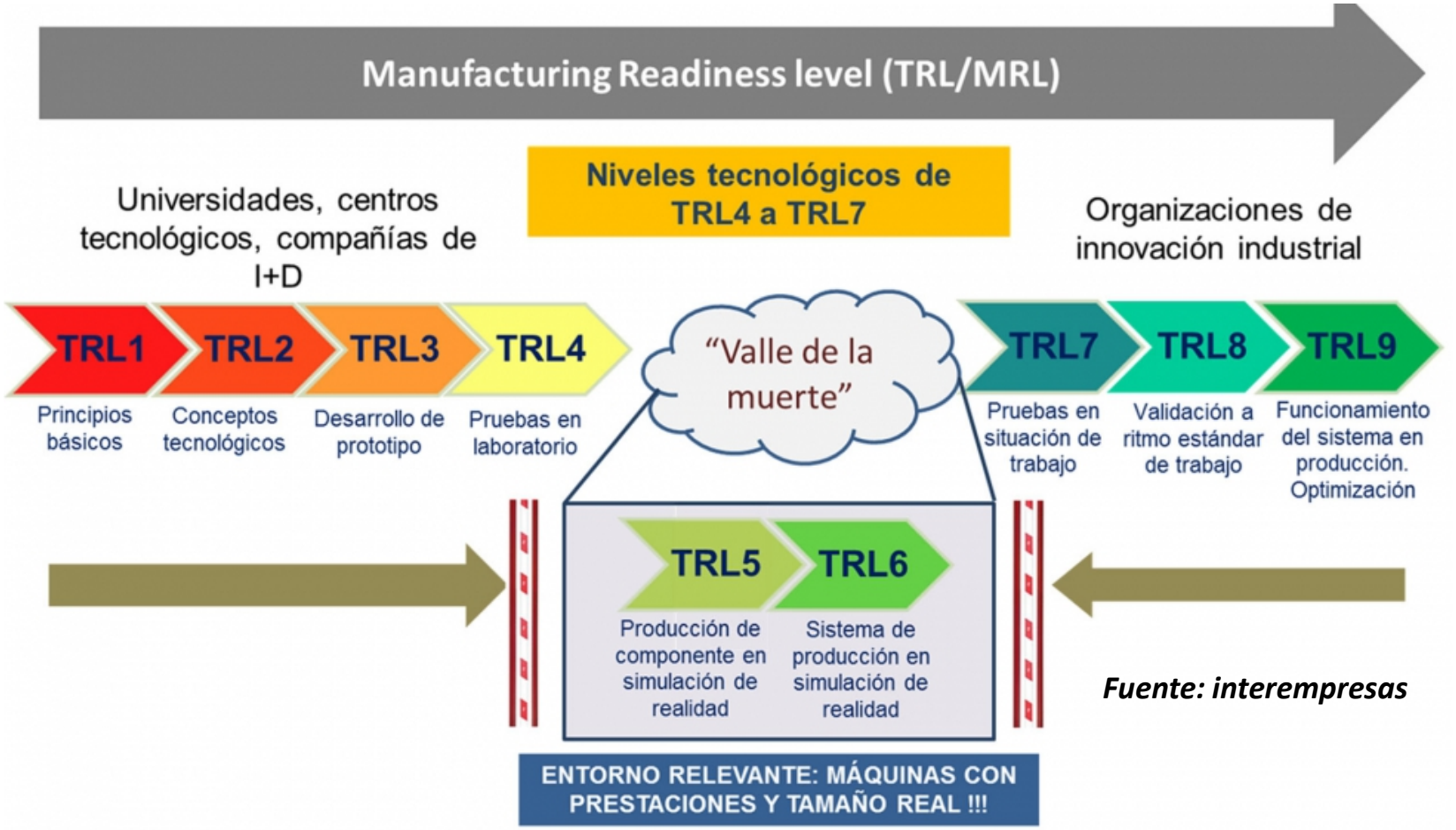
Procedimiento para el cultivo de paralarvas del pulpo común *Octopus vulgaris*

P201731369 (OEPM)

29/11/2017

Licenciada por Nueva Pescanova SL

Transferencia empresa



Fuente: interempresas

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 pose pro-

cated by hu-
oats, cows,
tury, in tune
Revolution,
mals, which
er of ani-
to concerns
, including
ation.
tly exempt
clusively

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 d
animal species, from oysters and shrimp to
and even bluefin tuna, are raised in captivi
countries. Farmed aquatic animals now co
the seafood market in many industrialized

As with terrestrial animals, the intensiv
aquatic animals is associated with animal
ronmental concerns, but little is known ab
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

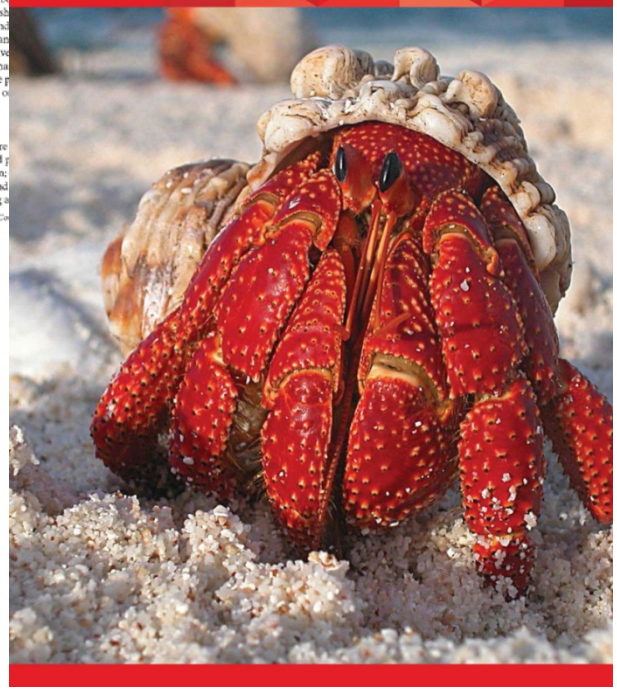
Co

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

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



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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)

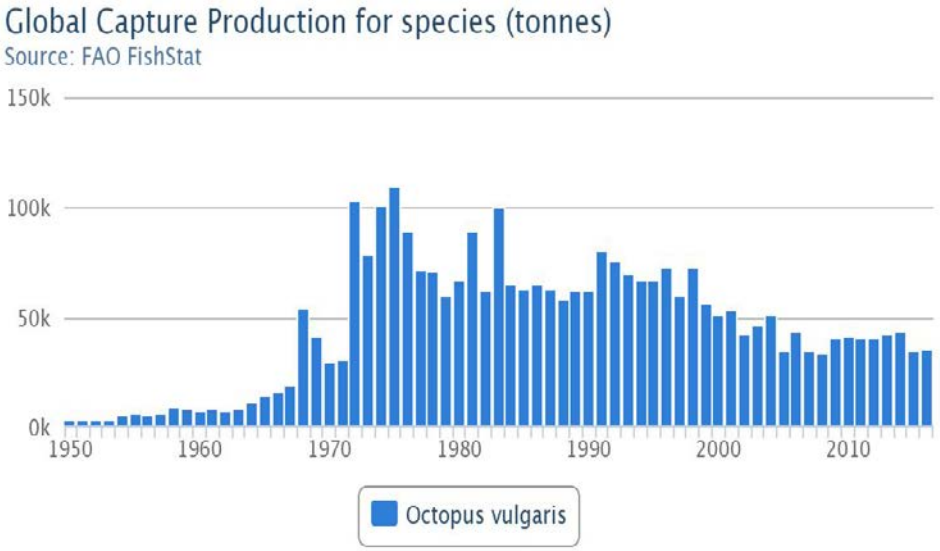
Published
19 November 2021

- Crabs, octopus and lobsters to be recognised as

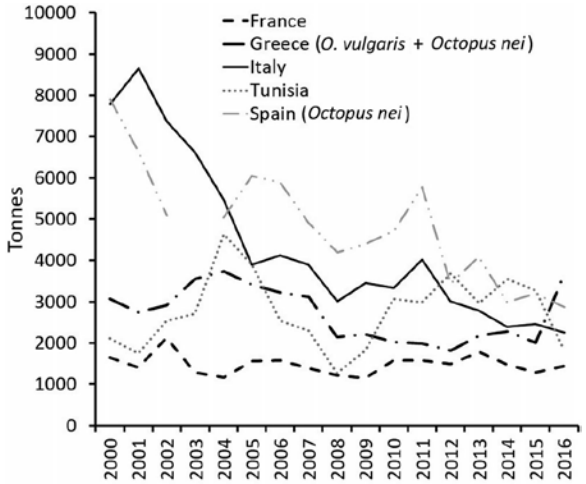
Related content

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

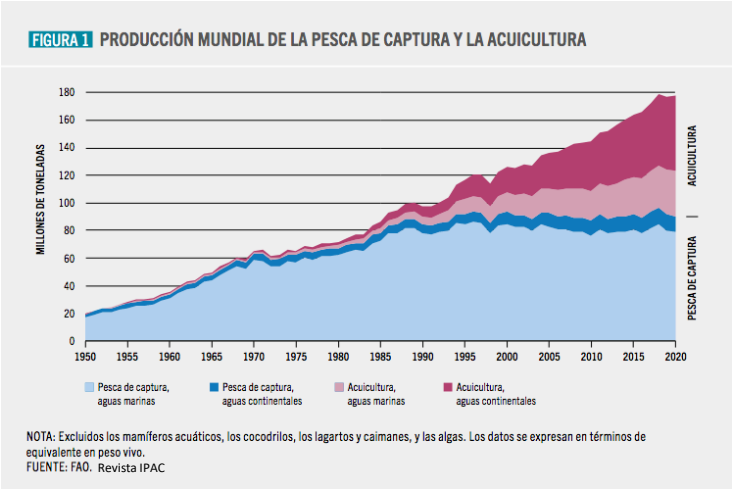
Producción pulpo



Captura de *O. vulgaris* en el Mediterráneo



Fuente FAO/Sauer et al., 2021. Rev. Fish. Sci. Aquac 29(3)




MUCHAS
GRACIAS POR
SU ATENCIÓN