The greater amberjack
(*Seriola dumerilii*):
objectives and progress

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DIVERSIFY
Final Coordination and Dissemination Meeting 2018
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A good candidate for diversification!

- **Interesting characteristics**
  - Fast growth
    - Growth rates **10x** higher than the European seabass
  - Excellent flesh quality and global market
  - Significant potential for exports
    - Congenmer species are produced commercially elsewhere

- **An innovative product**
  - Large size attained
    - Suitable for development of value added products
G. Amberjack rearing in the Mediterranean

- Started in the 80s with capture-based activities using wild juveniles
  - fish of ~90 g reached ~1 kg in a year, 4 and 6 kg in a period of 2 and 3 years
  - standard culture conditions in cages
  - feeding on fresh fish passing quickly to artificial feeds

- The Mediterranean production in 2016 was 500 t (FAO, 2016)
  - in Malta, Spain **hatchery-produced individuals**
  - interest exists and efforts have been made by various aquaculture companies in Spain, Greece, Italy, Turkey, etc.

- Market price >14 € kg\(^{-1}\) (capture fisheries catches)
Major bottlenecks for the G. amberjack aquaculture
... and what DIVERSIFY “promised”

- **Reliable reproduction**
  - In captivity problematic reproduction
  - Captive-reared breeders have reproduced after hormonal treatments, and in some cases spontaneously

- **Production of adequate numbers of juveniles.**
  - Larval rearing of greater amberjack using semi-intensive methods with limited survival

- **Fish health**
  - Several pathogens as potential threats
    - *Photobacterium damsel*la
    - Epitheliocystis
    - *Cryptocaryon*
    - Monogenean parasites
    - *Neobenedenia* spp …

- **Reproduction**
  - Spawning induction methods

- **Larval husbandry**
  - Rearing protocols

- **Nutrition**
  - Live food enrichments, weaning, grow-out diets and broodstock diets

- **Growout husbandry**
  - Feeding strategies, husbandry for cage rearing

- **Health**
  - Detection - diagnosis tools, veterinary solutions and preventive protocols

- **Consumer market analysis**
  - New products with physical prototypes
Broodstock management and spawning induction

Hipolito Fernandez-Palacios, Aldo Corriero, Salvador Jerez
Reproductive cycle studies

mid May – late July
19-26°C

Purse seine,
Lampedousa Island, Italy

Sea cages,
Salamina Island, Greece
## Available broodstocks

<table>
<thead>
<tr>
<th>Stocks</th>
<th>Rearing method</th>
<th>Number of individuals</th>
<th>Size (kg)</th>
<th>Feeding (pellets &gt;2 yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARGO</td>
<td>sea-cages</td>
<td>49</td>
<td>7.1-16.0</td>
<td>raw fish</td>
</tr>
<tr>
<td>GMF</td>
<td>sea-cages</td>
<td>28</td>
<td>6.3-15.6</td>
<td>live fish</td>
</tr>
<tr>
<td>SOUDA</td>
<td>sea-cages</td>
<td>12</td>
<td>7.4-14.8</td>
<td>moist pellet</td>
</tr>
<tr>
<td>AQUALABS</td>
<td>land-based</td>
<td>27</td>
<td>6.5-23.8</td>
<td>raw fish</td>
</tr>
<tr>
<td>ARGO</td>
<td>land-based</td>
<td>9</td>
<td>8.1-11.1</td>
<td>live, raw fish</td>
</tr>
<tr>
<td>FORKYS</td>
<td>land-based</td>
<td>22</td>
<td>7.7-10.3</td>
<td>raw fish, squid</td>
</tr>
</tbody>
</table>

**Spawning induction period:**

- mid May – late July
- 20-26°C
Initial approach

- Fish in tanks/ cages during the year
- Spawning induced at the expected spawning season
- Egg collection in tanks/ cages

New approach

- Fish in sea cages during the year
- Spawning induced at the expected spawning season
- Transfer immediately to land-based tanks
- Egg collection in tanks
Recommended protocol

- Fish in sea cages during the year with no handling after March-April
- Spawning induced at any time between late May - early July (20-25°C)
- Use a GnRHa implant at 50 µg kg\(^{-1}\) every 2 weeks
- Transfer immediately to land-based tanks
- Return to cages after spawning
Nutrition

Daniel Montero, C.M. Hernández Cruz, S. Sarih, H. Fernández-Palacios, M. Izquierdo (FCPCT-ULPGC)
S. Jerez, M. Virginia Martín (IEO), J. Perez, C. Rodríguez (ULL)
Kotzamanis, Y., (HCMR)
Fontanillas, R., Rosenlund, G. (SARC)
Hatchery nutrition for greater amberjack

- Determine the nutritional requirements and optimum levels of DHA, EPA, and combined PUFA-carotenoids in greater amberjack enrichment products during rotifer and Artemia feeding.
- DHA in enrichment products for rotifers 14% TFA
- EPA in enrichment products for rotifers 6% TFA
- DHA/EPA in enrichment products for rotifers 2.3
- DHA in enrichment products for Artemia 10-17% TFA
- EPA in enrichment products for Artemia 14-20% TFA
- DHA/EPA in enrichment products for Artemia 1-5
- Carotenoids levels in enrichment products 10 ppm
Feeding for broodstocks to optimize reproduction

- Effect of increased protein, histidine and taurine dietary levels on egg quality,
- Optimum DHA and EPA levels as essential fatty acids for reproductive success,
- Effects of an experimental diet with a potentially improved formula of lipids, on reproductive development of hatchery produced greater amberjack.
Raising histidine contents in broodstock diets from 1 to 1.5% optimize the reproductive performance.

Taurine levels in broodstock diets (1%) increase fecundity.

Increasing protein contents over 51% lead to the lowest number of egg and larvae produced.

Best spawn quality and production parameters were obtained from broodstock fed diet 1.57% EPA+DHA in contrast to 2.8% EPA+DHA.
Hatchery production

N. Papandroulakis, Tsalafouta, P. Anastasiadis, I. E. Papadakis, N. Mitrizakis (HCMR)
C.M. Hernández Cruz, A. La Barbera, H. Fernández-Palacios Barber, M. Izquierdo (FCPCT)
S. Jerez, M. Virginia Martín (IEO)
J. Perez, C. Rodríguez (ULL)
G. Iakovopoulos (GMF S.A.)
**Objectives**: to obtain new information on the larval rearing parameters

- Acquire basic biological information
  - ontogeny of digestion and vision system
  - ontogeny of Somatotrophic axis
  - skeletal Ontogeny

- Feeding regime - Prey enriching diet

- Husbandry parameters
  - tank type-shape
  - stocking density
  - light conditions
Ontogeny of digestive and vision systems

- Transitions to juveniles after 5.5 mm
- Protein main energy source since first feeding
- Night vision after 5.0 mm
- Rotifer appropriate as diet
- Difficult adaptation to Artemia
The effect of light

- Background color (black, green, white)

**SURVIVAL:**
- WHITE: 22.2%
- BLACK: 8.2%
- GREEN: 16.5%

The study showed a catalytic effect of the light conditions on larval survival.

Indicate a substantial technological step in the larval rearing of the greater amberjack.
Towards an industrial protocol

Validation in Commercial hatcheries

- **Hatchery 1**
  - 15,000 juveniles classified in 4 size-classes between 0.3 and 2.5 g to nursery
  - In 2018 similar method
    - until 20 dph survival ~10%
    - between 20-30 dph: no sorting ↠ mortality >65% due to cannibalism
    - 30 dph 15,000 individuals were transferred to nursery

- **Hatchery 2**
  - Tanks with high light intensity performed better
  - Sorting in size from 20 dph, improves significantly survival
    - 48,300 juveniles of 25-50 g transferred in cages
Recommendations

Rearing parameters
- large tank improves growth performance and survival
- egg stocking densities ~ 25 eggs l⁻¹
- pH: 7.8-8.5, T: 22 to 27°C, preferably between 23.5 and 25.0°C
- photophase 18L:06D from 1 to 25 dph
- light intensity: Defused light of 800-1200 lux

Feeding
- coordinate rearing conditions and larval development
- immune modulators (*Echium* and black cumin oil) together with optimized enriching emulsion and astaxanthin as carotenoid improve larval performance

Husbandry
- high size variability (at 20-30 dph) in all rearing systems tested until today (unknown reasons)
  - early sorting to appropriate size classes
- transportation of individuals
  - larvae with 15 > TL > 20 mm do not tolerate netting, transfer performed with care
Grow out
- Temperature tolerance ranges
- Husbandry in sea cages

HCMR: N. Papandroulakis, P. Pereira, A. Tsalafouta, M. Henry, P. Anastasiadis
IEO: S. Jerez, M. Virginia Martín
ULL: J. Perez, C. Rodríguez
FORKYS SA: A. Ploumis,
Argosaronikos SA: T. Raftopoulos
Temperature tolerance ranges

- **Juveniles of 20-300 g**
  - perform better at 26°C
  - higher caudal propulsion efficiency index (CPE) in fish at 26°C
  - improved movement efficiency during swimming

- **Individuals of 350-600 g**
  - perform better at 21°C
  - individuals at 26°C seemed to display compensatory growth throughout the last month
Development of rearing method in cages

- Two trials in commercial cages for 12 months

FORKYS (2016)
- 12,000 ind at 10g
- Two cages 2,800 and 1,600 m³

ARGOSARONIKOS (2017)
- 12,000+14,500 ind at 23g and 15g
- Two cages 1,300 and 900 m³
- In some cases parasites outbreak resulted in loss of more than 50% of the group
  - Later successfully treated with hydrogen peroxide
- All groups developed high size variability

![Size distribution before sorting (4th month of rearing)](chart.png)
Growth performance

Size distribution at harvesting 18 months post hatching

Big

Small

Deformed

500-1000

1000-2000

2000-3000

3000-4000

4000+

5%

10%

47%

36%

5%

2%
The rearing of greater amberjack in commercial cages although thought to be easy remains still a challenge.

- The fish accept commercial feeding of appropriate composition:
  - high protein (of fish origin) prepared at commercial scale
- No problem with standard husbandry practices:
  - net cleaning/changing and
  - stocking density of max apx 5 kg m$^{-3}$ is acceptable for a pelagic fish

- The species specific parasites
  - treatment with peroxide is well established and confirmed
  - application is not easy and methodologies for big cages should be developed

- The bacterial infections
  - *V. harvey* causing significant mortalities (HCMR)

- It exists a clear commercial potential for the species
Health

Dr. Pantelis Katharios et al, HCMR
Prof. Chris Secombes et al, Aberdeen University
Prof. Daniel Montero et al, FCPCT
Prof. Covadogna Rodriguez et al, ULL
Dr. Salvador Jerez et al, IEO
- **Immune system and Immunomodulation**
  - Identification and mapping of the immune-related genes

- **Epitheliocystis**
  - Toolbox for proper diagnosis

- **Vibriosis - *Vibrio harvey***
  - Difficult to treat

- **Parasites - *Zeuxapta seriolae***
  - Hydrogen peroxide extremely effective
Market, Consumer perception, new products and business model

G. Tacken, M. Reinders, M. Banovic, R. Robles, L. Guerrero, A. Krystallis, H. Saltavarea, K. Larentzakis
3 product ideas for G. amberjack

- Fresh greater amberjack fillet received the highest score

A consumer acceptance test

- Greater amberjack needs extra clarification to consumers before introducing the products in the market
What next for G. amberjack?
• **Biological barriers**
  
  o **Nutrition**  
    - Studies in all stages of production: breeders, larvae, on-growing
  o **Reproduction**  
    - Off season egg production, reproduction in land based facilities, natural spawning
  o **Larval rearing**  
    - Size variability, husbandry practices
  o **On growing**  
    - Size variability, husbandry practices
  o **Pathology**  
    - Prevention schemes
    - Oral antiparasitic treatment

• **Marketing/ trade-mark/ product development**
  
  o Develop a trademark
  o *G. amberjack* should not be “one-more-fish”  
    - base for more fish-products (the example of salmon)

**Coordination between producers**
  
  o for site selection
  o Pathology management
  o Promoting the product
Thank you!