Commercial Culture of the European Spiny Lobster - will it be viable?

Shellfish Association of Great Britain Annual Conference
19-20 May 2015

David Fletcher
Key Challenges to *P. elephas* Phyllosoma Culture:

- Water quality management & disease control
- Culture tank design
- Developing acceptable formulated feed

Objectives:

- Assess technical challenge of juvenile production
- Ultimately determine potential for land based farming and stock enhancement

Published data:

Kittaka et al. (1999-2001) pioneered research into *P. elephas*

- Live feeds and regular antibiotic treatment
- Reduced duration of larval cycle by 50% to 90 days
- Secured several juveniles which were ongrown to 200g

Project initiated and funded by RASAR in 2012 plus a grant from Natural England. Established Seiont Research Ltd in 2013 and secured EFF & WG support. Llŷn Pot Fishermen Cooperative.
Why culture the European spiny lobster, *Palinurus elephas*?

- Fulfils majority of key criteria for farming using land based marine RAS technology
- Potential ideal species for diversification of UK aquaculture and future revival of the *P. elephas* fishery?
- High ecological, conservation and socio-economic relevance to the UK and EU
Farming Suitability of *P. elephas* in the UK?

- Communal behaviour and can be held at high population densities (Phillips & Matsuda 2011).
- Broodstock domestication and captive breeding programmes appear perfectly feasible

- Stage VI *P. elephas* phyllosoma secured in 38 days from hatch. Next stage would be puerulus.
- Under culture conditions *P. elephas* has the shortest larval period to juvenile (est. ~85 days)
- Estimate 200 - 250g *P. elephas* within 2 years?
Global Lobster Market

- palinuridae - most highly prized seafoods in the world (~US$100kg⁻¹)
- live *P. elephas* - first sale price €40 – 120/kg (Groeneveld et al., 2013)
- global lobster harvest has plateaued averaging 241,831 metric tonnes 2000 – 2010 with landings of spiny lobster species down >20% (Sibeni & Calderini, 2012; Francis et al., 2013)
- demand expected to dramatically increase (Phillips & Matsuda, 2011).

- Global market = US$4bn pa 75% in Asia Pacific region (Musa Aman, 2012).

<table>
<thead>
<tr>
<th>Species</th>
<th>Origin</th>
<th>Representative price from 2012 (per kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p.cygnus</td>
<td>West Australia</td>
<td>$60-$75</td>
</tr>
<tr>
<td>p. Interruptus</td>
<td>Mexico</td>
<td>$72-$75</td>
</tr>
<tr>
<td>p. Argus</td>
<td>Florida</td>
<td>$36-$40</td>
</tr>
<tr>
<td>j. edwardsii</td>
<td>New Zealand</td>
<td>$75-$90</td>
</tr>
<tr>
<td>Homarus</td>
<td>US/ Canada</td>
<td>$15-$20</td>
</tr>
</tbody>
</table>

Relative valuation of live lobster in China (Saxton, 2013)
Progress with *P. elephas* Broodstock Management

Sex ratio and tank conditions identified to achieve 70% fertilized females during 2013/14. Breeding season mid-August to end October.

Phyllosoma quality from both wild and domesticated females can vary.

Assessing relationship between egg lipid / nutrient content and phyllosoma viability – broodstock nutrition requires development.

Hatching occurs February to July. Each hatch can last for 6 - 10 days. Possible to manipulate incubation period.
Water Quality Control for Phyllosoma

Designed water treatment system that enables complete control over a range of environmental parameters.

Application of marine RAS technology will be critical both to hatchery and ongrow sector.

Phyllosoma tanks / water supply designed to:

- maximise larvae / feed interaction
- enable gentle larval handling
- optimise hygiene / minimal biofilm exposure
- minimise larval energy expenditure
Microbial Fouling of *P. elephas* Phyllosoma

Microbial fouling interferes with feeding, moulting and reduces swimming efficiency which further increases rate of bacterial fouling.

Critical to have some control over dissolved organics levels.

Stage I *P. elephas* larvae raised under (A) controlled and (B) uncontrolled water quality conditions.

Mouth parts of a day 13 post-moult *Panulirus ornatus* phyllosoma showing extensive filamentous bacterial growth (Payne et al., 2006)
Disease Control during *P. elephas* Phyllosoma Culture

Septicaemia or “white gut” syndrome is a significant issue during phyllosoma culture (Jensen et al., 2011) - certainly true for *P. elephas*.

Stage V *P. elephas* with white gut syndrome

Combating phyllosoma disease

- RAS stability (Schulze et al., 2006; Payne et al., 2006; Attramadal et al., 2012) - benefits of ozonation during spiny lobster phyllosoma culture being recognised (Ritar et al., 2006).

- Pre- and probiotics, micronutrients?
Sensitivity of *P. elephas* phyllosoma to ozonated by-products

- Potential for severe phyllosoma deformities according to ozone dose
- Deformed phyllosoma ultimately fail.

- Reduced availability of some essential nutrients in ozonated water? At ORP of 400 mV and 800mV, iodide concentration declines 50 and 67% respectively (EU F7 – RAZone Project)

- Even at lower doses of ozone there will be a rapid loss of some minerals, particulate and dissolved organics in RAS using ozonated skimmer technology.
Current understanding of spiny lobster phyllosoma nutrition

Phyllosoma obtain nutrients in 3 ways (Souza et al., 2010):

• capture of large food items, oral ingestion of particulates and absorption of dissolved nutrients through the integument

• nutritional needs can vary during instar development to the ‘non-feeding’ puerulus stage (Jeffs et al., 2007).

Commercial feeds for spiny lobster phyllosoma culture

Non-existent (Francis et al., 2013).

AIMS* (2015) report that a formulated larval feed has been developed - suitable for 3 species. IP protected.

*Australian Institute of Marine Science
**P. elephas** nutrition

No published data on *P. elephas* phyllosoma nutritional requirements

- Live and fresh feeds give poor and inconsistent results:
  - larval deformities
  - low overall survival
  - gut infection
  - increase larval fouling

Priority for *P. elephas* Phyllosoma Culture – Develop Formulated Feed

Maintain high larval quality, reduce risk of infection and control phyllosoma size.

- Early phyllosoma feeding behaviour different to that of several related species
- Critical that phyllosoma feed meets:
  - required physical and sensory stimuli prior to ingestion
  - meets nutrient and energy needs at each instar
Progress with feed development during current 2015 season:

“I have not failed. I’ve just found 10,000 ways that won’t work.” Thomas A Edison.

➢ screened numerous commercial fish & crustacean larval feeds

➢ finally developed a pellet that fulfils the immediate sensory requirements of *P. elephas* phyllosoma – remains attractive for periods in excess of 15h after feeding

➢ optimal size range of pellets for different phyllosoma stages identified

➢ the feed enables delivery of balanced formulation and specific micronutrients.

➢ pellets acceptable to phyllosoma stages I – V. Stages I & V filmed feeding on formulated feeds.

➢ early results indicate high sensitivity and interaction of both culture conditions and feed quality on interstar duration and instar size – likely very relevant to robustness of any metamorphosed juvenile

➢ SEM work to better understand development of phyllosoma mouth structure
Will commercial culture of *P. elephas* be viable in the UK?

Consider 3 species of ornamental shrimp: *Lysmata amboinensis*, *L. debelius* and *Stenopus hispidus*

Value marine ornamental fish = $500 to $1,800 USD / kg. These shrimp species represent a significant proportion of all ornamental invertebrates traded (Wabnitz et al., 2003) at ~ £1.0 – 1.5K / kg.

Closed the larval cycle of all 3 species in 6 months. Reduced the larval settlement time from 17 to 7 weeks for *L. debelius* (Fletcher et al., 1994; 1995; 1999).

Commercialised 6 months later.
Univ. Tasmania closed cycle of 3 spiny lobster species (Battaglene, 2015).

The project aims to restock local fisheries and pave the way for lobster farming.

$5m in funding from the Australian Research Council and $3.7m backing from US restaurant company the Darden Group.

In Eastern Malaysia, Darden Restaurants has embarked on a long-term, $650 million, joint venture to farm *Panulirus ornatus*, the ornate rock lobster.
Acknowledgements

Welsh Government
European Fisheries Fund
Natural England
Technology Strategy Board
Staff at Anglesey Sea Zoo