Advances in marine fish hatchery technology in Australia workshop

Stephen Battaglene and Jennifer Cobcroft

Project No. 2008/743
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ACKNOWLEDGEMENTS

We thank our sponsors Skretting Australia, Seafood CRC and the University of Tasmania for funding the marine fish hatchery workshop. We thank Patrick Hone, Geoff Allan and Graham Mair for encouraging us to make the initial application. The workshop would not have been possible without the enthusiastic participation of Australia’s marine fish hatchery owners and staff. We thank everyone who attended the workshop for sharing their experiences and ideas on how to improve hatchery production and communication. We are indebted to our speakers Sagiv Kolkovski, Philippe Dhert, Richard Knuckey, Stewart Fielder and Wayne Hutchinson for presentations. Two international experts in marine finfish culture Giorgos Koumoundouros of the University of Patras, Greece, and Hiroshi Fushimi of Fukuyama University, Japan, provided invaluable insights into recent developments in Europe and Asia. The participation of Jennifer Cobcroft and the international experts was in part funded through the Australian Research Council.

We are grateful to Tanaz Jungalwalla for doing an excellent job with the administration behind organising the workshop. We thank Anna Overweter for assistance on the day of the workshop.

The Australian Seafood CRC is established and supported under the Australian Government’s Cooperative Research Centres Programme. Other investors in the CRC are the Fisheries Research and Development Corporation, Seafood CRC company members, and supporting participants.
1 NON TECHNICAL SUMMARY

2008/743 Advances in marine fish hatchery technology in Australia workshop

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OBJECTIVES:
1. Communicate recent advances in hatchery technology to industry
2. Increase communication within and between industry and research hatchery operators
3. Clarify R&D priorities in marine fish hatcheries
4. Identify technology transfer and training needs of industry

NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED TO DATE
The workshop successfully delivered better communication among industry and research hatchery participants. The variety of presentations in broodstock, larval nutrition, algae and live feeds, larval rearing systems, larval health and water treatment gave a beneficial context to train and inform hatchery workers. There is a revised understanding of strategic needs for hatchery research that will lead to better targeted research projects, particularly through the SfCRC. Together these outcomes will contribute to the improved hatchery production of a range of marine fish in Australia.

The ‘Advances in marine fish hatchery technology in Australia Workshop’ was attended by 49 people, approximately 10% international researchers and industry representatives, 20% from feed or Australian industry service providers, 30% from operating commercial hatcheries, and 40% research providers (mostly from hatcheries). The presentations covering several topics (broodstock, larval nutrition, algae and live feeds, larval rearing systems, larval health and water treatment) prompted considerable discussion and debate. The salient points relating to each topic were recorded, with particular focus on communication going forward which captured the attendees’ support for a Hatchery Network.

A CD has been developed, including this report, and PDF versions of the workshop presentations and selected talks from the “Marine Fish and Larval Rearing Innovations” session from the Skretting Australasian Aquaculture Conference in Brisbane and will be provided to all workshop participants.

KEYWORDS: aquaculture, marine fish larvae, hatcheries, communication
2 BACKGROUND

There have been a number of workshops in Australia that have prioritised research and development of live feed and hatchery technologies, notably two sponsored by the FRDC in 2000 and 2004. At the 2006 Australasian Aquaculture Conference, Skretting hosted a marine finfish hatchery session. An opportunity to continue this form of communication presented itself at the Skretting Australasian Aquaculture Conference in Brisbane in August 2008. At the conference there were a number of sessions that provided background material. Of note a session entitled “Marine Fish and Larval Rearing Innovations” which we organised and chaired. The session covered significant, recent innovations in marine finfish larval rearing systems and species, drawing on international and national speakers. The speakers set the scene for discussion between industry representatives and researchers concerning the national approach to improving production efficiency and juvenile quality in Australian hatcheries. The workshop on the 7th August took the process one step further with a series of industry and research hatchery presentations. At the end of the workshop we revised the hatchery plan for strategic research direction. This information was designed to feed into the FRDC and Seafood CRC processes and links directly to the newly created Business Theme for Finfish. The workshop was consistent with the priorities for communication and training discussed at the workshop on the Seafood CRC Theme Business Plan for Finfish production.

3 NEED

The FRDC has recently discussed a target of 100,000 tonnes of marine farmed fish by 2015 (FRDC 2008). This represents an over 40% increase on the 57,800 tonnes produced in 2006-07 (ABARE 2008). To achieve 100,000 tonnes it has been suggested that Yellowtail Kingfish production will have a five fold increase and Barramundi production needs to more than double. One of the major current constraints to achieving these increases is efficient hatchery production of seedstock. Australia’s finfish hatcheries are geographically isolated, working on quite diverse species, suffering skilled labour shortages and facing ever increasing biological and economic challenges. To remain economic they need to produce larger numbers of healthier seedstock at less cost. Previous hatchery workshops have promoted exchanges of knowledge, innovation, new methods, equipment, and encouraged and strategically directed research (Kolkovski 2004).

4 OBJECTIVES

1. Communicate recent advances in hatchery technology to industry
2. Increase communication within and between industry and research hatchery operators
3. Clarify R&D priorities in marine fish hatcheries
4. Identify technology transfer and training needs of industry

5 METHODS

Workshop participants from marine finfish hatcheries around Australia were invited to register for the national workshop on the 7th August at the same venue as the Australasian Aquaculture Conference 08 in Brisbane. Other selected key
stakeholders including feed and equipment suppliers and manufacturers, research providers and funding agencies were also invited. A pre-workshop dinner was arranged on the night preceding the workshop at the Kapsali Restaurant, South Bank Parklands, Brisbane. The dinner and workshop were funded by the sponsors of the workshop (Seafood CRC, Skretting, University of Tasmania).

The agenda for the workshop is provided in Appendix 3. There were a series of industry and research hatchery presentations and two international experts provided commentary on relevant experiences in Europe and Japan. Assistant Professor Giorgos Koumoundouros of the University of Patras, Greece, has extensive experience in investigating skeletal development and malformations in marine finfish and Professor Hiroshi Fushimi of Fukuyama University, Japan, leads a team of active researchers working on innovation in larval rearing techniques and new species development, including Northern Bluefin Tuna.

The speakers set the scene for discussion between industry representatives and researchers concerning the national approach to improving production efficiency and juvenile quality in Australian hatcheries. The topics covered included past R&D plans, broodstock, live feeds, algae, larval rearing, nutrition, health, systems, and water treatment. The last session focused on communication and strategic research direction.

6 RESULTS AND DISCUSSION

The workshop was well attended, organised and ran according to the agenda. A total of 49 participants attended, approximately 10% international researchers and industry representatives, 20% from feed or Australian industry service providers, 30% from operating commercial hatcheries, and 40% research providers (mostly from hatcheries). A full list of participants and affiliations is provided at Appendix 4.

The presentations covering several topics (broodstock, larval nutrition, algae and live feeds, larval rearing systems, larval health and water treatment) prompted considerable discussion and debate. We have captured the salient points relating to each topic in Appendix 5. Of particular relevance going forward is communication. We put forward the following questions and answers to stimulate debate in the communication session:

**What are the three biggest improvements in fish culture over the last 4 years?**
1. Rotifer culture reliability?
2. Algal paste?
3. Micro diet development?
4. Ozonation disinfection?

Responses included
- Broodstock management, nutrition, husbandry (NIWA)
- Rotifer enrichment + Art (GFB)
- Quality control (NIWA)

**Innovation from where?**
1. International research applied at a local level
2. International companies
3. Home grown (industry)
4. Local research
5. New species

Responses included
- Other sectors – selective breeding
- Return/repeat workshops
- Awareness of workshops (e.g. Gondol)
- Extension agents/Consultants

Communication history
Two previous workshops prioritised improved communication
Specific priorities:
- Promote highly skilled workforce
  - Exchanges, refresher training, tech workshops, tech manuals
- Improved communication between sectors
  - Secure website and e-newsletter, two yearly workshop, WAS chapters, group demo projects, contact data base
- Little progress

Responses included
- Need for a contact list/directory (This has been developed by TAFI and will be provided to the SfCRC Network pending checking from participants)
  - With brief detail of expertise/activity
- Survey 3 months before 2 year workshop to determine
  - Areas to concentrate on
  - Invited experts (international) (not necessarily every year)
  - Timing of other meetings
- Workshops before conference to give more time to develop relationships
- Avoid another layer that may already exist in FRDC/SfCRC

Current communication
1. Word of mouth (industry to industry; industry to background institute; staff movement)
2. Supply companies (Feed, health, equip)
3. Researchers to industry direct
4. Study tours
5. Technical exchanges (industry to industry; researcher to industry; national and international)
6. Workshops (Research or practical e.g. nodavirus v live feeds)
7. Conferences (AA two years, international)
8. Scientific papers and technical reports
9. Master classes

Communication problems
1. Small community, widespread and working hard on a diversified group of fish (silo syndrome)
2. Over worked and under resourced
3. High company and staff turnover
4. Lack of awareness of proven techniques and expertise
5. Slow uptake of new techniques (cost of change)
6. Poor flow between industry and research (both ways)
7. IP sharing and perceptions of secrets

Communication breakdown why?
Issues are:
- No structured organisation
- No agreement on model or funding
- Consequently no one given/taken the role
- Researcher v industry leadership
- FRDC offer of $30K to industry (includes shellfish) in AA 06
- Opportunities through Seafood CRC
- Proposal for two hatchery networks (fish and shellfish) as part of a CRC/FRDC initiative through Geoff Allan

Network objectives
1. Facilitate communication and collaboration among industry and research participants
2. Identify priorities for training and extension and develop targeted programs for production research
3. Help ensure scientific methodology is “world-best-practice”

Network structure
1. Proposed FRDC partnership model co-leadership (one from industry and research)
2. Technical advisory panel? (industry/state/research)
3. Annual and specialised workshops (research presentations, identification training needs, direct training, hatchery tours, staff exchanges, international experts)
4. Needs to include pre-competitive advantage research and protected IP
5. Needs to integrate and strengthen existing industry associations
6. Funding model (is industry prepared to support staff)

Responses included
FRDC commitment (John Wilson)
- FRDC will support what industry wants
- Possibility to link into AquaTT model
- Seafood CRC timeframe allows us to develop something sustainable
- No disagreement today – Graham Mair taken the consensus view of the group as a mandate to proceed to Seafood CRC Network

Ongoing workshop format
- Views on how often a workshop was needed varied: 1/yr (18 people), 2 yrs (14 people), 4 Years (none)
- Presentations from each hatchery (every 2 yrs)
- Once a year timing would allow sharing staff attendance between years (more individuals attend over time)
- Timing of annual/biennial workshops
  - Voting: April (4 people), May (11), June (6), July (3)
  - Pass on to AA conference organisers that May is the preferred timing
- Bring something to share e.g., pictures, bring DATA to share (industry)
- Longer coffee breaks to talk to each other
- Changing venue to increase accessibility for a widespread industry
- Changing leadership between years/events to spread the administrative load
• Prioritisation - clear aims, eg: 'nodavirus' is too broad
• Master classes – within TAFE structure? (certificate)
• Full time secretariat required for optimal workshop delivery
• If relevant training activities organised then industry WILL support staff attendance
• Good content today – add engineering components in future
• Include site visits to coincide with meetings
  - Plus practical workshop
  - Opportunity for service people to run workshop(s) either side for operational staff
• Industry communication today was great, companies to encourage continuation of Industry-Industry + Industry-Research communication
• Workshops/sessions for common areas of broader hatchery community (see diagram) (e.g. technology for live feeds production)

- Include Process control
- Involvement of sectors outside Aqua industry with relevant experience
- Some cross-sector involvement exists already eg: prawn hatchery, WA Fisheries and Cognis
- European model for comparison is Aqua TT (http://www.aquatt.ie/)
  - Student exchange
  - Staff exchange
  - Training material + short courses

Other training & communication activities proposed
• Study tours Aust/NZ vs Europe + US + Japan + Asia
  - Big leaps forward
  - Eg: ABFA – growers to Tasmania
• Keeping up with publication (difficult for industry)
  - Abstract circulation? – Australian
  - Or website/database? (AVOID bulk mailing lists)
  - Key article searching + summary for network
  - implications of research
  - interpretation/how to apply
  - Larval newsletter from Uni of Ghent about €12.50 p.a.
Current Issues and Strategic Research Plan

Besides research activity already prioritised and discussed in the presentations (mostly for Yellowtail Kingfish in the Seafood CRC, see Appendix 5), other current important issues for industry identified by the group were:

Communication and Hatchery Network (see above)

Selective Breeding
- Requirement for barramundi hatchery co-operation
- Must be accompanied by health monitoring (wild pathogens/translocation)

Nodavirus
- National, consistent regulation standards

AQIS
- Need to speed up a decision on product importation/treatment
- NAC submission to review process

Hatchery protocols
- Caution with algae paste adoption/deformity?
- Photobioreactors for live algae production
- Intensive vs Extensive systems
- Nodavirus source and management
- Intensive flow through vs recirculation systems
  - Older hatcheries - flow through design
  - Closed system – stable/protect fish
    - Bore water good result
  - Both methods in use
- Early implementation of biosecure systems/hatcheries/translocation

7 BENEFITS AND ADOPTION

An undertaking was made to distribute the final report and a CD of the workshop presentations and selected talks from the “Marine Fish and Larval Rearing Innovations” session from the Skretting Australasian Aquaculture Conference in Brisbane to workshop participants. The discussion relating to a future Network and workshops will inform project development in the Seafood CRC.

8 FURTHER DEVELOPMENT

A project has been funded by the Seafood CRC for a Production Research Hub (2008/902) which will encompass facilitation of the Finfish Hatchery Network and workshops.
9 PLANNED OUTCOMES

There were two main outcomes from the workshop.
1. The industry obtained better communication among hatcheries, better trained and
   more informed hatchery workers and ultimately improved production of a range of
   marine fish.
2. There is a revised understanding of strategic needs for hatchery research that will
   lead to better targeted research projects, particularly through the SfCRC.

10 CONCLUSION

The workshop was recognised as a success through the industry support in
attendance and their willingness to communicate. Despite the fact that many
companies protect IP associated with their operations, there was much common
ground and a willingness to share experiences. It is hoped that the enthusiasm of the
group to continue communication informally and through structured workshops and
training will be facilitated by the new SfCRC project.

11 REFERENCES

and Resource Economics and Fisheries Research and Development
Corporation, Canberra, 86.
FRDC 2008, Time to set Australian Aquaculture Targets, Fish, Fisheries Research
Kolkovski, S., Heine, J., Clarke, S., 2004. The Second Hatchery Feeds and
Technology Workshop. September 30 - October 1, 2004. Western Australia
Department of Fisheries - Research Division, North Beach, 135 pp.
Appendix 1: Intellectual Property

There was no intellectual property generated by this project. All participant organisations of the workshop have background IP relevant to marine fish hatchery operations and group discussion was restricted to publically available information.

Appendix 2: Staff engaged on the project are listed

Staff

A/Prof Stephen Battaglene In-kind 5%
Dr Jenny Cobcroft In-kind 5%
Ms Tanaz Jungalwalla In-kind 5%
Appendix 3: Workshop agenda

Advances in marine fish hatchery technology in Australia

Thanks for registering for the workshop. The agenda for the day is below. Please join us for a pre workshop dinner on Wednesday 6th August at 7pm at Kapsali Restaurant, South Bank Parklands, Brisbane. To reserve your place please RSVP to Tanaz (Tanaz.Jungalwalla@utas.edu.au) by the 30th July.

Agenda for workshop

Date

Thursday 7th August (day after Skretting Australasian Aquaculture 2008 Conference)
Starting at 9:00 am and finishing at 16:00 pm.

Cost

Dinner and lunch are provided free to invited participants. The Workshop is sponsored by the Australian Seafood Cooperative Research Centre, Skretting Australia and TAFI.

Workshop Venue

Brisbane Convention and Exhibition Centre, Cnr Merivale and Glenelg St., South Bank, Brisbane

Agenda

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<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
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<tr>
<td>9:00-9:15</td>
<td>Jenny Cobcroft</td>
<td>Welcome and introduction</td>
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<td>9:15-9:45</td>
<td>Sagiv Kolkovski</td>
<td>R&amp;D Plans</td>
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<td>9:45-10:15</td>
<td>Stephen Battaglene</td>
<td>Broodstock</td>
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<td>10:15-10:30</td>
<td>Philippe Dhert</td>
<td>Recent advances in larval nutrition</td>
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<td>10:30-11:00</td>
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<td>Morning tea</td>
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<td>11:00-11:45</td>
<td>Richard Knuckey</td>
<td>Algae and live feeds</td>
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<td>11:45-12:30</td>
<td>Stewart Fielder</td>
<td>Larval rearing (Systems)</td>
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<td>12:30-13:30</td>
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<td>Lunch</td>
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<td>13:30-14:15</td>
<td>Jenny Cobcroft</td>
<td>Larval rearing (Larval health)</td>
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<td>14:15-15:00</td>
<td>Wayne Hutchinson</td>
<td>Water treatment</td>
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<td>15:00-15:15</td>
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<td>Afternoon tea</td>
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<td>15:15-16:00</td>
<td>Stephen &amp; Jenny</td>
<td>Communication</td>
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We look forward to seeing you at the workshop.

Stephen Battaglene and Jenny Cobcroft
## Appendix 4: List of participants

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<tr>
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<th>Department</th>
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<td>AIMS</td>
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<tr>
<td>Justin</td>
<td>King</td>
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Appendix 5: Presentations with main discussion points

R&D Plans

Background attendance. Of the participants at the current (Aug 2008) workshop, 6 had attended the planning meeting in 2000, 11 had attended in 2004, 10 attended in 2006, 8 attended the Seafood CRC Theme Business Plan for Finfish production in 2008.
Rotifers and Brine Shrimp

- Benchmarks for rotifer / Artemia production
- Technology transfer
- Assessment and production of Australian strains and alternative species
- Australian production of Artemia in ponds
- Weaning and co-feeds

! High priority  ! High return  ! Longer term

Copepods

- Scale-up of existing systems
- Development of a knowledge base
- Food type and feeding regimes
- Matching species

! High priority  ! High return  ! Longer term

Artificial Diets

- Develop standard testing systems
- Test available diets
- Weaning and co-feeding
- Develop local diets

! High priority  ! High return  ! Longer term

2004 Sydney

Live feeds and technology

- Keynote speakers
  - Larvae nutrition
  - Health
  - Recent development in hatchery technologies
- Overview of Australian R&D centers and industry perspective
- Discussion – R&D priorities for 2005-2010

Do Industry and R&D providers have the same goals?

- Ideally, R&D institutes should work and link with industry to solve priority problems in larave rearing.
- However, projects undertaken by many research institutions are often perceived by industry to have little direct application.
- Long term R compared to short term D, or Proactive Research Vs. Reactive Research
### Goals in 2004
- To remove nutritional limitations to juvenile production.
- To meet the changing needs of end-users.
- To ensure good health and high performance in juvenile production using sustainable methods.

*Communication and technology transfer was highlighted as the most important issue by the industry.*

### R&D Priorities
The R&D plan for 2005-2010 developed during the workshop was not incorporated into FRDC strategic plan and did not appear to be taken into consideration in annually research project selection.

**WHY BOTHER?**

### 2006 Adelaide
**AA conference / Skretting Workshop**
- Skretting launch of new products
- Industry and research presentations by invitation in workshop
- Research and industry presentations in conference
- Good range of hatchery industry molluscs, fish and crustaceans
- No strategic planning but FRDC offer of $30K to an industry driven association

### Seafood CRC Aquaculture Theme
**Business Plans Workshop**
14/15 April 2008

**Priorities driven by industry**

### Seafood CRC workshop 2008
**Planned outputs of Production Program**
- To increase cultured finfish production volume by 100% by 2014
- Improve efficiency of production by increasing the Return on Investment (ROI) by 25% per Kg of fish
- Double the capital investment in finfish aquaculture

### Seafood CRC workshop 2008
**Hatchery summary**
- Matrix of priorities against species and life stages was developed
- Species includes: YTK, SBT, Barramundi, Mullet, Salmon, Cobia, red sp., striped trumpeter.
- Life stages were: broodstock, eggs, yolk-sac, metamorphosis, juveniles (to about 5-g)
- Identified common issues:
  - Notaribus screening
  - Maternities
  - Cannibalism & grading
  - Nutrition
Seafood CRC workshop 2008
Hatchery summary – main problems by species

- YTK – Early larval survival
- Barramundi – Translocation
- Mulloway – Cost of production
- Cobia – Optimal larval rearing protocols
- Salmon – effects of elevated temperatures on maturation and vitellogenesis
- Reef fish – Nodavirus, Cannibalism
- Striped Trumpeter – Malformation

Future R&D Plan and communication

- Covered in detail the afternoon session
- Need to identify during the presentations issues and solutions

Acknowledgements

- We thank
- Sponsors
  - Seafood CRC
  - Skretting Australia
  - TAFI
Updates and comments

- Plans for photothermal manipulation of cobia
- GFB & Bluewater Barra – selective breeding
- Some F1 E. coïdes (QDPI)
- 2nd generation Jack (Gladstone Area Water Board)
- F1 Kingfish (NIWA, NZ) – about 18 parents – crossed with wild stock
- 8 people attending representing barra industry
- GFB, replacement broodstock F1 policy, progressed with family line separation
• Have F1 – Cobia, Barramundi, Mulloway (NSW DPI), Snapper (NSW DPI), Yellowfin Bream (Searle), Australian Bass (Searle), F2 Mulloway (Searle)
• Mahi Mahi is only wild broodstock
• F1 diets – combination of artificial diet or fresh/frozen fish (WA), moist pellet (NIWA), ‘home-made’ moist pellet (QDPI, Cairns), all commercial formulated INVE diet (Searle).

Nodavirus – international. No issues with Seabream and Seabass in Europe. Atlantic Cod in US – screen broodstock by destructive sampling. Issues with cost of screening and false +ves. GFB screen broodstock & +ves moved off-site, all larvae batches screened ~$100/fish - $6-800, depends on lab & method & states involved.

Hatcheries using ozone disinfection – Searle Aquaculture, NSW DPI, DAC (Barra), QDPI Cairns, GFB (use & trials), NIWA (trials), TAFI.

Screening research in progress
• Cod, Halibut, Seabream & Seabass formulations in development
• Prawn hatcheries developing a collaborative approach (diversification into...
Notes on Yellowtail Kingfish

- Table updated, especially addition of F2
- NZ – no commercial YTK farms, NIWA positioned to produce fingerlings when industry is ready.

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Nodavirus

- NSW DPI – Kingfish wild broodstock have tested +ve by PCR for nodavirus, but no detection in larvae
- Tested in NIWA but not detected
- Comment from Matt Landos (Vet) – nodavirus is only 1 pathogen. Must be biosecurity screening built into R&D program (c.f. abalone sector – viral outbreak and previously no biosecurity screening).
  Should include:
  - Wild fish screening for key pathogens
  - Screening for translocation
  - Thorough biosecurity & a surveillance program
Recent Advances in Marine Larval Nutrition
(no Powerpoint presentation available)

Philippe Dhert (Skretting)

Early life stages of marine fish larvae are difficult to handle and mortality rates are high. Recent advances in the physical concept of manufacturing live feed diets and substitution diets coupled with more knowledge on the nutritional requirements of marine fish larvae has opened new perspectives for larval fish rearing.

Particle size and particle distribution of rotifer culture diets and enrichment diets are important physical parameters for filter feeders. However, most commercial diets are offering diets with a narrow size distribution and a relatively uniform particle shape. The nature of these particles results in a higher filtration rate of live food and hence a faster passage in the gut. This generally results in reduced gut retention time, lower utilisation degree and a lack of binding and dehydration of the faecal material. Live food produced on mono-species algae and/or yeast generates a non-consistent semi-soluble material that is constantly re-ingested. The constant re-ingestion of own faecal material creates a gradual decrease in food quality and has a snowball effect on floccule occurrence in the culture tank.

In the natural environment where live food thrives on a multitude of different particle shapes of different sizes, faecal pellets are more compressed and large enough to avoid re-ingestion due to size incompatibility with the filter system. Moreover the larger particles sink to the bottom where they are gradually decomposed.

The ORI-GO concept mimicking what is happening in nature benefits from the same advantages: a larger window of particle sizes allows a more efficient and faster enrichment while waste is allowed to sediment, physically separating food from excrements. Bacteria and ciliates are trapped in the faecal pellets reducing oxygen consumption.

Further on the way to use nature as an example for diet husbandry the ORI-GO products abandon the use of yeast-protein and replace it by natural algal blends and extracts. Using dried algal products, harvested at the optimal exponential phase of production reduces the disadvantage of the use of algal paste or live algae (labour, logistics and biosecurity) and makes the product user friendly and cost-effective.

Today commercial culture and enrichment products tend to reduce the protein content of rotifers and Artemia by overdosing on fat and causing unnatural protein/lipid balances that need to be corrected during weaning of the fish larvae. The ORI-GO philosophy focuses on the correction in the protein/lipid balance in live food stage in order to enhance survival and larval quality as early as food intake is initiated. Live food health condition, diserves as much attention as the enrichment packages it carries. Digestive enzyme studies have shown the importance of optimal levels of pre-digested protein. Furthermore, phospholipids are essential for energy metabolism, proper lipid digestion and directly related to growth performance and larval development (no deformities).
Notes on P. Dhert presentation

- Quicker enrichment time due to absorption of larger particles
- Lower oxygen requirement of Origo compared with control
- Stable growth at various densities (300 to 2,600 and 3,000 to >4,500 rots/mL in 3 days)
- Ori-culture
- Ori-green enrichment 0.2g/million rotifers, 1-2 hour enrichment, density ~2000/mL – HUFA and protein enrichment
- Ori-culture 3 days 59% protein, DHA:EPA = 1.5:1
  after 2h enrichment with Ori-green, 63% protein, DHA:EPA = 3:1
  after 5h in cold storage 62% protein, DHA:EPA = 3:1
  after 5h in cold storage the 3h at ambient temp 61% protein, DHA:EPA = 3:1
- Algae and live feeds

Rotifer culture
- Algal concentrates used in 6-7 hatcheries
- 2 or 3 using INVE Culture Selco, better shelf life & better for low volume hatcheries
- QDPI (Bribie and Cairns) supply to barra and reef fish industry
- NSW Fisheries supply B. plicatilus
Rotifer enrichment
- Red pepper (NIWA)
- Algamac (3 hatcheries)
- Chlorella (no other enrichment, DAC)
- INVE Protein Selco & RotiSelco Alg (others)

Rotifer cold storage
- NIWA cold store enriched rots
- GFB tried it but it didn’t work

Copepods
- Cairns QDPI, still using some copepods, for fish with small mouth size, improves larval quality, economics to be tested, replicated experiments 2008. NB wild harvest & use in Asia.
- GFB, went away from copepods last season, may look at it again in future
- GAWB, used copepods with lutjanids, but left because it was too hard. Harvested copepods from broodstock tanks to culture. Limited success with culture and issue with time requirement.
- NIWA, no malformations observed when using copepods and greenwater compared with 15-20% in other systems.

**Artemia enrichment**
- Algamac 3050 (2 hatcheries)
- INVE (GFB & GAWB)
- Cognis - on grown Artemia & weaning diet
Algae pastes (concentrates)

There was discussion about the use of algae pastes and Richard suggested this should be done with caution, due to the risk of losing some nutrients with resuspended pastes & enrichments and that deformities reflect quality of algal pastes. DAC experienced high deformity with one algal paste, but changed the pastes to non-enriched Chlorella in greenwater and Reed TISO and Nanno in greenwater to reduce the malformations.

- GFB found algae paste enrichment was an issue and use other enrichment products to combat deformity.
- TAFI have trialled pastes vs live algae in replicated experiments with striped trumpeter – found lower survival and bacterial issues with pastes. Supplementation of live algae with pastes sometimes in production systems.
- SARDI moving to hanging bag system from 60 to 400 L, Bayes operated and 5x production from the same space.
- Intensive algae production system available from Aquasonic (around $20-30k)
Take home message – use caution when moving quickly to algal pastes
Larval rearing (Systems)

Comments on advances
- Hygiene is better with automation - no ‘bucket’ transfer of pathogens to fish, no condensation on ceilings, improvement in supply of food to rotifers and rotifers to fish, adoption of grading stations.
- In Europe, stocking density reduced from 100/L to 50-60/L and added automation of feeding and cleaning – result is 15 million fish produced by 2-3 people. Cod sold for €0.60 for 5g fry, bass & bream €0.20 for 2g fry (vaccinated) and production cost is €0.10 for 2g fry – better survival improves costs.
- GAWB, tending to intensification, modification dependent on systems available.

Possible improvements in barra culture could be made with photoperiod. Other priority – Nodavirus – source and management
• Searle Aquaculture – several species, but not same techniques for all, intensive to extensive, with native rotifers and copepods harvested from extensive ponds & intensively cultured with INVE products or live feeds from the ponds (2-5 weeks in tanks) and add back to extensive (fed INVE products or wild zooplankton). Never had a positive nodavirus test. Very low deformities. Use copepods to minimise Artemia use. Suggest nutrition better so lower malformations.
Comments
Mulloway better survival in 24h dark – perhaps due to reduced cannibalism.
Using other senses besides vision for feeding.
Larval Development

- Sensory development
- Swim bladder inflation
- Skeletal structure
- Digestive system

Shardlow et al., Aquaculture 2005
Tobler, PhD thesis 2003

Optimising abiotic rearing parameters

- Improved regime
- Previous best practice

Fielden et al., impressed 2005

Larval nutrition

- Dose response designs
- Commercial diet evaluation
- Feed intake
- Microbial control

Sabolik, et al., Aquaculture 2005

Barramundi culture
Case Study

Current state of production

- Approximately 75% (12.5 million) of fingerlings produced in intensive culture, 25% (4.5 million) in extensive pond culture.
- Wide range of locations
- 7 major hatcheries in Australia
- About 85% of production capacity is used.
- Industry is highly sensitive to problems in any one hatchery.
- Production occurs throughout the year.

Larvae Culture

- Low stocking densities (12.5-37.5 larvae/L compared to 100 larvae/L in Europe)
- Tank size 2-10 thousand L
- Labour intensive
Larval rearing (Health)

**Background**
- Larvae hatch at a small size and early stage in development
- Sensitive to pathogens, nutritional imbalances and environmental conditions
- Improving health status of larvae will improve growth, survival and quality of juveniles

**Background**
- Major health issues
  - Viral infection (esp. nodavirus)
  - Bacterial infection
  - Parasites
  - Skeletal malformation

**Background**
- Improve larval resistance
  - Immunostimulants
  - Disinfection of eggs
  - Better filtration
  - UV and ozone
  - Biocontrol
  - Non-selective reduction in bacteria
  - Selective enhancement of bacteria

**Challenges in 2004**
- Health and Hygiene
  - Develop and promote methods for the control of microbial populations through
    1. Understanding and delivery of water treatments (eg ozone)
    2. Probiotics
    3. Immune stimulants

**Challenges in 2004**
- Health and Hygiene (cont.)
  - Understand and manage factors contributing to the onset and proliferation of disease and malformations
  - Encourage disease and malformation identification and epidemiology studies
  - Development of vaccines
  - Formulation and acceptance of protocols for translocation and risk minimisation
Walling observed in cobia (Eamonn)
Industry Case Study

Development of ‘Fusion’

Day 23 Bent and twisted maxilla

Day 45 Bent and twisted maxilla

Research Case Study

Myxozoan (Kudoa neurophila)
Infection in striped trumpeter
- Clinical signs wasting, whirling and scoliosis
- Diagnostic mature plasmodia in CNS
- PCR assay available
- Control using ozone disinfection

Myxospore
Actinospore
Lifecycle?
Alternate polychaete host

TAFI recently installed an Atlantium, Hydro Optic Disinfection (HOD) UV unit
- Current experiment to compare with ozonation as a potential barrier for myxozoan parasite (Kudoa neurophila)
- Same ‘Total Internal Reflection’ principle as in optical fibres
- Combines elements of physics, optics, and hydraulics

HOD UV
Future Research

- Cost-effective screening for nodavirus
- Probiotics
- Natural products as alternative to antibiotics
- Immunostimulants, vitamin supplementation
- Diet additives – BioMos

Future Research

- Investigate malformations in Australian hatcheries (ARC Linkage project)
  - Hatchery survey
  - Assessment of samples provided
  - Association with production factors
    - Larval nutrition (vitamins, lipids)
    - Environmental conditions, systems

Acknowledgements

We thank
- Sponsors
  - Seafood CRC
  - Skretting Australia
  - TAFI

Research Case Study

Microbial management in striped trumpeter larval culture
- 1990’s chronic low survival
- Still low after elimination of nodavirus
- Grey gut syndrome
- Bacteria associated with low survival (antibiotic experiment)

Research Case Study

Reference:
Collett et al, Australian Aquaculture 2006
Water treatment and weaning

Why is water treatment needed?
- Oceanic water quality is very stable
- Marine finfish larvae have a poorly developed immune system and are sensitive to bacterial infection and poor water quality
- Intensive aquaculture production methods induce large fluctuations in water quality and environmental conditions and provide good conditions for fast growing opportunistic pathogenic bacteria
- Provide biosecurity to prevent ingress of pathogens into, and spread within, hatcheries

Hatchery water treatment trends?
- In hatcheries, production of wastes (i.e., ammonia, CO₂) and organic loading are relatively low and it is important to achieve stable water quality
- Recent increase in research to develop methods to stabilize the fish larva’s microbial environment
- Recirculation systems can maintain a mature microbial environment for hatchery production and can be more secure from variable external influences, than flow-through tanks
- Bacterial proliferation will follow disinfection of water so there is trend to methods to control bacteria of live feeds and water within larval rearing tanks (i.e. probiotics, antibacterial treatments)

Where is water treatment needed?
- Incoming water
- Water within components of culture system (i.e. larval rearing tanks, live feed cultures)
- Recirculated water – intensive larval rearing systems
- Effluent water

Water treatment process
- Pre-filtration of water is required before disinfection to remove particles of organic matter that reduce the efficiency and effectiveness of disinfection
- Hatchery water treatment may include a combination of pre-filtration (min 0.2μm to remove particles), ozone (disinfect and clarify water) and UV (back-up disinfection and residual ozone removal)
- Additional water treatment components may include foam fractionation and degassing
1.1 billion fry produced in EU last year (2007). Yann, seabass produced without nodavirus by using ozone. Replaced by UV and bore holes and closed recirculation systems.

Drum screens expensive when <40µm. SARDI, 90µm screen 200,000L/h. Bacteriological monitoring?

Now only 1 cod hatchery using *Artemia*
Barramundi weaning
- DAC, started d7-8 (used to be d9-10 but lower survival), initially conditioning fish to the diet, keep on small microdiet 150m for a bit longer than previously.
- GAWB, started 12 mm and finished 18 mm

Microbial control
- Benetti, up to 100 ppm formalin every 3-4 days to increase cobia survival
- GFB, not needed, not same parasite problem.
• Sagiv, questioned whether formalin treatment was illegal in Australia.
• Matt Landos replied, no it’s okay.
• NIWA, Improved conditions means formalin no longer needed.
• Eamonn – Europe – light formalin use (not 100 ppm) and ozone not used for OH&S reasons
• Greece, no. Other big commercial companies using formalin.
• Note on paper by Birkbeck – documented Vibrio transmission from rotifer (live feeds) to larvae.
Communication

What are the three biggest improvements in fish culture over the last 4 years?

1. Rotifer culture reliability?
2. Algal paste?
3. Micro diet development?
4. Ozonation disinfection?

Innovation from where?

1. International research applied at a local level
2. International companies
3. Home grown (industry)
4. Local research
5. New species

Communication history

- Two previous workshops prioritised improved communication
- Priorities
  - Exchanges, refresher training, tech workshops, tech manuals
  - Improved communication between sectors
  - Secure website and e-newsletter, two yearly workshop, WAS chapters, group demo projects, contact data base
- Little progress

Current communication

1. Word of mouth (industry to industry; industry to background institute; staff movement)
2. Supply companies (Feed, health, equip)
3. Researchers to industry direct
4. Study tours
5. Technical exchanges (industry to industry; researcher to industry; national and international)
6. Workshops (Research or practical e.g. nodavirus v live feeds)
7. Conferences (AA two years, international)
8. Scientific papers and technical reports
9. Master classes

Communication problems

1. Small community, widespread and working hard on a diversified group of fish (silo syndrome)
2. Over worked and under resourced
3. High company and staff turnover
4. Lack of awareness of proven techniques and expertise
5. Slow uptake of new techniques (cost of change)
6. Poor flow between industry and research (both ways)
7. IP sharing and perceptions of secrets
Communication breakdown why?

- No structured organisation
- No agreement on model or funding
- Consequently no one given/taken the role
- Researcher vs industry leadership
- FRDC offer of $30k to industry (includes shellfish) in AA 06
- Opportunities through Seafood CRC
- Proposal for two hatchery networks (fish and shellfish) as part of a CRC/FRDC initiative Geoff Allan

Network objectives

1. Facilitate communication and collaboration among industry and research participants
2. Identify priorities for training and extension and develop targeted programs for production research
3. Help ensure scientific methodology is “world-best-practice”

Network structure

1. Proposed FRDC partnership model
2. Technical advisory panel? (industry/state/research)
3. Annual and specialised workshops (research, presentations, identification, training, direct connection, hatchery tours, staff exchanges, international experts)
4. Needs to include pre-competitive advantage research and protected IP
5. Needs to integrate and strengthen existing industry associations
6. Funding model (is industry prepared to support staff)

"The Australian Seafood CRC is established and supported under the Australian Government’s Cooperative Research Centres Programme. Other investors in the CRC are the Fisheries Research and Development Corporation, Seafood CRC Company members, and supporting participants."