
Downloaded from: http://insight.cumbria.ac.uk/id/eprint/2595/

Usage of any items from the University of Cumbria’s institutional repository ‘Insight’ must conform to the following fair usage guidelines.

Any item and its associated metadata held in the University of Cumbria’s institutional repository Insight (unless stated otherwise on the metadata record) may be copied, displayed or performed, and stored in line with the JISC fair dealing guidelines (available here) for educational and not-for-profit activities provided that

• the authors, title and full bibliographic details of the item are cited clearly when any part of the work is referred to verbally or in the written form

• a hyperlink/URL to the original Insight record of that item is included in any citations of the work

• the content is not changed in any way

• all files required for usage of the item are kept together with the main item file.

You may not

• sell any part of an item

• refer to any part of an item without citation

• amend any item or contextualise it in a way that will impugn the creator’s reputation

• remove or alter the copyright statement on an item.

The full policy can be found here. Alternatively contact the University of Cumbria Repository Editor by emailing insight@cumbria.ac.uk.
Effects of substrate size and cleaning regime on growth and survival of captive-bred juvenile freshwater pearl mussels, *Margaritifera margaritifera* (Linnaeus, 1758)

Lavictoire, L.1,2*, Moorkens, E.3, Ramsey, A.4, Sinclair, W.5, Sweeting, R.A.2

1 University of Cumbria, Ambleside, UK; 2 Freshwater Biological Association, Windermere, UK; 3 Independent Consultant, Dublin, Republic of Ireland; 4 College of Life and Natural Sciences, University of Derby, UK; 5 Independent Consultant, Isle of Islay, Scotland. *llavictoire@fba.org.uk

2nd International Seminar on Rearing of Unionoid Mussels
24-27 November 2015, Clervaux, Luxembourg
What we’ll cover

• Experiment 1 – Effect of substrate size and cleaning regime on survival and size
• Experiment 2 – Investigating environmental factors affecting survival and size
  – Flow rate
  – Interstitial space
  – Dissolved oxygen
  – Ammonia concentration
Initial experiment – Exp 1

- In 2012, 3600 juveniles (9 replicates) divided into 4 treatments:
  - 0.25-1 mm cleaned weekly
  - 0.25-1 mm cleaned monthly
  - 1-2 mm cleaned weekly
  - 1-2 mm cleaned monthly
Exp 1 - Method

- Cleaning regime maintained for 25 months
- Substrate emptied into a glass dish, elutriated and poured through a 0.18 mm sieve to catch juveniles
- Sampled every 2 months for growth and survival during first 12 months, then final check at 25 months
Exp 1 - Results

- Survival
Exp 1 - Results

• Survival
  - Significantly ($P < 0.001$) different on all sampling occasions
  - On day 362 all treatments were significantly different from each other but by day 758 two groupings became obvious, larger and smaller substrate
  - 1-2 mm monthly $> 1$-2 mm weekly $> 0.25$-1 mm monthly $> 0.25$-1 mm weekly
  - Mortality slowed over winter but did not stop completely
Exp 1 - Results

• Size
Exp 1 - Results

• Size
  - Significantly different ($P < 0.001$) on all sampling occasions
  - Weekly treatments were statistically the same on day 362 ($P = 0.058$) but all treatments were significantly different by day 758 ($P < 0.001$) and size ranges increase
  - 1-2 mm weekly > 0.25-1 mm weekly > 1-2 mm monthly > 0.25-1 mm monthly
Exp 1 – Conclusions

- Higher survival in larger substrates
- Higher growth in substrates cleaned weekly
- Near cessation of growth < 10 °C concurring with previous findings e.g. Ziuganov *et al.*, 1994; Buddensiek, 1995; Hruška, 1999
- No size-dependent over-winter survival observed in any treatment
- ...but why these differences???
Additional experiment – Exp 2

• Investigating factors which may affect growth and survival:
  – Flow rate through substrate & interstitial space
  – Dissolved oxygen
  – Ammonia concentration at 4 weeks
Exp 2 - Methods

• Same experimental set up but only 3 replicates
• Took place over 8 weeks starting 21/07/2015

1. Flow rate:
   – Measured time to clear 1L of water
   – Repeated after substrate had been cleaned

2. Interstitial space:
   – Emptied substrate into measuring cylinder and topped up with water until meniscus touched top of substrate
Exp 2 - Methods

3. DO – logged every 15 minutes over weeks 5-8
   - Water column - multi-parameter sonde
   - Monthly treatments – Onset DO loggers
   - Weekly treatments – PreSens DO dipping probe

4. Ammonia concentration of interstitial water taken after 4 weeks by siphoning 2 ml out of sieves using plastic tubing (spectrophotometer)
Exp 2 - Results

- **Survival (%)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2012 ±</th>
<th>2015 ±</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25-1 mm weekly</td>
<td>40</td>
<td>72</td>
</tr>
<tr>
<td>0.25-1 mm monthly</td>
<td>75</td>
<td>68</td>
</tr>
<tr>
<td>1-2 mm weekly</td>
<td>76</td>
<td>80</td>
</tr>
<tr>
<td>1-2 mm monthly</td>
<td>85</td>
<td>81</td>
</tr>
</tbody>
</table>
Exp 2 - Results

- Juvenile length (mm) was not significantly different in 2015 (\(P = 0.53\))

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2012</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25-1 mm weekly</td>
<td>0.72 ±0.07</td>
<td>0.82 ±0.10</td>
</tr>
<tr>
<td>0.25-1 mm monthly</td>
<td>0.70 ±0.07</td>
<td>0.83 ±0.08</td>
</tr>
<tr>
<td>1-2 mm weekly</td>
<td>0.65 ±0.08</td>
<td>0.84 ±0.10</td>
</tr>
<tr>
<td>1-2 mm monthly</td>
<td>0.63 ±0.07</td>
<td>0.81 ±0.09</td>
</tr>
</tbody>
</table>

- More analysis required on size differences & relationship to temperature
Exp 2 - Results

1. Flow rate:
   - Pre-cleaning, flow through 0.25-1 mm monthly treatment was significantly slower than all other treatments \( F_{(3,8)} = 8.83, P = 0.006 \)
   - Flow through cleaned substrates was significantly higher \( F_{(3,8)} = 18.80, P = 0.001 \) in the 1-2 mm compared to the 0.25-1 mm substrates

2. Interstitial space:
   - 0.25-1 mm substrates had significantly less \( t_{(10)} = -4.72, P = 0.001 \) interstitial space \( 2.6 \pm 0.61 \text{ ml} \) compared with 1-2 mm substrates \( 4.3 \pm 0.25 \text{ ml} \)
Exp 2 – Results

3. Dissolved Oxygen
Exp 2 - Results

- Ammonia concentrations were the same between the four treatments ($F_{(4, 14)}=1.38; P=0.307$)
Conclusions

• Larger substrate provides better survival rates
• Growth patterns were different between exp 1 & 2
• DO and flow are significantly affected by substrate size and cleaning regime
• Further analysis of DO data will help explain this further
REFERENCES & ACKNOWLEDGEMENTS


The authors would like to thank the Malacological Society of London for funding travel to this conference, Natural England for part-funding this work and Eloy Benito-Reyes from the FBA for practical support during 2013/14. The findings of experiment 1 have been published and can be found at [http://link.springer.com/article/10.1007%2Fs10750-015-2445-4](http://link.springer.com/article/10.1007%2Fs10750-015-2445-4).

Please come and speak to us at our posters during the poster sessions!