Biology and ecology of *Muggiaea atlantica* in the northeast Atlantic

Mike Blackett
Muggiaea atlantica

- Holoplanktonic
- **ASEXUAL** and **SEXUAL** reproduction
- **RAPID** development
EXPANDING DISTRIBUTION


Pre 1980s
Post 1980s

ECOLOGICAL IMPACTS

EXPANDING DISTRIBUTION

Data source: Greve (1994) The 1989 German Bight Invasion of Muggiaea atlantica

Weeks →

M. atlantica

$500 \text{ ind. m}^{-3}$
ECOLOGICAL IMPACTS

EXPANDING DISTRIBUTION

Data source: Greve (1994) The 1989 German Bight Invasion of Muggiaea atlantica

M. atlantica
Copepods
Predation

Weeks

+0

ECOLOGICAL IMPACTS

EXPANDING DISTRIBUTION

Data source: Greve (1994), The 1989 German Bight Invasion of Muggiaea atlantica
**ECOLOGICAL IMPACTS**


**M. atlantica**

Copepods

Chlorophyll

Phosphate

+ 0

−

Predation

Grazing

Nutrient uptake

**Data source:** Greve (1994) The 1989 German Bight Invasion of Muggiaea atlantica

**EXPANDING DISTRIBUTION**

AQUACULTURE IMPACTS
Fosså et al. 2003, Baxter et al. 2011

ECOLOGICAL IMPACTS

EXPANDING DISTRIBUTION
Licandro et al. (2012), Malej et al. (2013), Blackett et al. (2015)

Mortality

 licandro et al. (2012), malej et al. (2013), blackett et al. (2015)

Mortality
Historical distribution

Western English Channel
• Transient
• ‘Indicator’ species

Scottish Shelf
• Exceptionally rare
  Totton & Fraser (1955)
Contemporary distribution...?

Persistence or transience?
Source–sink dynamics

Pulliam (2000)

Available habitat

Factor

Source

Sink

Factors

Habitat suitability

Optimal

Medium

Critical

Unsuitable

Helaouët et al (2013)
<table>
<thead>
<tr>
<th>Source</th>
<th>Sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production $=$ recruitment</td>
<td>Production $\neq$ recruitment</td>
</tr>
<tr>
<td>$\propto$ Life history</td>
<td>$\propto$ Life history</td>
</tr>
<tr>
<td>Persist indefinitely</td>
<td>Require immigration</td>
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</tbody>
</table>

*Pulliam (2000)*
Local production

Blackett et al (2014)
Local production
Blackett et al (2014)

Abundance

GRADUAL
(reproduction)

Significant TROUGH

1 — Months — 12

Significant PEAK

Kendall (1976), Ibañez (1982)

LOCAL PRODUCTION
Reproduction = recruitment

Blackett et al (2014)
Reproduction = recruitment

~80% RANDOM

~70% LOCAL PRODUCTION

Western English Channel

Blackett et al (2014)
Reproduction = recruitment

∞ Life history?
Persist indefinitely?
Reproduction = recruitment

Life history

Persist indefinitely?
Reproduction = recruitment

Life history

Persist indefinitely?
Reproduction = recruitment

 Persist indefinitely?
Western English Channel

1 Weeks → 52

10 °C (p < 0.05)

Eudoxid vs. polygastric abundance

Eudoxid

Polygastric

Abundance

Reproduction = recruitment

\( \infty \) Life history

Persist indefinitely

✓ Reproduction = recruitment
✓ $\infty$ Life history
✓ Persist indefinitely
Scottish Continental Shelf

Blackett et al (submitted)

Polygastric Abundance

Year

Month

2003 2005 2007 2009 2011 2013

2 4 6 8 10 12

1999 2001 2003 2005 2007 2009 2011 2013

2 4 6 8 10 12

Blackett et al (submitted)
Reproduction = recruitment

Scottish Continental Shelf

Blackett et al (submitted)
Reproduction = recruitment

∞ Life history?
Persist indefinitely?

Scottish Continental Shelf

13–15 °C

<11 / 8 °C

< 8 / 6 °C

Abundance vs. temperature

p = < 0.05

Blackett et al (submitted)
Reproduction = recruitment

∞ Life history

Persist indefinitely

Immigration?
European Slope Current

- Poleward flow
- Warm, saline water
- Disperses plankton
**M. atlantica vs. Slope Current**

- **Standard anomalies**
  - Values: 0, -1, -2, -3, 1, 2, 3

- **Correlation**
  - $r = 0.74$
  - $p < 0.05$

- **Source**
  - Blackett et al (submitted)

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**Slope Current**

- **Sampling stations**
  - Xu et al 2015

**European Slope Current**
Increased immigration

Improved conditions

Muggiaea atlantica

Slope Current

European Slope Current

SOURCE
Partial linear regression


Source
Demographics (SST)

Sink
Immigration (Slope Current)

Explanatory variables

Dependent variable

Muggiaea atlantica variation
Partial linear regression

Source
Demographics (SST)

Sink
Immigration (Slope Current)

Explanatory variables

Dependent variable

Muggiaea atlantica variation
Partial linear regression


Source
- Demographics (SST)

Sink
- Immigration (Slope Current)

Explanatory variables

Dependent variable

Muggiaea atlantica variation
% of explained variation in annual abundance

SST & Slope Current 62%
% of explained variation in annual abundance

- SST: 33%
- Slope Current: 49%

$p < 0.05$

Blackett et al (submitted)
Slope Current

Total variation (100%)

- SST: 13%
- Intersect: 20%
- Slope Current: 29%
- Residual: 38%

$\text{Total variation} = 100\%$

$p = < 0.05$

Blackett et al (submitted)
Scottish Continental Shelf

European Slope Current

SOURCE

SINK
Summary

*Muggiaea atlantica* has expanded its northern distribution in the northeast Atlantic

- Established a resident population in the Western English Channel
- Established transient populations on the Scottish shelf
- Complex interaction of habitat-specific demography and current driven dispersal
References


Average annual cycle (compromise)

M. atlantica

PC1

PREY

SAL.

TEMP.

PC 2
Individual annual cycles (trajectories)

M. atlantica

PC1

SAL.

PC 2

TEMP.

PREY

1 2 4 5 10 11 12 3 6 8 7
Inter-annual environmental variability

Sink years

Source years

PC1

PC2