Exploring the microzooplankton-ichthyoplankton link:

A combined field and modeling study of Atlantic herring (*Clupea harengus*) in the Irish Sea

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Protozooplankton – ichthyoplankton link

- Enhance first feeding (Overton et al., 2010; Illing et al., 2016)
- Preferred prey for first feeding (Hunt von Herbing et al., 2001)
- Improve survival (Nagano et al., 2001)
- Observations in gut content & stable isotopes (Fukami et al., 1999; Figueiredo et al., 2005; Pepin & Dower, 2007; Denis et al., 2016)

Why is there so little knowledge?

- Rapid digestion → difficult gut content analysis
- Preservation in Formalin → many protists dissolve
- Few data on PZP abundance and composition

PZP = Unicellular hetero- and mixotrophic plankton
Microzooplankton – ichthyoplankton link

(Hardy, 1924, modified by Dolan et al., 2013)
Atlantic herring as model species

1. Commercially important species

2. Well studied species
   - Knowledge about larval physiology, feeding, prey preferences and behaviour (e.g. Illing, 2016; Spittler, 1990; Blaxter, 1965)

3. Autumn- and winter spawning stock
   - Small prey may be of higher importance during times of low productivity (Alvarez-Fernandez, 2015; Payne, 2013)
Larval foraging

Max. prey size

*mouth gape (Cohen & Lough, 1983)*

*Modeled data (IBM)*

(modified after Hufnagl & Peck, 2011)
Irish Sea – Autumn spawning herring

What is the potential small sized *in-situ* prey field (20-300µm) herring larvae experience and how does it influence larval abundance and growth?

Combination of field sampling and modeling.
ICES coordinated herring larvae survey (NINEL) coordinated by AFBI, Belfast

**Gulf VII** (280 µm)

- Abundance, distribution & length
- Biochemistry: RNA:DNA

**Micro – and small mesozooplankton (MZP)**

- **PUP-net** (52 µm)
  - (52 – 300 µm)
- **Protozooplankton (PZP)**
  - **CTD-rosette**
  - (12 – 200 µm)

**Irish Sea – November 2012 & 2013**

- Temperature: 9.9 – 12.9 °C
- Salinity: 31.4 – 34.4 psu
- Rel. Fluorescence: 0.7 – 1.9 (unitless)

(Bils et al., 2016)
PZP composition

- Mainly ciliates and dinoflagellates
- 13 ciliate taxa
- 16 dinoflagellate taxa

![Diagram with taxa images]

(Bils et al., 2016)
Is there enough prey to sustain survival?
Sufficient food supply for herring larvae?

Field vs. Model

Biochemically derived RNA:DNA

observed

Growth rate

Individual based foraging and growth model (IBM)

Copepods 200-300 µm
Nauplii 100-200 µm
PZP < 100 µm

Energy gain  Assimilation  Metabolism


modelled
Plankton biomass (µg C·L⁻¹)

Growth rate (d⁻¹)

2012

2013

- 200-300 µm
- 100-200 µm
- < 100 µm

[Image of box plots showing plankton biomass and growth rate for different size classes in 2012 and 2013.]

(Bils et al., 2016)
Model suggests: PZP is important for larval growth!
Conclusion

1. Small plankton is important for herring larvae and likely other larvae under low productivity conditions
2. IBM’s need to include PZP
3. We lack data on autumn- and winter PZP community
   → Potential for augmenting routine surveys for fish stock assessment
   → Simultaneous sampling of different trophic levels

Future tasks:
What are the food preferences of larvae?
What is the nutritional quality of potential prey organisms?
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References

(1) nordicmicroalgae.org
(2) by E. Sherr


