Ctenophores
– peeking into the group of unidentified species
Morphological and molecular evidence reveal underestimated ctenophore species richness

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Outline

• Background
  – What are they? Why should we care?
  – Where are we today?
• Local and global case studies
  – Arctic
  – Ryggefjord
  – Taxa with potential world wide distribution

- Slightly modifying sample processing
- combining morphological and molecular tools
-> increase knowledge on ctenophore diversity and distributions
- without the need to necessarily increase sampling effort

• Focus on monitoring programs and net samples
Background

Ctenophores - What are they?
Why should we care?
Ctenophores - terminology

- Gelatinous zooplankton
  - Overarching synonym for taxonomically different groups
- Jellyfish / Jellies
  - Gelatinous animals belonging to the phyla Cnidaria and Ctenophora
- Cnidaria
  - Invertebrate phylum (e.g. scyphozoans, hydrozoans, anemones and corals)
- Medusa
  - Mobile, bell-shaped lifestage of Cnidarians
- Ctenophora
  - Invertebrate phylum, sometimes called comb jellies or sea gooseberries
Ctenophores - ecology

- Holopelagic
- Carnivorous
- High feeding rates
- Fast growth
- Ability to starve and shrink
- Regenerative ability
- Self-fertile hermaphrodites
- High reproductive potential

Photo: P. Leopold
Ctenophores - ecology

Photo: R. Larsen
Ctenophores - ecology

PREY SIZE

Small

Pleurobrachia

Dryodora

“Nepheloctena”

Charistephane

Shallower

Bolinopsis

Cestum

Euplokamis

Bathocyroe

Lampocteis

1 cm - 10 cm

Deeper

Medium

Velamen

Beroe

Beroe cucumis

Beroe abyssicola

Lampea

Haeckelia

Thalassocalyce

Kiyohimea

Hormiphora

Leucothea

Red Cydippid

Large

1.0 cm

Bathycyrene

Autocoectena

Beroe

Haddock 2004
Ctenophores - Phylogeny

- The relationship to the rest of Metazoa
  - to understand the early evolution of animals
    - E.g. the origin of multicellularity
Ctenophores - Phylogeny

Broad phylogenomic sampling improves resolution of the animal tree of life

Genomic data do not support comb jellies as the sister group to all other animals

Error, signal, and the placement of Ctenophora sister to all other animals

The ctenophore lineage is older than sponges? That cannot be right! Or can it?
Why watching comb jellies poop has stunned evolutionary biologists.
Background

Ctenophore taxonomy - where are we today?
Ctenophores - taxonomy

- Estimated 150-250 species worldwide
- 25-50 undescribed species
- Main focus on 3-5 species

Example from Australia

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Described species</th>
<th>Known undescribed/undetermined species</th>
<th>Estimated unknown species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tentaculata</td>
<td>12</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Cydippida</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Platyctenida</td>
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<td>0</td>
</tr>
<tr>
<td>Lobata</td>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Cestida</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nuda</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Beroida</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>15</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

Gershwin et al. 2010
Ctenophores - taxonomy

Bits and pieces

Cydippid larvae

Shrinking

Preservatives
Working with net caught specimens is like trying to construct a snowball after it has hit a wall.

Peter Herring
The Biology of the Deep Ocean, 2002
Ctenophores - taxonomy

• They are difficult to sample...
• They are impossible to identify...
• Slime clogs my nets and are a nuisance...

Photo: M. Daase
Case studies
With little effort we can increase our knowledge
Case: Arctic

Methods:
- WP2 and multinet
- Upper 50m
- Picked up alive
- Photo-ID
- EtOH
- 18S, ITS1
Case: Arctic

AF293684 Valliulca multiformis
AF293683 Coeloplana bannwarthii

Beroe cf. abyssicola
AF293699 Beroe cucumis
AF293698 Beroe forskali
AF293697 Beroe forskali
AF293696 Beroe gracilis
AF293694 Beroe ovata
AF293674 Haecckella rubra
AF293673 Haecckella beehleri
AF293700 Mnemiopsis leidyl
AF293693 Velamen parallelum
AF293692 Cestum veneris
AF293688 Leucothea pulchra
AF293685 Thaissocoleye inconstans
AF293686 Undescribed ctenophore sp. 4
AF293687 Bollinopsis Infundibulum
AF293688 Ocyrops maculata
AF293691 Ocyrops crystallina
AF293690 Ocyrops crystallina
AF293677 Pleurobranchia bachei
AF293678 Pleurobranchia pileus
AF293675 Undescribed pleurobranchiid A
AF100944 Hormiphora sp.
AF293676 Hormiphora plumosa

21-2_A1 Mertensilid sp. (Spitsbergen)
AF293681 Undescribed mertensilid sp. 3 (California)
Undescribed cydippid
Undescribed cydippid
Undescribed cydippid

Euplokamis sp. (North Sea)
Euplokamis sp. (Svalbard)
Euplokamis sp. (Gullmarsfjord, Sweden)

Mertensia ovum
Mertensia ovum

AF293679 Mertensia ovum
AF293680 Undescribed mertensilid sp. 2
AF293682 Charistephane fugiens
Case: Ryggefjord, Northern Norway
Case: Ryggefjord, Northern Norway

Methods:
- WP2
- Picked up and enumerated alive
- Photo-ID
- EtOH

![Graph showing Ind per m³ for different stations and species: Ctenophore, Lobate larvae, Ctenohore, Cydippid larvae, Euphysa cf. aurata, Obelia sp., and Unident hydrozoa sp. 1. Station 6 has the highest value of 65.64 Ind per m³.](image)
Case: Ryggefjord, Northern Norway

Methods:
- WP2
- Picked up and enumerated alive
- Photo-ID
- EtOH
- In future
  18S, ITS1
  CO1
Case: undescribed cydippid

- Undescribed cydippid
  - Euplokamis sp. (North Sea)
  - Euplokamis sp. (Svalbard)
  - Euplokamis sp. (Gullmarsfjord, Sweden)
  - Mertensia ovum
    - Mertensia ovum
    - AF293679 Mertensia ovum
  - AF293680 Undescribed mertensid sp. 2
  - AF293692 Charistephane fugiens

Map showing distribution of species.
Case: undescribed cydippid
Case: *Euplokamis* sp.

Family Euplokamididae (= Euplokamidae)

- *Euplokamis* Chun, 1879
- *crinita* (Moser, 1909) (moved to Euplokamis by Mills (1987))
- *dunlapae* Mills, 1987
- *evansae* Gershwin, Zeidler and Davie, 2010 - the tentacles of this species do not seem to justify its inclusion in Euplokamis (C.E.M.)
- *helicoides* (Ralph and Kaberry, 1950) (moved to Euplokamis by Mills (1987))
- *octoptera* (Mertens, 1833) - likely to be *Mertensia ovum* (moved to Euplokamis by Mills (1987))
- *stationis* Chun, 1879

By Mills 2016
Case: *Euplokamis* sp.
Case: *Euplokamis* sp.
Morphological and molecular tools

- In GenBank 18S: 111 Sequences from app. 30 species (portion of partial sequences is high)

<table>
<thead>
<tr>
<th>Species</th>
<th>Sequences</th>
<th>Barcodes &gt;600bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beroe abysicola</td>
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<td>0</td>
</tr>
<tr>
<td>Beroe dufresnii</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Beroe ovata</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Bolinopsis infundibulum</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Calirina antarctica</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Coeloplana bocki</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dryocora grandisformis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Haptina ovum</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mnemiopsis lineata</td>
<td>2</td>
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</tr>
<tr>
<td>Pleurobrachia bachei</td>
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</tr>
<tr>
<td>Pleurobrachia pleuris</td>
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<tr>
<td>Veleicum sp. BMOC06986</td>
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</tr>
</tbody>
</table>

Total 4, of which 3 are currently public

- Misidentification problem
Suggested modifications

• Routine protocol
  – Gentle processing
  – Picking up and enumerating specimens alive
  – Photographic ID
  – Preserve samples in EtOH for molecular analysis

• Need for a reference database

• Need for a collaboration!
Thank you!