Fatty Acids of Zooplankton of 34 to 22 °S

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Aims

• examine the variability in zooplankton feeding from south to north off Western Australia in three water masses: inshore of Leeuwin Current, in Leeuwin Current and offshore of Leeuwin Current

zooplankton: a key trophic link in marine ecosystem and an important mediator of carbon flux; uses a wide range of prey including phytoplankton, microzooplankton, bacteria and marine snow.

• unveil information about the potential of food quality to higher trophic levels
Hypotheses:

- Zooplankton from coastal waters will have higher % of diatom FA

- Zooplankton from oceanic waters will have higher % of FA associated with small phytoplankton and higher carnivory/omnivory markers
Zooplankton sampling stations

Mid May – early June 2007
Timing of the cruise was linked to seasonal chlorophyll dynamics

**Summer:**
low chl, deep chl max

**Autumn/winter:**
chl shoals & blooms

Zooplankton sampling

- **Bongo nets**
  - 355 and 100 µm mesh nets
  - ~ 150 m$^3$ of water filtered
  - Oblique tows to 150 m (or maximum depth of the station)

- Mesozooplankton size fractionated and frozen immediately after collection. Fatty acids are a mixture of fatty acids from the food in the guts and fatty acids assimilated into the mesozooplankton body tissues.
Fatty acids as trophic biomarkers.

• Phytoplankton, microzooplankton and bacteria all produce taxon-specific fatty acids which are retained by their predators.

• Feeding experiments (early 1970s) have verified that dietary fatty acids are transferred largely unmodified from phytoplankton to zooplankton.

• Fatty acid signature analysis has been used for many years to study marine food webs.
Advantage of fatty acids

• Gut content analyses provide a snapshot clues but lipid data integrate dietary information over a time scale of several weeks to months

• Some food items in gut can not be identified
Pelagic food webs

Size of phytoplankton determines type of food web:

**Small phytoplankton**

- bacteria
- small algae
- protozoa

**Microbial food web**

**Large phytoplankton**

- crustaceans
- gelatinous zooplankton
- fish larvae
- chaetognaths

**Metazoan (herbivorous) food web**

- Microbial food web supports the metazoan food web
- Metazoans graze phytoplankton, flagellates and ciliates \( \geq 5 \mu m \)
- In oligotrophic oceans main trophic links to the metazoa is via protozoea
**Herbivorous food web**

- Usually large diatoms
- Efficient transfer of energy to higher trophic level

**Microbial food web**

- Usually flagellates
- Dinoflagellates 2 to 6 x more proteins & calories than diatoms
- Growth and production of copepods increased
- Protist $\rightarrow$ trophic upgrading (18:3 n-3... $\rightarrow$ LC n-3 EPA & DHA)

**Diatoms vs dinoflagellates food web**

$\rightarrow$ 16:1 n-7/16:0 $\geq$ 1

$\rightarrow$ 20:5 n-3 high

$\rightarrow$ $\sum C16/ \sum C18$ high

$\rightarrow$ EPA (20:5 n-3)/DHA (22:6 n-3) high

**Herbivorous diet**

$\rightarrow$ n-3/n-6PUFA high

$\rightarrow$ 16:1 n-7/16:0 $>$ 1

$\rightarrow$ PUFA higher (not always)

$\rightarrow$ 20:1n-9 & 22:1 n-11 higher

$\rightarrow$ 18:1n-9 lower

$\rightarrow$ 18:4 n-3 high

**Omnivorous diet**

$\rightarrow$ 18:1 n-9/18:1n-7 high

$\rightarrow$ PUFA/SFA high (not always)

$\rightarrow$ DHA/EPA high
Degree of correlation $r = \text{Pearson's product movement correlation coefficient}$

Between diatoms and dinoflagellates markers

$r = 0.878$

$P<0.01$

$n = 171$
Hypothesis 1.

We found no difference between inshore and offshore or LC water masses in diatom food web markers in zooplankton (Mann Whitney P = 0.9)

Dinoflagellate food web dominated off WA in May/June 07
Degree of correlation $r = \text{Pearson’s product movement correlation coefficient}$

between omnivory markers

$\begin{array}{l}
\text{PUFA/SFA} \\
\text{DHA/EPA}
\end{array}$

$r = -0.294$
$P < 0.01$
$n = 161$

$r = -0.192$
$P = 0.01$
$n = 161$

$r = 0.758$
$P = <0.01$
$n = 161$
Hypothesis 2: higher degree of omnivory in oceanic waters comparing to LC and inshore.

There is a trend of increased omnivory index from offshore to inshore but there is no statistical difference in degree of omnivory among water masses (Kruskal-Wallis P = 0.8).
Fish

- EPA & DHA important
- Fish can’t convert short FA to EPA and DHA
- Lack of EPA and DHA = lower recruitment
- High DHA/EPA is critical for growth and development (neural, eyes) of larval and juvenile fish

Based on % data we do not know if these environments have sufficient amounts of FA or not – we need to consider also the pool of FA.
Fatty acids as trophic markers

• Provided information
  – on the dietary composition and trophic relationships of zooplankton of WA and defined the type of the pelagic food web
  – on food available to higher trophic levels allowing prediction of recruitment success and survival

• Longer time series would describe seasonality of fatty acids, match-mismatch in predator/prey that can occur when climate changes
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