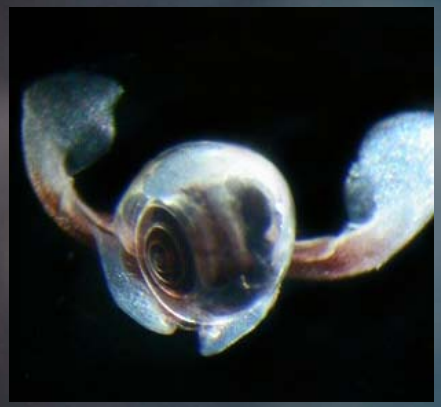
Pteropods in Southern Ocean ecosystems: a review



Brian Hunt, Evgeny Pakhomov, Graham Hosie,
Volker Siegel, Peter Ward and Kim Bernard

Earth and Ocean Sciences

UBC

What are Pteropods?

Class: Gastropoda

Order Thecosomata
(shelled pteropods)

Order Gymnosomata
(naked pteropods)

Order Thecosomata
(shelled pteropods)

4 Southern Ocean species

Limacina helicina

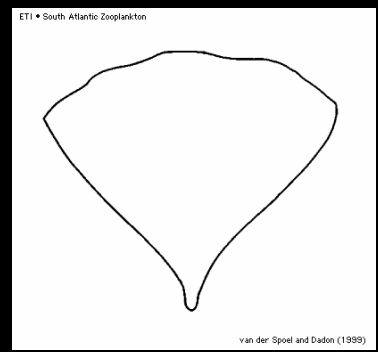
Photo:
R. Giesecke

Clio pyramidata

Photo:
R. Giesecke

Limacina retroversa

Clio piatkowskii



Order Gymnosomata
(naked pteropods)

2 Southern Ocean species

Clione limacina

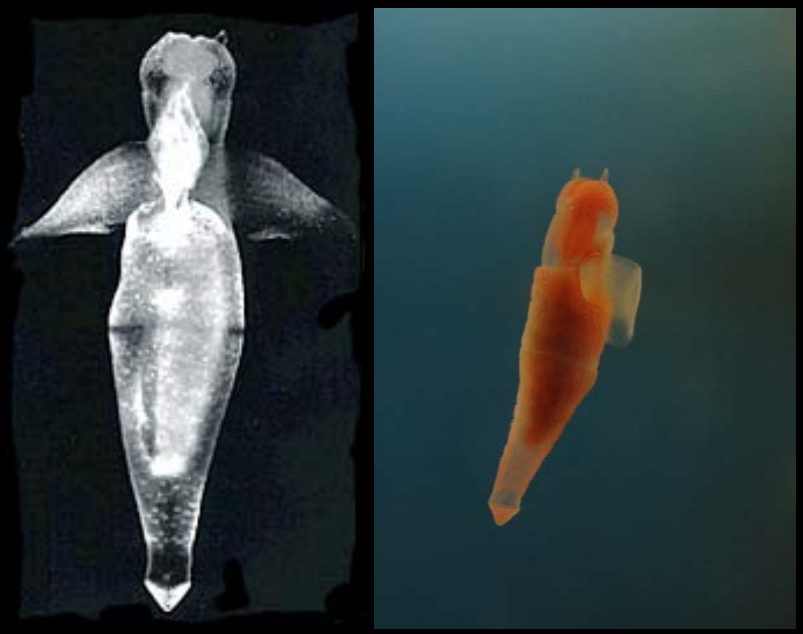


Photo: R. Giesecke

Spongiobranchaea australis

Why the interest in pteropods?

- ubiquitous but ignored component of SO zooplankton
- few studies of their biology

- ocean acidification – SO surface waters to begin to become under-saturated with respect to aragonite by 2050 *(Orr et al. 2005)*

ocean acidification

reduction in abundance and
ultimately a northward shift in the distribution
of thecosome pteropods

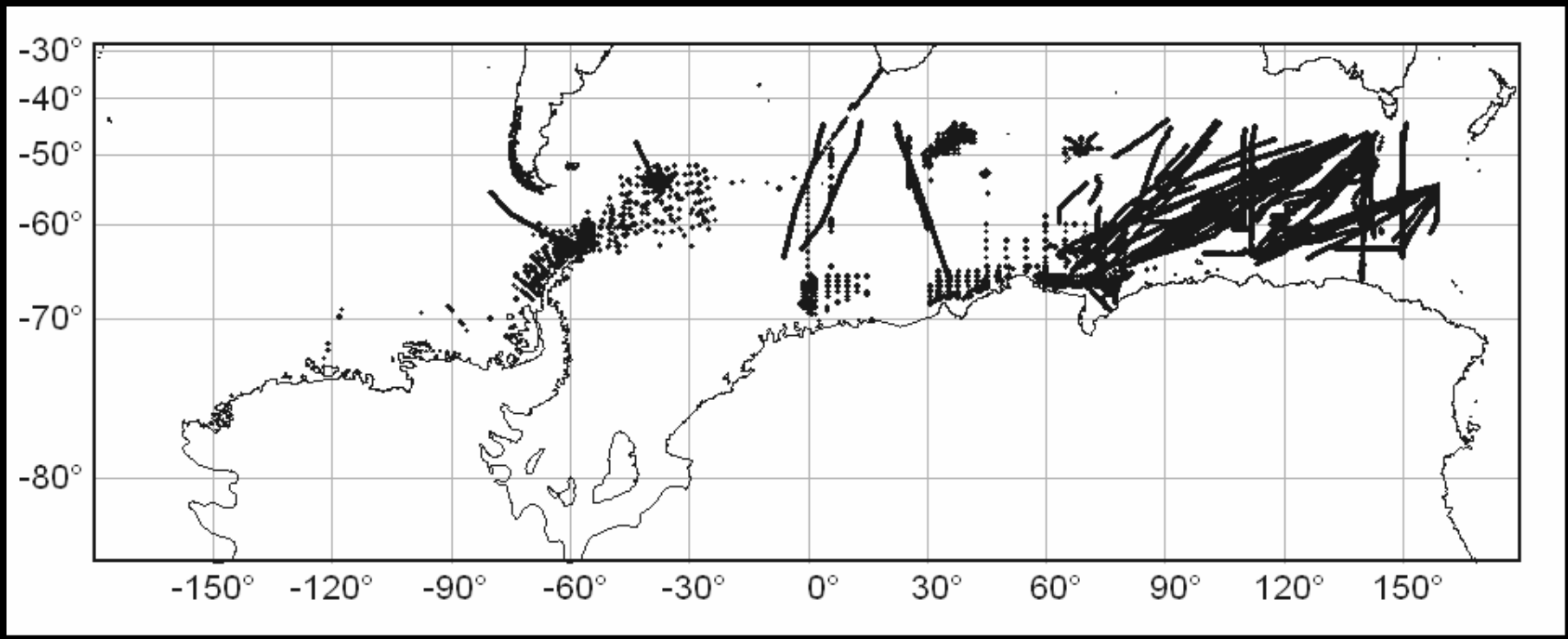
How will this impact on Southern Ocean ecosystems?

Aim: to investigate the role of pteropods in the SO

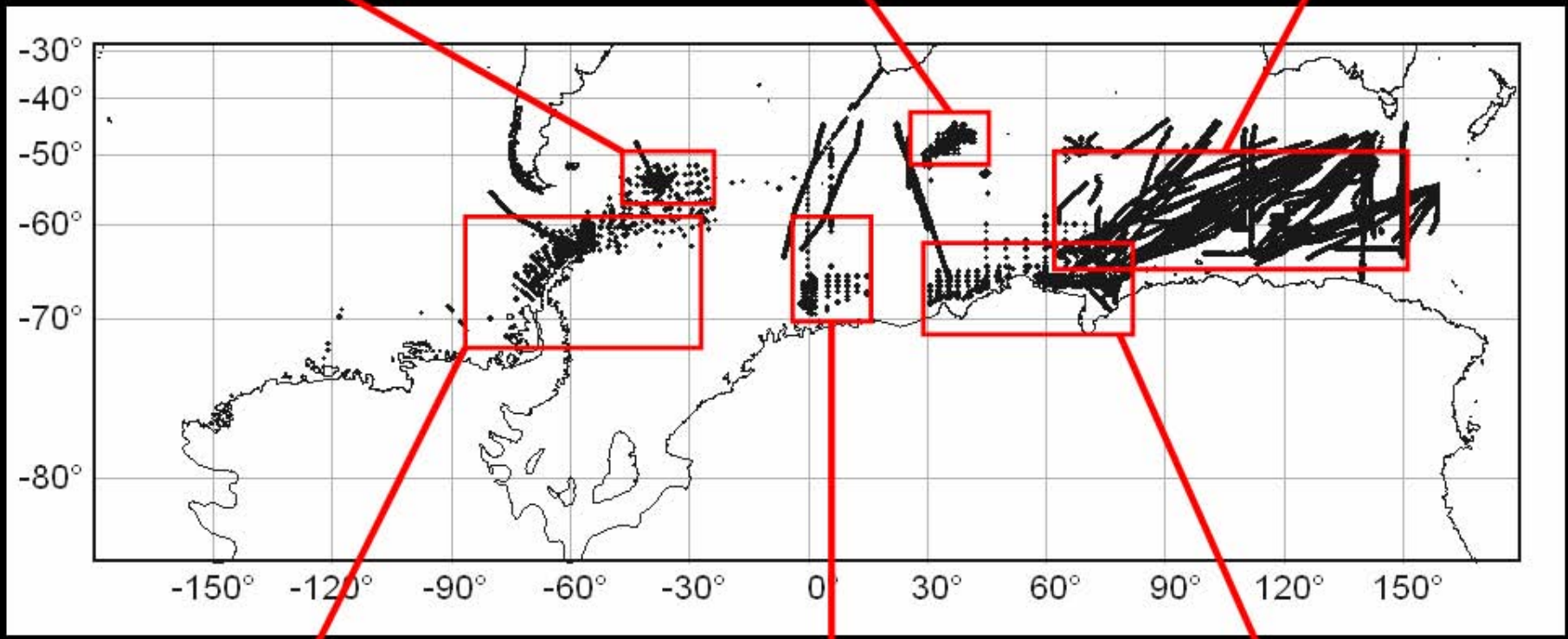
- density contribution to zooplankton communities
- feeding biology and grazing impact
- life cycle
- contribution to carbon flux

Densities of pteropod species

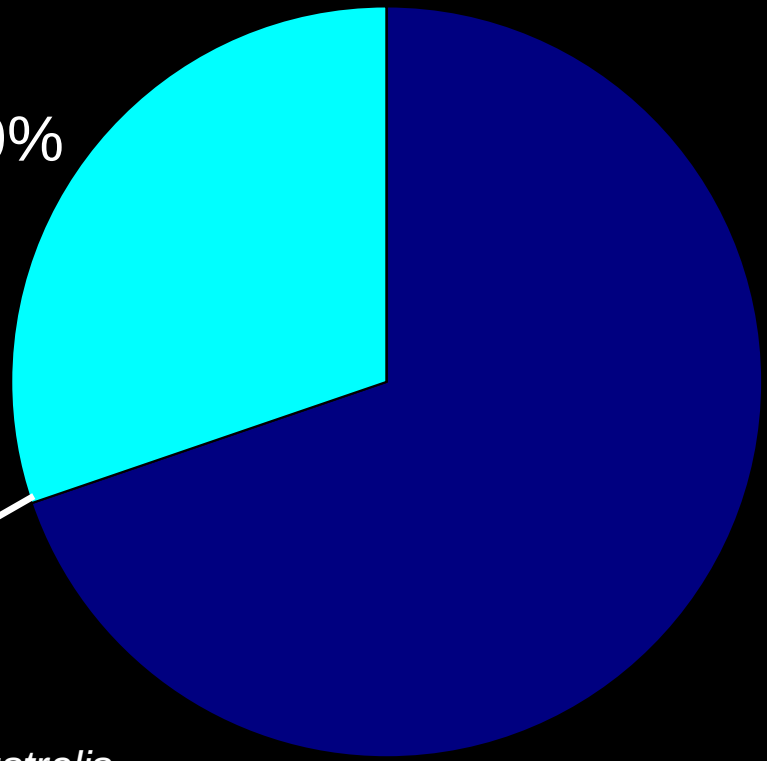
- 45 voyages – 2848 samples
- CPR survey – 16456 samples



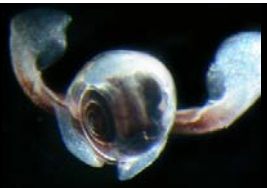
Densities of pteropod species



Relative proportions of pteropod species



Limacina helicina

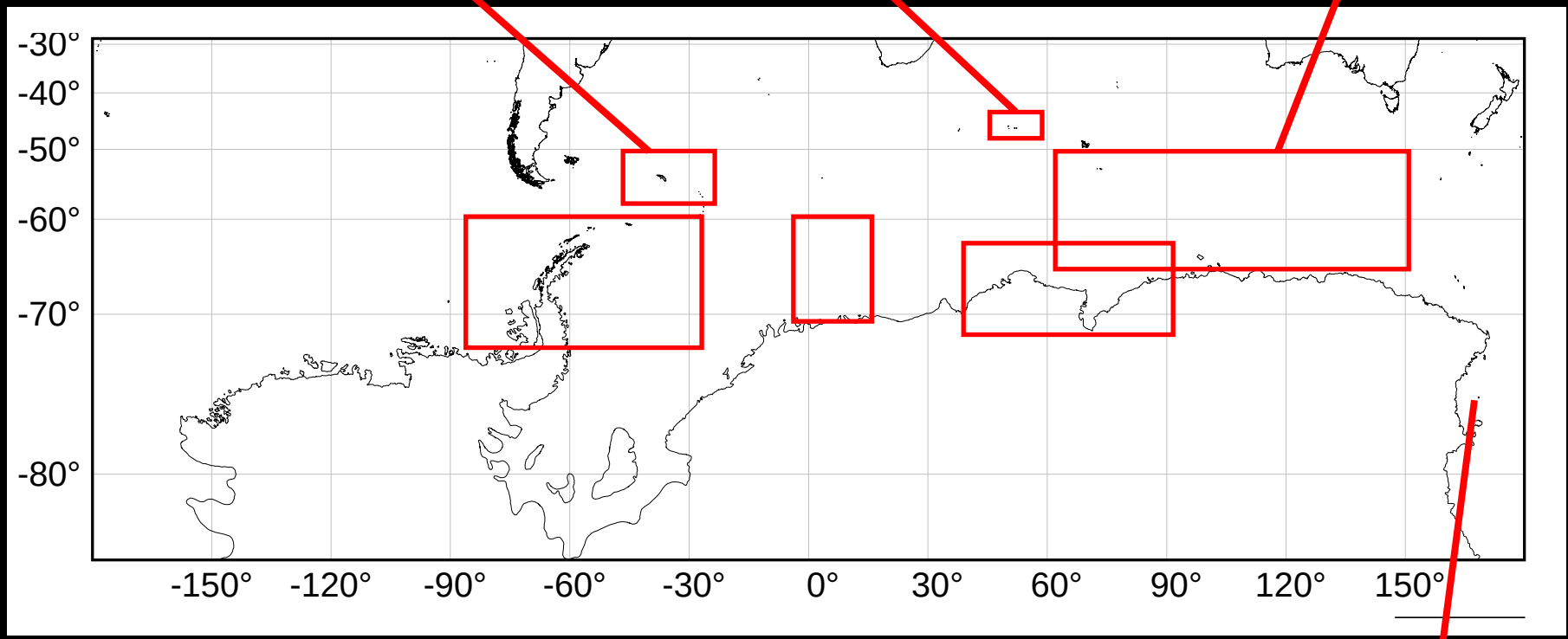


ave 165 ind.m^{-3}
max 2681 ind.m^{-3}

Limacina retroversa

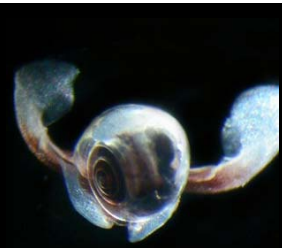
ave 60 ind.m^{-3}
max 802 ind.m^{-3}

Limacina spp.
ave 3.7 ind.m^{-3}
max 479 ind.m^{-3}



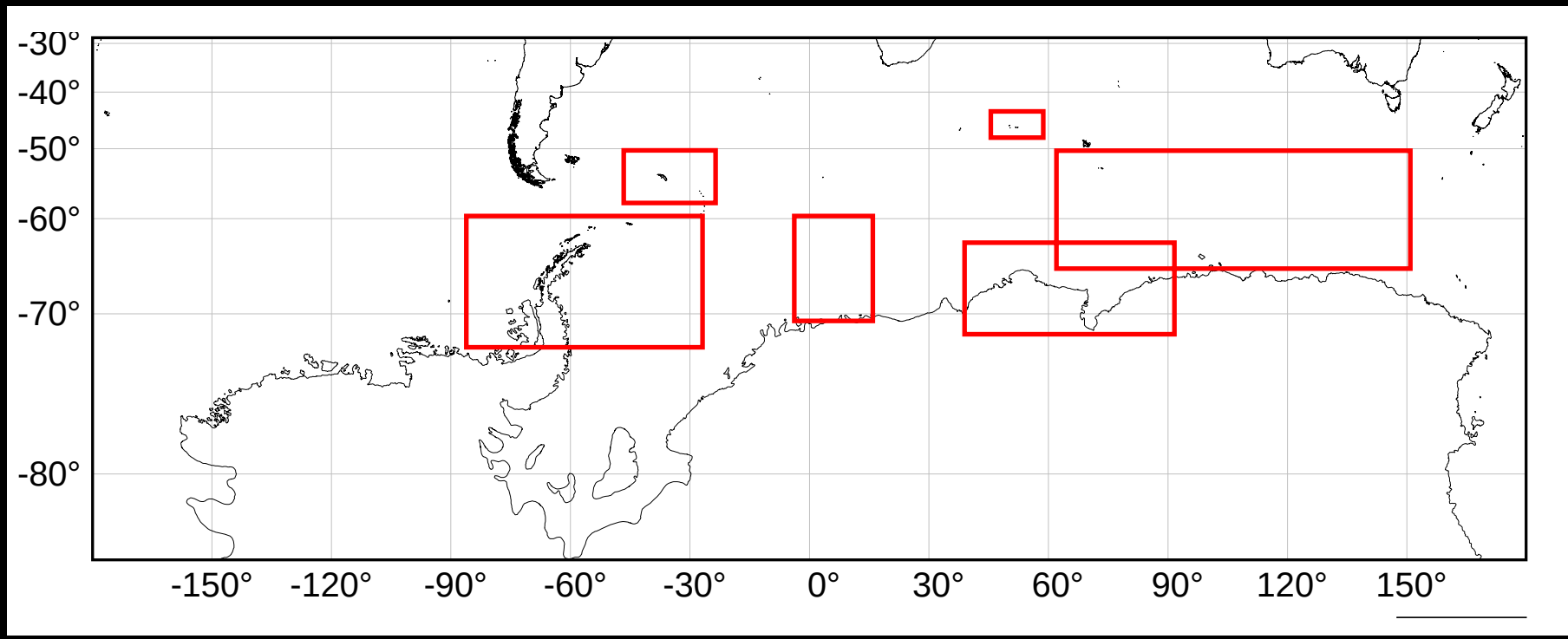
All sample ave (Nov-Apr)

Limacina helicina ➢ 24.89 ind.m^{-3}
Limacina retroversa ➢ 15.75 ind.m^{-3}



Limacina helicina
> 1000 ind.m^{-3}

Proportion of total zooplankton



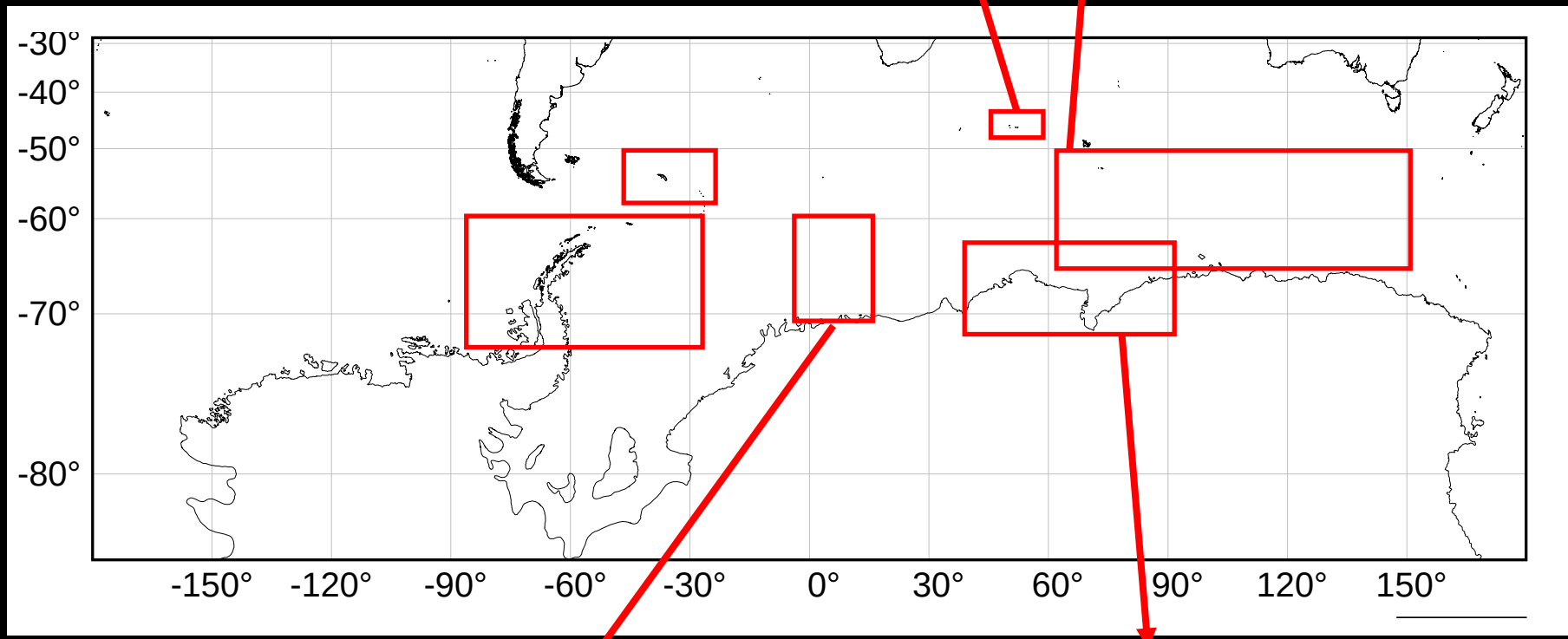
Prince Edward Islands meso

1996-2005 ave = 11%

2000 ave = 27%

CPR survey meso

1997-2005 ave = 2.5 ± 8.6



Lazarev Sea

meso ave = 1.1%

macro ave = 1.1%

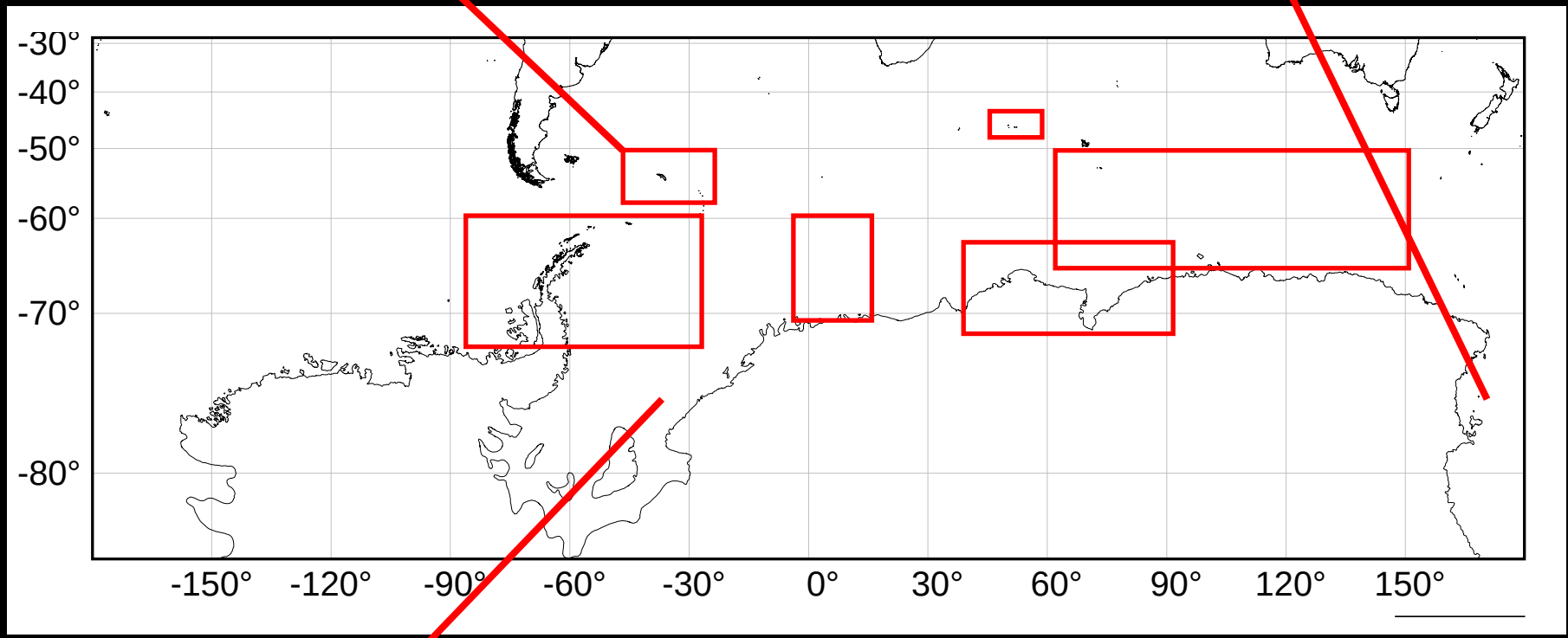
East Antarctic macro

1985-1990 ave = 11.6%

1985, 1987 ave > 20%

South Georgia meso
11 – 53 % (density)
Atkinson et al 1996
Pakhomov et al 1997

Ross Sea
63 % (density)
23 % (biomass)
Hopkins 1987



Weddell Sea
17 % (biomass)
Boysen-Ennen et al 1991

Abundance summary

- Pteropods, particularly *Limacina* species, are an abundant group, with regionally very high densities

- Pteropods can make a substantial contribution to both meso- and macrozooplankton communities

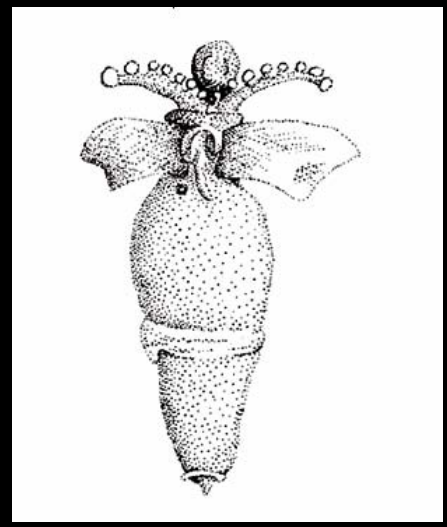
Trophic Ecology

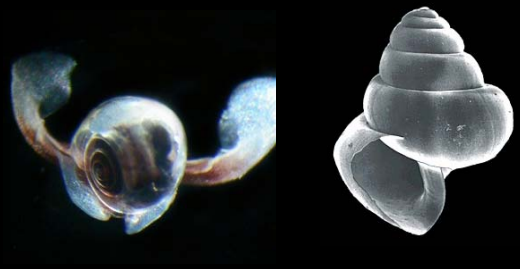
Trophic Ecology: Gymnosomes

Clione limacina

monophagous

Spongiobranchaea australis





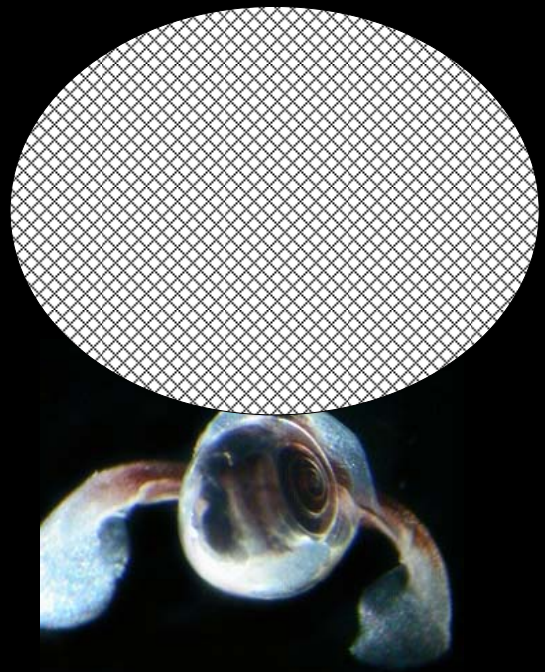
Limacina spp.

Clio pyramidata

Trophic Ecology: Thecosomes

Ciliary feeders

"Flux feeding" *Jackson (1993)*



mucous web

trapping of
motile organisms
Gilmer & Harbison (1986)

Diet: Gut content analysis

Only 4 studies in the Southern Ocean:

- No data for *Limacina retroversa*
- *Limacina helicina* (2-3mm) - diatoms and dinoflagellates (*Hopkins 1987)*
- *Clio pyramidata* - dinoflagellates (>40%)
  microzooplankton (~30%) *(Hopkins & Torres 1989)*
  zooplankton (~25%)

Northern hemisphere - Arctic and sub-Arctic

- *Limacina retroversa* - diatoms and dinoflagellates
- *Limacina helicina* - diatoms and dinoflagellates
- *Limacina helicina* (5-13mm) – zooplankton ~ 46% of prey volume

Gilmer & Harbison (1986)

Thecosome diet summary

- phytoplankton dominated diet indicated by stable isotopes and lipid analysis

- possible shift to increased carnivory at larger size

Grazing Impact

• only 6 published studies

Sub-Antarctic Zone

Limacina retroversa

➢ Ave IR = 1430 ng(pig)ind^{-1}.d^{-1} *6 years (April/May)*

➢ ave 25 % of community grazing impact (max = 60%)

Grazing Impact

Seasonal Ice Zone

Limacina helicina

- Ave IR = 3179 ng(pig)ind^{-1}.d^{-1}

2 years (Dec/Jan)

Clio pyramidata

- Ave IR = 22192 ng(pig)ind^{-1}.d^{-1}

1 year (Dec/Jan)

- up to 40% of community grazing impact

Grazing Impact

- Ingestion rates of thecosomes were amongst the highest of any grazers, and in the case of *Clio pyramidata* were equivalent to *Salpa thompsoni*

- Thecosomes can therefore be major contributors to community grazing impact

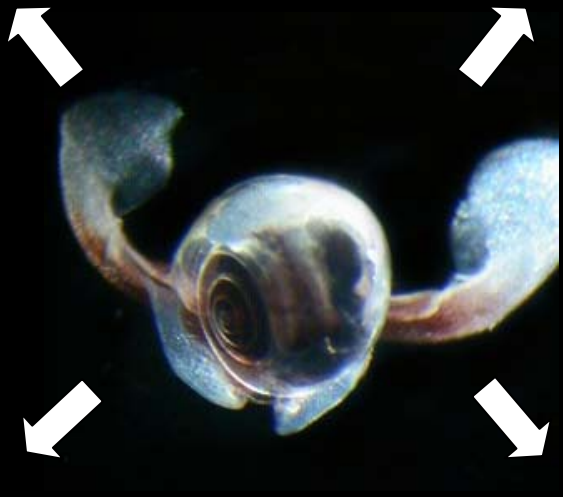
Carbon Flux

Faecal pellets

- assimilation efficiency *unknown*
- FP production rates *unknown*
- *Clio* spp. sink up to 650m.d^{-1}

Mucous flocs

- discarded nets; reproduction
- scavenge suspended particles
- sink at 300m.d^{-1} up to 1000m.d^{-1}



Consumption by predators

Zooplankton, benthos,
pelagic fish (up to 40%)
demersal fish (up to 90%)

Aragonite shells

- ballast for organic carbon transfer

e.g. Ross Sea - 56-96% of organic carbon flux in April-June
>50% of carbonate flux south of PF

Conclusions

- Pteropods are an abundant group & make a substantial contribution to both meso- and macrozooplankton communities

- Thecosomes have amongst the highest ingestion rates, and their grazing impact can be substantial

- Thecosomes are potentially important contributors to Southern Ocean carbon flux

Knowledge Gaps

Life cycle

A single study of *L. retroversa* in sub-Antarctic (Dadon & de Cidre 1992)

- population structure
- Intraspecific regional variation in population and size structure

Feeding studies

- the role of carnivory in thecosomes *significance for trophic models*
- mucous web production rates

Carbon Flux

- faecal pellet production and its relationship to food quality
- faecal pellet morphology – sediment trap studies