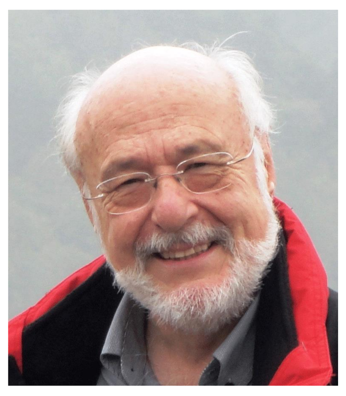
GLOBAL WARMING, ZOOPLANKTON SHIFTS, AND BIOGENIC CARBON FATE IN THE SOUTHERN OCEAN



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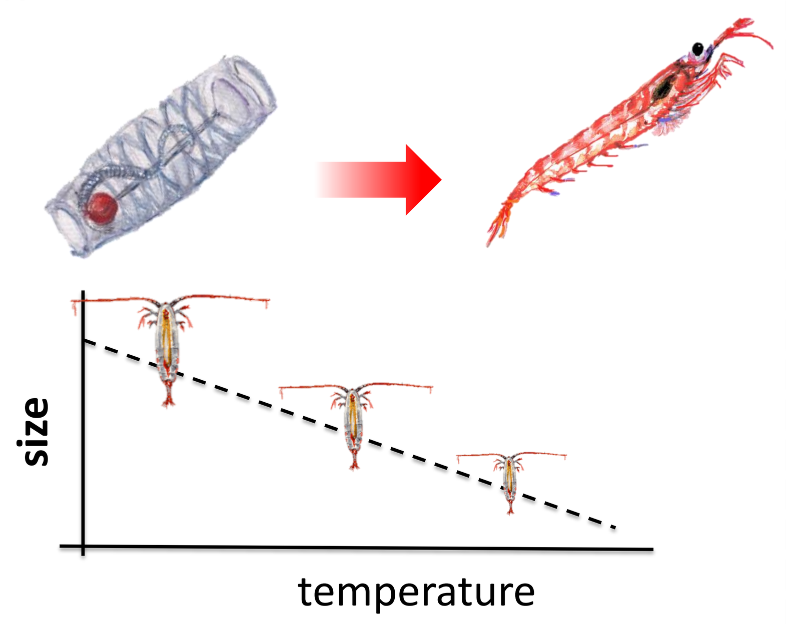
1 The facts

- **Krill** and **salps** are efficient grazers and contributors to the vertical carbon flux.
- While **krill** are a fundamental link between autotrophs and upper consumers, **salps** are quite indifferent as food- but more efficient than **krill** in packing biogenic carbon into large, heavy faecal pellets[(1)].

2 A future problem

- Rising temperatures, ice retreat and whale decimation are predicted to lead to crucial ecosystem changes in the Southern Ocean, like the substitution of **krill** by **salps** as the dominant grazer and the **reduction of individual size** (biomass) of zooplankton [(2)].



3 Main questions

- In the case of ***krill-salps shift*** and ***individual biomass reduction***, will the present metabolic C requirements of the zooplankton community change?
- What will be the **fraction of primary production required** by zooplankton to compensate for the metabolic C requirements, and the **fate** of the biogenic C?

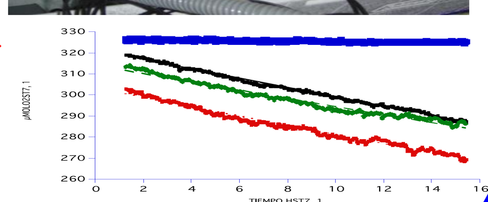
4 What we did and how

We analysed primary production (total and particulate, **TPP** and **PPP** respectively), taxonomic composition, individual biomass and metabolism (respiration rates) of zooplankton in the vicinity of the Antarctic Peninsula. We compared the percentage of **PPP** allocated to zooplankton respiration losses in this study and for the future **zooplankton shifts.**

* Total and particulate primary production (**TPP** and **PPP**, respectively) were measured by the ^{14}**C** technique[(3)] and *in situ* incubation.

* Zooplankton was sampled with a double **200-µm WP2** net. **Mesozooplankton** biomass (as µmol C m^{-3}) was calculated by the relationships between **volume** (ZooImage®) and **organic C** relationships[(4)]. **Krill** biomass was measured with a Simrad® EK60 multifrequency echosounder[(5)].

- C-specific respiration rates (C_R) for **krill, salps** and **copepods** were estimated by incubation experiments at "in situ" temperature[(6)] and measured by semi-continuous analysis of O_2 concentration using OXY-10 PreSens® optodes.

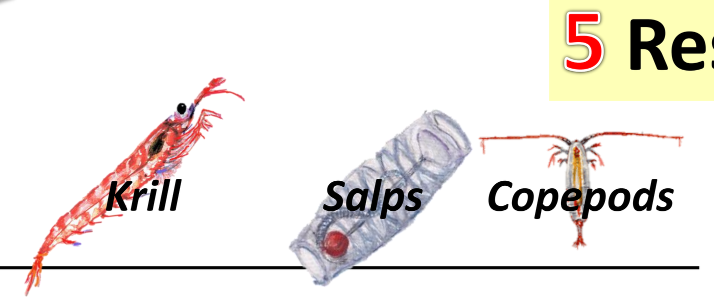


O_2 consumption graph

- Respiration (C_R) was used as a proxy of the metabolic C requirements of zooplankton. Assimilation efficiency was used to calculate ingestion (C_I) and vertical carbon export (C_E) .

5 Results

5·1



	Krill	Salps	Copepods
Biomass (µmol C m^{-3})	4726.99	7.51	388.02
C_R (day^{-1})	0.0136	0.0841	0.0348

- **Krill** biomass: **92 %** of total zooplankton.
- Specific metabolic rates of **salps** higher than those of **krill** by a factor of **7**.

5·3

Present

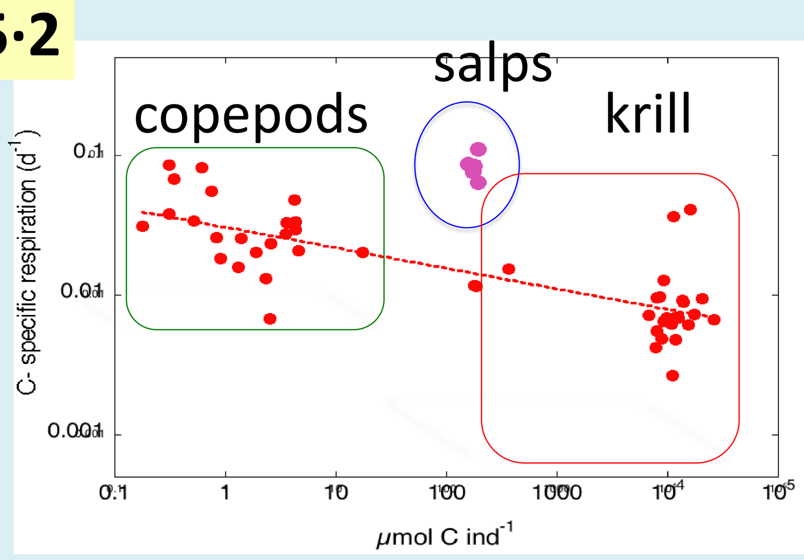
	Krill	Salps	Other	Total
Biomass	4726.9	7.5	388.0	5121.3
C_I	96.0*	1.2**	13,7	110.8

Salp-krill shift

	Krill	Salps	Other	Total
Biomass	47.3	4687.2	388.0	5121.3
C_I	1.0*	758.3**	13.6	772.9

- Carbon ingested by zooplankton **(C_I)**. ***Present*** and in a future ***Salp-krill shift***. (from respiration, C_R, µmol C m^{-3} day^{-1}, corrected for the assimilation efficiency of Krill* (70 %) and salps** (52 %).

5·2

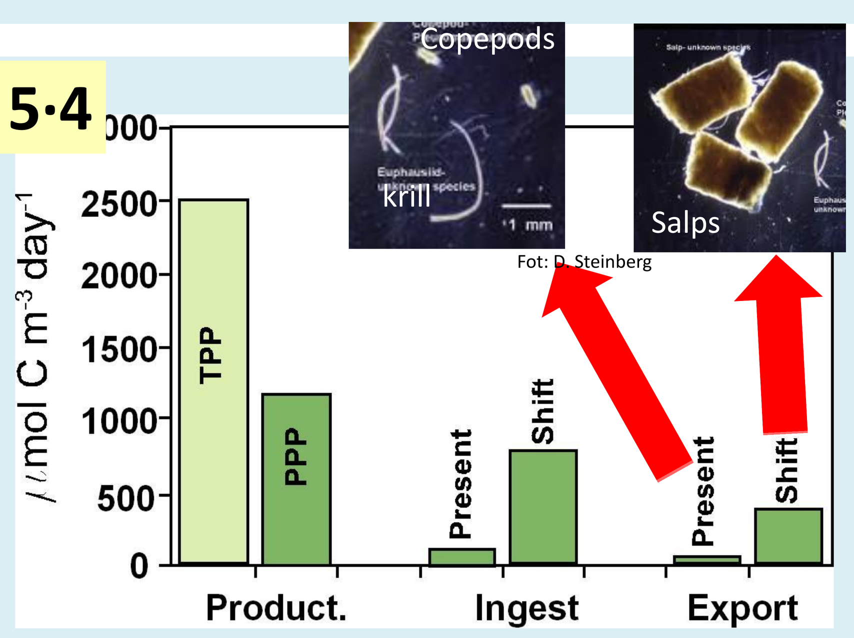


- C- specific respiration rates inversely related to individual biomass.

$C_R = 0.030\ C_{zoo}^{-015}$

$r = -0.70$, $p < 0.01$, $n=63$

5·4



Salp-krill shift:
- The carbon ingested (C_I) by zooplankton will increase by a factor of **7**
- The vertical carbon export (as fecal pellets) will increase by a factor of **10**.

6 Conclusions

- In a future **salps-dominated** Southern Ocean and in which the average individual biomass has **decreased** by temperature rising, more than **50 %** of the carbon fixed by primary producers will be necessarily allocated to compensate for the respiratory losses of zooplankton (**C_I**). In the present krill-dominated community less than **8 %** of PPP will be necessary.
- Near **50 %** of the carbon ingested (**C_I**) will be packed in the form of large, fast settling faecal pellets, intensifying the rate of carbon export (**C_E**) to the long-lived and/or sequestered biogenic carbon pool, while the present community structure less than **30 %** of the ingested carbon is egested (**C_E**) as fragile krill faecal pellets.
- The expected major shift in the structure of the Southeren Ocean zooplankton would thus induce changes in the food webs that will affect the whole Antarctic ecosystem, with a decrease of the **P/R** (production/respiration) quotient with, paradoxically, a saimultaneous decrease of the regenerative processes in surface waters.

7 Bibliography

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