Increased seawater temperatures cause temporal shifts in catabolic pathways of Antarctic krill *Euphausia superba*

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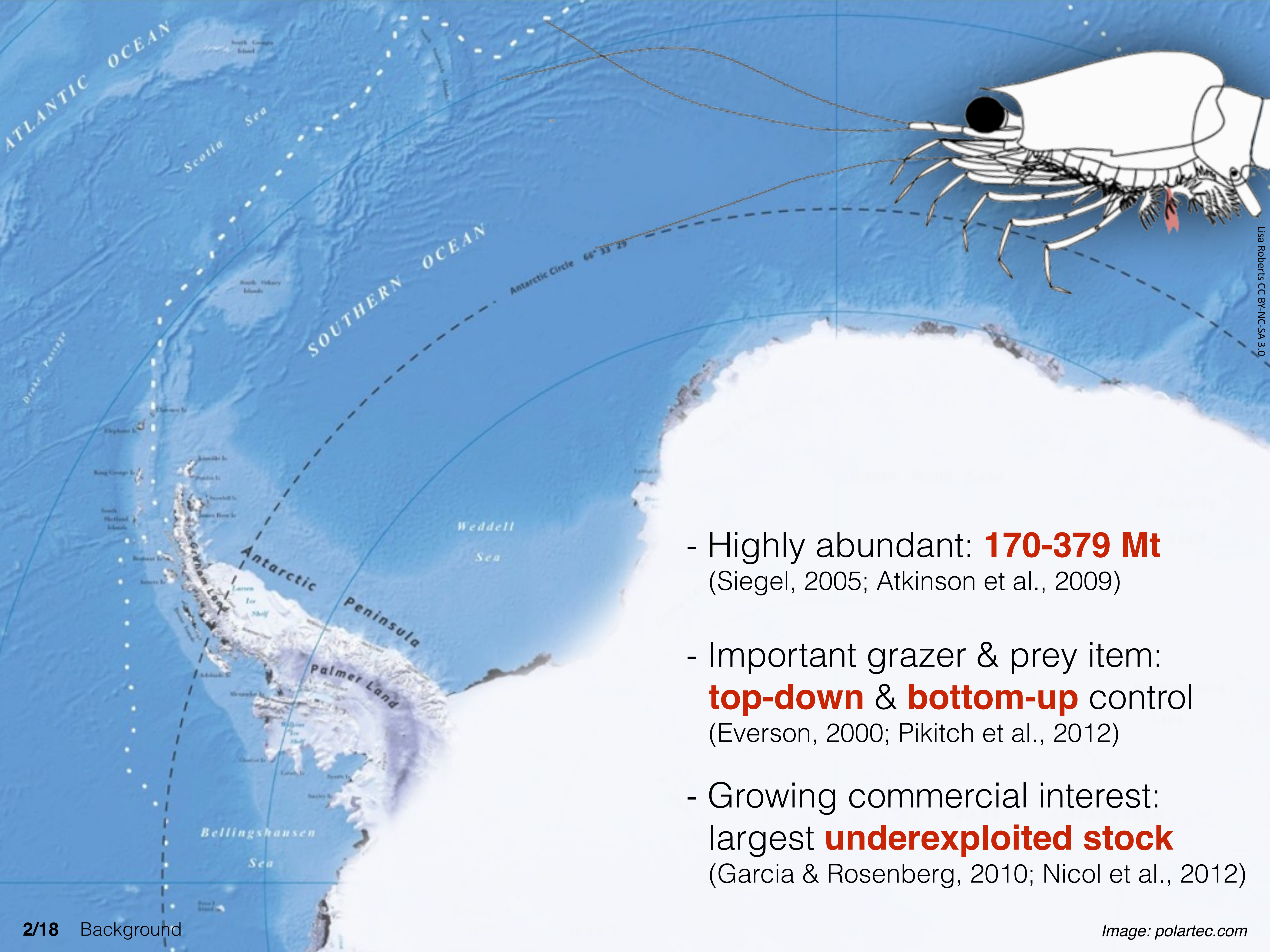
Photo: J. v. Franecker

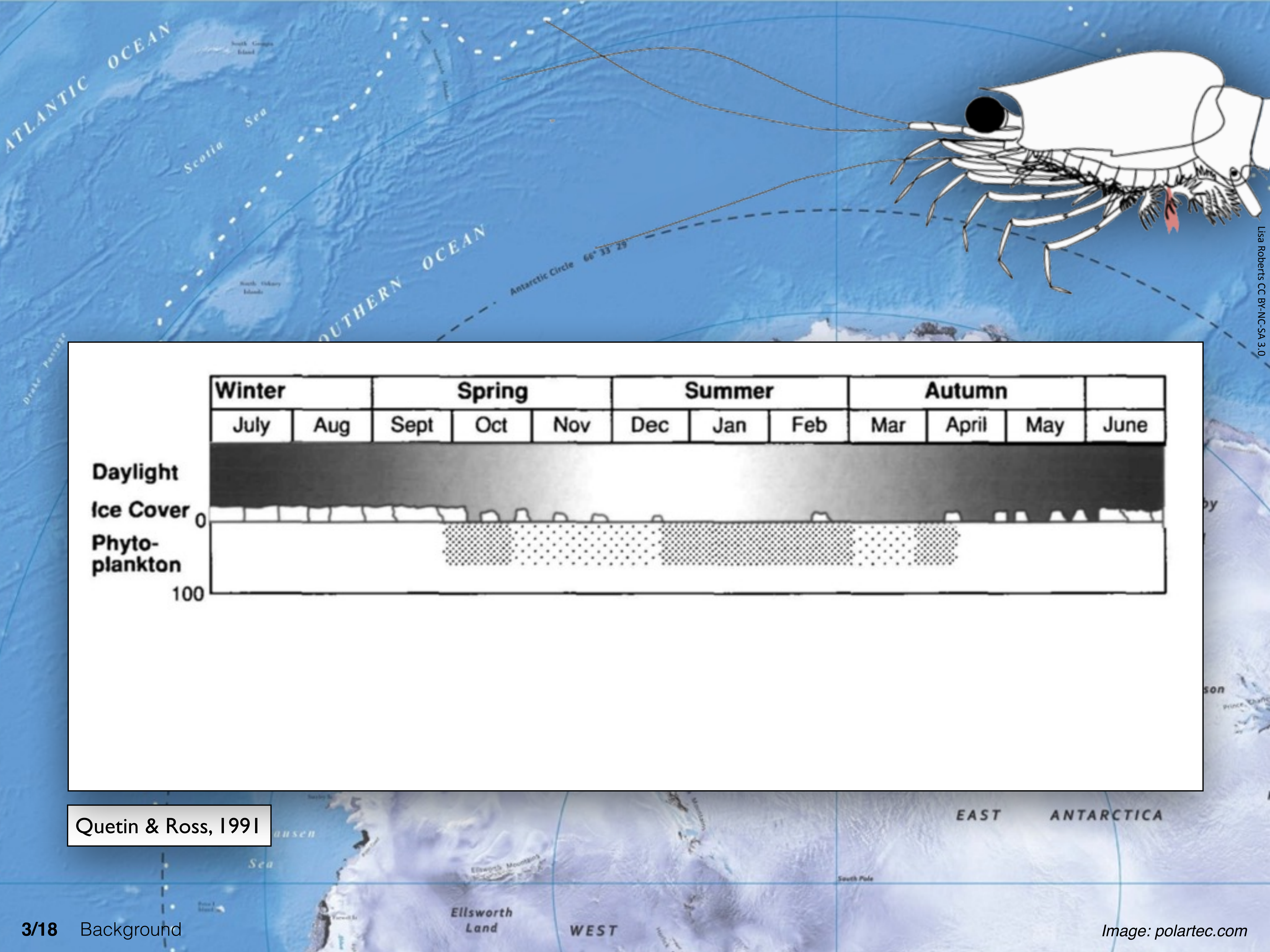


- Highly abundant: **170-379 Mt**
  (Siegel, 2005; Atkinson et al., 2009)

- Important grazer & prey item:
  top-down & **bottom-up** control
  (Everson, 2000; Pikitch et al., 2012)

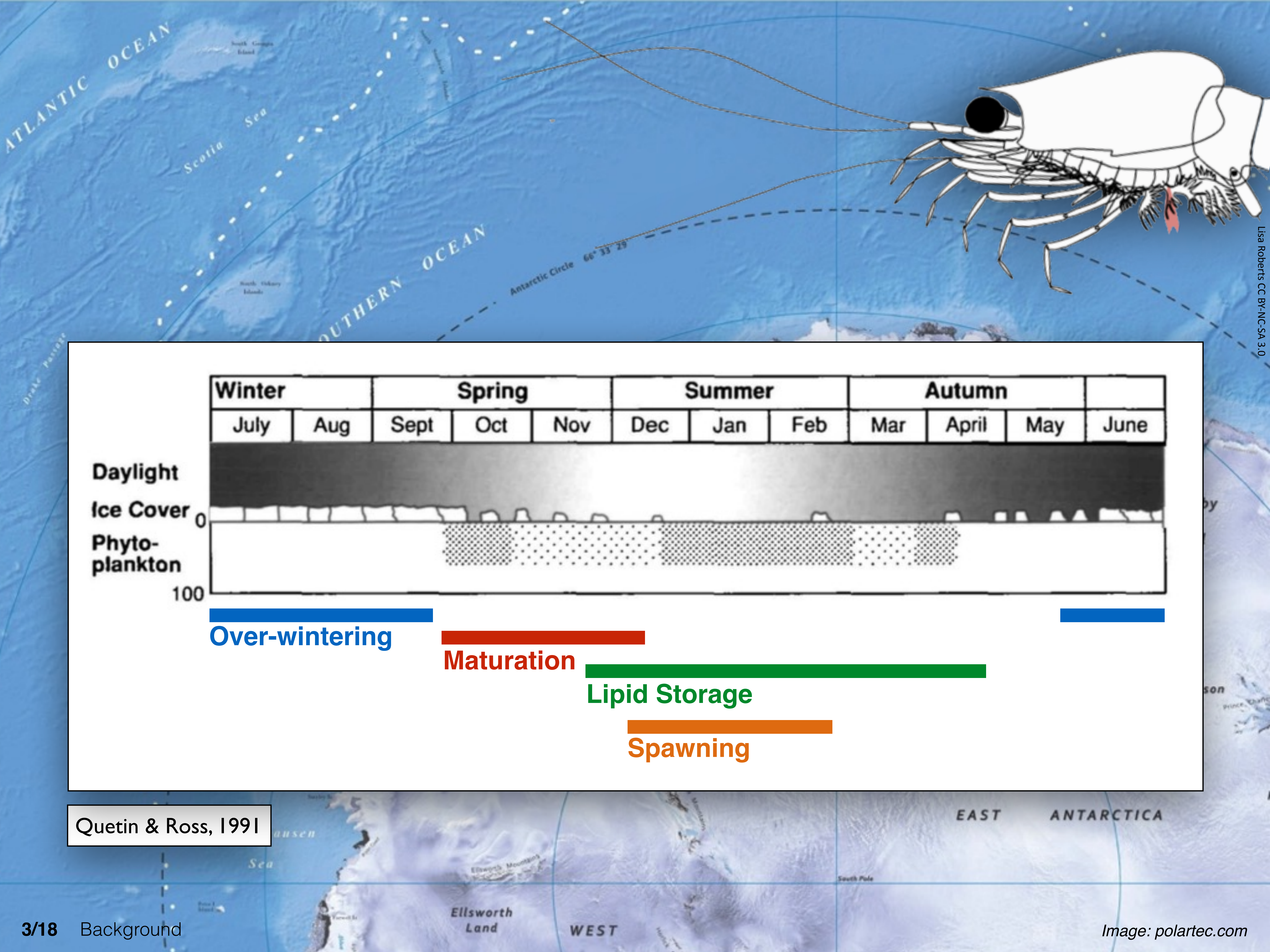
- Growing commercial interest:
  largest **underexploited stock**
  (Garcia & Rosenberg, 2010; Nicol et al., 2012)

Image: polartec.com



Quetin & Ross, 1991

Image: polartec.com


ATLANTIC OCEAN
Scotia Sea
SOUTHERN OCEAN
Antarctic Circle 66° 33' 29
Winter
Spring
Summer
Autumn
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Daylight
Ice Cover
0
Phyto-
plankton
100
Over-wintering
Maturation
Lipid Storage
Spawning
Quetin & Ross, 1991
EAST
ANTARCTICA
Ellsworth
Land
WEST
Lisa Roberts CC BY-NC-SA 3.0
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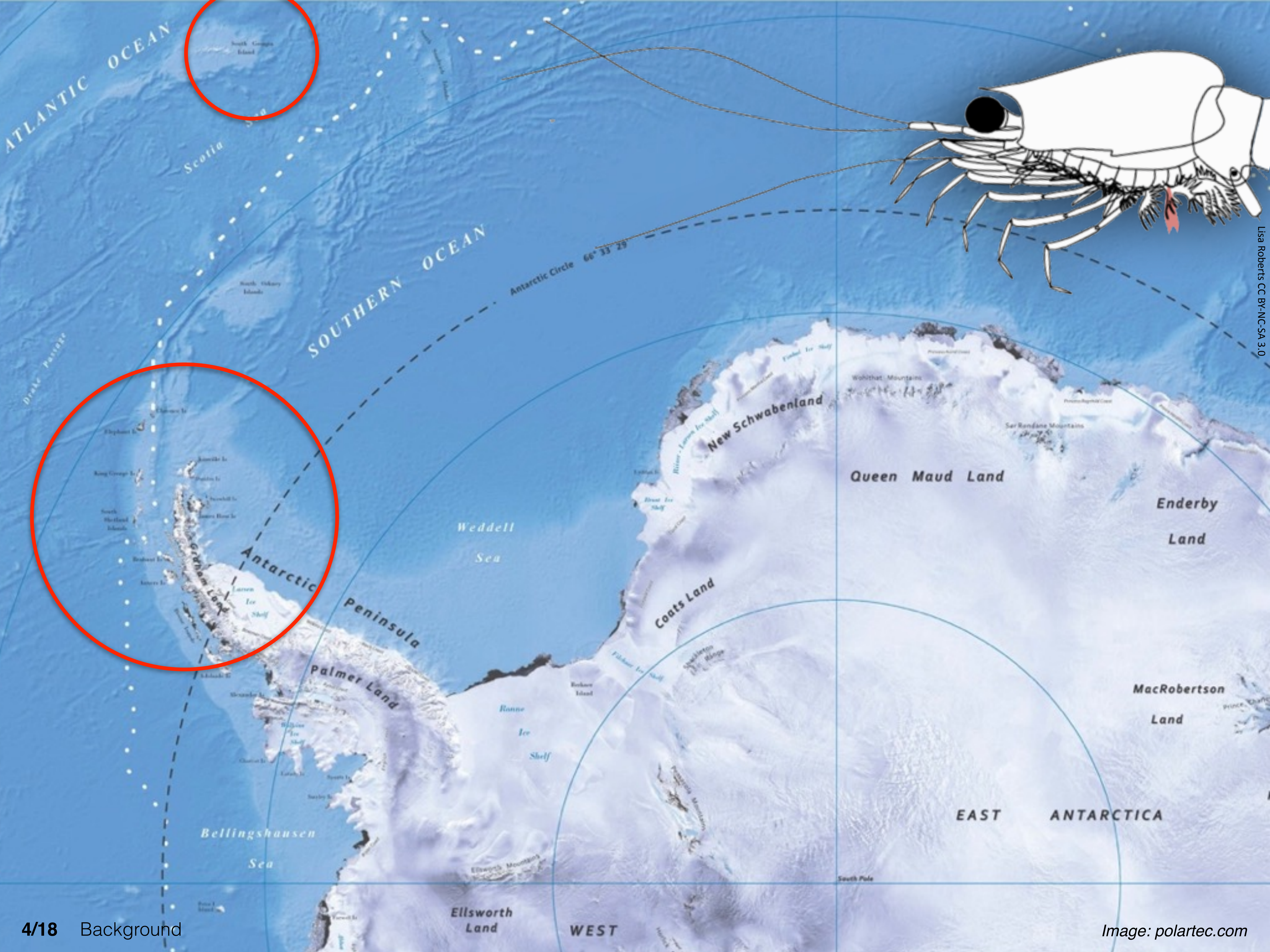

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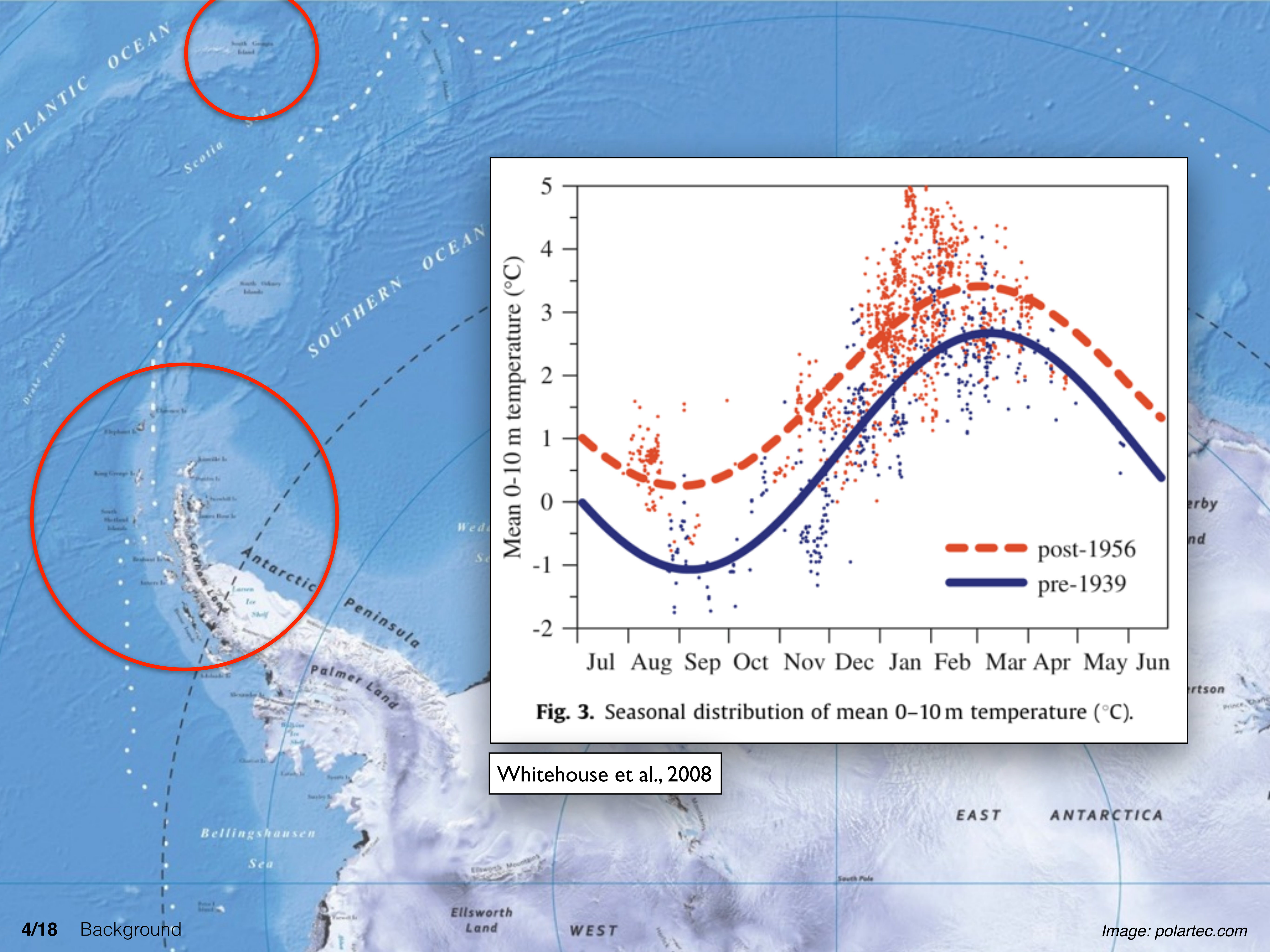
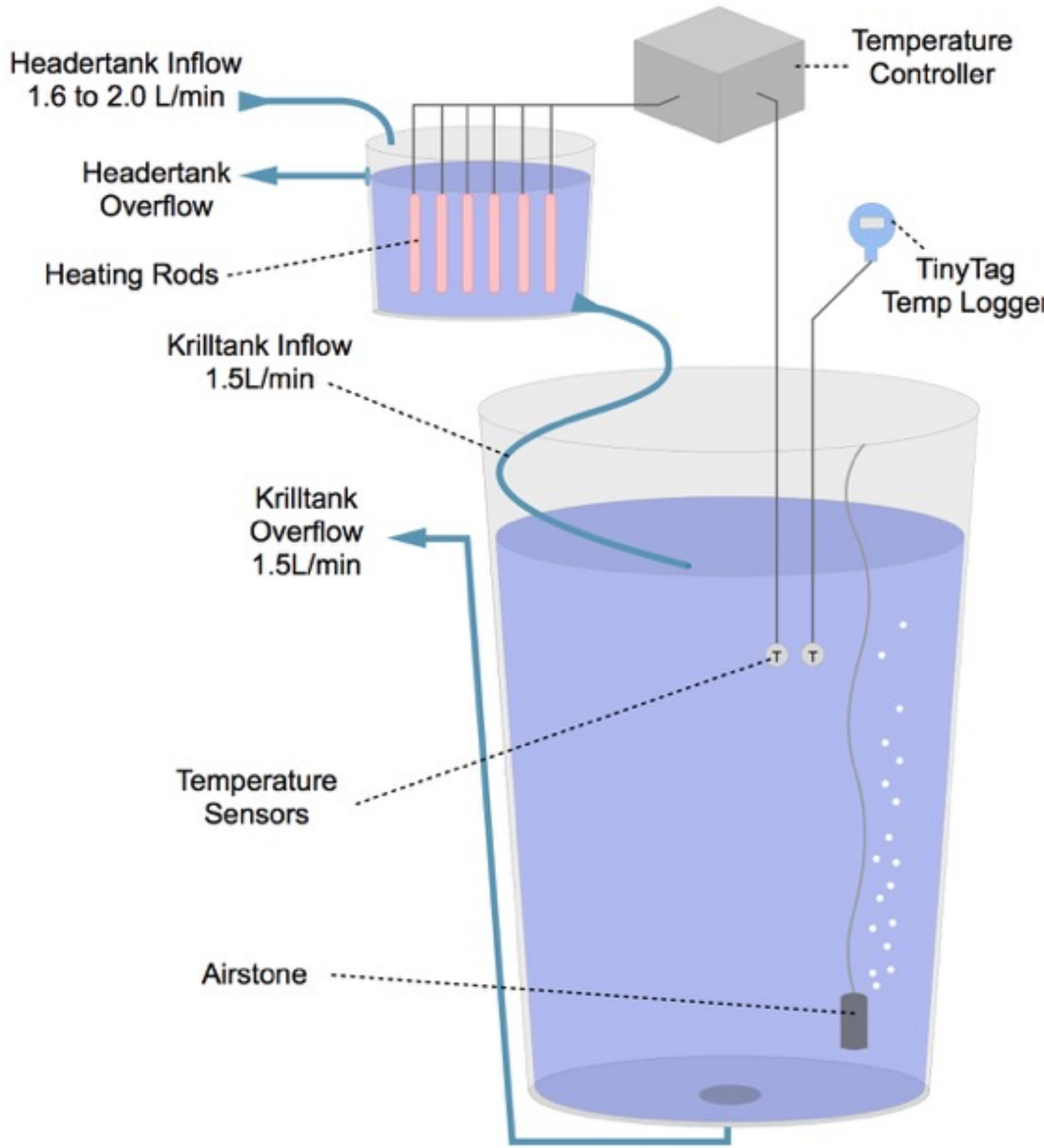


Fig. 3. Seasonal distribution of mean 0–10 m temperature (°C).

Whitehouse et al., 2008

Image: polartec.com

Experimental Setup



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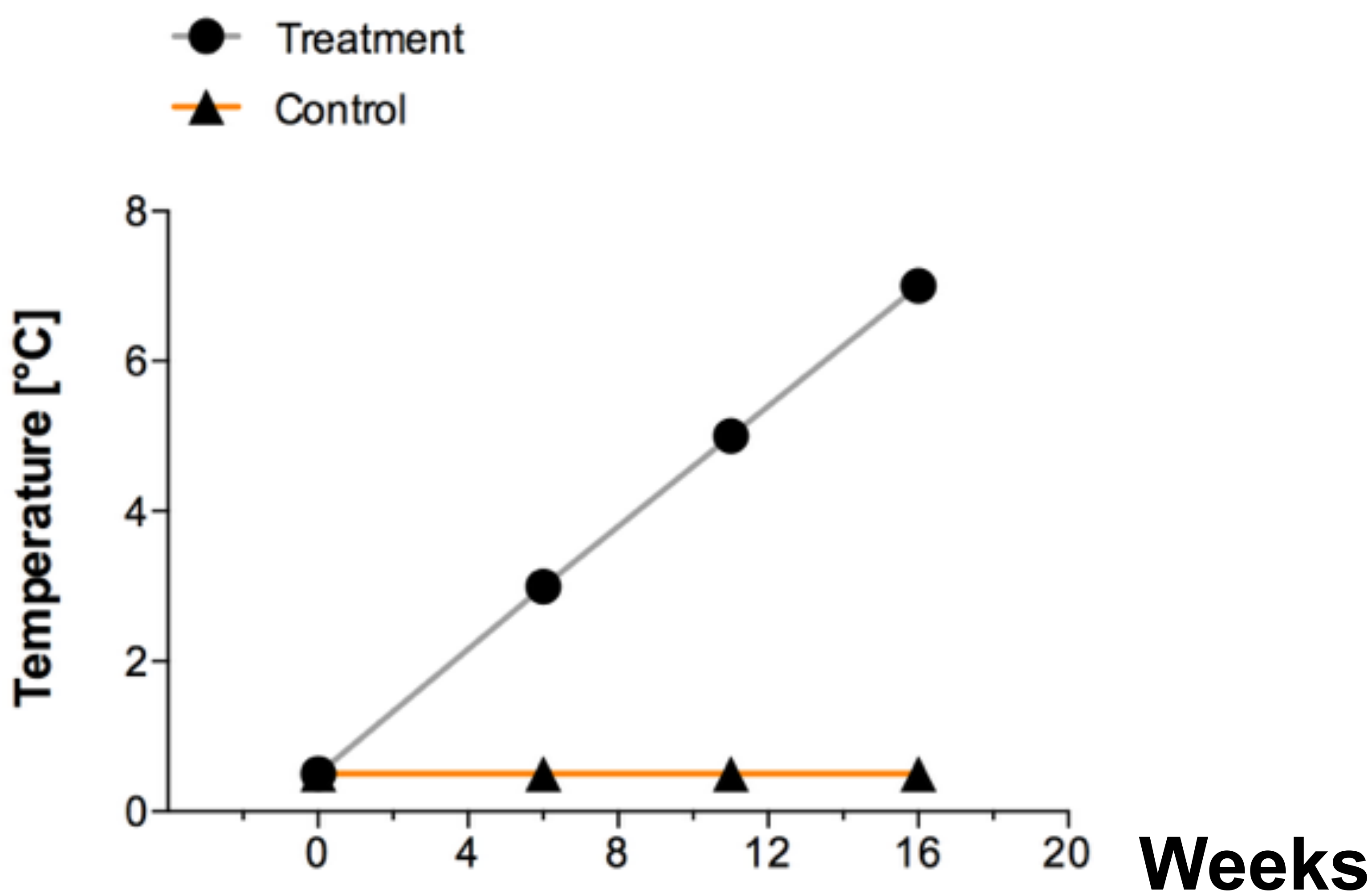
Sampling Scheme



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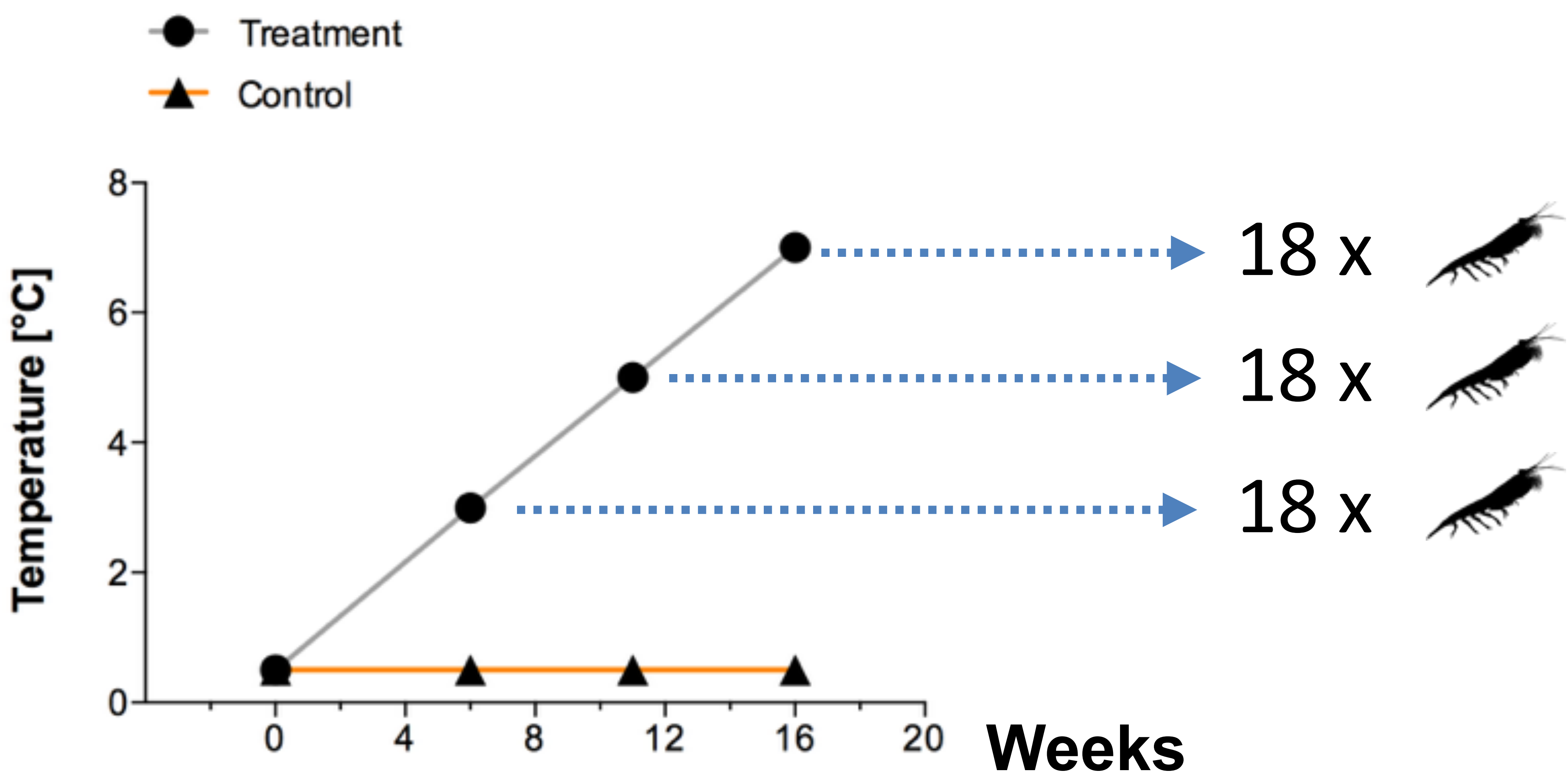
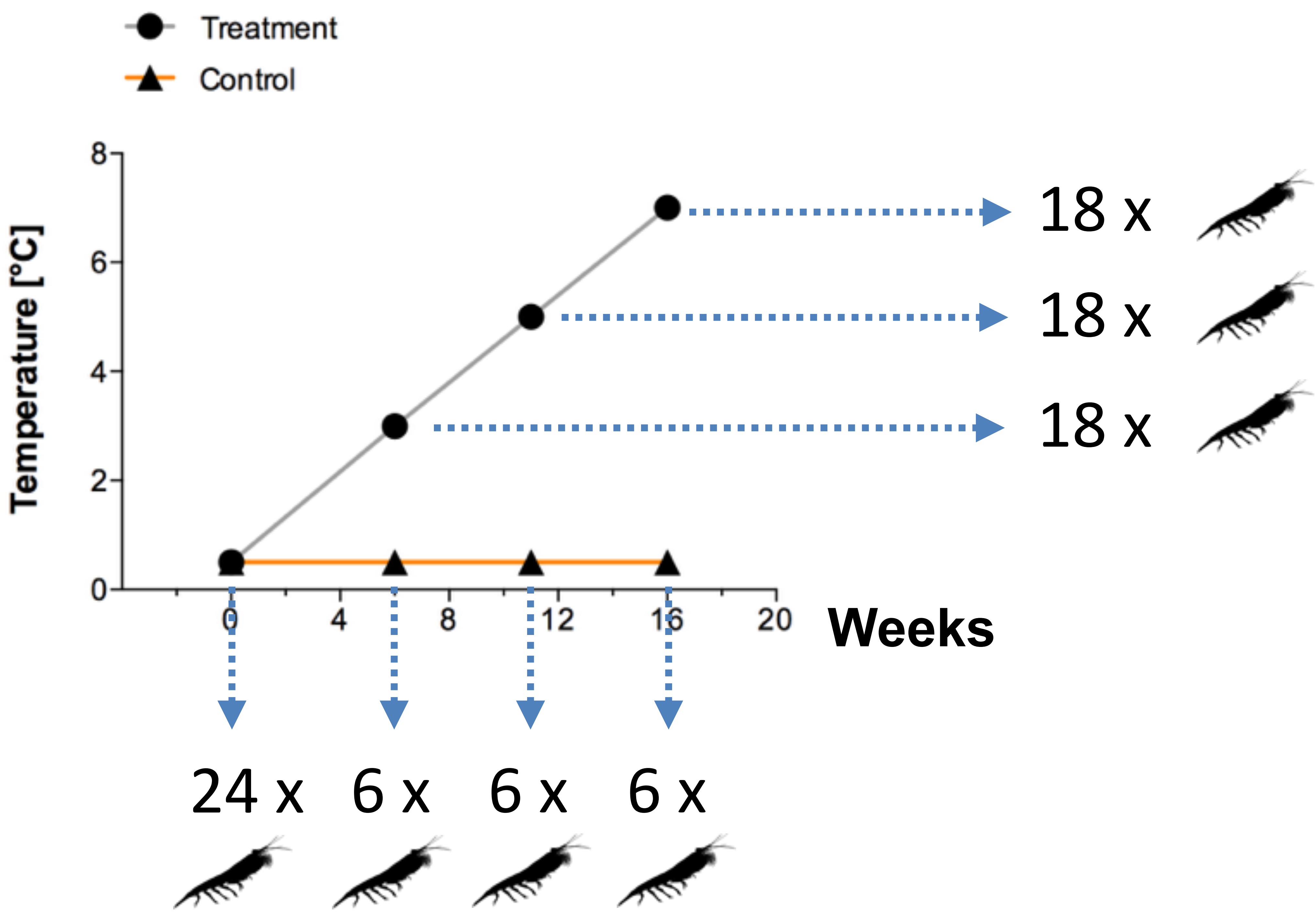
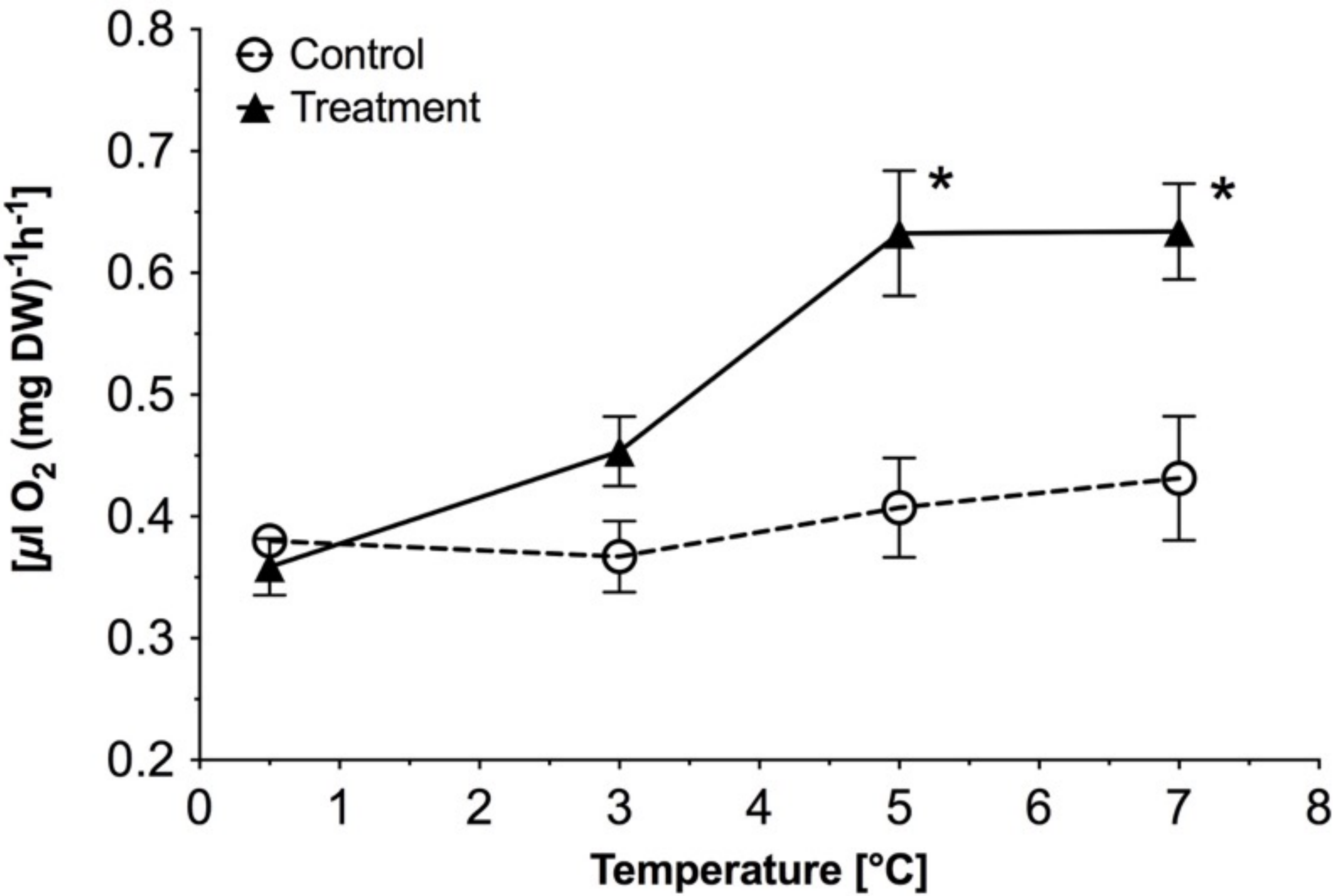


Sampling Scheme



Respiration



Respiration -> Energy Requirement

	Temperature [°C]	Equation from linear regression	Individual energy requirement [Joule/d]
Treatment	0.5	$y = 0.3117x$	1,12
	3	$y = 0.4021x$	1,45
	5	$y = 0.5903x$	2,13
	7	$y = 0.6268x$	2,26
Control	0.5	$y = 0.3544x$	1,28
	3	$y = 0.3753x$	1,35
	5	$y = 0.3587x$	1,29
	7	$y = 0.4155x$	1,50

after Brett & Groves, 1979
caloric equivalent during catabolism of protein/lipid is **19.4 J per ml O_2**

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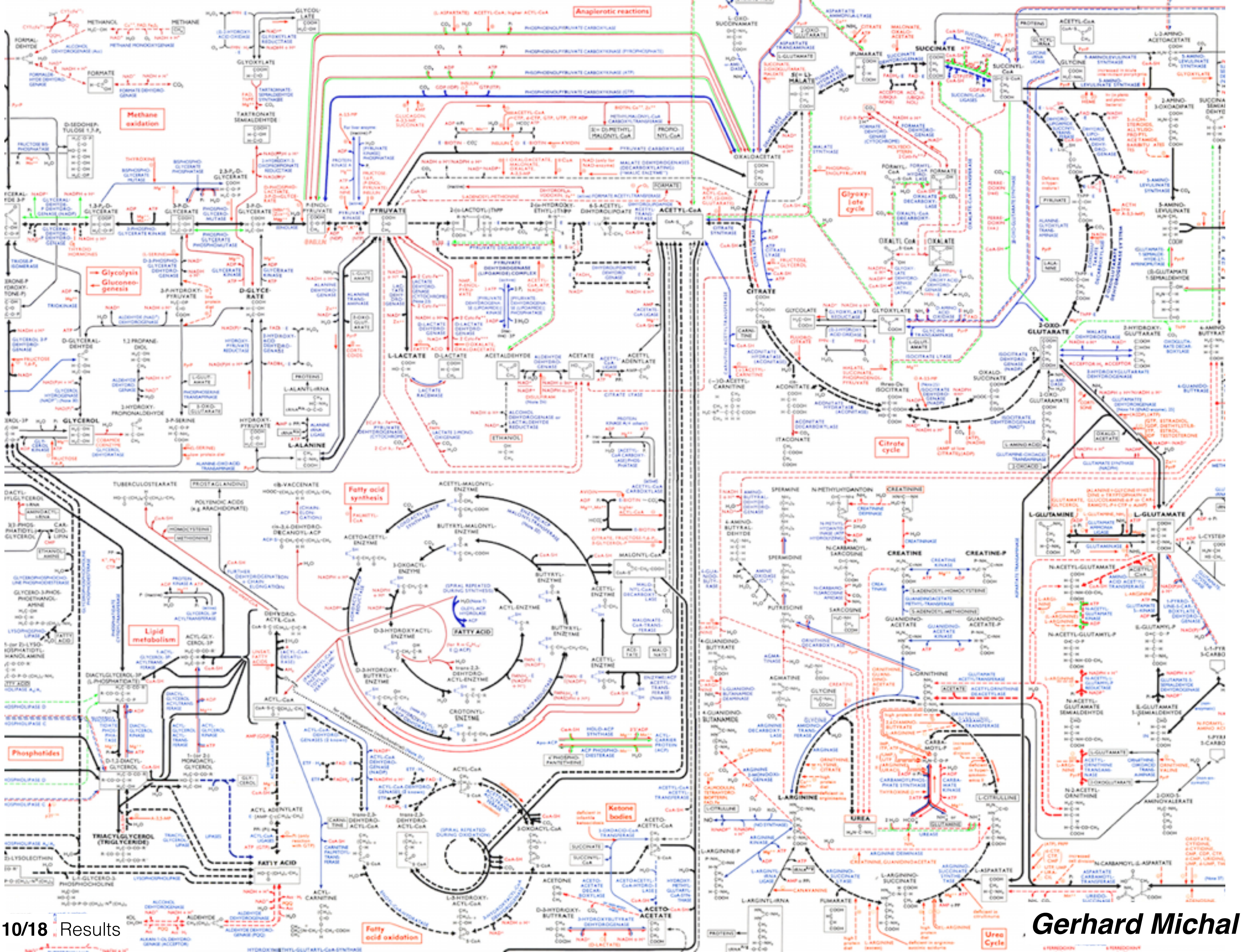
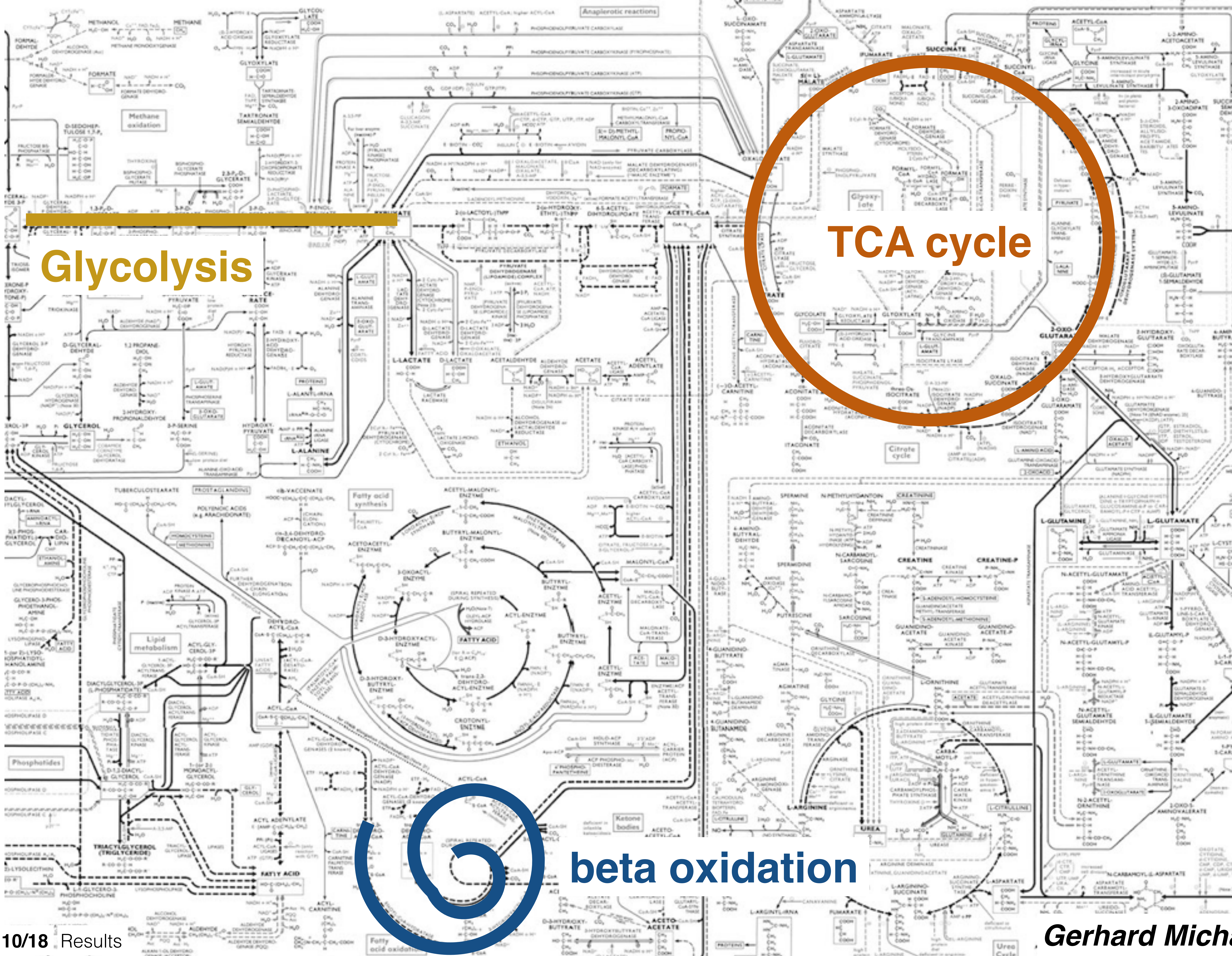
How are energy demands met?



Gerhard Michal



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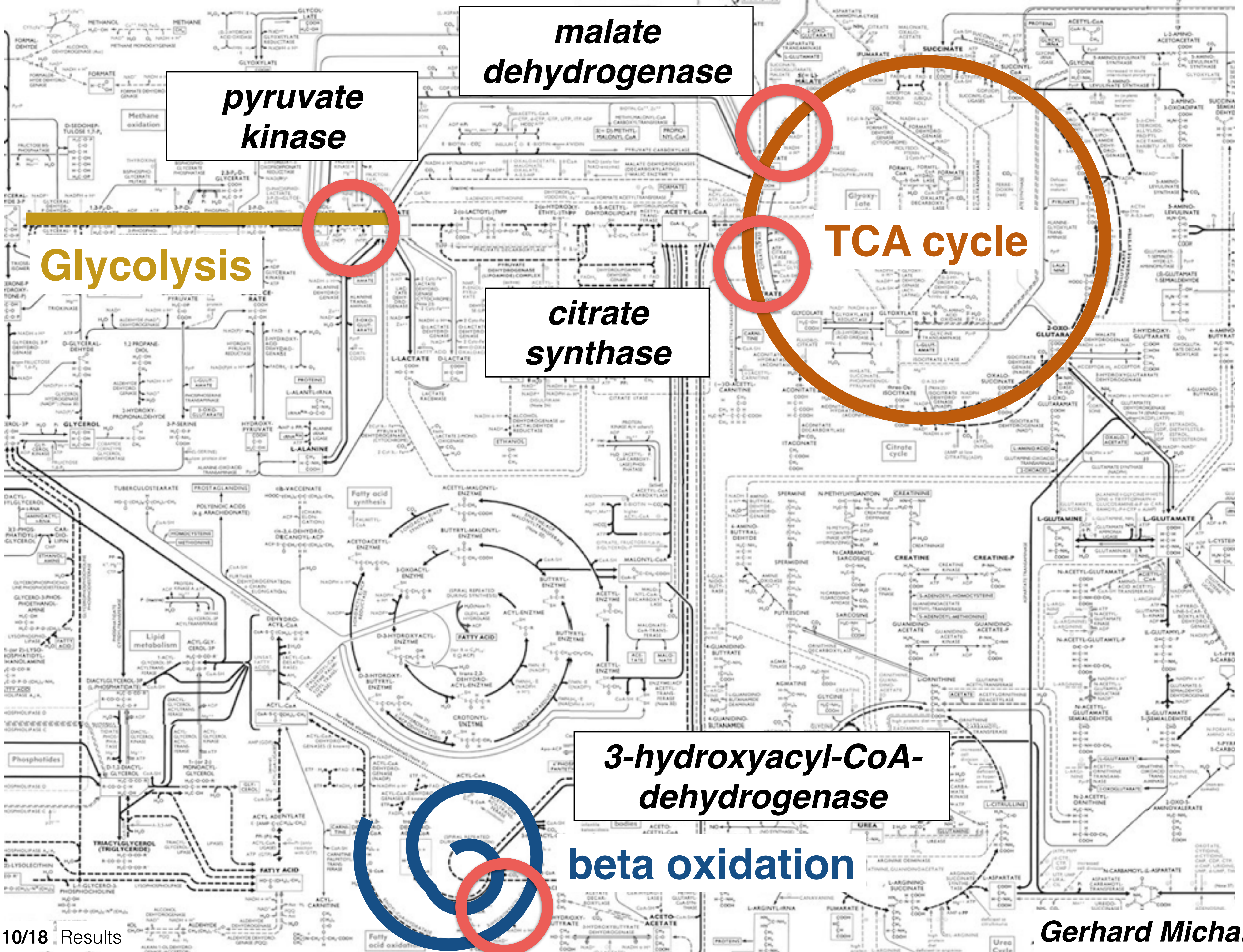
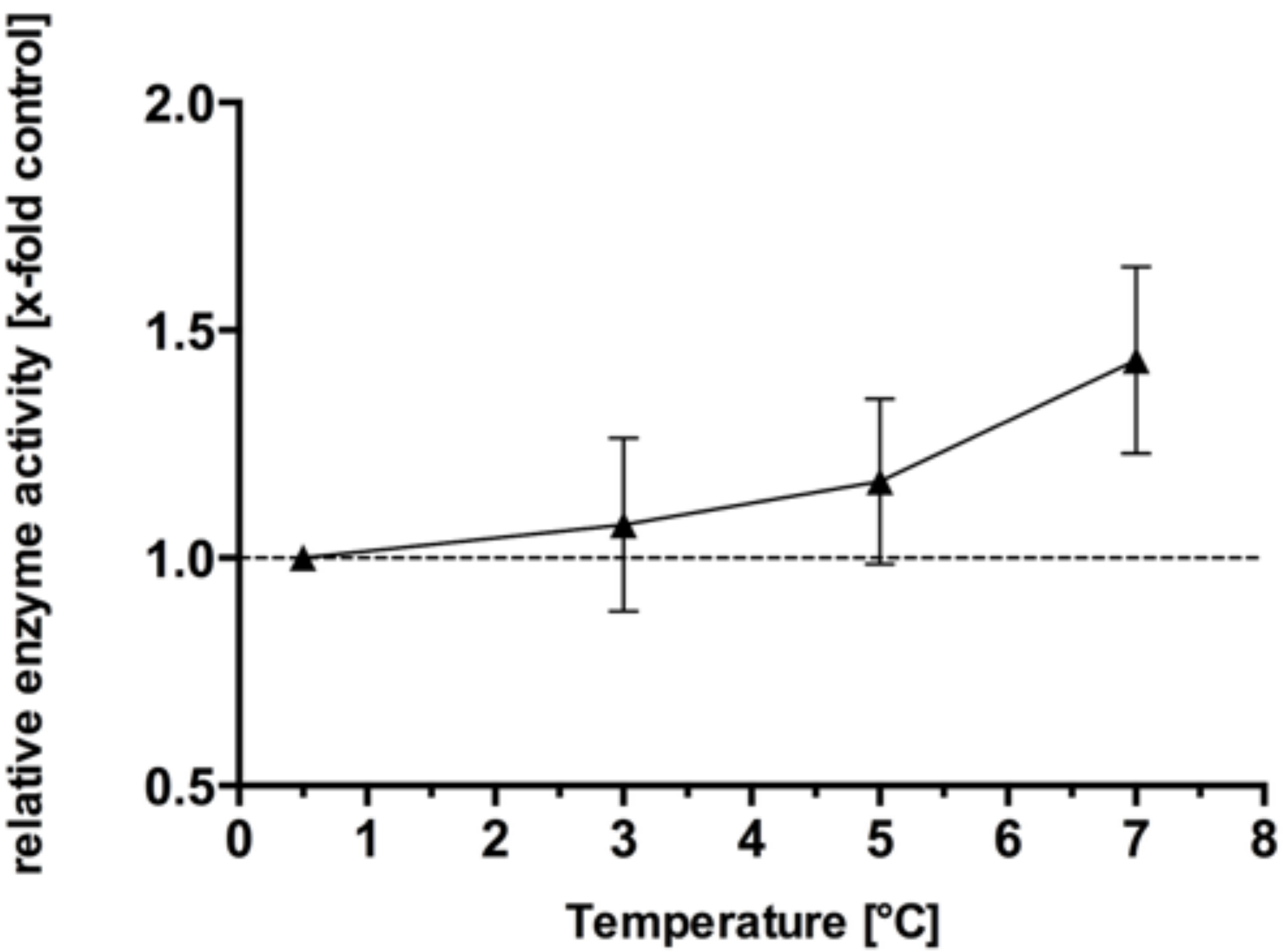


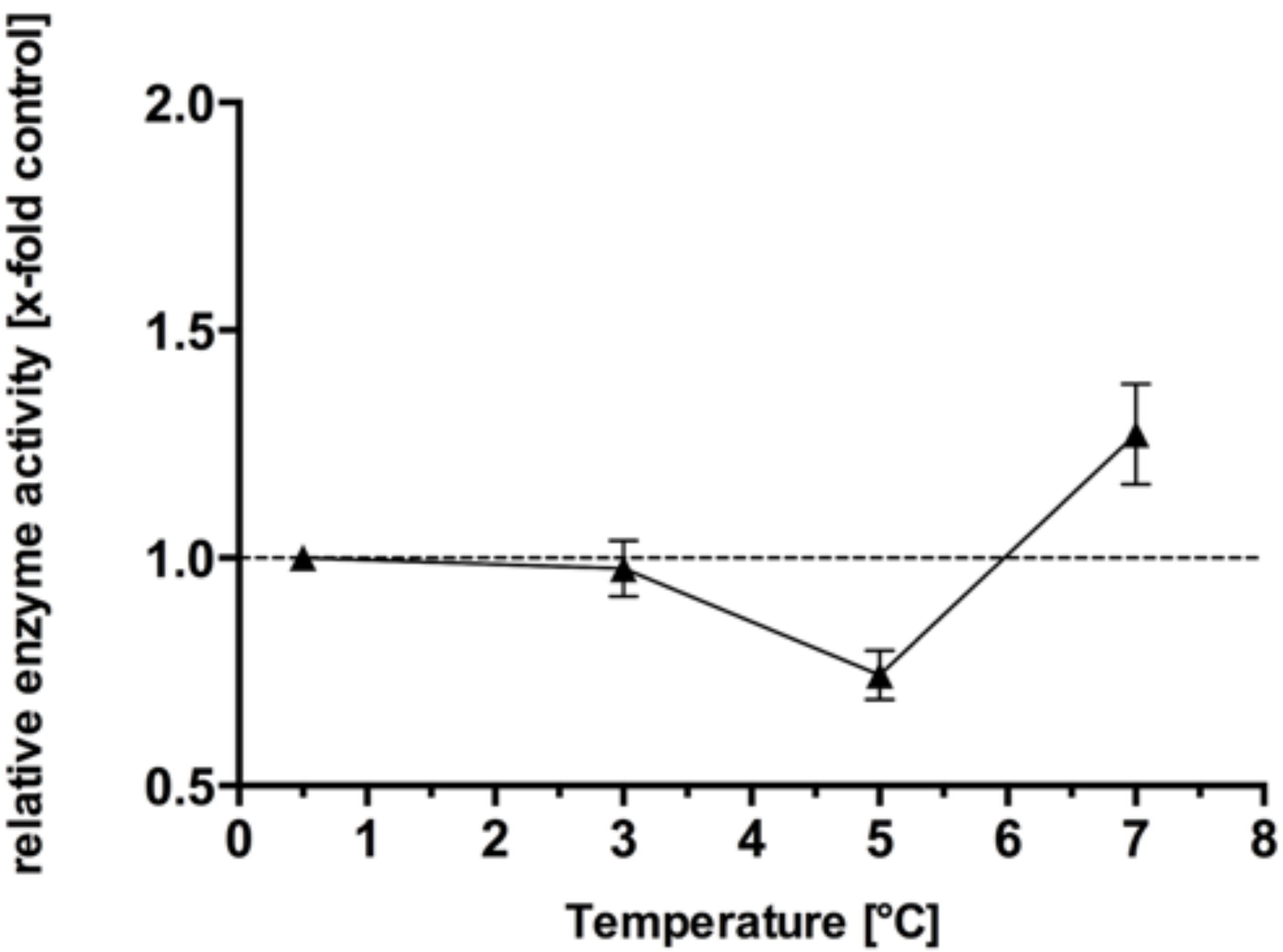
Gerhard Michal

Malate Dehydrogenase MDH



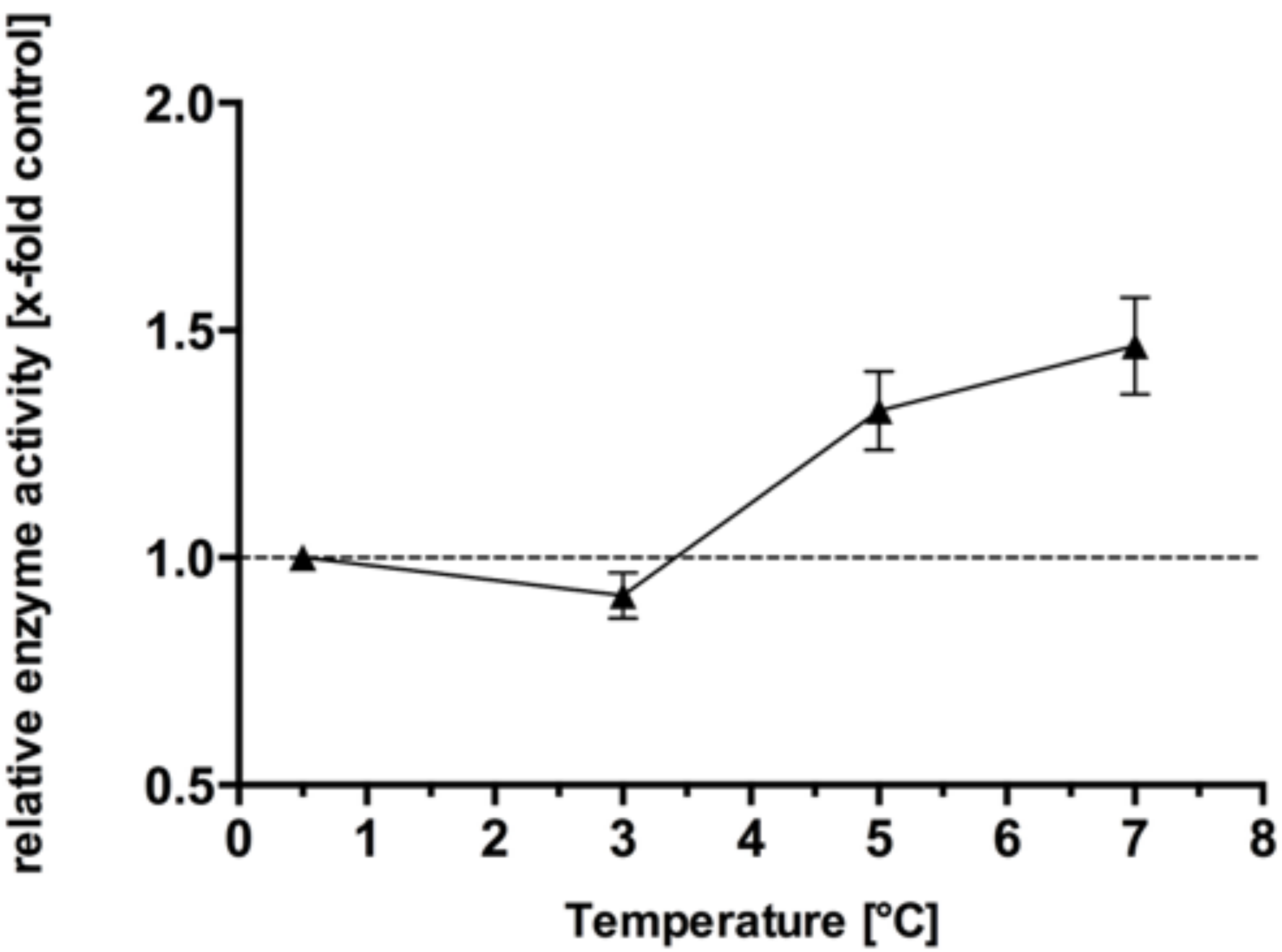
- **key enzyme** in TCA cycle
- also **involved in other pathways** (gluconeogenesis, malate-aspartate-shuttle)

Citrate Synthase CS



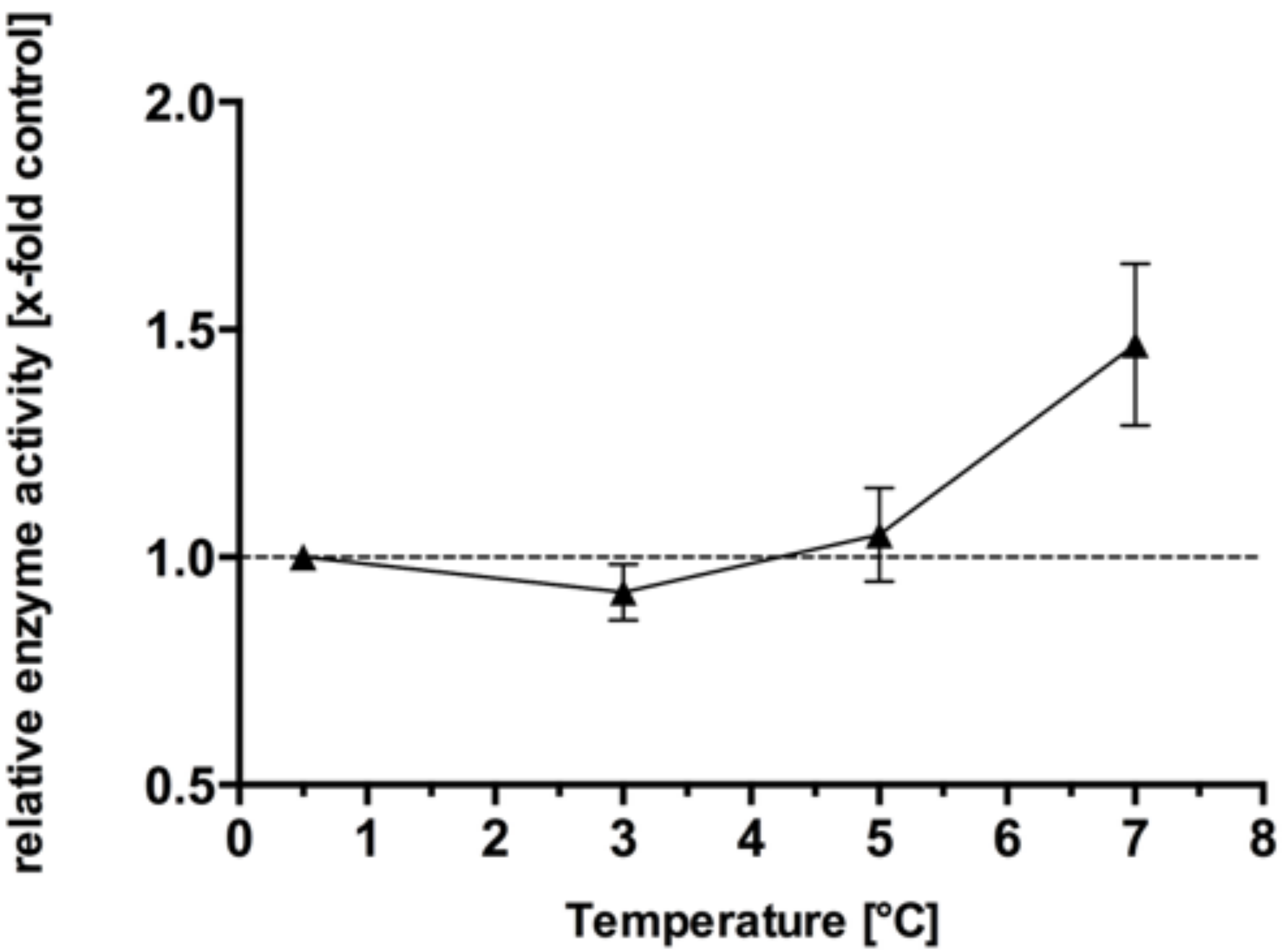
- **pace-making** first reaction in the cycle
- marker for **aerobic capacity**
- acts as **central crossing point** for various pathways
- **entry point for fat synthesis** (acetyl-CoA to cytosol via citrate)

Pyruvate Kinase PK



- key enzyme in glycolytic pathway
- constitutes **primary metabolic intersection** *(Munoz 2003)*
- suggested to play an important role in the **transition to anaerobic metabolism** *(Vial et al. 1992)*

3-Hydroxyacyl-CoA-DH HOAD



- 3rd step in **beta oxidation**
- **marker enzyme** for utilization of lipids

Carbohydrate Catabolism

pyruvate kinase ↑

citrate synthase ↓ ↑
5°C 7°C

- no onset of anaerobiosis
- still within aerobic capacity

Carbohydrate Catabolism

pyruvate kinase ↑

citrate synthase ↓ 5°C ↑ 7°C

malate dehydrogenase ↑

Additional role of MDH: malate-aspartate shuttle? gluconeogenesis?

Lipid Catabolism

3-hydroxyacyl-CoA-DH ↑

- increased oxidation of lipids

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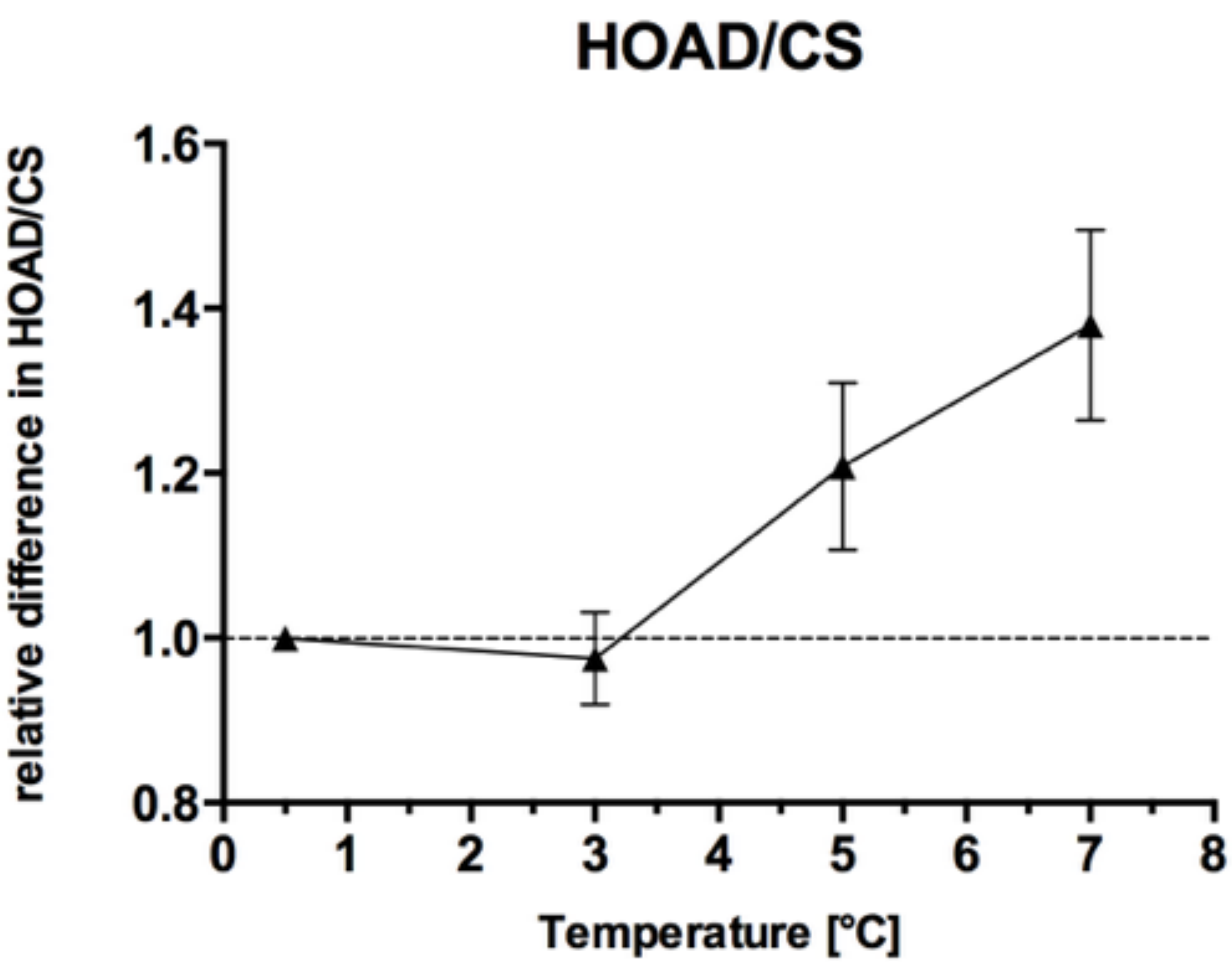
Lipid Catabolism

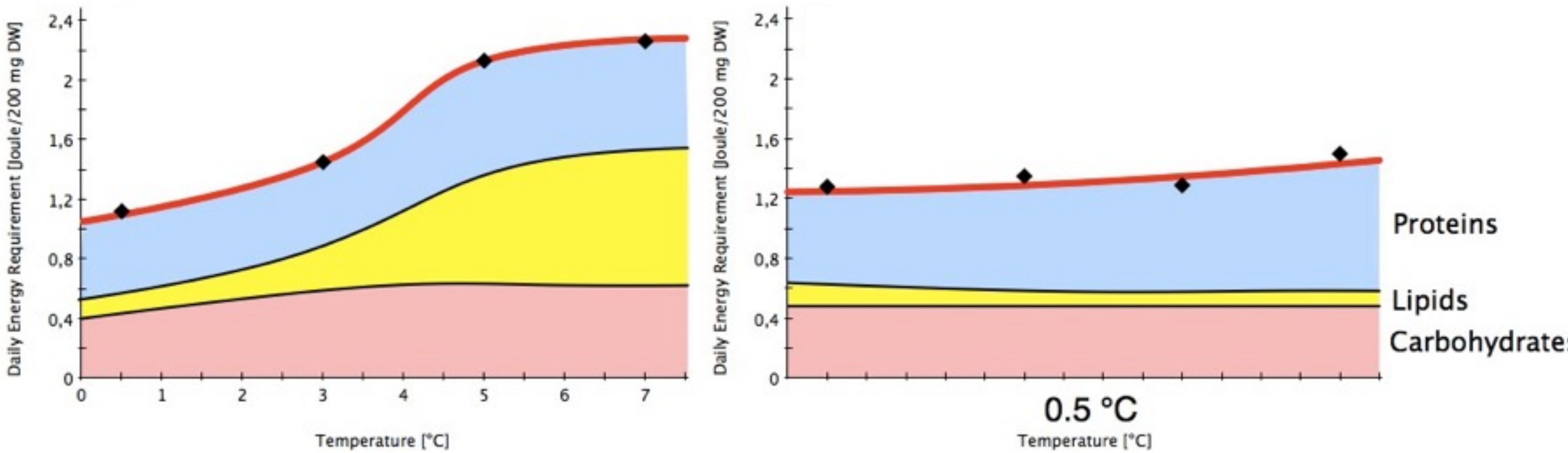
3-hydroxyacyl-CoA-DH ↑



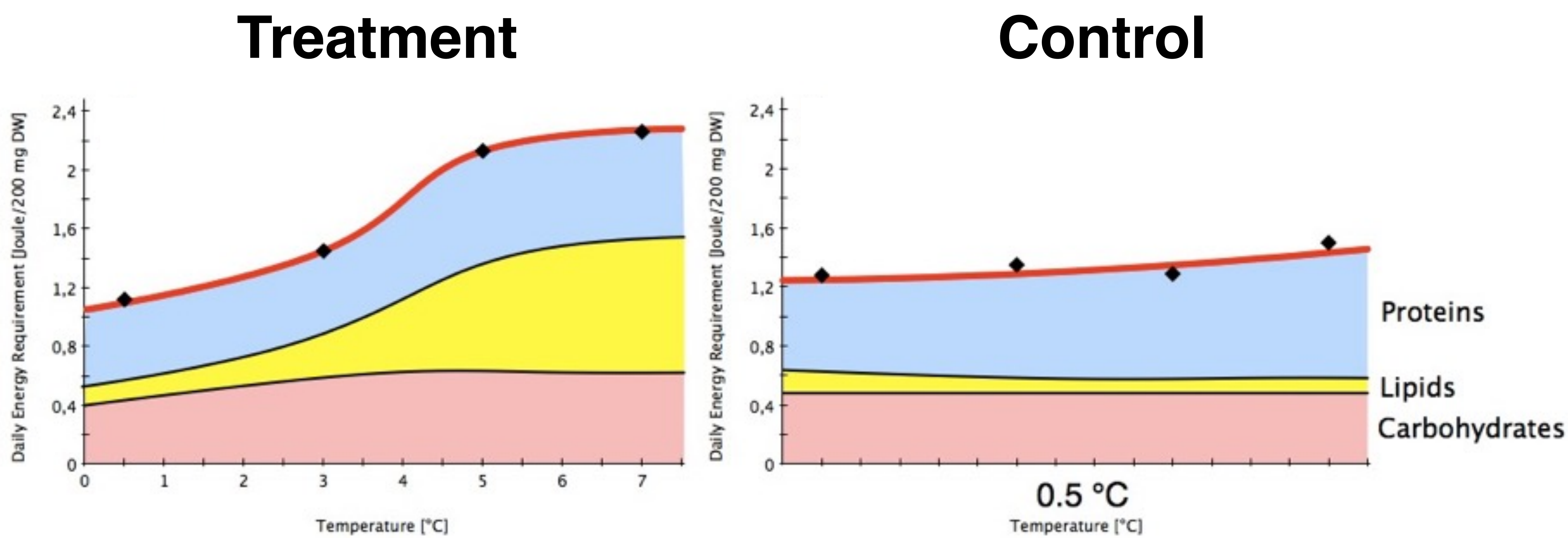
- increased oxidation of lipids

- normalization to CS as central crossing point in metabolism (*Windisch et al., 2011*)
- increase in ratio hints at **tendency towards lipid oxidation**, NOT lipid synthesis

Treatment Control

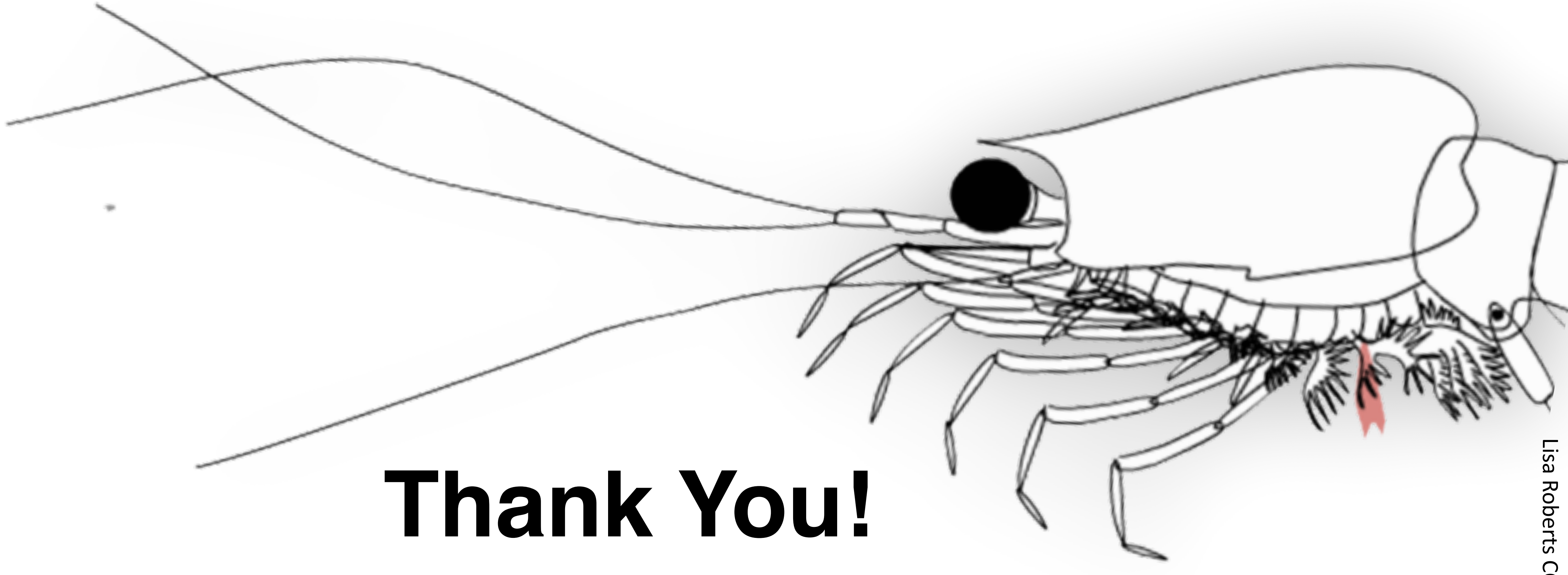


Energy may lack elsewhere, for example maturation



Energy may lack elsewhere, for example maturation

Krill relies on productive summer months to accumulate lipid reserves for winter - increased lipid oxidation may impede the build-up of these crucial reserves - overwinter-ability affected



Thank You!

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