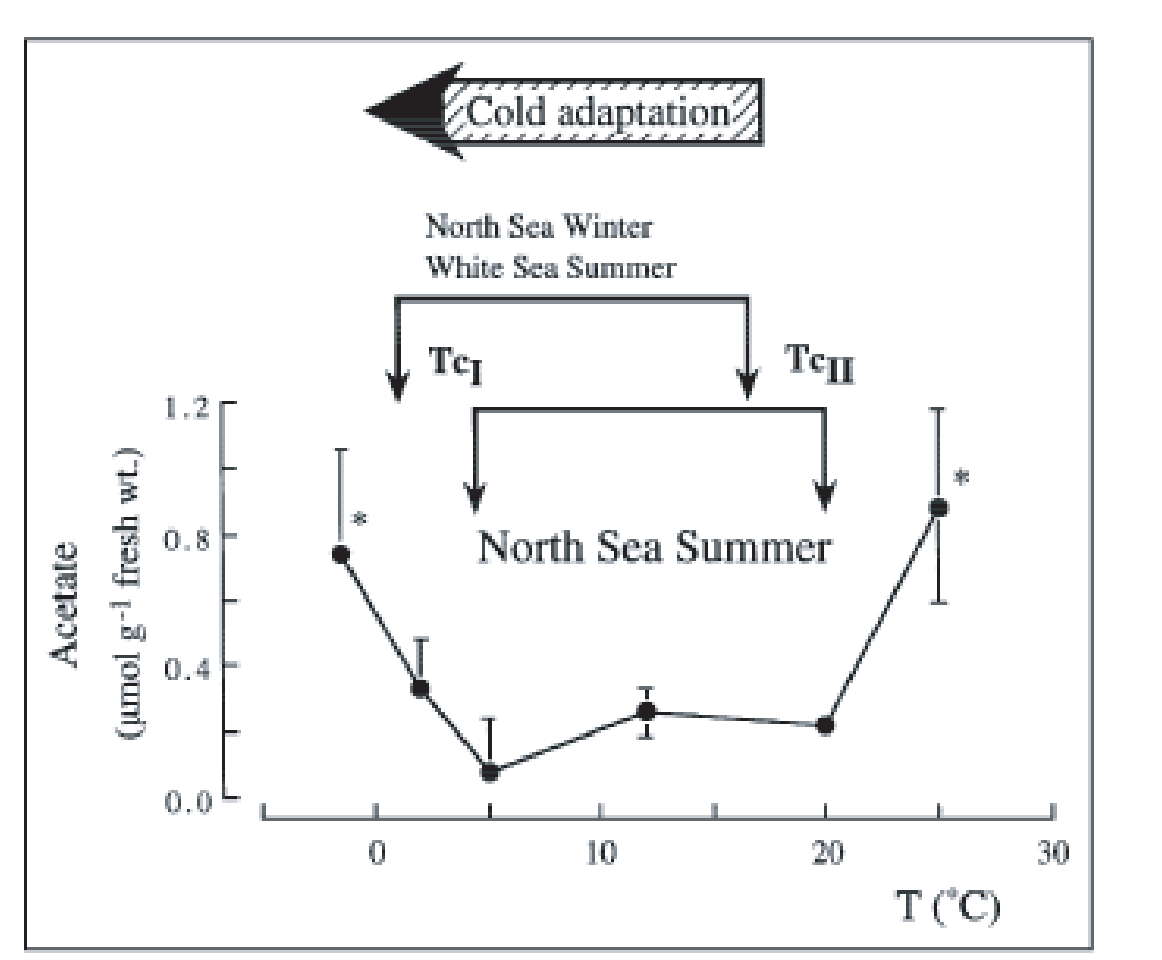


Mareike Schröer, H.-Ulrich Steeger*, Christian Bock, Rüdiger Paul*, Hans-O. Pörtner

Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven
*Institut für Zoophysologie der Westfälischen Wilhelms-Universität Münster

Questions:

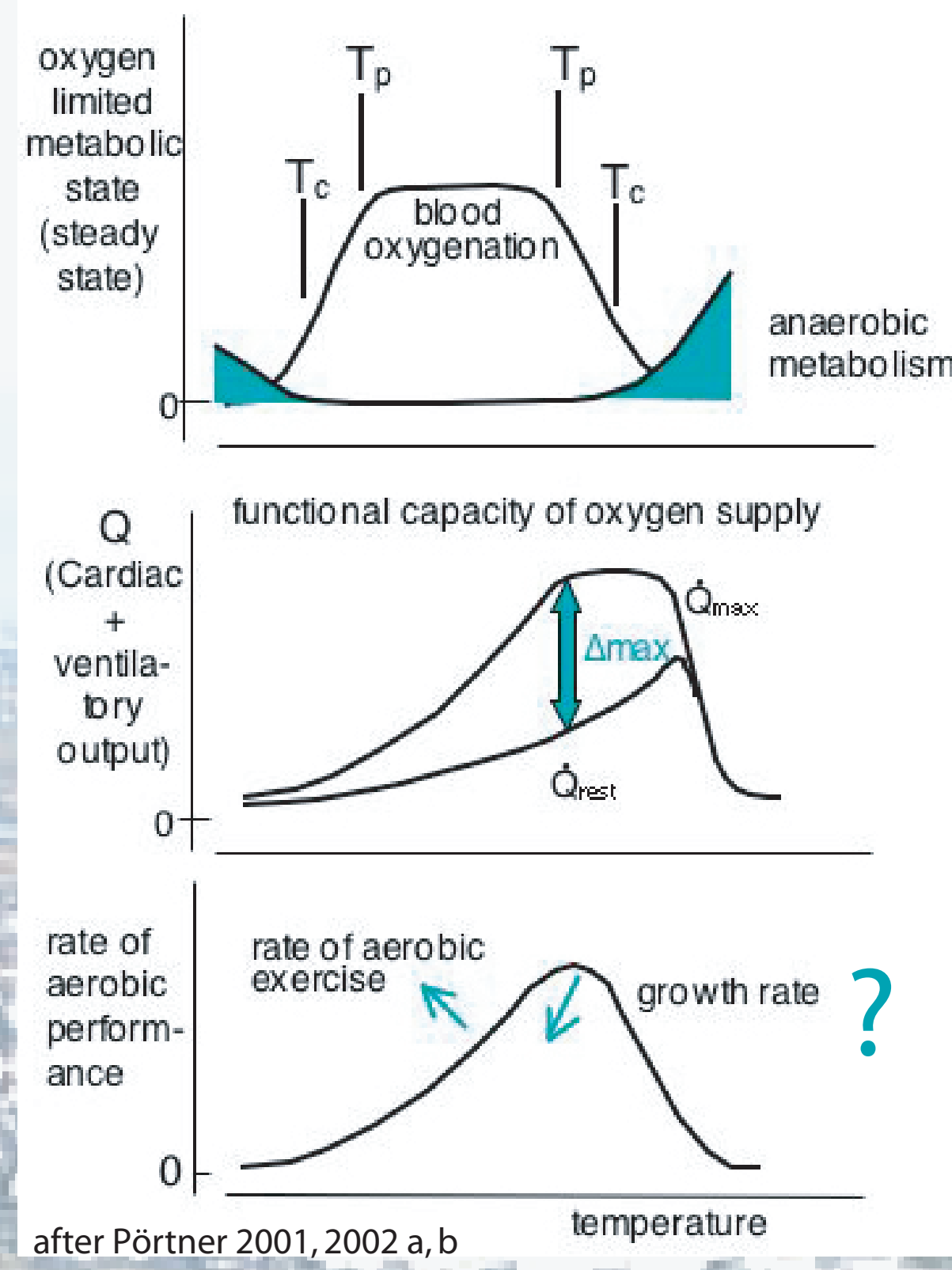
- What are the ecologically relevant temperature tolerance thresholds in *Arenicola marina*?
- Which physiological processes are influenced by temperature changes?
- What are the differences between cold and warm acclimatised animals of the same population?
- How do the temperature tolerance windows differ between populations from various latitudes?



from: Sommer et al. 1997, Sommer 2002
Shift of the temperature tolerance window with seasonal cold acclimatisation and latitudinal cold adaptation, critical temperatures defined by acetate accumulation in the tissue.



Arenicola marina beside the casting at the tailshaft and the funnel-shaped headshaft of its burrow.



after Pörtner 2001, 2002 a, b

The concept of oxygen limited thermal tolerance

Oxygen supply through ventilation and circulation reaches its limits at the pejus temperatures (T_p) leading to decreasing blood oxygenation. Above or below critical temperatures (T_c) metabolism turns anaerobic and allows survival only for a limited time.

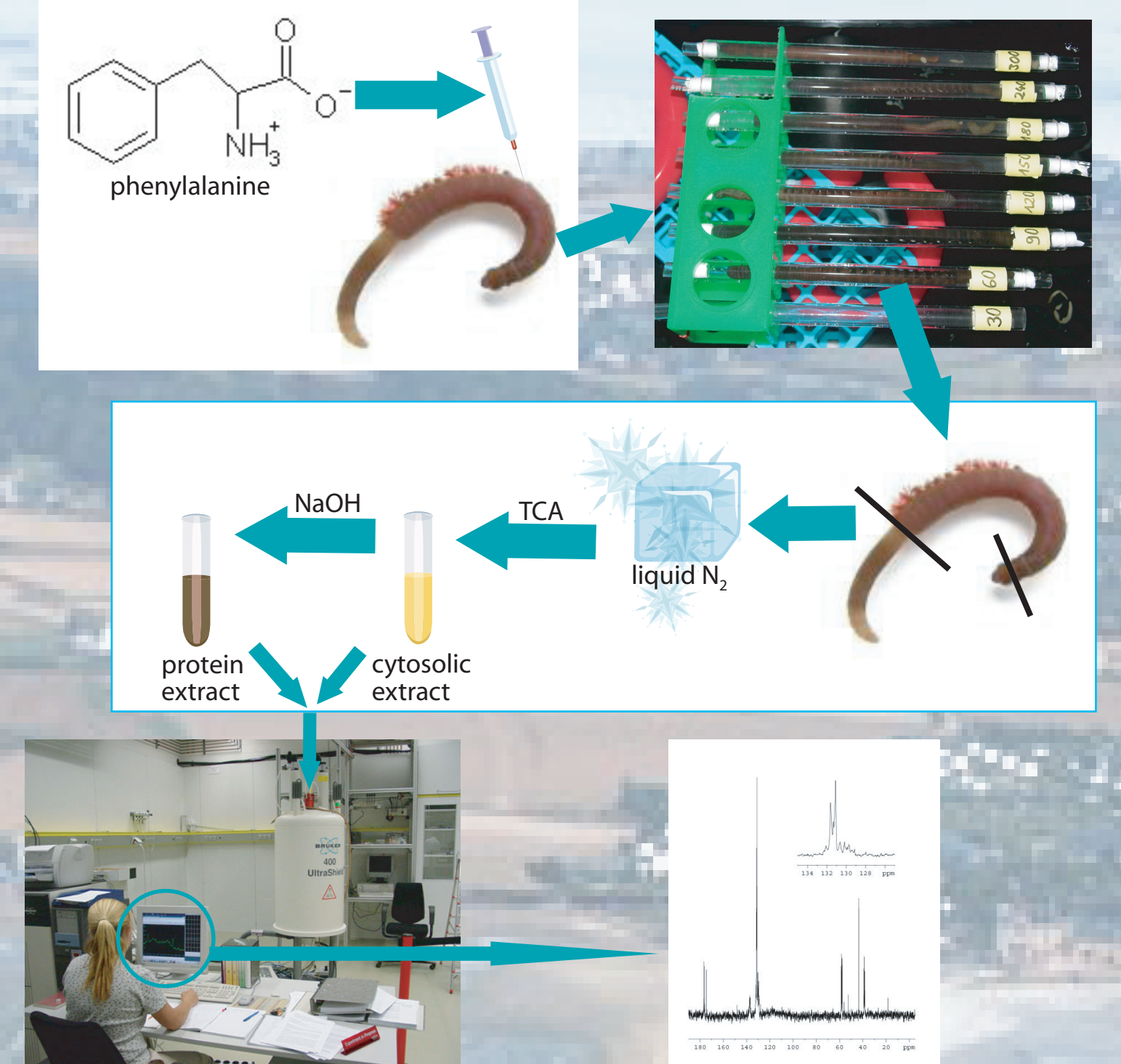
With increasing temperature the oxygen demand of resting metabolism rises covered by an increase in cardiac and ventilatory output. By subtracting oxygen demand from maximum ventilatory output an asymmetric performance curve results.

This residual oxygen supply budget with its maximum at the upper pejus temperature is spent in varying proportions for muscle activity, growth and reproduction. Towards the thresholds of the temperature tolerance window the rate of aerobic performance decreases and all functions except those essential for maintenance are reduced and consequently stopped.

Protein biosynthesis rate: a measure for growth performance

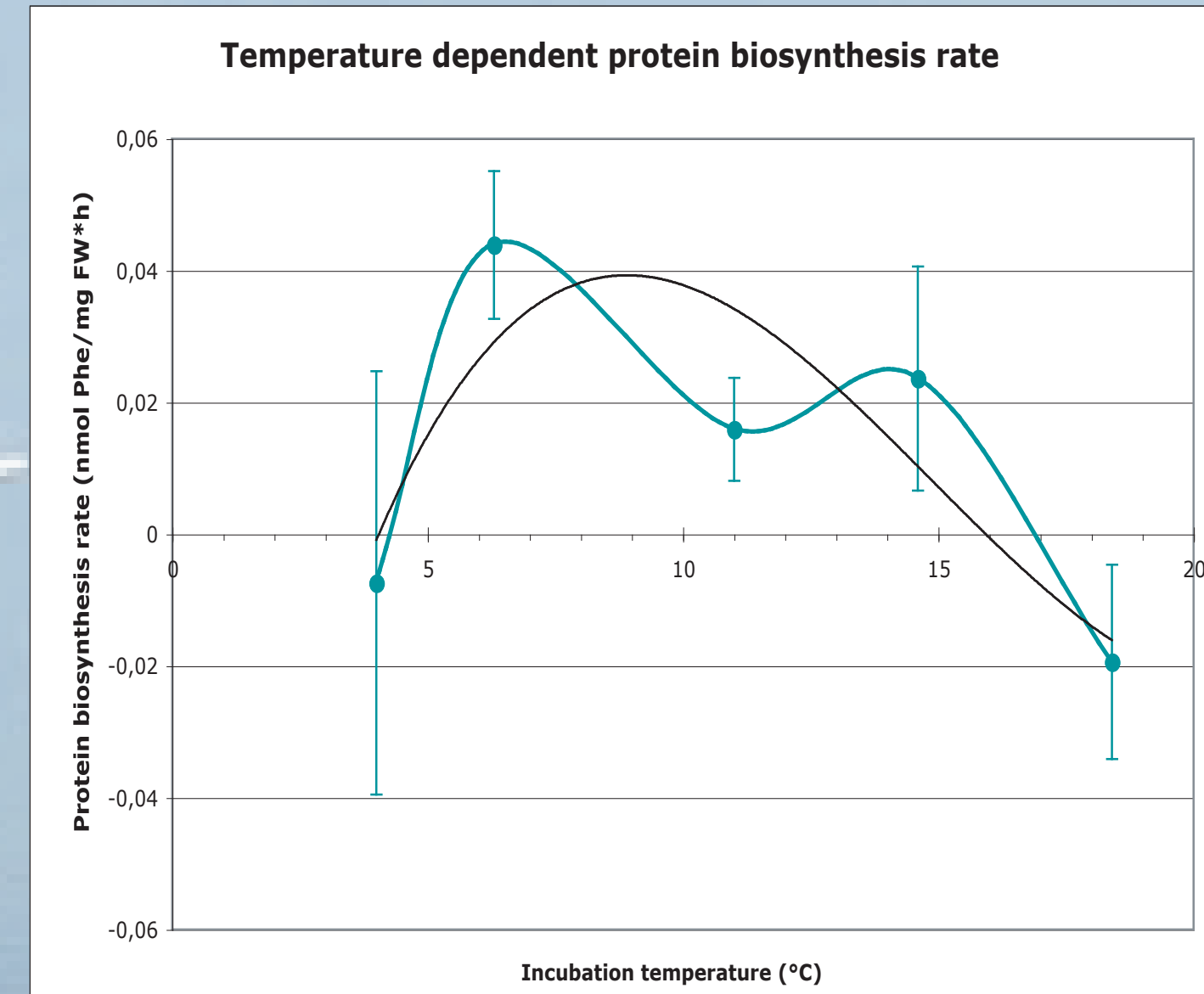
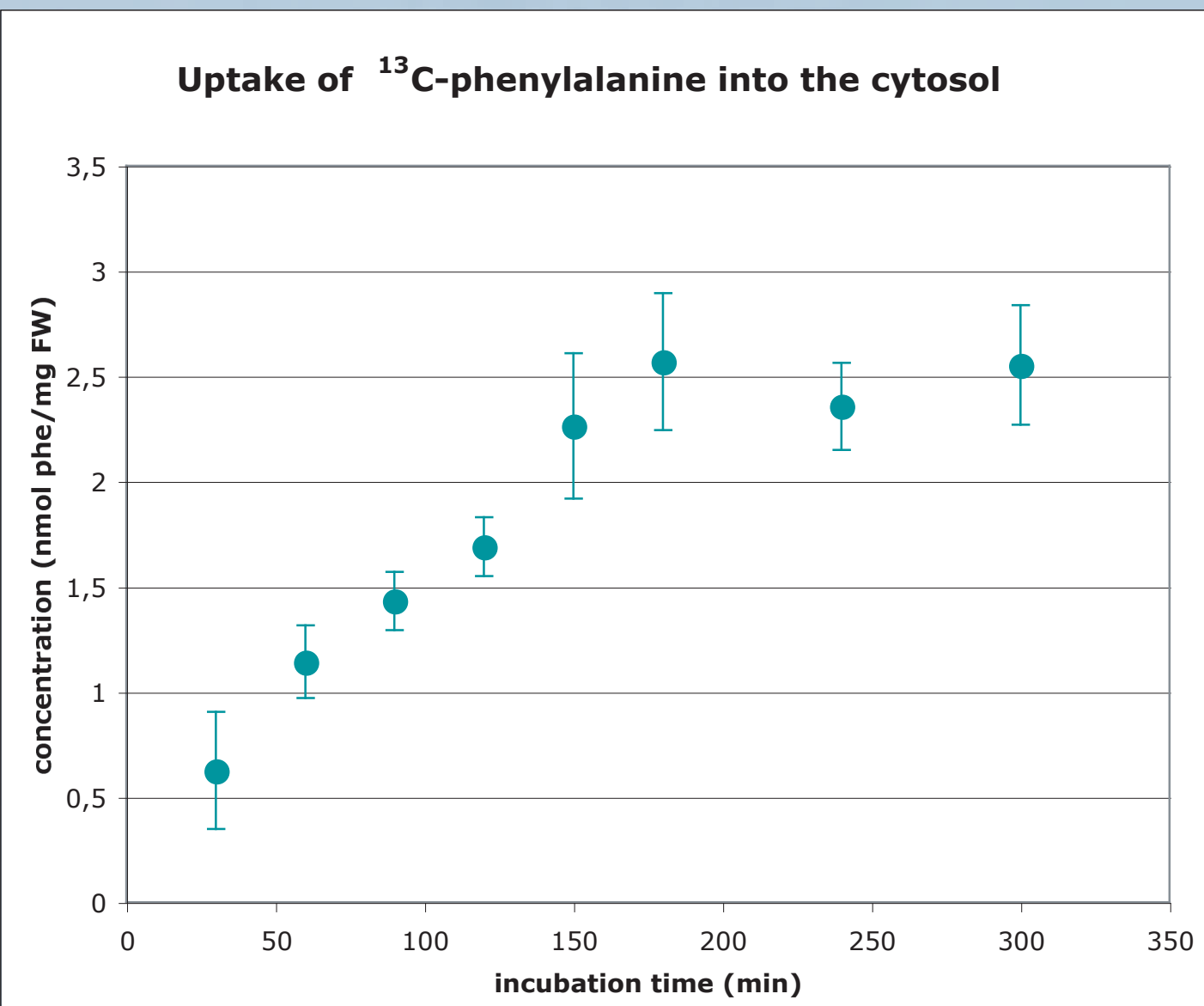
Protein biosynthesis is the most important cellular process which forms the basis of organismal growth.

Method: Uniformly ^{13}C -labeled phenylalanine is injected into the worm's coelomic cavity. From there it is taken up into the cytosol of the cells (especially those of the cuticulo-muscular tube) and incorporated in the proteins instead of ^{12}C -phenylalanine.



The incorporated ^{13}C -phenylalanine is visible in the NMR spectrum of the extracts. Integration of the peak areas of the peaks gives a measure for the newly synthesised protein.

First results



Protein biosynthesis rate in the cuticulo-muscular tube of *Arenicola marina*, animals collected at Saint Pol de Léon (Atlantic coast) early in march at 10°C, kept at 10°C, mean \pm standard error. At each temperature eight animals were incubated for different times. For each time three peaks of the NMR spectrum were evaluated. The slope of the curve corresponds to the mean protein biosynthesis rate at the respective temperature. At 4°C and at 18.4°C there is no net protein synthesis detectable.

Discussion

The maximum protein synthesis rate in cold-acclimatised (10°C) lugworms from Saint Pol de Léon was found as $0,29 \pm 0,07$ to $0,88 \pm 0,22$ nmol phe/mg protein*h, assuming a protein content of 5 to 15% in the cuticulo-muscular tube. For comparison the protein biosynthesis rate in the foot muscle of the Snail *Helix aspersa* was determined to be $0,32 \pm 0,07$ nmol phe/mg protein*h, in a comparable order of magnitude.

The curve shows an asymmetric shape. The aerobic energy spent for growth reaches a maximum at 6-7°C and decreases steeply towards colder temperatures whereas it diminishes more slowly towards warmer incubation temperatures. Below 4°C and above 18°C the critical temperature range seems to be reached and growth performance is suspended.

Compared to the theoretical performance curve, the maximum is shifted to the left. The metabolic background of the growth optimum remains to be investigated. A hypothesis suggests an antagonistic behaviour of growth and resting metabolism performance.

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^{13}C -phenylalanine concentration in the cytosol during the incubation time at 6,3°C, values from eight animals, mean \pm standard error of three peaks evaluated. A saturation of the intra-cellular phenylalanine pool is reached 150 to 180 min after the injection of the flooding dose into the coelomic cavity. The normal value for free phenylalanine in the cells of the cuticulo-muscular tube amounts to $0,12 \pm 0,01$ μ mol/g FW (B. Siegmund 1982, diploma thesis). The concentration exceeds the normal value more than fivefold already after 30 min such that protein biosynthesis is not substrate limited.

Arenicola marina, collected early in march 2005:
fresh weight $6,22 \pm 1,62$ g
water temperature 11°C

Saint Pol de Léon

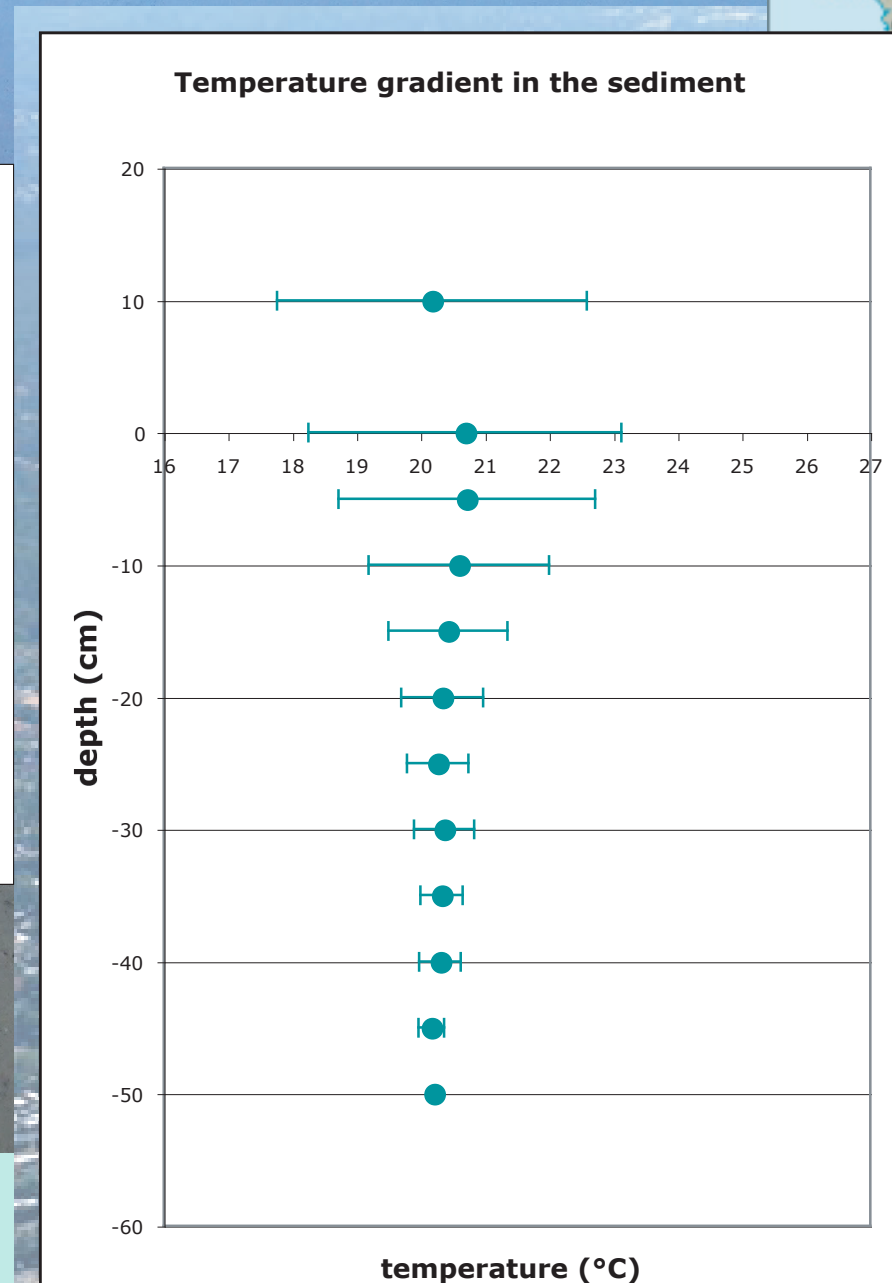


Kartesh ?
(expedition planned)

Arenicola marina

	abundance (n/m ²)	fresh weight (g)
July 2004	13,77 \pm 3,48	6,57 \pm 1,65
April 2005	14,88 \pm 7,10	6,90 \pm 1,94
July 2005	12,89 \pm 5,17	

Carolinensiel



Arenicola marina, collected end of august 2005:
abundance 22,67 /m²
fresh weight 4,13 \pm 1,40 g
length 6,68 \pm 1,28 cm

Abiotic conditions at the time of animal collection:
surface water
pH 8,45 \pm 0,46
salinity 35,79 \pm 1,16‰

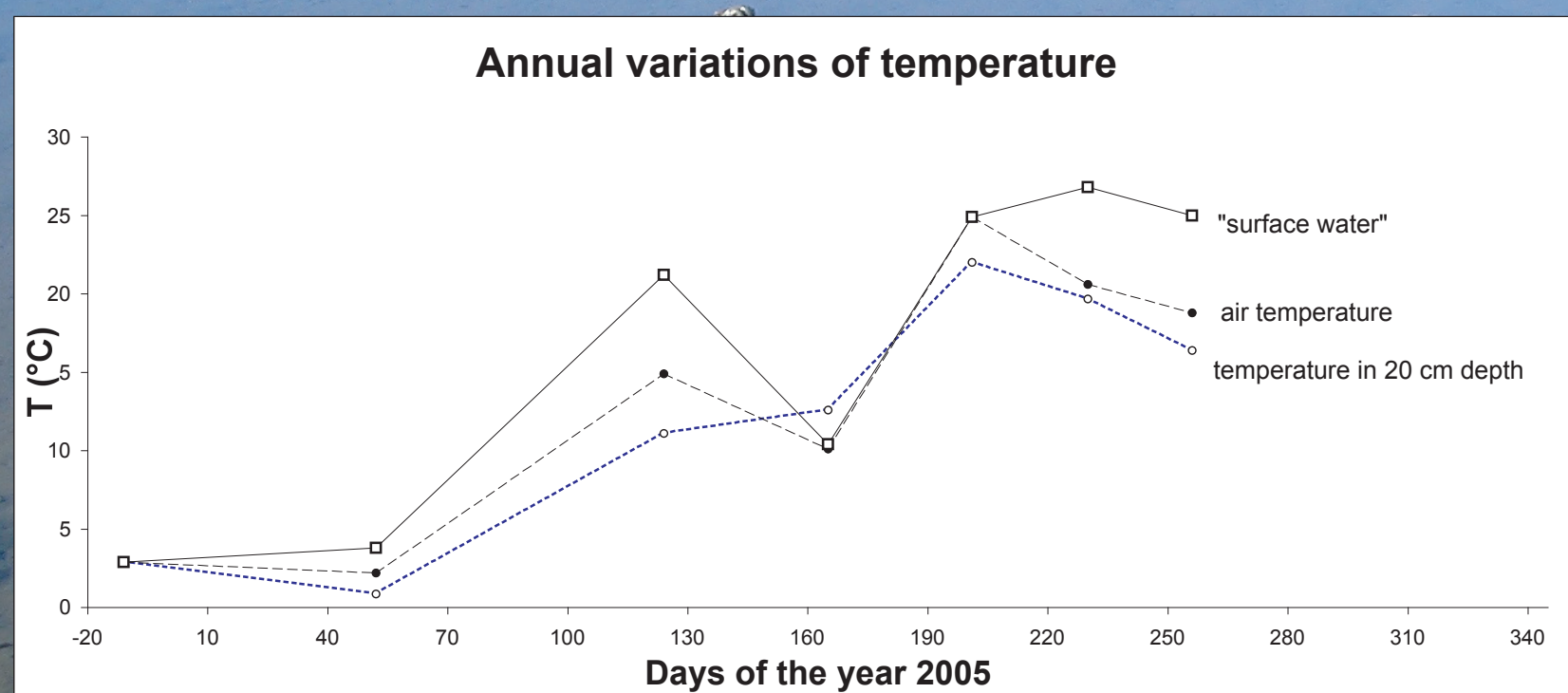
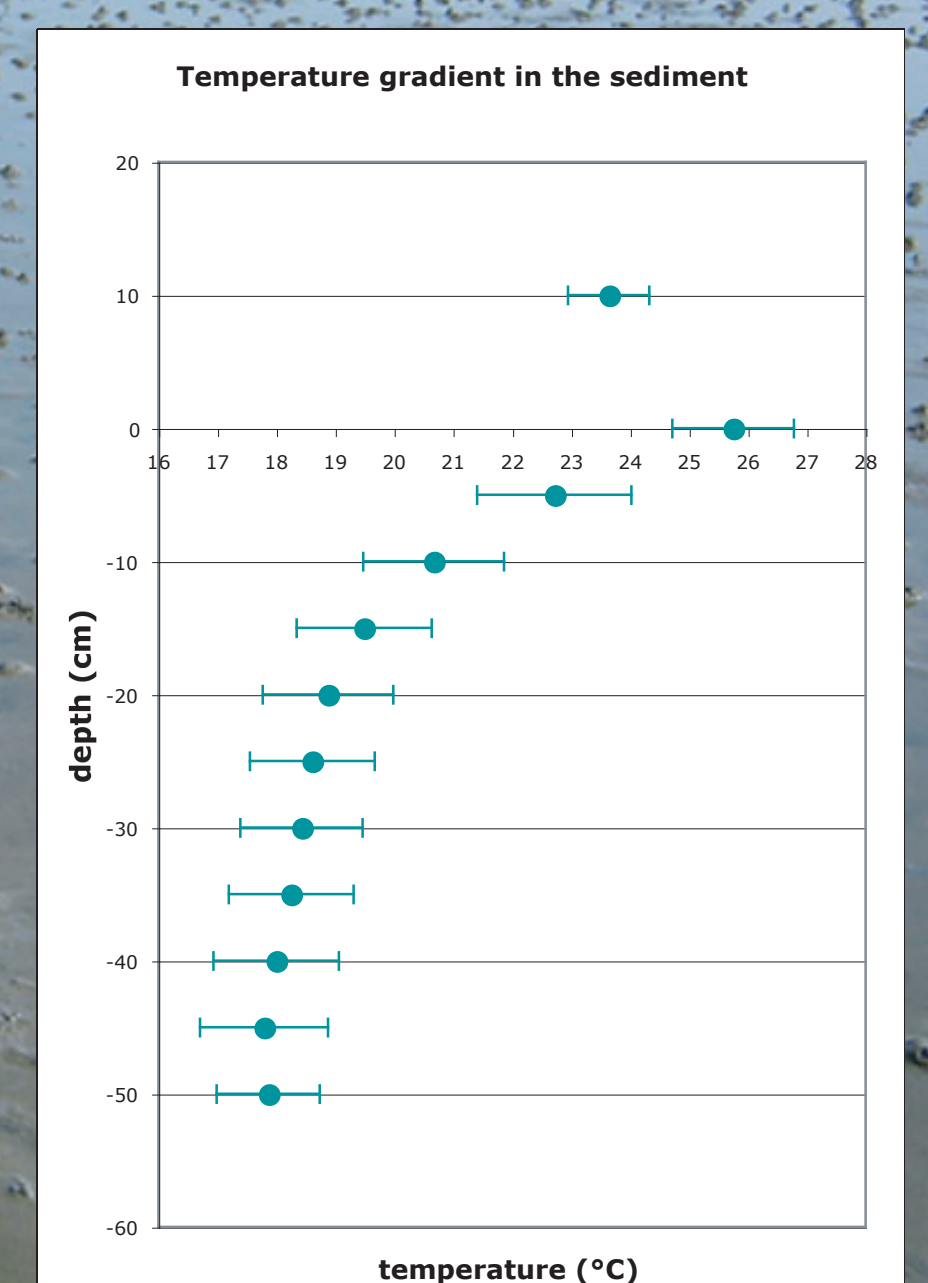
La Hume



Dorum-Neufeld

Arenicola marina, collected early in september 2005:
abundance 18 \pm 3,7 /m²
fresh weight 6,3 \pm 1,0 g
length 8,2 \pm 0,8 cm
depth of burrow 18,3 \pm 3,7 cm

Abiotic conditions at the time of animal collection:
surface water
pH 8,88 \pm 0,03
salinity 27,36 \pm 0,16‰



water salinity: 30-31 ‰