Dynamics of lipid storage in marine copepods

and its consequences for effects of oil pollution

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DEBtox Research

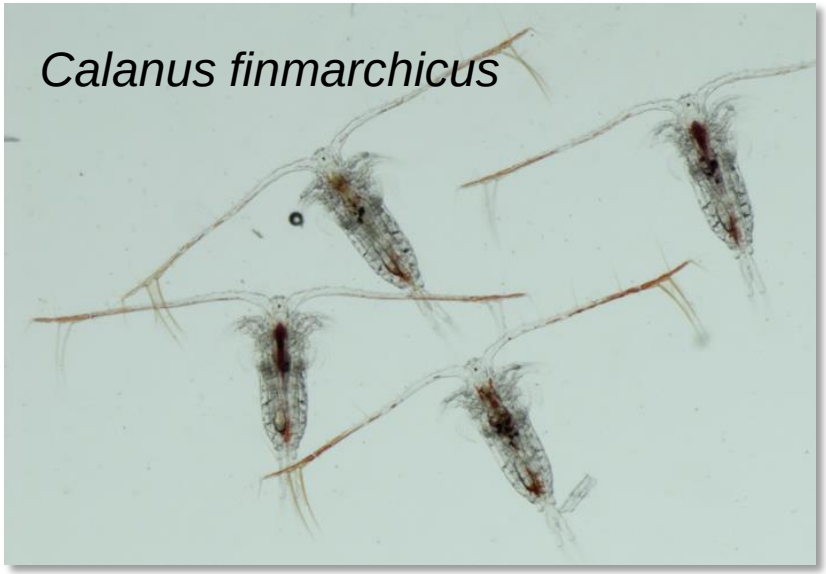
SINTEF

DEB symposium, May/June 2017

Context

EnergyBar project (RCN-funded)

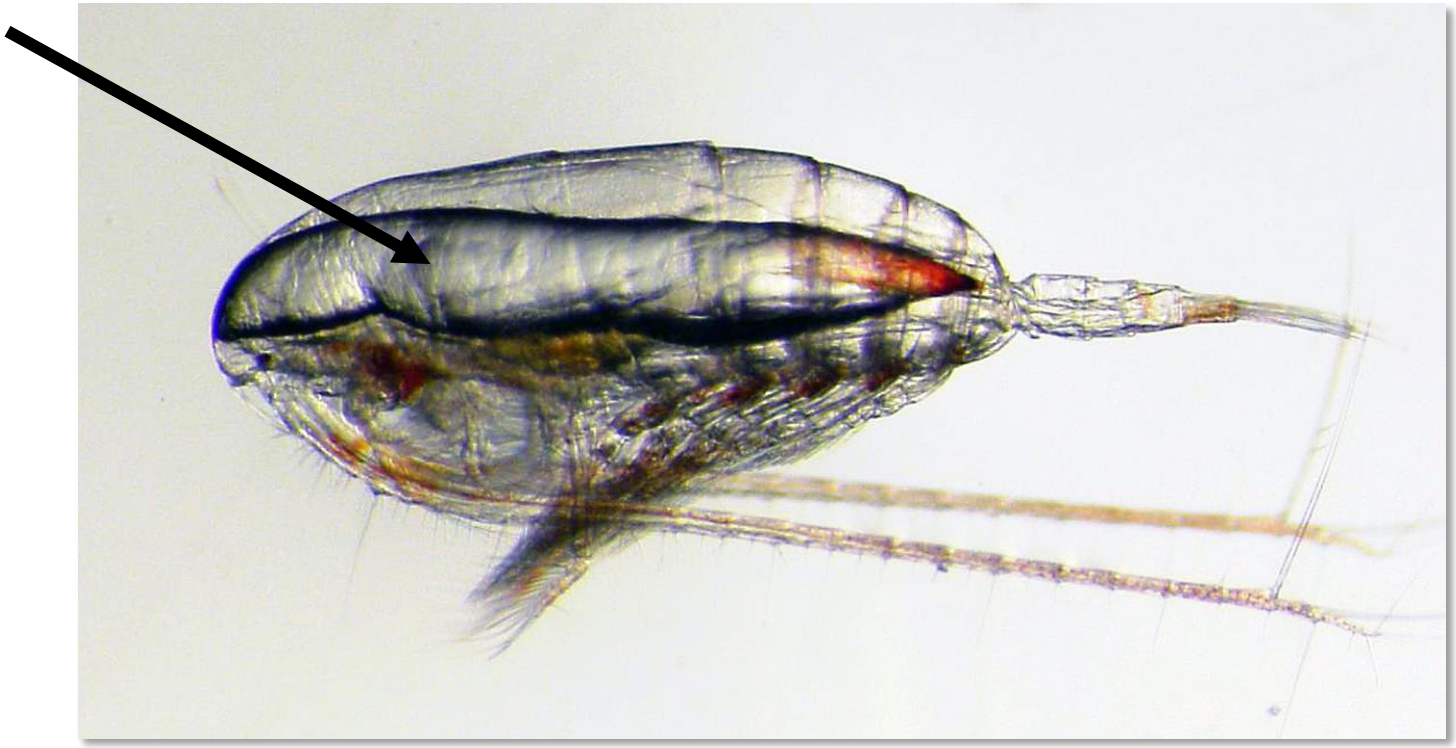
- Effects of produced water on copepods
- Tools for ERA offshore petroleum activities



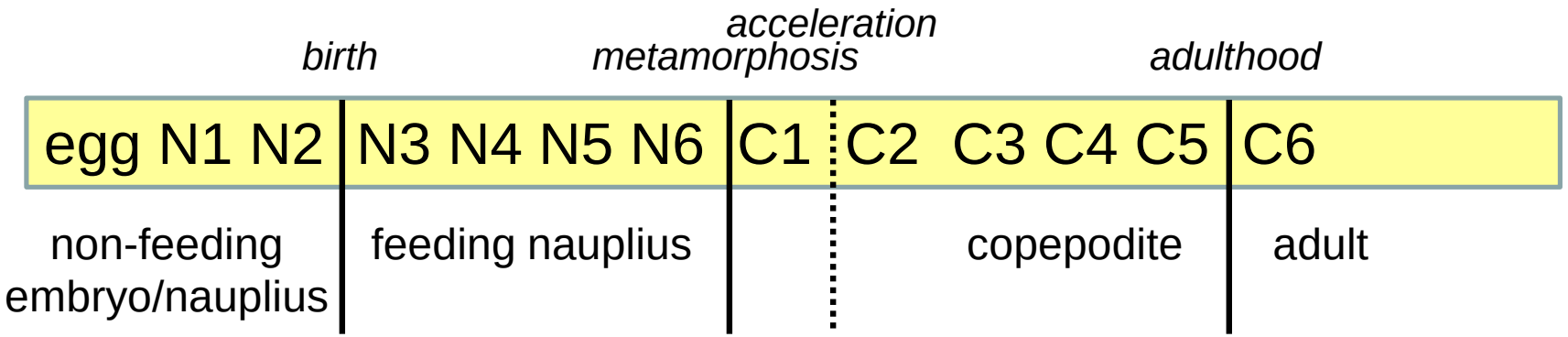
Context

Focus on lipid storage

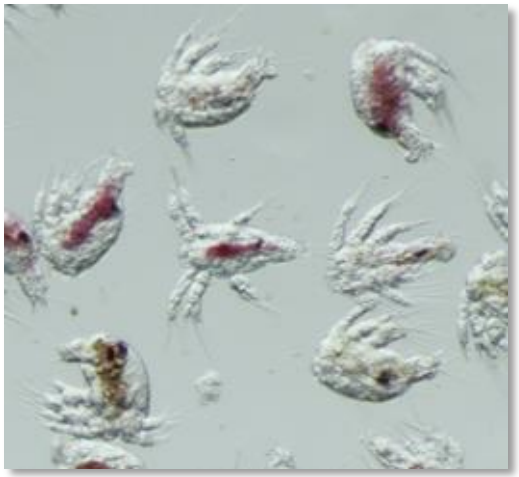
- Capture its dynamics in a DEB context?
- Effects on accumulation/toxicity of chemicals?



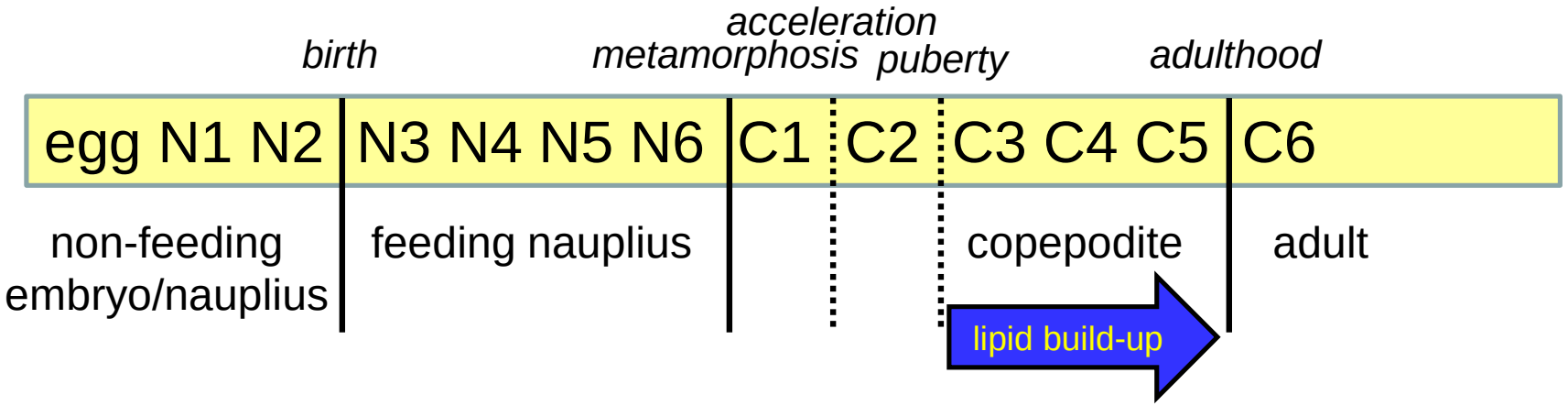
Calanus life cycle



- Acceleration of growth after metamorphosis
- Abrupt stop of growth after final moult

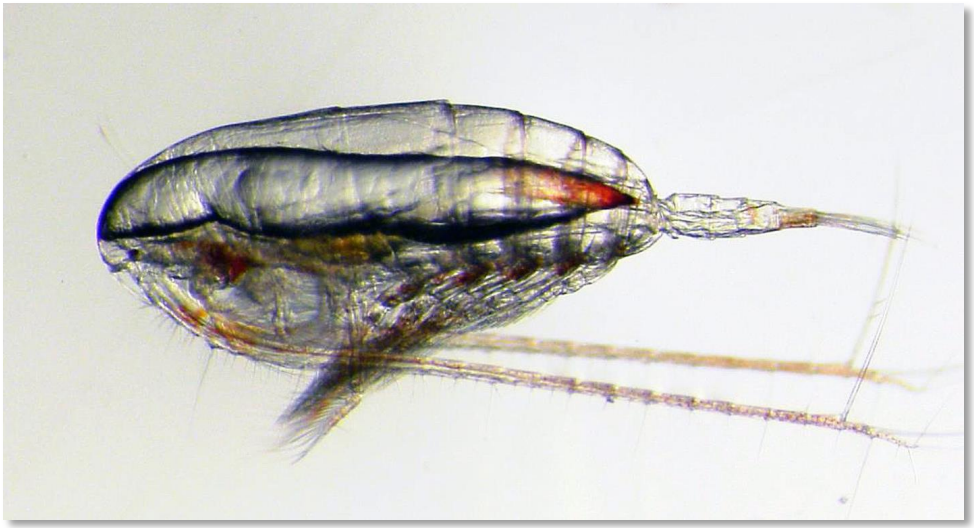


Calanus life cycle

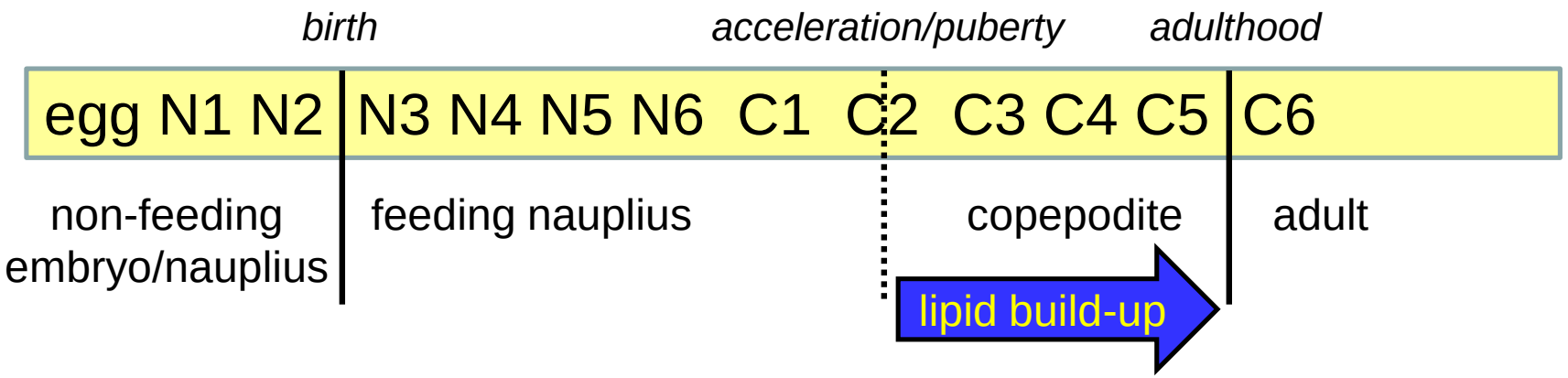


- Lipids clearly visible from C3 onwards:
  - increases over C3-C5
  - decrease in adults

treat as
'reproduction buffer'



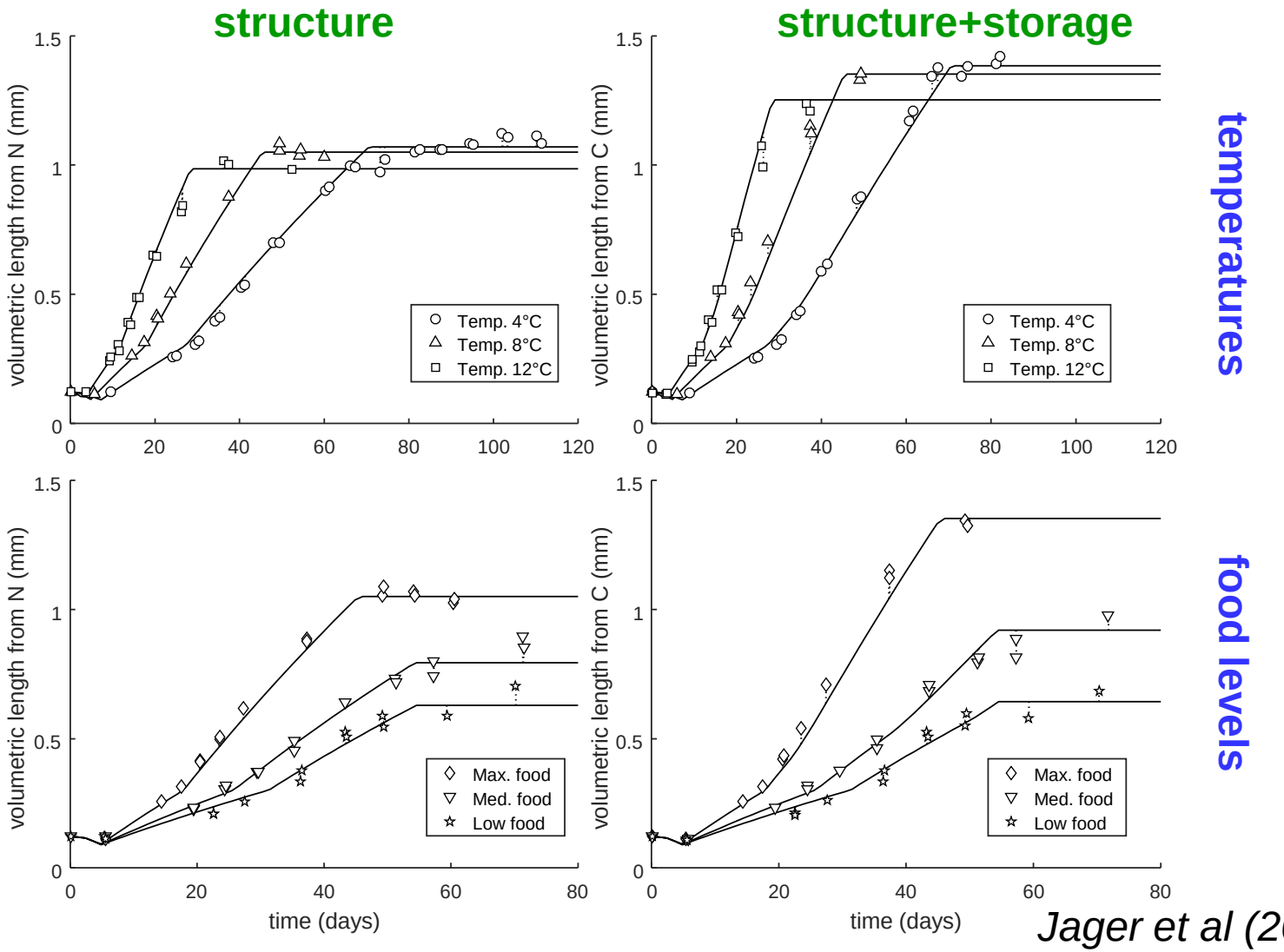
Calanus life cycle



- Model design:
  - use one switch for acceleration and puberty
  - depart from reserveless model (‘DEBkiss’)
  - treat lipid storage as reproduction buffer
  - different scheme for adults (no kappa rule)
  - stop growth at size limit

Jager et al (2017), Mar Biol

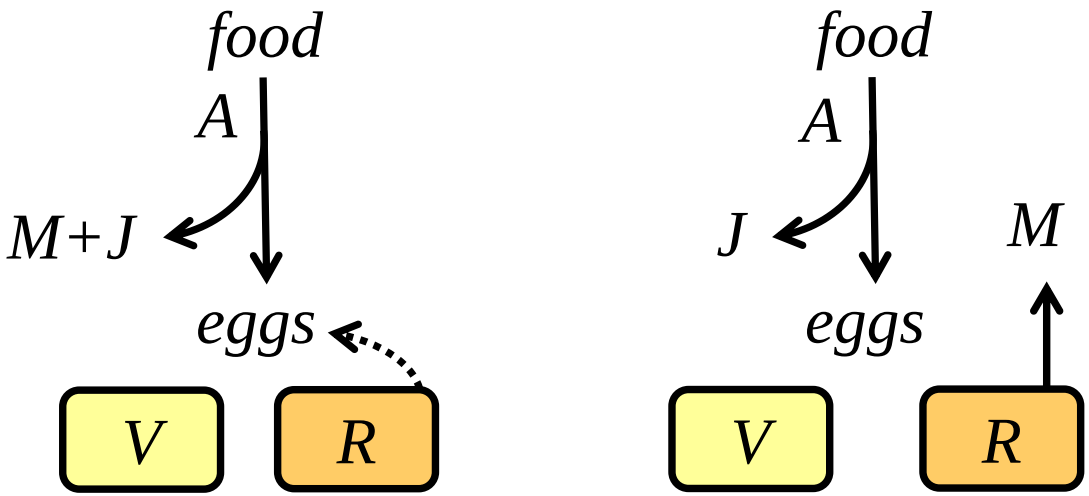
Model fit (data Campbell et al, 2001)



Jager et al (2017), Mar Biol

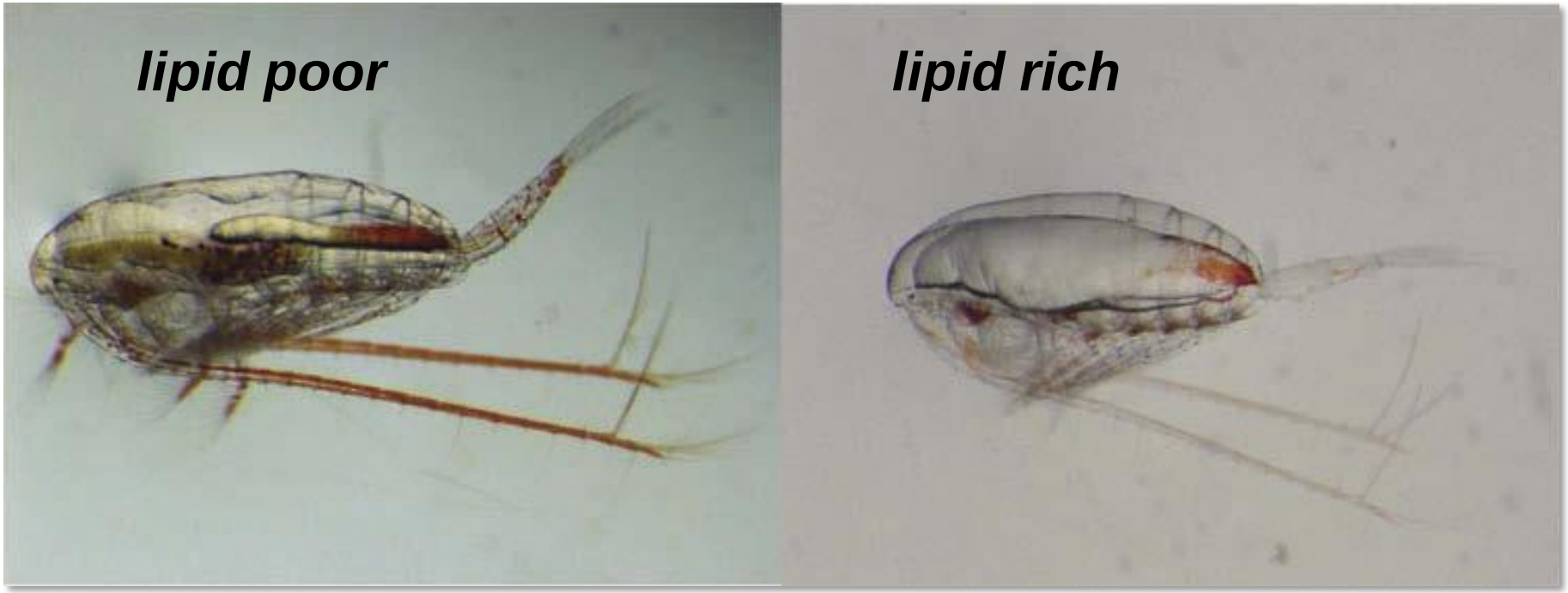
We're not there yet …

- Open issues:
  - maintenance estimated from respiration
  - effect temperature/food on final size descriptive
  - high maturity maintenance to capture food limitation
  - energetics of gonad maturation requires attention
  - rules for allocation to eggs unclear



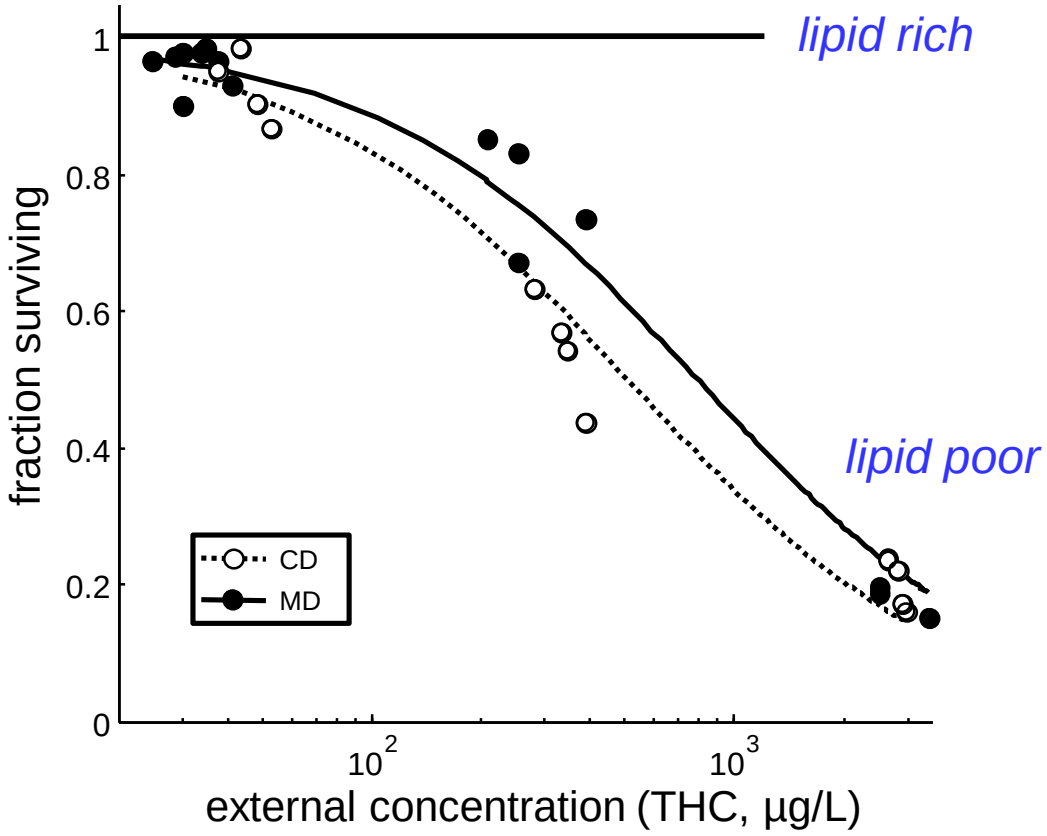
Lipids and toxicants

- Hydrophobic chemicals high affinity for wax esters
- Effect lipid on uptake/elimination and toxicity?
  - focus on survival (GUTS-SD or DEBtox-survival)



Lipids and toxicants

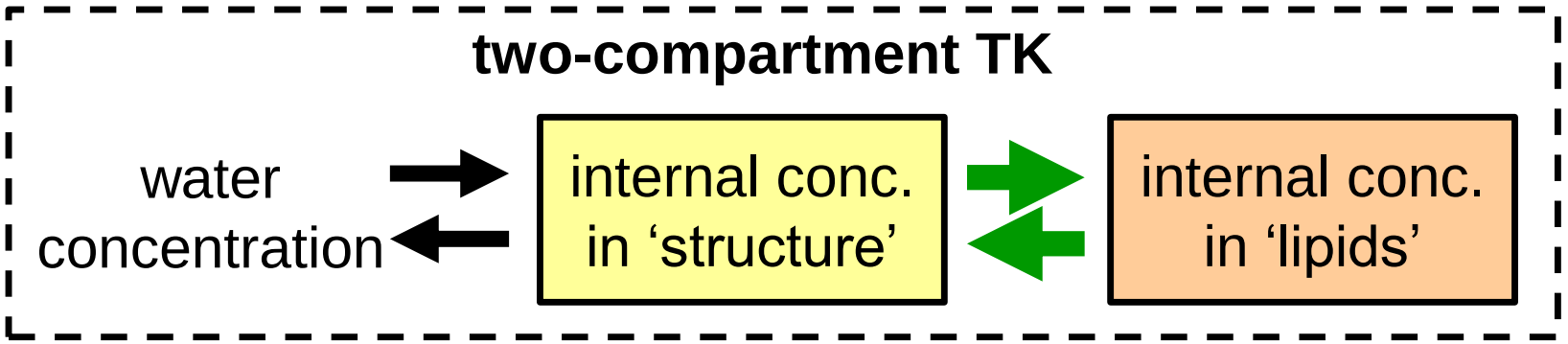
- Can lipids explain differences between experiments?



Hansen et al (2016), JTEH

Lipids and toxicants

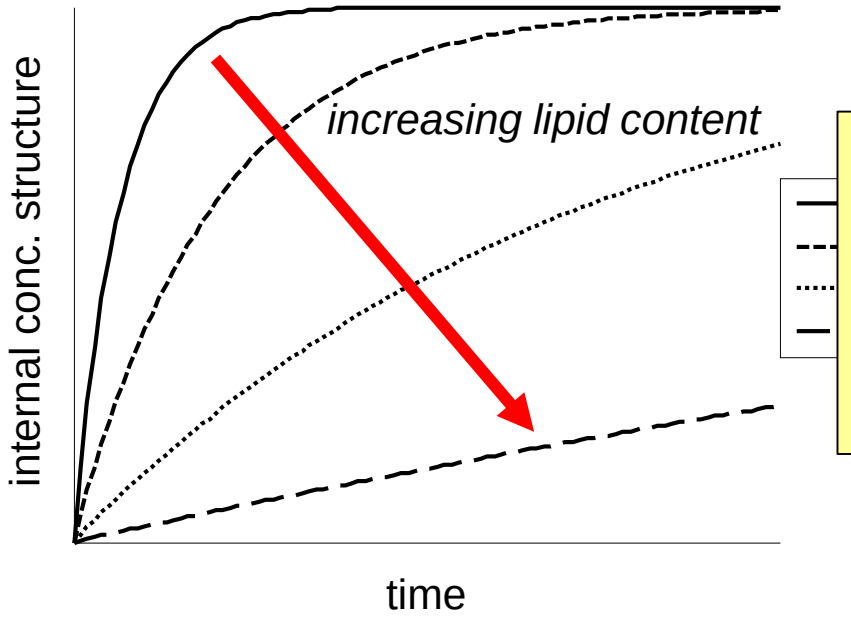
- Can lipids explain differences between experiments?
- 'Survival of the fattest' (Lassiter & Hallam, 1990):
  - two compartments to represent individual
  - assume fast internal redistribution



Hansen et al (2016), JTEH

Lipids and toxicants

- Can lipids explain differences between experiments?
- 'Survival of the fattest' (Lassiter & Hallam, 1990):
  - two compartments to represent individual
  - assume fast internal redistribution
  - fatter individuals take longer to reach steady state



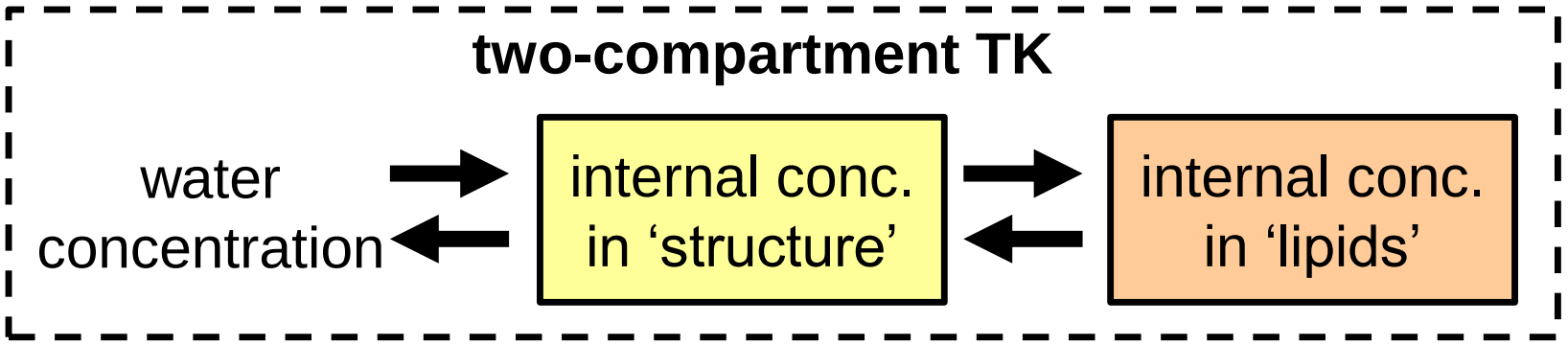
however, in this case …

- *insufficient difference in lipid content*
- *no shift in lipid content survivors over treatments*

Hansen et al (2016), JTEH

Case: dimethylnaphthalene

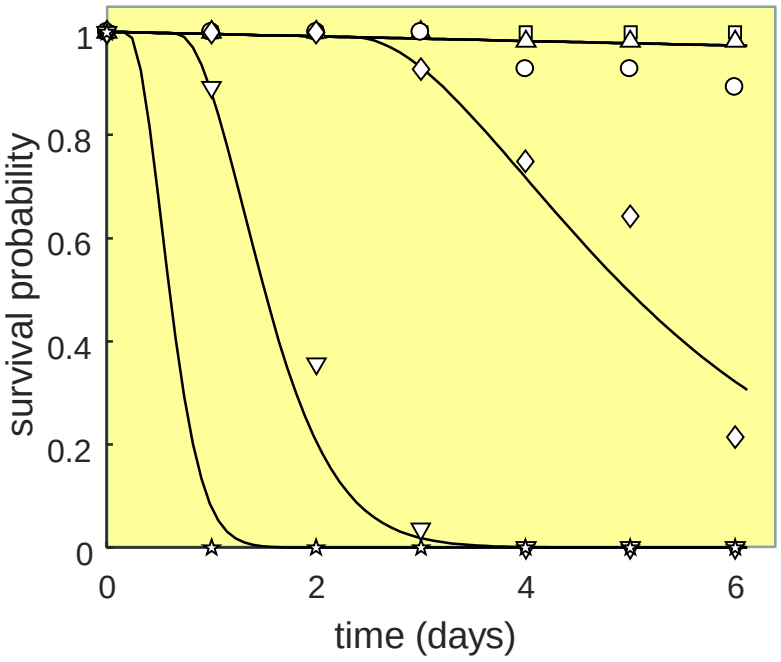
- Survival and body residues over time
  - do *not* assume that lipids are fast
  - mortality linked to concentration in ‘structure’

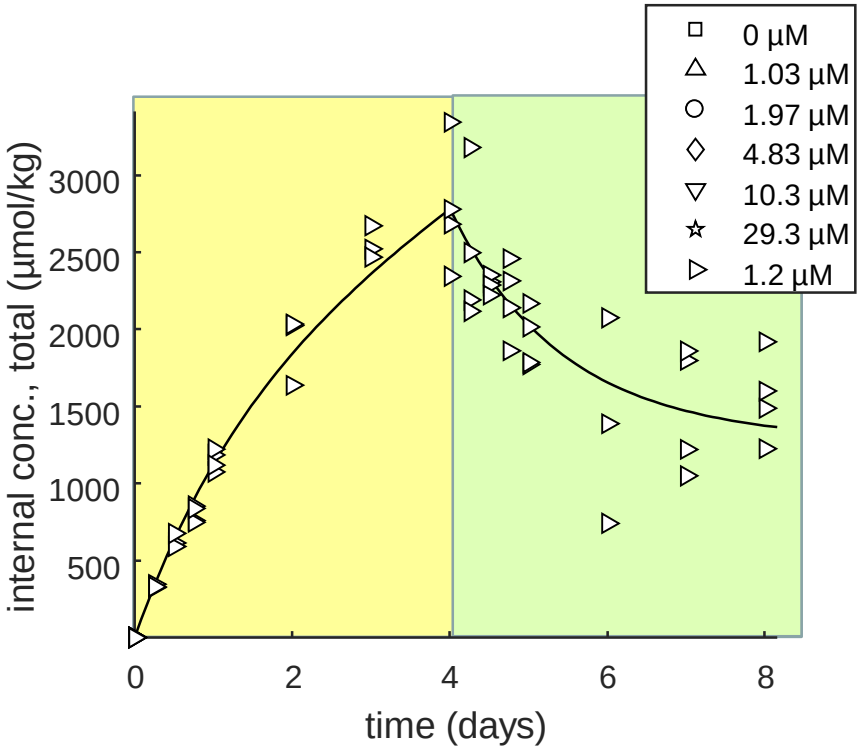


*submitted: Jager **et al** …*

Case: dimethylnaphthalene

- Survival and body residues over time
  - do *not* assume that lipids are fast
  - mortality linked to concentration in ‘structure’
  - lipids are very *slow* …

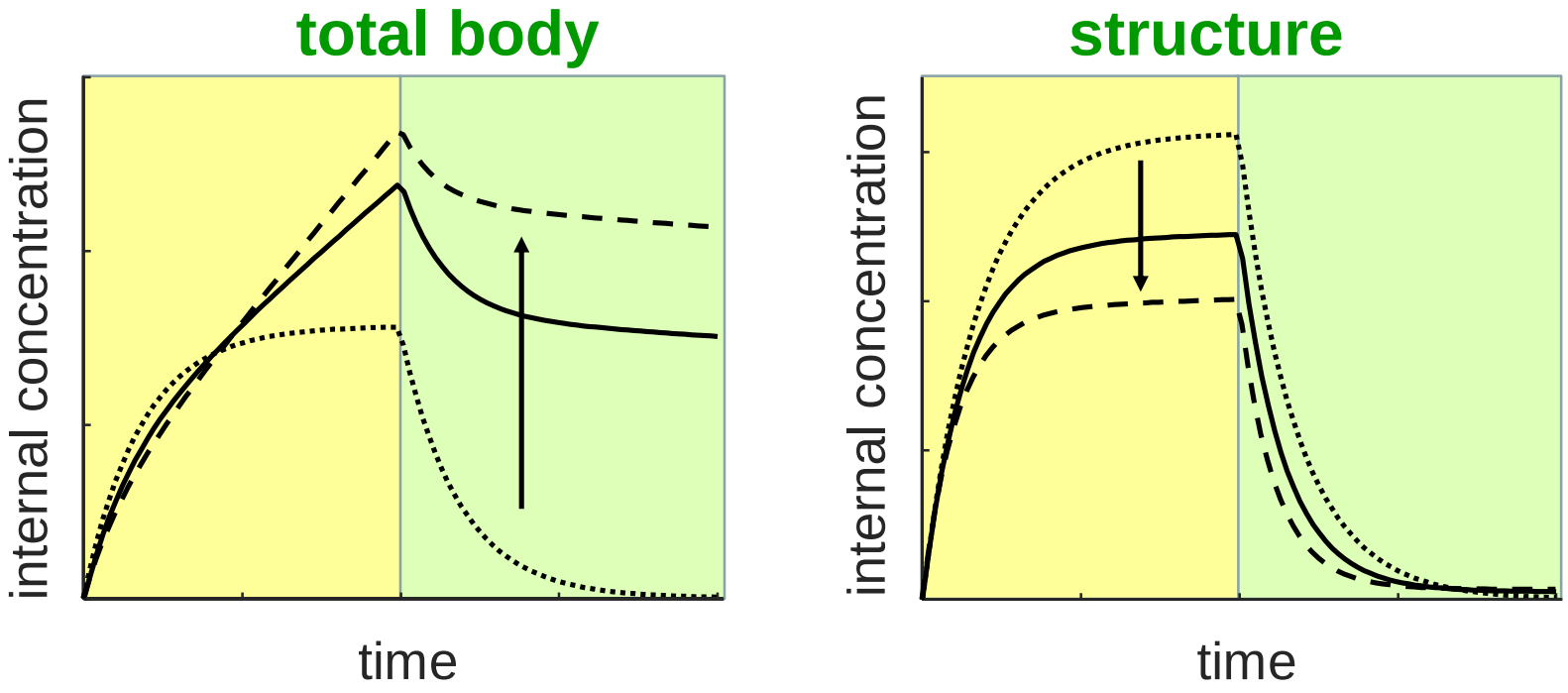




submitted: Jager et al …

Case: dimethylnaphthalene

- Simulate effect of different lipid content

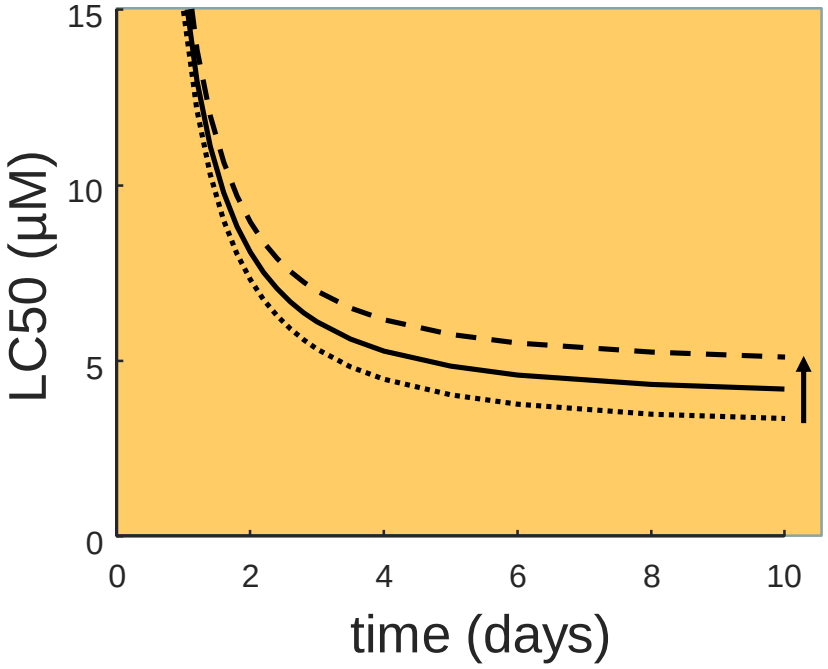


submitted: Jager et al …

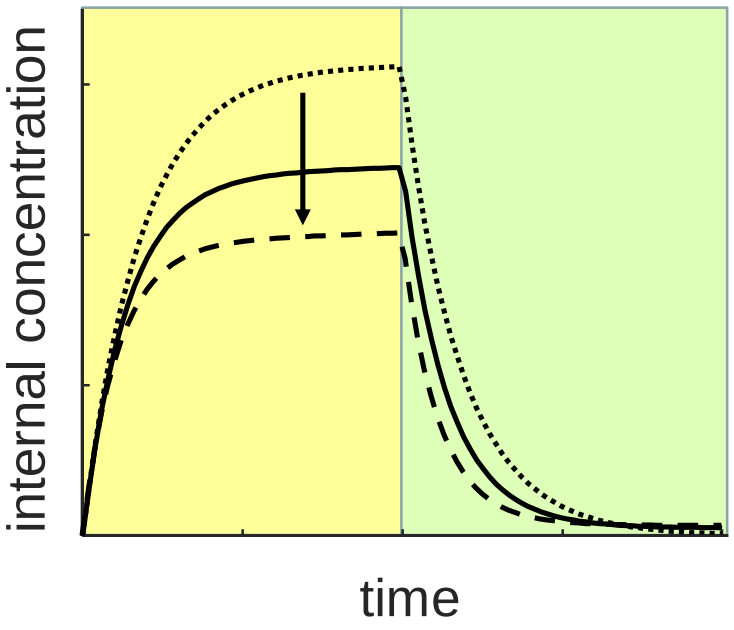
Case: dimethylnaphthalene

- Simulate effect of different lipid content
- Limited effect on toxicity

toxicity



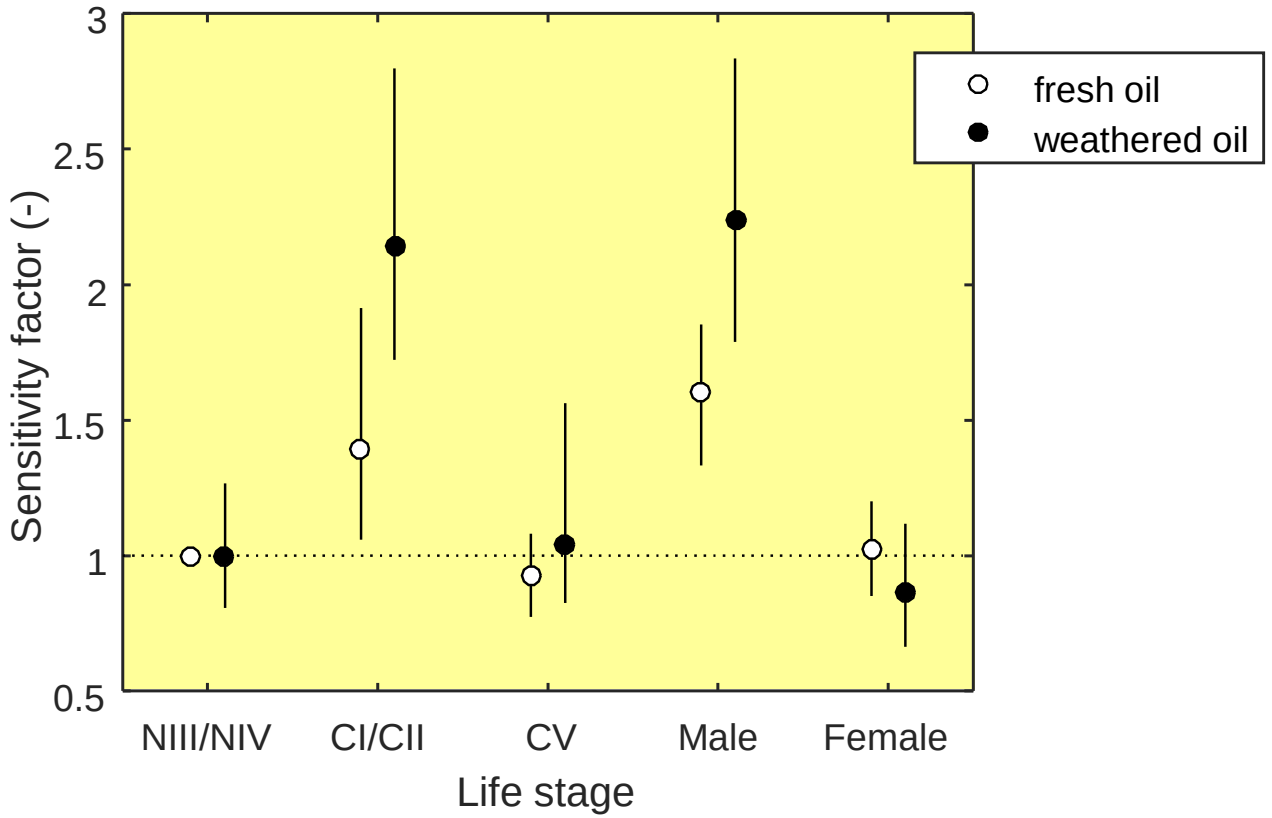
structure



submitted: Jager et al …

Difference toxicity life stages

- No effect lipid content … but several stages differ …



Jager et al (2016) ETC

Conclusions

- Lipids play important role in life cycle and toxicity
  - lipid storage functions like ‘repro buffer’
  - lipids affect toxicokinetics, limited effect on toxicity
  - differences in sensitivity not explained by lipids …
  - maternal transfer and secondary poisoning?
- Mechanistic models increase understanding
  - first version of DEBkiss *Calanus* model
  - GUTS-SD works well for survival data
- Predictive tools for the field situation?

Funding

EnergyBar 225314/E40

The Research Council of Norway

Project output:

www.debtox.nl/projects/project_energybar.html

More information

on DEBtox/GUTS: ***www.debtox.info***

summercourse dynamic modelling of toxic effects, August 2018 (DK)

International Network of Expertise on Dynamic Energy Budgets

DEBnet