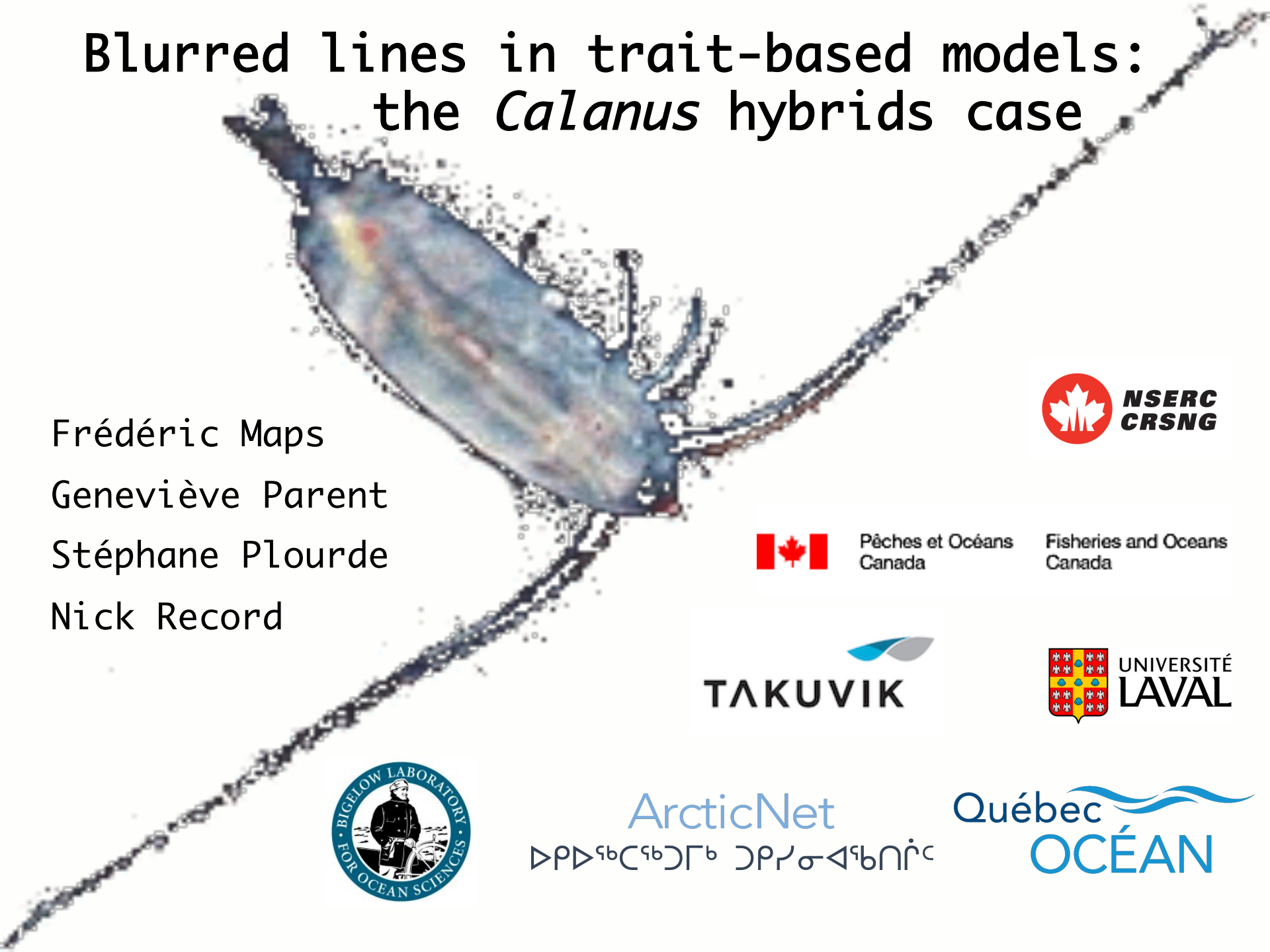
Blurred lines in trait-based models: the *Calanus* hybrids case



Frédéric Maps

Geneviève Parent

Stéphane Plourde

Nick Record

NSERC CRSNG

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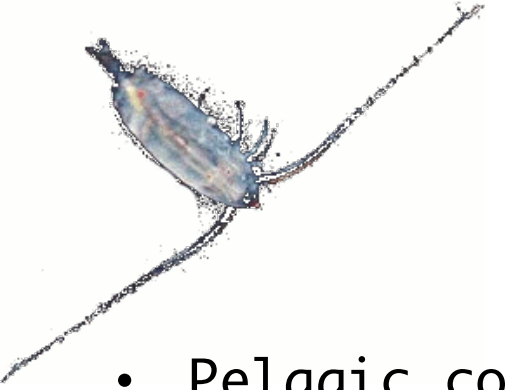
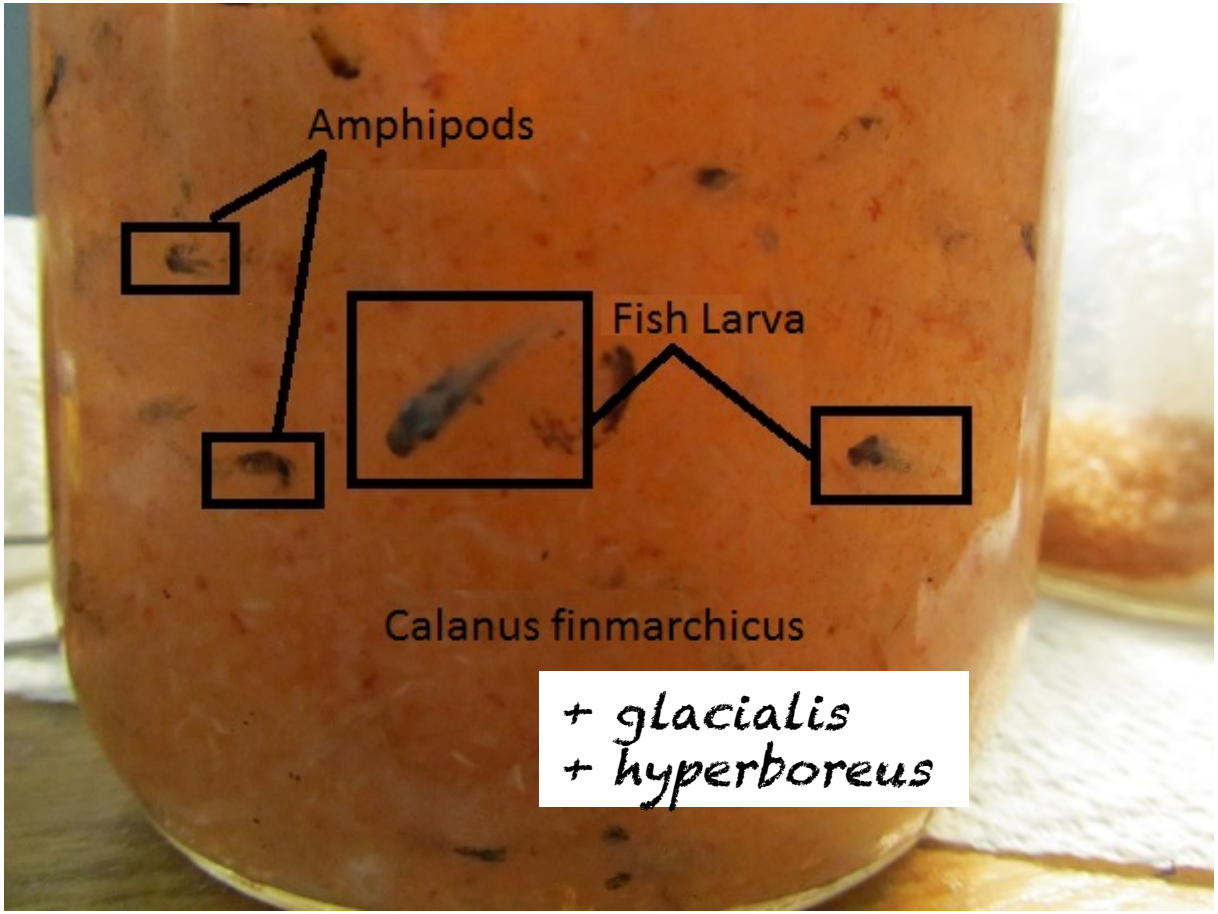
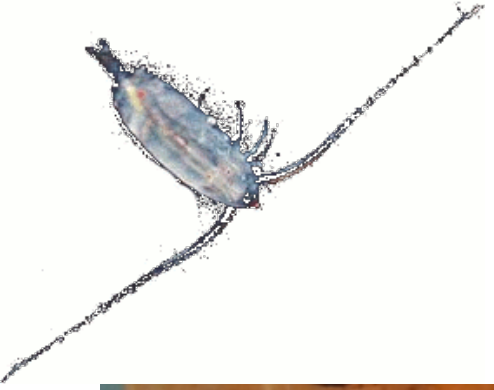


Presentation outline

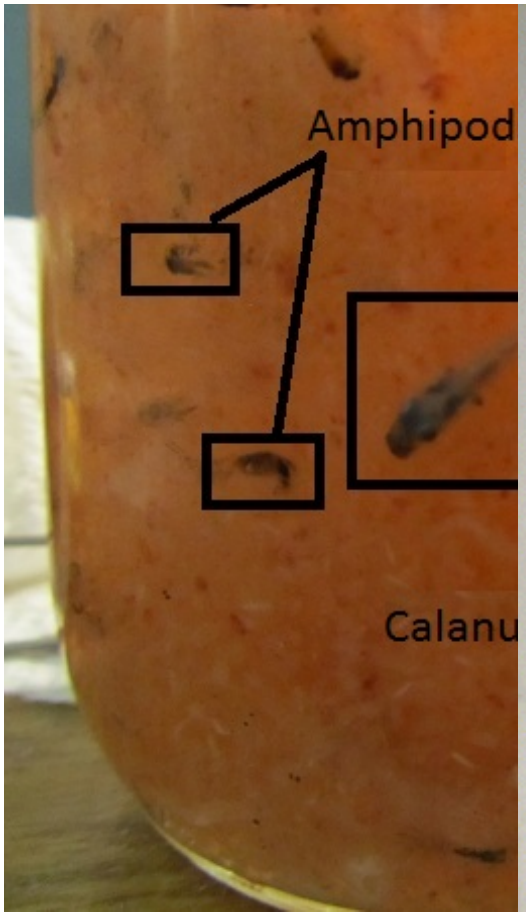
- Pelagic copepods (that matter) ≈ *Calanus* spp
- Hybrids?
- State of art in modelling *Calanus*
- “Hybrids” in trait-based models?
- Prospective: ecological implications + approaches

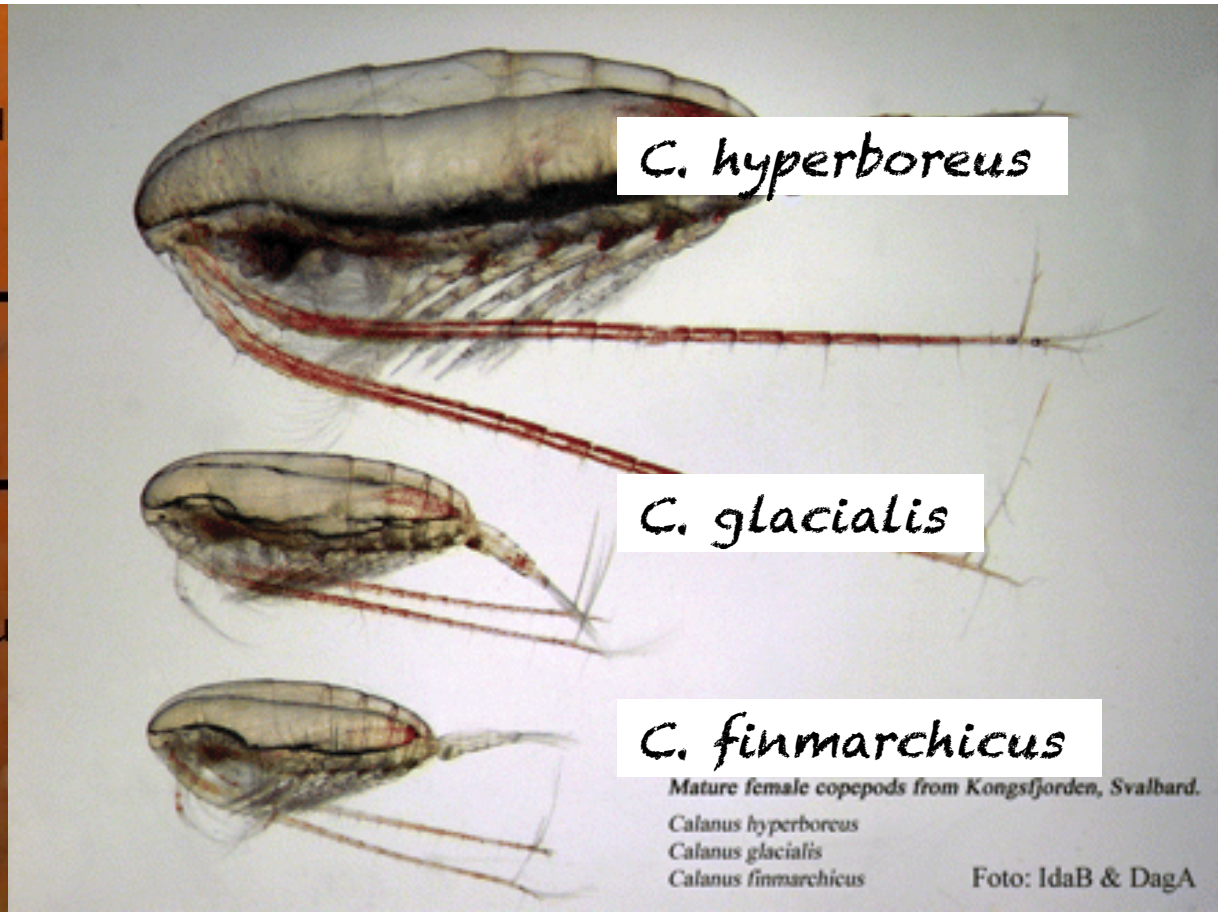
Pelagic copepods ≈ *Calanus* spp





Pelagic copepods ≈ *Calanus* spp





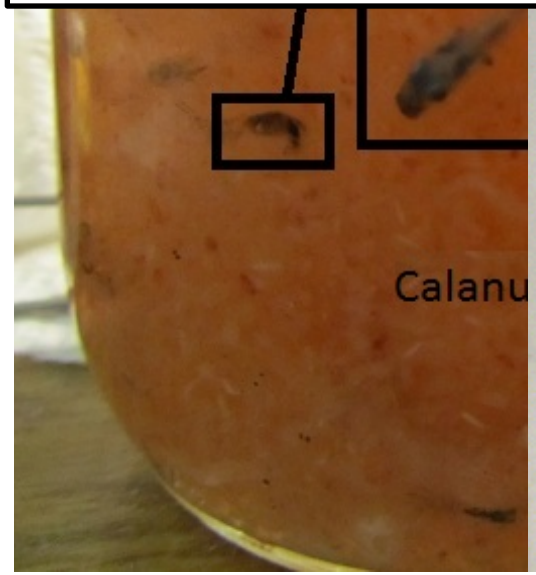
Hybrids

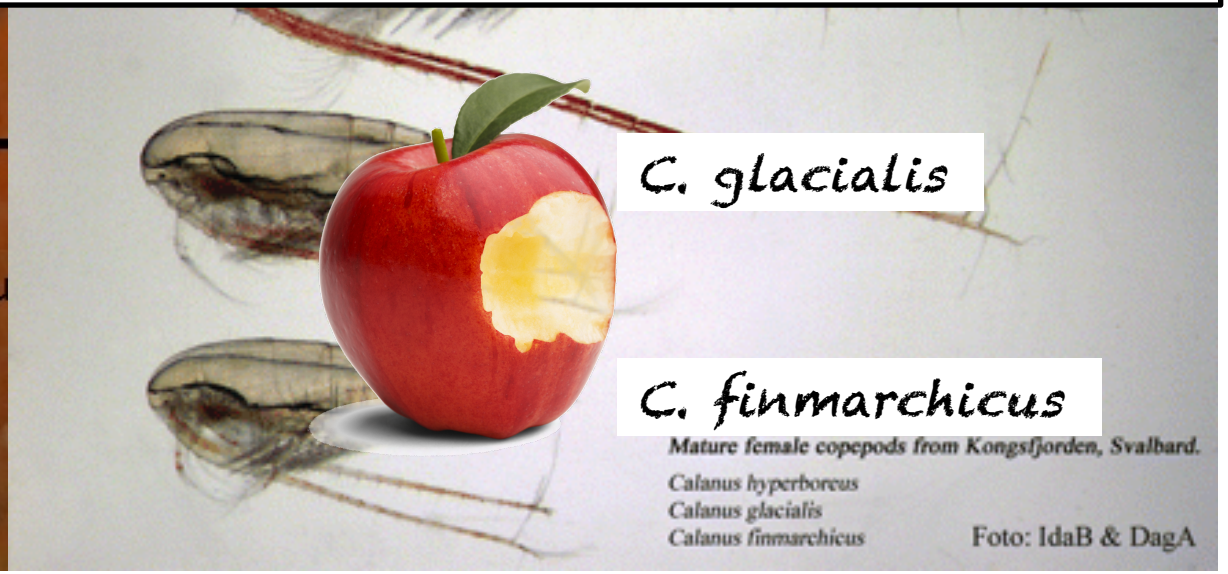
Limnol. Oceanogr., 57(4), 2012, 1057–1066

doi:10.4319/lo.2012.57.4.1057

Natural hybridization between *Calanus finmarchicus* and *C. glacialis* (Copepoda) in the Arctic and Northwest Atlantic

Geneviève J. Parent,[a,*] Stéphane Plourde,[b] and Julie Turgeon[a]





Hybrids

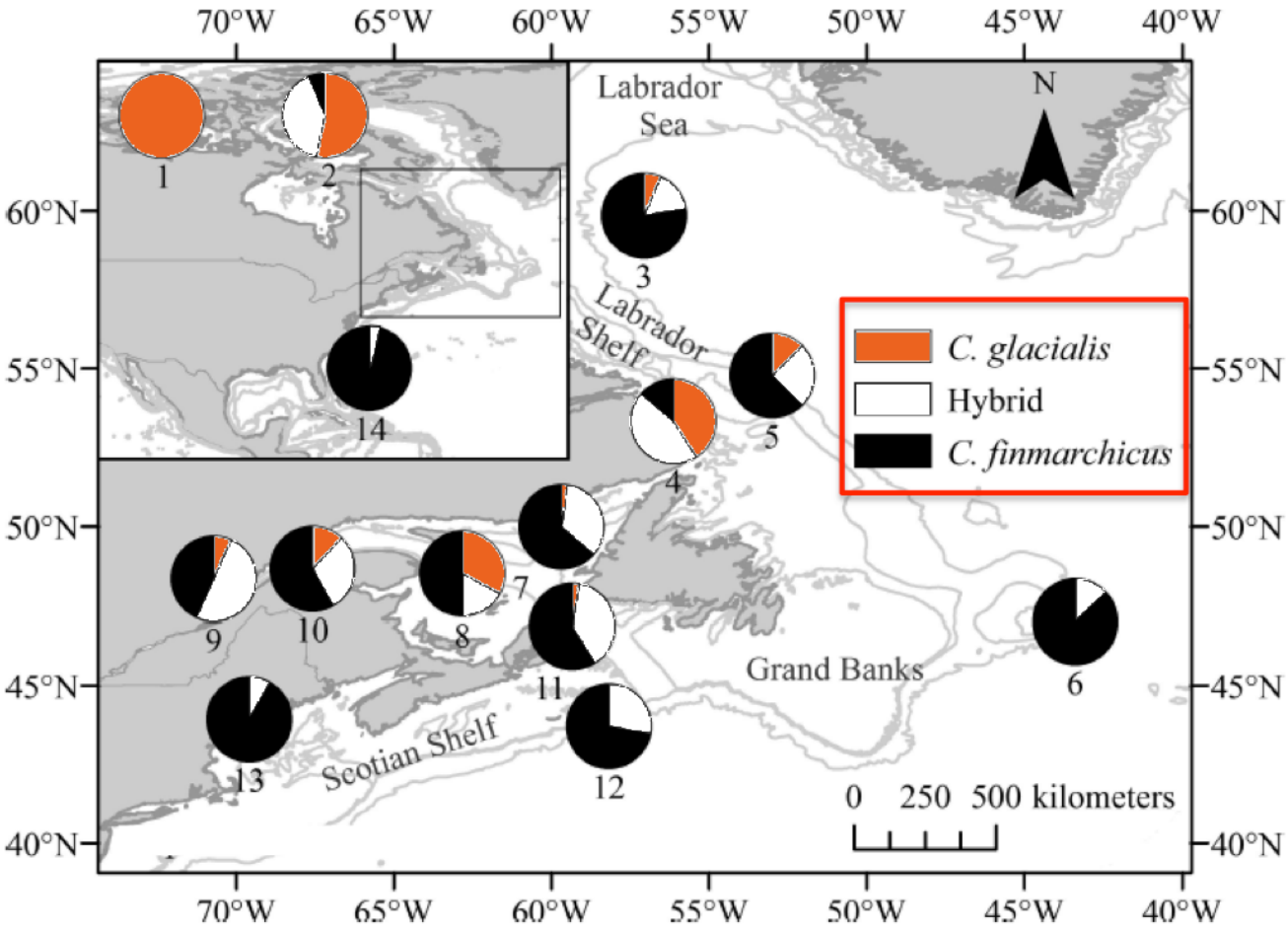


Fig. 1. Map of the Arctic and North Atlantic Oceans showing the frequency of parental species and hybrids (as determined with mtDNA and nucDNA markers) at each station.

Hybrids

- Example of practical impact for current research: only true Arctic stage development data published for *C. glacialis* = McLaren 1969 in Frobisher Bay (ᐃᖃᓗᐃᑦ) …

- … but all current models based (at least in part) on Corkett et al. 1986 who sampled down there:

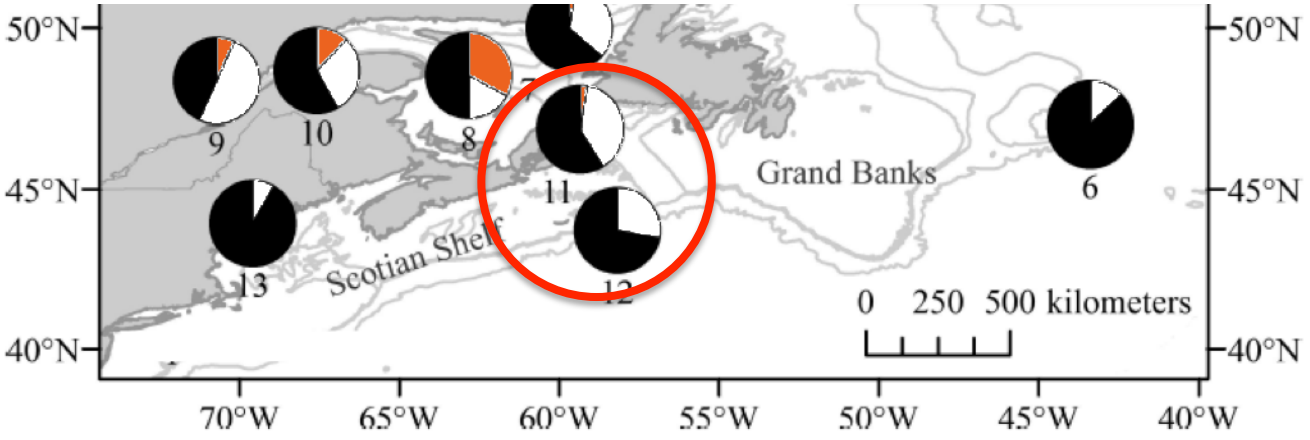
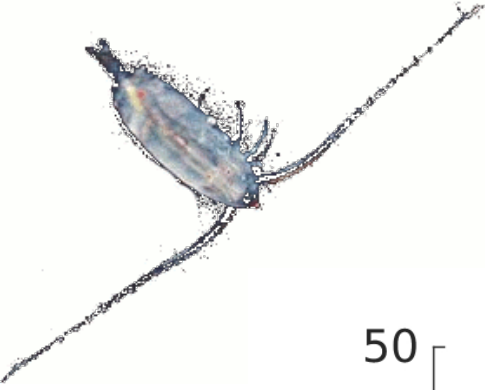
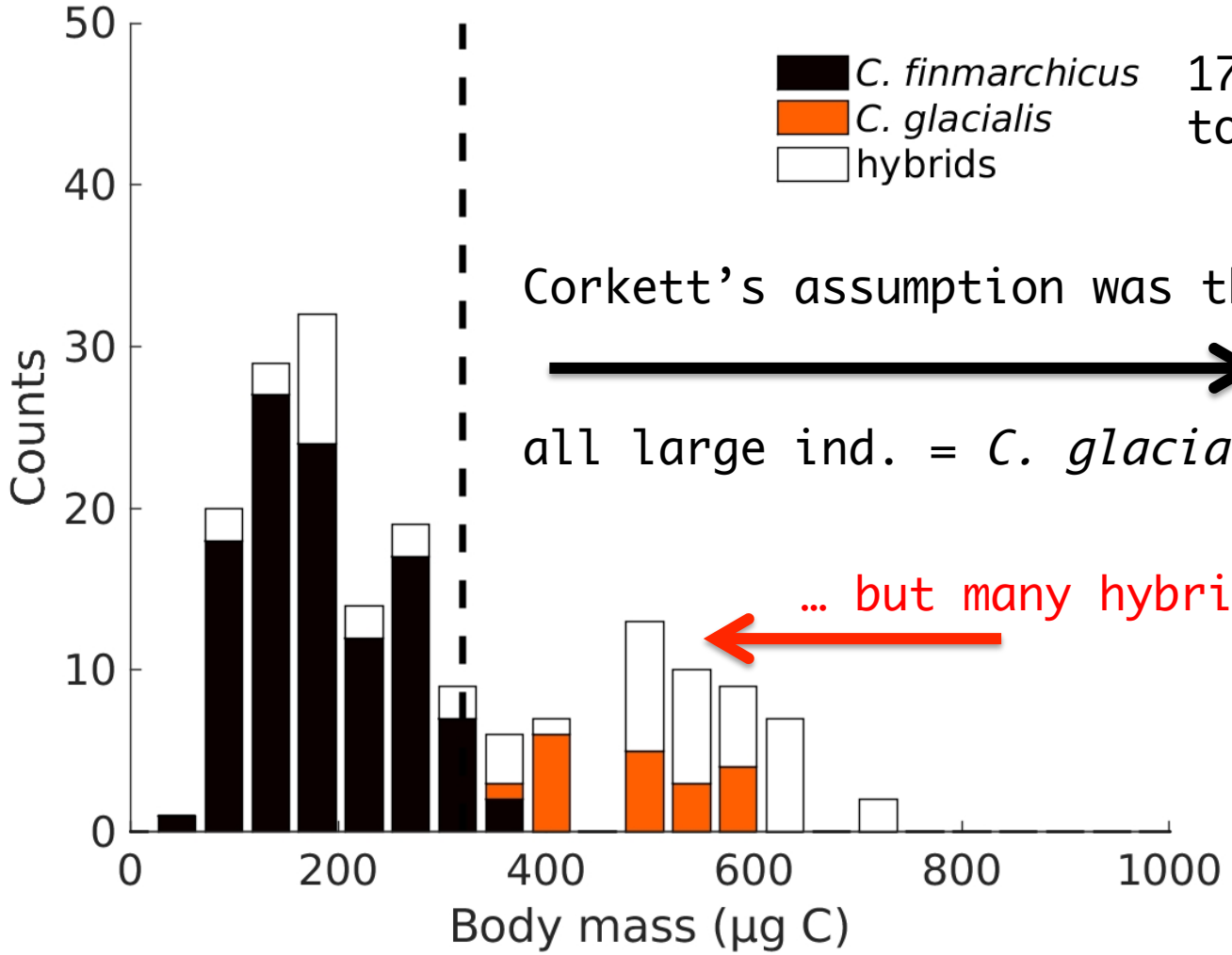
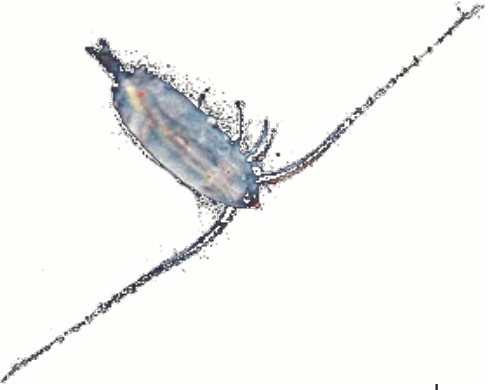


Fig. 1. Map of the Arctic and North Atlantic Oceans showing the frequency of parental species and hybrids (as determined with mtDNA and nucDNA markers) at each station.



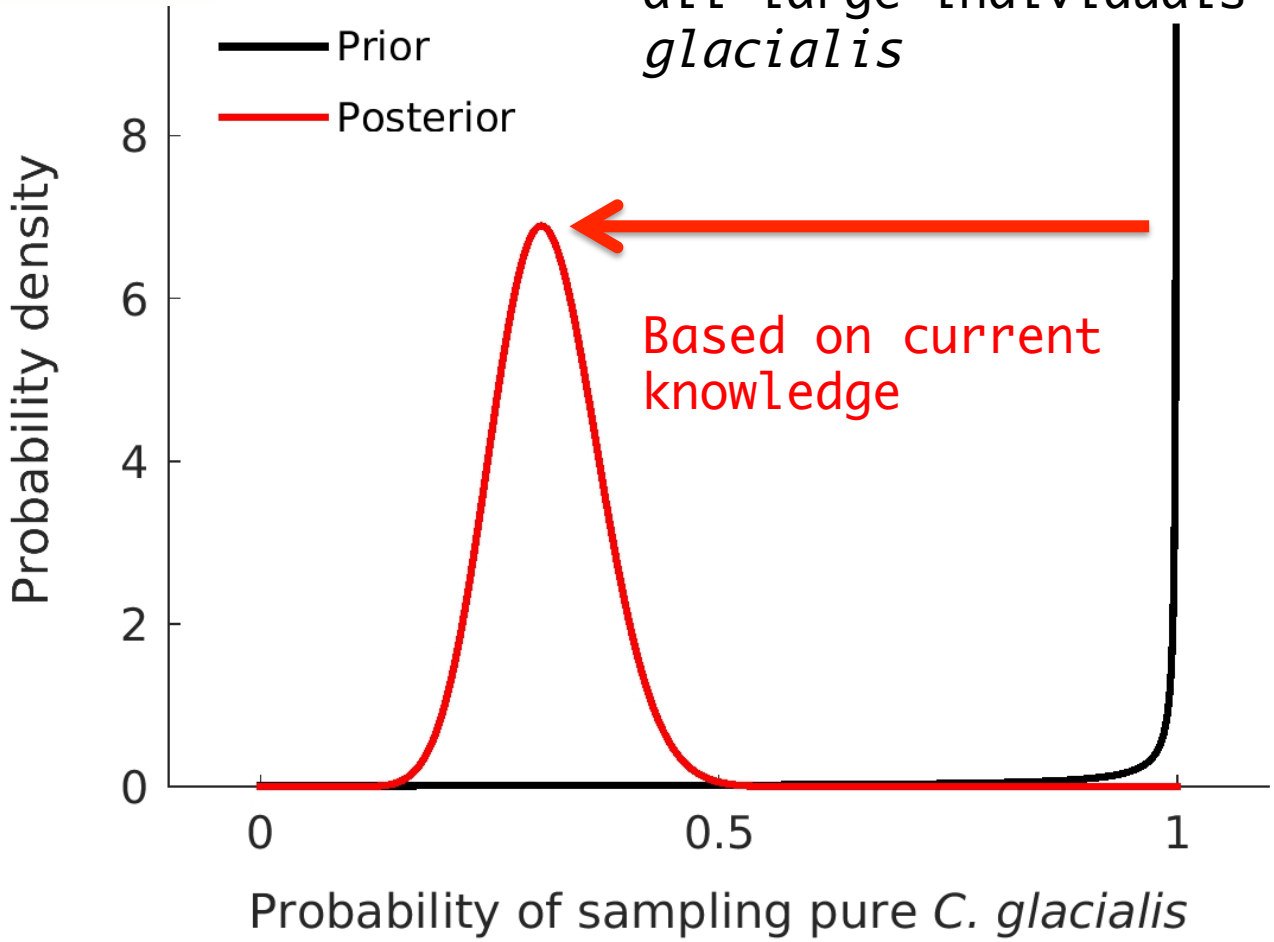
Hybrids

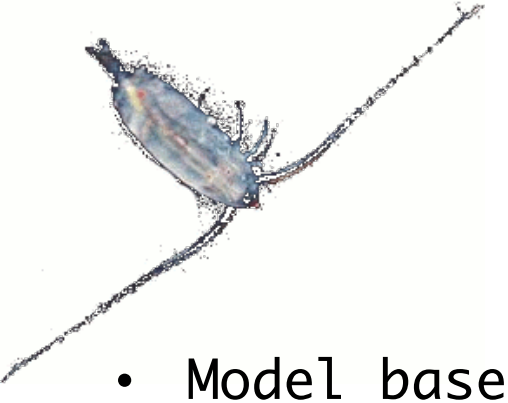

C. finmarchicus
C. glacialis
hybrids
178 ind. total
Corkett's assumption was that
all large ind. = C. glacialis
… but many hybrids!
Counts
Body mass (µg C)
0
10
20
30
40
50
0
200
400
600
800
1000



Hybrids

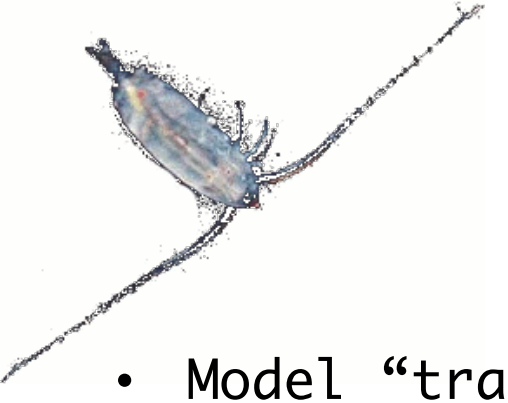
Prior = strong belief that all large individuals are *glacialis*





State of art in modelling *Calanus*

- Model based on first principles of biology and physiology (Arrhenius, allometry, Holling type...)
- Allow the decoupling between growth & development = variable individual size
- Now model the whole life cycle of 3 (sub)Arctic *Calanus* congeners + different strategies (use McLaren 1969 for *C. glacialis* development)
- Hybridization ?

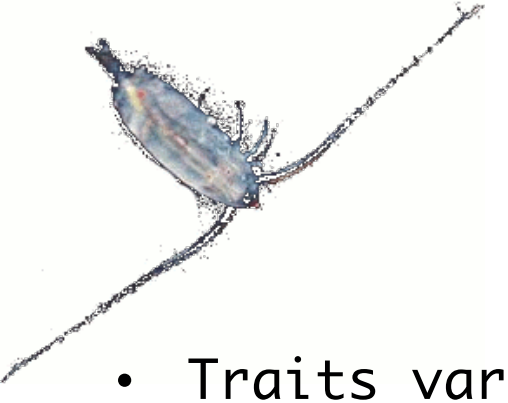


“Hybrids” in trait-based models?

- Model “traits” = clusters of parameters used for a specific process / life-cycle strategy

```
%   cluster(1)  : param(1)     -> ME     : Mass of the egg (ug C)
%   cluster(2)  : param(2)     -> Eb     : Activation energy for metabolism (eV K^-1)
%   cluster(3)  : param(3)     -> B0(1)  : Metabolism constant for active individuals
%   cluster(4)  : param(4)     -> B0(2)  : Metabolism constant for diapausing individuals
%   cluster(5)  : param(5)     -> Ed     : Activation energy for development (eV K^-1)
%   cluster(6)  : param(6:18)  -> SD0    : Stage-specific stage duration coefficients (d)
%                                          generation time varies, not the equiproportional schedule
%   cluster(7)  : param(19)    -> A      : Assimilation efficiency = 1-egestion(~.3)-excretion(~.1)
%   cluster(8)  : param(20:21) -> F0     : Food limitation coefficient for nauplii|copepodid
%   cluster(9)  : param(22:23) -> K0     : Kernel prey encounter coefficient
%   cluster(10) : param(24:25) -> H0     : Handling time of food unit (s)
%   cluster(11) : param(26)    -> Ei     : Activation energy for ingestion (eV K^-1)
%   ...
```

- 9 groups belong to metabolism, development, feeding



“Hybrids” in trait-based models?

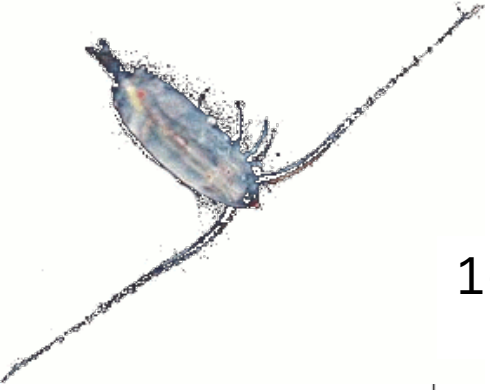
- Traits vary with a CV=3% from the species-specific canonical “paramosome”.

- Hybridization strategies:

  1. Linear average of parameters from each parent (“mean”)

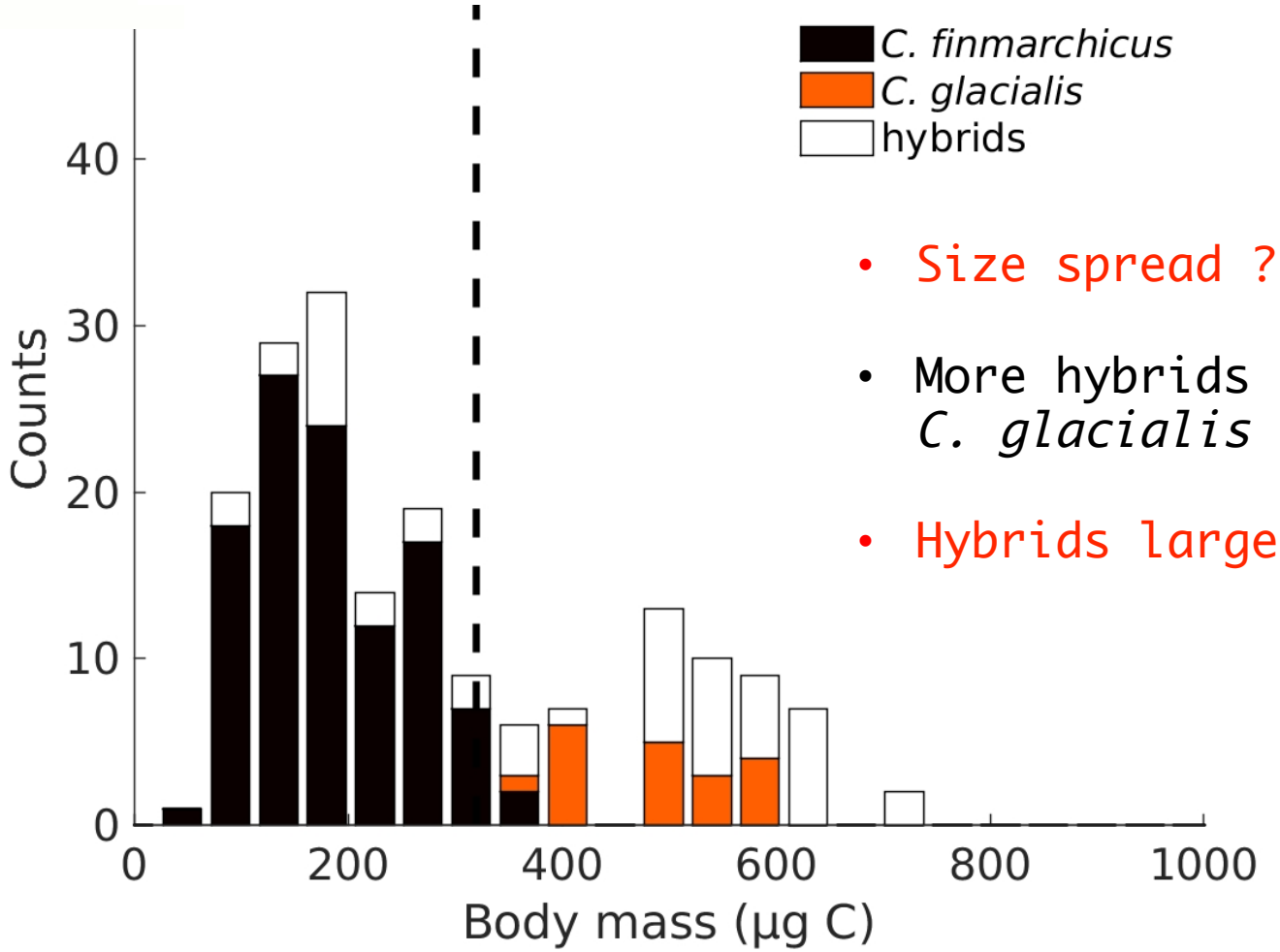
  2. Simple exchange of parameters (“cross”)

  3. 1 or 2 + maternal effect (“mom” = values inherited as is)

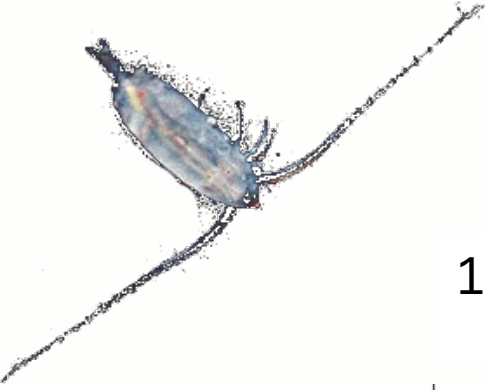


“Hybrids” in trait-based models?

1- Results from the “mean” scenario



- Size spread ?
- More hybrids in *C. glacialis* range
- Hybrids larger ?



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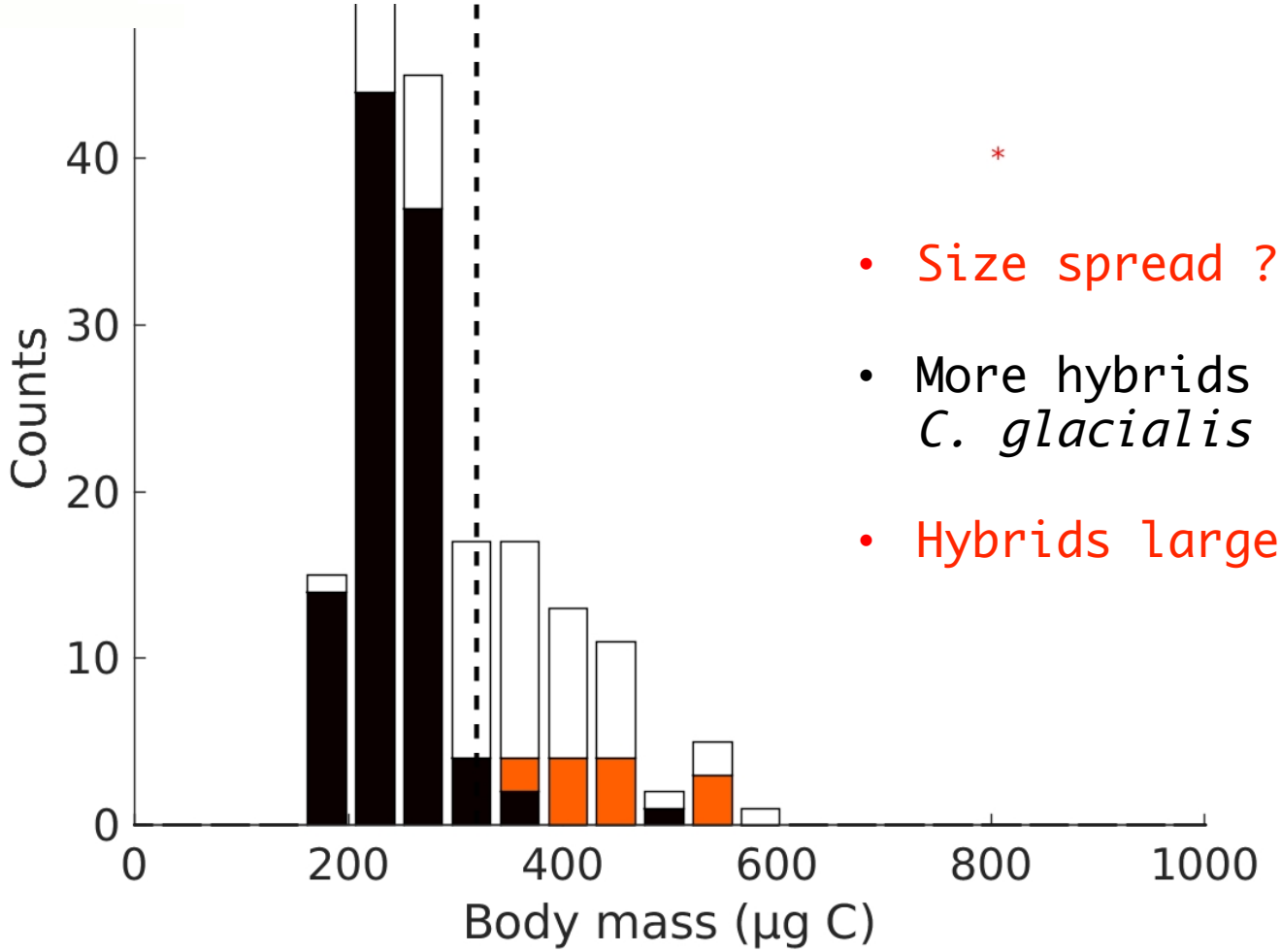

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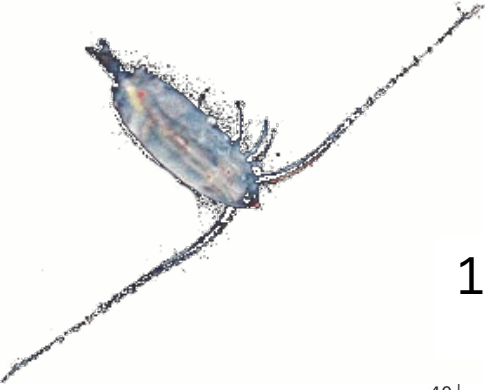

“Hybrids” in trait-based models?

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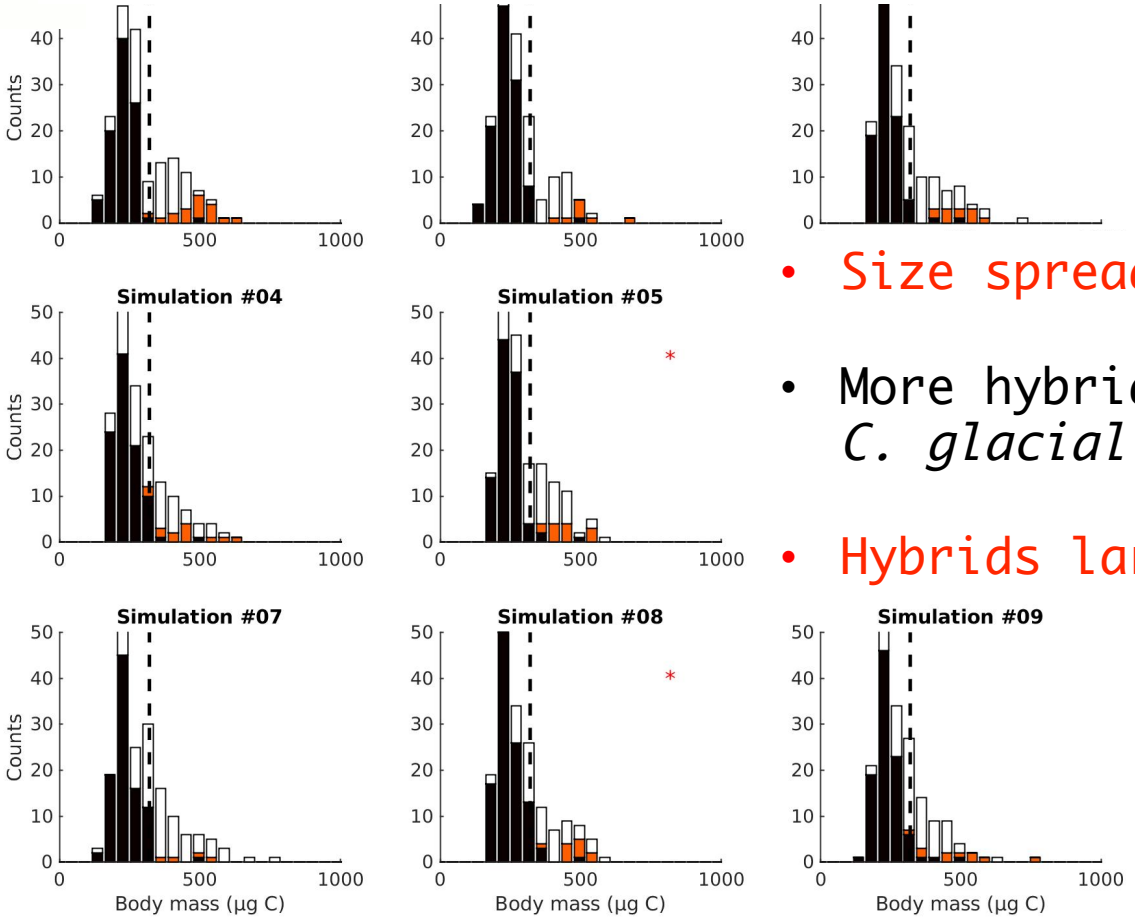

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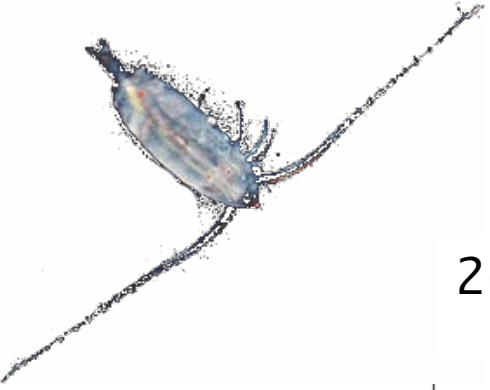
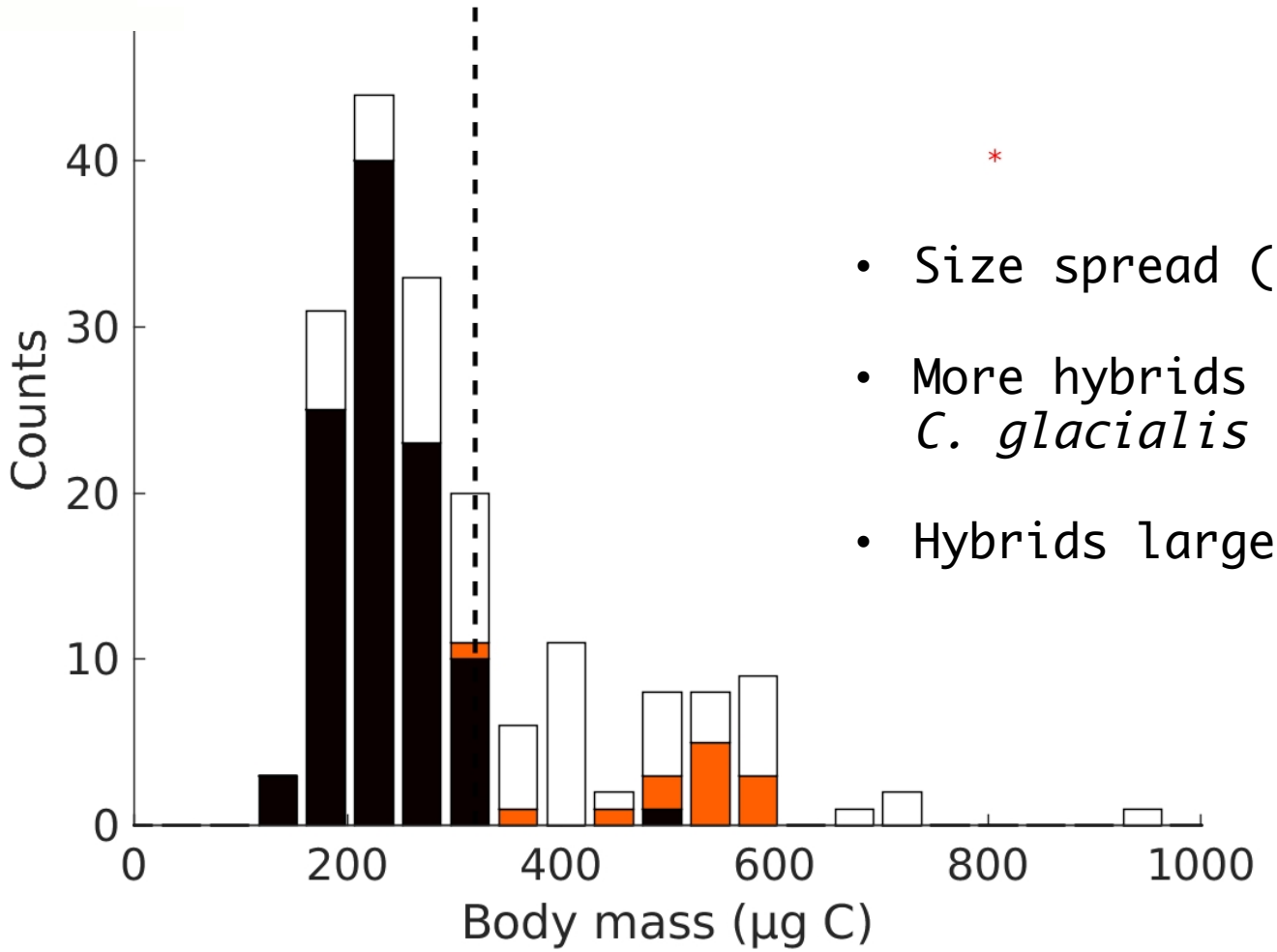
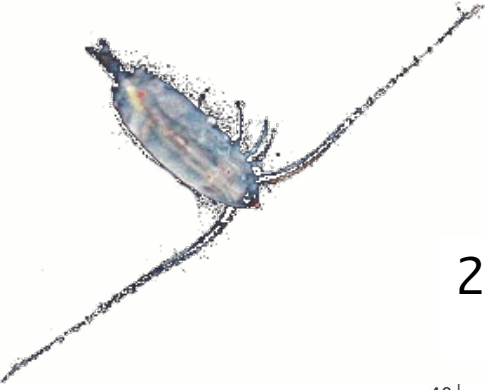


“Hybrids” in trait-based models?

2- Results from the “cross” scenario

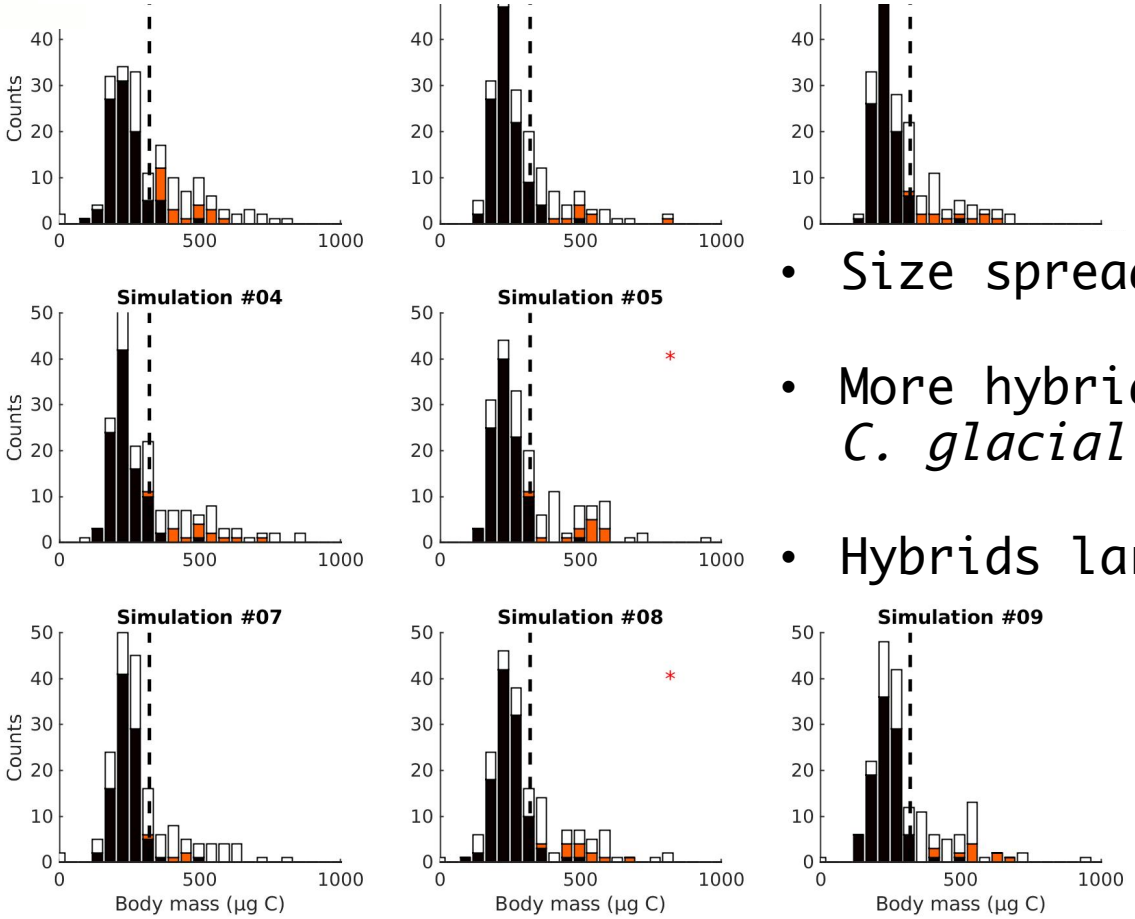


- Size spread (?)
- More hybrids in *C. glacialis* range
- Hybrids larger



“Hybrids” in trait-based models?

2- Results from the “cross” scenario



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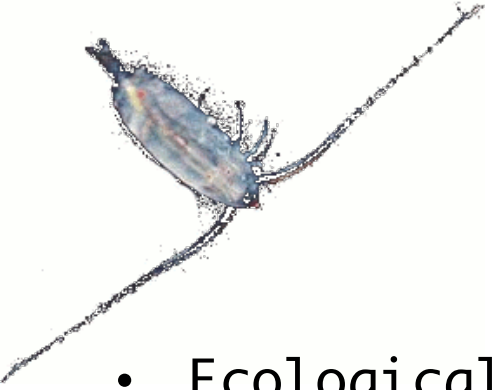
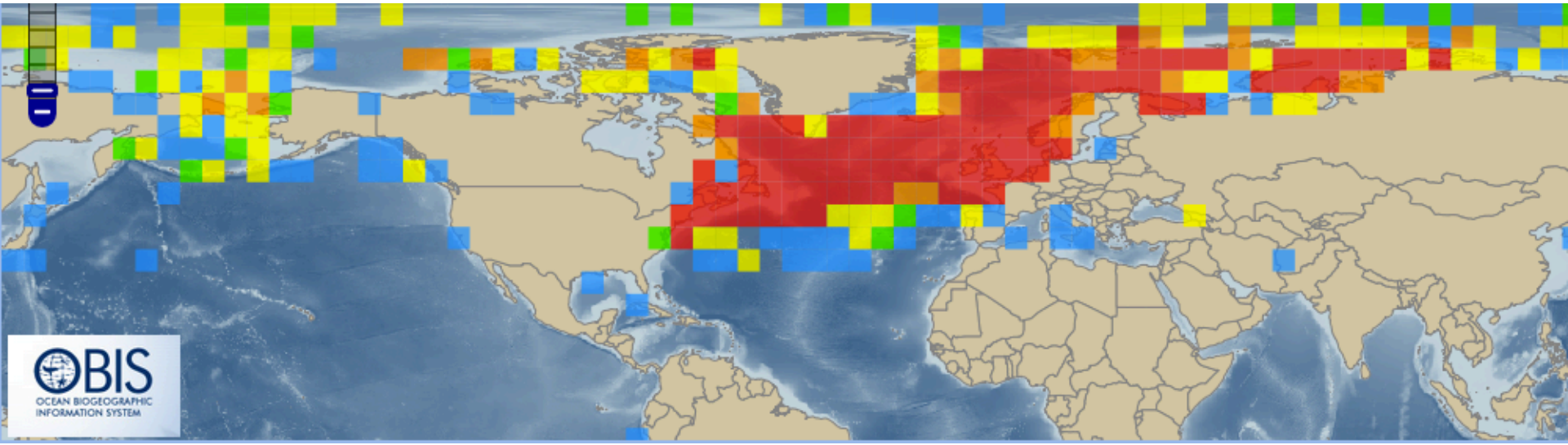
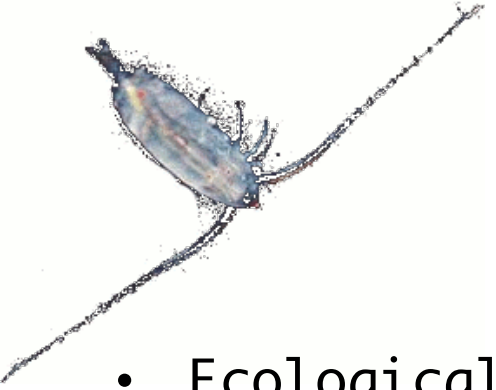
- More hybrids in *C. glacialis* range
- Hybrids larger



Prospective

- Ecological implications
  - Biogeography & boundaries between species affected by climate changes = hybridization more and more an issue?





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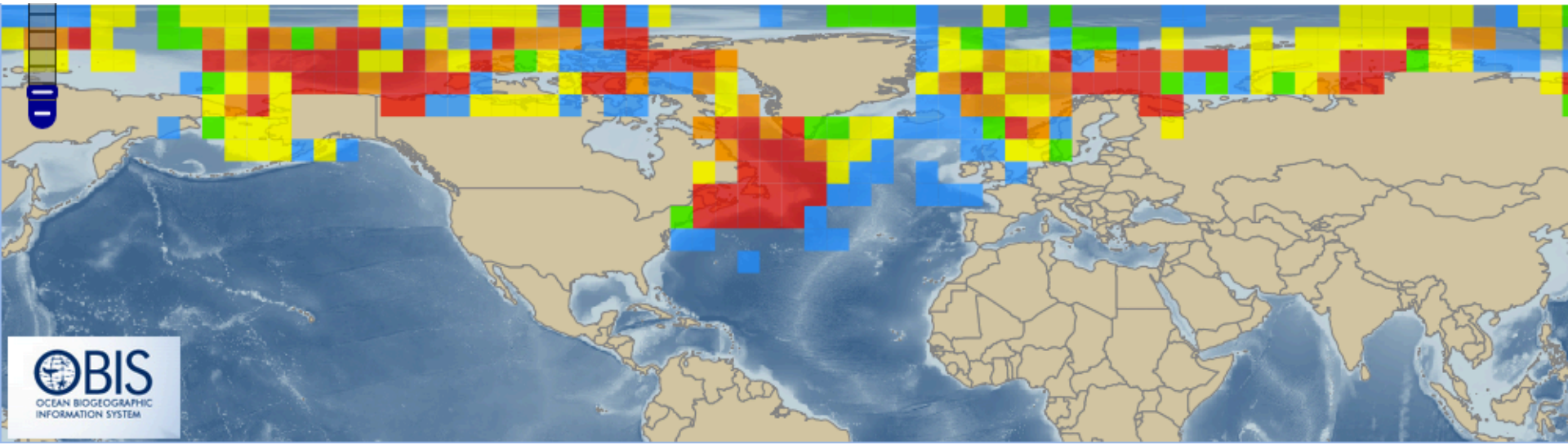

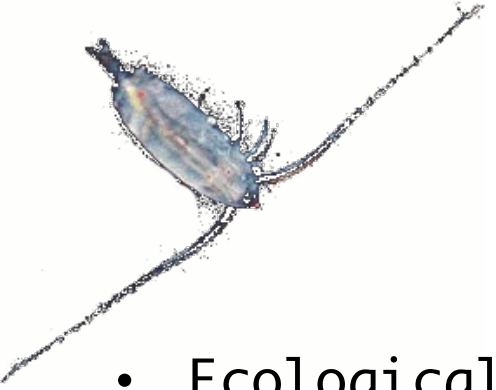

Prospective

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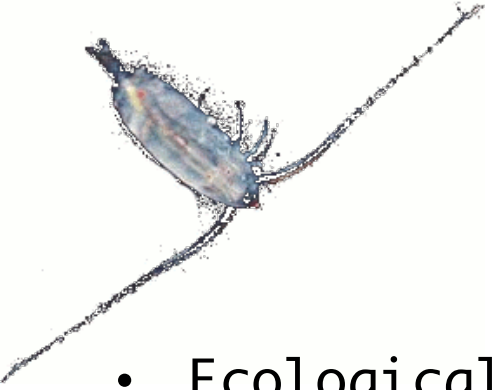
FEATURE ARTICLE

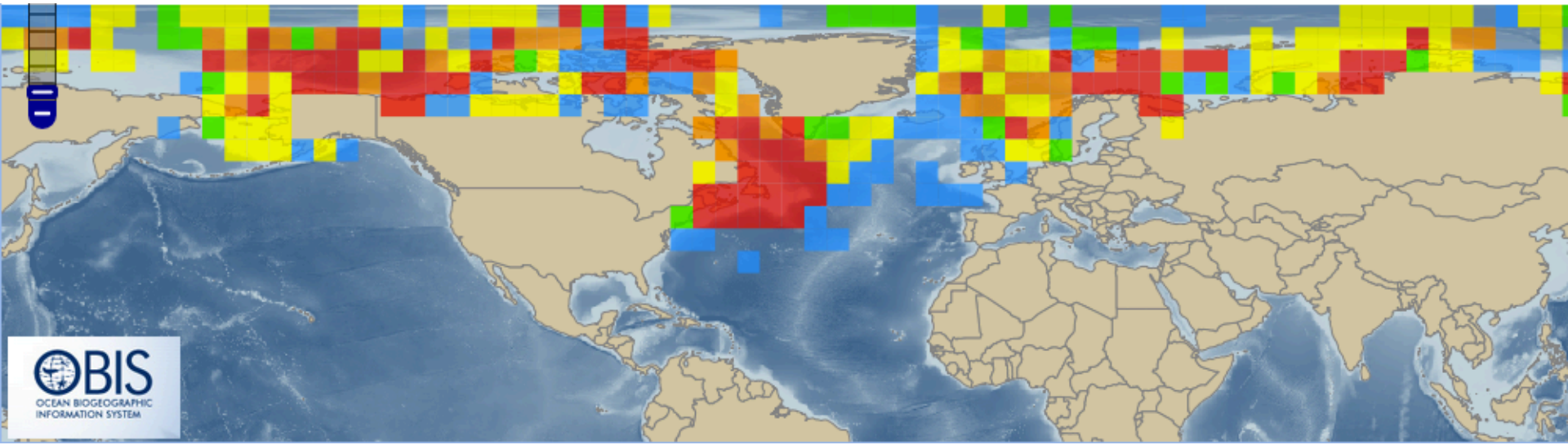
Phenology and fitness of *Calanus glacialis*, *C. finmarchicus* (Copepoda), and their hybrids in the St. Lawrence Estuary

Geneviève J. Parent[1,*], Stéphane Plourde[2], Pierre Joly[2], Julie Turgeon[1]



Prospective

- Ecological implications
  - Biogeography & boundaries between species affected by climate changes = hybridization more and more an issue?
  - Traits more important than actual species (?) (Nick's poster) = If only lipid biomass: hybridization not so much an issue? If lipid "packaging" : hybridization an issue!




Thank
y0u!