Application des isotopes stables en Ecologie trophique et Ecotoxicologie

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Studies in the Oceanology Lab involving Stable isotopes (C,N, S):

- Delineation of marine trophic web
- Trophic ecology of aquatic animals (aquatic invertebrates, fishes, birds, marines mammals)
- Relation between trophic ecology and ecotoxicology

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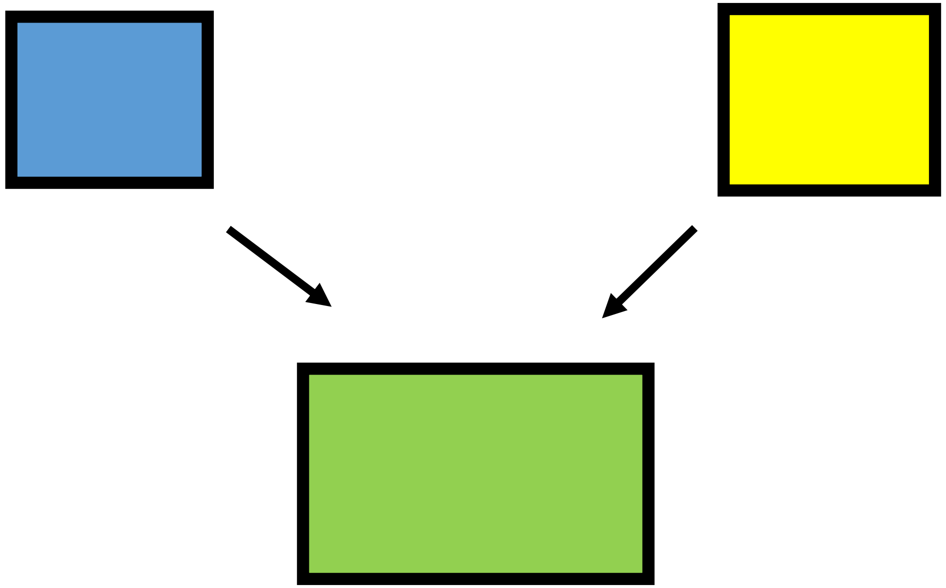
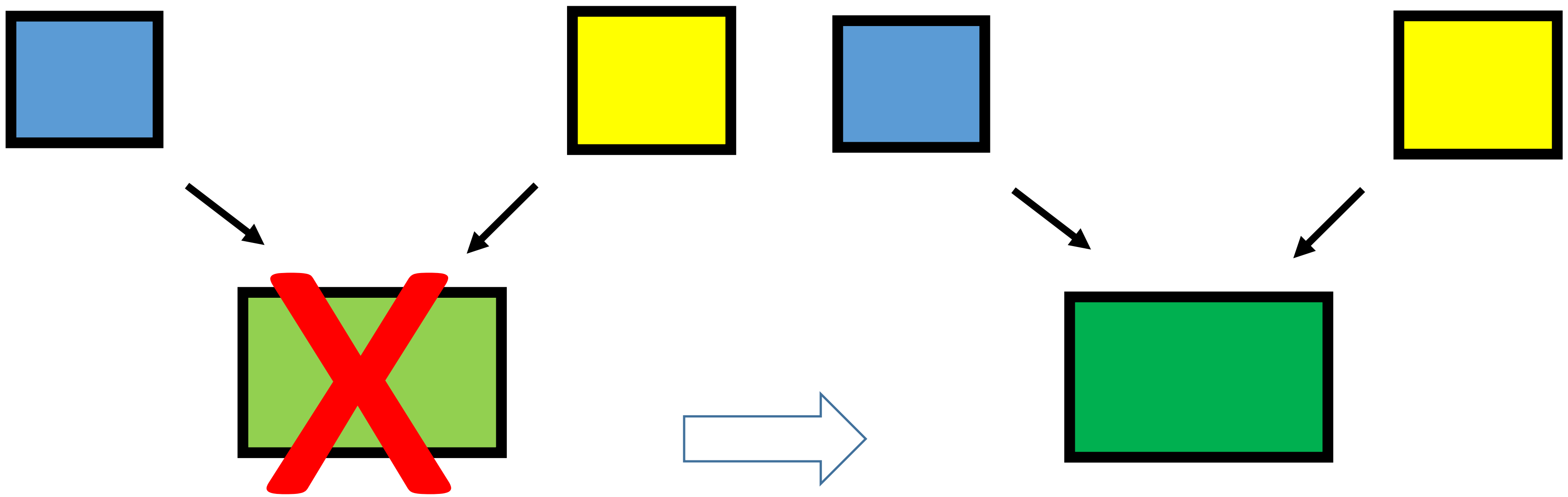
EA – IRMS
(Isoprime 100 – Vario MicroCube)
and
MS- GC- IRMS

"You are what you eat…plus a few per mille"
DeNiro & Epstein, 1978

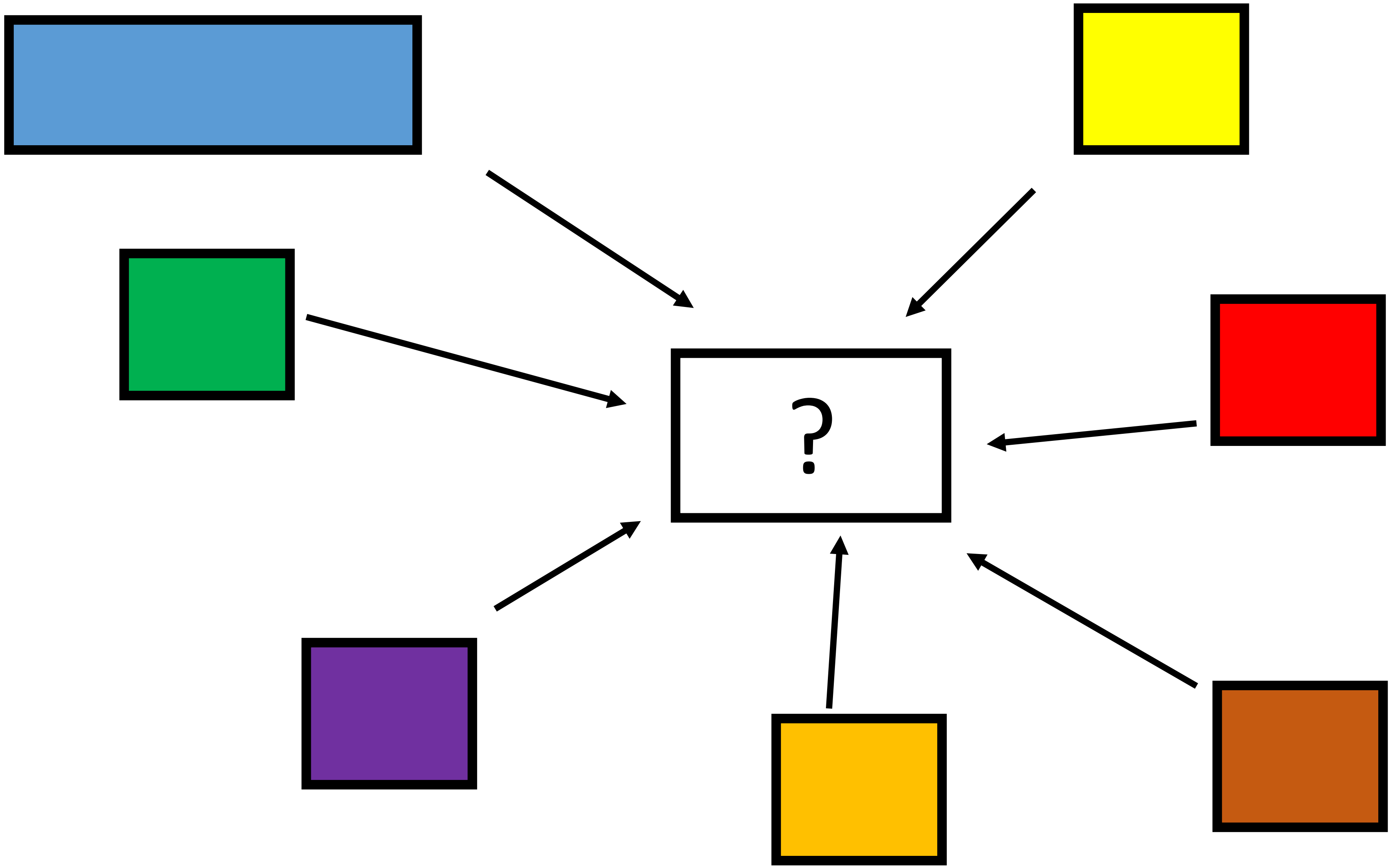


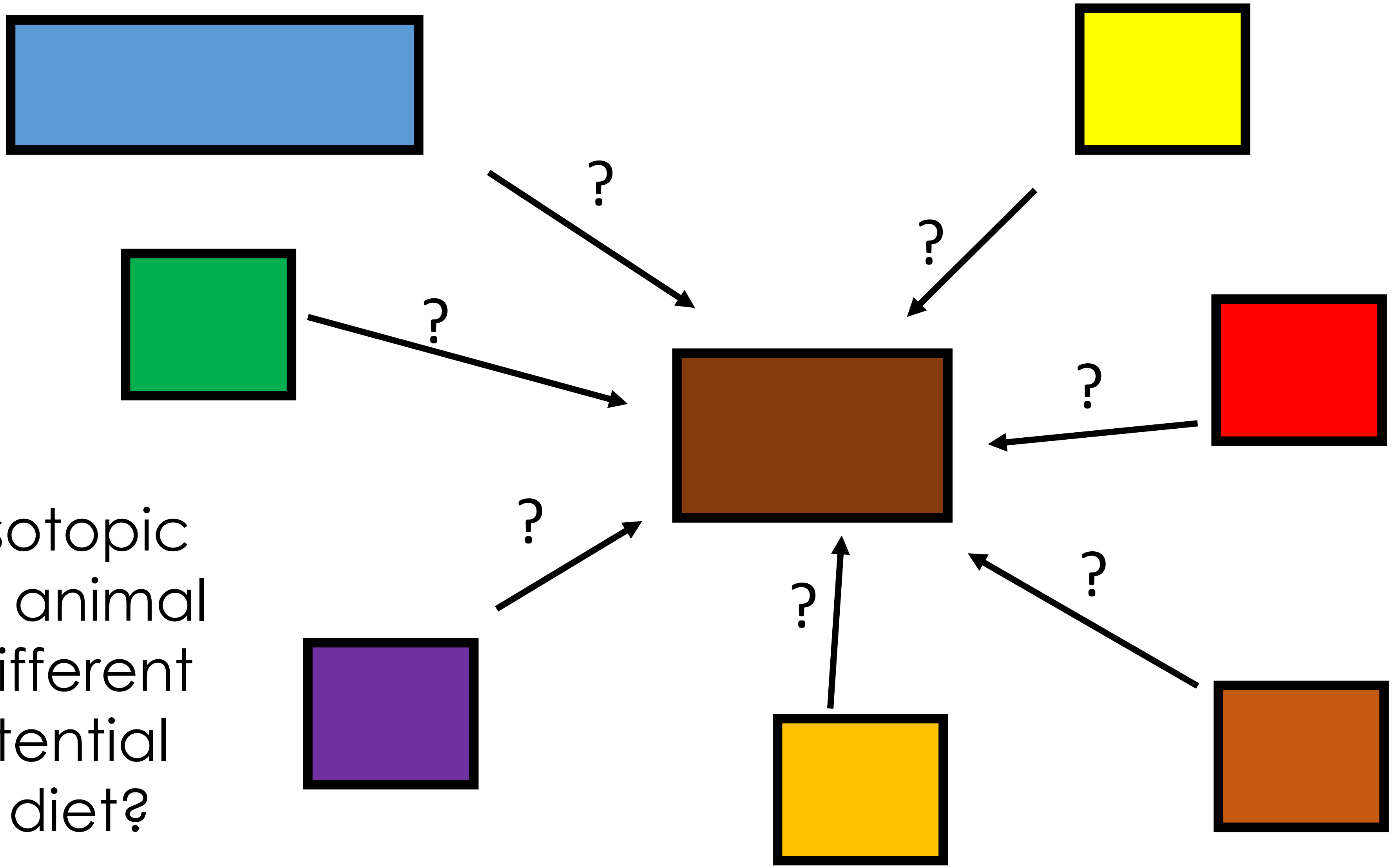
MIXING Law:
"YOU ARE WHAT YOU EAT"



« Plus few per mille »

Plus few per mille = trophic enrichment factor (TEF)
= trophic fractionation factor





Our question:
Is it possible from isotopic composition of an animal to calculate the different contribution of potential food sources to its diet?

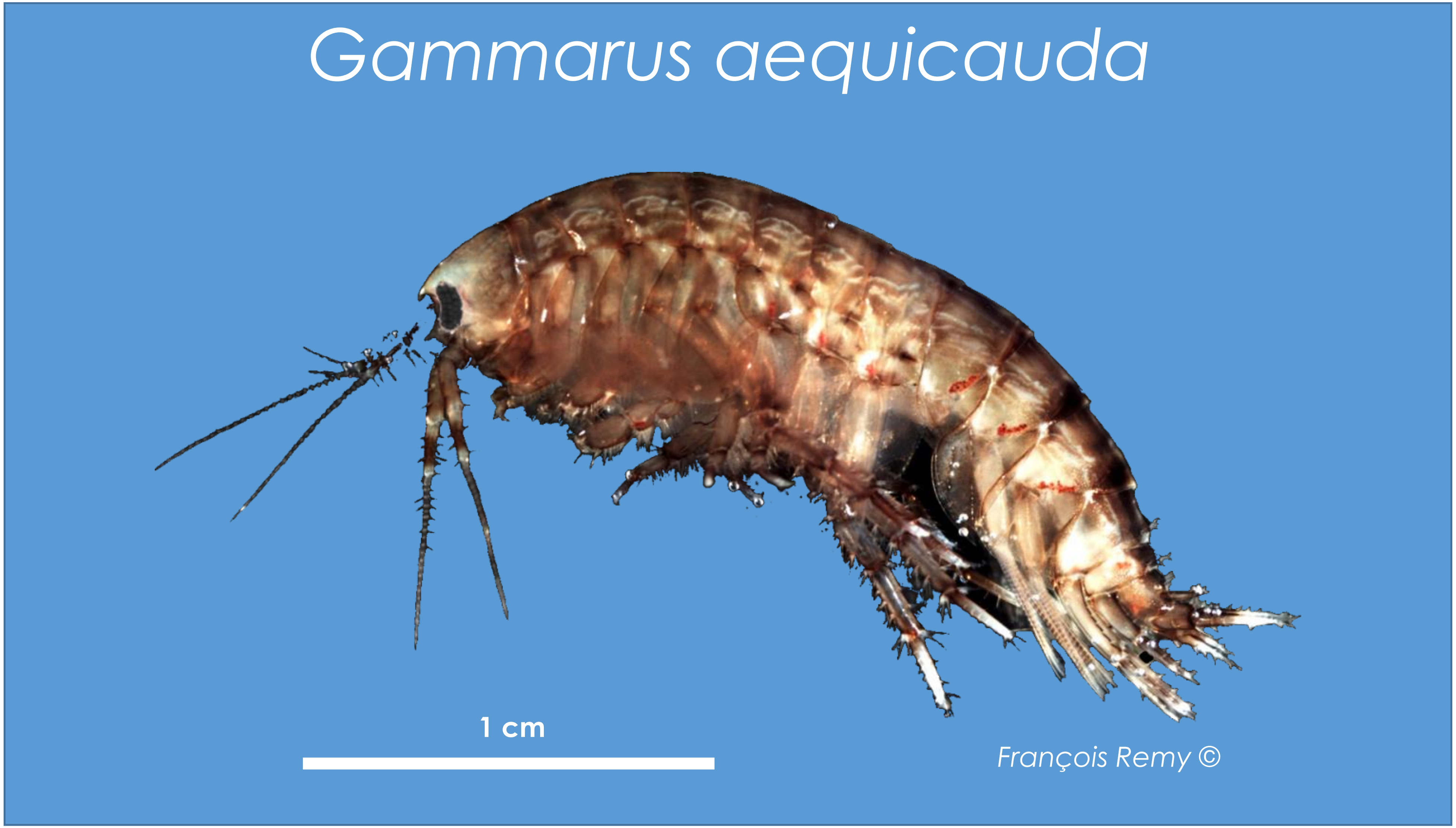
Mixing equation for n sources:

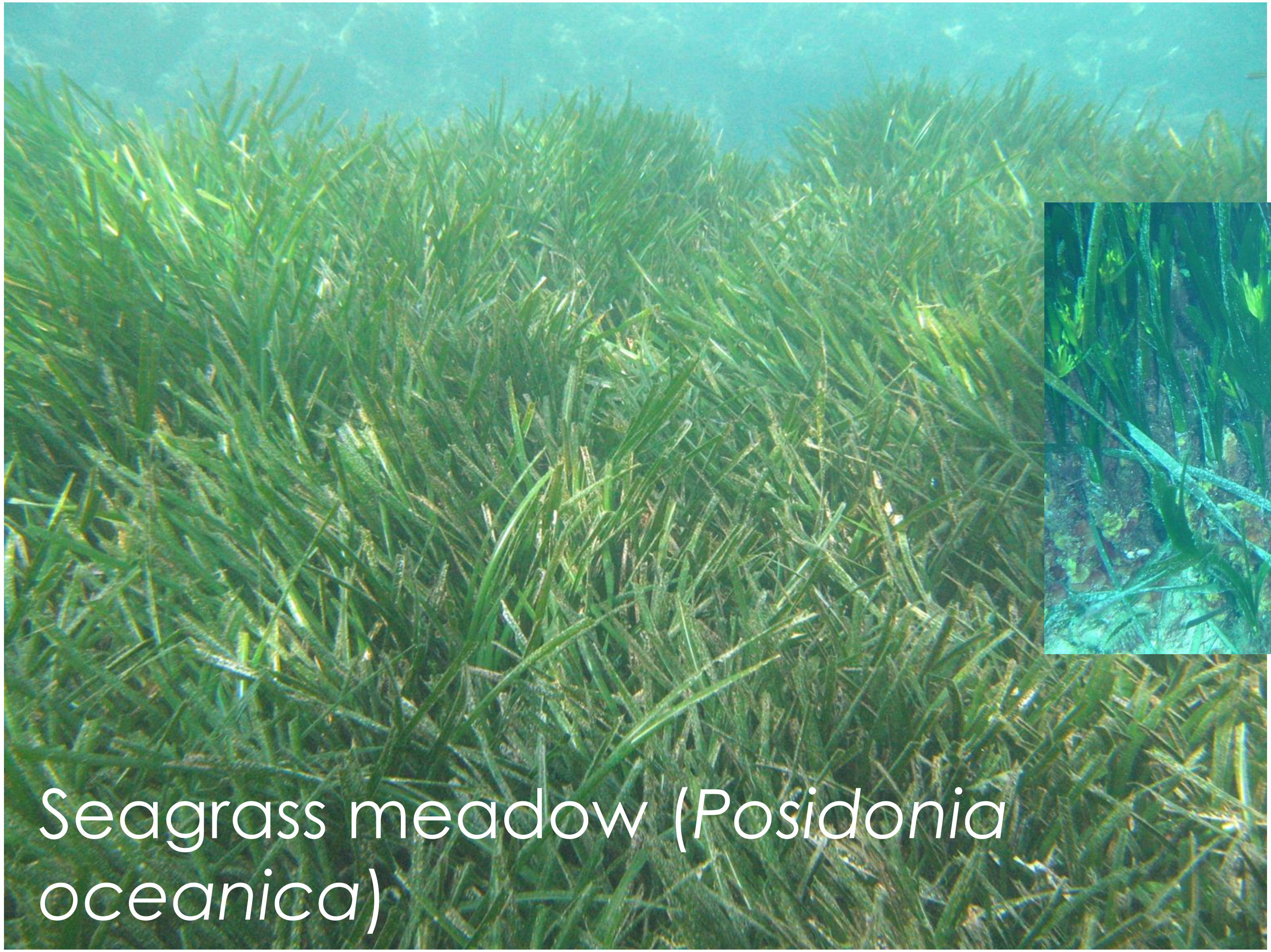
$$\delta_m = (f_a\delta_a + f_b\delta_b + f_c\delta_c + \ldots)$$

⇒ Complex mixing modelling

⇒ IsoSource (Philips et al., 2001) or SIAR (Parnell et al. 2010) or ….

Case study 1: Trophic ecology of Gammarus aequicauda (amphipoda)

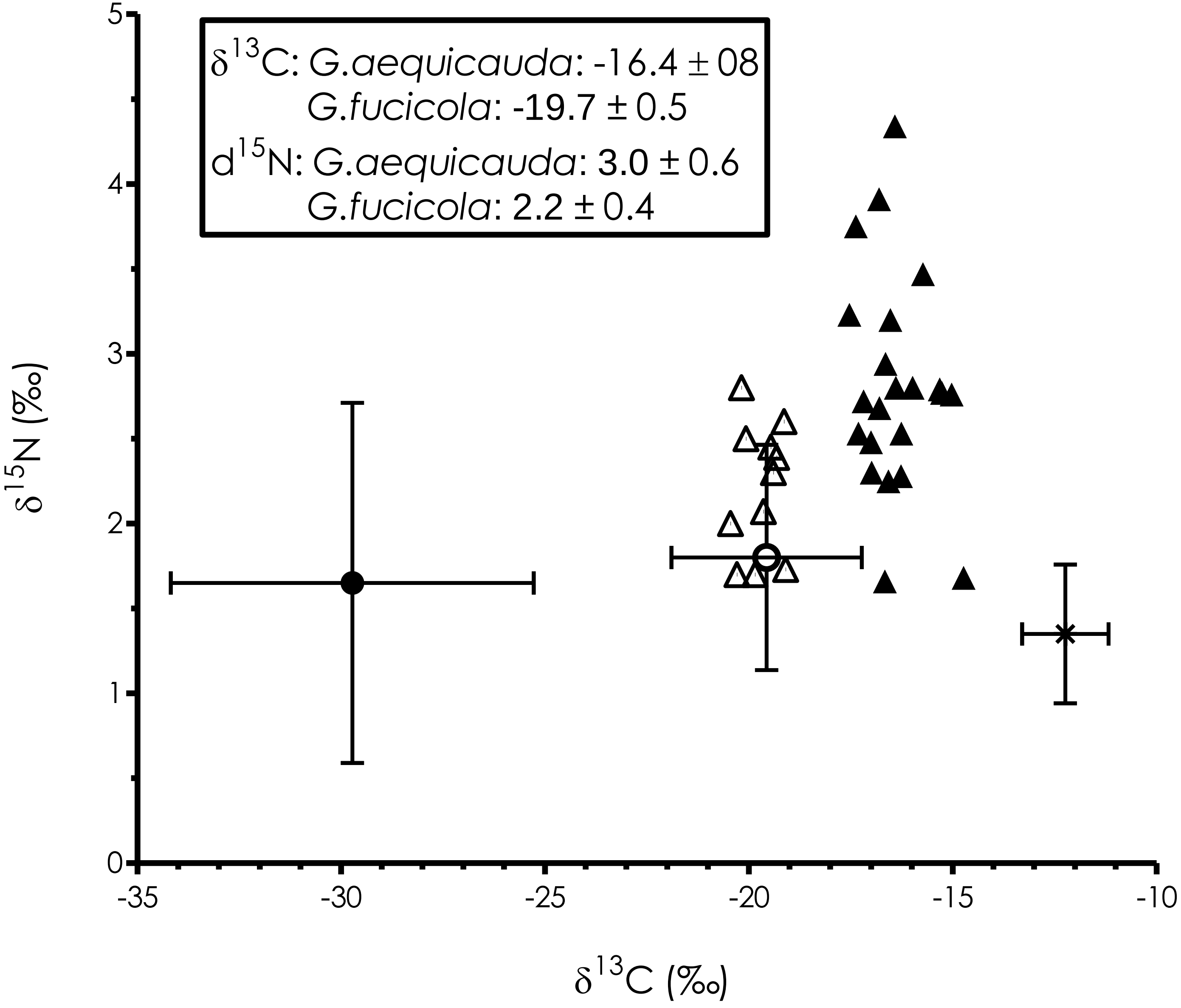




Seagrass meadow (*Posidonia oceanica*)

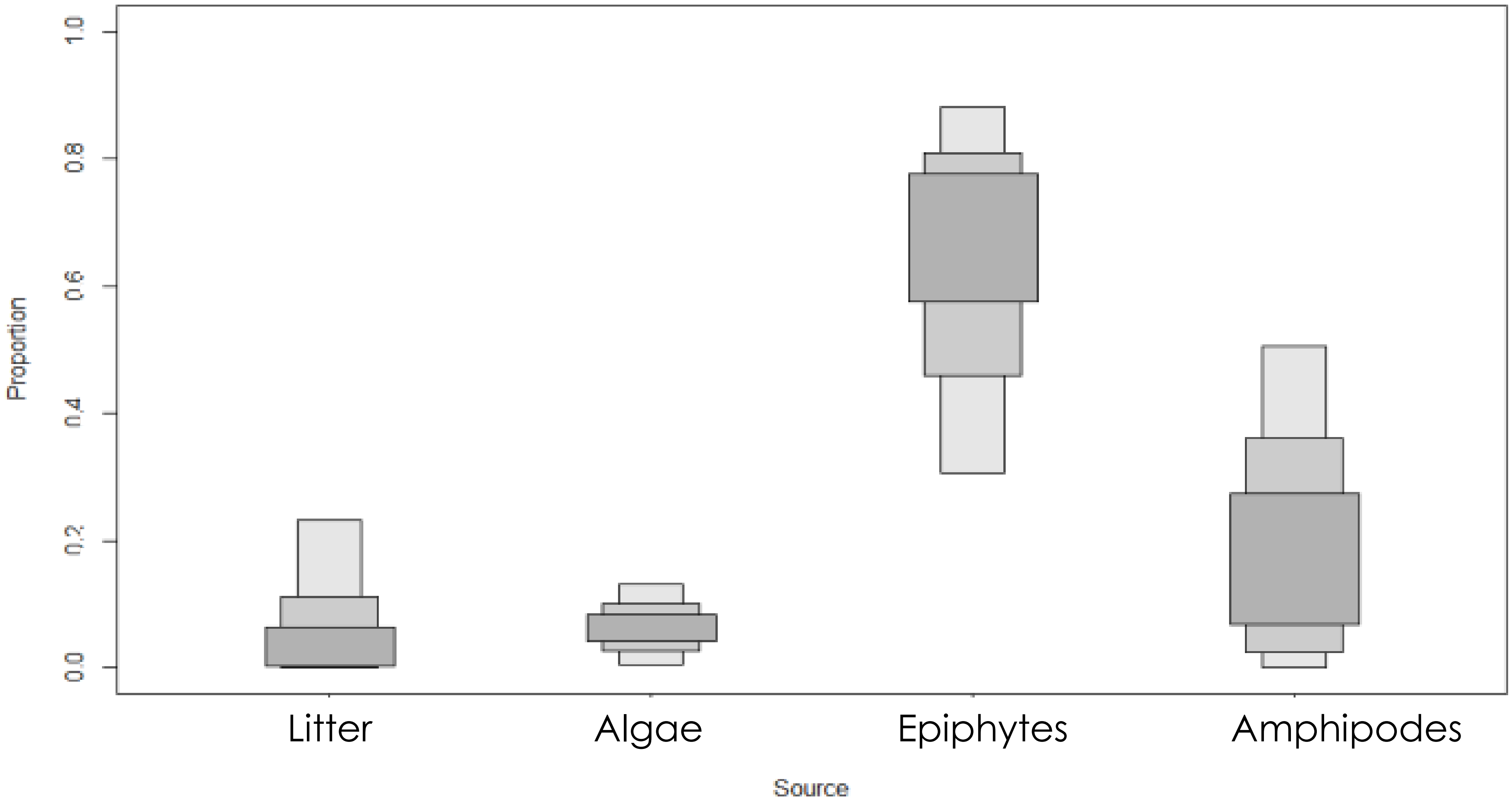
Exported
Dead Leaves

- More than 120 species
- Up to 6000 $id.m^{-2}$
- Dominated by amphipods
- Prey for fishes



Source: Lepoint et al. 2006

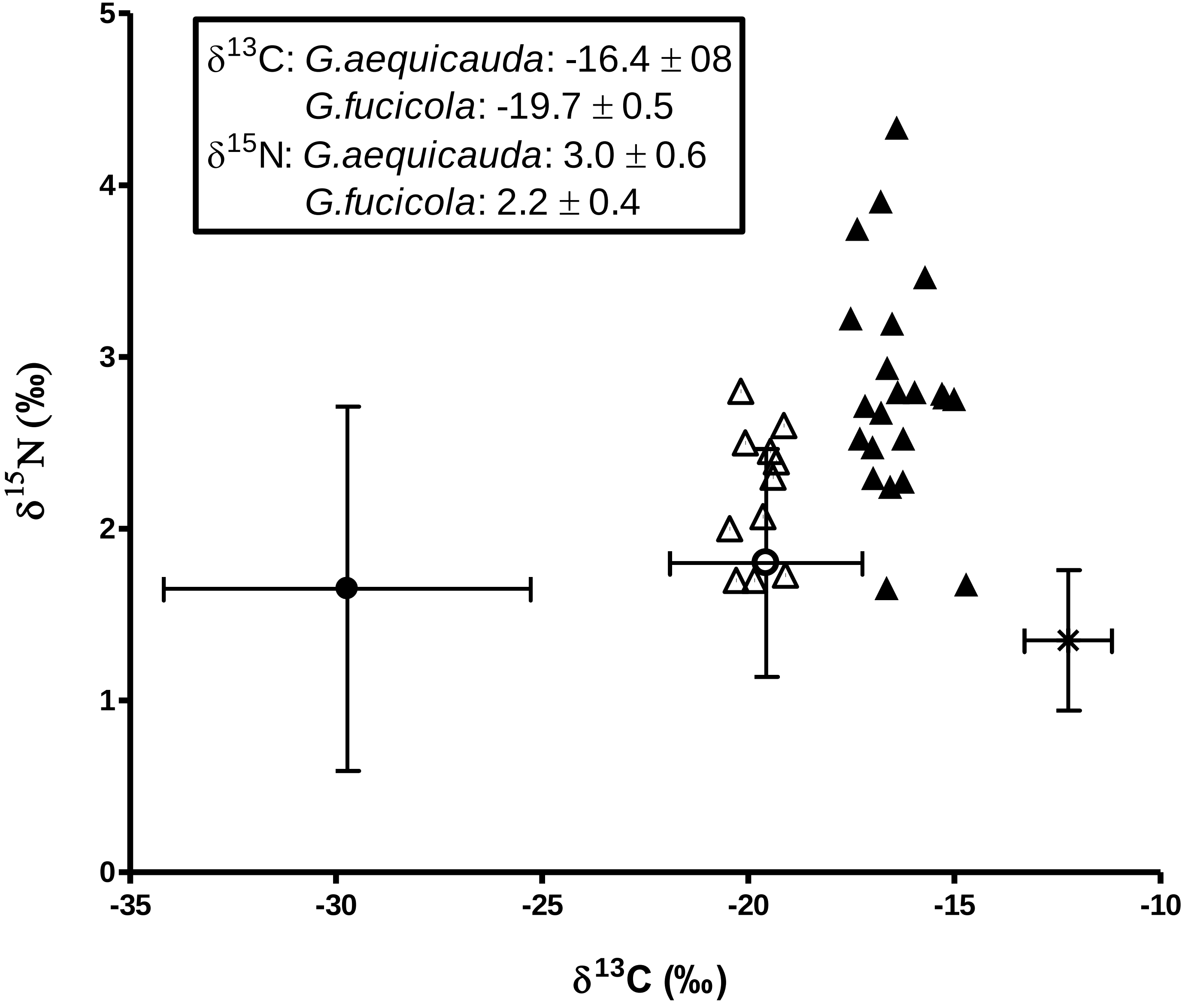
SIAR Modelling



TEF All the same

$\Delta^{13}C = +1$

$\Delta^{15}N = +3.4$

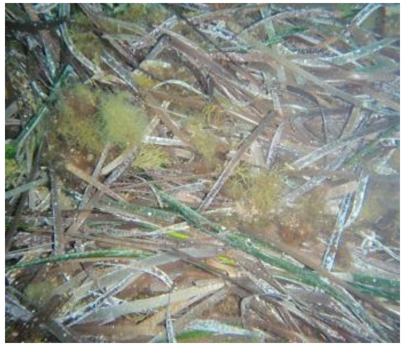


Source Lepoint et al. 2006

TEF Determination: Experimental design

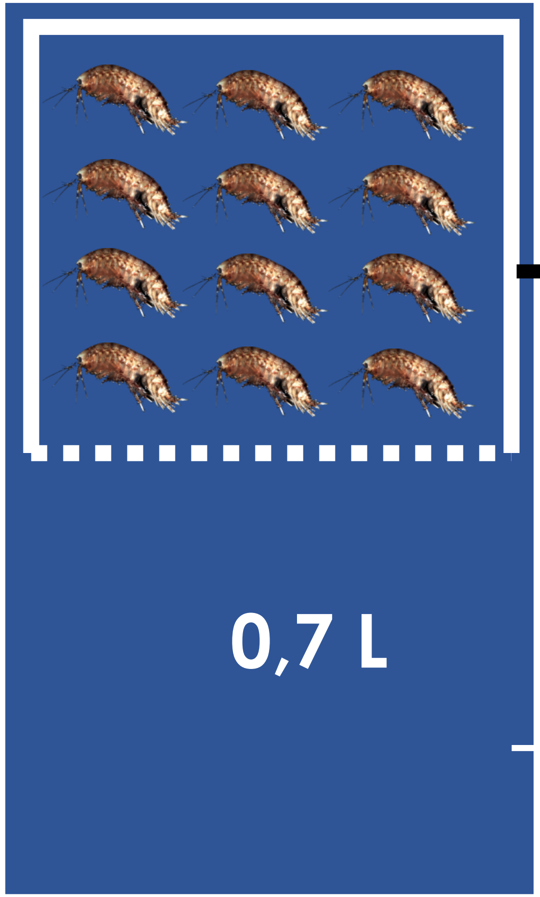
3 different treatments :

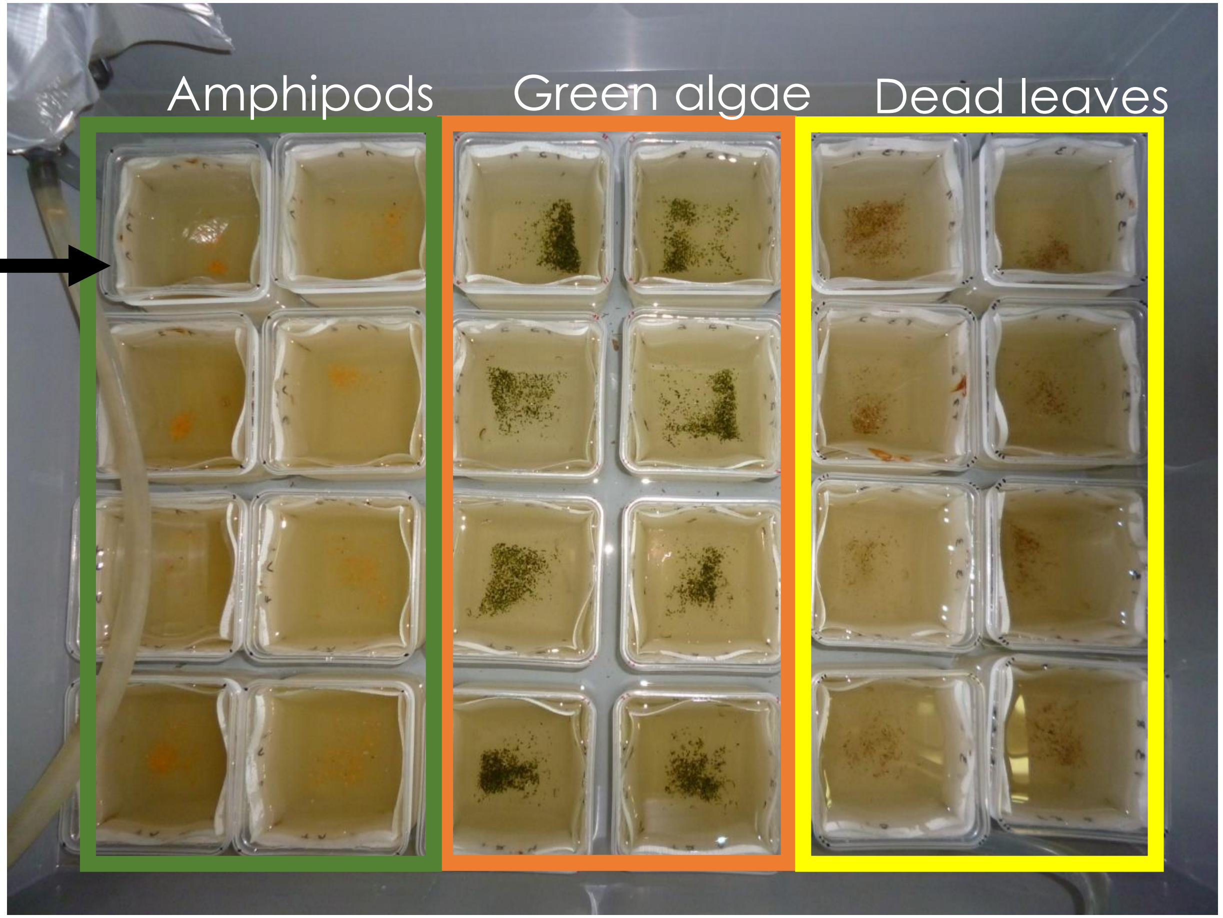
- Freshwater amphipod powder
- Green algae powder
- Dead *P. oceanica* powder



- Different carbon and nitrogen isotopic compositions
- Different quality (C/N ratios)
- All <u>potentially</u> ingestible by G. *aequicauda*

TEF Determination: Experimental design

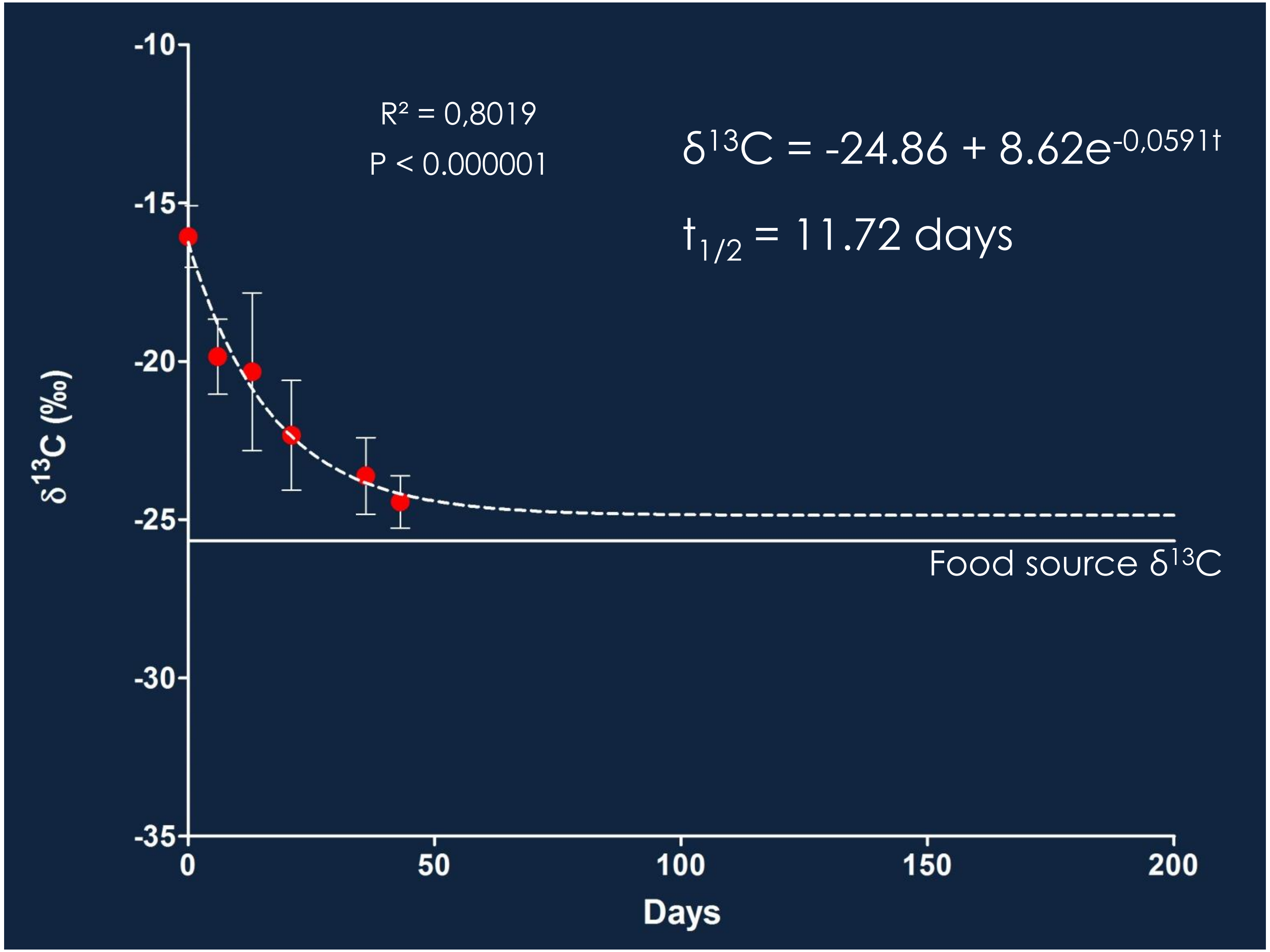




- Controled conditions
- 96 ind / treatment (individual isotopic compositions

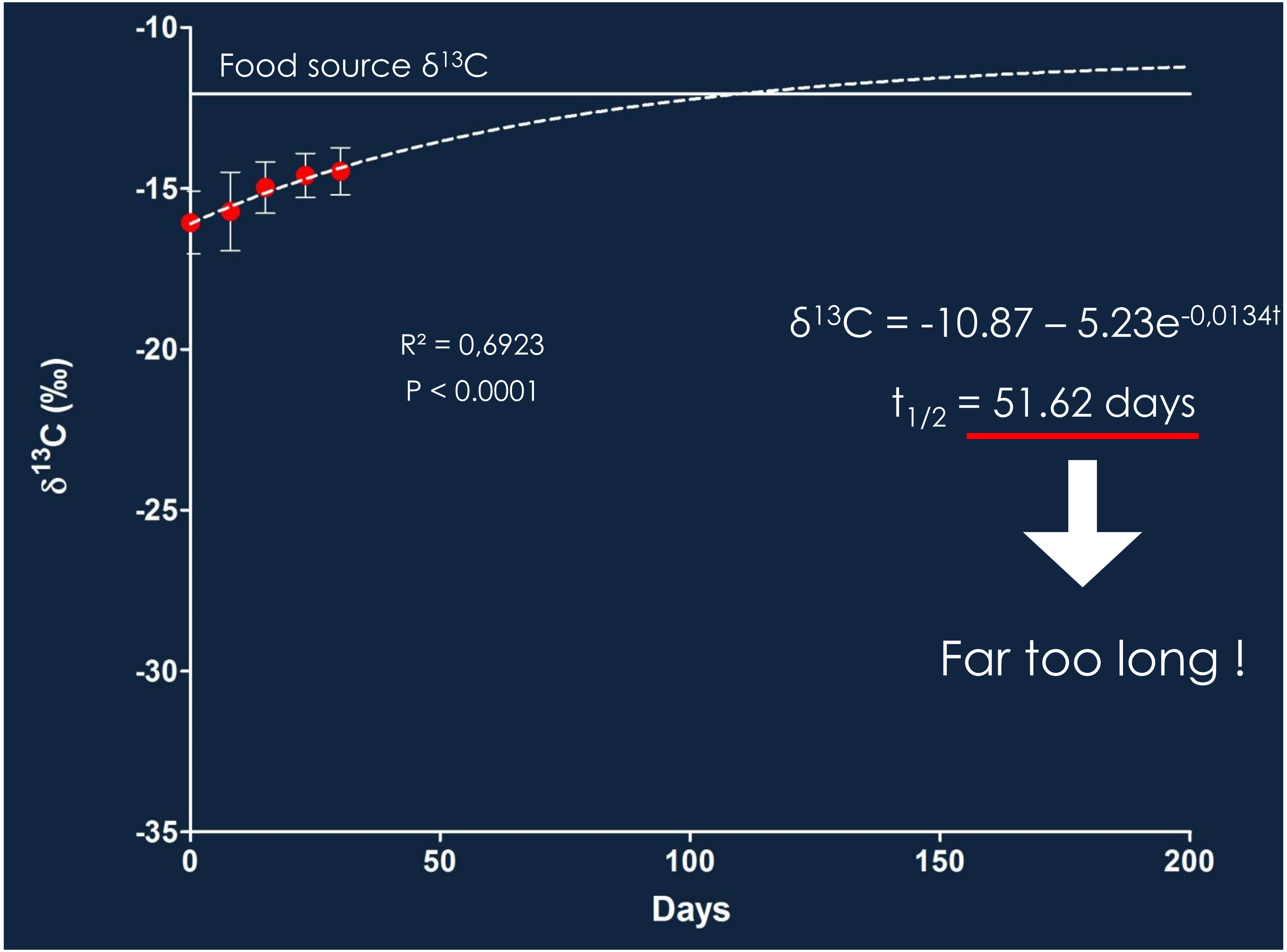
TEF Calculations and C turnover

Amphipod as food



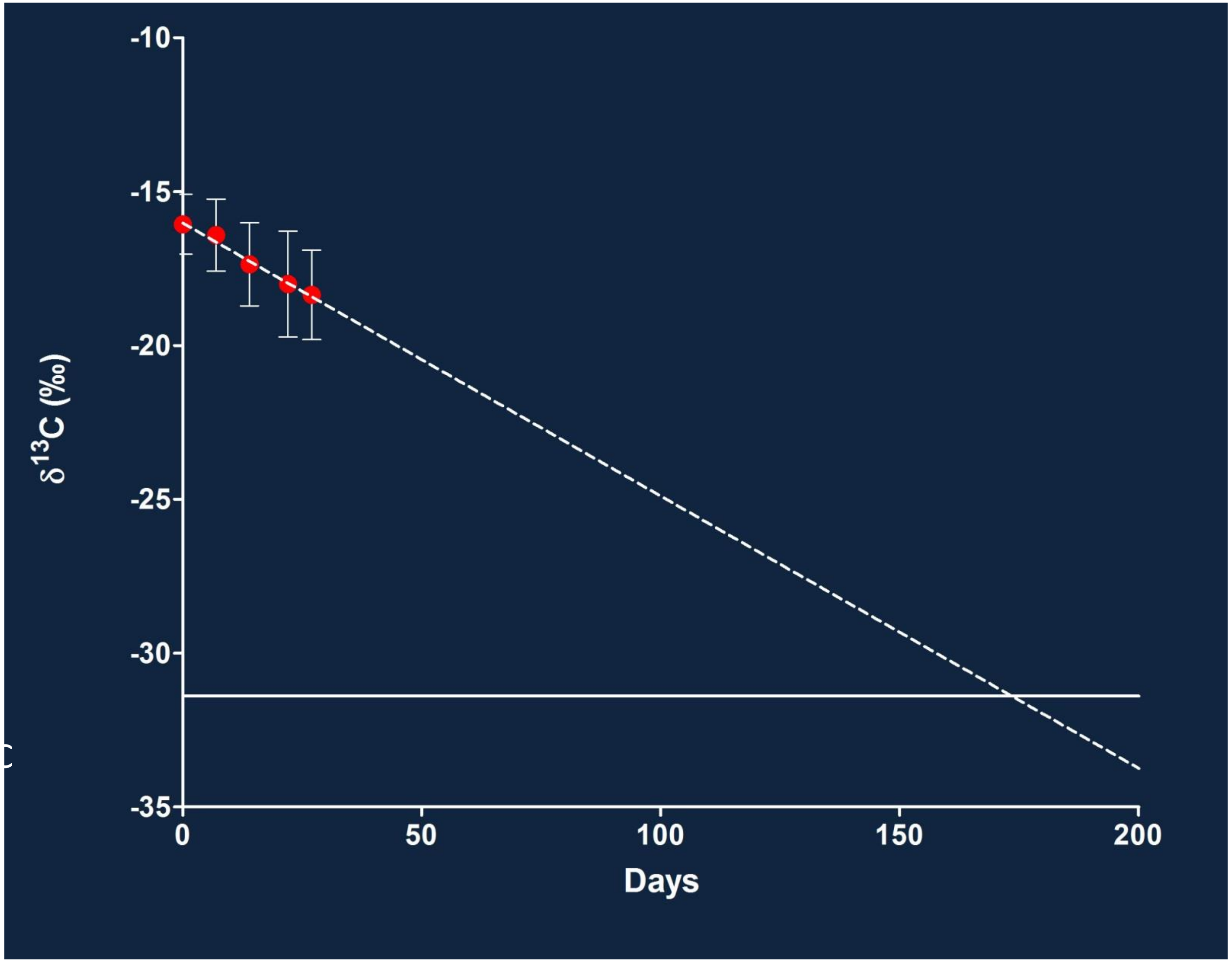
Posidonia litter as food

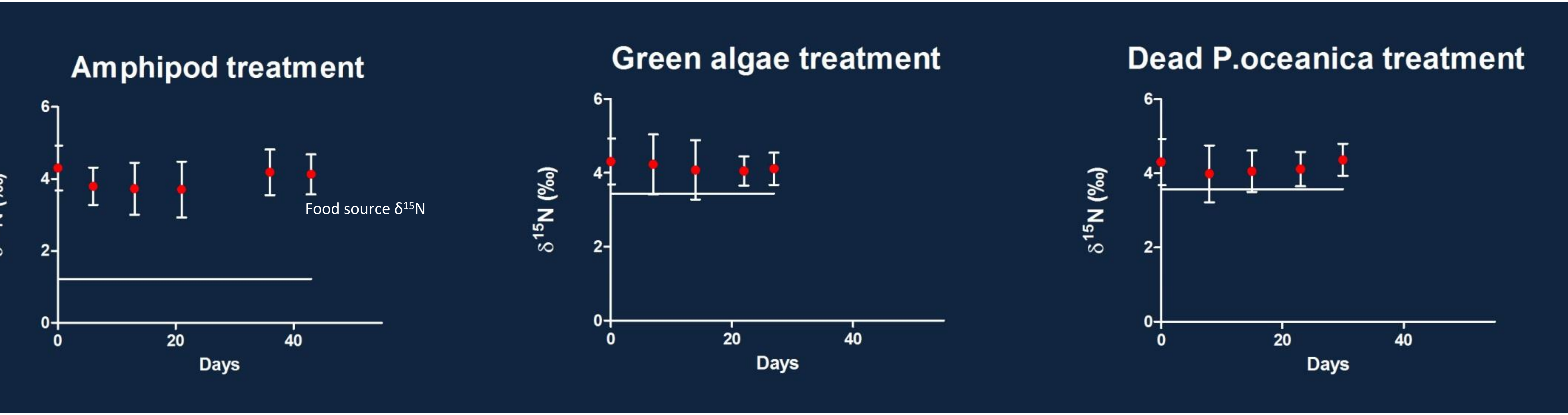
- High mortality
- Very slow assimilation



Green Algae as food:

Even worst (algae toxicity)





No significant change of isotopic composition

➔ No turnover rates calculation

Trophic Enrichment Factors : TEFs or Δ

	1	2	3
	Amphipod treatment	Algae treatment	Litter treatment
$\Delta^{13}C$ (‰)	0.81 ± 0.39	/	1.19 ± 0.13
$\Delta^{15}N$ (‰)	$\boxed{2.91 \pm 0.56}$	0.53 ± 0.44	0.96 ± 0.42

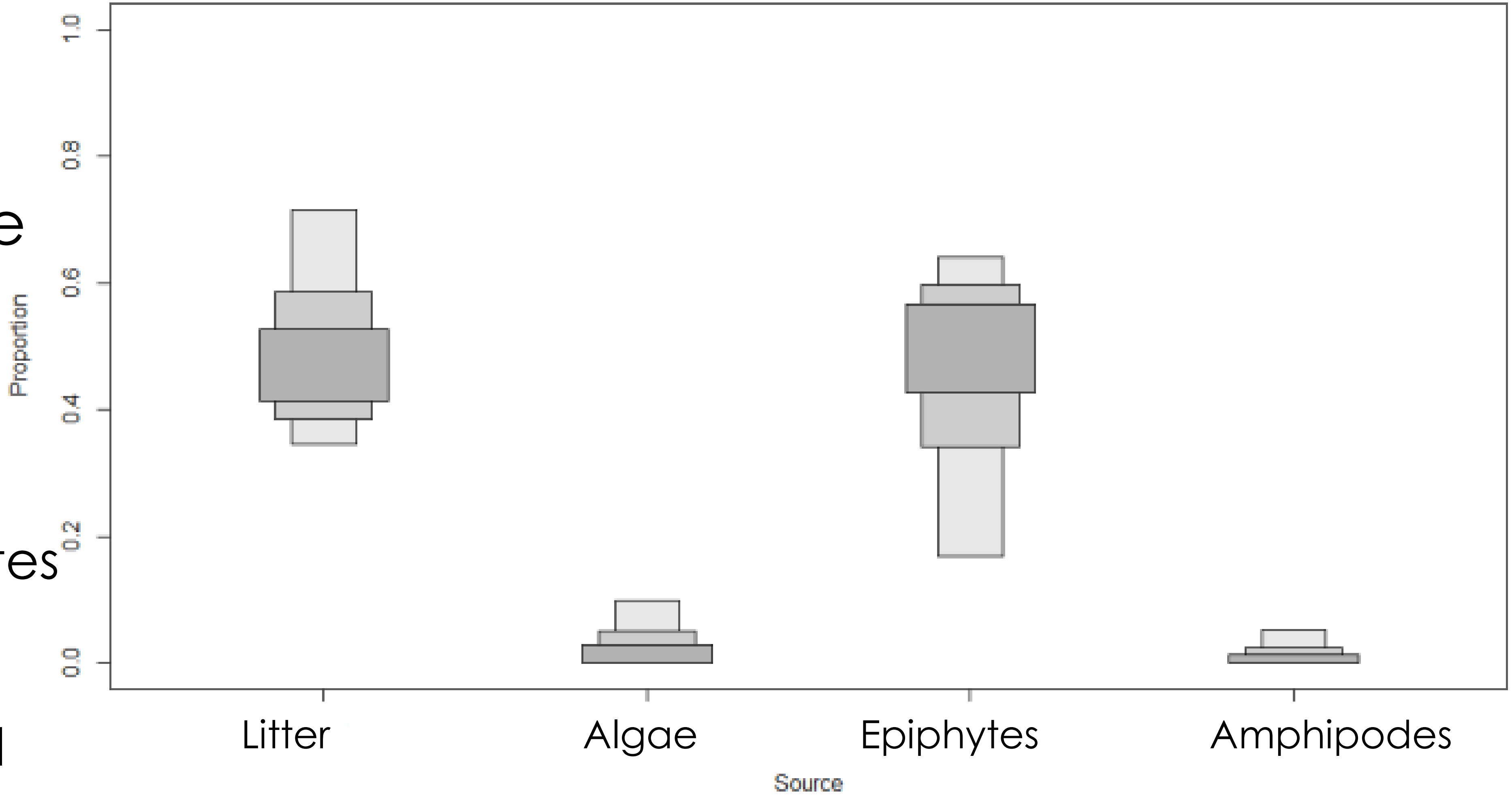
Treatment 1 ➔ typical of predator

Treatments 2 & 3 ➔ typical of primary detritic-feeder

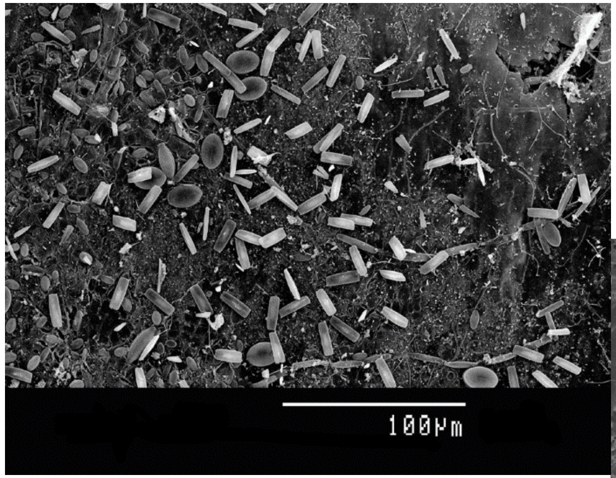
SIAR Modeling : the return

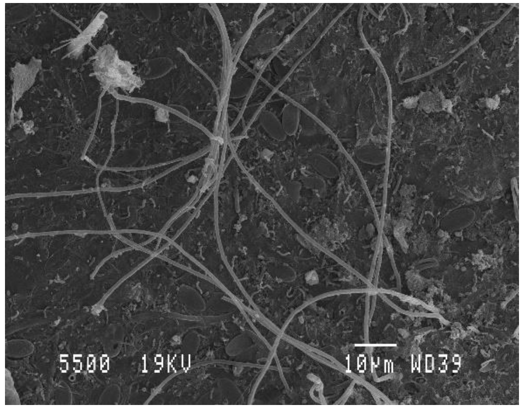
TEF: food source specific

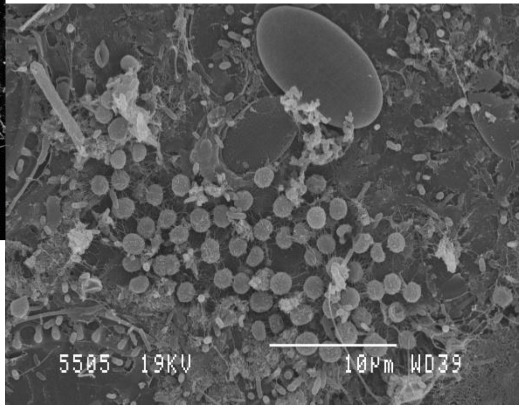
(experimentally determined by Michel for epiphytes and by Remy for litter, sciaphilous algae and animal diets)



* Bulk IRMS does not discriminate different component of epiphytic community







- Discriminate different component of epiphytic community using GC –IRMS

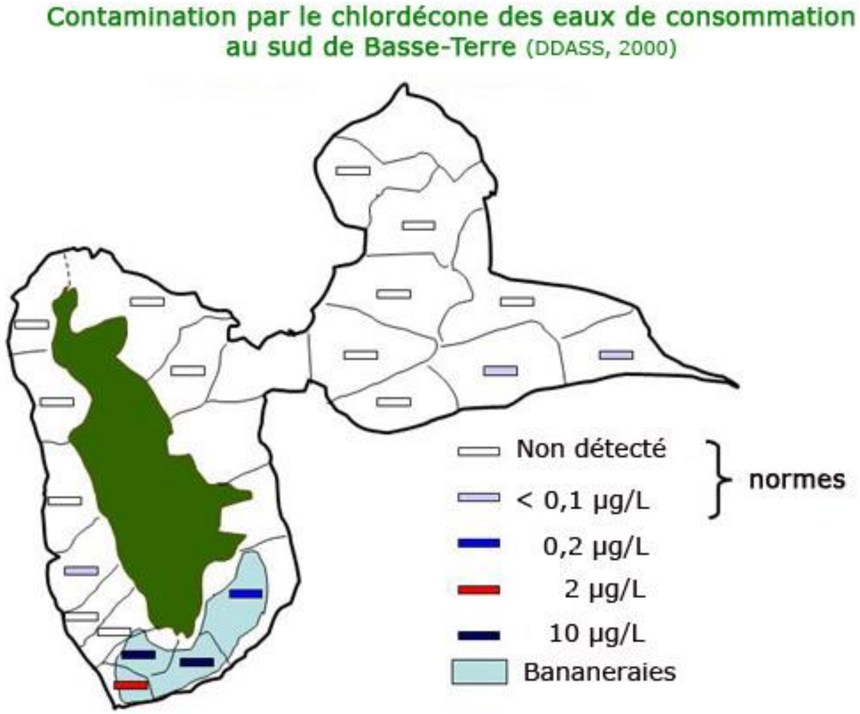
⇒ Measurement of delta ^{13}C on fatty acids

Next Elementar Seminar

Case study 2: to elucidate contamination pathway of an organochlorine pesticide

Organochlorine pollution in tropical rivers (Guadeloupe): Role of ecological factors in food web bioaccumulation

•Heavy contamination by organochlorine pesticides (Banana culture)



•What is the general structure of the trophic web?

•Is there a relation between trophic level and pollutant contamination

Figure 1: Pérou River sampling site (Guadeloupe)

Figure 2: Example of crustacean species found the river Pérou fauna (photos: Nicolas Marichal)

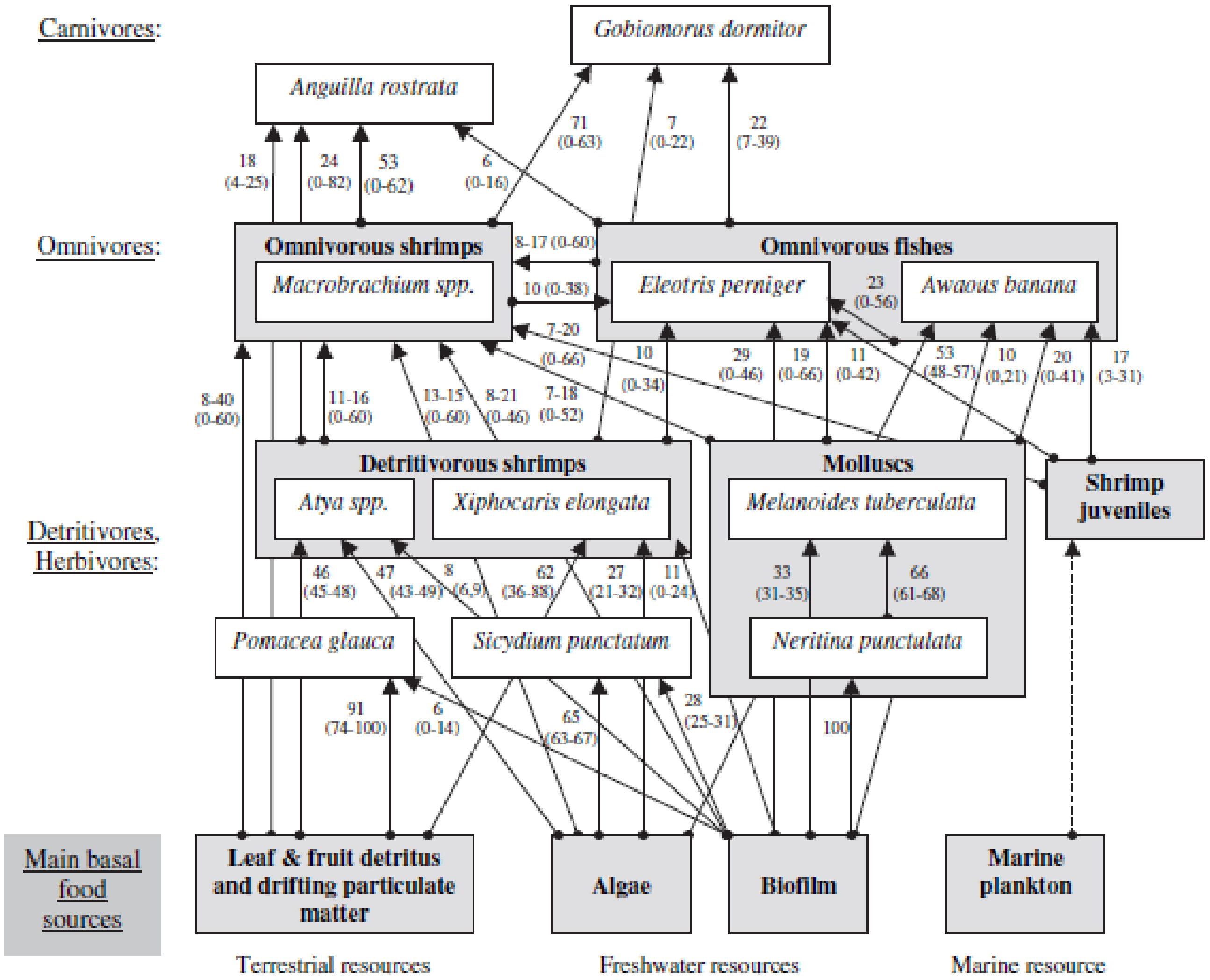


Fig. 2 Food web of a Caribbean stream (Grande-Anse, Guadeloupe), based on stable isotope analysis (grey units show elements with similar carbon isotopic signatures and constitute the dominant potential food sources of this aquatic ecosystem during the dry season. Mean percent contributions of sources to adult consumers are indicated below the arrows when ≥5%. They are followed by the minimum and the maximum in parentheses (the presence of two means indicates a range of contributions for the different species of a genus). Arrows start with a black dot and link species and/or units). 208 × 179 mm (600 × 600 DPI).

Source: Coat et al. (2009) Freshwater Biology 54, pp. 1028-1041 ,

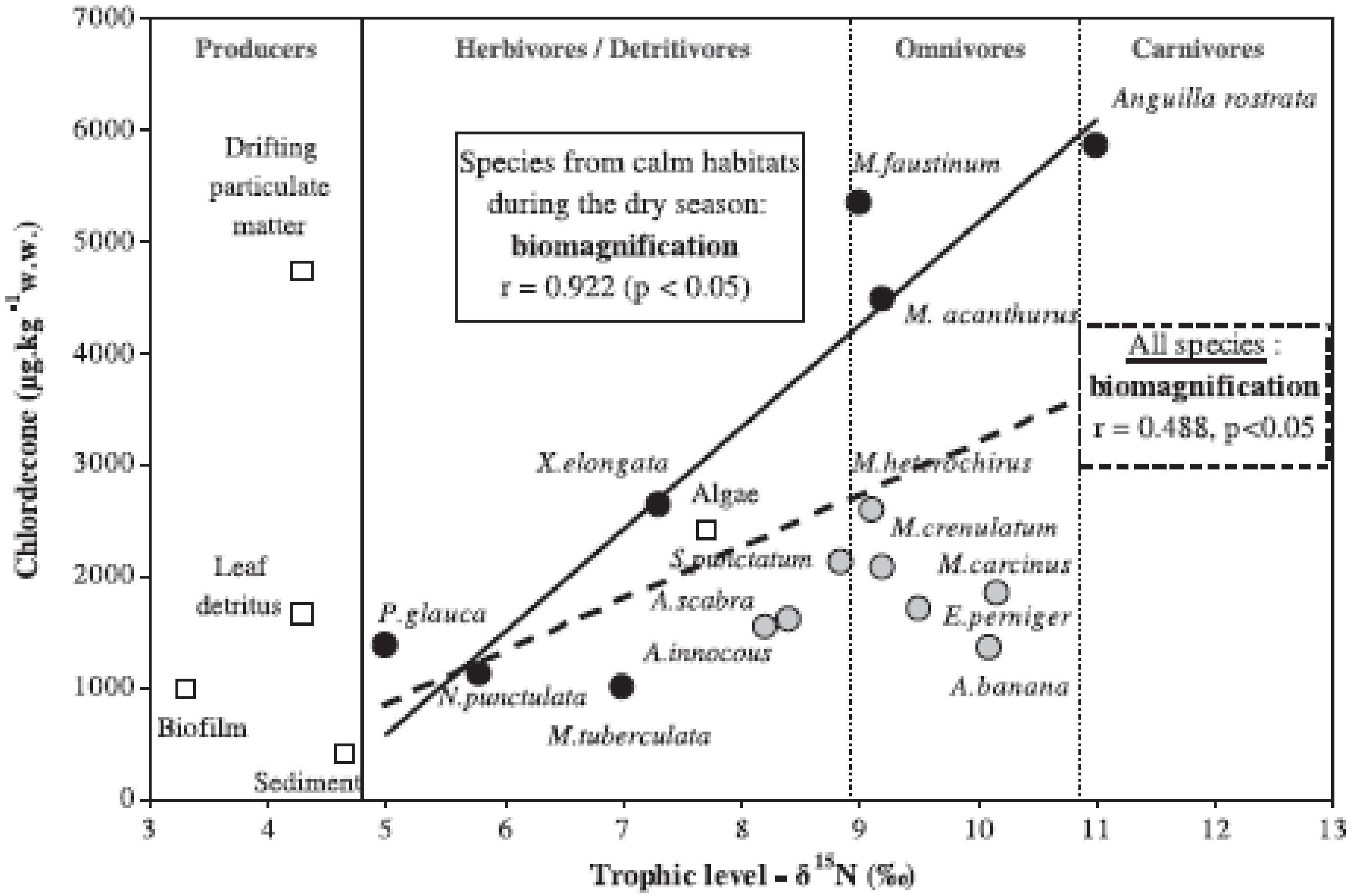
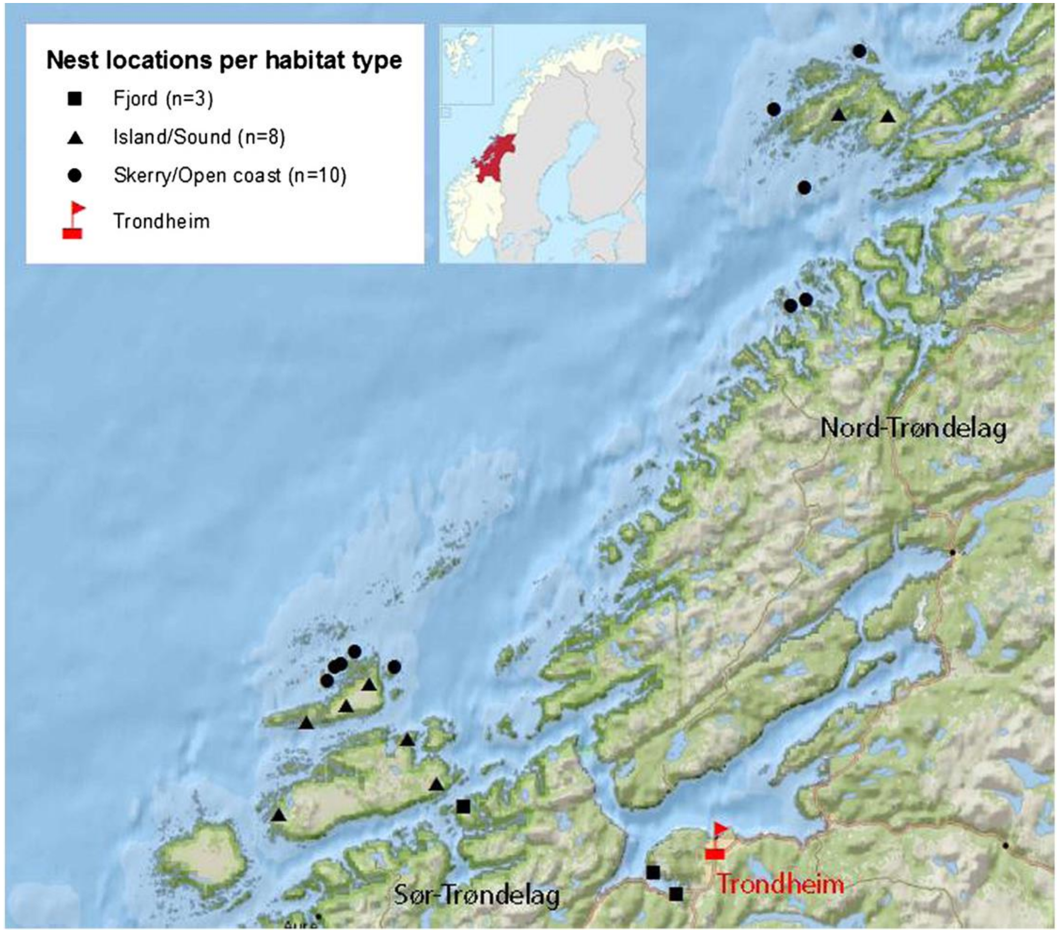
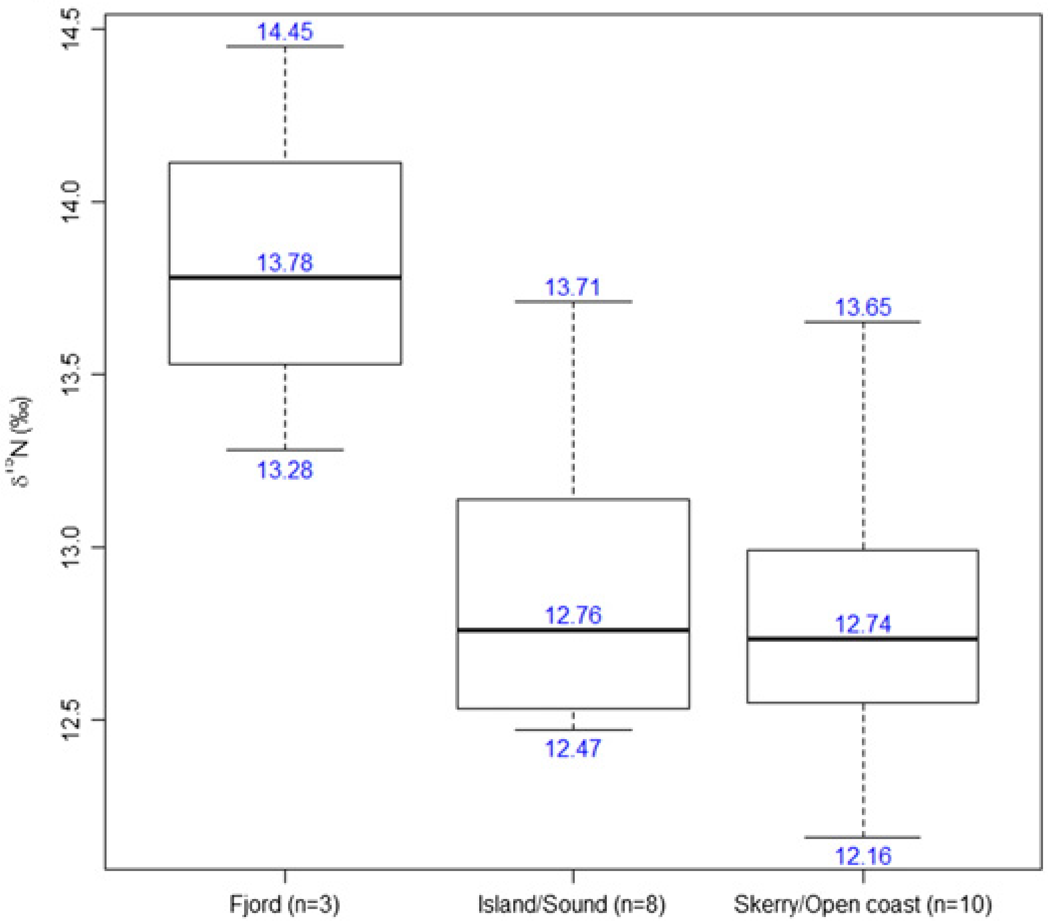


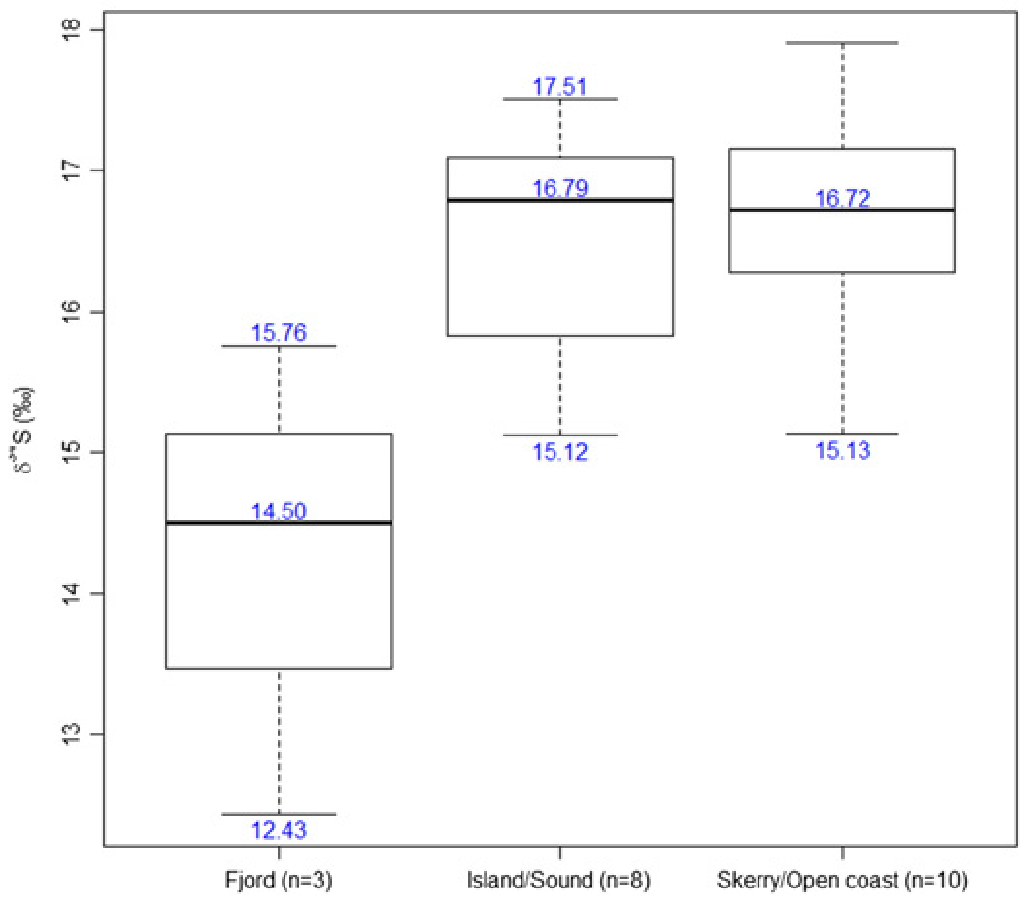
Fig. 3. Chlordecone concentrations versus trophic level measured in river samples during the dry season (the hatched regression line represents the statistically significant relationship in biota (all circles), the complete regression line only takes into account the species living in calm habitats (black circles), no relationship is observed for the species living in rapid running waters (grey circles)).

Source: Coat et al. (2011), Environmental Pollution 159: 1692-1701

Case study 3: Brominated and phosphorus flame retardants in White-tailed Eagle *Haliaeetus albicilla* nestlings: Bioaccumulation and associations with dietary proxies ($\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$)







C, N, S stable isotopes measurements in feathers

source: Eulaers et al., 2014

Thank you for your attention