# Application of stable isotopes in trophic ecology:

## Importance of TEF and seasonal baseline for robust interpretations

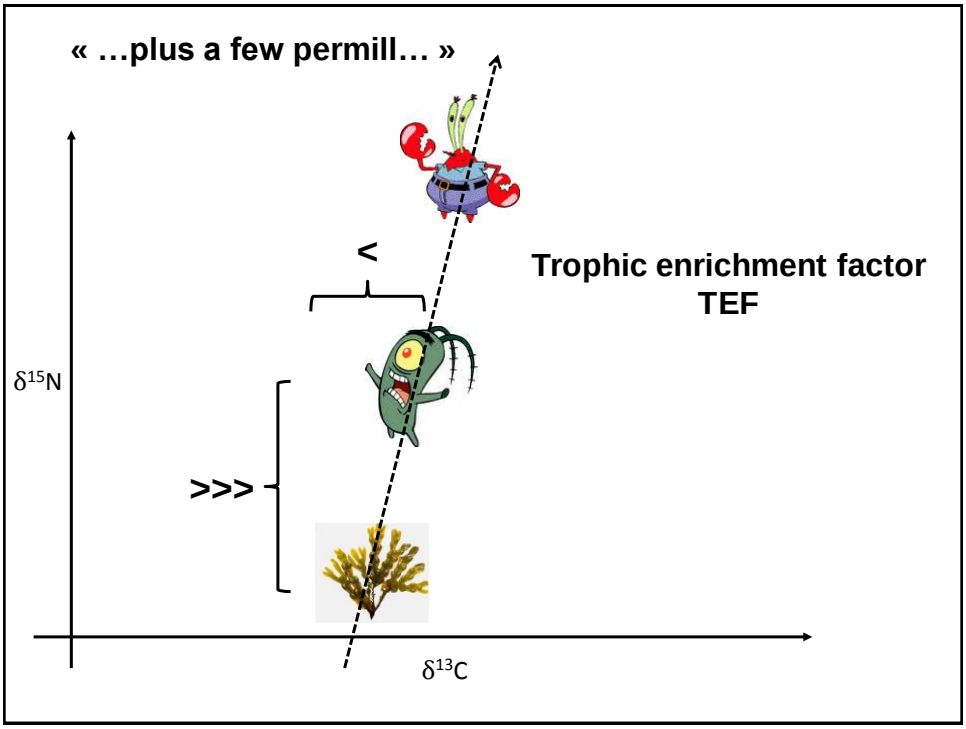
**François REMY**, Aurélie Melchior, Thibaud mascart & Gilles Lepoint

Laboratory of Oceanology
University of Liège

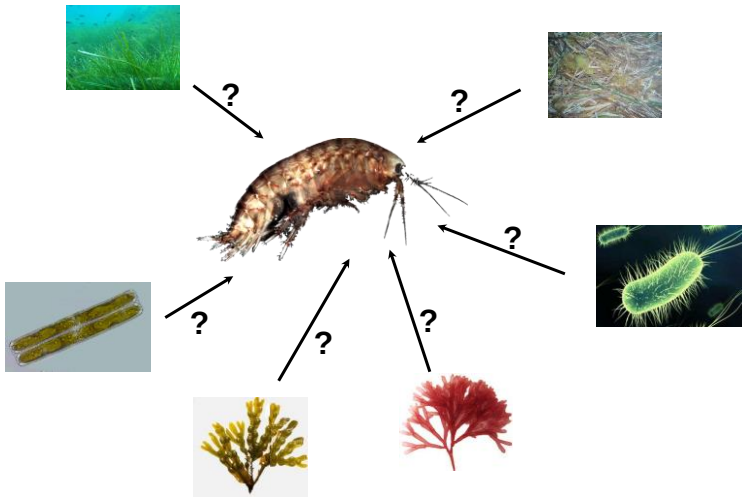
**Why using stable isotopes in trophic ecology?**

➔ Mixing Law in trophic ecology:


"You are what you eat, plus a few permil…" (DeNiro & Epstein 1976)




**QUESTION :**




Can we calculate the contribution of each potential food source of an animal diet from the isotopic compositions?

**Yes !!** ➔ Using Mixing Models

For ***n*** sources the mixing equation is :

$$\boldsymbol{\delta_m = (fa\delta_a + fb\delta_b + fc\delta_c + \cdots)}$$

$$\boldsymbol{fa\delta_a + fb\delta_b + fc\delta_c + \cdots = 1}$$

Complex Bayesian Mixing models : SIAR, MixSIAR, FRUITS…

See : Parnell *et al*. 2010; Fernandes *et al*. 2014…

**Case study 1 : TEF determination for the amphipod *Gammarus aequicauda***

1 cm

*Posidonia oceanica*
meadow


Macro-algae

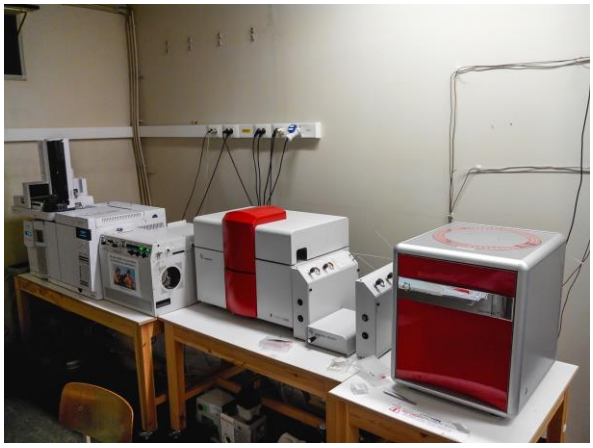
*P.oceanica* dead leaves

Micro-organisms

*P.oceanica* living leaves

« Dead leaves litter »


50-90 %
exported



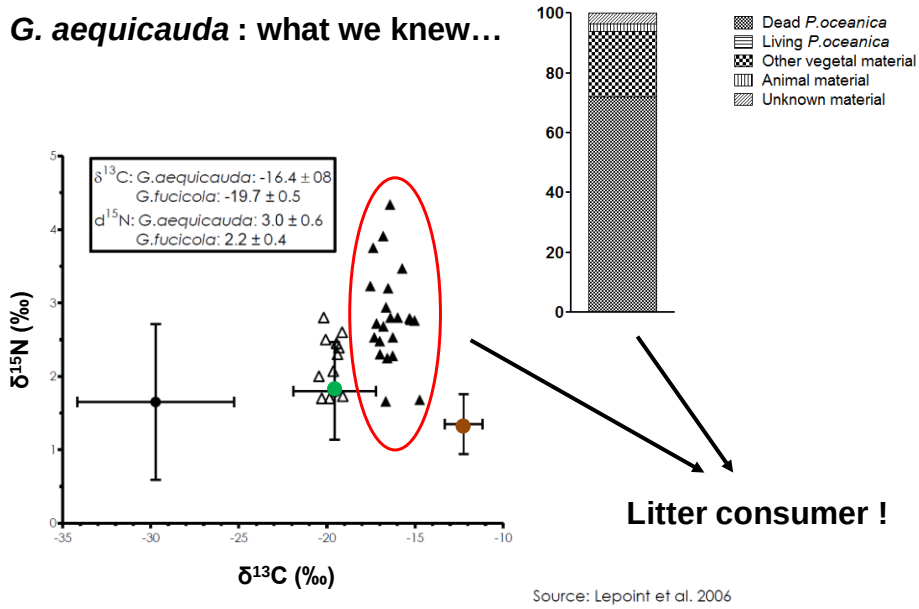
elementar
EXCELLENCE IN ELEMENTS

isoprime
FOCUSING PRECISION

Agilent Technologies

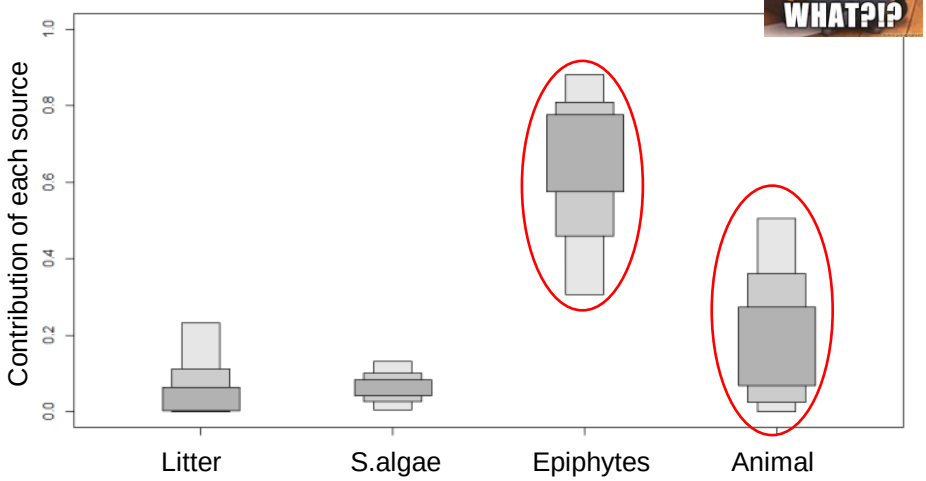
EA-IRMS (Isoprime100® IRMS+Vario MicroCube®EA)
+
GC-MS (Agilent7890A ®)

## *G. aequicauda* : what we knew…




Source: Lepoint et al. 2006

## SIAR run with litterature TEF ➔ wrong !!

## Experimental design

**3** different treatments :

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

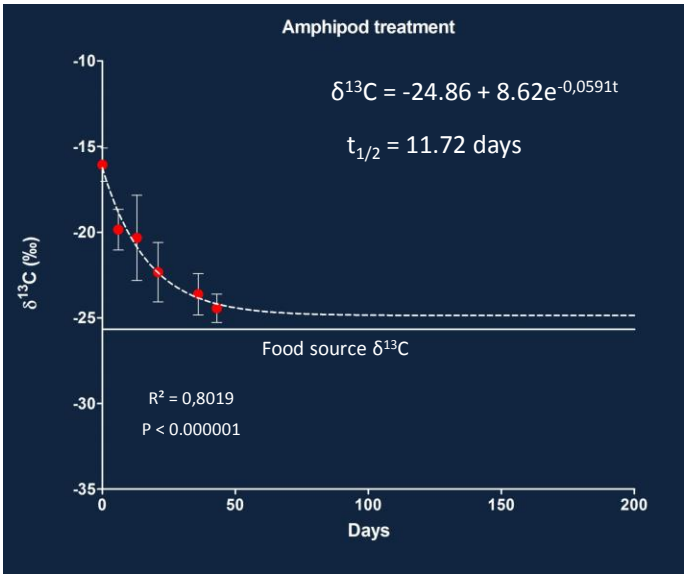
(1-2 mm powder)



Different carbon isotopic compositions
Different quality (C/N)
All potentially ingestible by *G. aequicauda*

## Experimental design

## Results




## Results

Trophic Enrichment Factors : TEFs or **Δ**

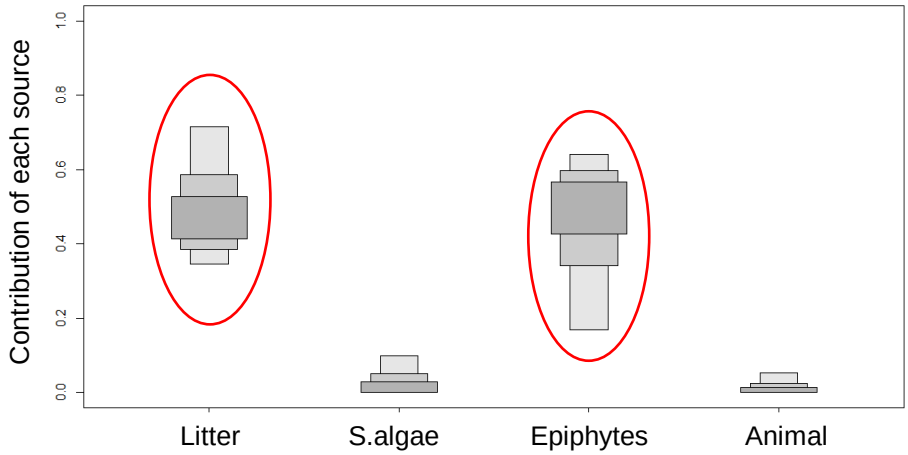
| | 1<br>**Amphipod treatment** | 2<br>**Algae treatment** | 3<br>**Litter treatment** |
|---|---|---|---|
| $\Delta^{13}C$ (‰) | 0.81 ± 0.39 | / | 1.19 ± 0.13 |
| $\Delta^{15}N$ (‰) | 2.91 ± 0.56 | 0.53 ± 0.44 | 0.96 ± 0.42 |

Treatment 1 ➔ typical of predator

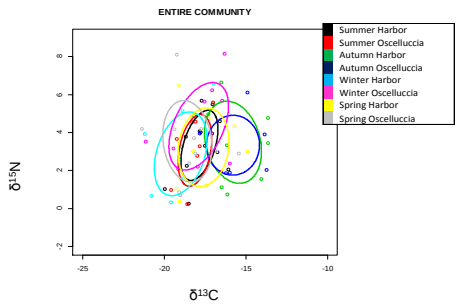
Treatments 2 & 3 ➔ typical of primary detritic-feeder

SIAR new run with custom TEF ➔ <u>better</u> !!

TEF = major parameter




## Case study 2 - Isotopic composition modifications: baseline variations *vs.* real diet shift?



## Litter patches are dynamic places!

31/10/12 – 16:00h ⋯⋯▸ 01/11/12- 10:00h

Mean thickness: 53,4 cm
Cover : 100%

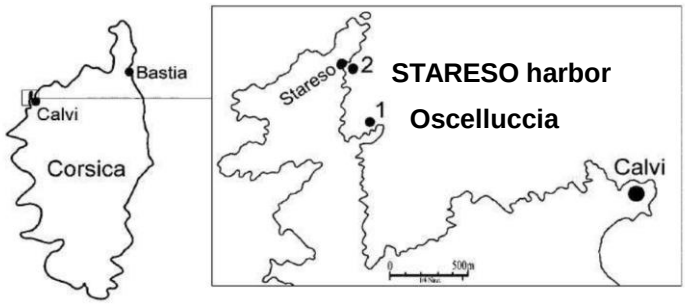
Mean thickness: 1,8 cm
Cover : < 5%

➔ Potential effect on food availability/type !!

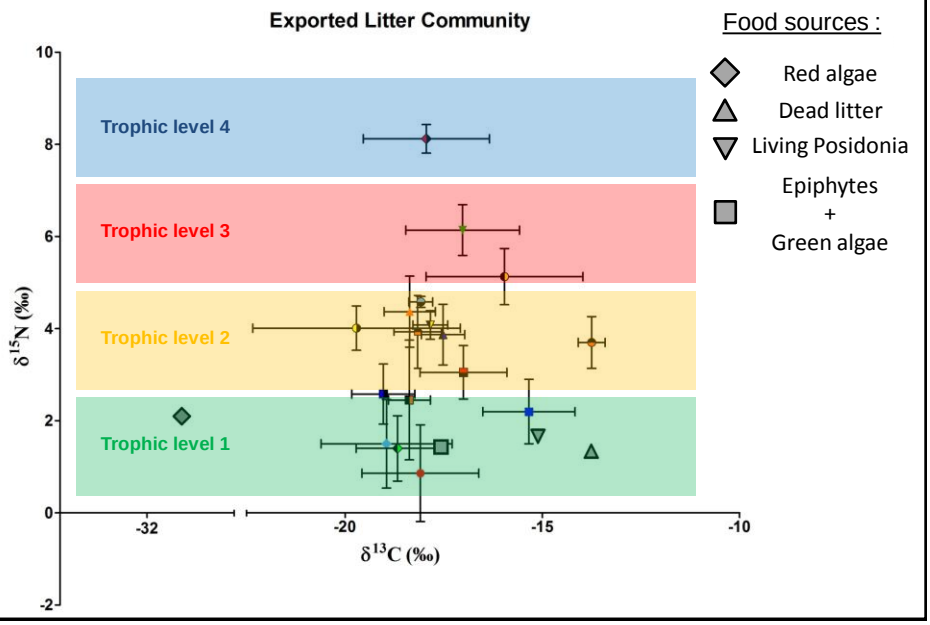
## Sampling design

STARESO
Station de Recherches Sous-Marines et Océanographiques

- 4 seasons
- 2 sites
- Litter, macrofauna AND potential food sources

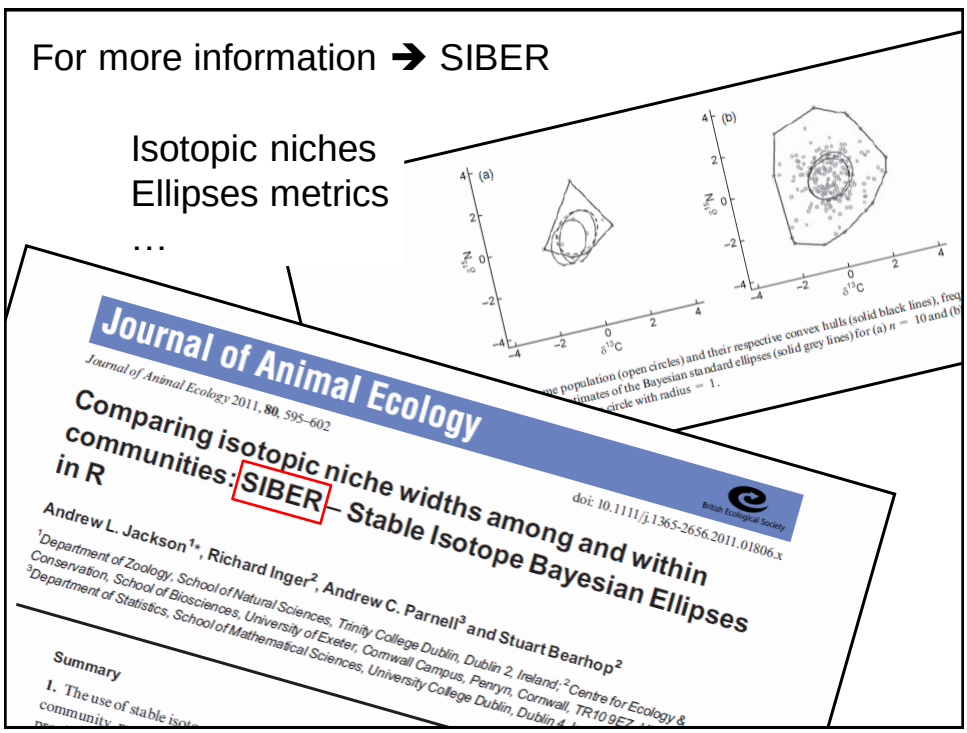


## Results

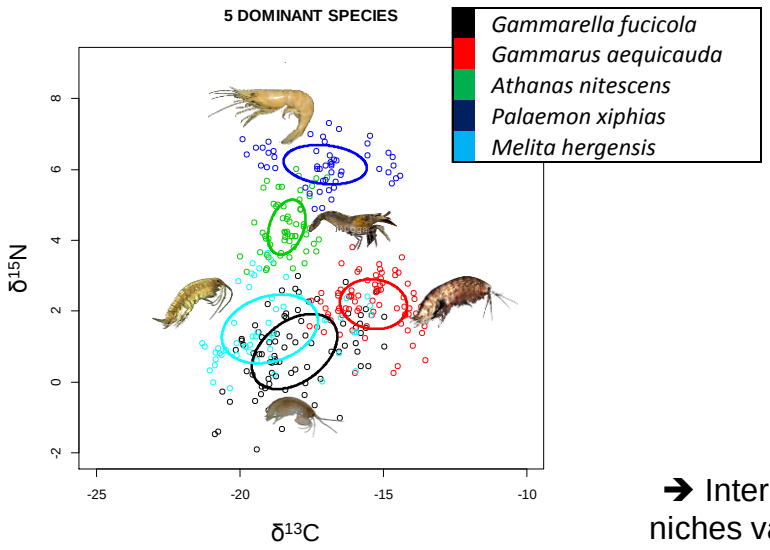



## For more information ➔ SIBER

Isotopic niches
Ellipses metrics
…

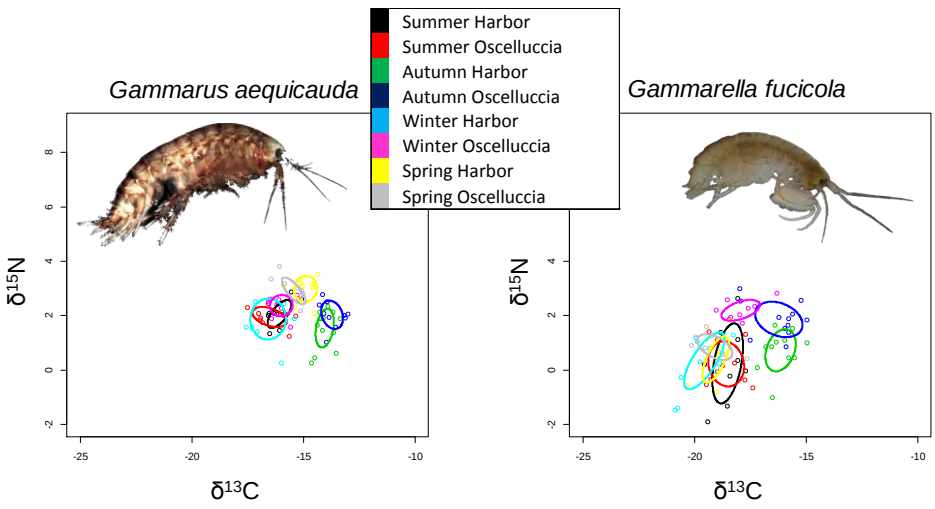


## Results




➔ Interspecific niches variations

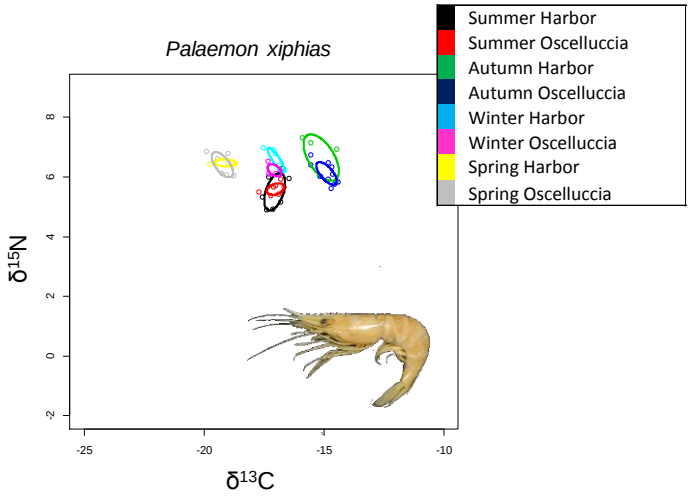
## Results



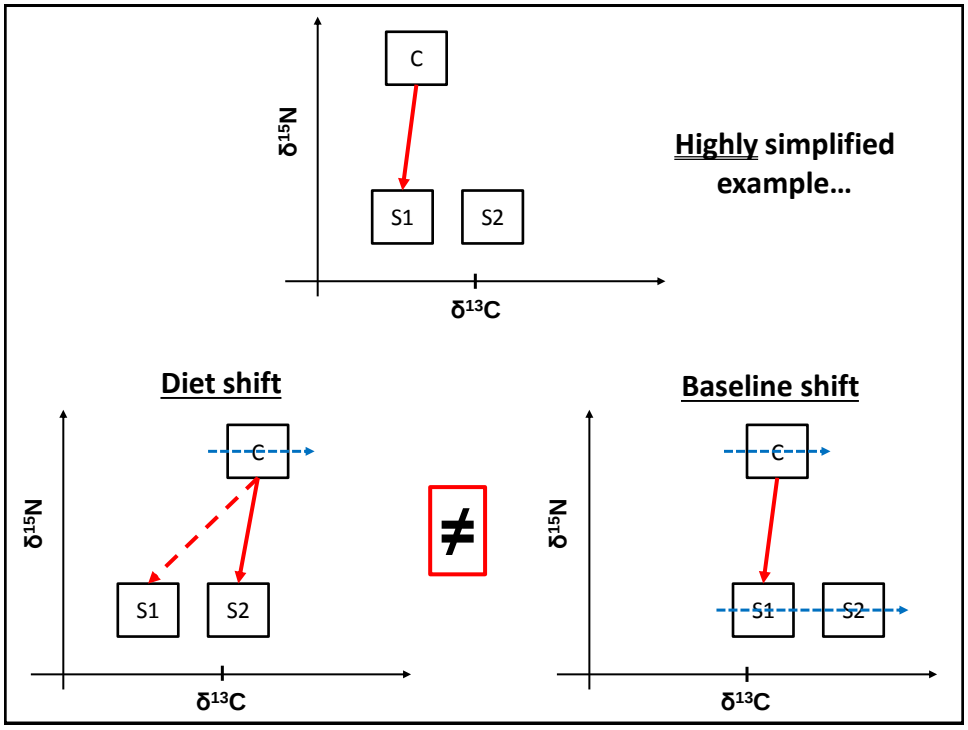

➔ Spatio-temporal intraspecific level niche variations

## Results

**Also true for their predator…**




**Question :** are these clear variations due to actual diet modifications or only to a baseline shift of the food sources?




## How to answer that question?

Time to remember an old friend :

## SIAR

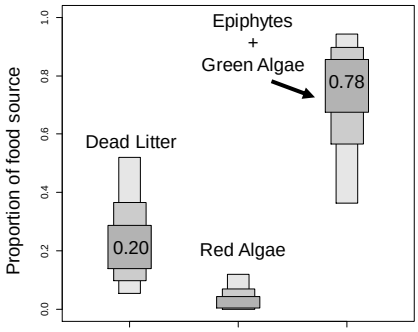
**Why?**

➔ **It uses food sources compositions**

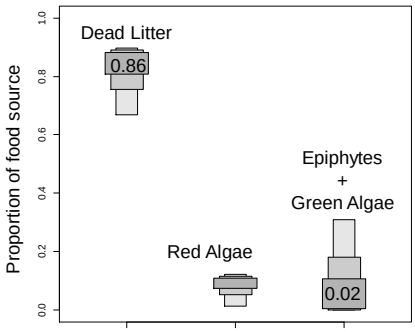
# Results

Use of the custom TEF from Case study 1 !!

*Gammarus aequicauda,* **summer**, site 1

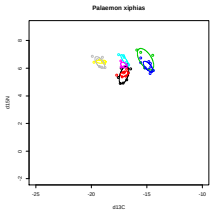



*Gammarus aequicauda,* **autumn**, site 1

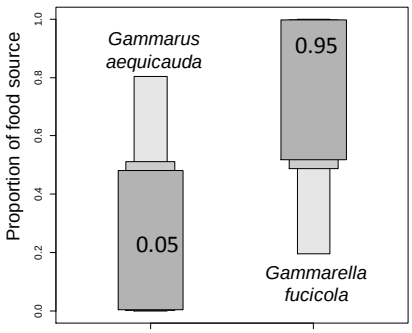



**Real diet change independently of food sources isotopic composition!**

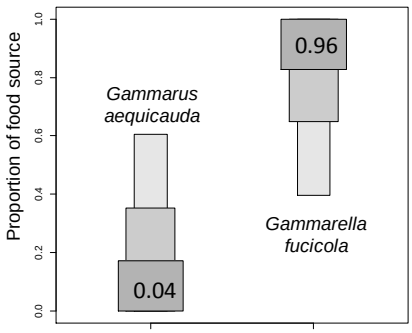
# Results




*Palaemon xiphias,* **summer**, site 1




*Palaemon xiphias,* **autumn**, site 1




**For *P. xiphias* ➔ looks more like a baseline shift**
**BUT : warning…**

## SIBER+SIAR

➔ Variations of “isotopic niche”
➔ Potential origin of the changes

## BUT…

Need to sample sources
Specific level data analysis when possible
TEF are a major parameter

## Acknowledgment

The authors warmly thank the STARESO field station staff for their support during the sampling campaign.

The first author acknowledges a PhD F.R.I.A. grant (**F**und for **R**esearch training in **I**ndustry and in **A**griculture) of the Belgian National Fund for Scientific Research (FRS-FNRS).

**Thank you for your attention !**