Changes in the diet of Bay of Biscay sardines according to sampling location and age, through fatty acid composition

Mathilde BERTRAND

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Spatial and ontogenetic variations in sardine feeding conditions in the Bay of Biscay through fatty acid composition

Mathilde Bertrand [a,b,*], Pablo Brosset [a,b,c], Philippe Soudant [b], Christophe Lebigre [a,**]

[a] *Ifremer, Laboratoire de Biologie Halieutique, ZI Pointe du Diable - CS 10070, 29 280 Plouzané, France*
[b] *Université de Brest - UMR 6539 CNRS/UBO/IRD/Ifremer, Laboratoire des sciences de l'environnement marin - IUEM - Rue Dumont D'Urville - 29280 - Plouzané, France*
[c] *ESE, Ecologie et Santé des Ecosystèmes, Agrocampus Ouest, INRAE, 65 rue de Saint-Brieuc, 35042, Rennes Cedex, France*

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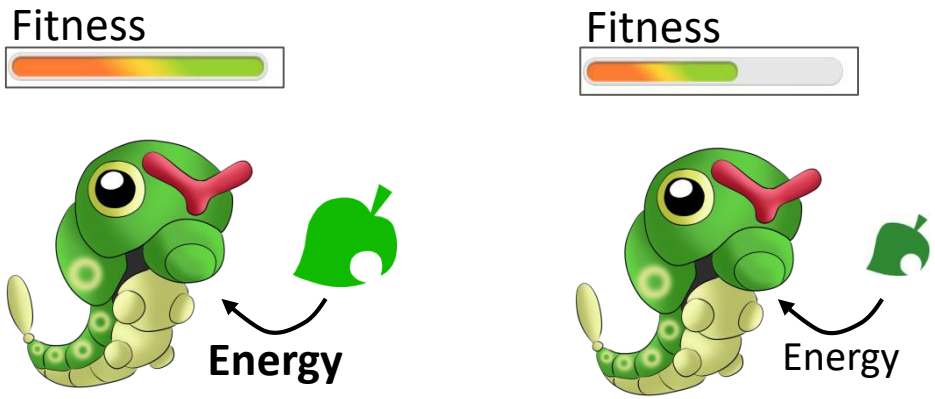
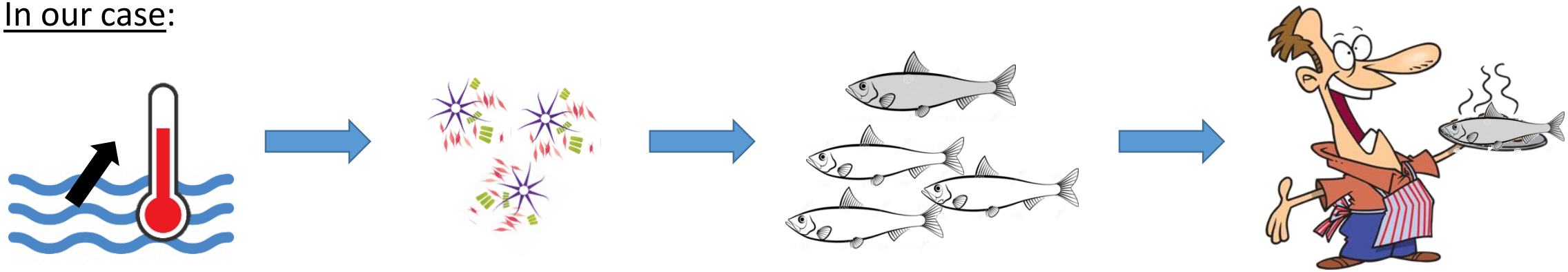


- Quantity and quality of food influence the survival, growth and reproductive success of individuals.

<u>In our case</u>:



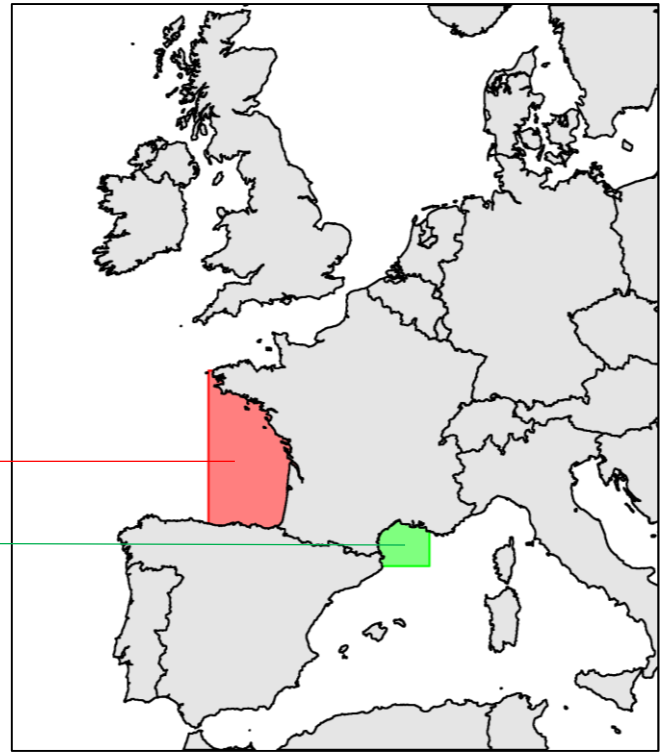
↘ nutritional quality

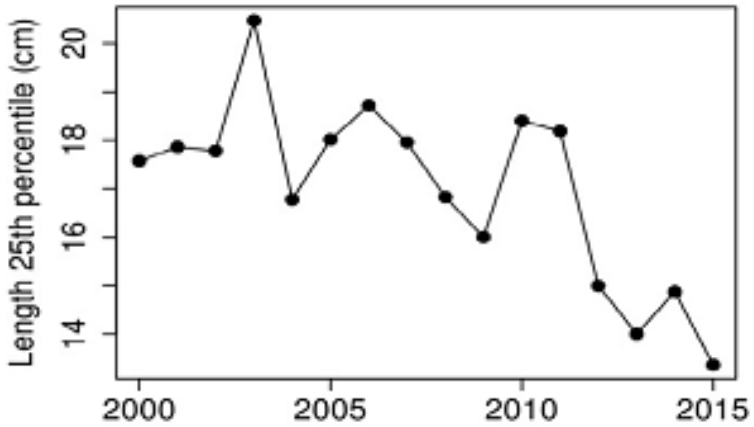
Recruitment and dynamics?

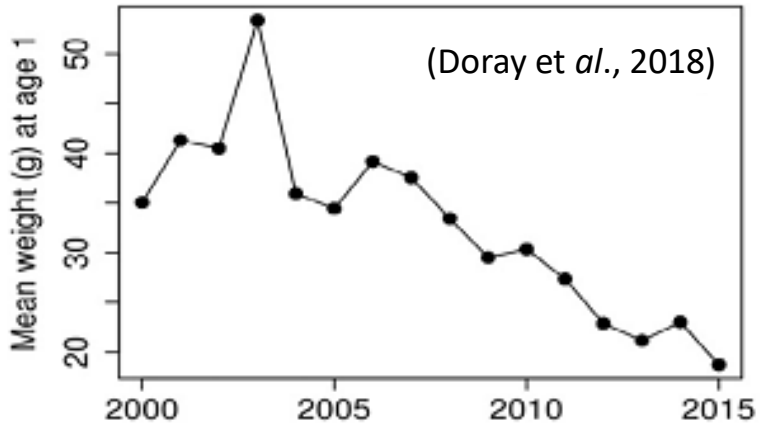
Human food safety?

- Crucial to understand the impact on higher trophic levels.

European sardine
Sardina pilchardus







- Important ecological and economic roles.
- Size-at-age, weight-at-age and body condition decreased, particularly at age 1 sardine.
- Phenotypic trends similar in the Gulf of Lions explained by bottom-up processes.

Changes in the diet of young sardines in the Bay of Biscay?

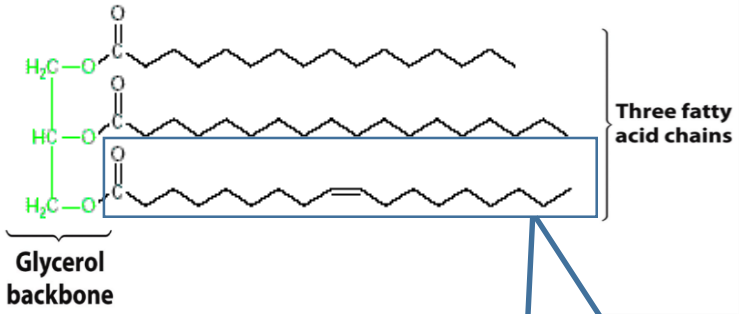
State of the art:

- Feed on small species of zooplankton and phytoplankton.
- Food contribution varies depending on fish length/age, season and region.
- Strong spatial structure of primary producers and zooplankton in the Bay of Biscay.
- Younger sardines usually located in the South of the Bay of Biscay.

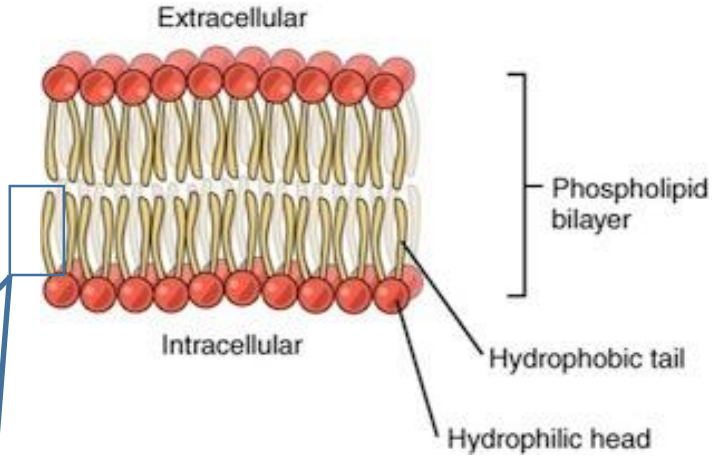
→ Characterisation of fatty acids in sardines from the Bay of Biscay.

- Lipids perform essential biological functions.

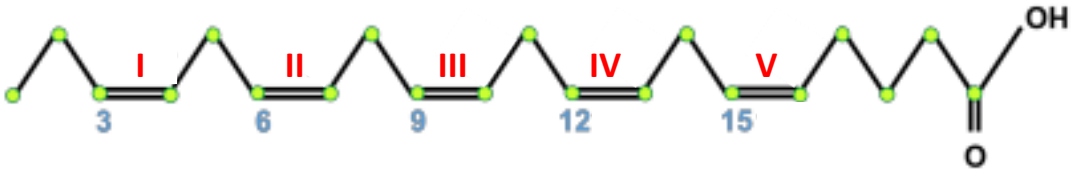
<u>Neutral lipids:</u> metabolic energy source



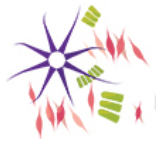
<u>Polar lipids:</u> provide the properties of cell membranes



Fatty acid notation = X:Yn-Z (e.g.: 20:5n-3)



- Fatty acid synthesis chains differ between zoo- and phytoplankton.



22:6n-3

20:1n-9

- Some fatty acids can reflect changes in sardines' diet.

- Marine fish have little or no ability to synthesise essential fatty acids *de novo*.

Fatty acids = food web biomarkers

Prey groups of sardines	Fatty acids trophic markers
Herbivorous copepods (calanoids) 	20:1n-9, 22:1n-11
Diatoms 	16:1n-7,16:2n-4, 16:2n-7, 16:3n-4, 16:4n-1, 20:5n-3
Non-diatom phytoplankton 	18:2n-6, 18:3n-3, 18:4n-3, 18:5n-3, 22:6n-3

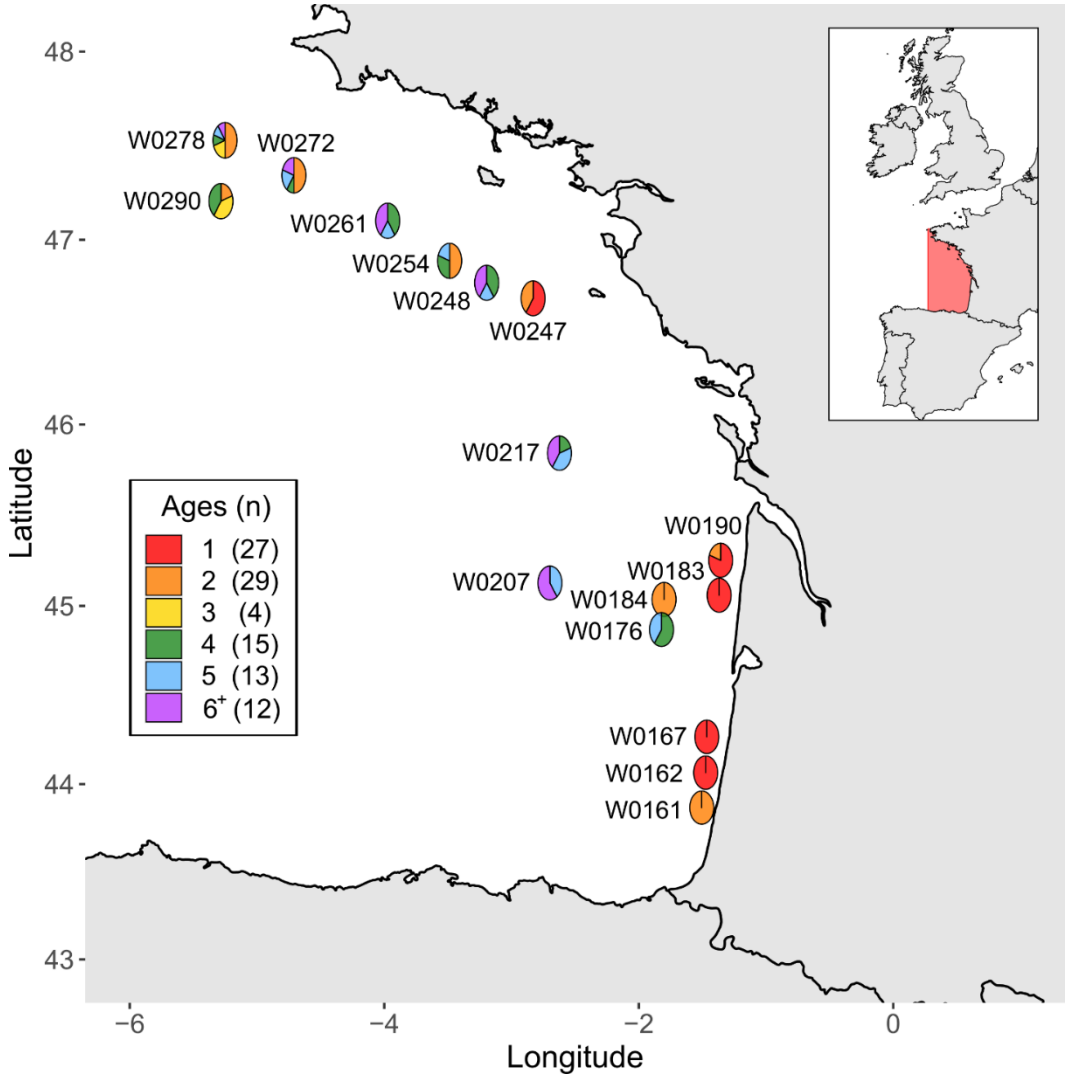
Objectives

- Characterise the fatty acid composition of sardine muscles.
- Determine the link with: - sardine endogenous characteristics.
  - spatial distribution in the Bay of Biscay.
- Understand the sardine feeding conditions thanks to fatty acids trophic markers.

Assumptions

- Sardine fatty acid composition changes according with:
  - individuals' age.
  - sampling location in the Bay of Biscay.
- Dietary changes more visible in the neutral lipids than in the polar lipids.

1. Acquisition of sardine samples: PELGAS 2018



Survey in May 2018 in the Bay of Biscay

- Muscle samples from 100 sardines at the 16 stations.

- Collection of biological parameters:
  - Length,
  - Weight,
  - Sex,
  - Maturity stage,
  - Age (otoliths)

- Heterogeneous sampling: young sardines in the South and older ones in the North.

2. Analysis of samples in the laboratory

Grinding (liquid nitrogen, ball mill) → Lipid extraction 6 mL $CHCl_3$/MeOH

1 mL →

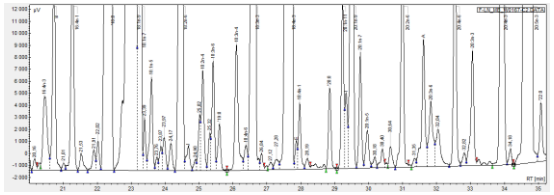
Separation of neutral and polar lipids (silica micro-columns)

1 mL ↓

Identification and quantification of lipid classes by HPTLC
No free fatty acids = no degradation of samples

Transmethylation of neutral lipids

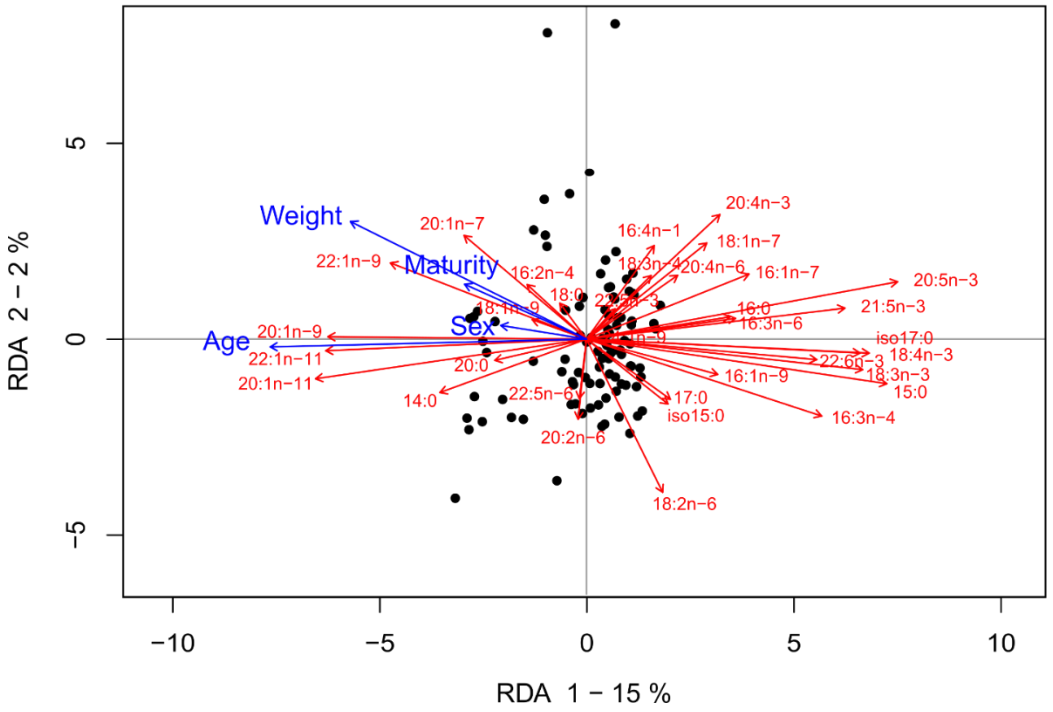
Transmethylation of polar lipids



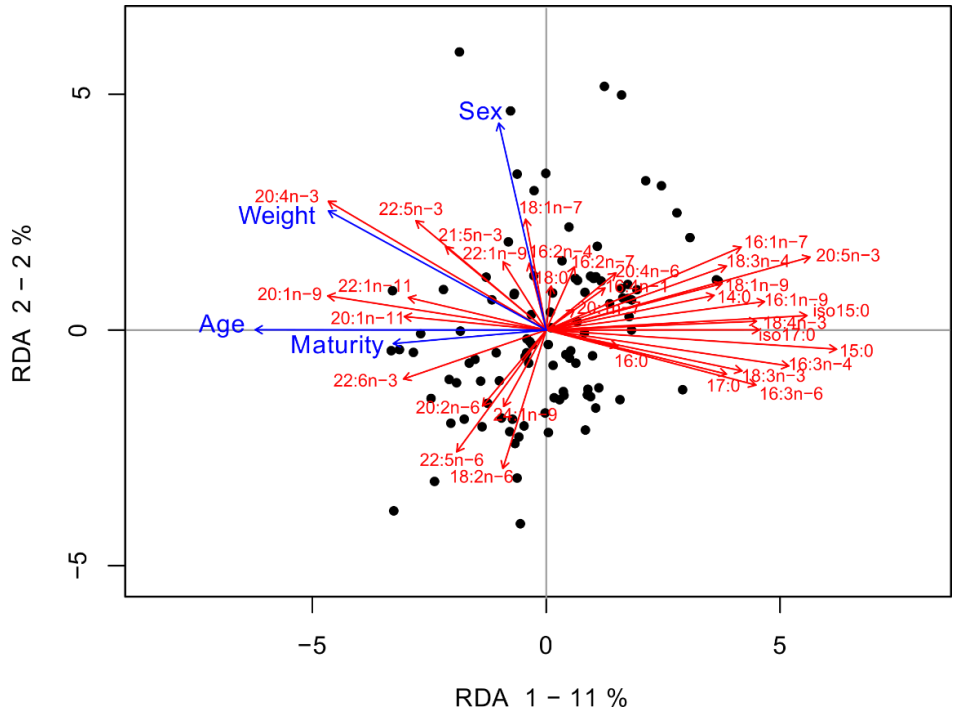
Identification and quantification of fatty acids by GC-FID

1. The relationship between endogenous variables and fatty acids profiles

Neutral lipids



Polar lipids

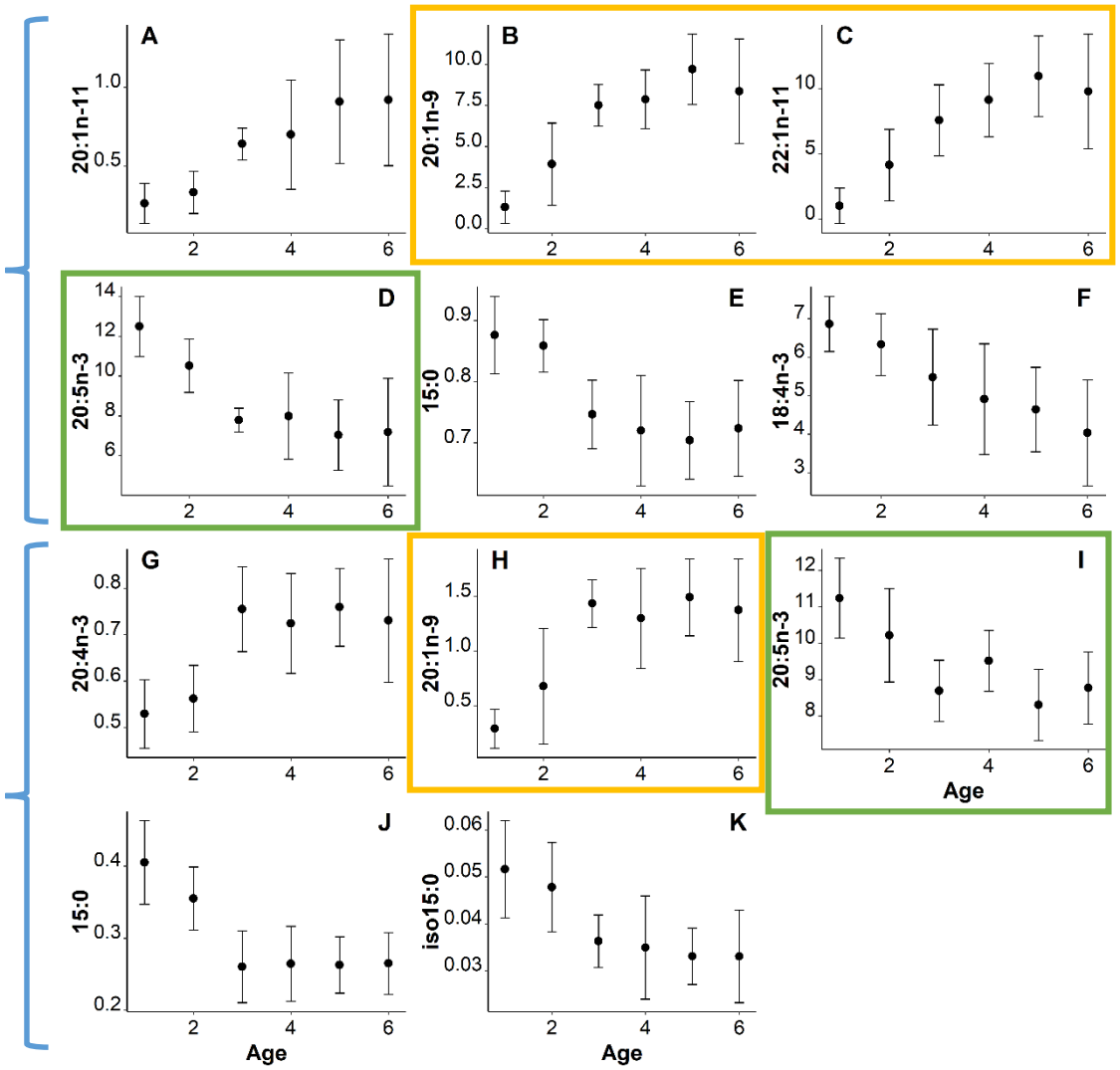


Link between the sardines' age and the amount of certain fatty acids.

1. The relationship between endogenous variables and fatty acids profiles

Neutral lipids

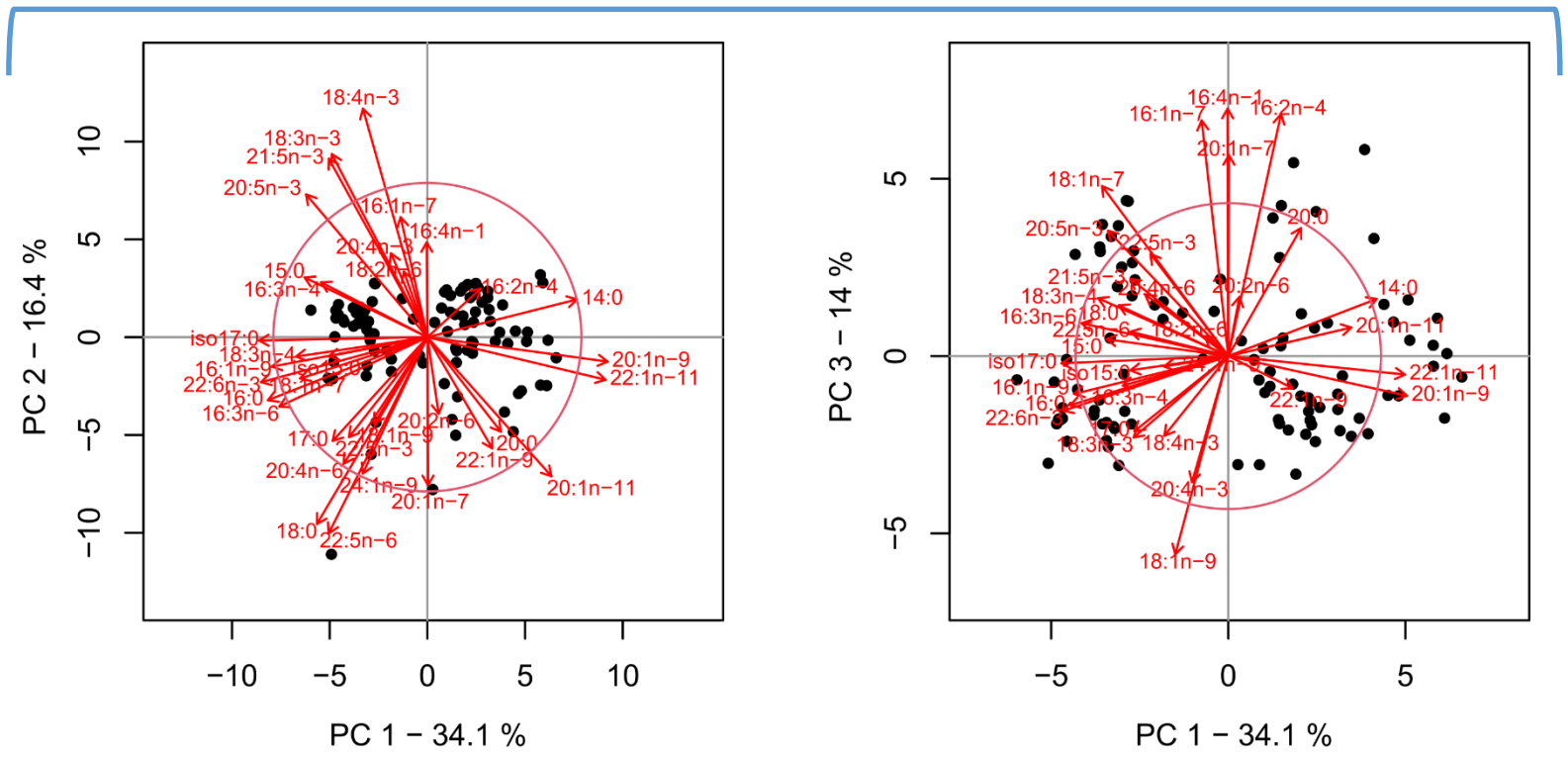
Polar lipids

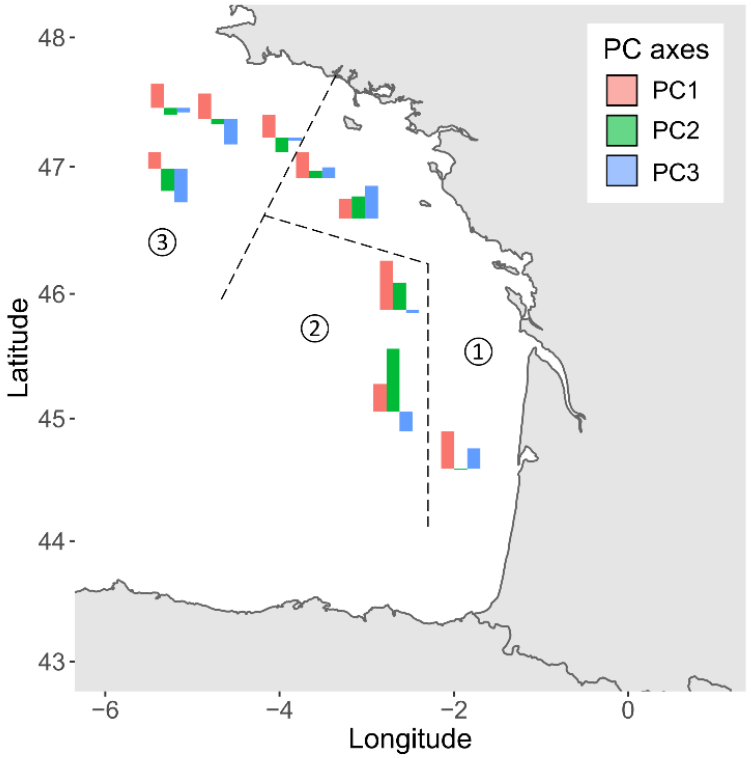


- Neutral and polar lipids:
  - ↗ fatty acids specific of copepods
  - ↘ fatty acids specific of phytoplankton
- Changes between the sardines aged 1 and 2 and those older than 2 years old.

→ Ontogenetic dietary change!

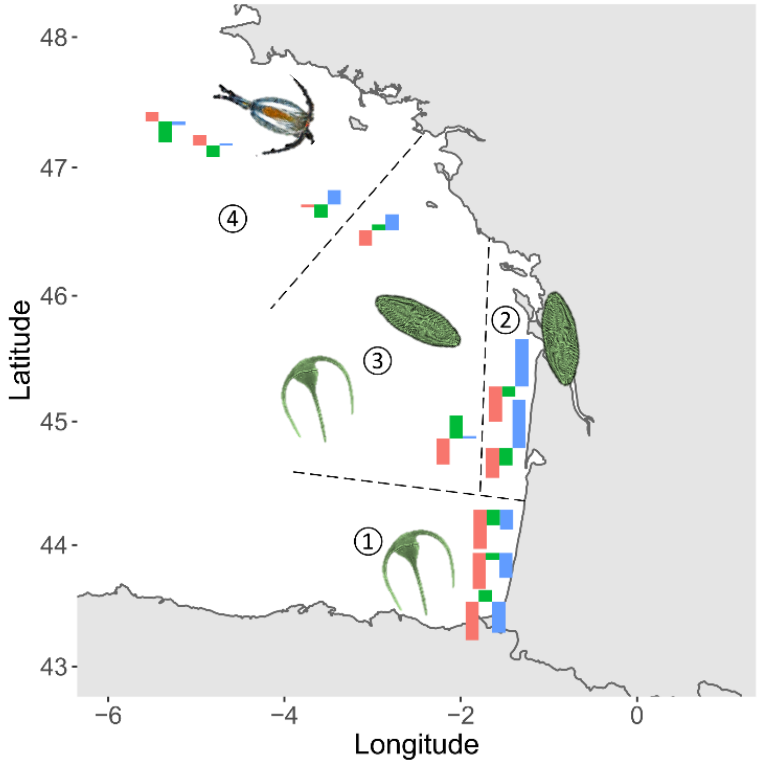
2. Spatial variability of fatty acids profiles



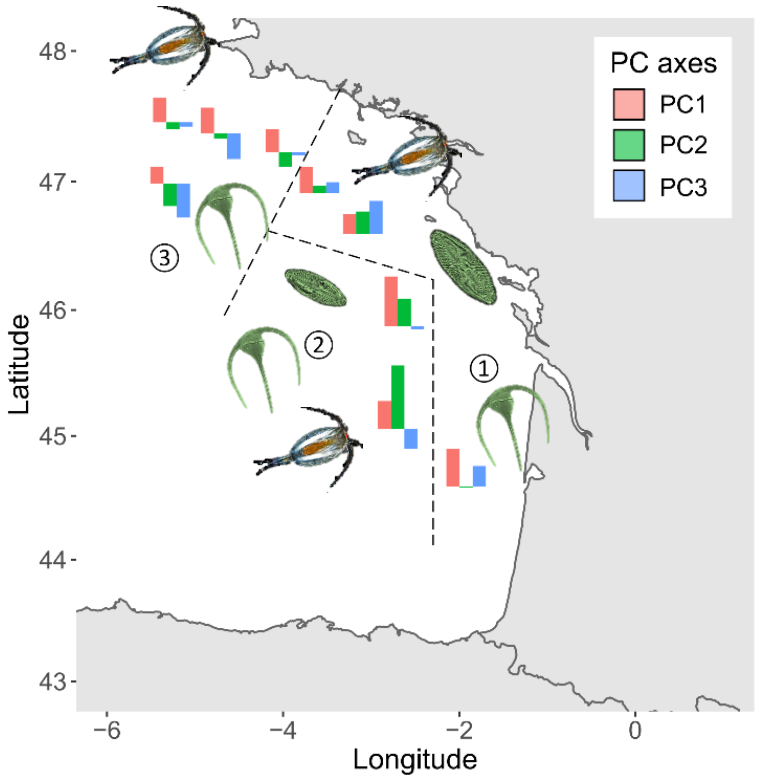


2. Spatial variability of fatty acids profiles

Ages 1 and 2 sardines



Age 3 and older sardines



<u>Neutral lipids</u>

- Clusters of stations distributed along a latitudinal gradient.

Ages 1 and 2 sardines:

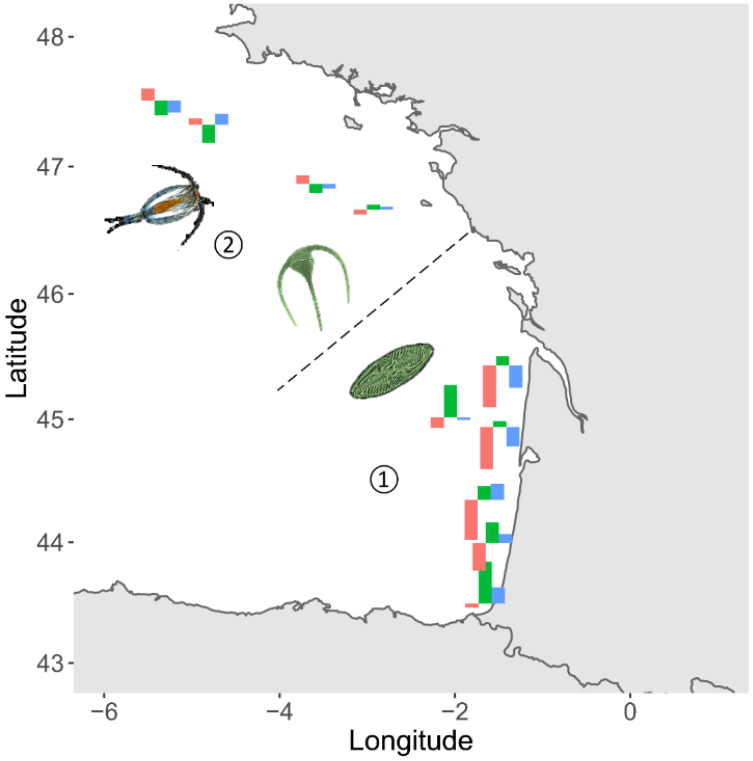
- ↗ proportion of copepods towards the North-Western.
- ↗ proportion of non-diatom phytoplankton in the South-Eastern.
- Highest proportion of diatoms near the Gironde estuary.

Ages 3 and older sardines:

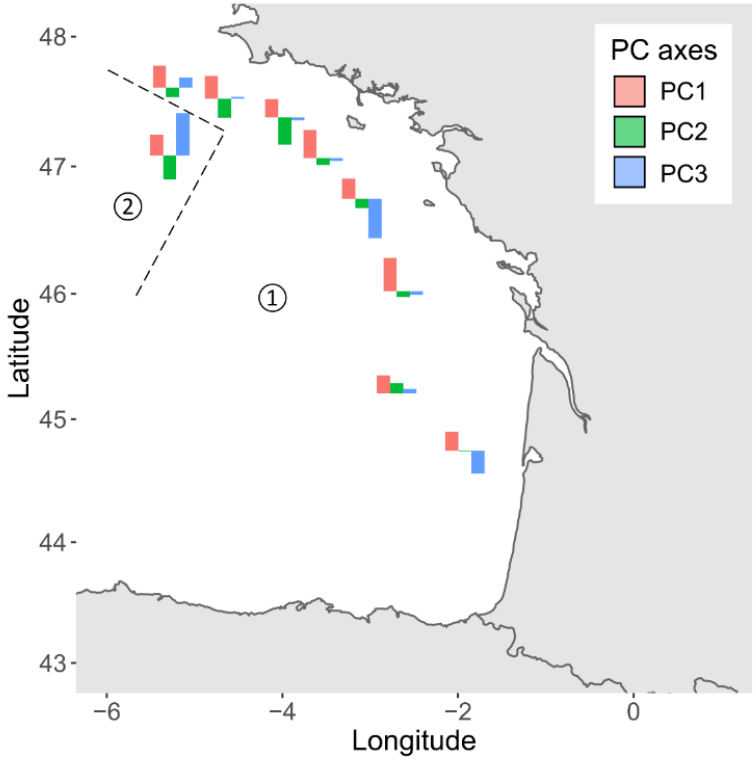
- Spatial structure by the fatty acids specifics of diatoms.

2. Spatial variability of fatty acids profiles

Ages 1 and 2 sardines



Age 3 and older sardines



Polar lipids

- Less clear spatial structure.
- Different fatty acids profiles between young and old sardines sampled in the same station.

→ Important to test and account for ontogenetic changes in the species of interest.

2. Spatial variability of fatty acids profiles

- Results in agreement with the spatial distribution of phyto- and zooplankton in the Bay of Biscay in spring.
  - → Young sardines are probably more filter-feeding or consume smaller zooplankton.
  - → Decline in size-at-age may reflects changes in primary production that is somehow lagged in secondary production.

- More pronounced differences in sardine diet when studying neutral lipids than polar lipids.
  - → Selective incorporation of essential fatty acids into polar lipids.
  - → Consider neutral and polar lipids fractions separately to deeply investigate the ecological meaning.

First study to characterise the composition and variability in the fatty acids of sardines in the Bay of Biscay.

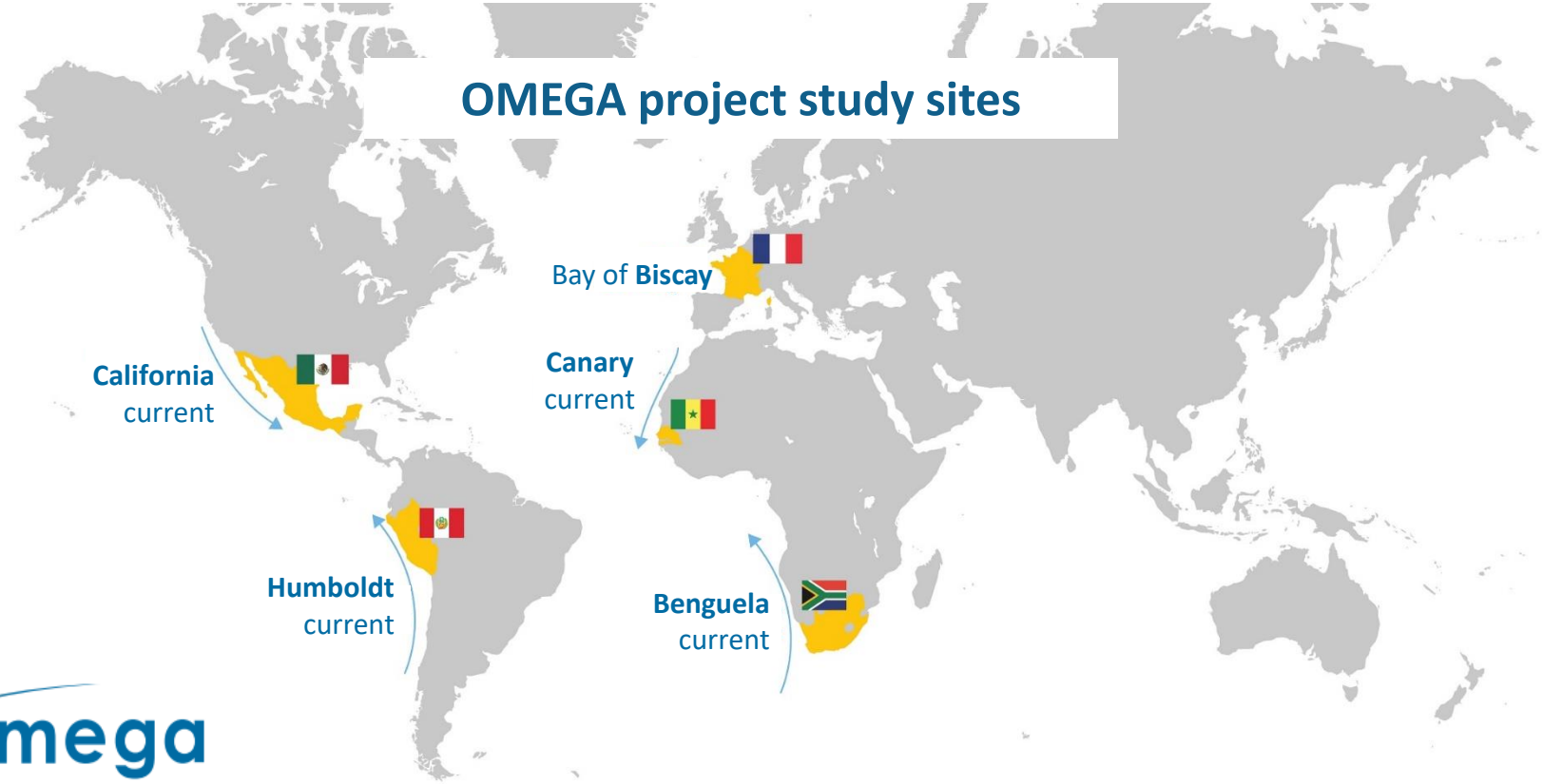
Some limits but validated assumptions:

- Sardine fatty acid composition changes according with:
  - individuals' age.
  - sampling location in the Bay of Biscay.
- Dietary changes more visible in the neutral lipids than in the polar lipids.

Changes in primary production (quantity and quality) may explain the stronger decline in size-at-age of sardines aged 1 and 2 years during the last decade in the Bay of Biscay.

Perspectives

- A more homogenous sampling with respect to sardines' age over space.
- Expanded study over time and seasons.



WP1: Observation

WP2: Experimental

WP3: Modelling

WP4: Economy

WP5: Psycho-sociology

Changes in the diet of Bay of Biscay sardines according to sampling location and age, through fatty acid composition

Mathilde BERTRAND
Mathilde.Bertrand@univ-brest.fr

Marie VAGNER and Laure PECQUERIE
omega-coord@univ-brest.fr

Thank you to my work team!

Thank you for your attention!

Any questions?