Trophic ecology of small pelagic fish in the Mediterranean Sea

overall knowledge,
recent advances and
future challenges

Marta Albo-Puigserver 9th of November 2022

@MartaAlboP

Small Pelagic Fish:
New Frontiers in Science and Sustainable Management
November 7 - 11, 2022
Lisbon, Portugal

PICES

ICES CIEM

Food and Agriculture Organization of the United Nations

CSIC
Consejo Superior de Investigaciones Científicas

Instituto Español de Oceanografía 1914

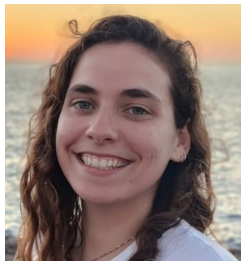
Institut de Ciències del Mar















PelWeb

pelCAT
PETITS PELÀGICS AL MAR CATALÀ

SPELMED

ECOTRANS

Small Pelagic Fish:
New Frontiers in Science and Sustainable Management
November 7 - 11, 2022
Lisbon, Portugal

PICES

ICES
CIEM

Food and Agriculture Organization of the United Nations

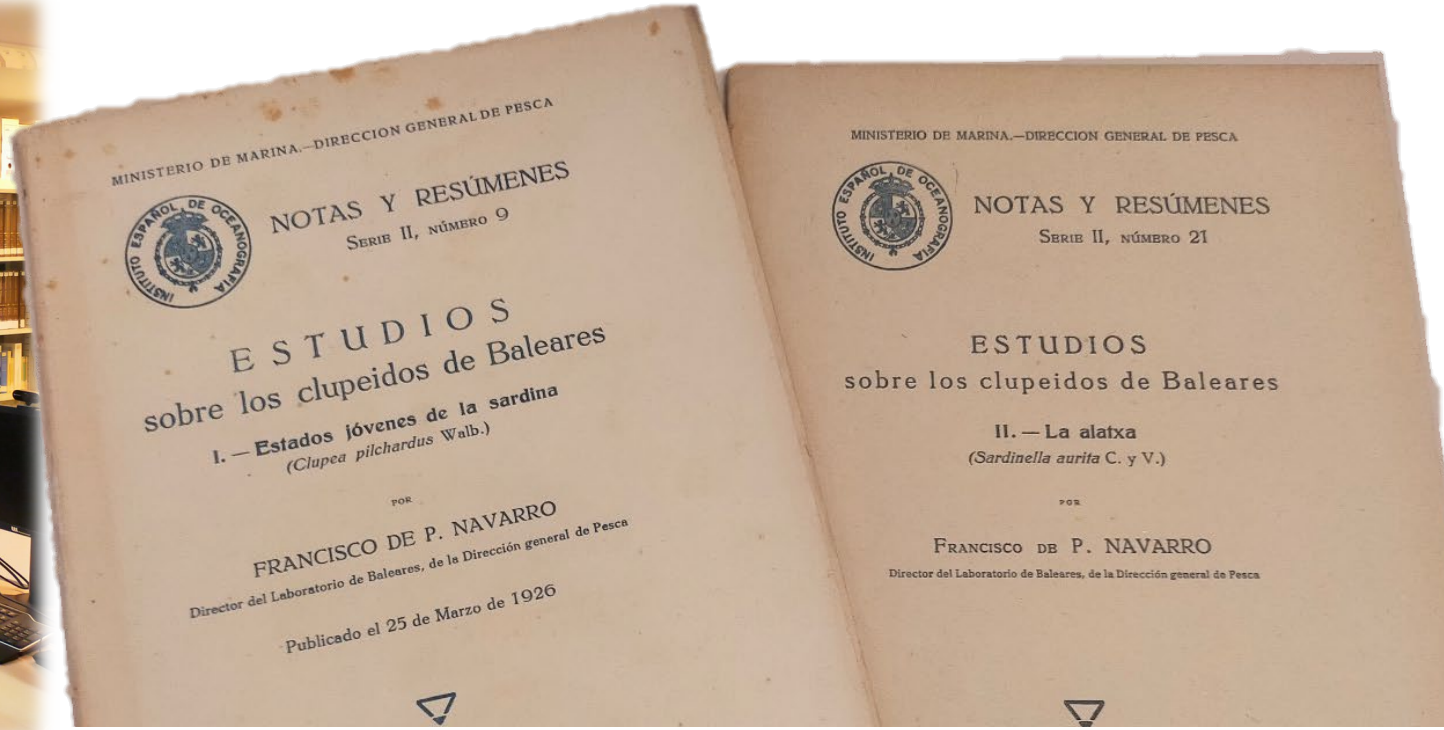
MINISTERIO DE CIENCIA E INNOVACIÓN

Financiado por la Unión Europea
NextGenerationEU

Plan de Recuperación, Transformación y Resiliencia

AGENCIA ESTATAL DE INVESTIGACIÓN

Background



MINISTERIO DE MARINA.—DIRECCION GENERAL DE PESCA

NOTAS Y RESÚMENES
SERIE II, NÚMERO 9

ESTUDIOS
sobre los clupeidos de Baleares

I.—Estados jóvenes de la sardina
(*Clupea pilchardus* Walb.)

POR

FRANCISCO DE P. NAVARRO
Director del Laboratorio de Baleares, de la Dirección general de Pesca

Publicado el 25 de Marzo de 1926

MINISTERIO DE MARINA.—DIRECCION GENERAL DE PESCA

NOTAS Y RESÚMENES
SERIE II, NÚMERO 21

ESTUDIOS
sobre los clupeidos de Baleares

II.—La alatxa
(*Sardinella aurita* C. y V.)

POR

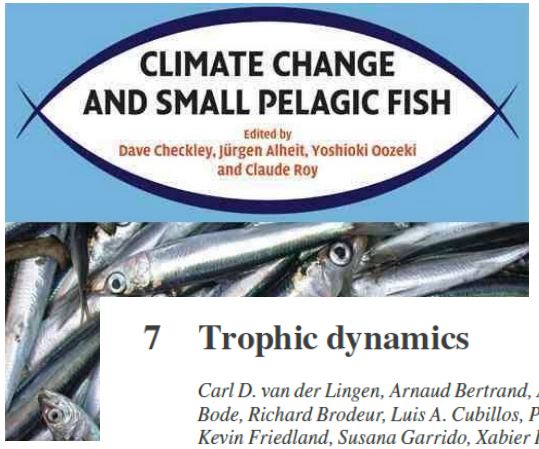
FRANCISCO DE P. NAVARRO
Director del Laboratorio de Baleares, de la Dirección general de Pesca

1926-1927

Navarro, 1926,1927

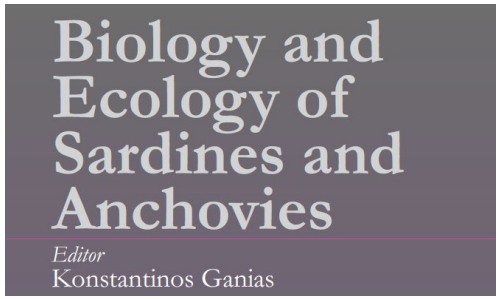
How much do we know about SPF trophic ecology in the Mediterranean Sea?

Which methodologies have been used so far?



7 Trophic dynamics

Carl D. van der Lingen, Arnaud Bertrand, Antonio Bode, Richard Brodeur, Luis A. Cubillos, Pepe Espinoza, Kevin Friedland, Susana Garrido, Xabier Irigoien, Todd Miller, Christian Möllmann, Ruben Rodriguez-Sanchez, Hiroshige Tanaka, and Axel Temming



CHAPTER 4

Feeding Biology and Ecology

Susana Garrido[1,] and Carl David van der Lingen[2]*

Progress in Oceanography 191 (2021) 102494

Contents lists available at ScienceDirect

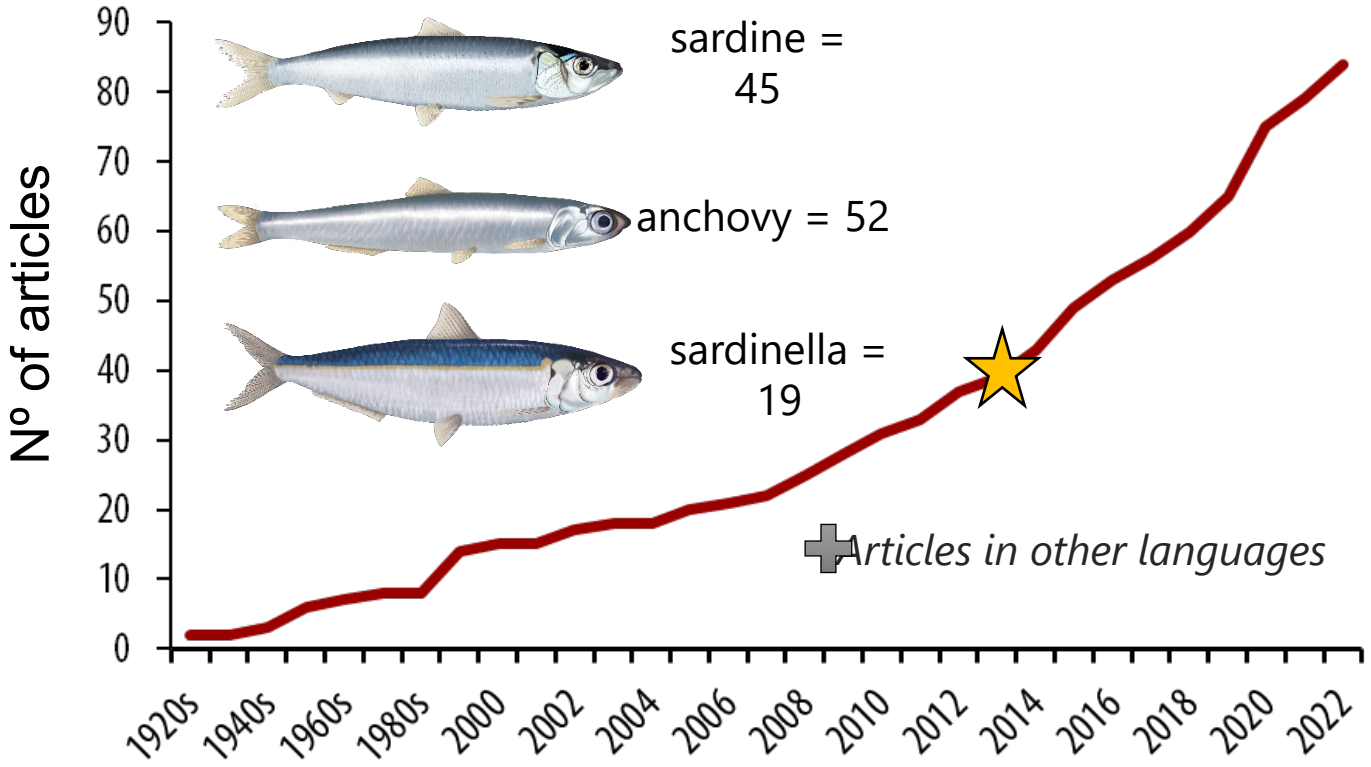
Progress in Oceanography

journal homepage: www.elsevier.com/locate/pocean

Small pelagic fish in the new millennium: A bottom-up view of global research effort

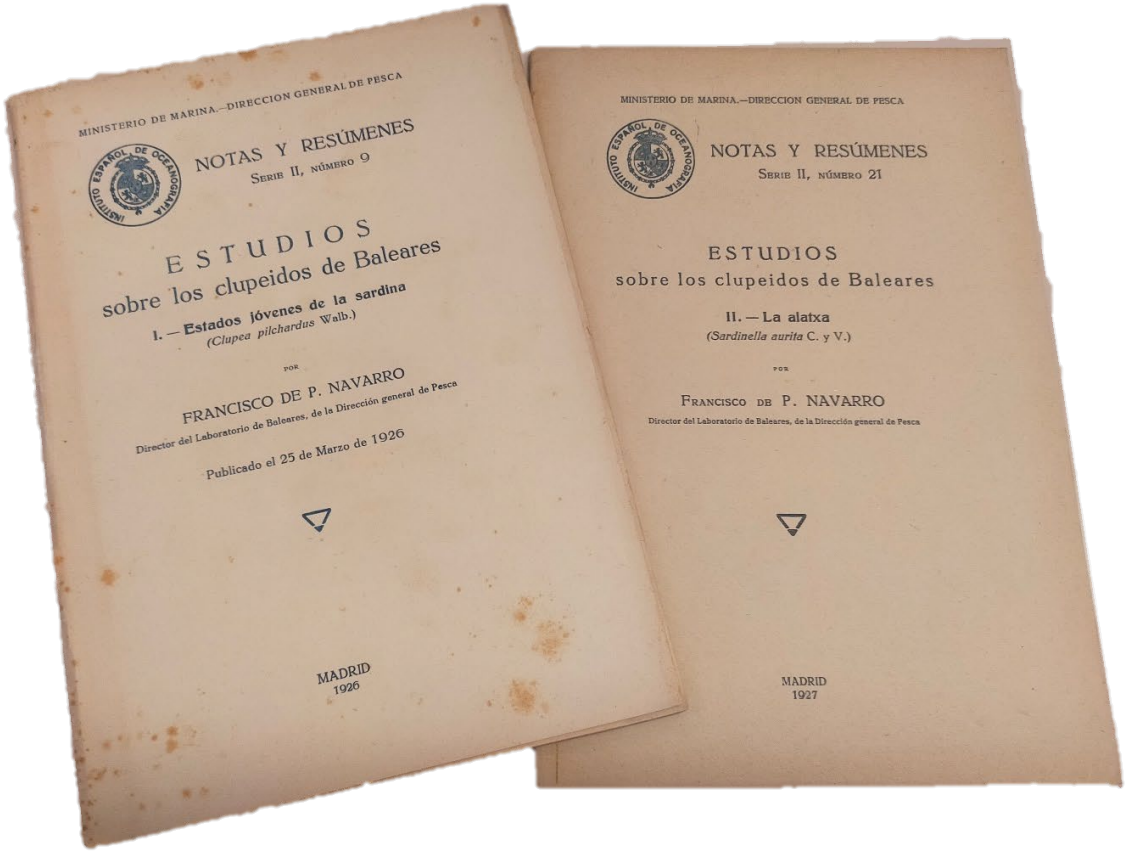
Myron A. Peck[a,*], Jürgen Alheit[b], Arnaud Bertrand[c], Ignacio A. Catalán[d], Susana Garrido[e], Marta Moyano[f], Ryan R. Rykaczewski[g,k], Akinori Takasuka[h], Carl D. van der Lingen[i,j]

Studies on SPF trophic ecology



Cummulative published trophic ecology articles of Sardine, Anchovy and Round Sardinella

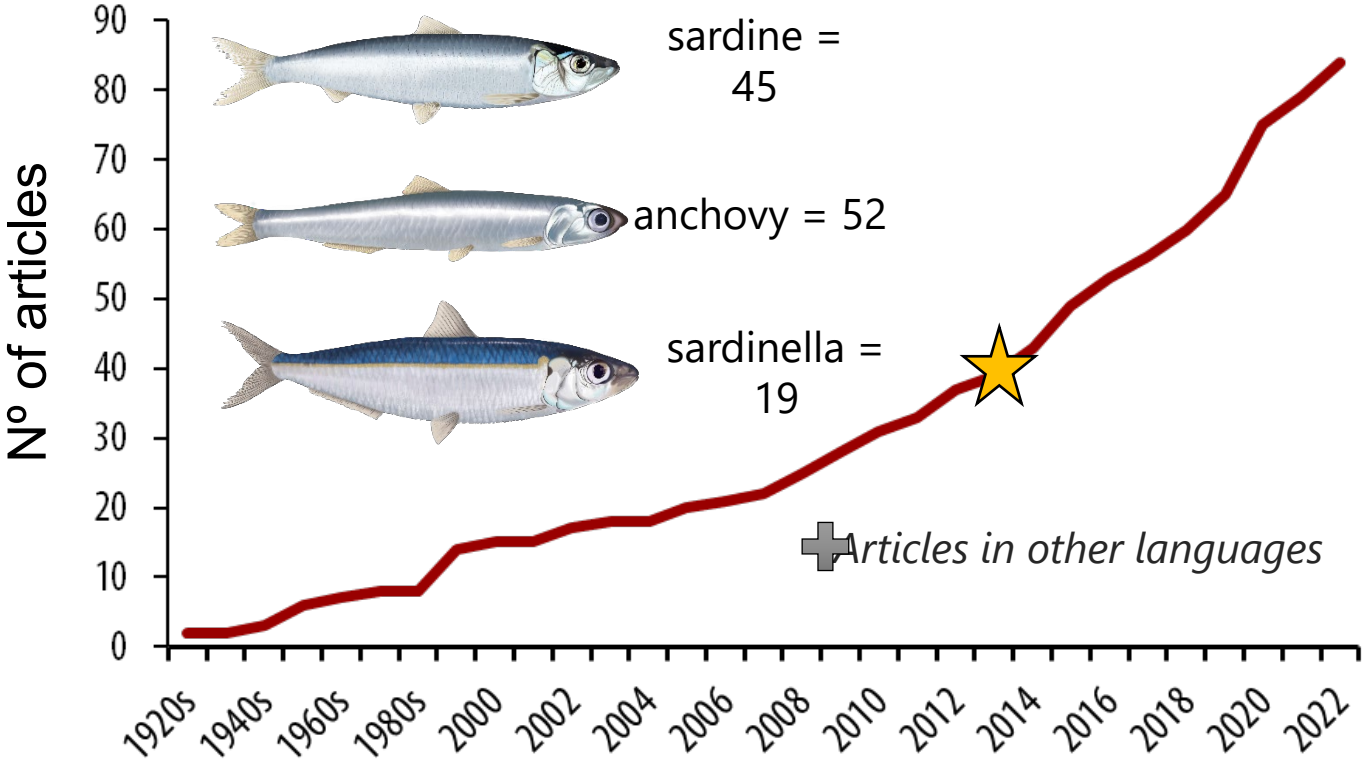
85 studies, 22 larval stages, 63 juvenile and/or adult



1926-1927

Navarro, 1926,1927

Studies on SPF trophic ecology



Cummulative published trophic ecology articles of Sardine, Anchovy and Round Sardinella

85 studies, 22 larval stages, 63 juvenile and/or adult

Changes observed

⇩ Decline in biomass / landings
⇩ Decline in body condition
⇩ Decline in growth and L50

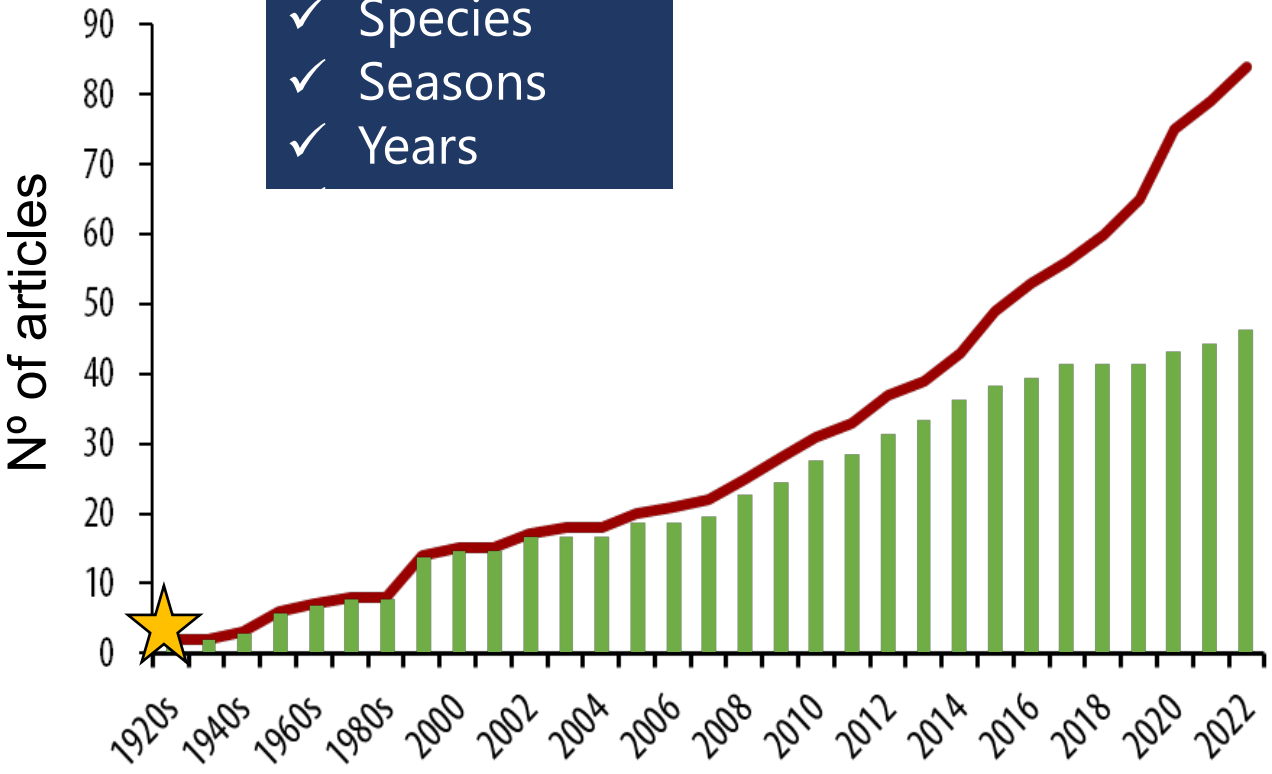
Hypotheses

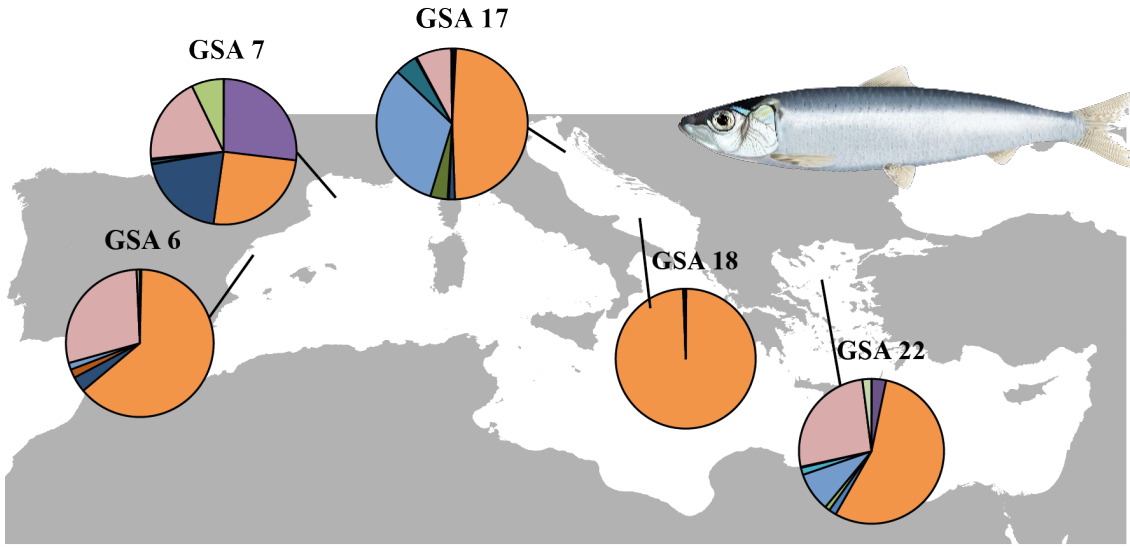
- **Fishing effort**
- Disease
- Predators-competitors
- Contamination
- Changes in diet (bottom-up)
- Environmental changes

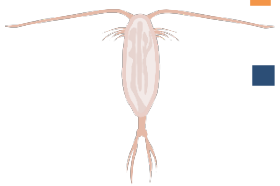
Van Beveren et al., 2014
Brosset et al., 2016
Saraux et al., 2019
Coll et al., 2020

Stomach Content Analysis (SCA)

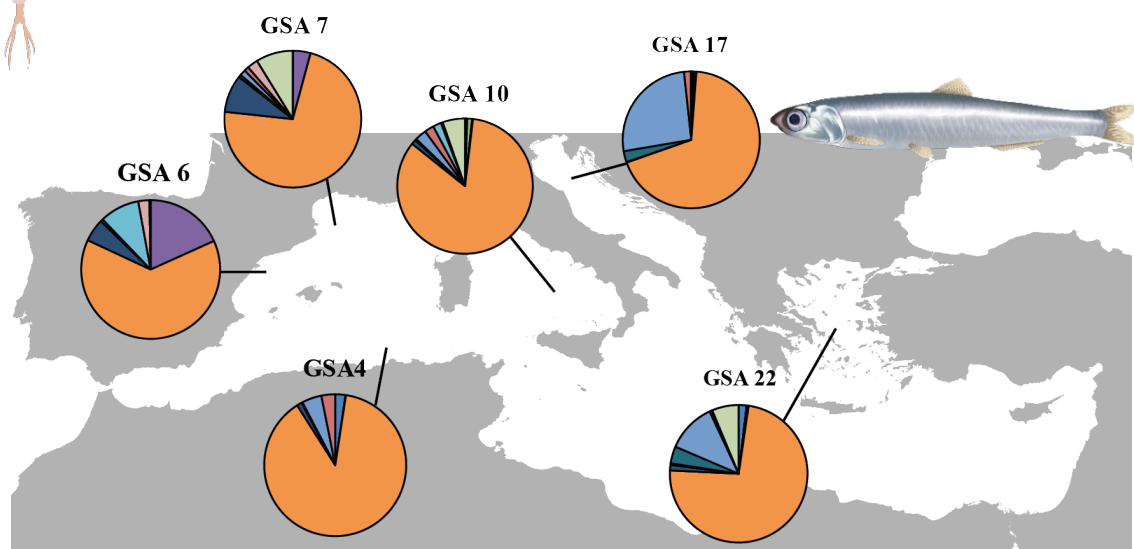
Diet variability:
- ✓ Species
- ✓ Seasons
- ✓ Years





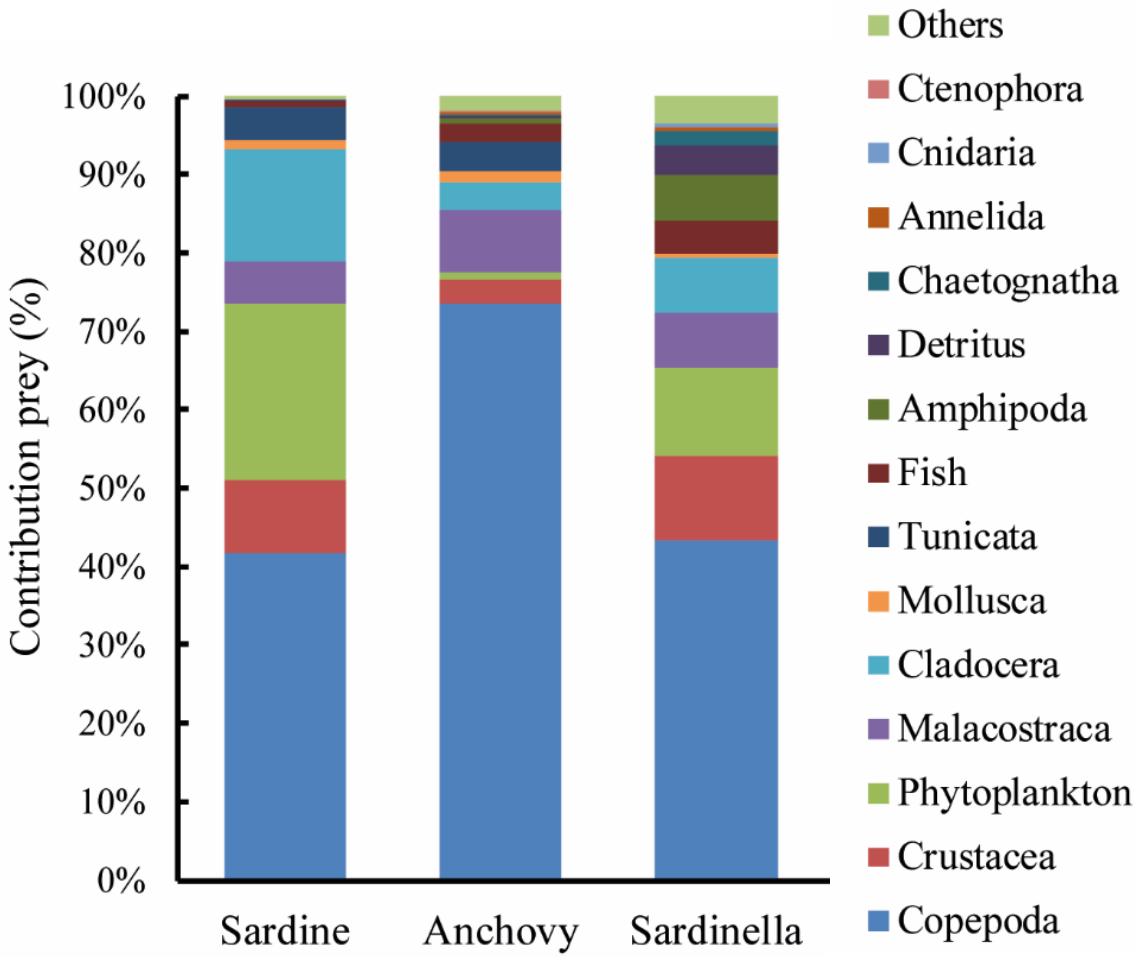


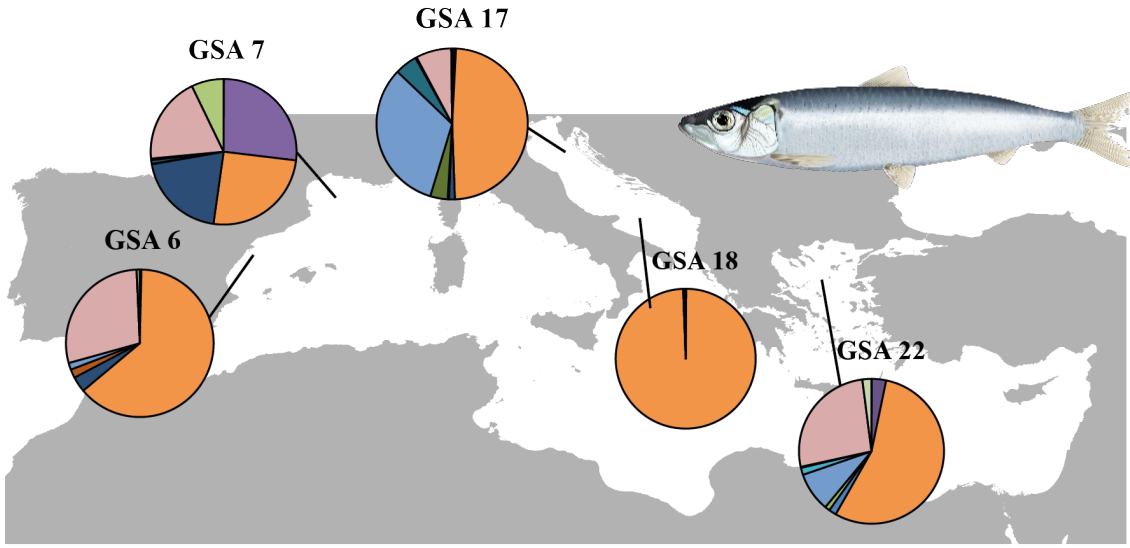
Copepoda Cladocera Tunicata
Crustacea Malacostraca Phytoplankton

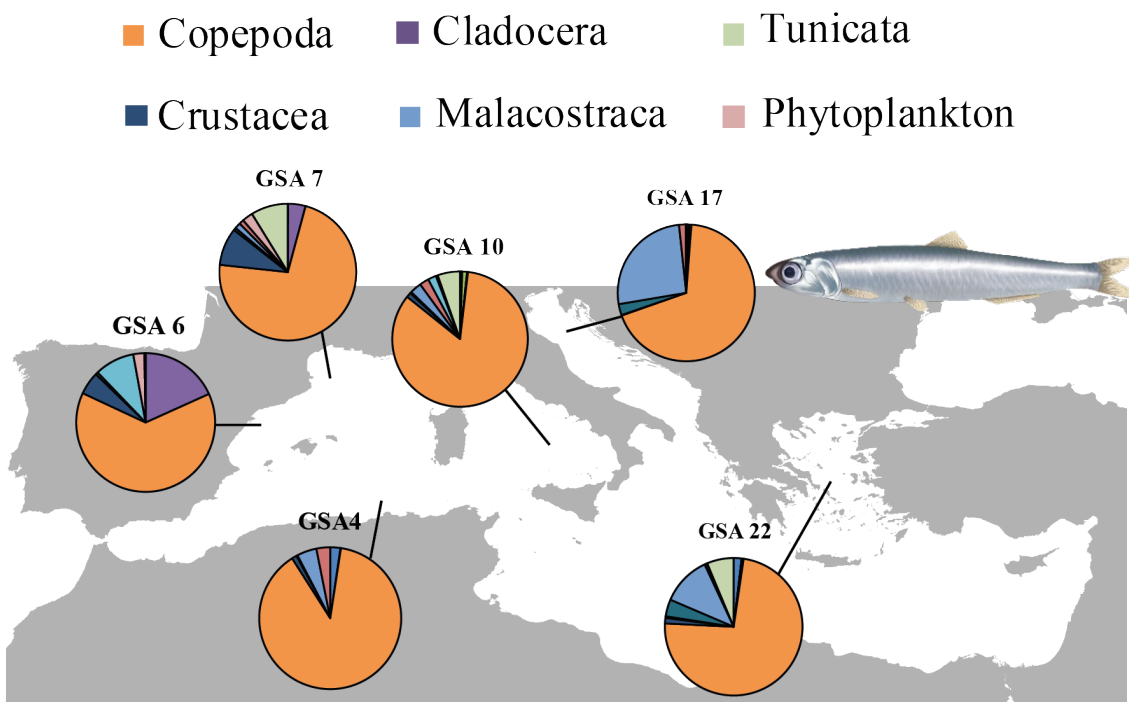


Stomach Content Analysis (SCA)

Juvenile-Adult

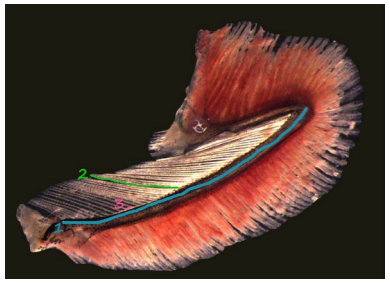






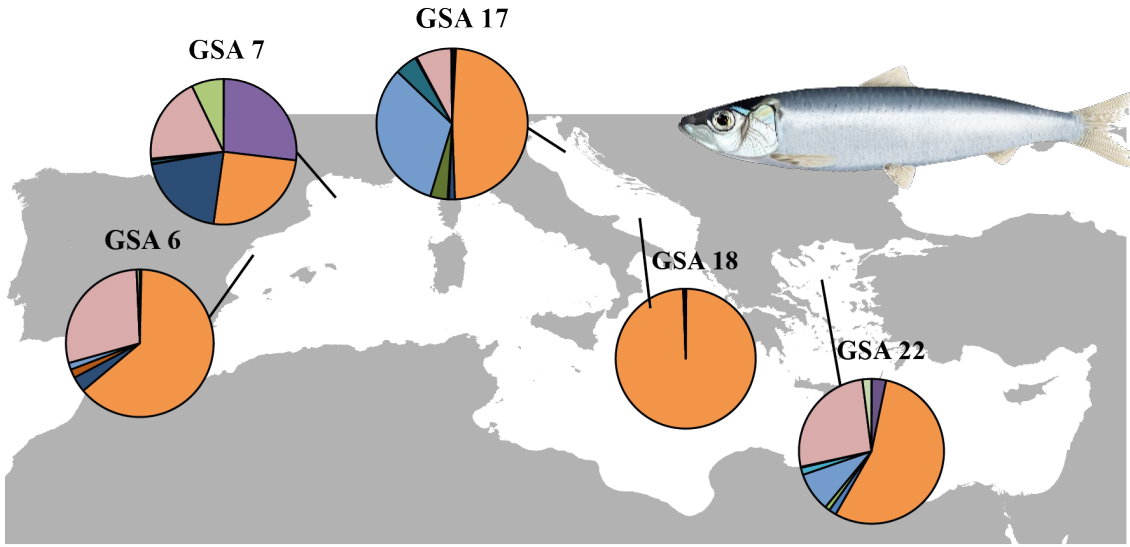
Stomach Content Analysis (SCA)

Filter vs Particulate feeding

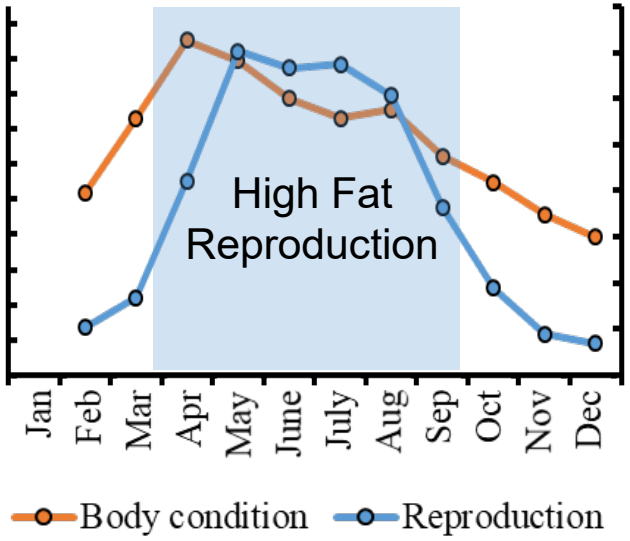


Costalago et al., 2014, 2015
Karachle & Stergiou, 2013
Andreu, 1969

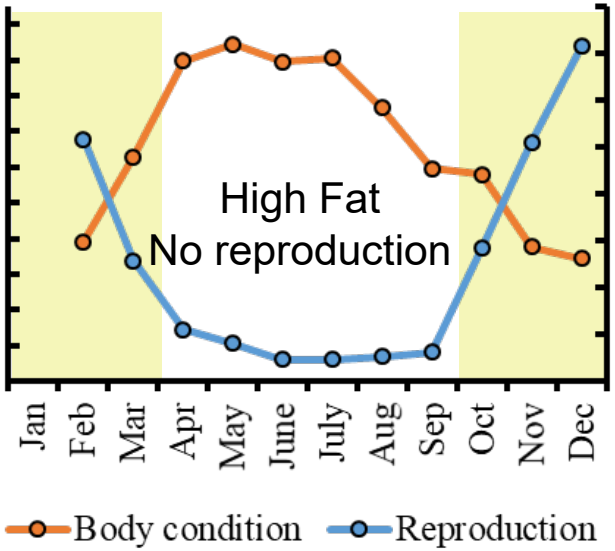
Diet variability:
- ✓ Species
- ✓ Seasons
- ✓ Years

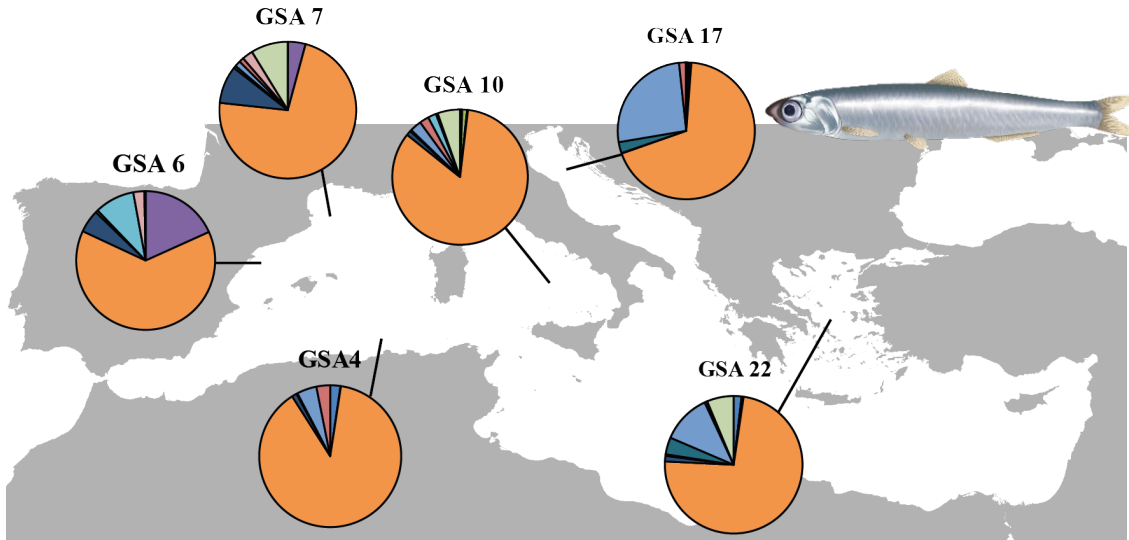


Anchovy



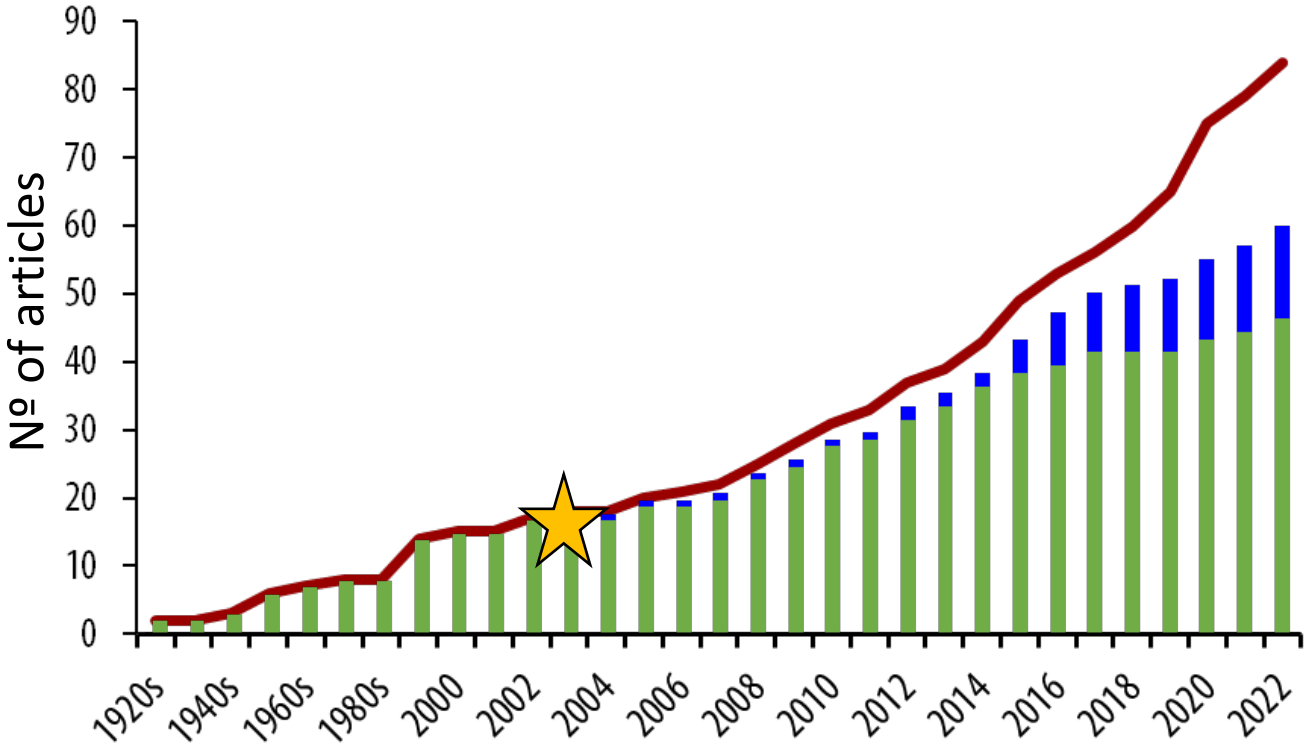
Sardine



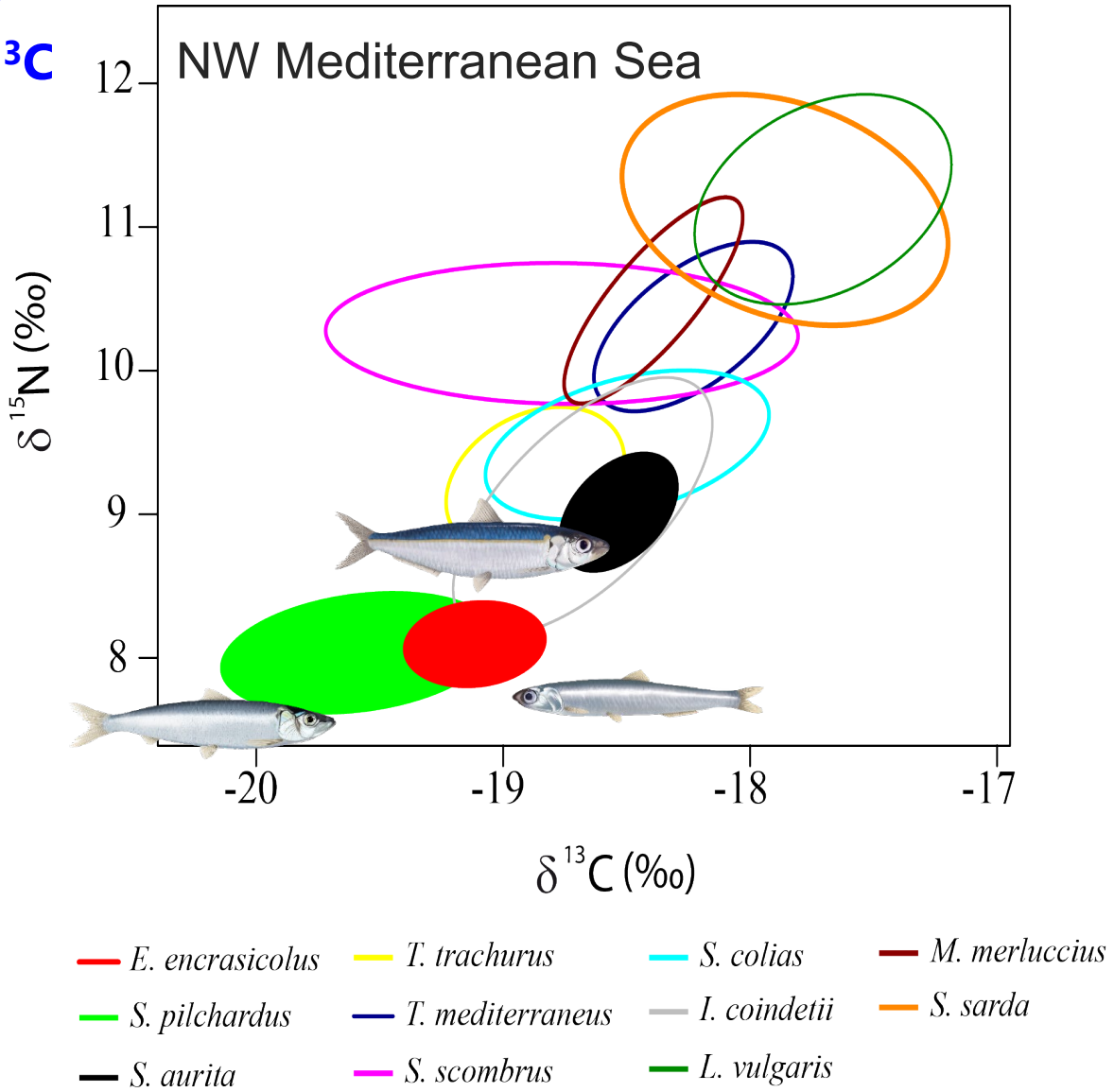


Bulk Stable Isotope Analysis (SIA)

$\delta^{15}N$ & $\delta^{13}C$



Pinnegar et al., 2003



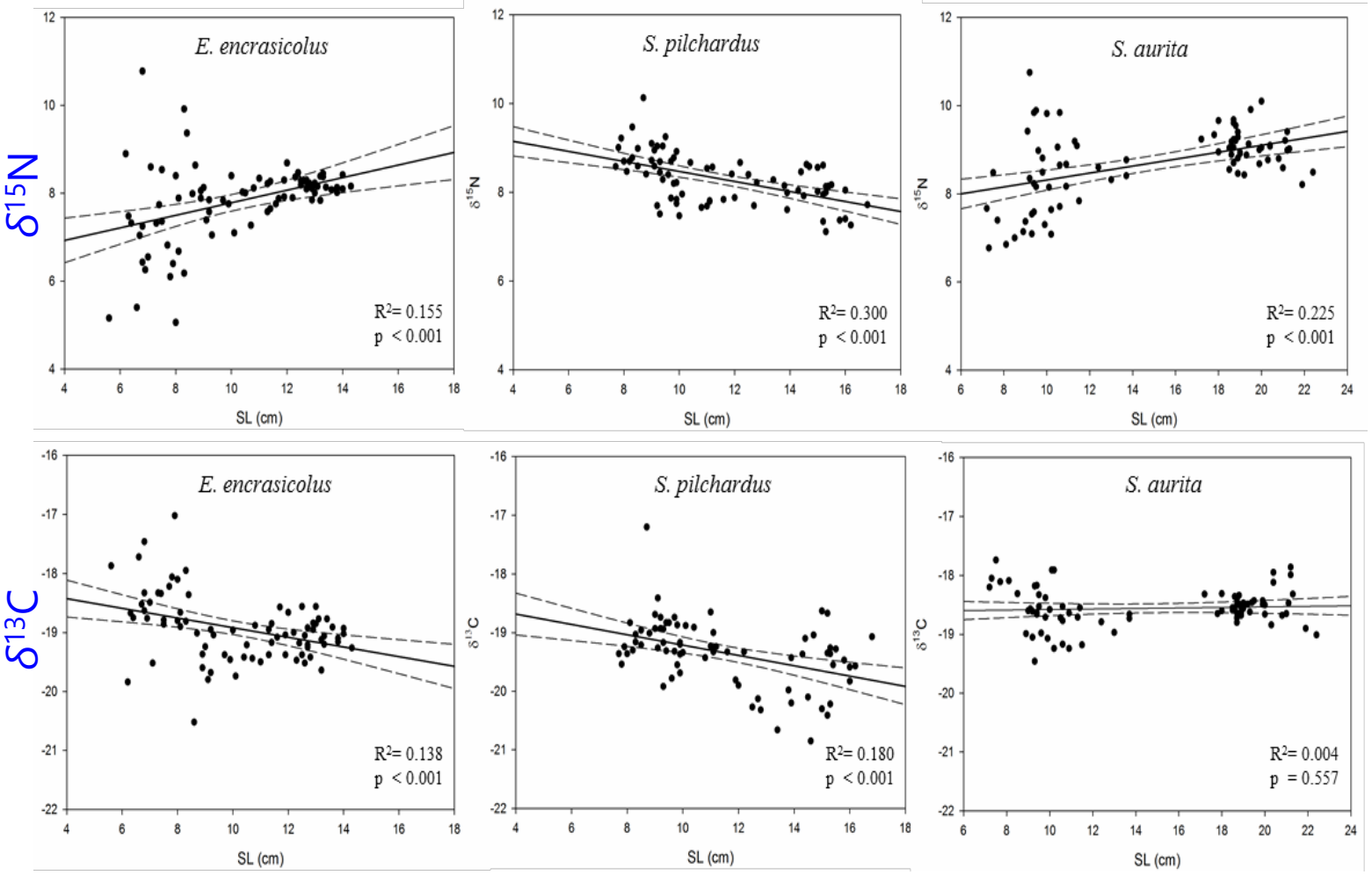
Testing SPF competition hypothesis →

Albo-Puigserver et al., 2019

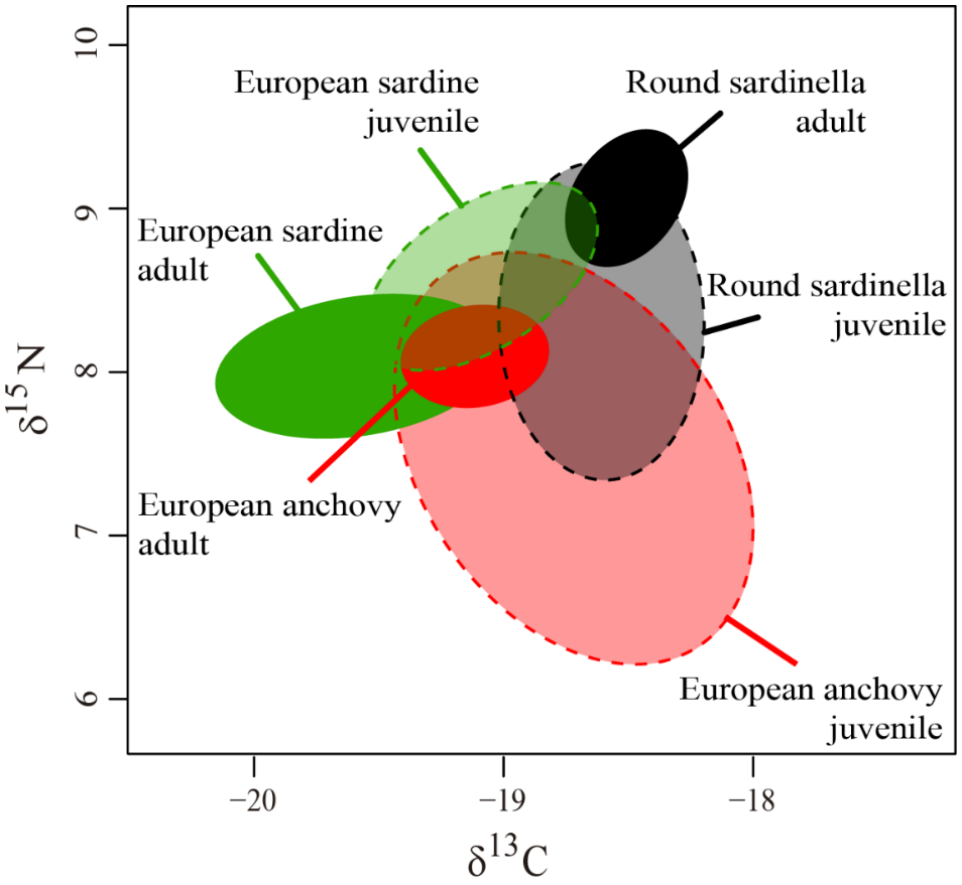
Bulk Stable Isotope Analysis (SIA)

$\delta^{15}N$ & $\delta^{13}C$

Anchovy | Sardine | Round Sardinella



$\delta^{15}N$ / $\delta^{13}C$– Body length

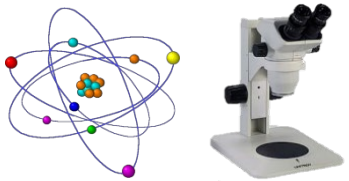


Trophic overlap of juveniles

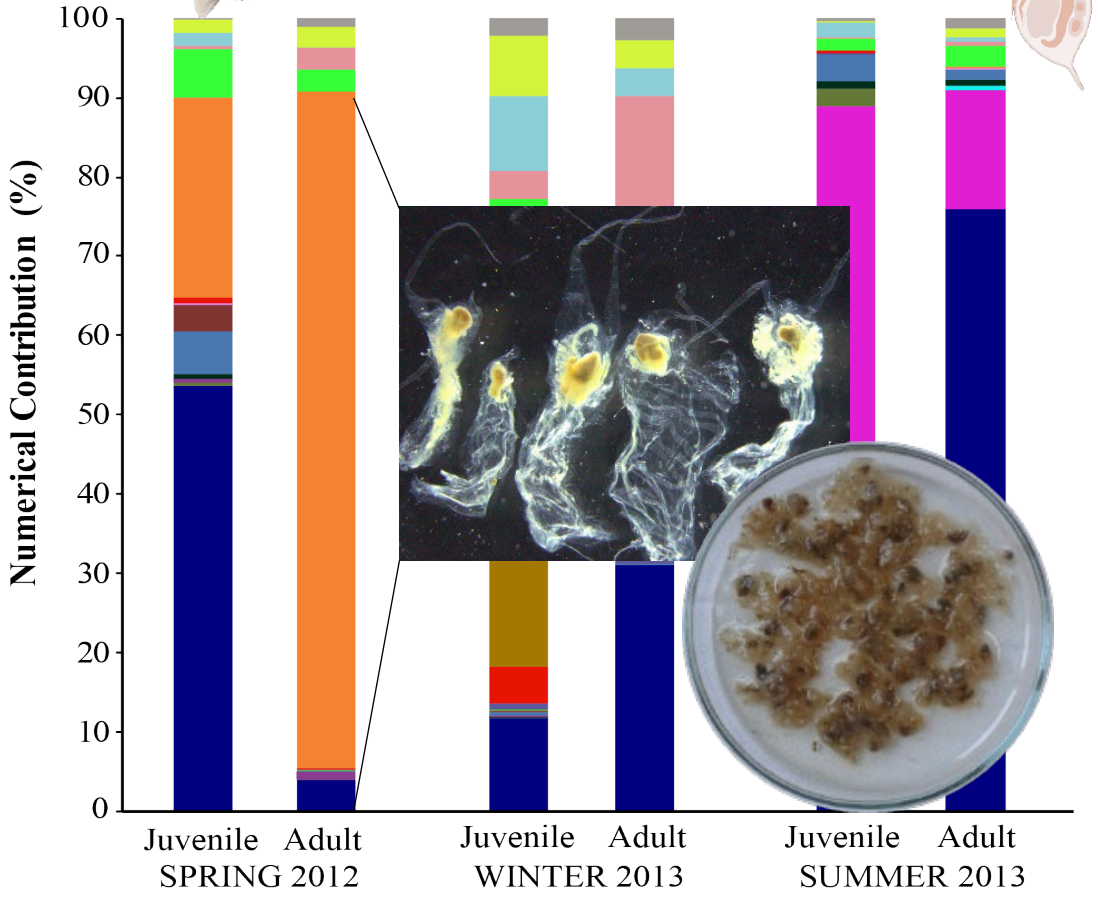
Albo-Puigserver et al., 2019

Bulk Stable Isotope Analysis (SIA)

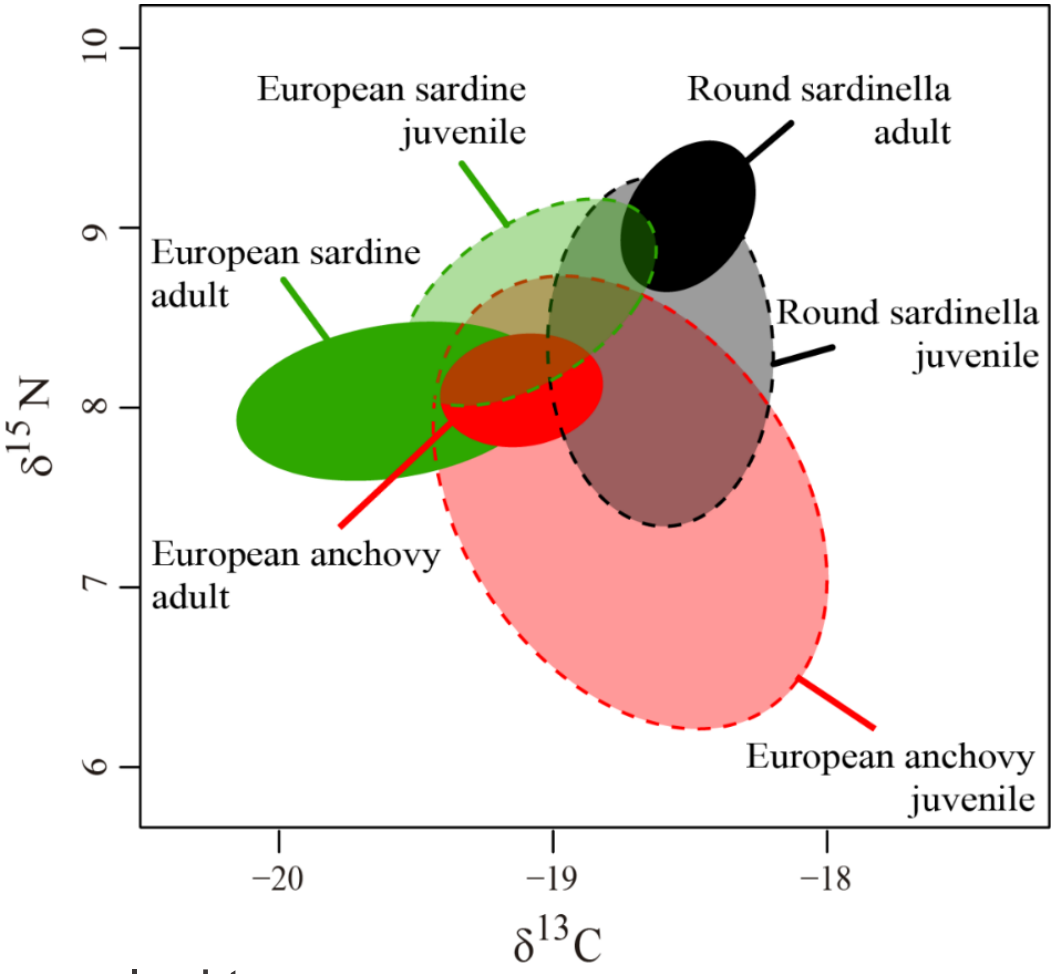
Combined with stomach content (SCA)

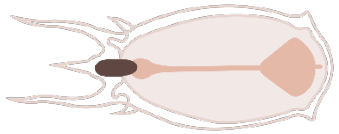


SCA



SIA





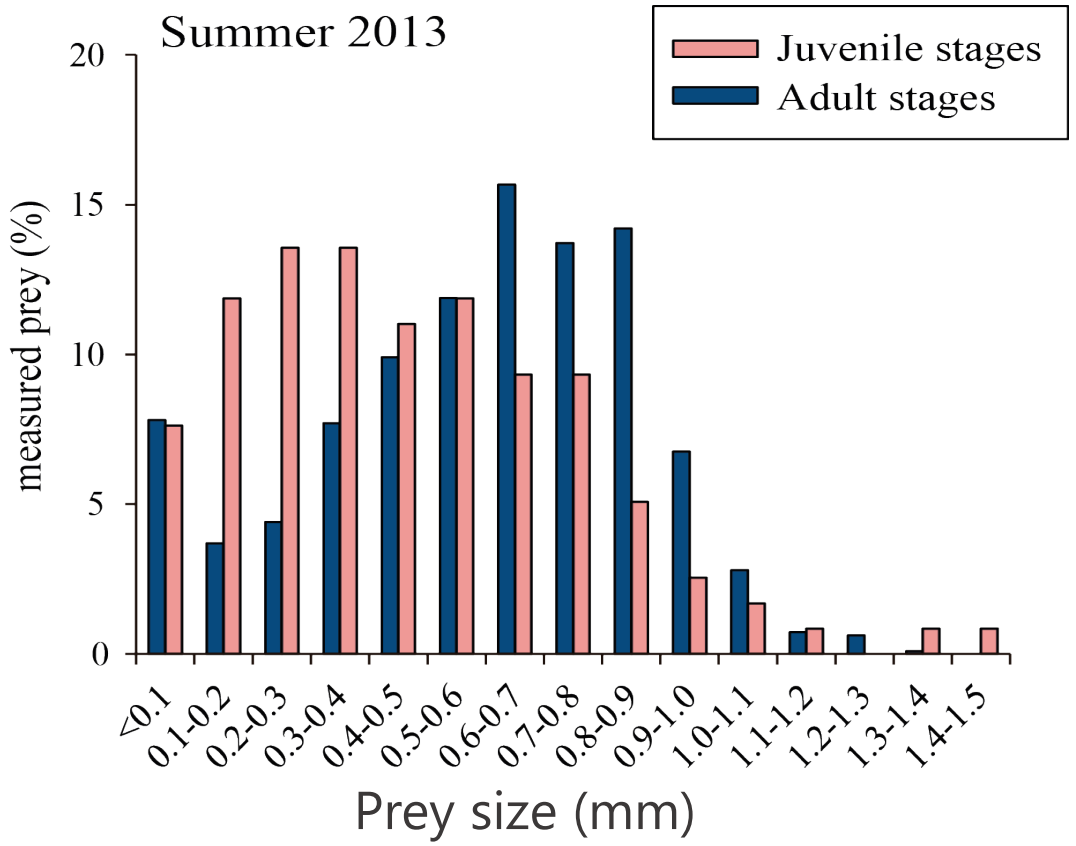
How an increase of gelatinous zooplankton might impact SPF trophodynamics?

Albo-Puigserver et al., 2019

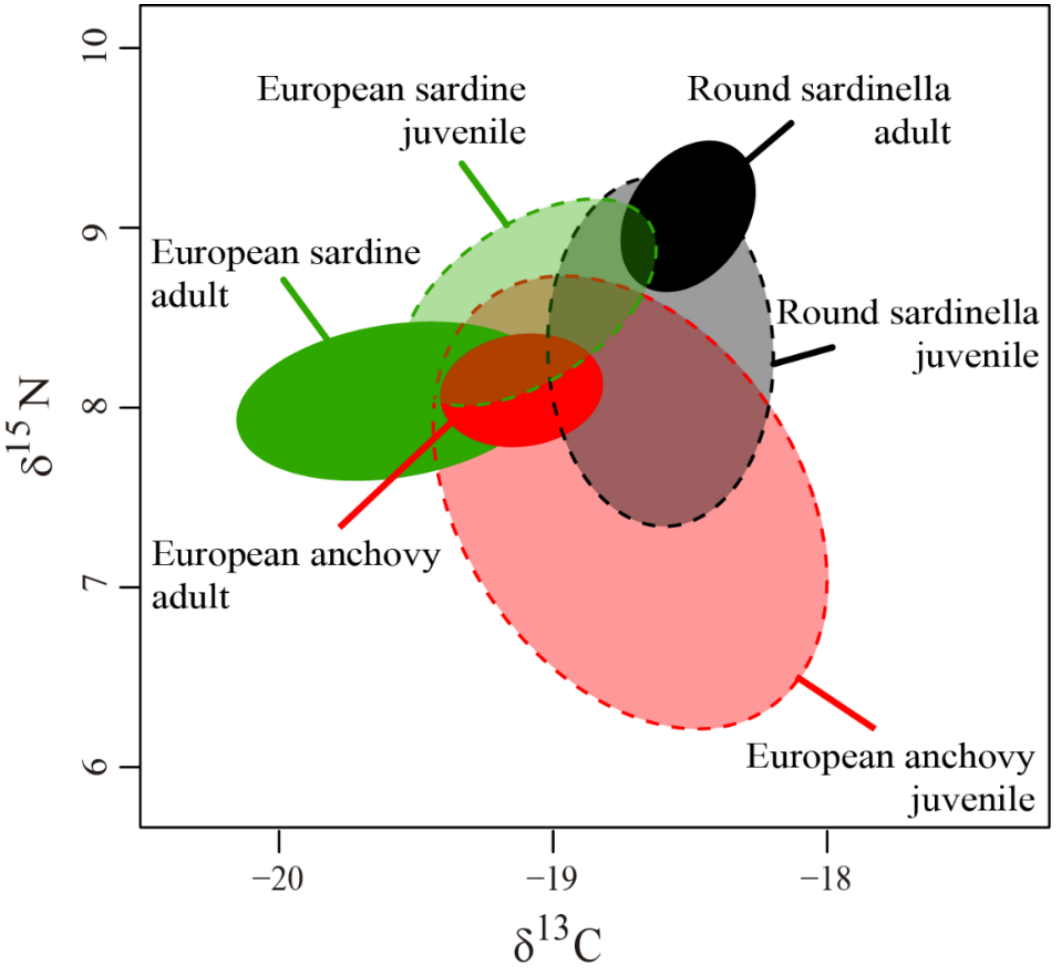
Bulk Stable Isotope Analysis (SIA)

Combined with stomach content (SCA)

SCA

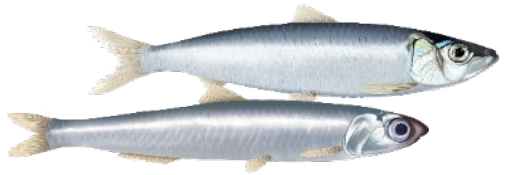


SIA



Adults' prey size: 0.5-0.9 mm

Adults' prey size: 0.2-0.6 mm

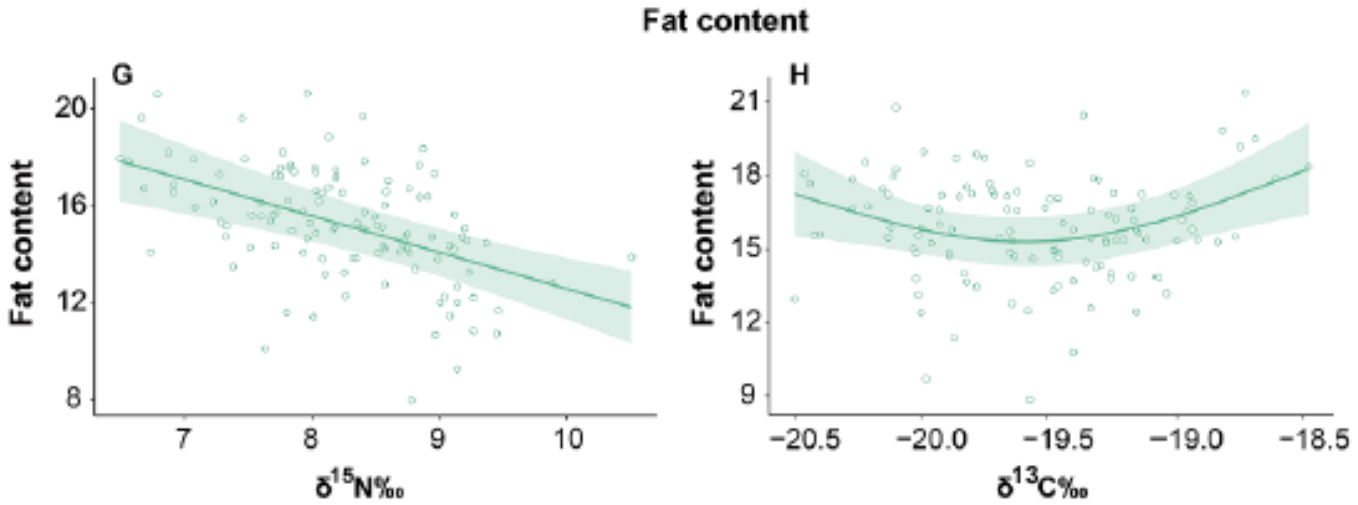


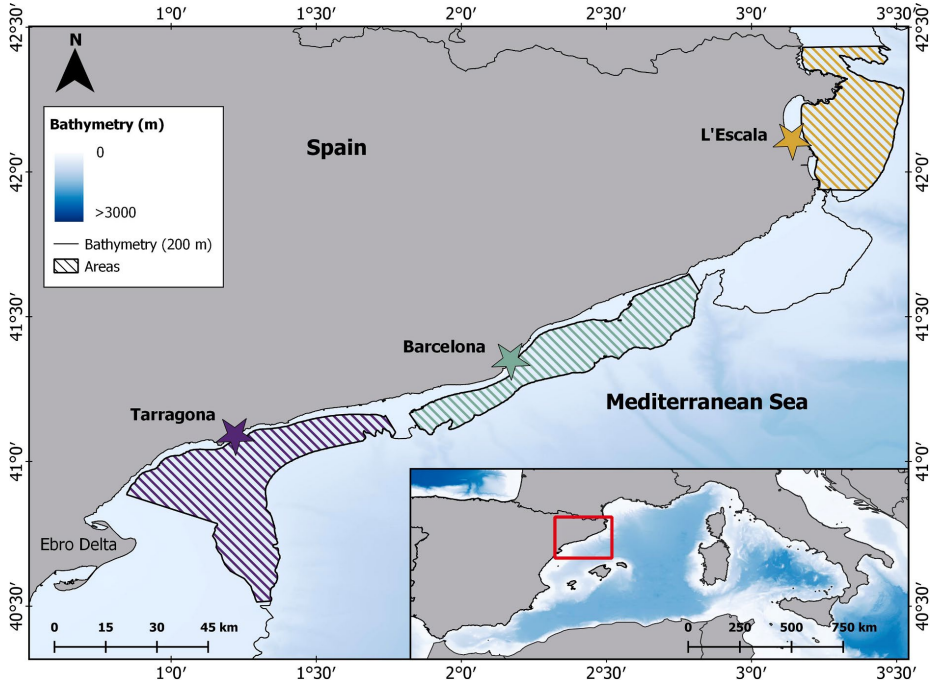
Le Bourg et al. 2015

Albo-Puigserver et al., 2019

Bulk Stable Isotope Analysis (SIA)

... trophic marker





14:20 **Elena Lloret-Lloret**
Small pelagic fish fitness relates to local environmental conditions and trophic variables

Progress in Oceanography 202 (2022) 102745

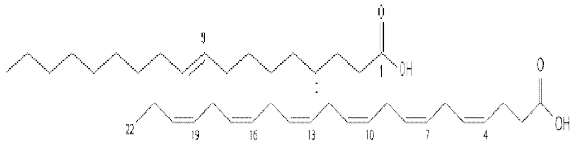
Contents lists available at ScienceDirect

Progress in Oceanography

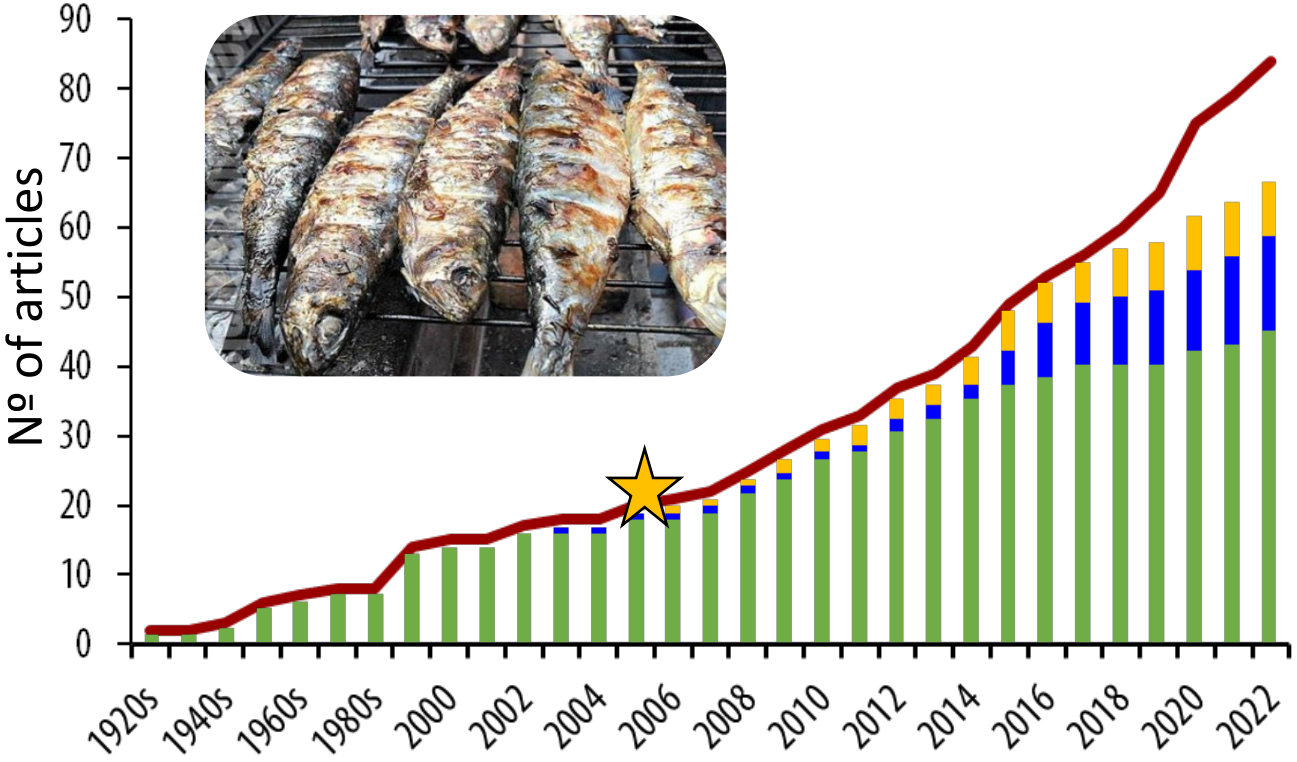
journal homepage: www.elsevier.com/locate/pocean

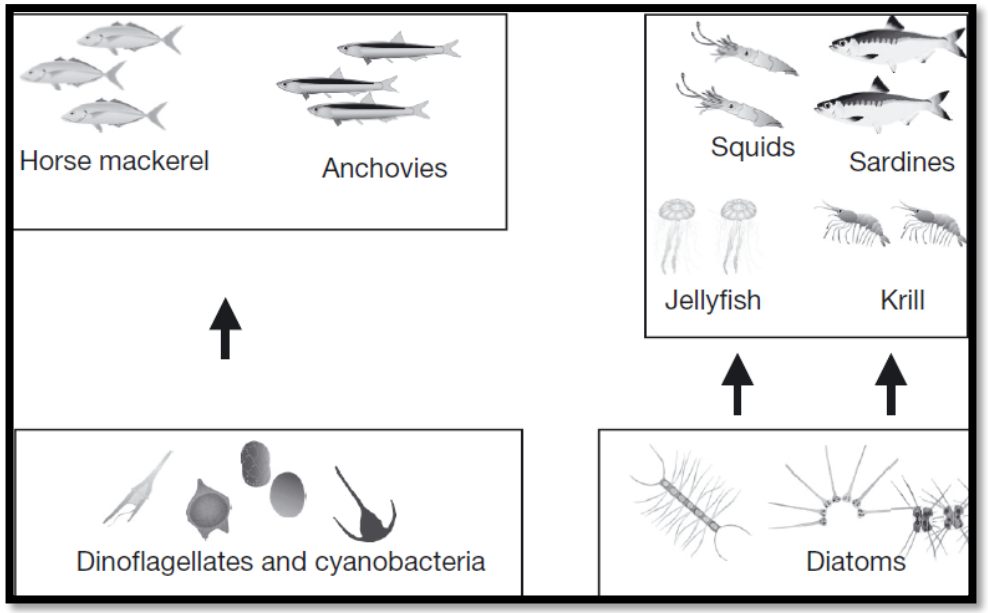
Small pelagic fish fitness relates to local environmental conditions and trophic variables

E. Lloret-Lloret [a,b,*], M. Albo-Puigserver [a,c], J. Giménez [a], J. Navarro [a], M.G. Pennino [d], J. Steenbeek [e], J.M. Bellido [f], M. Coll [a,e]



Fatty acids (FA)





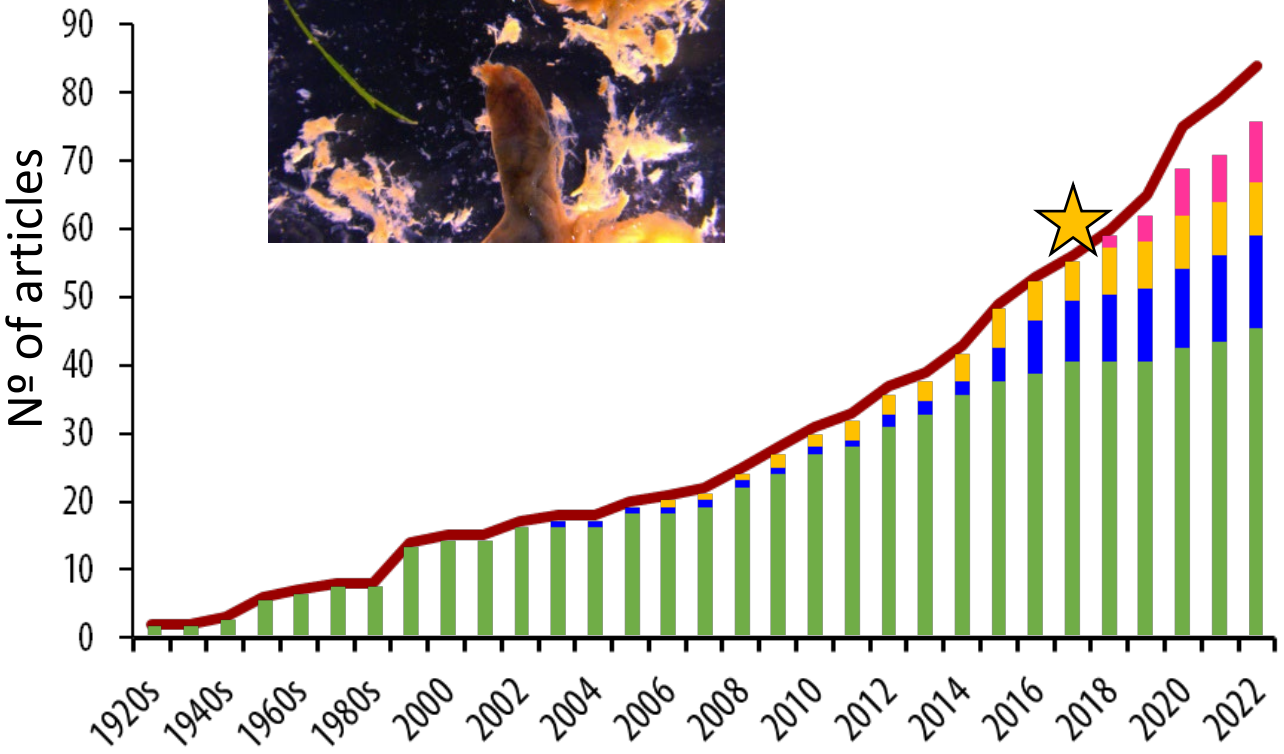
From Cardona et al., 2015

Ratios of 16:1ϖ7 to 16:0 and DHA/EPA index

FAs used to assess:
-Diet preference at group level
-Physiological condition

- Rossi et al., (2006) →PUFA proportion in different developmental stages of anchovy larvae
- Biton-Porsmoguer et al., 2020→ bottom-up hypothesis, poorer reproductive health status of sardine

Anthropogenic items in SCA (AIs)



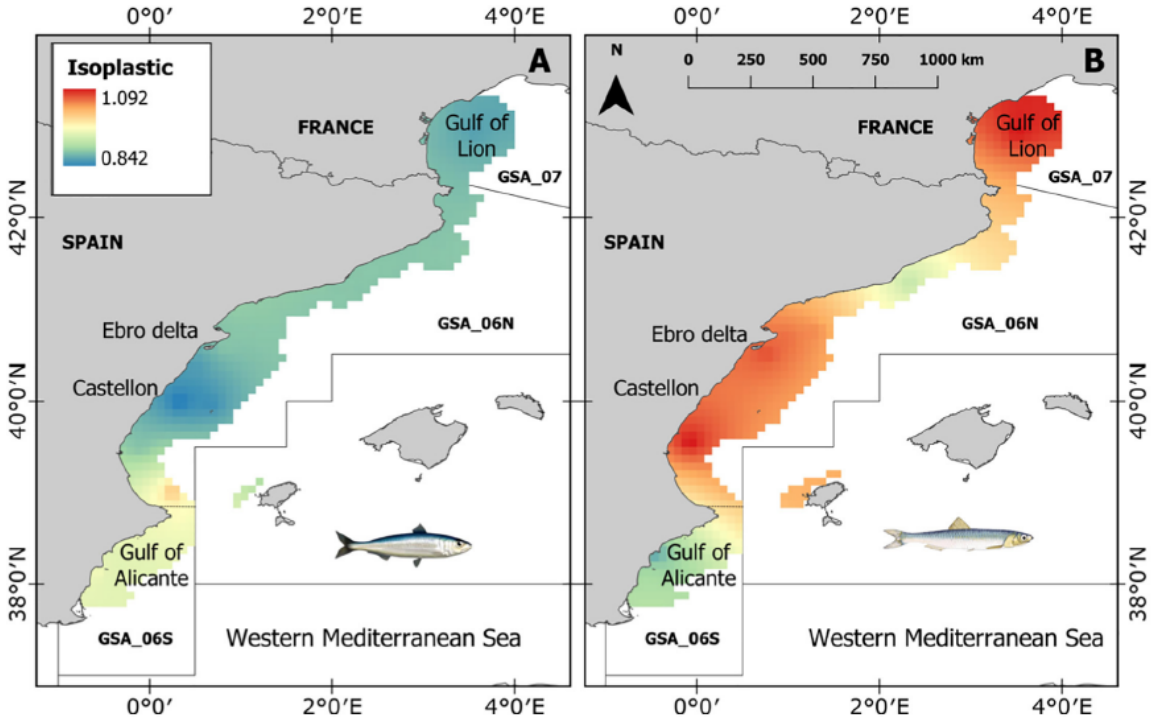
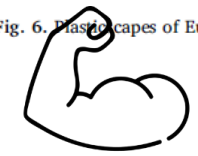


Fig. 6. Plastiscapes of European sardine (A) and anchovy (B) obtained plotting the posterior mean of the spatial B-GLM by species.

Pennino et al., 2020

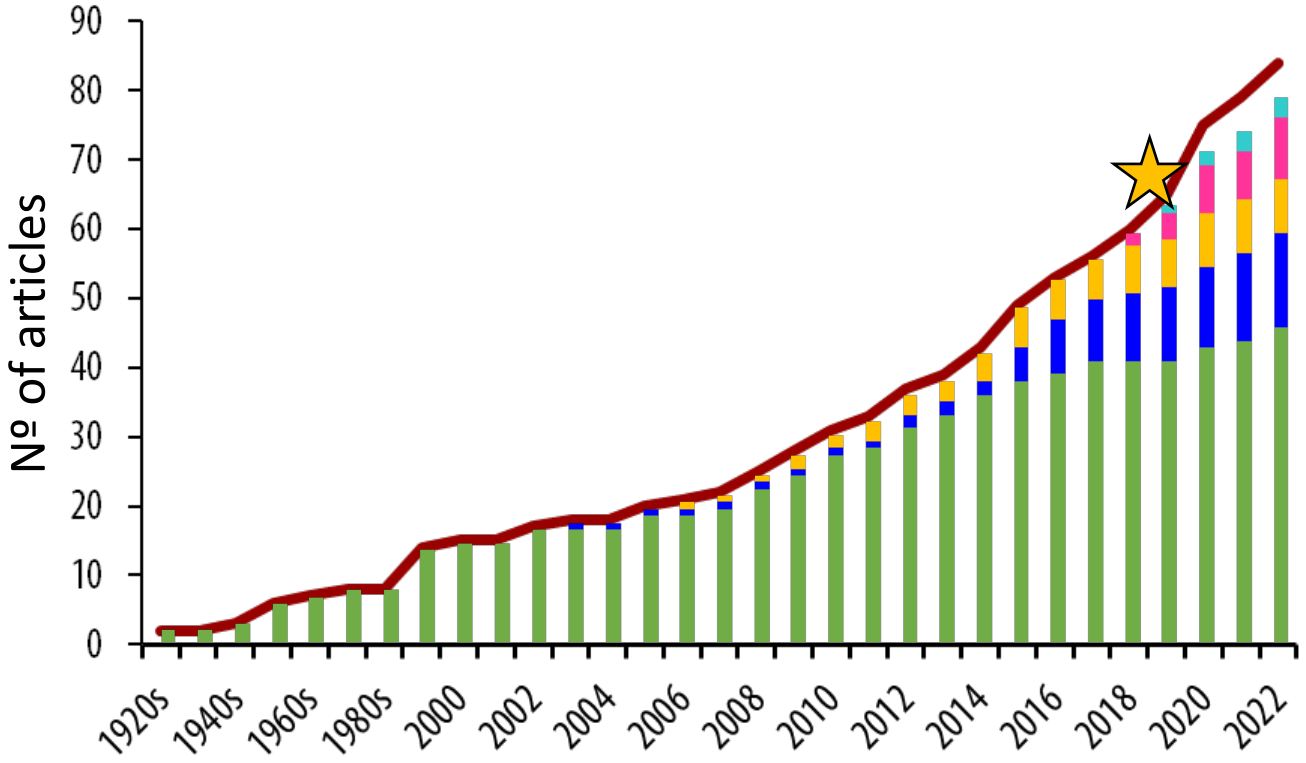


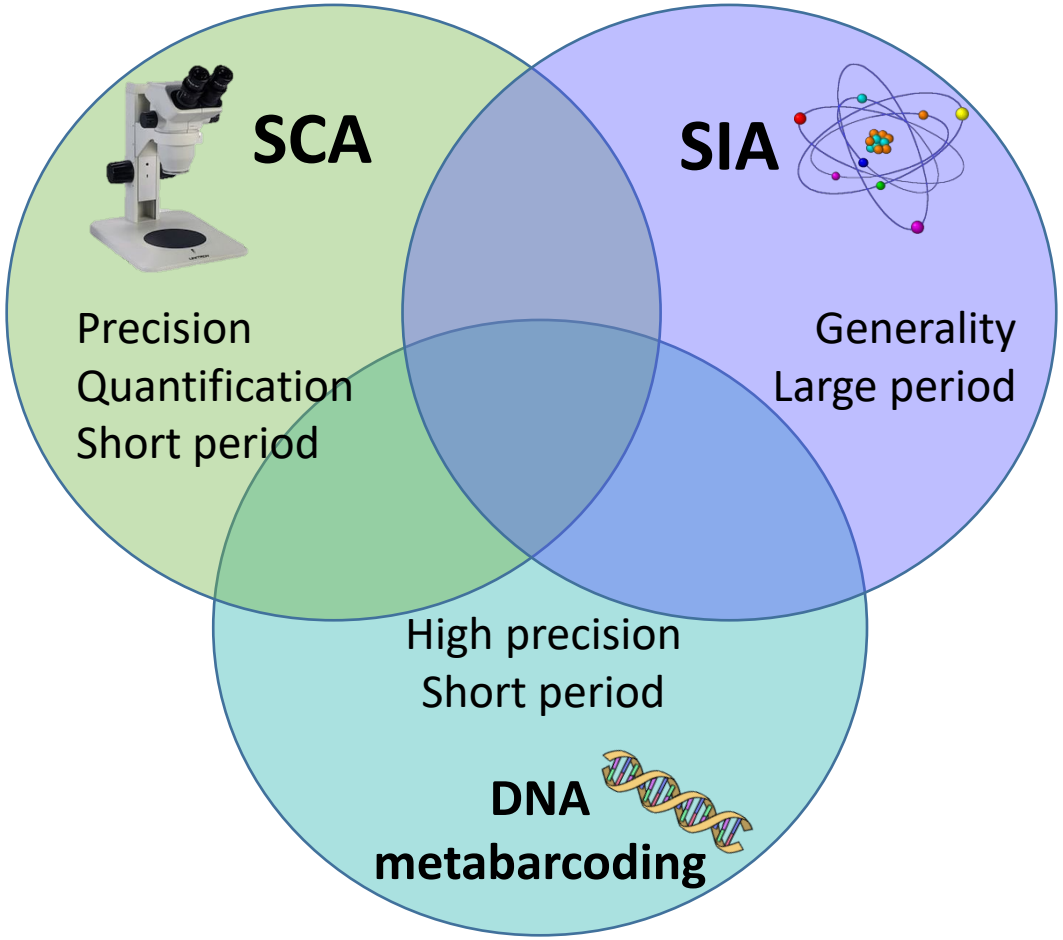
Body condition
Parasites

In 2015, 15% of individuals of sardine and anchovy with AIs (Compa et al., 2018)
Recently 60 to 70% of AIs have been found in stomachs of sardine & anchovy (Pennino et al., 2020; Rodriguez-Romeu et al., 2022)

→ Relation with environmental conditions and climate see Misic et al., 2022

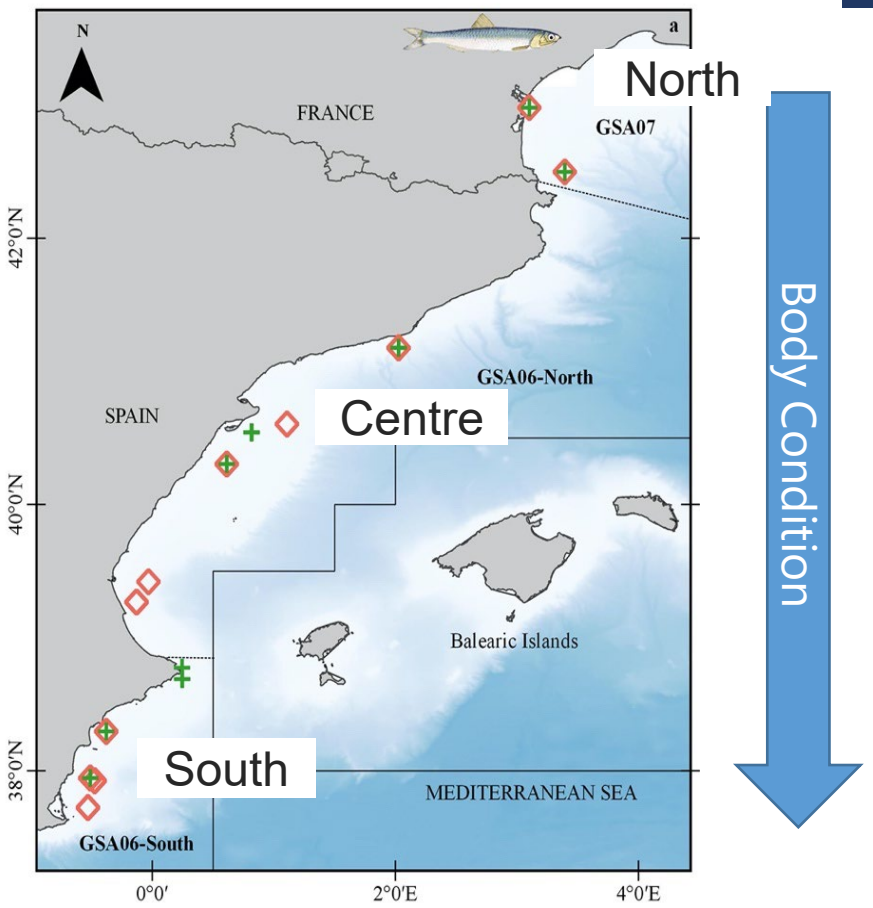
DNA Metabarcoding





DNA Metabarcoding

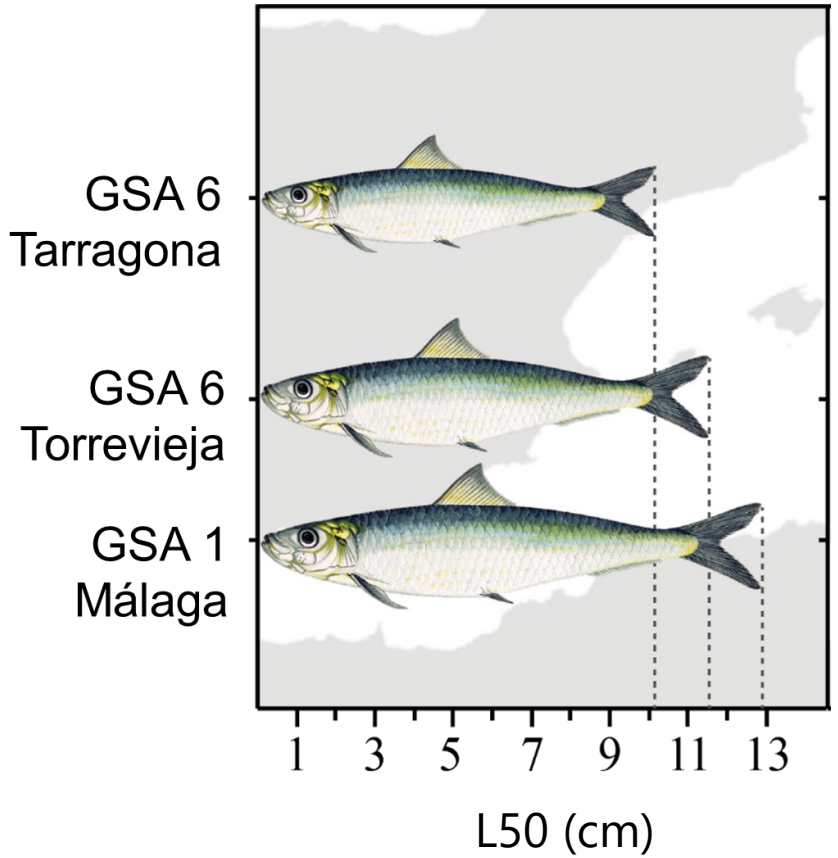
Latitudinal changes



Bachiller et al., 2020

Body Condition

Latitudinal changes in L50

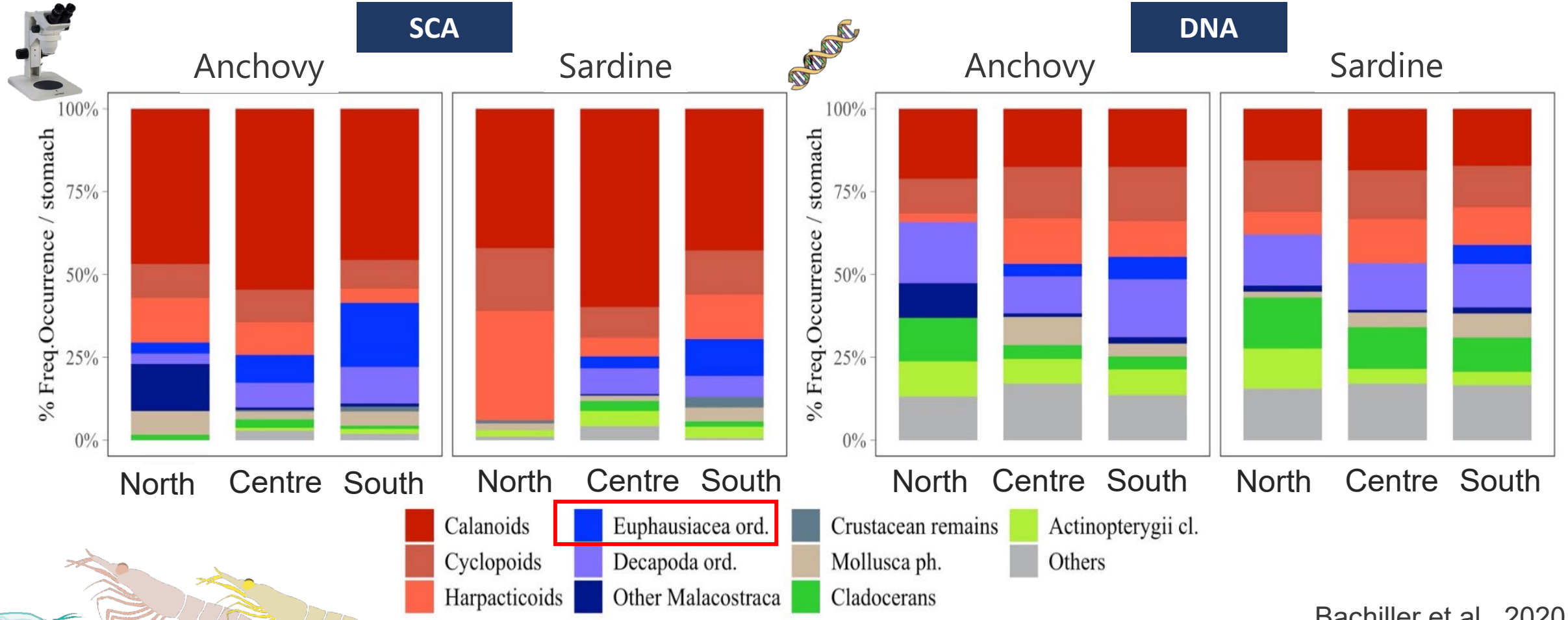


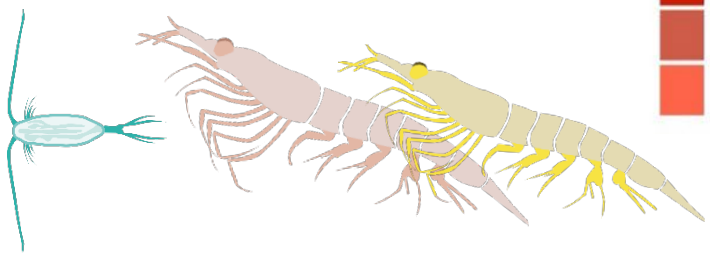
Albo-Puigserver et al., 2021

Hypothesis: Latitudinal changes in diet

DNA Metabarcoding

Latitudinal changes



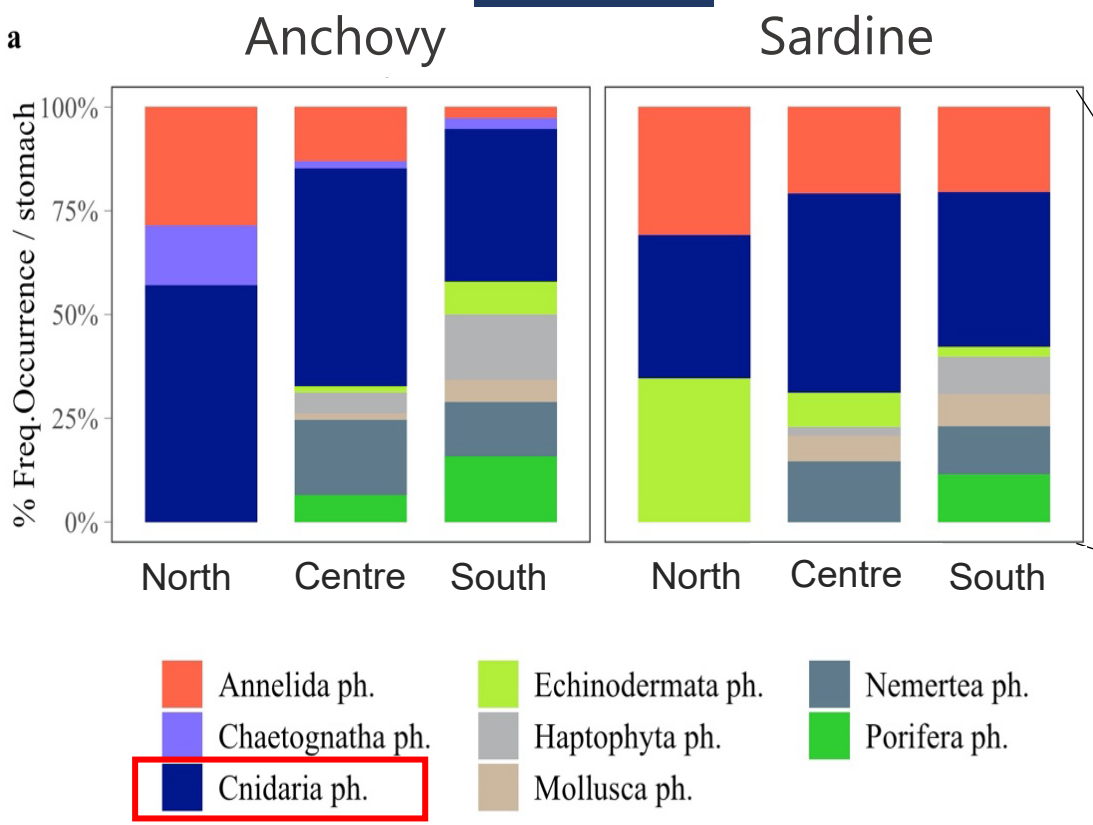


Bachiller et al., 2020

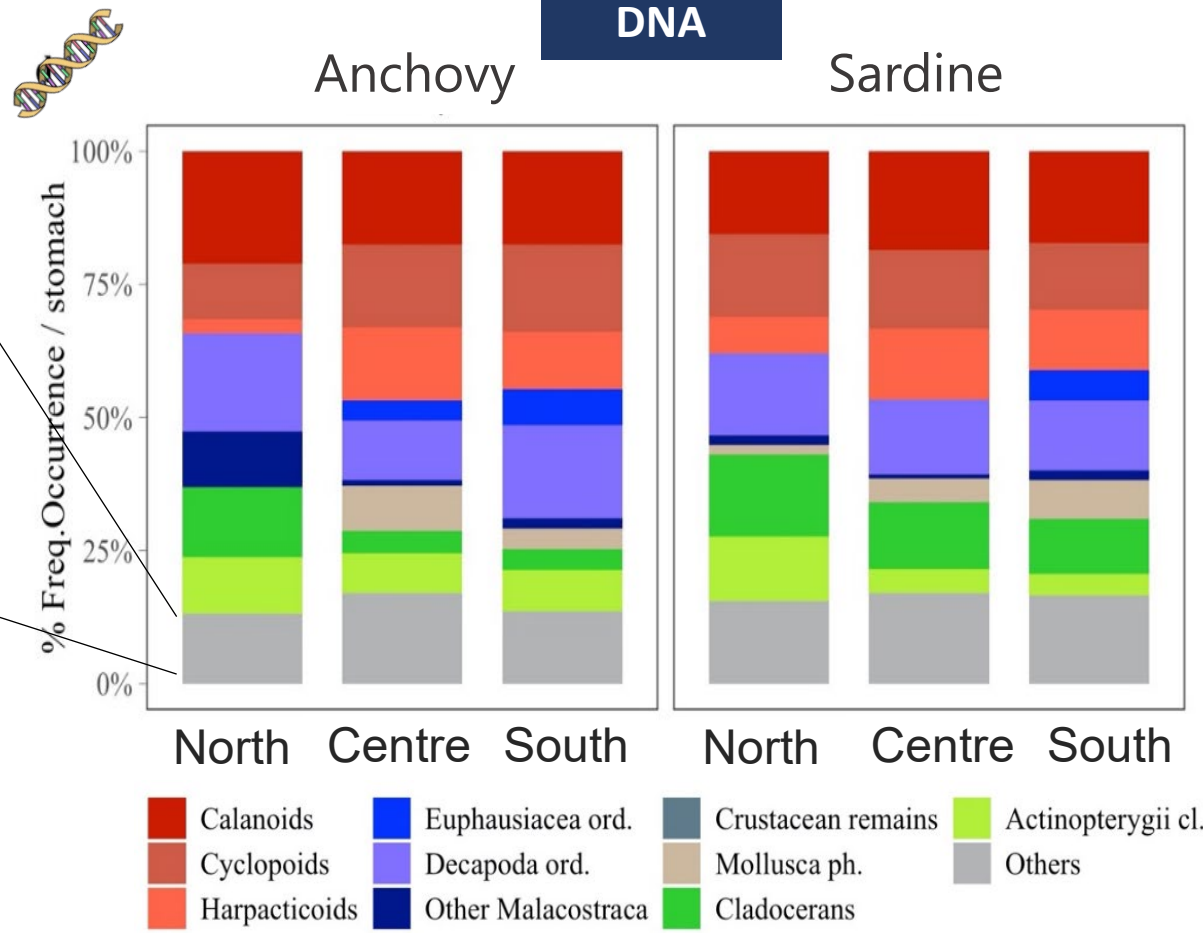
DNA Metabarcoding

Latitudinal changes

DNA



DNA



Gelatinous zooplankton not identify with SCA

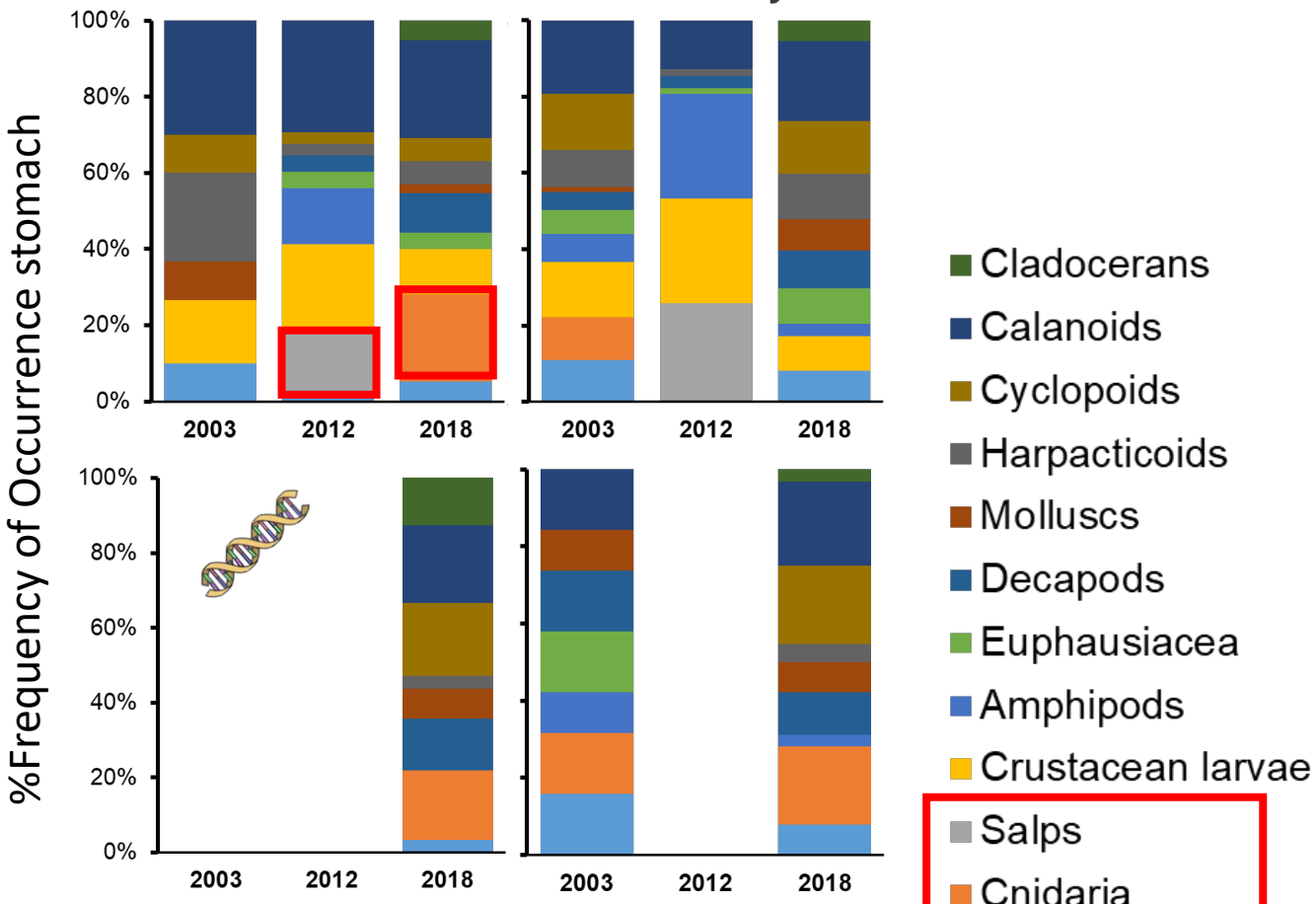
Bachiller et al., 2020

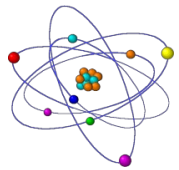
DNA Metabarcoding

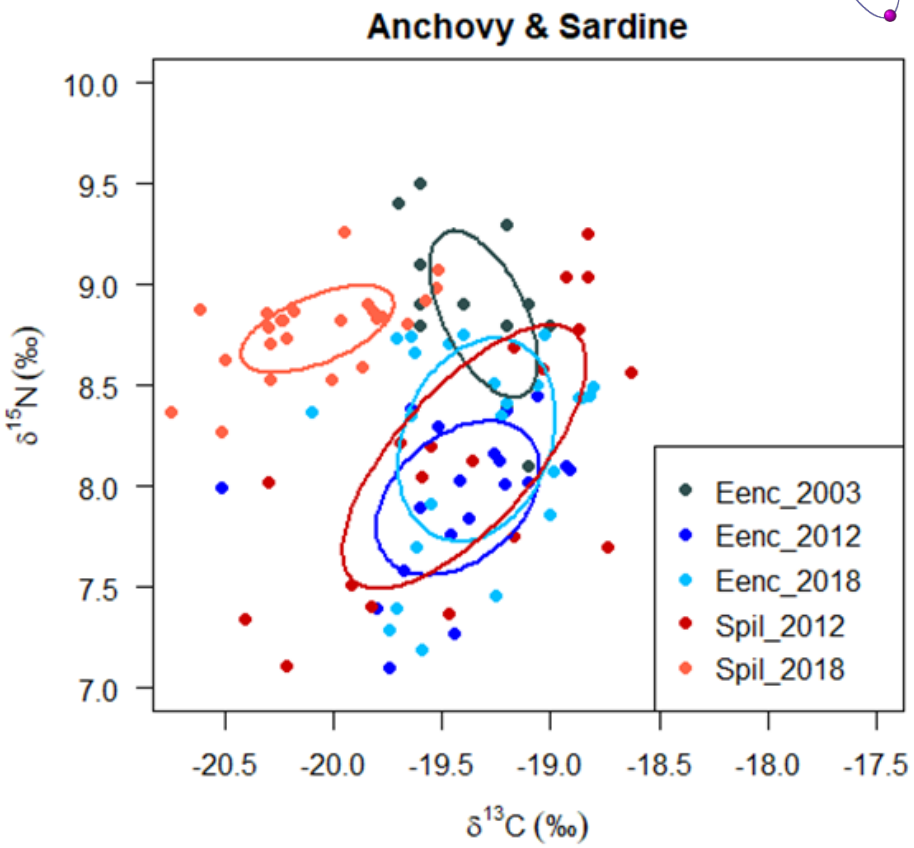
Time-series not available

Temporal changes

What about the temporal changes in diet?
Bottom-up hypothesis





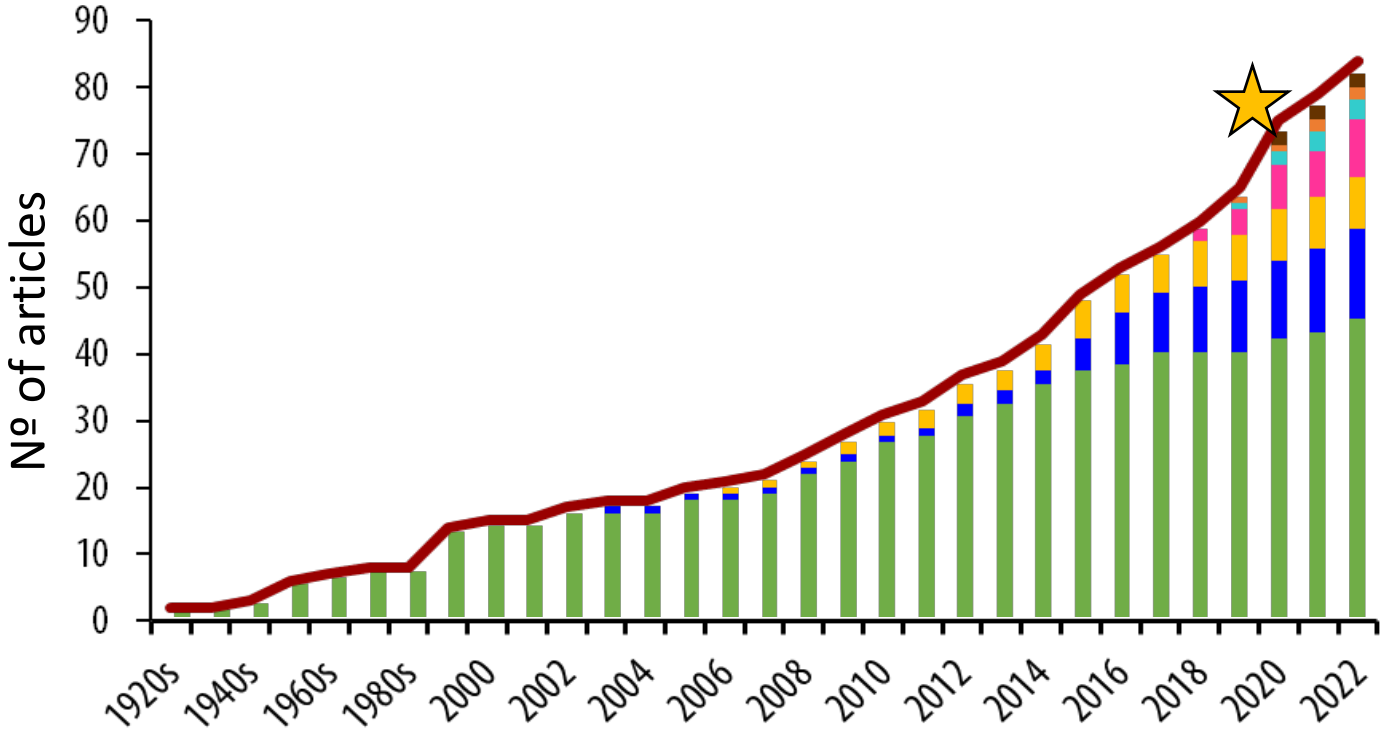


Albo-Puigserver (in prep)

More methods to be developed

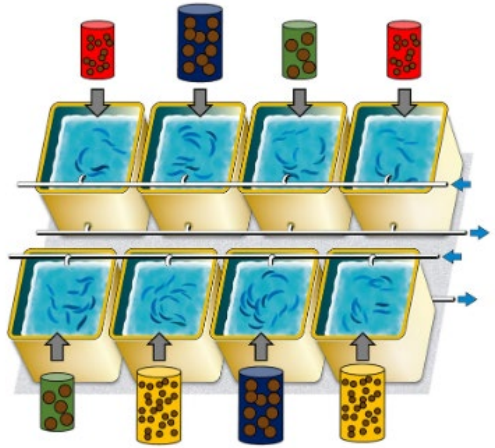
Experimental diet studies

Compound specific stable isotopes (C-SIA)

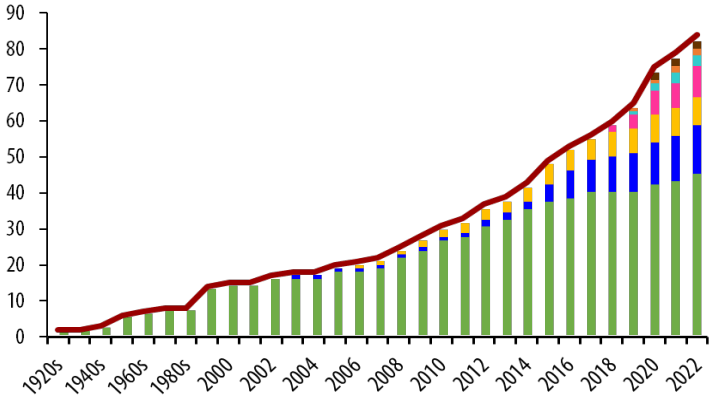


More methods to be developed

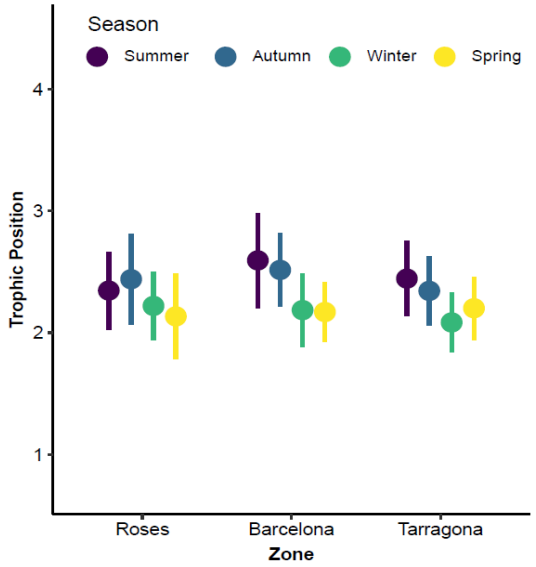
Experimental diet studies



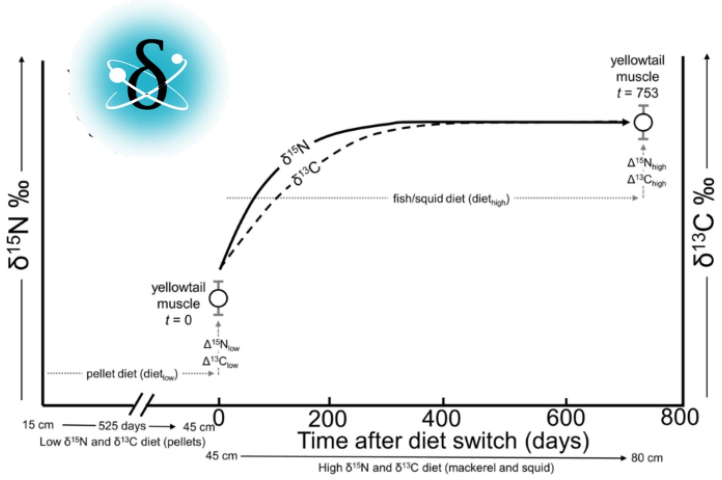
Queiros et al., 2019; Thoral et al., 2021



Compound specific stable isotopes (C-SIA)



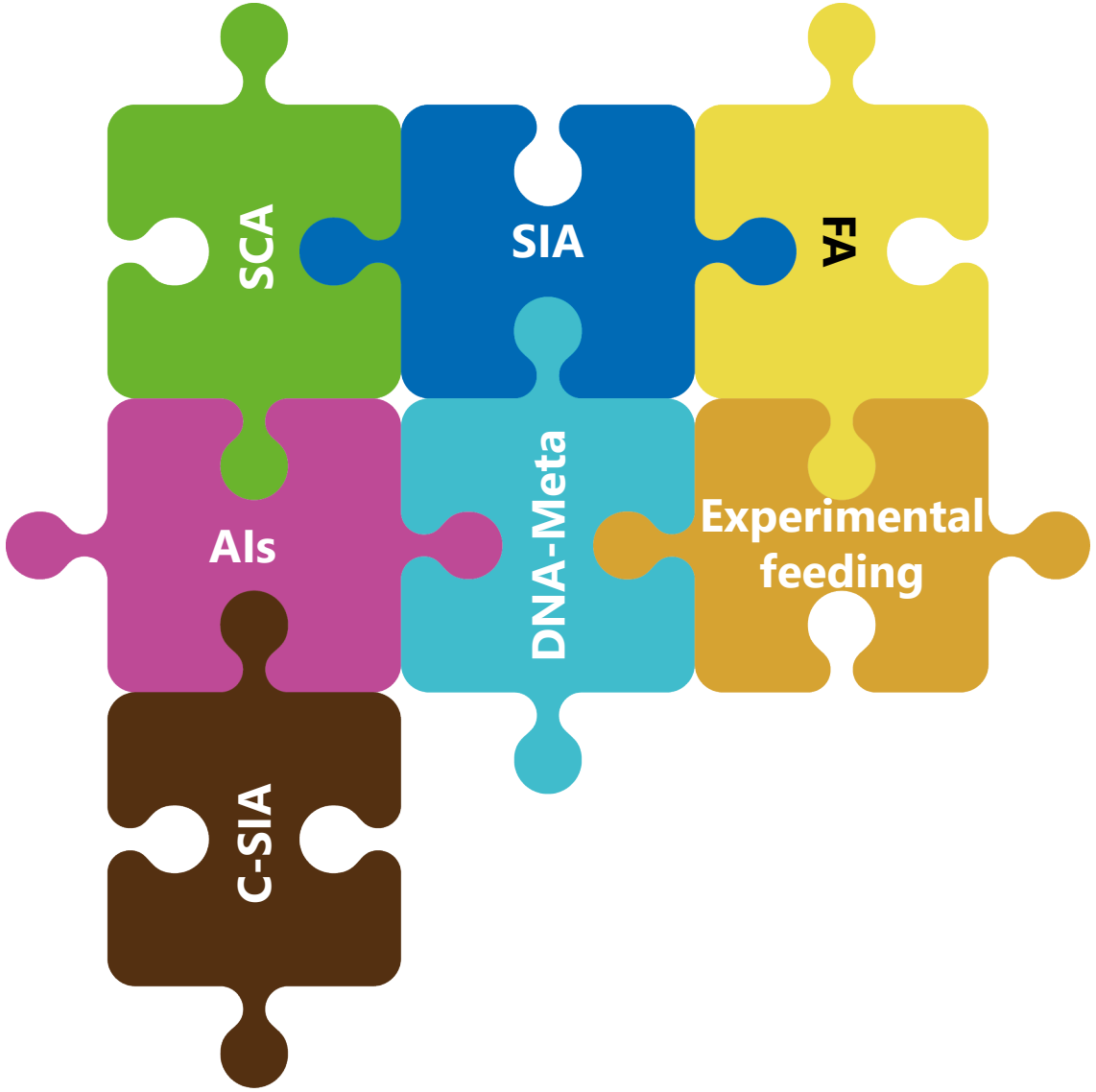
$$TP = 1 + (\delta^{15}N_t - \delta^{15}N_s - \beta_{t/s}) / TDF_{t/s}$$



Madigan et al., 2021

15:20	**Joan Giménez** Seasonal and spatial variation of the trophic position of European sardine in the NW Mediterranean Sea using compound-specific stable isotope analyses

Combination of methods



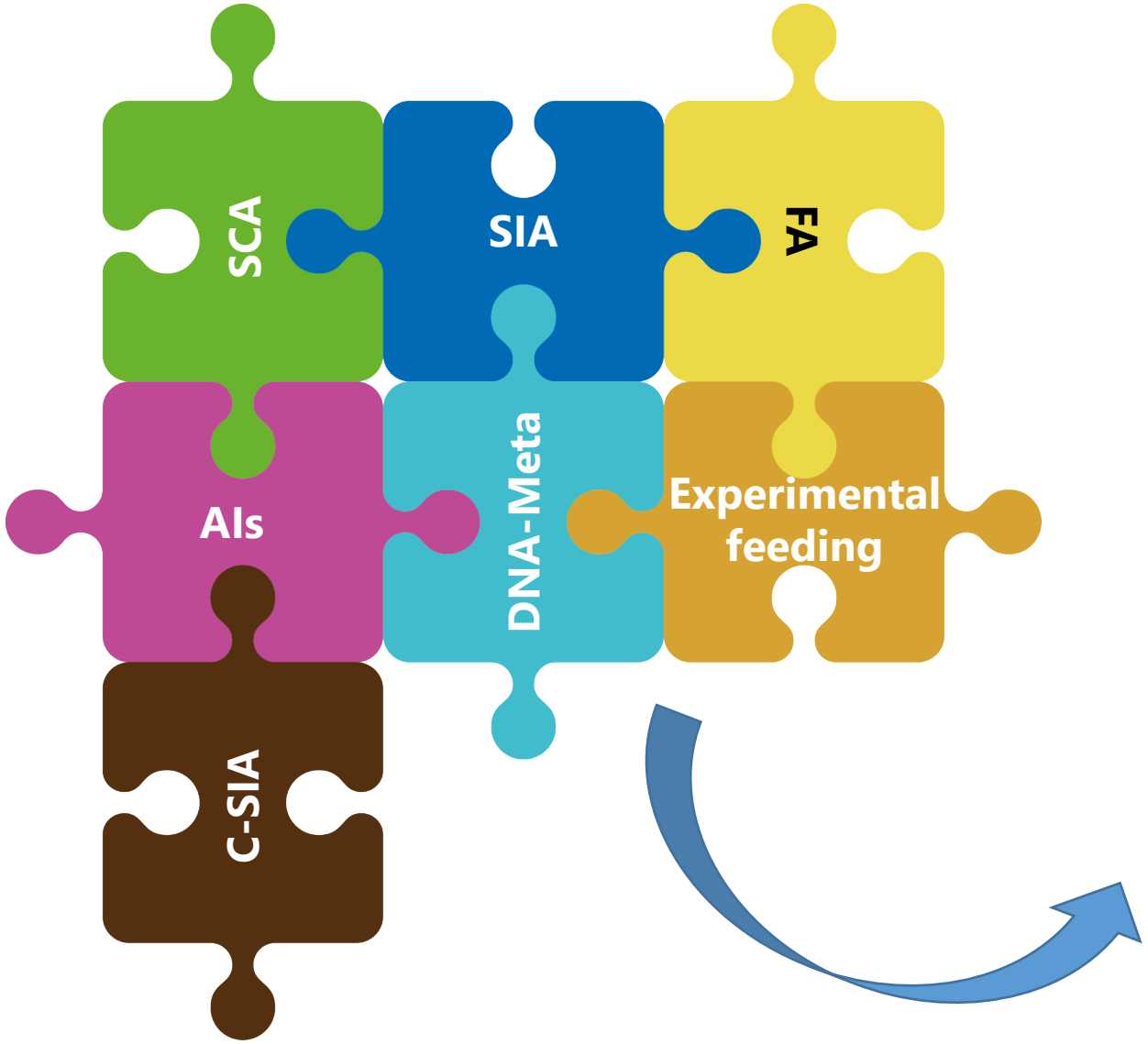
ADVANCES:

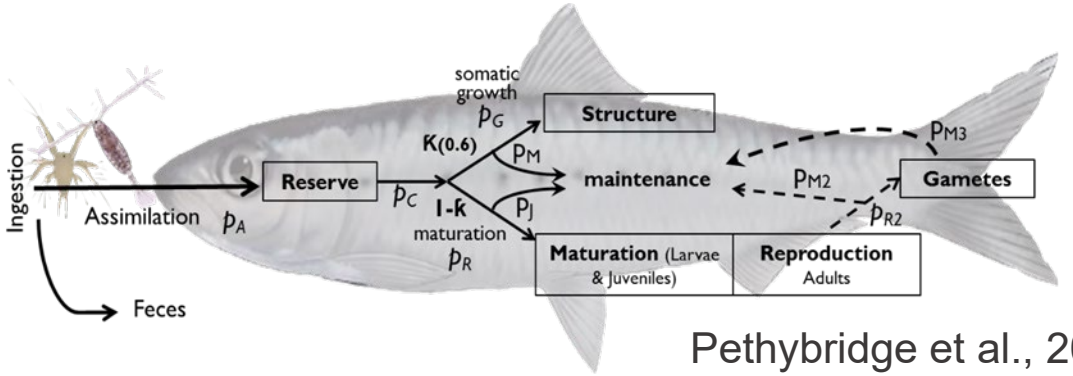
- Increasing studies combining methods and species (few in ontogeny)
- Seasonally included (sometimes)
- Combination with environmental parameters and life history traits

GAPS:

- Adult and juvenile are better represented than larvae
- Uneven distribution of studies available
- Lack of time-series and regional intercomparison

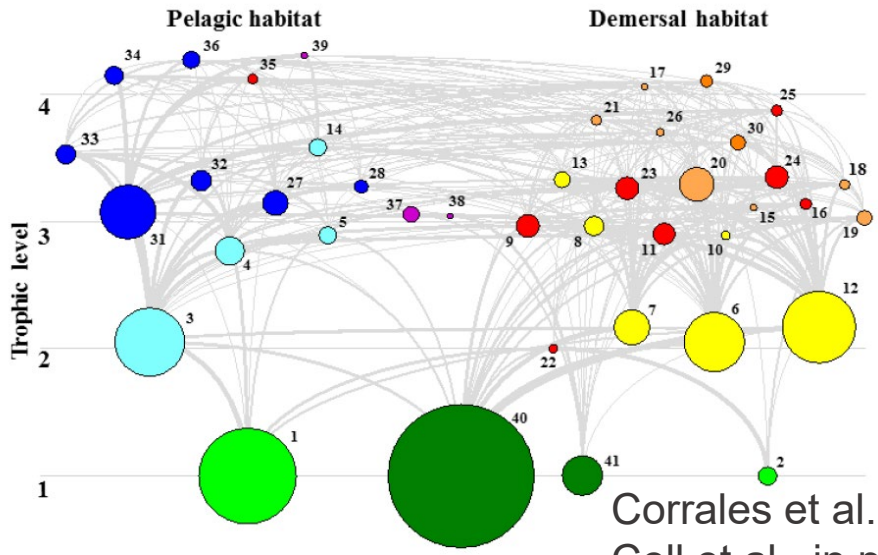
Combination of methods





Pethybridge et al., 2013

Bioenergetic model



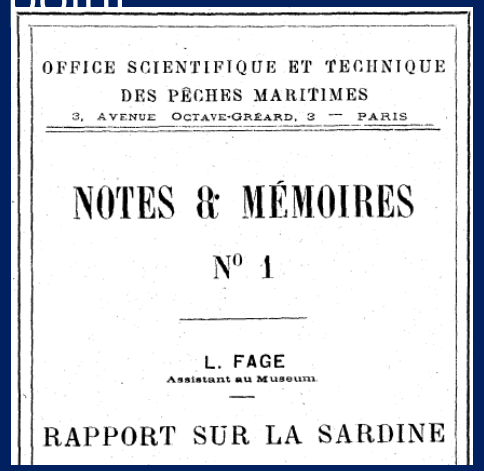
Corrales et al., 2017
Coll et al., in prep

Ecosystems mechanistic models

Thoughts and reflections

Fage (1920):

"The nature of the feeding (sardine) is certainly known in broad terms, but it seems essential to be more precise at this point."



OFFICE SCIENTIFIQUE ET TECHNIQUE
DES PÊCHES MARITIMES
3, AVENUE OCTAVE-GRÉARD, 3 — PARIS

NOTES & MÉMOIRES

N° 1

L. FAGE
Assistant au Museum

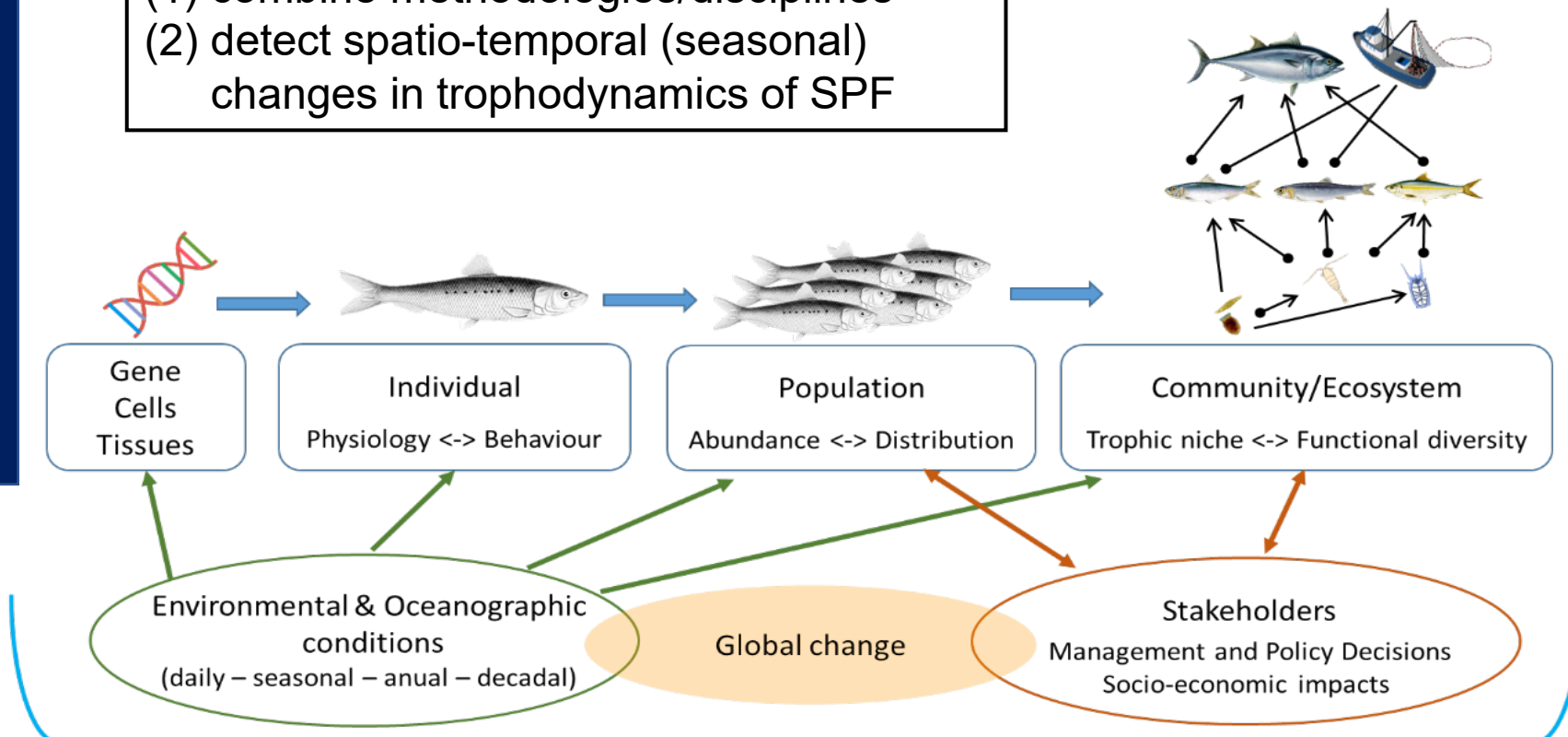
RAPPORT SUR LA SARDINE

2022:

Good news! After one century we have the precision and knowledge.

The new challenges:

(1) combine methodologies/disciplines
(2) detect spatio-temporal (seasonal) changes in trophodynamics of SPF



Thoughts and reflections

How should we move forward in trophic ecology of SPF in the Mediterranean Sea?

a) Implementation of monitoring program
b) Increasing studies on larval stages
c) Boost experimental studies
d) Collaboration to compare different areas
e) …..

Obrigada!

Marta Albo-Puigserver

marta.albo@ieo.csic.es

@MartaAlboP

Small Pelagic Fish:
New Frontiers in Science and Sustainable Management
November 7 - 11, 2022
Lisbon, Portugal

ICES CIEM PICES CSIC Consejo Superior de Investigaciones Científicas Instituto Español de Oceanografía 1914

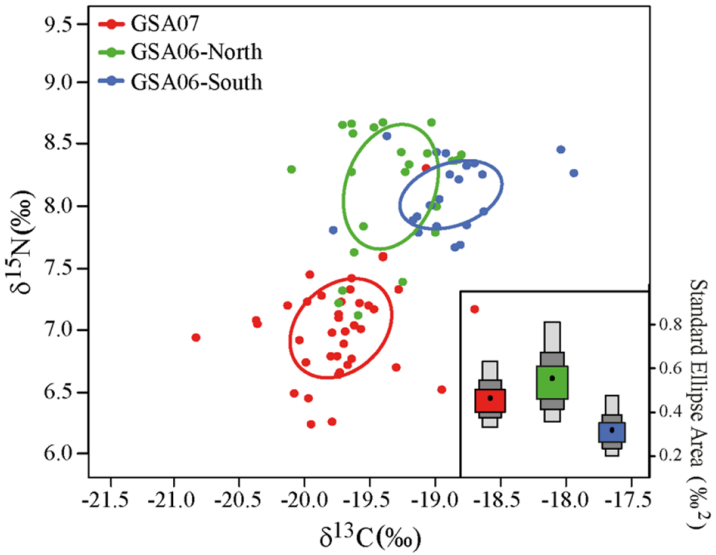
Illustrations credit of **Amparo Hidalgo**

Cover backgroup credit, my mother

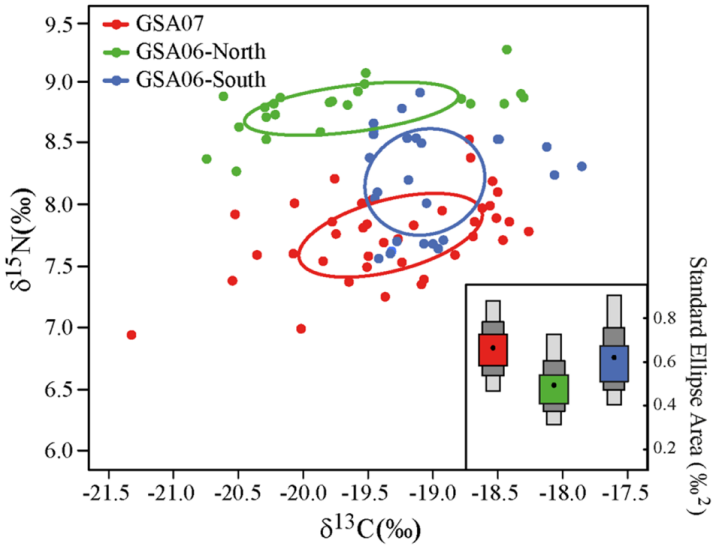
DNA Metabarcoding

Latitudinal changes

Anchovy



Sardine



- SCA and DNA-Metabarcoding indicate larger (more energetic) prey in the south and higher values of $\delta^{15}N$
- Trophic niche with does not present clear pattern

Bachiller et al., 2020