



Navigating Changes in  
Small Pelagic Fish  
and Forage Communities:  
Climate, Ecosystems, and  
Sustainable Fisheries  
May 4 – 8, 2026 | La Paz, Mexico

# Insights in the European sardine genome unraveling population structure and somatic condition

Marta Caballero, Judith Ollé-Vilanova, Xènia Frigola-Tepe, Marta Muñoz, Jordi Viñas

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Grup de recerca en Biodiversitat i Recursos Marins



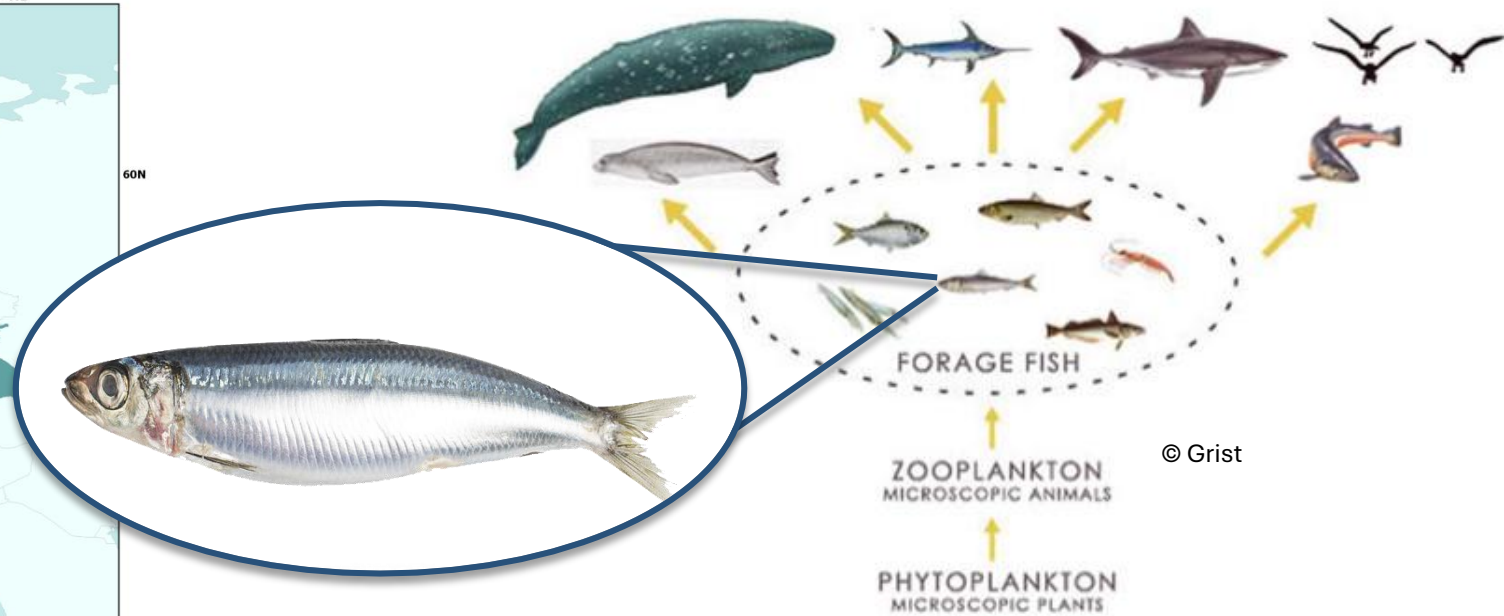
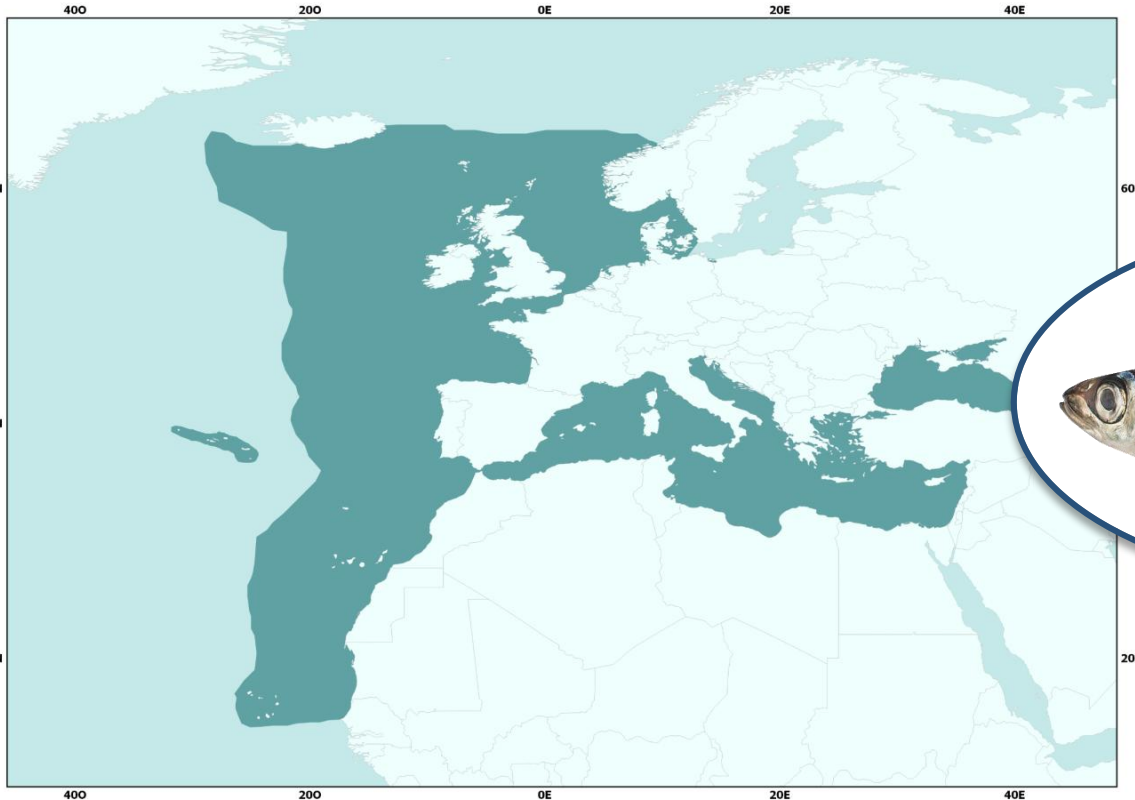
Laboratori d'Ictiologia Genètica



# Sardina pilchardus

(Walbaum, 1792)

- **Important ecological role in the ecosystem**
- **Forage species** - Energy transfer



- **Preference for cold waters** - Spawning at 13–15°C
- **High nutritional value** (Omega-3)
- **25% of fish catches in the Mediterranean**



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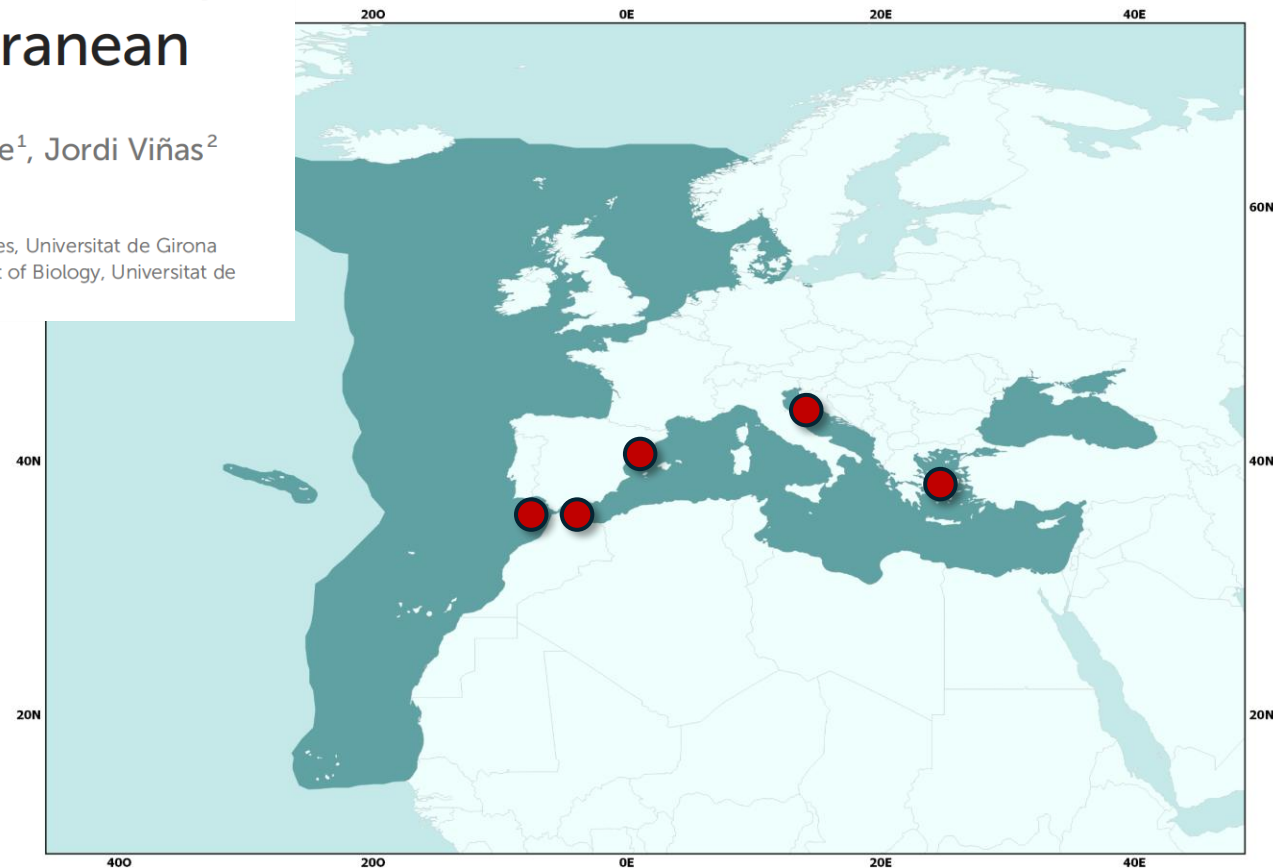
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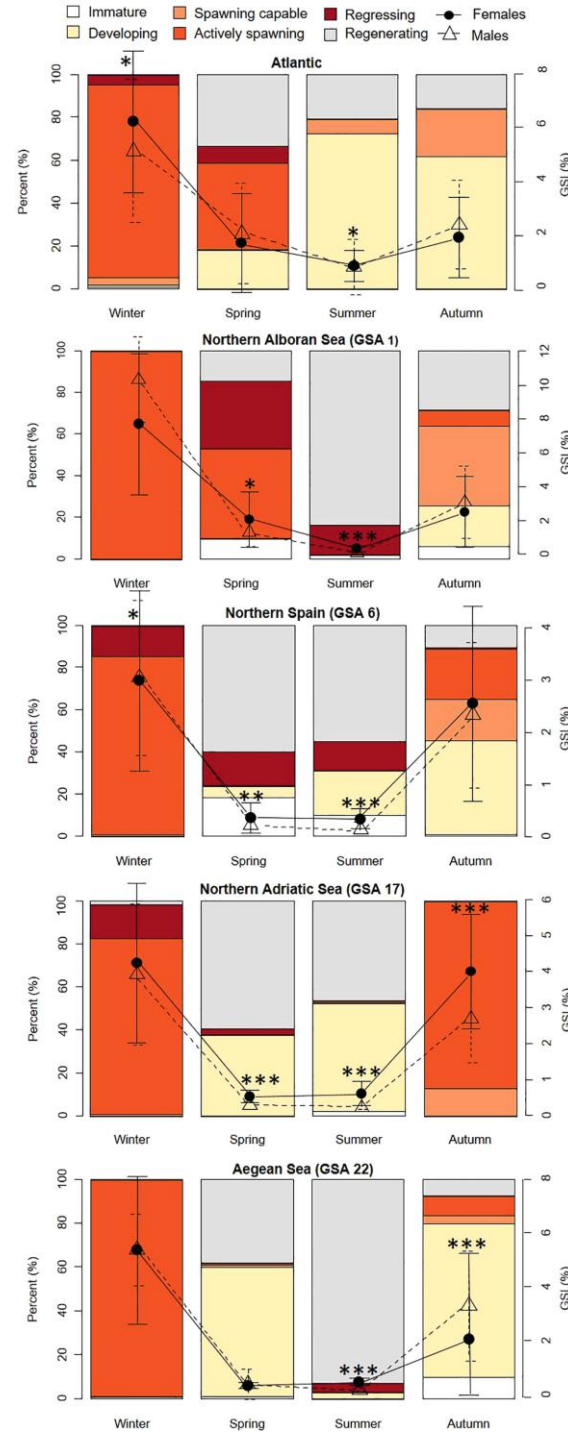
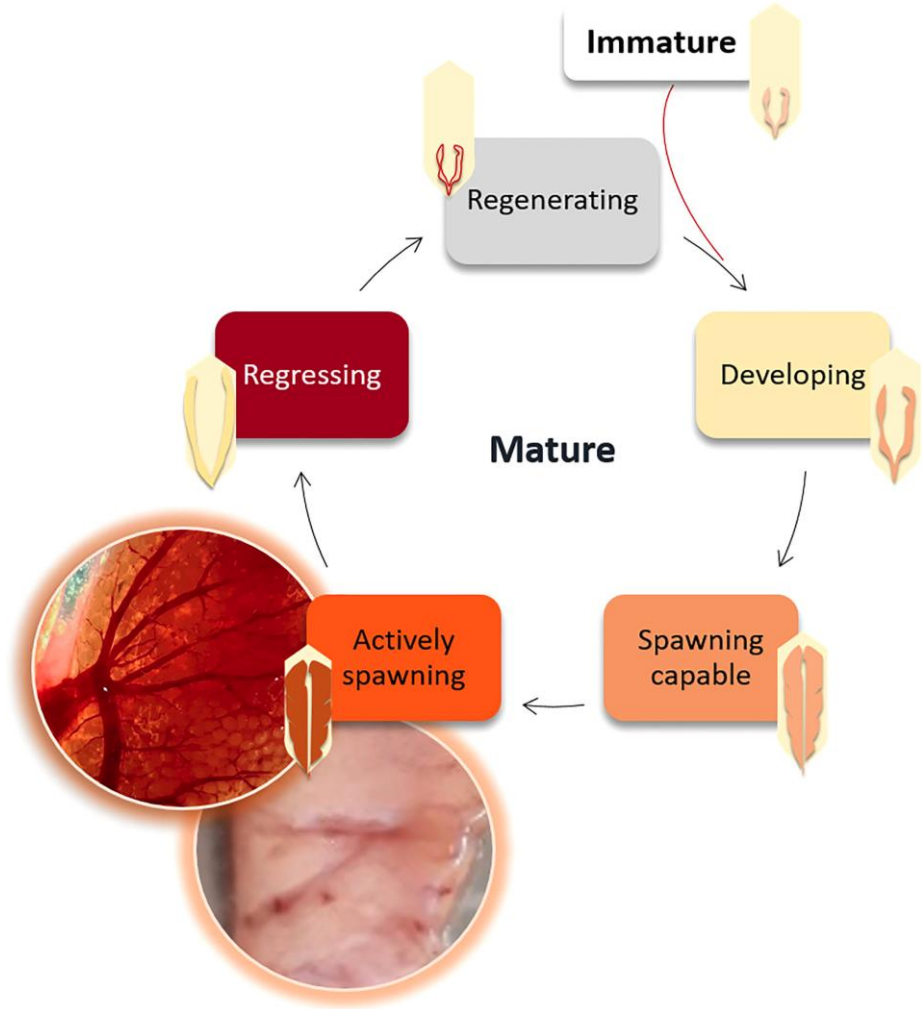
# From west to east: Heterogeneity in the life history traits of a small pelagic fish (*Sardina pilchardus*) throughout the Mediterranean

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# Reproduction

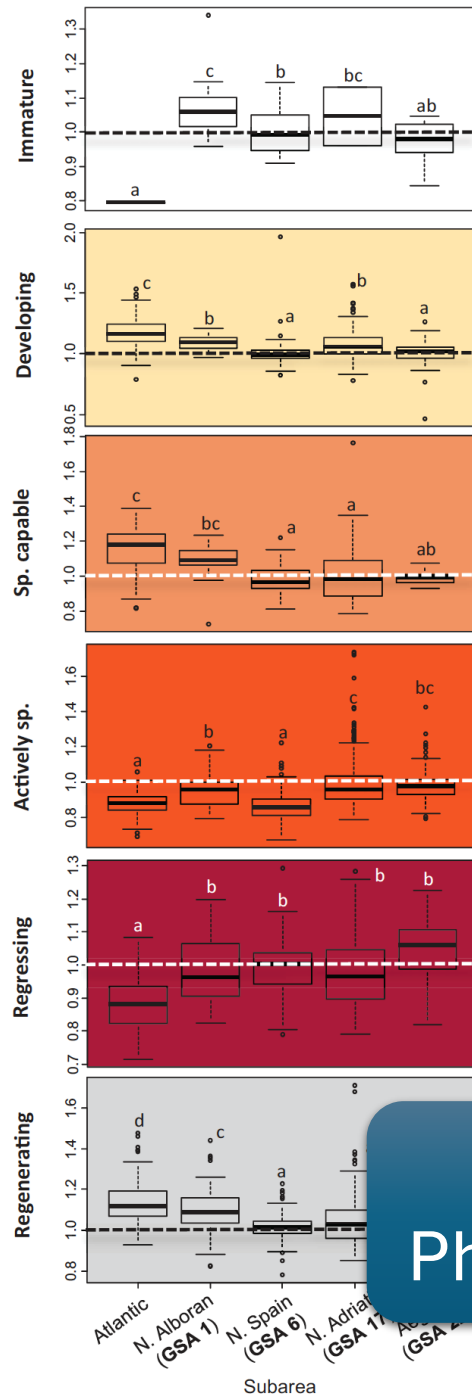


Differences  
in reproductive behavior  
Mediterranean

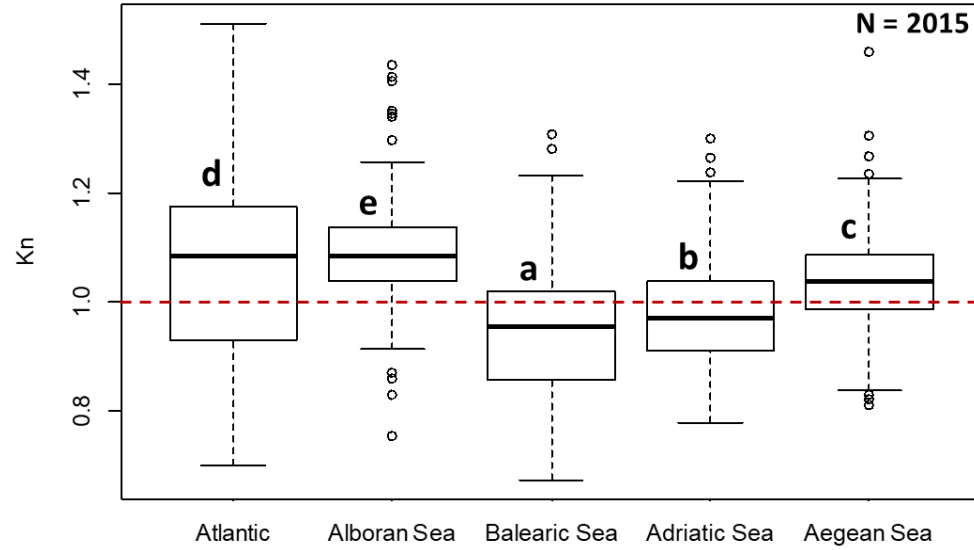


Linked to  
somatic condition (Ks)

# Condition (Kn) Related to reproduction



## Summary-Kn

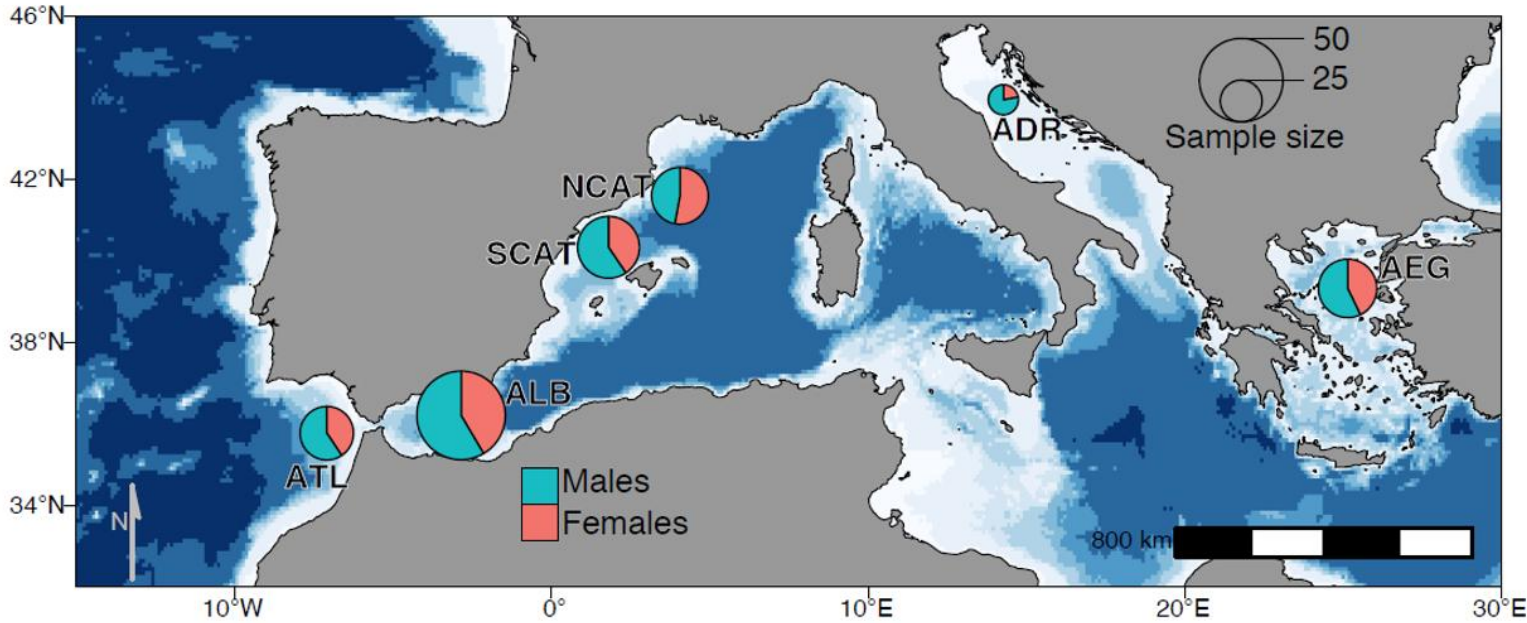


Clear differences



Population genetics  
Phenotype (condition)- genotype association

# Population structure



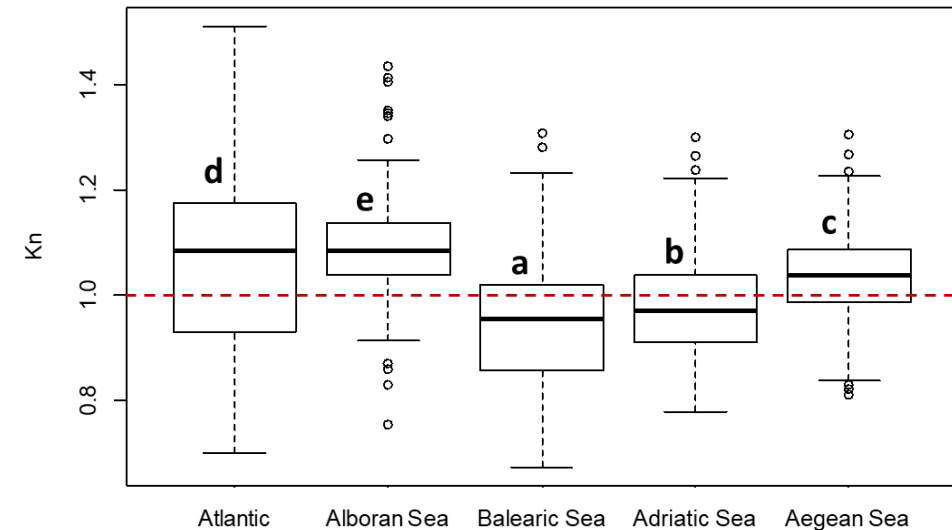
Location	N	$K_n$
East Atlantic	32	$1.039 \pm 0.108$
Alboran Sea	54	$1.069 \pm 0.138$
S. Catalan coast	37	$1.019 \pm 0.070$
N. Catalan coast	34	$1.069 \pm 0.138$
Adriatic Sea	17	$0.926 \pm 0.054$
Aegean Sea	35	$1.256 \pm 0.125$
	209	

Selection of Caballero-Huertas et al., 2023.

5506 SNPs

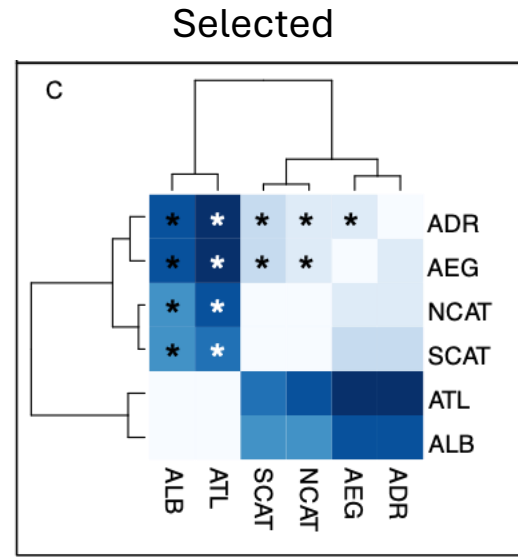
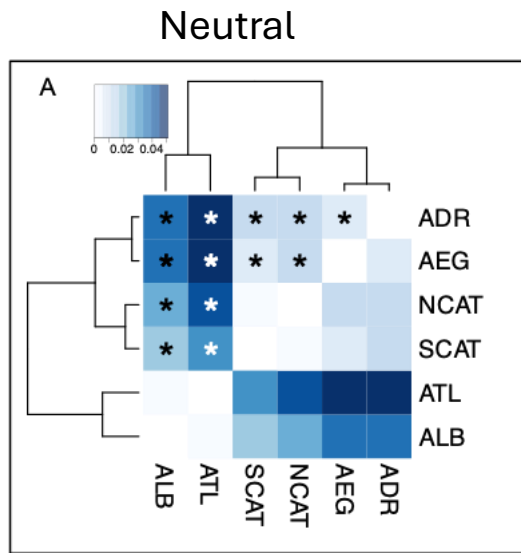
ddRadseq

5381 neutral loci - 125 selected ( $F_{ST}$  outlier)



# Population differentiation

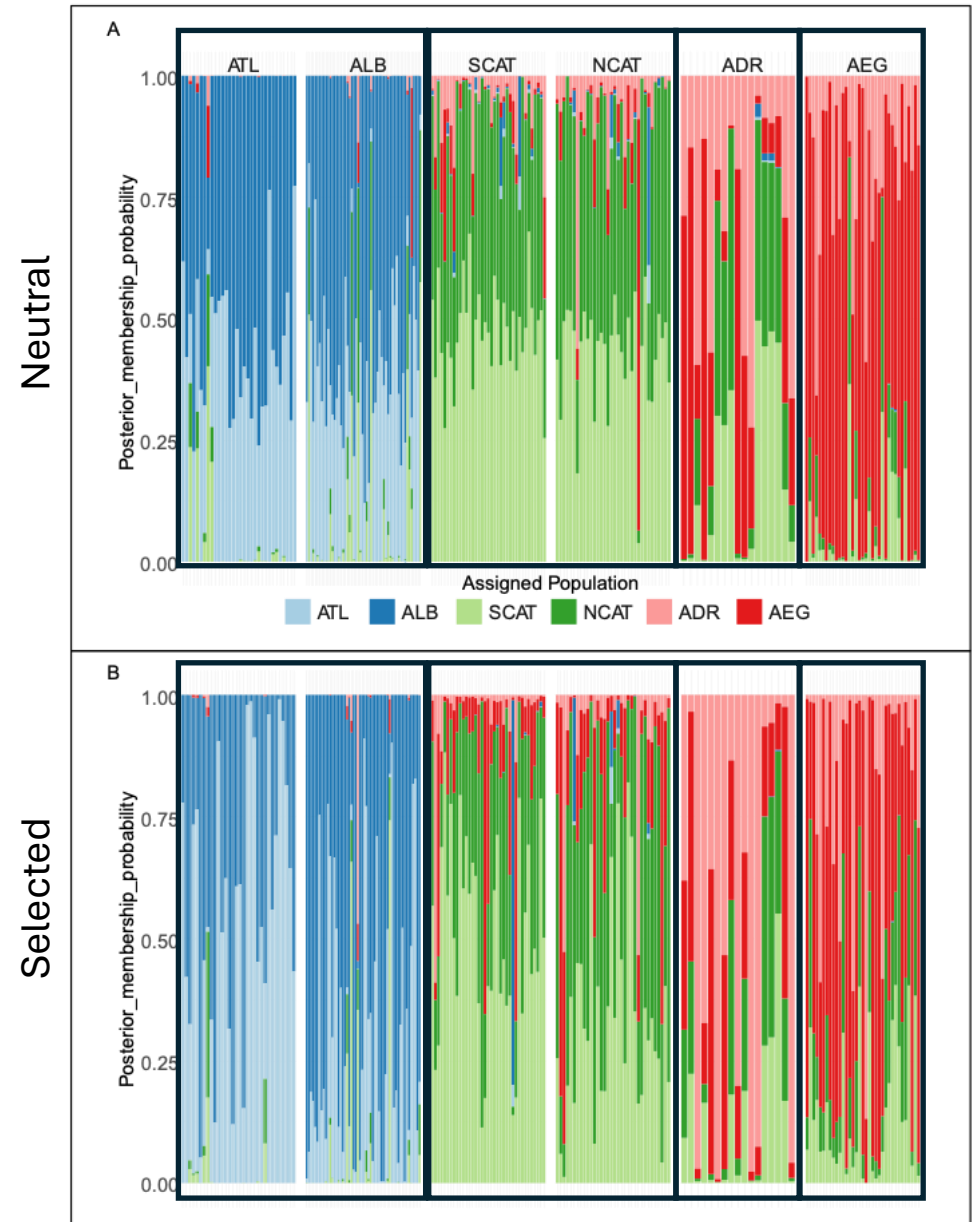
$F_{ST}$



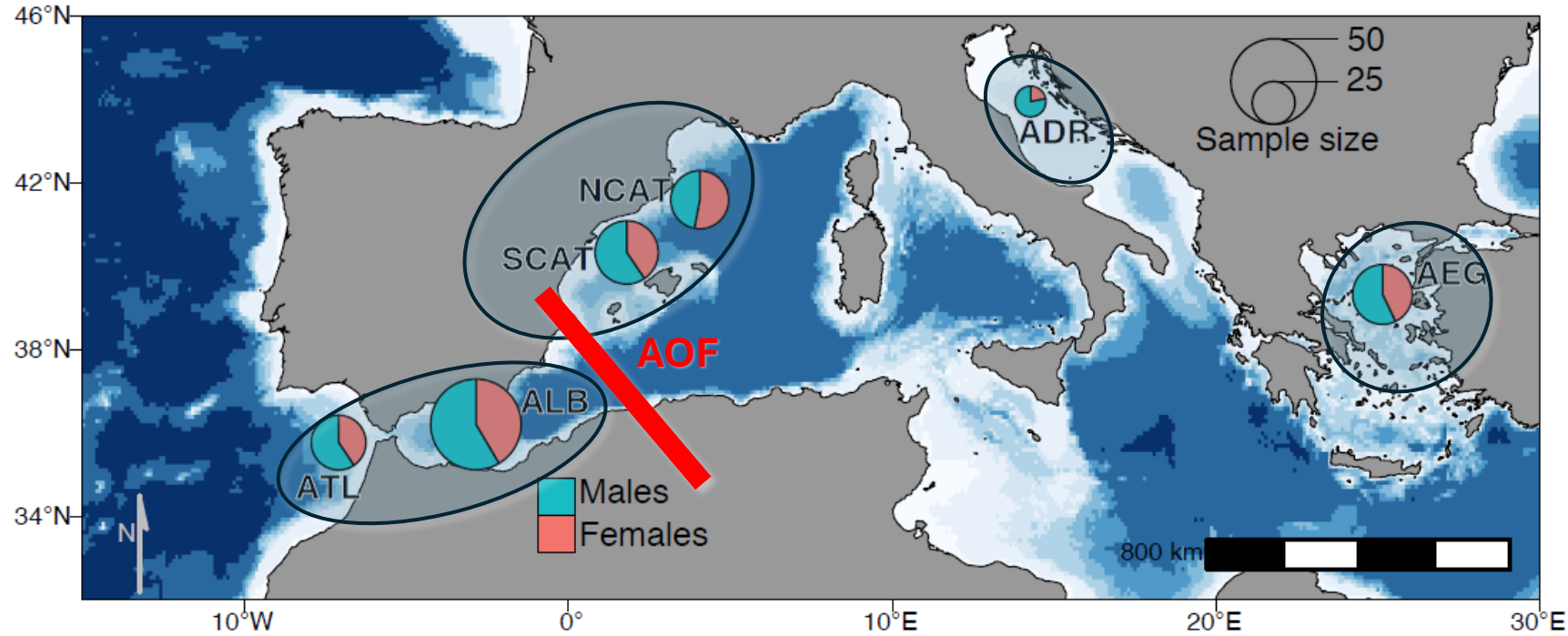
## Population structure

- 1.- ATL-ALB
- 2.- NCAT/SCAT
- 3.- ADR
- 4.- AEG

# DAPC (K = 4)

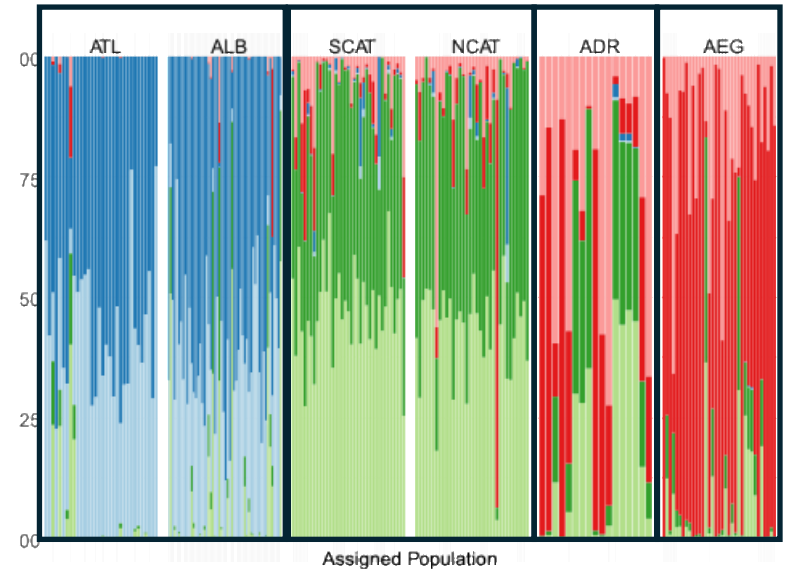


# Population Structure

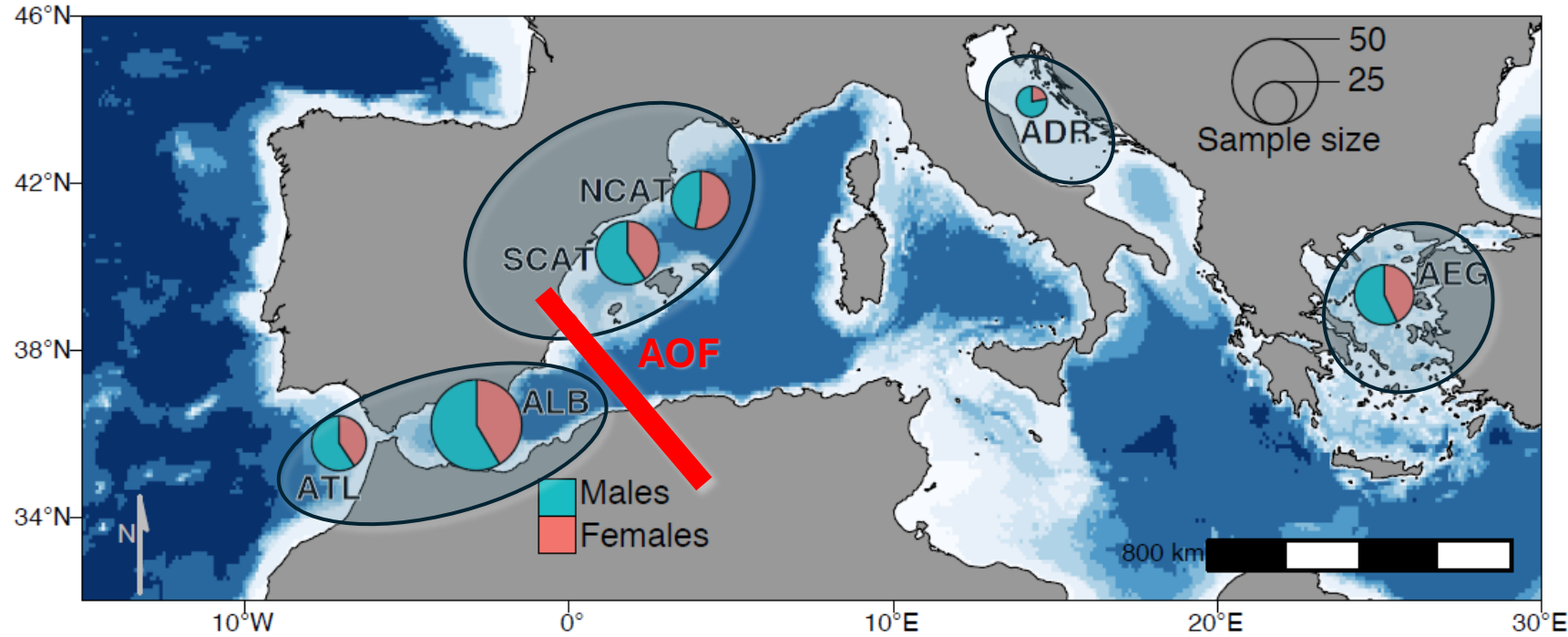


4 genetically differentiated populations  
(Neutral and selected markers)

Almeria Oran front (AOF) as gene flow barrier – No strait of Gibraltar



# Population Structure

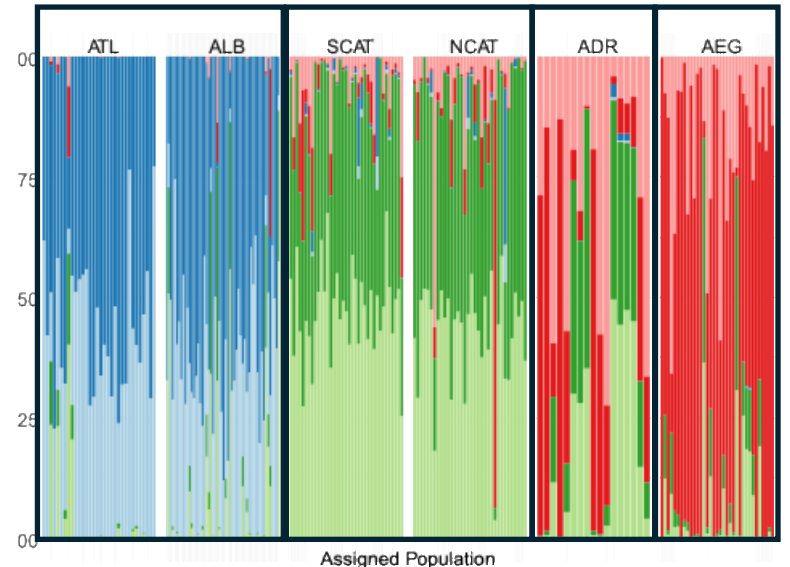


4 genetically differentiated populations

(Neutral and selected markers)

Almeria Oran front (AOF) as gene flow barrier – No strait of Gibraltar  
Adriatic intermediate (transition)

Correspondence of differences in somatic condition  
(reproductive)



# Phenotype – genotype association

5506 SNPs

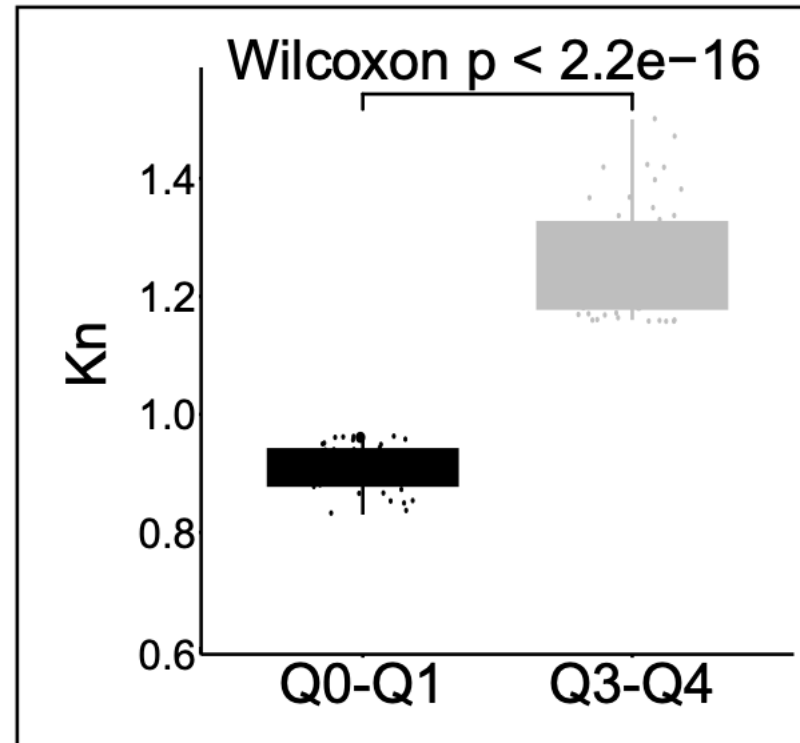
- All individuals in regenerating reproduction phase
- $K_n$  recalculated for each genetically differentiated stock
- $K_n$ , upper ( $\geq$  third quartile) vs lower ( $\leq$  first quartile) quartiles



reduce noise



maximize phenotypic contrast

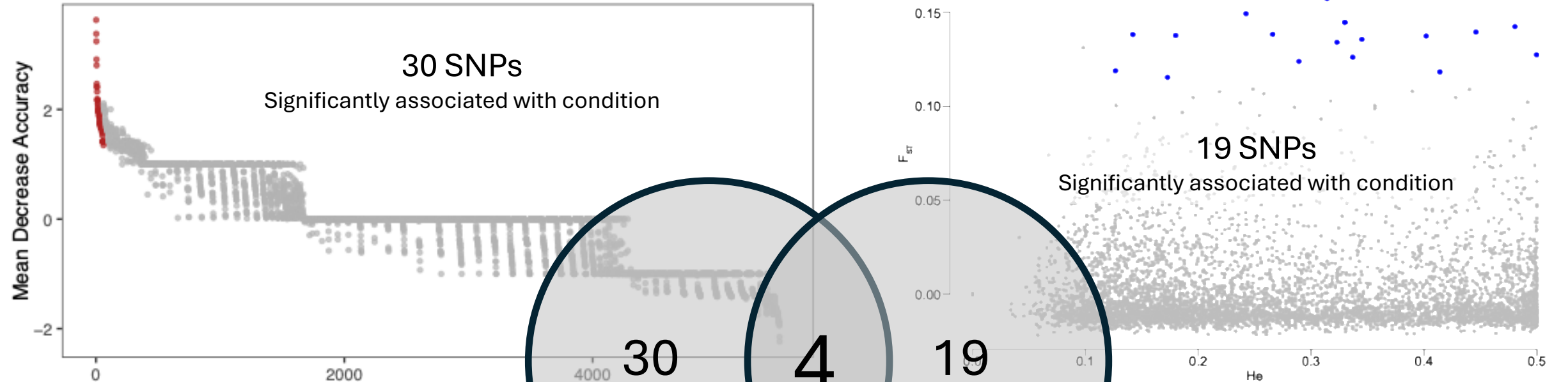


# Phenotype – genotype association

Two approaches

Random forest

OutFLANK



3 annotated

- tetraspanin 17
- mitogen-activated protein kinase 12
- immunoglobulin superfamily, DCC subclass, member 4

4 SNPs significantly associated with condition

# Future prospects

- Phenotypic adaptation on environmental changes
- Validation of markers associated with condition  
Epigenetics
- Fine scale population structure  
Reproduction connectivity Atlantic –Alboran  
Gulf of Lion – Balearic sea
- ...





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Consarfish  
PID2024-158108OB-I00

QUALISARD  
PDC2022-133950-I00

SARDTEMP  
TED2021-132521B-I00





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Questions  
Preguntes?





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