FROM ALLOZYMES TO NEUTRAL MOLECULAR MARKERS: POPULATION GENETICS OF SARDINES AND ANCHOVIES A LONG THE NWA

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In the Northwest Africa and adjacent seas

Introduction

Sardine(*Sardina pilchardus*)	Anchovy (*Engraulis encrasicolus*)
• 1,2 M tons (FAO , 2021) in NWA • Atlantic Iberian waters: 22143 tons (Portugal and spain), (ICES 2021)	• 51 000 tons, (NWA) (FAO 2021) • Atlantic Iberian waters:13 000t

Sardine and anchovy play a major ecological role in their ecosystem

Effective management of fisheries resources

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Setting up of management measures

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1- Circumscription of management units based on a Biological Reality

2- Understanding Biological and environmental mechanisms structuring the distribution of the resource

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Determine sustainable harvest levels

Fish stock identification

- Holistic approach: Combination of a wide range of complementary techniques :life history traits, naturels marks; tagging)

- The genetic markers are considered to be the most powerful markers used in fish stock identification as they directly reflect reproductive isolation, a fundamental mechanism structuring observed differences between populations

Genetic structure of European sardine and anchovy s was invistegated using differents markers from allozymes to micosatellites in the NOA

I: Sardina pilchardus stock structure

Allozymes

- Fst : 0,205, p<0,000
- Genetic cline in allelic frequencies along the NWA coastline
- IBD (SOD 100 allel)
- Structuration : In 2 stocks :

1: From north of Sidi Ifni (29°12'N) to the south of Iberian Peninsula: Cadiz and south Portugal (37 °N) and including Moroccan alboran sea

- Genetic break (large transition zone)

2: Sidi Ifni to Mauritania (19°03N16°28'W)

Chlaida et al , 2005, 2009

mit DNA and EPIC - PCR

Mit DNA (control region) :

- 2 clades without specific geographic distribution
- EPIC-PCR: Exon-primed intron-crossing PCR (EPIC-PCR) polymorphism

Fst = 0.034 (P < 0.05)

1. A genetic partition between Alboran Sea and Atlantic Ocean
2. Weak genetic break between northern and southern stocks along the Moroccan Atlantic coast
3. Genetic break at Cape Ghir (30°N)

Laurant et al.,2005, 2007;Atarhouch et al ., 2007

Microsatellites

(A total of 800 individuals, 9 microsatellites)

- Fst global=0.02, P= 0.000
- Fst ranges from 0.000 to 0.068, which is an important value in pelagic species
- No isolation by distance
- No Loci departing from neutrality
- The highest average likelihood was found at K= 2
- Structuration in 2 stocks

1.Northern stock : From Bay of Agadir (30. 392°N) to -Portugal (37 . 339°N including Alboran Sea

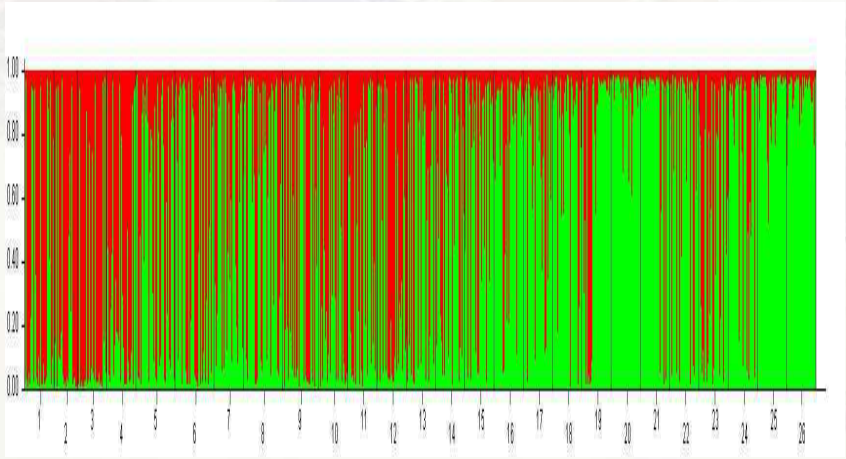
Barrier: 29°.962_29°.817

2.Southern Stock : From Sidi Ifni (29.303°N) to North of Mauritania (20.99°N).

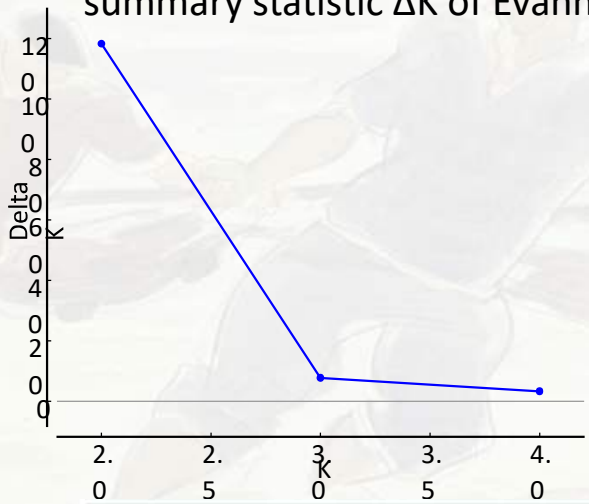
Chlaida et al sous press.....

The Bayesian clustering approach implemented in STRUCTURE

Probabilities of assignment to the different classes identified by STRUCTURE



summary statistic ΔK of Evanno et al. (2005)



K	Reps	Mean LnP(K)	Stdev LnP(K)	Ln'(K)	|Ln''(K)|	Delta K
1	10	-44269.640000	0.648417	—	—	—
2	10	-43321.690000	3.298973	947.950000	603.510000	182.938756
3	10	-42977.250000	7.337461	344.440000	99.234444	13.524357
4	18	-42732.044444	8.472254	245.205556	92.115657	10.872627
5	11	-42578.954545	18.323993	153.089899	—	—

Genetic structure at K = 2 groups of the 26 sardine populations analysed

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What is gained in term of sardine stock structure information ?

- Allozymes :
  - 2 stock were identified with strong genetic differentiation but a large transition zone and an IBD
- mit DNA:
  - Two clades without specific geographic distribution
- EPIC PCR (Intron):
  - A genetic partition between Alboran Sea and Atlantic Ocean,
  - A weak genetic break between northern and southern stocks along the Atlantic coast

Microsatellites

- Structuration in 2 stocks was confirmed ,
  - ✓First group spreads from Agadir (30. 392°N) to Portugal (37 . 339°N)
  - ✓Second one spreads from Sidi Ifni (29.303°N) to the north of Mauritania (20.99°N)
- The boundary between the identified stocks is refined (29.962_29.817)

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II: Anchovy (Engraulis encrasicolus) stock structure

Allozymes

- Fst= 0.0077, p = 0.13)
- No significant differentiation between samples
- Fis =0.48959 ± 0.07863
- (p<0.001)!

Mit DNA (Cytochrome b)

- Presence of two clades (A and B) Clade A is prevalent
- Φst = 0,013; p < 0.0):high homogeneity among Atlantic populations
- weak genetic heterogeneity between Alboran population and Atlantic populations

Microsatellites

- Microsatellites markers
- overall Fst value was 0.018 (p < 0.001)
- 3 groups: (i) lagoonal sample, (ii) samples north of the 25°N latitude and (iii) samples south of 25° N
- clear genetic break around 25°N, isolating two groups on each side of this latitude,
- Admixture between the group north of 25°N and the lagoonal ecotype,

What is gained in term of anchovy stock structure information ?

Anchoy Genetic structure investigation

- **Allozymes**
  - No genetic structure
- **Microsatellites**
  - North of the 25°N latitude ≠ South of the 25°N latitude
  - The existence a lagoonal ecotype either in pure or hybrid form
- **Cytochrome b**
  - Alboran sea ≠ Atlantic

Conclusion

The followings are some important takeaways to conclude with:

1. It is certain that genetic markers do not all have the same robustness and efficiency, however the use of several markers at the same time to address stock units issues in SFPs is to be encouraged due to the complementary nature of the information obtained from such analysis.
2. In genetics there is no miracle marker or magic wand, the holistic approach must be favored to address, not only, the identification of SPF stocks but many other issues related to these species whose behavior is complex due to their natural habitat,

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Thank you for your attention

Anatomy lesson

Anatomy lesson:Anne Catherine Becker-Echivard