

# Cryptic vicariance of Northeastern Pacific and Gulf of California angel shark (*Squatina californica*) populations. Evidence from Mitochondrial sequences.

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## Introduction

The Pacific angel shark *Squatina californica*, has a discontinuous distribution on the west coast of America, Fig. 1. Regional studies have revealed morphometric differences between shark from Gulf of California (GCF) and western coast of Baja California Peninsula (PCM) México, table I. IUCN declared the angel shark as a species near threatened, because its rather limited geographical range and life history, resident stocks of Pacific Angel shark may be particularly vulnerable to heavy localized fishing pressure (IUCN, 2011). The apparent overexploitation of Pacific angel sharks in Mexico set important economic and conservation incentives to identify its population subdivision, towards the effectively manage this species.

## Objectives

The objectives of this study were (1), to characterize the polymorphism of the mtDNA control region in the angel shark, (2) to assess the degree of genetic structure among sharks from Gulf of California and the west coast of Baja California Peninsula, (3) to establish genetic relationships among haplotypes found in both sampling areas.

## Material and Methods

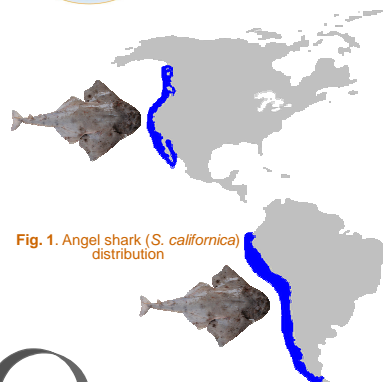
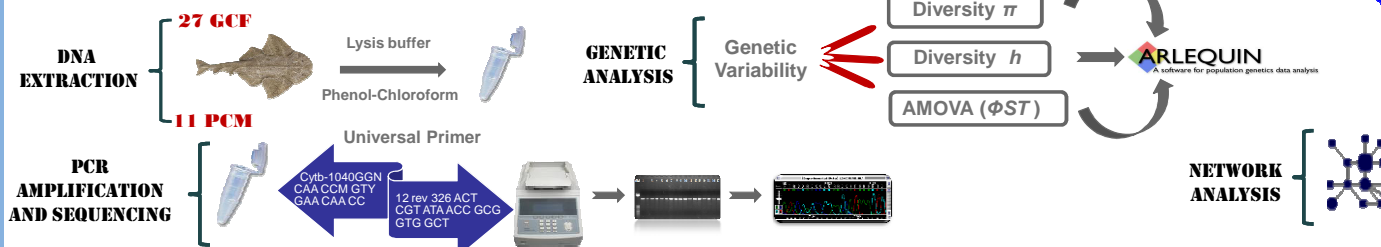


Fig. 1. Angel shark (*S. californica*) distribution

## Results and Discussion

The length of the angel shark control region in this study was 980 bp. 29 haplotypes of the 38 individuals were identified, it is worth mentioning that no haplotype was shared among sites, showing a genetic heterogeneity among the angels sharks from GCF and PCM, table II, Fig. 3. The analysis of mtDNA control region revealed a significant difference ( $\Phi_{ST}:0.45, P<0.15$ ), in differentiating among the sharks from GCF and PCM, which suggests the existence of two populations of angel shark, Fig. 2. Genetic potential barriers to gene flow between the two populations may be caused by the behavioral characteristics often does not perform migration, resulting in reduced gene flow (Whitlock and McCauley, 1999; Compagno *et al.*, 2005). Gaida (1997) mentions that the extreme depths can be a barrier to migration of individuals angel shark and therefore decrease the gene flow between populations, which for the present study suggests that the area "mouth" of the Gulf of California can be a potential barrier to the angel shark, since this region consists of ocean basins that reach depths of more than 3.000 m

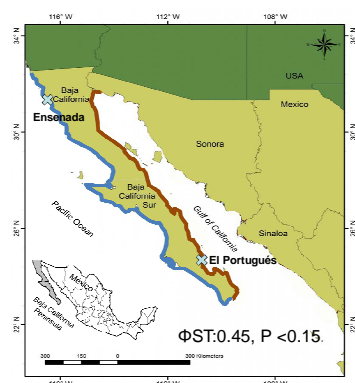


Fig.2. The X represents the sampled site. The brown line represents the population of the GCF and the blue line represents the population of the PCM.

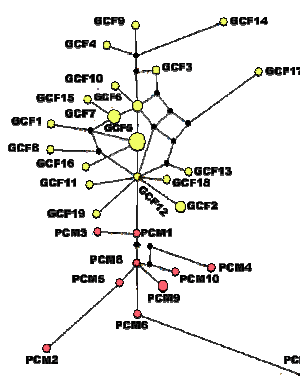


Fig.3. Network analysis with haplotypes from both regions. The nodes size is proportional to the frequency. The GCF is represented in yellow and PCM is represented in red.

Table I. Reproductive and morphological differences angel shark

Average measures	Pacific Angel	Gulf Angel
Total length	117 cm	91 cm
Length at first maturity	99 cm	70 cm

(Villavicencio-Garayzar, 1996)

Table II. Number of samples (N), number of haplotypes, haplotype and nucleotide diversity by region and overall.

Region	N	Haplotypes number	Haplotype diversity (h)	Nucleotide diversity ( $\pi$ )
GCF	27	19	0.9818	0.007499
PCM	11	10	0.9573	0.055251
Overall	38	29	0.9772	0.012841

## Conclusion

Ward (2000) mentions that if there are genetic differences for two areas and if this difference arises from the restriction of gene flow as might occur with the angel shark, therefore suggested the formation of two fish stocks. Angel shark populations from GCF and PCM found in this study are eligible to be preserved as different evolutionary significant units (ESU) following the criteria of Moritz (1994). These population units deserve a proper handling and must have a high conservation priority, as defined by Ryder (1986).

**Keywords:** Angel shark, D-Loop, Populations, Mexican Pacific

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