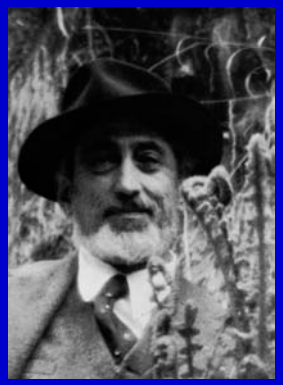
SPATIOTEMPORAL GENETIC VARIATION OF ATLANTIC BLUEFIN TUNAS FROM SARDINIAN AND MEDITERRANEAN TUNA TRAPS

Rita Cannas, Giorgia Ferrara, Monica Landi, Piero Addis, Angelo Cau, Corrado Piccinetti, Massimo Sella, Fausto Tinti

ICCAT-GBYP TUNA TRAP SYMPOSIUM ON TRAP FISHERY FOR BLUEFIN TUNA
23-25 May 2011, Tangiers, Morocco

Bluefin tuna and tuna traps: historical and contemporary source of population samples

Massimo Sella and his archive



Piero Addis and his archive

Massimo Sella

Biella, 29 May 1886 - 4 September 1959

1904Natural Sciences graduation

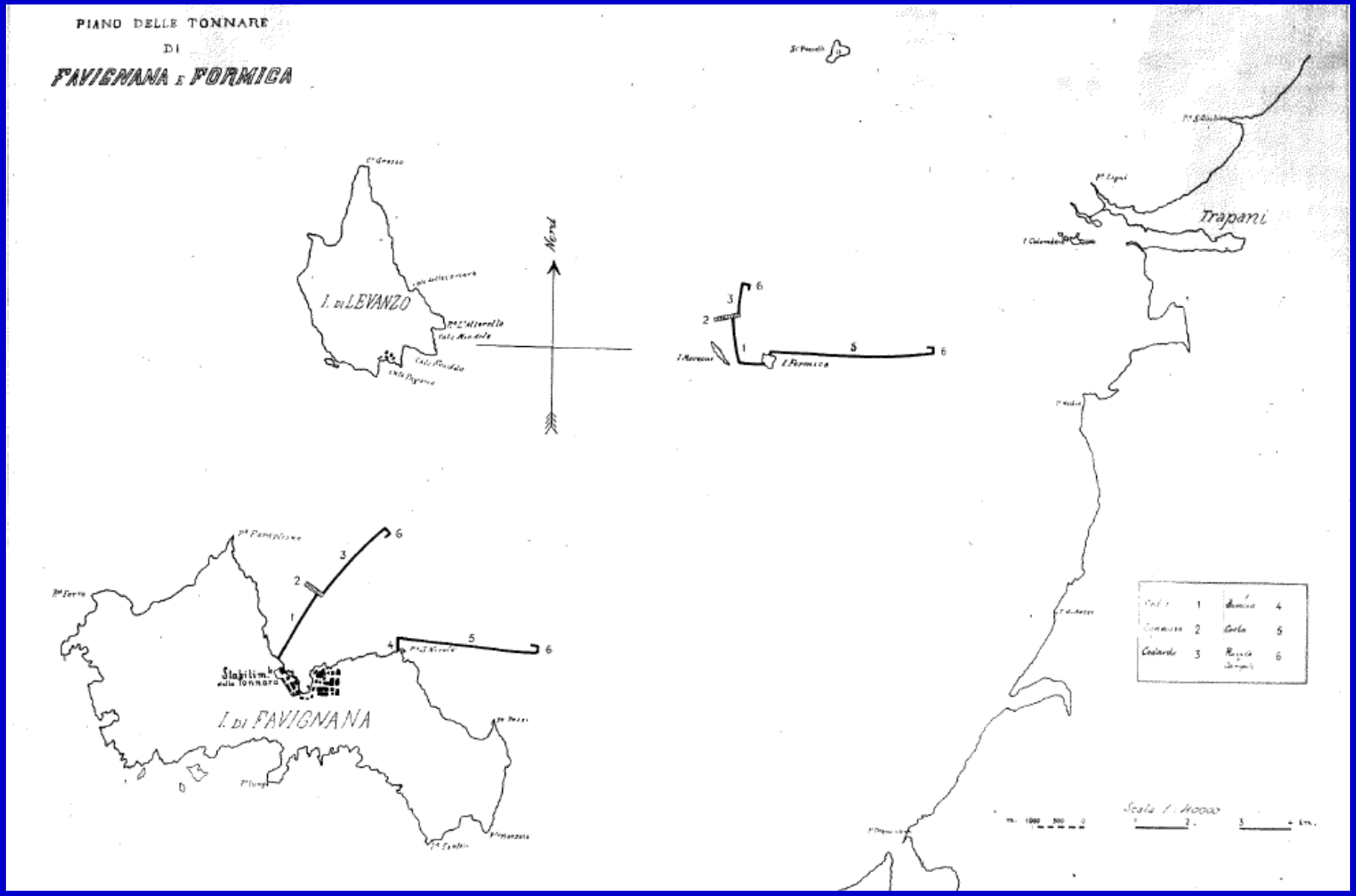
1918 Professor of Comparative Anatomy.

1921 Fellowship at Rockfeller Foundation (malary)

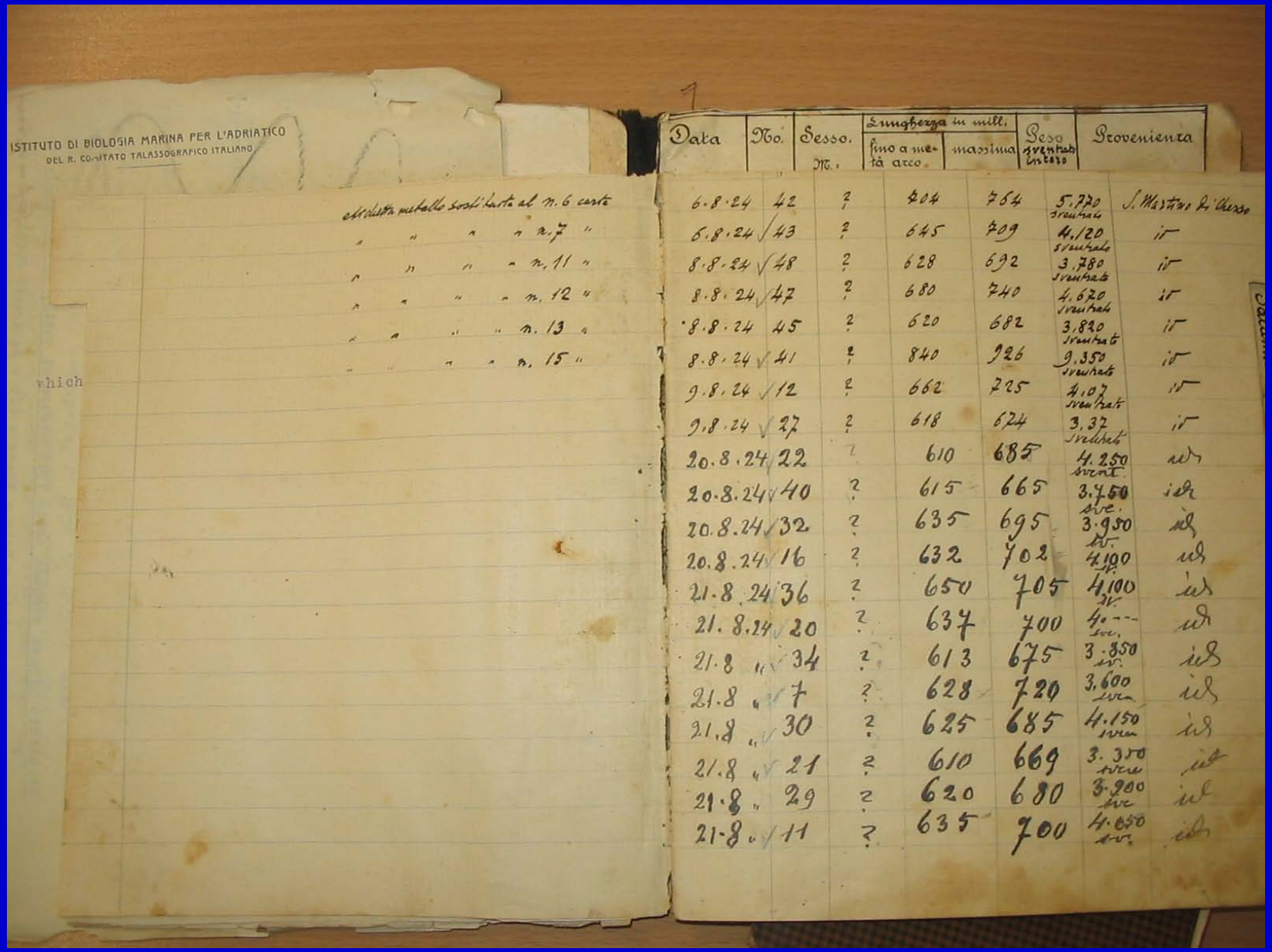
1924-1943 director of the Istituto di Biologia Marina per l'Adriatico di Rovigno d'Istria

Massimo Sella,
private archive

Massimo Sella,
private archive



Massimo Sella, private archive



Massimo Sella, private archive

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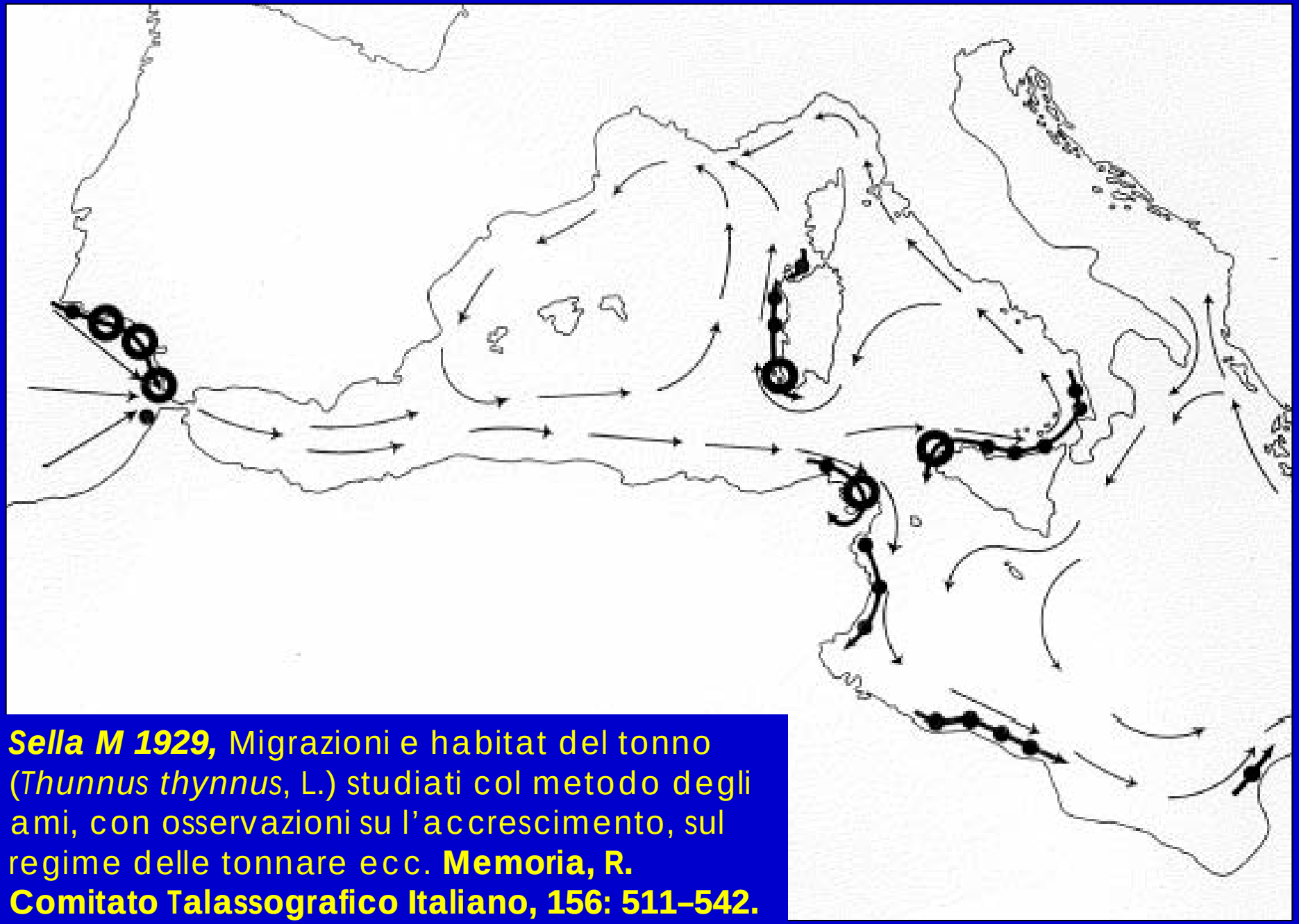
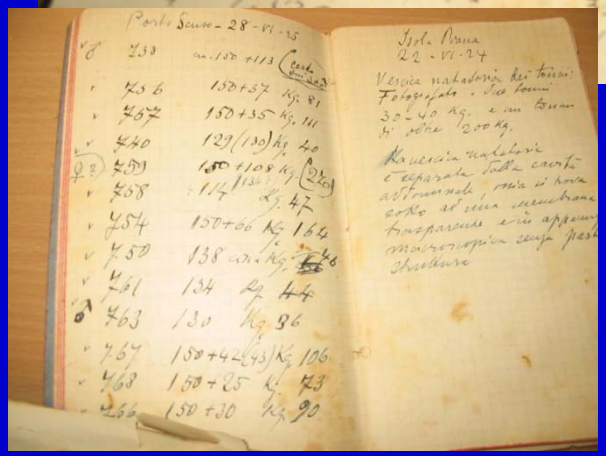
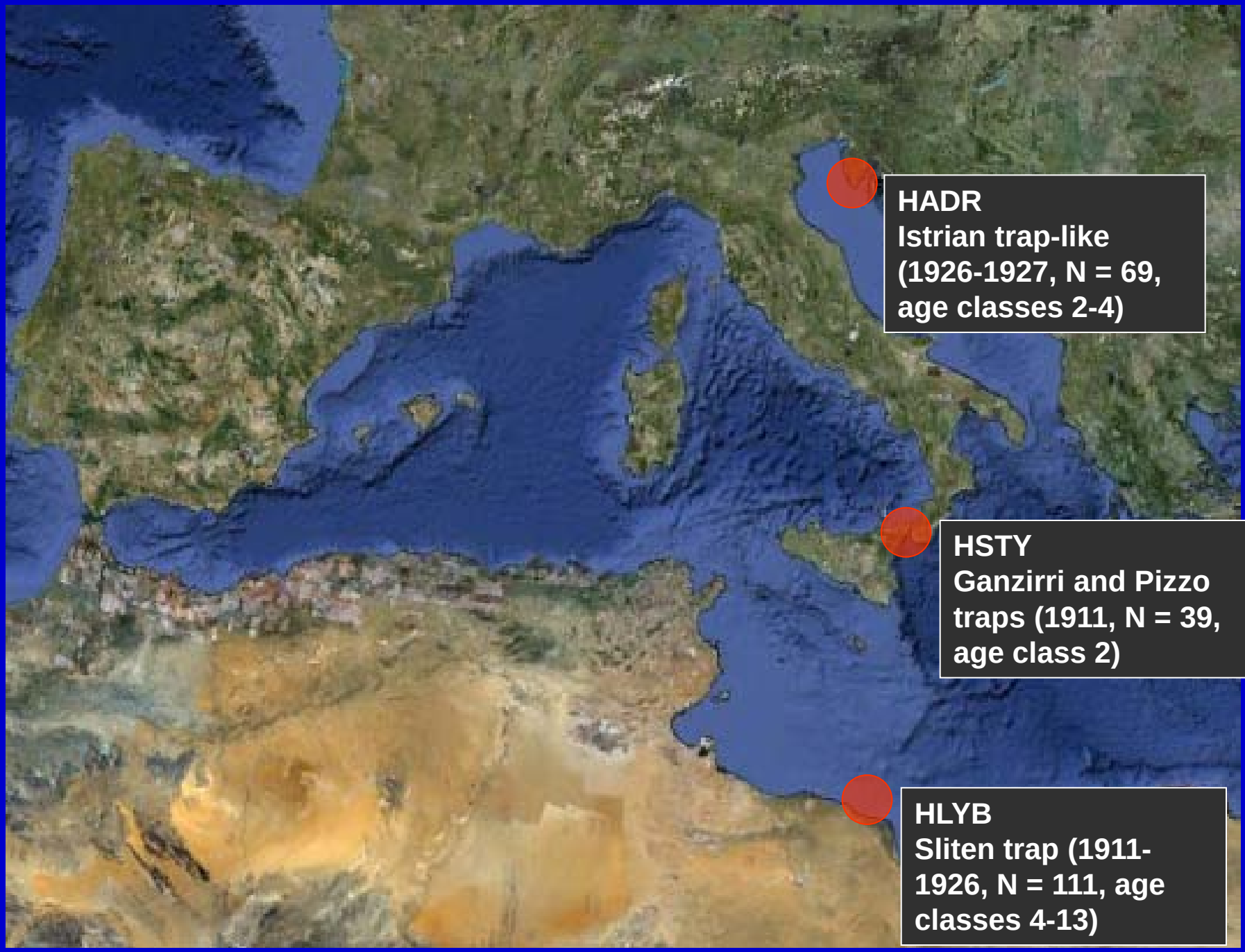


Sella M 1929, Migrazioni e habitat del tonno (*Thunnus thynnus*, L.) studiati col metodo degli ami, con osservazioni su l'accrescimento, sul regime delle tonnare ecc. **Memoria, R. Comitato Talassografico Italiano, 156: 511–542.**

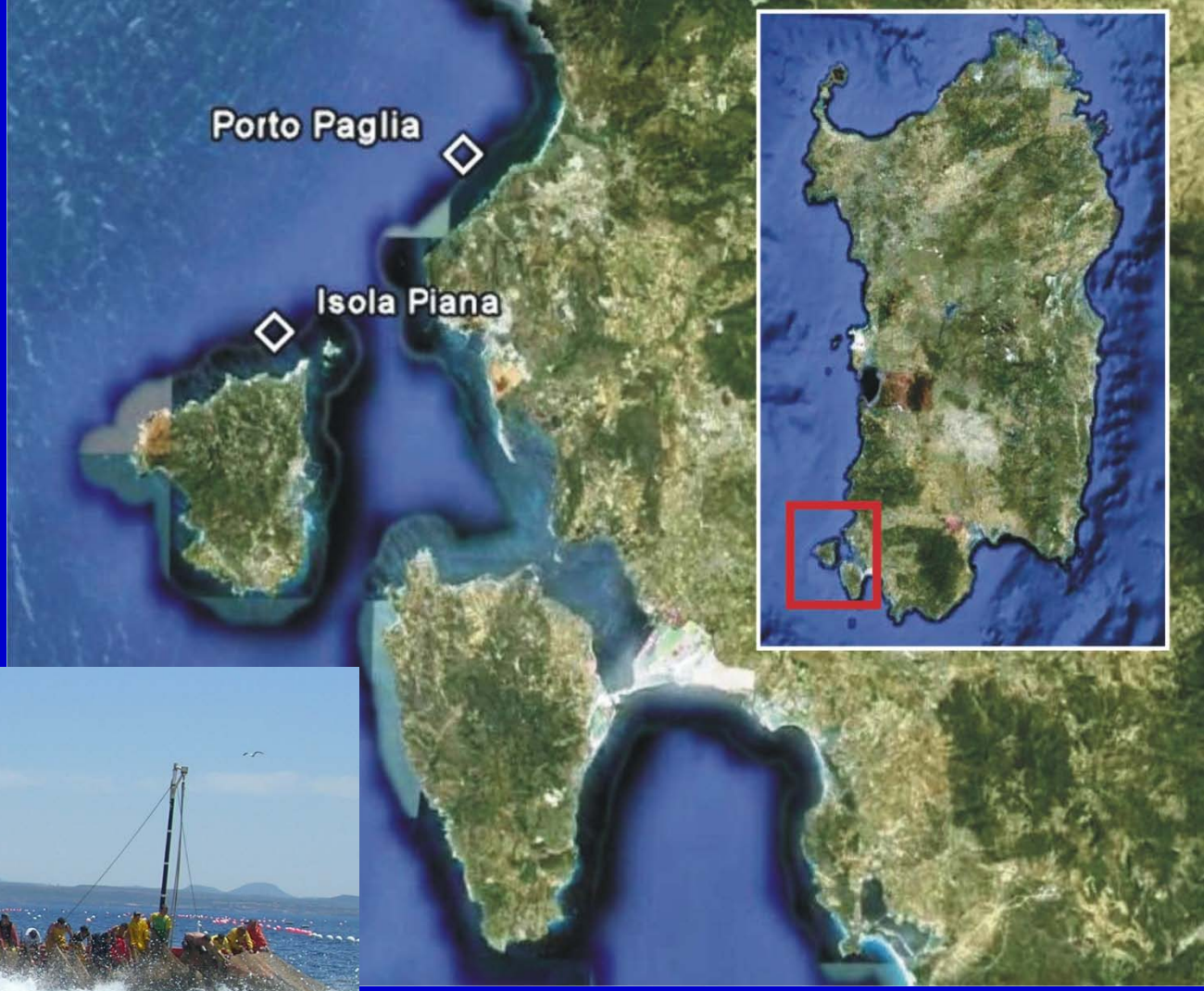
The Massimo Sella ABFT tissue archive



The Massimo Sella ABFT tissue archive:
> 6000 specimens, most of them are ABFTs


HADR
Istrian trap-like (1926-1927, N = 69, age classes 2-4)
HSTY
Ganzirri and Pizzo traps (1911, N = 39, age class 2)
HLYB
Sliten trap (1911-1926, N = 111, age classes 4-13)

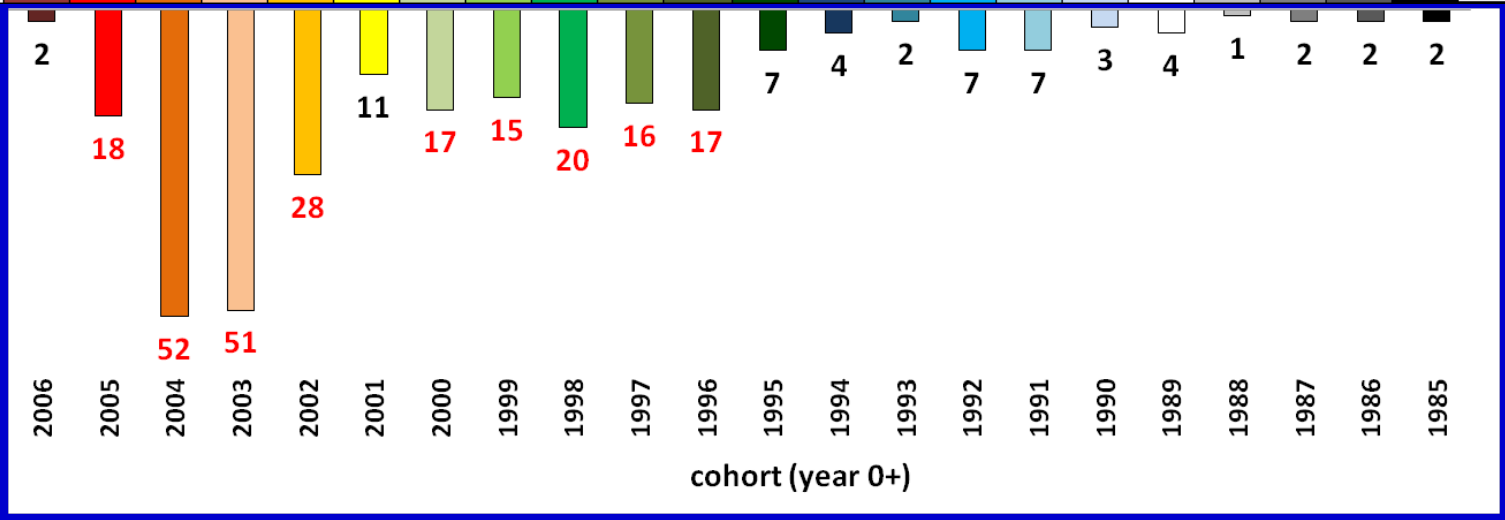
The University of Cagliari ABFT tissue archive: 7-years collection of ABFT tissue specimens



- 2 traps
- 5 years (2005→2009)
- 288 individuals

The University of Cagliari ABFT tissue archive

year classes	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11	y12	y13	y14	y15	y16	y17	y18	y19	y20	y21	y22	y23	y24	
total individuals	1	20	55	51	49	19	20	16	12	6	5	13	4	3	6	1	2	2	2				1	tot n
n° samples 2005				4	11	10	10	10	7	2	1	7	4	1	4	1	2	1	1					76
n° samples 2006			4	4	8	3	4	3	2		2	1		2	1				1					35
n° samples 2007	1	7	20	7				1							1									37
n° samples 2008		11	25	16	15	4	3		2	1														77
n° samples 2009		2	6	20	15	2	3	2	1	3	2	5						1					1	63



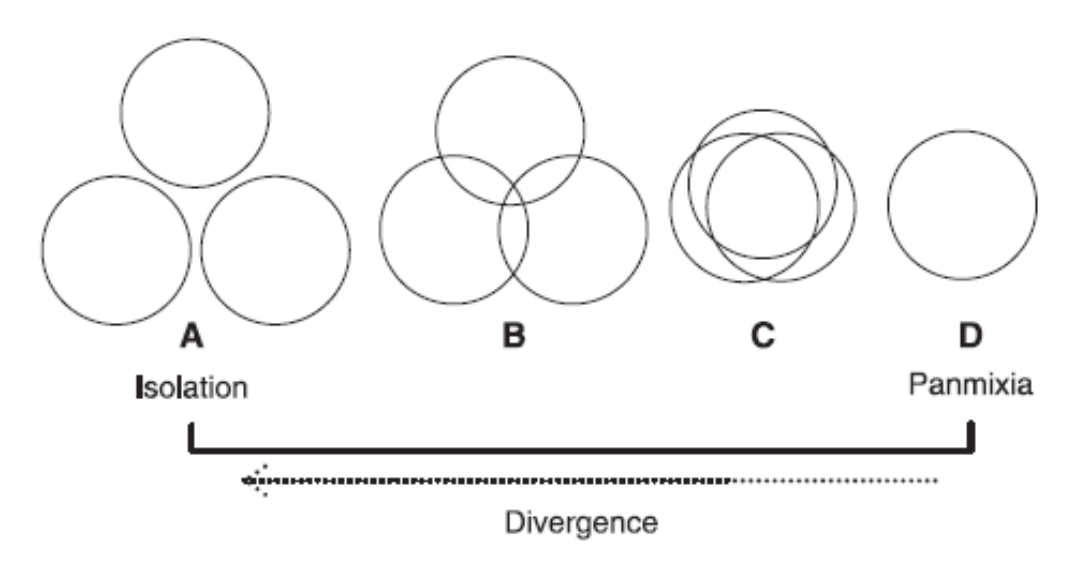
High-frequency age classes used for genetic analysis

The University of Cagliari ABFT tissue archive

Two phenotypic classes >> resident and migratory ABFTs????

Bluefin tuna and molecular markers: population structure of historical and contemporary ABFTs

Population genetic tools: the essential



1----------Fst----------0

allele frequency-based estimator of the population differentiation

+ immediate tools (descriptive and clustering analyses)

Population genetic tools: the essential

mtDNA loci
ABFT marker: control region sequence
moderate variation in the population time scale

nuDNA loci
ABFT markers: (27 microsatellites)
high variation in the population time scale
•Neutral (11): genetic drift
•Associated to expressed genes (16): genetic drift + environmental forces

*New concept of markers****: under-selection SNPs
Under-selection: environmental forces

*** developed for ABFT and will be used in the GBYP genetic analyses

Used for the analysis of trapped ABFTs

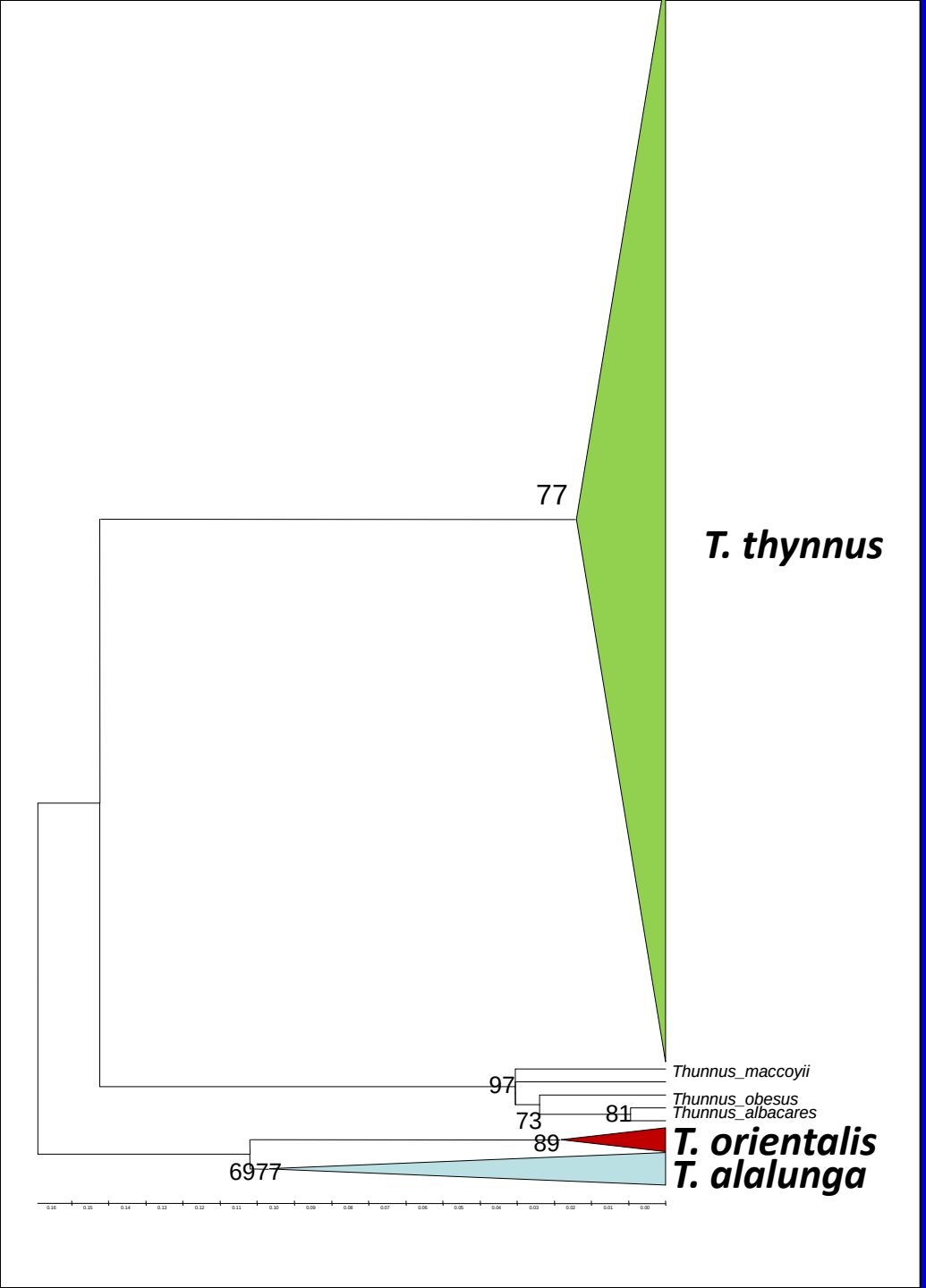
The genetic analysis of trapped ABFTs

OBJECTIVES

genetic analyses of historical and contemporary ABFT samples collected in the Central-Western Mediterranean tuna traps in the last ca. 100 years in order to infer

1) the occurrence of more than one panmictic population inhabiting the Mediterranean Sea,

2) long-term and short-term spatiotemporal shift of ABFT population structure in the Mediterranean tuna traps.



mtDNA CR sequence

The mtDNA marker **did not provide evidence of genetic differences** in historical and contemporary ABFTs

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RESEARCH PAPER

Facts and uncertainties about the genetic population structure of Atlantic bluefin tuna (*Thunnus thynnus*) in the Mediterranean. Implications for fishery management

Jordi Viñas · Ana Gordoa · Raquel Fernández-Cebrián · Carles Pla · Ünal Vahdet · Rosa M. Araguas

nuDNA neutral microsatellites

Fst pairwise estimates

	HLYB	HADR	HSTY	CADR
HADR	0.066			
HSTY	0.071	0.020		
CADR	0.051	0.015	0.017	
CSTY	0.093	0.021	0.016	0.016

PNAS

Spatio-temporal population structuring and genetic diversity retention in depleted Atlantic Bluefin tuna of the Mediterranean Sea

Giulia Riccioni[a,1], Monica Landi[b,1,2], Giorgia Ferrara[b], Ilaria Milano[b], Alessia Cariani[b], Lorenzo Zane[c], Massimo Sella[d,3], Guido Barbujani[a], and Fausto Tinti[b,4]

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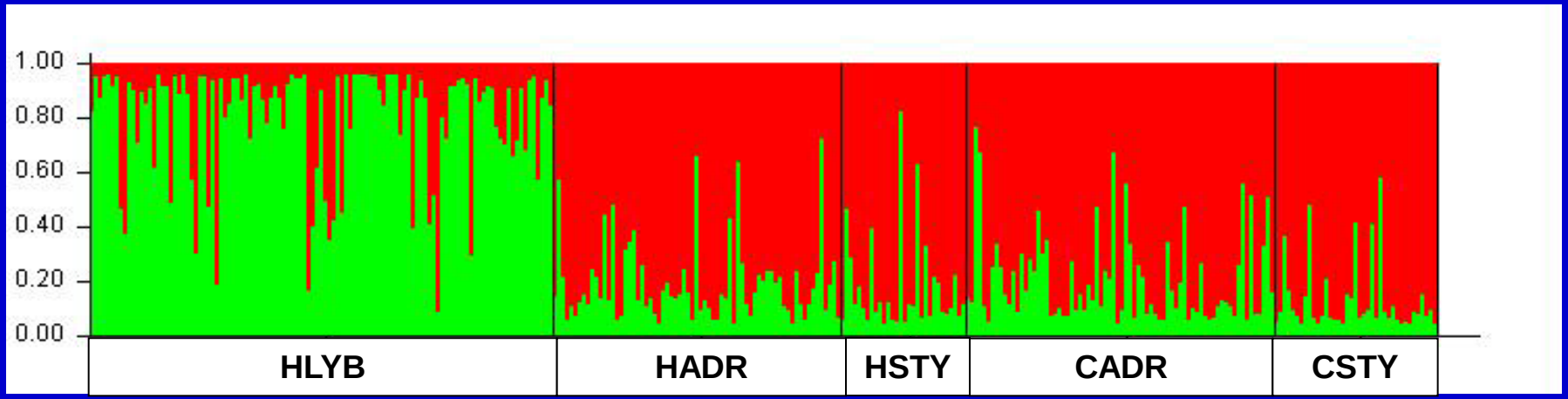
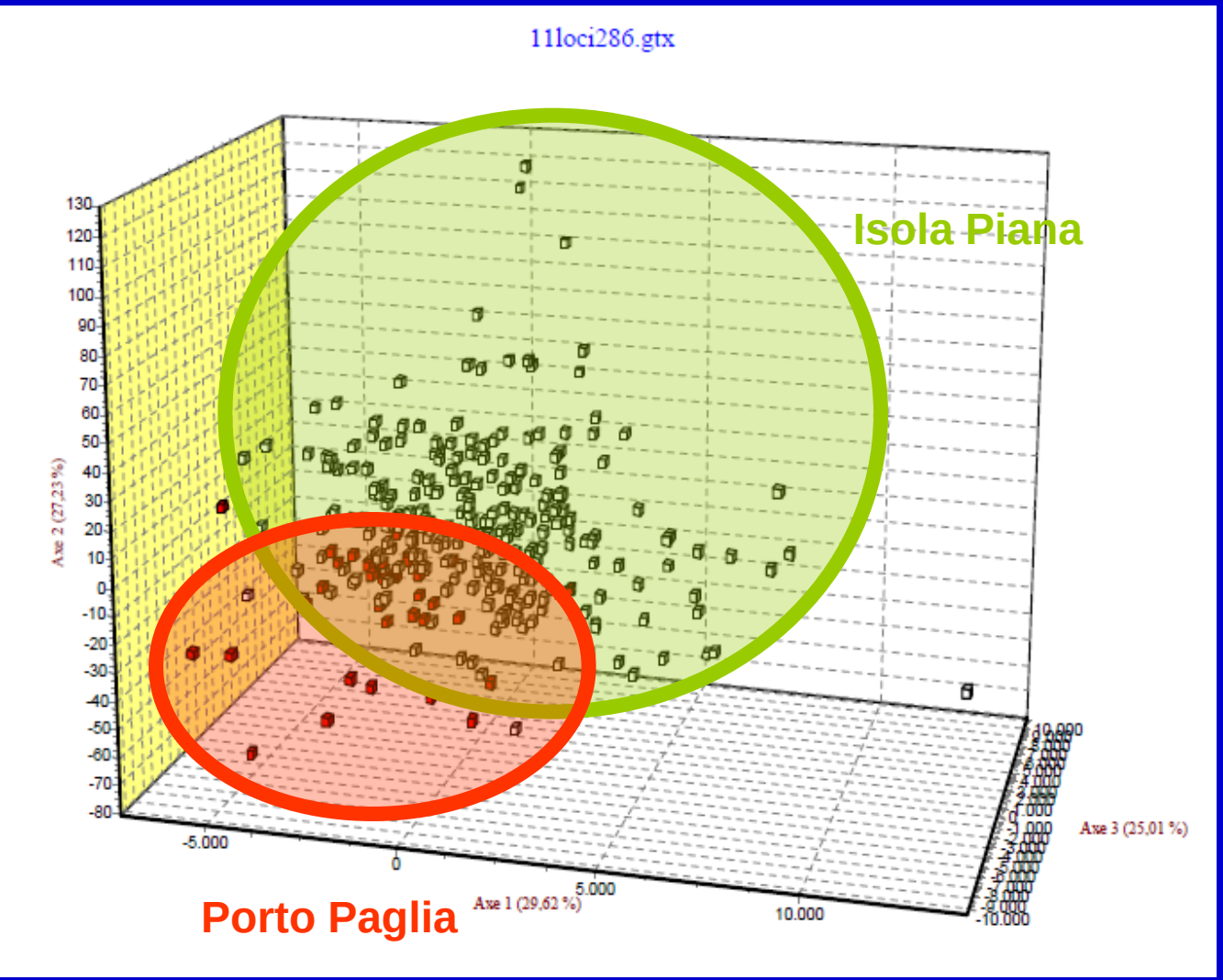
Bayesian clustering



Factorial correspondence analysis

nuDNA neutral microsatellites

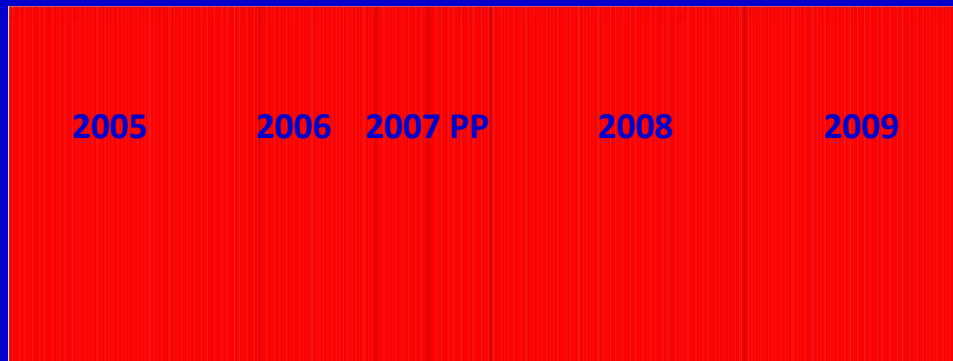


Fst pairwise estimates

nuDNA neutral microsatellites

Fst/P	coh2005	coh2004	coh2003	coh2002	coh2000	coh1999	coh1998	coh1997	coh1996
coh2005	--	0.803	0.813	0.604	0.392	0.879	0.831	0.985	0.609
coh2004	-0.003	--	0.086	0.046	0.183	0.424	0.097	0.954	0.664
coh2003	-0.004	0.003	--	0.058	0.422	0.733	0.286	0.942	0.555
coh2002	-0.001	0.005	0.006	--	0.178	0.256	0.363	0.594	0.001
coh2000	0.001	0.004	0.001	0.005	--	0.439	0.115	0.275	0.370
coh1999	-0.007	0.001	-0.002	0.003	0.001	--	0.698	0.967	0.054
coh1998	-0.005	0.005	0.002	0.001	0.007	-0.003	--	0.628	0.001
coh1997	-0.011	-0.006	-0.006	-0.001	0.003	-0.009	-0.003	--	0.590
coh1996	-0.003	-0.001	-0.001	0.017	0.001	0.009	0.015	-0.003	--

Bayesian clustering



Fst pairwise estimates

nuDNA under-selection microsatellites

Fst/P	2005	2006	2007 (IP)	2007 (PP)	2008	2009
2005	--	0.522	0.020	0.231	0.521	0.004
2006	**0.001**	--	0.495	0.194	0.420	0.406
2007 (IP)	**0.012**	**0.002**	--	0.396	0.018	0.030
2007 (PP)	**0.004**	**0.005**	**0.003**	--	0.027	0.000
2008	**0.000**	**0.001**	**0.012**	**0.010**	--	0.040
2009	**0.007**	**0.001**	**0.012**	**0.018**	**0.004**	--

AMOVA

Structure tested	Variance	% total	FST	P
SAMPLING YEARS				
Among populations	0.0226	0.48	0.00477	0.0010
Within populations	4.71767	99.52		
COHORTS				
Among populations	0.01169	0.25	0.00247	0.30
Within populations	4.72977	99.75		
PATCHY-NOT PATCHY				
Among populations	0.01395	0.29	0.00292	0.21
Within populations	4.76134	99.71		
SEX				
Among populations	0.01094	0.23	0.00229	0.16
Within populations	4.76049	99.77		

Trapped ABFTs and population genetics: what issues?

Population genetic and ecological issues from the historically trapped ABFTs

1) At the beginning of the last century genetically differentiated groups of ABFTs were in the Central and Western Mediterranean tuna traps (e.g. Lybian tuna trap).

2) the pattern of genetic structuring detected in the historical tuna trapped ABFTs is coherent with the contemporary pattern of population genetic structuring of ABFT within the Mediterranean.

3) The recent evidence of a correlation between genetic variation of contemporary ABFTs and the latitudinal (from south to north) variation of environmental parameters in the Mediterranean is coherent with the finding of deep north to south genetic structuring of historical ABFTs.

4) The unique genetic composition of the HLYB sample indicates that some spatiotemporal shifts of ABFT population structure and dynamics have occurred in the Mediterranean (e.g. parallel cases: the Black and Marmara Sea ABFT stock disappearance and the “Brazilian episode”).

Population genetic and ecological issues from the contemporarily trapped ABFTs

5) Only few evidence of significant genetic differences in the ABFT trapped in the still active Sardinian tuna traps and not correlated significantly neither with the age classes nor with the phenotypic classes > Interannual stability of the ABFT population exploited by this trap.

6) Some significant genetic differences are in the comparisons involving the Porto Paglia: different ABFT groups/populations exploited by the two Sardinian traps (unreliable!).

General issues from the genetic analysis of Mediterranean trapped ABFTs

7) Our genetic data and those present in the literature clearly indicated that more than one ABFT panmictic population are exploited in the Mediterranean.

8) Spatiotemporal shift in the Mediterranean ABFT population structure have been occurred and to figure out such dynamics more robust sampling design and highly-performing population genetic markers are required.

9) mtDNA markers are not sensitive at all while neutral or potentially under-selection microsatellite markers have only limited power of resolution at this small geographic scale. New concept of markers ....are needed and developed for ABFT