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Growth of the endangered bivalve *Pinna nobilis* in the western Mediterranean Sea

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Objectives

Constrain the variability in growth parameters in *Pinna nobilis* populations.
Study age and growth rates in different populations of this species in order to identify the best environmental conditions for growth and development.

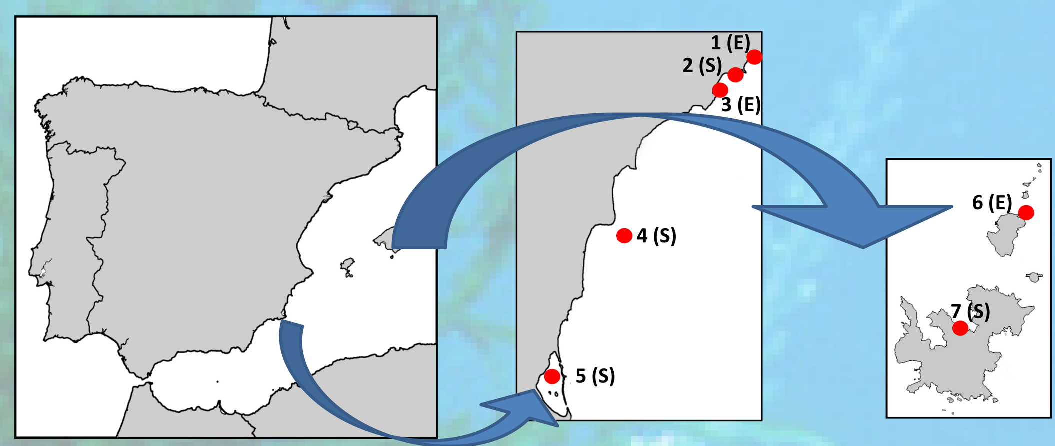

Fig. 1: Distribution of sampled populations

Methods

Sample collection and processing

1.We used 132 empty shells collected in a depth range between 5 and 10 m and from 3 exposed (E) and 4 sheltered (S) populations (see Fig. 1): 1-Moraira, 2-Racó, 3-Olla and 4-Tabarca in Alicante, 5-Mar Menor in Murcia and 6-Freus, 7-Gandulf in Cabrera.

2.Empty shells were imbibed in epoxi resin and cut dorso-ventrally. Each piece was then cut in sections across the records of the posterior adductor muscle scar (PAMS) (Garcia-March et al, 2011).

3.One side of the cross sections was polished, mounted on a glass slide, and a thick section (c. 300 µm) was cut using a slow speed saw (Buehler Isomet low-speed saw).

4. The free surface of the slide was polished to improve growth record observation.

Back-calculation of total sizes from growth records

1.PAMS positions were back-calculated to total sizes using a linear regression (Fig. 3).

Results and discussion

We observed important differences in growth parameters among populations.
- The most variable growth parameter is maximum size (L_{max}).
- Individuals from Moraira and Freus are dwarf in comparison to the rest of populations (see Tables).

Tables: von Bertalanffy growth equations from the 7 populations

MORAIRA	t_0*	L_{max}	K**
MOR6_10_121103_12	-0.72	37.26	0.21
MOR6_10_121103_2	-0.72	37.65	0.21
MOR6_10_121103_6	-0.72	41.30	0.21
MOR6_10_121103_7	-0.72	38.41	0.21
MOR6_10_121103_11	-0.72	39.89	0.21
M6_10_180102_8	-0.72	44.80	0.21
M6_10_180102_5	-0.72	44.66	0.21
MOR_10_9MP	-0.72	44.44	0.21
M6_10_180102_7	-0.72	39.65	0.21
M6_10_180102_10	-0.72	42.07	0.21
MOR6_10_121103_9	-0.72	45.47	0.21
M6_10_180102_3	-0.72	46.11	0.21
M6_10_180102_1	-0.72	46.99	0.21
MOR6_10_121103_8	-0.72	43.60	0.21
MOR6_10_121103_10	-0.72	45.69	0.21
M6_10_180102_11	-0.72	43.24	0.21
M6_10_180102_4	-0.72	46.01	0.21
M6_10_180102_2	-0.72	48.11	0.21
M6_10_180102_13	-0.72	48.33	0.21
M6_10_180102_6	-0.72	45.93	0.21
M6_10_180102_9	-0.72	49.06	0.21

RACÓ	t_0	L_{max}	K
Raco_200913_7_5a	0.21	62.28	0.25
Raco_111013_9a	0.21	55.11	0.25
Raco_110913_6_7	0.21	48.84	0.25
Raco_191213_5	0.21	50.53	0.25
Raco_170913_7_3	0.21	64.64	0.25
Raco_160913_5	0.21	56.84	0.25
Raco_150913_8_3	0.21	50.85	0.25
Raco_170913_8_9	0.21	57.32	0.25
Raco_200513_6	0.21	55.93	0.25
Raco_111013_9d	0.21	57.09	0.25
Raco_111013_9c	0.21	58.42	0.25
Raco_190913_8	0.21	64.06	0.25
Raco_110913_7_3	0.21	63.12	0.25
Raco_200913_7_5b	0.21	63.20	0.25
Raco_170913_10_2	0.21	64.10	0.25
Raco_120913_9_8	0.21	58.58	0.25
Raco_170913_9_9	0.21	67.27	0.25
Raco_170913_9_3	0.21	62.46	0.25

OLLA	t_0	L_{max}	K
Olla_180112_4_3	-0.53	36.20	0.28
Olla_140214_3_7_8	-0.53	38.89	0.28
Olla_110414_4	-0.53	47.15	0.28
Olla_110414_3	-0.53	52.42	0.28
Olla_140214_3_7_6	-0.53	42.08	0.28
Olla_110414_7	-0.53	44.51	0.28
Olla_171012_3_4	-0.53	48.09	0.28
Olla_171012_2_9	-0.53	57.14	0.28
Olla_110414_2	-0.53	48.50	0.28
Olla_140214_3_7_5	-0.53	46.07	0.28
Olla_110414_1	-0.53	54.83	0.28
Olla_171012_3_1	-0.53	48.74	0.28
Olla_211112_4_2	-0.53	57.89	0.28
Olla_140214_3_7_3	-0.53	47.41	0.28
Olla_171012_3_7	-0.53	55.84	0.28
Olla_171012_2_2	-0.53	52.52	0.28
Olla_171012_3_5	-0.53	60.75	0.28
Olla_140214_3_7_2	-0.53	59.06	0.28
Olla_140214_3_7_4	-0.53	56.91	0.28

TABARCA	t_0	L_{max}	K
Tabarca_111213_8_2	-0.43	59.26	0.19
Tabarca_111213_5_3	-0.43	54.63	0.19
Tabarca_111213_8_12	-0.43	50.46	0.19
Tabarca_111213_5_2	-0.43	47.67	0.19
Tabarca_111213_8_1	-0.43	55.04	0.19
Tabarca_111213_8_13	-0.43	48.53	0.19
Tabarca_111213_5_1	-0.43	53.36	0.19
Tabarca_111213_8_3	-0.43	58.65	0.19
Tabarca_111213_8_5	-0.43	60.53	0.19
Tabarca_111213_8_7	-0.43	62.57	0.19
Tabarca_111213_8_6	-0.43	61.08	0.19
Tabarca_111213_8_14	-0.43	56.02	0.19
Tabarca_111213_8_11	-0.43	59.92	0.19
Tabarca_111213_8_16	-0.43	66.48	0.19
Tabarca_111213_8_8	-0.43	61.02	0.19
Tabarca_111213_8_9	-0.43	62.82	0.19
Tabarca_111213_8_10	-0.43	61.01	0.19
Tabarca_111213_8_15	-0.43	58.65	0.19
Tabarca_111213_8_4	-0.43	69.85	0.19
Tabarca_111213_8_17	-0.43	71.03	0.19

MAR MENOR	t_0	L_{max}	K
MM2P_Est_4	0.23	63.43	0.23
MM2P_Est_10	0.23	67.78	0.23
MM2P_Est_7	0.23	70.22	0.23
MM2P_Est_9	0.23	58.41	0.23
MM2P_Est_1	0.23	65.23	0.23
Mint1MM1	0.23	62.35	0.23
MM1	0.23	63.57	0.23
MM3Ep5S	0.23	71.01	0.23
Muerta2MM1	0.23	63.42	0.23
MM3Muerta1	0.23	62.11	0.23
MM3Ep4S	0.23	60.12	0.23
X28vol	0.23	66.97	0.23
MM3Ep7S	0.23	71.08	0.23
Muerta1MM2	0.23	64.58	0.23
Mint3MM1	0.23	68.94	0.23
Mint2MM1	0.23	68.01	0.23
X10vol	0.23	75.23	0.23

FREUS	t_0	L_{max}	K
Freus_051213_5	-0.81	28.86	0.21
Freus_051213_13	-0.81	38.44	0.21
Freus_051213_12	-0.81	35.85	0.21
Freus_051213_1	-0.81	41.40	0.21
Freus_051213_15	-0.81	42.09	0.21
Freus_051213_14	-0.81	37.42	0.21
Freus_051213_7	-0.81	32.70	0.21
Freus_051213_4	-0.81	38.15	0.21
Freus_051213_6	-0.81	37.27	0.21
Freus_051213_8	-0.81	33.25	0.21
Freus_051213_9	-0.81	34.59	0.21
Freus_051213_3	-0.81	38.73	0.21
Freus_051213_17	-0.81	39.58	0.21
Freus_051213_11	-0.81	36.81	0.21
Freus_051213_10	-0.81	37.62	0.21
Freus_051213_16	-0.81	40.49	0.21

GANDULF	t_0	L_{max}	K
GAN_S6_251111	-0.32	56.62	0.19
GAN_S8_150312	-0.32	50.32	0.19
GAN_S3_240112	-0.32	71.06	0.19
GAN_S5_251111	-0.32	66.85	0.19
GAN_S4_240112	-0.32	60.49	0.19
GAN_S7_150312	-0.32	61.27	0.19
GAN_S1_240112	-0.32	65.10	0.19
GAN_S4_100112	-0.32	73.12	0.19
GAN_S2_100112	-0.32	63.61	0.19
GAN_S3_251111	-0.32	64.43	0.19
GAN_S1_100112	-0.32	63.40	0.19
GAN_S8_240112	-0.32	68.57	0.19
GAN_S7_170212	-0.32	63.40	0.19
GAN_S1_150312	-0.32	66.95	0.19
GAN_S4_150312	-0.32	67.18	0.19
GAN_S10_240112	-0.32	71.82	0.19

****t_0:*** age at length 0
*****K:*** speed at which reach maximum asymptotic size of the population

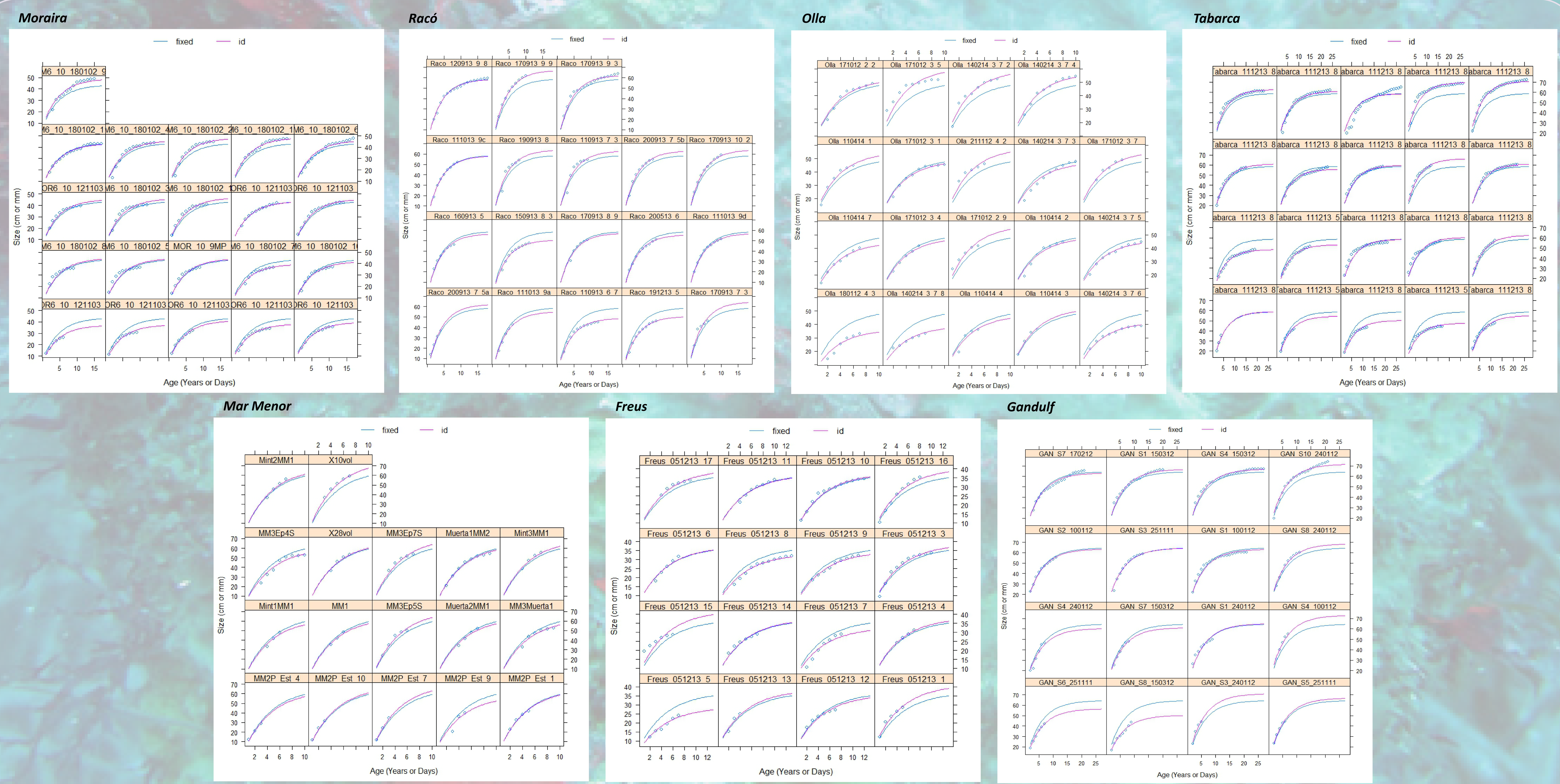

Fig. 2: Individual von Bertalanffy growth equations. T_o and k fixed (L_{max} random)

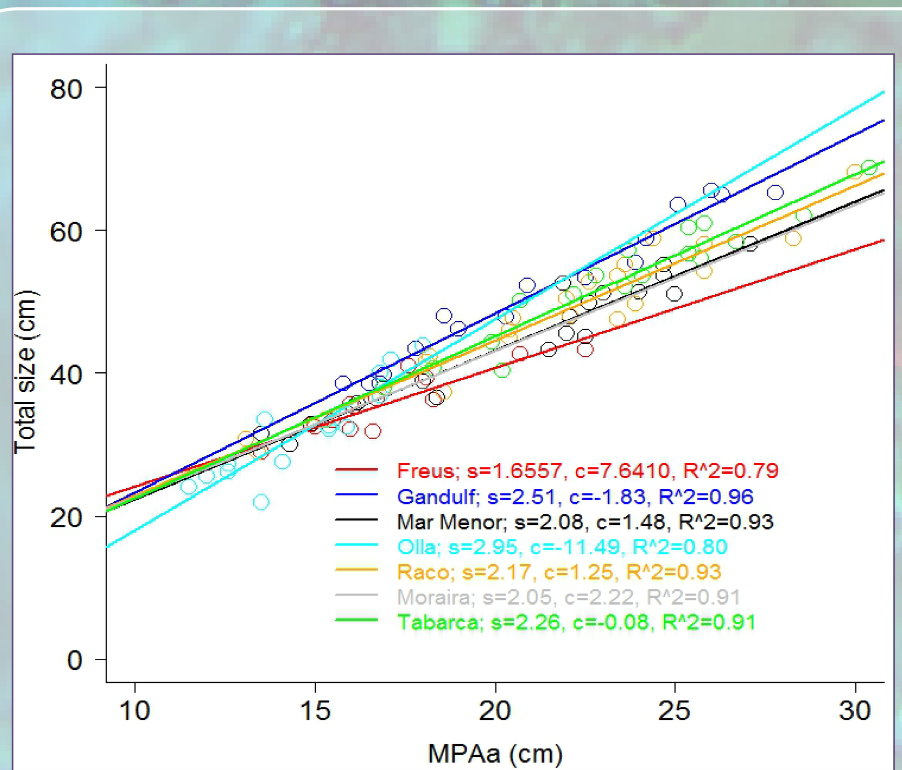

Fig. 3: Regression between total size *P. nobilis* and length of the dorsal nacre lobe (MAPa) in each population. c, constant. s, slope.

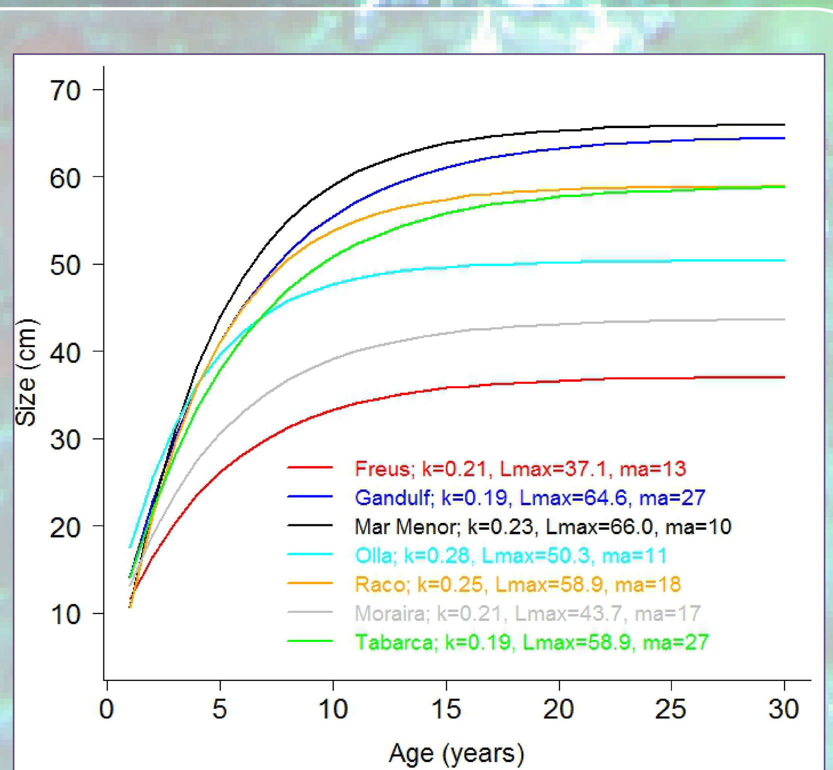

Fig. 4: Growth equations of the 7 populations studied in the present work. Ma, maximum age of the studied individuals in each population.

- Populations from Marine reserves such as Tabarca and Gandulf (Cabrera Island) grow older (up to 27 years old). However, no individuals from Freus (Cabrera Island) was older than 13 years old. Hydrodynamics seems to be an important factor modulating *P. nobilis* growth and survival.

- Individuals from Mar Menor lagoon (the most sheltered population) are not older than 10 years old, indicating either an early dead or that the population was very young when surveyed. Strikingly, these are also the largest individuals.

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