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P8 - SHELL ALLOMETRIC DIFERENCES IN BROWN MUSSEL UNDER LONGLINE CULTURE REGARDING WILD POPULATION (CANARY ISLANDS, SPAIN)

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Changes in the morphology of the shell in cultivated mussel may affect the acceptance and value of the product on the market (Cubillo et al. 2012). Furthermore, it could be that when developing new cultures from wild species, morphological changes may cause confusion and even lead to think that they are different species. Also, if the cultures are carried out with protected species, the knowledge of these morphological differences may help to distinguish both origins in the markets, helping the proper management of the resource. This is the case of the brown mussel *Perna perna* (LINNÉ, 1758) which was subject of several studies (Project I, II and III) to assess the possibility of developing this kind of culture in the islands of Fuerteventura (Viera et al. 2009) and Gran Canaria. In the latter, the grown was of small scale and tied to a culture of fish (sea bass) as part of a multitrophic experiment (González et al. 2012). The purpose of this study was to compare the height (H), width (W) and shell weight (SW) relative to the total length (TL) in the natural population (3 cases) and in culture (7 cases). We considered the log-transformed allometric relation (logY=loga+blogX) and the parameters of the line were obtained from Model II regression through Standarised Major Axis (SMA) estimation. The calculations were performed with the R program (R Core Team 2015) and the SMART package (Warton et al. 2012). The data were previously filtered from a minimum size of 25.2 mm, as this was the minimum average size of the starting cultures. Anomalous data were eliminated by graphical methods and then the slopes of the lines were calculated in each case with 95% confidence interval (CI). To assess the sign of the alometry (+,–,=) the slope values were compared to "1" (H and W), and to "3" (SW). In general, as in other studies, the shell of our cultured mussels (the values of the slopes) was rounder and triangular (>H), narrower (<W) and lighter (<SW) than in natural populations. For the W even changes in the allometric sign were observed, + in wild and – in cultured (while in the other two variables was the sign –). These values can be explained because the mussels present in culture have more favorable conditions for growing (less environmental stress) and have a lower age.

Project I ("Estudio de viabilidad del cultivo de mejillón *Perna perna* en Fuerteventura") was co-funded by the FIFG (Financial Instrument for Fisheries Guidance) and the EFF (European Fisheries Fund), both of the European Union (EU), and the "Viceconsejería de Pesca de la Consejería de Agricultura, Ganadería, Pesca y Alimentación del Gobierno de Canarias". Projects II ("Acuicultura Integrada: Experiencia Piloto para el desarrollo de sistemas multitróficos") and III ("Vialidad del cultivo de *Perna perna* en Canarias") were financed by the "Junta Asesora de Cultivos Marinos" (JACUMAR).

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Keywords: brown mussel; *Perna perna*; shell allometry; culture; wild.

Brown mussel shell allometric characteristics: *longline* culture *vs.* wild population

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Introduction

The study of the allometric growth is performed by comparing the increases of one body part relative to another and its usefulness for comparing the dimensions of the shell mussels that are developed in different habitats (Seed, 1968). Changes in shell morphology in cultured mussels may affect the acceptance and value of the market product (Cubillo *et al.*, 2012). Furthermore, it could be that when developing new cultures from wild species, morphological changes may cause confusion and even lead to think that they are different species. Also, if the cultures are carried out with protected species, the knowledge of these morphological differences may help to distinguish both origins in the markets, helping the resource to be properly managed. Three different projects were conducted (Project I, II and III) to assess the suitability of the brown mussel Perna perna (Linné, 1758) as a potential species for Canarian aquaculure development. The aim of this communication is to report changes in shell allometric characteristics between wild and *longline* cultured brown mussel.


Wild populations


Perna perna

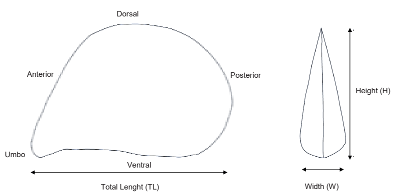

Preparing a culture rope


***Longline* culture**

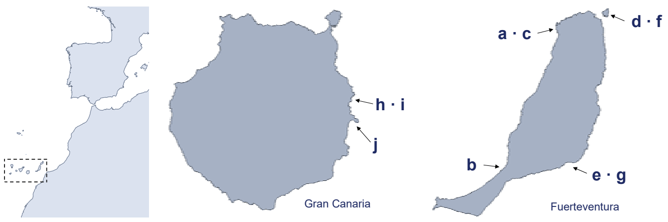

***Longline* culture linked to fish farming**

Materials & Methods

Three studies (Project I, II and III) were undertaken in Fuerteventura and Gran Canaria islands. The height (H), width (W) and shell weight (SW) relative to the total length (TL) in the natural population (3 cases) and *longline* culture (7 cases) were compared. We considered the log-transformed allometric relation (logY=loga+blogX) and the parameters of the line were obtained from Model II regression through Standarised Major Axis (SMA) estimation. All data were statistically treated with the R program (R Core Team, 2015) and the SMART package (Warton *et al.*, 2012). The data were previously filtered from a minimum size of 25.2 mm, as this was the minimum average size of the starting cultures. To assess the sign of the allometry (+,-,=) the slope values were compared to "1" (H and W), and to "3" (SW).



Terminology of the mussel shell



Location: wild (a,b,c), mussel culture (d,e,f,g,h,i), mussel culture linked to fish farming (h,i)

Differences: wild (l), culture (c), culture detail (r)

Results

Data should be considered as average annual values. Besides, the duration of the experimental culture was not the same therefore our results have a more descriptive value than inferential ones. Regarding to H-TL the slopes values tended to be higher in the case of culture conditions than those in natural populations. In most of the cases the sign of the allometry is negative (<1), except "f" (heteroscedasticity?), "i" and "j " where isometric relationship type (=1) was shown. Concerning W-TL the biggest slopes cases correspond to natural populations. It also highlights the change of the allometric sign being positive (>1) in natural populations, except in the case "c" where it occurs isometrics (=1). In culture conditions have negative allometry (<1), with the exception of the case "j" which also occurs isometrics (= 1). In all cases, PC-TL, presented negative allometry values (<3), but stresses that the highest values of the slopes cases correspond to the wild populations.

case	origin	n	slope (IC)	intercept (IC)	R^2	relation	p-value
H *vs.* TL							
a	natural	252	0.78 (0.76, 0.81)	0.00 (-0.05, 0.05)	0.92	- allometry	<0.001
b	natural	239	0.67 (0.64, 0.70)	0.18 (0.14, 0.23)	0.88	- allometry	<0.001
c	natural	461	0.81 (0.77, 0.85)	-0.04 (-0.11, 0.02)	0.84	- allometry	<0.001
d	culture	973	0.80 (0.79, 0.82)	0.02 (0.00, 0.04)	0.94	- allometry	<0.001
e	culture	1099	0.81 (0.80, 0.82)	0.02 (0.00, 0.04)	0.94	- allometry	<0.001
f	culture	389	0.97 (0.94, 1.00)	-0.24 (-0.29, -0.20)	0.89	isometry	0.06
g	culture	573	0.93 (0.90, 0.95)	-0.18 (-0.22, -0.13)	0.89	- allometry	<0.001
h	culture	672	0.89 (0.87, 0.90)	-0.10 (-0.12, -0.07)	0.95	- allometry	<0.001
i	culture	156	0.98 (0.94, 1.01)	-0.25 (-0.31, -0.20)	0.93	isometry	0.23
j	culture	153	0.99 (0.94, 1.04)	-0.28 (-0.35, -0.20)	0.90	isometry	0.60

case	origin	n	slope (IC)	intercept (IC)	R^2	relation	p-value
W *vs.* TL							
a	natural	252	1.04 (1.01, 1.07)	-0.52 (-0.57, -0.46)	0.93	+ allometry	0.02
b	natural	251	1.09 (1.06, 1.12)	-0.58 (-0.63, -0.54)	0.95	+ allometry	<0.001
c	natural	461	1.02 (0.98, 1.07)	-0.50 (-0.58, -0.42)	0.85	isometry	0.30
d	culture	963	0.90 (0.88, 0.93)	-0.35 (-0.38, 0.31)	0.87	- allometry	<0.001
e	culture	1102	0.88 (0.86, 0.90)	-0.31 (-0.34, -0.27)	0.84	- allometry	<0.001
f	culture	389	0.87 (0.83, 0.91)	-0.28 (-0.34, -0.23)	0.83	- allometry	<0.001
g	culture	574	0.87 (0.84, 0.90)	-0.28 (-0.33, -0.23)	0.82	- allometry	<0.001
h	culture	672	0.85 (0.84, 0.86)	-0.24 (-0.26, -0.21)	0.95	- allometry	<0.001
i	culture	156	0.84 (0.79, 0.89)	-0.21 (0.29, -0.13)	0.85	- allometry	<0.001
j	culture	154	1.01 (0.93, 1.09)	-0.46 (-0.58, -0.34)	0.75	isometry	0.85

case	origin	n	slope (IC)	intercept (IC)	R^2	relation	p-value
SW *vs.* TL							
a	natural	125	2.55 (2.48, 2.62)	-3.58 (-3.70, -3.46)	0.97	- allometry	<0.001
b	natural	163	2.72 (2.62, 2.82)	-3.84 (-4.01, -3.67)	0.95	- allometry	<0.001
c	natural	436	2.46 (2.38, 2.54)	-3.38 (-3.53, -3.24)	0.92	- allometry	<0.001
d	culture	686	2.47 (2.43, 2.52)	-3.58 (-3.65, -3.50)	0.93	- allometry	<0.001
e	culture	800	2.43 (2.39, 2.48)	-3.51 (-3.58, 2.39)	0.93	- allometry	<0.001
f	culture	290	2.32 (2.23, 2.40)	-3.28 (-3.42, -3.15)	0.88	- allometry	<0.001
g	culture	434	2.43 (2.35, 2.51)	-3.49 (-3.62, -3.37)	0.85	- allometry	<0.001
h	culture	694	2.49 (2.47, 2.52)	-3.55 (-3.60, -3.51)	0.97	- allometry	<0.001
i	culture	153	2.26 (2.19, 2.34)	-3.15 (-3.27, -3.02)	0.93	- allometry	<0.001
j	culture	151	2.06 (1.94, 2.19)	-2.86 (-3.06, -2.66)	0.82	- allometry	<0.001

Discussion

As previously reported (Seed, 1968; Hickman, 1973) the shell of our cultured mussels was rounder and triangular (>H), narrower (<W) and lighter (<SW) than in natural populations. Probably linked to the higher quantity and availability of food, the less environmental stress and the younger age of the specimens in culture conditions relative to the natural populations. However, in our case, if we consider the island of Fuerteventura, where mussels from natural populations have more food, this is limited to submerged periods. Also, these mussels are under higher stress condition (tides, waves, currents, air exposure, etc.). Hence, in our study, it is no clear enough if the food factor should be considered a major one. Since low density string were used (about 400 initial individuals per meter of rope) being lower than in other culture trial (1.150 Cubillo *et al.*, 2012 or 2.600 Babarro *et al.*, 2000). Therefore our results could be due to both environmental conditions and the higher age of the wild specimens. Indeed, when mussels are reared linked to fish farming where the quantity and availability of food is higher (in preparation), further significant changes in shell shape are detected. However the shell accretion did not vary significantly, suggesting that in culture conditions, its could be mainly influenced by the environmental factors rather than the food disponibility.

Acknowledgments

Project I ("Estudio de viabilidad del cultivo de mejillón *Perna perna* en Fuerteventura") was co-funded by the FIFG (Financial Instrument for Fisheries Guidance) and the EFF (European Fisheries Fund), both of the European Union (EU), and the "Viceconsejería de Pesca de la Consejería de Agricultura, Ganadería, Pesca y Alimentación del Gobierno de Canarias". Projects II ("Acuicultura Integrada: Experiencia Piloto para el desarrollo de sistemas multitróficos") and III ("Viabilidad del cultivo de *Perna perna* en Canarias") were financed by the "Junta Asesora de Cultivos Marinos" (JACUMAR).

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