

Research Article.

Biological parameters of cultivated *Mytilus galloprovincialis* in two shellfish farms in Bou Ismail Bay, Tipaza

Ines Belmokhtar ⁽¹⁾ and Yassine Guendouzi ⁽¹⁾

⁽¹⁾ Laboratory Management and Valorization of Agricultural and Aquatic Ecosystems. Natural and Life Sciences Department. University Center of Tipaza Morsli Abdellah, Oued Merzoug 42200, Tipaza, Algeria.

Corresponding author: inesbelm60@gmail.com

Abstract

This study aims to determine the morphometric and physiological parameters between *Mytilus galloprovincialis* mussels at two farms located in Bou Ismail Bay, Tipaza (Algeria). A sexual comparison between these parameters was taken into consideration. Results show dominance of females over males on both farms, with an overall sex ratio (F/M) of 2.65 ± 0.16 . A minorant growth ($b < 1$) of the shell is recorded for all studied morphometric couples (H-L, W-L and W-H). Moreover, the mussels of the farm of Culte Mare are the largest according to their factor of shell size ($FTC = 96.94 \pm 12.69 \text{ cm}^3$). On the other hand, the mussels of the farm of Ain Tagourait are the most filled by the flesh according to the condition index ($IC = 0.144 \pm 0.052$).

Keywords

Mussel farming;
Morphometry;
Sex ratio;
Condition index;
Algeria.

Received December 13th 2024; **Received in revised form** January 06th 2024; **Accepted** April 18th 2024;
Available online July 5th 2024

1 INTRODUCTION

Aquaculture in Algeria is a recent activity, it is rapidly evolving with multiple environmental and socio-economic impacts. The huge lack of scientific and precise data on the dynamics of the cultivated species, the state of health of the breeding environment and the nutritional quality of the livestock products, requires the implementation of a control strategy, analysis and monitoring for responsible and sustainable aquaculture development.

Moreover, mussel farming in Algeria is mainly based on the breeding of a single species, the Mediterranean mussel *Mytilus galloprovincialis* (Lamarck, 1819). This activity, which is currently small, seems to attract investors. *M. galloprovincialis* mussel is the species chosen by Algerian investors for its presence on the Algerian coast, its resistance and its rapid growth (Brahimi *et al.*, 2021).

The Mediterranean mussel *Mytilus galloprovincialis* is widely studied at the Mediterranean scale both in the natural environment and on farms, it is well studied by its biology, physiology, reproduction, population dynamics, its ecology, and its behaviour towards pollution (Guendouzi *et al.*, 2021a).

The main aim of this work is to study the sex distribution (sex ratio); the shell morphometric parameters; the shell growth model; the physiological index (Condition Index) for the whole population and in relation to sex.

2 MATERIALS AND METHODS

2.1 Sampling sites

From two mussel farms (located in Bou Ismail Bay, Algeria): (1) Culte Mare farm located in Tipasa city (coordonnee) and (2) Ain Tagourait Farm (coordonnee), a sample is taken during the month of April and May 2022, respectively. Forty (40) commercial-sized *Mytilus galloprovincialis* were sampled. The biological parameters are measured in the laboratory «Laboratory Management and

Valorization of Agricultural and Aquatic Ecosystems» of the University Center of Tipaza, Algeria.

2.2 Morphometry of the species

Using a caliper with a precision of 1/10 mm, the morphometric parameters considered are Length (L: maximum measurement of the anteroposterior axis), Height (H: maximum measurement of the dorsoventral axis) and Width (W: maximum lateral axis measurement) of the shell (Rouane-Hacene *et al.*, 2015).

Values obtained by direct reading with a caliper are subject to error, so these variables are random. In this case, the regression model used is that of the reduced main axis (Scherrer, 1984). For this, we calculated the regression line by the method that is most frequently used, that of least squares that allowed us to estimate the correlation between these parameters using the power model.

The allometric relationships obtained $H = aL^b$, $W = aL^b$, and $W = aH^b$, characterize the entire population of *M. galloprovincialis*, and define the type of growth on the three growth axes of the mussel shell.

The calculation of the shell size factor (FTC) follows the following formula (Guendouzi *et al.*, 2021b; Rouane-Hacene *et al.*, 2015; Soto *et al.*, 2000):

$$FTC [cm^3] = Length \times Height \times Width \text{ of the shell}$$

2.3 Sex ratio

The monitoring of the sex ratio index is one of the parameters that contribute to maintaining a certain limit the reproductive capacity of the species, and is expressed in different forms (Guendouzi, 2019). The sex ratio is an index of sex-to-sex abundance in a population of a given species (Kartas and Quignard, 1984)

$$Sex - ratio = \frac{\text{Nombre des femelles}}{\text{Nombre des males}} \pm 1.96 \sqrt{\frac{\text{Male (\%)} \times \text{Femelle (\%)}}{n}}$$

with $n \geq 30$.



Figure 1. *M. galloprovincialis* mussel gonad: pink to orange (female) left, creamy-white to yellow (male) right

Individuals' sex can be determined prior to spawning by the color of their gonadal follicles formed in the mantle (pink to orange for females and creamy-white to yellow for males) (Fig. 1; Richir and Gobert, 2014).

2.4 Condition index

The physiological index (condition index IC) is the ratio of the dry weight of the flesh (g) to the dry weight of the shells (g). (Andral *et al.*, 2004; Galgani *et al.*, 2014; Guendouzi *et al.*, 2021a).

This index has the advantage (1) of being an index that encompasses several physiological factors (nutrition, reproduction) and (2) disregard variations due to water content (Kantin and Pergent-Martini, 2007). It is the one that is least subject to the hazards of inter-cellular water loss.

3 RESULTS AND DISCUSSION

3.1 Morphometry of *M. galloprovincialis*

According to the morphometric parameters of the shell measurements of length (L), height (H) and width (W), the individuals from the farm of Culte-mare (Tipasa) are larger than those taken from the farm of Ain Tagourait ($p < 0.05$). As a result, mussels from the Culte-Mare farm are the largest with a maximum value of shell size factor, equal $96.94 \pm 12.69 \text{ cm}^3$ compared to mussels from the Ain Tagourait farm with $74.39 \pm 17.27 \text{ cm}^3$ (Fig. 2).

The individuals used in our study are larger than those used by Soto *et al.* (2000) in Menakoz (Bizkaia, Spain),

and by Rouane-Hacene *et al.* (2015) in Kristel, (Oran, Algeria) and by Guendouzi *et al.* (2021b) in Oran, Algiers and Skikda (Algeria).

The reading of the power curves (Tab. 1), between the length (L), the height (H) and the width (W) of the shell, on both farms, gives us an overview of the growth of *M. galloprovincialis* individuals.

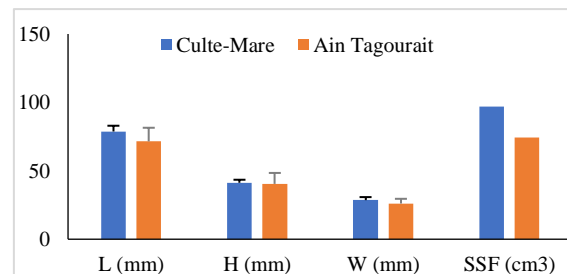


Figure 2. Length (L), Height (H), width (W) and shell size factor (SSF) of *M. galloprovincialis* shell

A strong correlation between height and thickness (61%), then length and height (58%), is recorded in individuals grown on the farm of Culte Mare. On the other hand, the correlation between the length and the highest thickness (32%) is recorded in the individuals cultivated on the farm of Ain Tagourait.

According to the slope values (b), the growth between each pair of parameters studied (L/H), (L/W) and (H/W) of the shell of the mussel *M. galloprovincialis*, is minorant ($b < 1$) for both farms.

3.2 Sex ratio

One of the primary characteristics of a population is its sex structure, or sex ratio. It also plays a major role in the mechanisms that control the number of species and rate of reproduction within populations (Chelyadina *et al.*, 2021).

The sex ratio (F/M) values calculated in the mussels of the two farms ($n = 30$) are close, with 2.33 ± 0.18 in the farm of Culte Mare and 2.75 ± 0.14 in the farm of Ain Tagourait. For both farms, there is a dominance of females over males.

Table 1. Parameter values of the correlation equation (power equation) of the morphometry of *M. galloprovincialis* mussels from Culte Mare and Ain Tagourait (Bou Ismail Bay, Algeria). n=30.

Parameters	Farm	a	b	Growth type between X and Y	r ²
H-L	Culte Mare	8.83	0.35	Minorante	0.11
	Ain Tagourait	314.21	-0.49	Minorante	0.58
E-L	Culte Mare	0.43	0.96	Minorante	0.32
	Ain Tagourait	78.48	-0.26	Minorante	0.28
E-H	Culte Mare	20.15	0.09	Minorante	0.09
	Ain Tagourait	3.36	0.55	Minorante	0.61

This gender imbalance may be explained by: environmental conditions; increasing anthropogenic effects on mussel populations (Chelyadina *et al.*, 2021).

3.3 Condition index

The condition index is a robust index, it is often used to describe the biological state of the mussel, whose growth and physiology of the individuals (Andral *et al.*, 2004; Bajt *et al.*, 2019).

Mussels from the Culte Mare farm have a condition index of order 0.093 ± 0.028 ; although mussels from the Ain Tagourait farm had a condition index of order 0.144 ± 0.052 . The CI calculated on the Culte Mare farm is lower than the condition index calculated by Benedicto *et al.* (2011) in the Mediterranean basin. On the other hand, this index is higher in the farm of Ain Tagourait. The difference in this index may be explained by the environmental conditions of the medium (nutrient availability) For both farms, the calculated condition index for females is higher than that calculated for males, the difference in CI between the sexes may be due to population dynamics (reproduction).

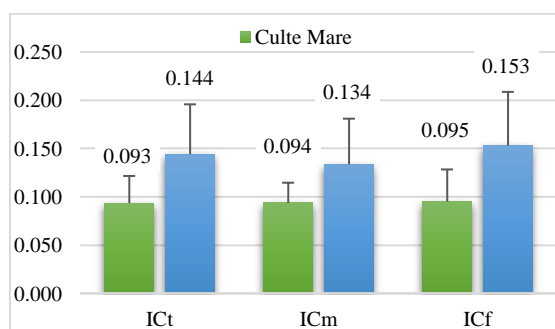


Figure 3. Total condition index (ICt), condition index for males (ICm) and for females (ICf) of *M. galloprovincialis* from Culte Mare and Ain Tagourait Farms (n=30)

4 CONCLUSION

Local comparison (between the two farms) reveals dominance of females over males, with a sex ratio (F/M) of order 2. All individuals undergo a type of minorant shell growth ($b < 1$). According to the values of the shell size factor (SSF), the mussels of the farm Culte mare are the largest. However, their condition index (CI) is lower compared to Ain Tagourait mussels. As a result, CI is a key factor in classifying cultured mussels in terms of nutritional quality. In addition, Ain Tagourait mussels have a higher index at the Mediterranean scale according to the reference CI calculated by Benedicto *et al.* (2011). Females have the highest CI values, the sexual gap in CI requires a specific study in this context in the future.

• Conflict interest

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. Also, there are no funding was received for this work.

5 LITERATURE CITED

- Andral, B., Stanisiere, J.Y., Sauzade, D., Damier, E., Thebault, H., Galgani, F., Boissery, P. (2004) Monitoring chemical contamination levels in the Mediterranean based on the use of mussel caging. *Marine Pollution Bulletin* 49, 704-712.
- Bajt, O., Ramšak, A., Milun, V., Andral, B., Romanelli, G., Scarpato, A., Mitrić, M., Kupusović, T., Kljajić, Z., Angelidis, M. (2019) Assessing chemical contamination in the coastal waters of the Adriatic Sea using active mussel biomonitoring with *Mytilus galloprovincialis*. *Marine Pollution Bulletin* 141, 283-298.
- Benedicto, J., Andral, B., Martínez-Gómez, C., Guitart, C., Deudero, S., Cento, A., Scarpato, A., Caixach, J., Benbrahim, S., Chouba, L., Boulahdid, M., Galgani, F. (2011) A large scale

- survey of trace metal levels in coastal waters of the Western Mediterranean basin using caged mussels (*Mytilus galloprovincialis*). *Journal of Environmental Monitoring* 13, 1495-1505.
- Brahimi, S., Bouyakoub, I., Taounza, R., Boudjenah, M., Morsli, H., Koheil, A. (2021) Essai de captage des naissains de moules dans la baie de Bou-ismail. *Hypocampus* 06, 15-19.
- Chelyadina, N., Pospelova, N., Popov, M.J.I.R.o.H. (2021) Effects of environmental factors on changing sex structure of cultivated mussels (*Mytilus galloprovincialis*, Lamarck, 1819) in the coastal zone of the Black Sea. *Int Rev Hydrobiol.* 106:183-190.
- Galgani, F., Chiffolleau, J.F., Barraha, M., Drebika, U., Tomasino, C., Andral, B. (2014) Assessment of heavy metal and organic contaminants levels along the Libyan coast using transplanted mussels (*Mytilus galloprovincialis*). *Environ Sci Pollut Res Int* 21, 11331-11339.
- Guendouzi, Y., (2019) Etude de la bioaccumulation des métaux traces et des radioéléments chez la moule *M. galloprovincialis* et l'oursin *P. lividus* dans le littoral algérien, Département de Biologie. Université Abdelhamid Ibn Badis, Mostaganem, Algérie, p. 180 + Annexes.
- Guendouzi, Y., Soualili, D.L., Boulahdid, M., Eddalia, N., Boudjenoun, M. (2021a) Effect of physiological conditions and biochemical factors of mussels *Mytilus galloprovincialis* in radioactivity monitoring programs along the Algerian coast. *Environmental Science and Pollution Research* 28, 46448-46457.
- Guendouzi, Y., Soualili, D.L., Boulahdid, M., Eddalia, N., Boudjenoun, M., Noureddine, A., (2021b) The Mussel *Mytilus Galloprovincialis*: Nutritional Quality and Bioindicator of Availability of Radionuclides in the Marine Environment (Algerian Basin). Springer International Publishing, Cham, pp. 665-670.
- Kantin, R., Pergent-Martini, C., (2007) Monitoring de la qualité des eaux et de l'environnement marin-Rapport final-Région Corse, Programme INTERREG IIIA Sardaigne/Corse/Toscane, MONIQUA NMCD IIIA-03/08, Convention Ifremer PAC-Equipe Ecosystèmes Littoraux & Collectivité Territoriale de Corse MCD IIIA-03/08, Ifremer publ., La Seyne. La Seyne.
- Kartas, F., Quignard, J., (1984) La fécondité des poissons téléostéens. Collection de Biologie des Milieux Marins 5. 121 p. Paris: Masson.
- Richir, J., Gobert, S. (2014) The effect of size, weight, body compartment, sex and reproductive status on the bioaccumulation of 19 trace elements in rope-grown *Mytilus galloprovincialis*. *Ecological Indicators* 36, 33-47.
- Rouane-Hacene, O., Boutiba, Z., Belhaouari, B., Guibbolini-Sabatier, M.E., Francour, P., Rissode-Faverney, C. (2015) Seasonal assessment of biological indices, bioaccumulation and bioavailability of heavy metals in mussels *Mytilus galloprovincialis* from Algerian west coast, applied to environmental monitoring. *Oceanologia* 57, 362-374.
- Scherrer, B. (1984) Biostatistique.
- Soto, M., Ireland, M.P., Marigómez, I. (2000) Changes in mussel biometry on exposure to metals: implications in estimation of metal bioavailability in 'Mussel-Watch' programmes. *Science of The Total Environment* 247, 175-187.