# Mytilus Galloprovincialis - A Valuable Resource of the Black Sea Ecosystem

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**Abstract**

The Bivalvia family has been traced back to the beginning of the Paleosoic Era (The Devonian age) and have survived to this day, with very small changes. While more common in the Mediterranean, the Black Sea has been penetrated by representatives of the family, most frequently along the coastal area. Representatives of the Mytilus genus, mussels are very common in the seas and oceans of the world. Mytilus Galloprovincialis Lamarck has long been considered as being only a variety of Mytilus edulis Linne. Anatomical studies have shown that there are sufficient differences in order to accurately distinguish the two species. This paper presents a characterization of the Mytilus galloprovincialis mussel, which is a valuable resource existing in the Black Sea ecosystem.

**Keywords:** Molluscs, Mytilus Galloprovincialis, Mytilus Edulis Black Sea

**Introduction**

The Bivalvia family has been traced back to the beginning of the Paleosoic Era (The Devonian Age) and, with slight changes, has survived until today. Current representatives are very wide spread, found especially in marine waters, with the exception of a few species that can be found in fresh water. Most species of the family live in usually numerous colonies, creating genuine banks at varying depths [1]. In general, they live free or they are set in rocks through byssus. More rarely, they form galleries in limestone cliffs, through the acidic secretion of the glands located in the mantle. Several genera, which are commonly found in the Mediterranean, have entered the Black Sea and are widely spread over the Romanian coastal zone [2].

**Characterization of the Mussel (*Mytilus Galloprovincialis*)** [1, 3]

**The Mussel - *Mytilus galloprovincialis* -** (**LAMARCK** 1819) - according to the grading system introduced by **J. Piveteanu** order and still using the nomenclature proposed by **J. Theile** for determinations of suprafamilies and subordinate level, is a Bivalve lamelibranhiated mollusc belonging to: MOLLUSCA phylum, ord. DYSODONTA, suprafam. MYTILACEA, fam. MYTILIDAE, gen. MYTILUS. Bivalvia species representative of the genus Mytilus, mussels are widespread in seas and oceans. They are spread from tropical to polar seas, usually at depths of 10 to 15 m, but can be found at higher depths, reaching up to 60-70 m, sometimes forming large areas referred to as “mussel banks” or “true facies with mussels”.

a b

Fig. 1 - *Mytilus edulis* LINNE. (a) and *Mytilus galloprovincialis* LAMARCK(b)

There are many species of *Mytilus* but only two of them are the object of exploitation in Europe: *Mytilus edulis* and *Mytilus galloprovincialis* Lamarck Linn. Fig. 1. [4]. *Mytilus edulis* lives in the northern regions and is found in the Baltic, North Sea and Atlantic Ocean all the way to Portugal, while *Mytilus galloprovincialis* is common in Mediterranean and Atlantic coasts by the Western Channel.

*Mytilus galloprovincialis* Lamarck has long been considered only as a variety of *Mytilus edulis* Linn. Anatomical research has established that there are enough differences that clearly separate these species. The main issue to solve is the convergence due to the same factors – mainly salinity and temperature – which make the valves of these animals to exhibit numerous similiarities and make both forms of *M. Galloprovincialis* to resemble *M. Edulis.* This has made numerous researchers, not only those studying the Mediterranean and Black Sea, to reconsider the existence of *M. Edulis* in these seas. What can still distinguish the two species are: biometric characters (in case the two species coexist in the same conditions), the height / length ratio for the species *M. edulis*, mantle edge color (yellow-brown for *M. edulis* and black-purple for *M. galloprovincialis*) and the presence for *M. edulis* or absence in *M. galloprovincialis* of longitudinal purple bands on the shell visible until the periostracum is removed. Lubert (1969) managed to hybrid the two species, obtaining viable larvae perfectly normal. He observed a number of identical chromosomes in the two species *M. edulis* and *M. galloprovincialis* but a different behaviour regarding sexual cycle. The author concluded that certain biological features (growth in height, sexual cycle) allow separating the two species - *galloprovincialis* - and - ¬ *edulis* - hampered by high variability identification of individuals (as valves). However likely, the same number of chromosomes and the possibility of hybridization emphasize the possibility of two distinct genetic races of the same species, differentiated by ecological conditions.

The rock mussels are found in rocky areas with shallow waters - less than 20 m and although they can be found in relatively large quantities they do not have a direct economic interest yet for at least two reasons: strong attachment to the hard substrate (cliffs, rock platforms, articulated concrete blocks) which means they cannot be harvested mechanically (harvesting by autonomous divers only) and by the fact they are heavily covered by a rich epibiosies and contain a high percentage of foreign bodies inside them (sand, small fragments of valves, pearls, etc.) that do not give them a commercial aspect (or require a great deal of work for sale). However, rock mussels have an important role in maintaining a healthy quality of water near tourist beaches by strong water biofiltration action.

Deep mussels form a ring around the Black Sea, located on the continental shelf between izobates of 25 ÷ 55 m deep on the muddy bottoms. - The presence of mussels on the muddy bottoms of Black Sea - an exception in this world, is one of the basic features of the basin. - Mussels living in the muddy areas in 'nests' consisting of a few specimens caught with the byssus between them and the substrate, which forms a real "condensation" core, isolated specimens are rarely met. – The epibiosies attached to mussels at higher depths is generally poor and the valves have a small percentage of foreign bodies.

**The Main Nutrients in Mussels** [1,3]

It is well known that, certain mussels, such as midia, represent an appreciated food product in numerous European, Asian, and North American countries. Due to its nutritious qualities, this species has been the object of research for numerous marine laboratories around the world, where important attention is given to ecological, physiological, and biochemical research and analysis [1,3].

Biochemical analysis has shown that this species has superior nutritive qualities, comparable to food products obtained from terrestrial animals, while in what regards certain biochemical compounds, midia are undeniably superior – vitamins and amino acids.

In the Romanian Black Sea sector, besides deep mussels banks that can be exploited there are specific opportunities on intensive mariculture installations. To determine the optimal period to harvest mussels for industrialization it is necessary to determine the seasonal dynamics of physiological parameters and nutritive value of major compounds in mussels. Meat is 30 ÷ 31% by weight, and valves 40 ÷ 41%, 24.0 ÷ 26.3% interstitial juice, so a full harvest would contribute to efficient cultivation of mussels. Biochemical composition of biologically active points attribute support - protein, carbohydrates, lipids and their distribution in different extracts (aqueous and organic solvents) and enzymatic events adjutant with anti-inflammatory qualities. Processing this raw material will bring changes in the microbial load and the relationship between biochemical constituents detected in meaning, amplify the effects of using products to achieve desired bioproducts. Concerns and recommends analysis results for mineral and organic component recovery shell - and juice recovery by appropriate processing procedures. The Romanian Black Sea coast is characterized by wide variations of the main environmental factors that have direct impact on physiological behaviour of organisms and the accumulation of biochemical components with nutritional value. Key dynamics biochemical compounds were correlated with environmental factors and annual ontogenetic stages of an organism. (Table 1 and 2). The ultimate aim of these biochemical tests was to specify the annual biological cycle of major quantitative changes in biochemical components of food value and optimal timing of harvesting industry without jeopardizing the current stocks in the Romanian Black Sea coast. (Table 2).

Table 1. Physical and biological characteristics of aqueous extract of shellfish meat

| | |
|---|---|
| pH | 6,3 – 7,4 |
| Electrical conductivity µS | 8,3 – 8,5 |
| Salinity ‰ | 2,1 – 2,5 |
| Proteins mg/ml | 7,5 – 7,8 |
| Carbohydrates mg/ml | 2,8 – 3,0 |
| Uronic acid mg/ml | 0,5 |
| **Enzyme activity and enzyme inhibition** | |
| Superoxiddismutasa U/mg protein | 2,20 – 2,24 |
| Alkaline phosphatase m U/mg protein | 3,9 – 5,7 |
| Alkaline catalase µ mol $H_2O_2$/sec | 0,65 – 0,70 |
| Hyaluronidase% inhibition compared to incubation enzyme: protein 1:1, 2:1; 3:1 | 40 – 15 |

Biochemical composition of mussels in the Black Sea has some seasonal dynamics (Table 3). These variations may be caused by: normal and abnormal seasonal physical factors - sea of chemicals, the existing density and high food quality,

depth and, in the case of mussel banks, age and annual physiological cycle of the animal. In cases with specific environmental factors, normal changes in season, area and depth of the habitat where mussels normally reside, trophic plankton elements show quantitative oscillations. These seasonal dynamic changes in mussels' biochemical composition are normal and vary according to the physiological cycle phase.

Table 2. Biochemical characterization of the lipid extract of mussels meat

| | |
|---|---|
| Neutral Lipids | 82,6 ± 0,3 |
| Glicolipids | 1,4 ± 0,1 |
| Phospholipids of which: | 17,0 ± 1,0 |
| Fosfatidil ethanol amine and lizofosfatidil ethanol amine | 31,5% |
| Fosfatidil colina and lizofosfatidil colina | 30,2% |
| Fosfatidil inozitol | 2,4% |
| Fosfatidil scrin | 14,2% |
| Sfingomiclin | 8,5% |
| Unidentified lipids | 15,0% |

**Table 3. Seasonal dynamics have major biochemical components in Mytilus galloprovincialis (averages)**

| Quarter | Examined species | Biochemical analysis (expressed in g/100 g of fresh substance) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total carbohydrate | Reducing carbohydrate | Glycogen | Total nitrogen | Total protein | Total fat | Mineral | Water % | Dry matter % |
| I. | Deep mussels | 1,5 | 0,2 | 1,2 | 1,3 | 8,5 | 2,7 | 0,9 | 72,2 | 12,8 |
| | Rock mussels | 1,0 | 0,2 | 0,9 | 1,5 | 9,5 | 2,5 | 0,7 | 69,9 | 13,80 |
| II. | Deep mussels | 1,7 | O,2 | 1,5 | 1,5 | 9,6 | 1,1 | 0,6 | 70,6 | 13,2 |
| | Rock mussels | 1,5 | 0,2 | 1,5 | 1,7 | 11,2 | 2,1 | 0,8 | 67,7 | 13,3 |
| III. | Deep mussels | 1,5 | 0,2 | 1,3 | 1,5 | 9,2 | 1,3 | 0,8 | 71,5 | 12,7 |
| | Rock mussels | 1,6 | 0,2 | 1,4 | 1,7 | 10,5 | 1,7 | 0,8 | 69 | 14,8 |
| IV. | Deep mussels | 1,9 | 0,2 | 1,7 | 1,4 | 8,3 | 2,3 | 0,7 | 70 | 13,5 |
| | Rock mussels | 1,8 | 0,2 | 0,5 | 1,3 | 8,5 | 2,5 | 0,6 | 72,9 | 13,2 |

**Growth Rhythm of Midia in the Black Sea Coastal Area**

In areas with a rocky aspect, the growth rhythm of new midia generations, where young species fixate on the pre-existing colony thus having to battle the laws of natural selection from the very beginning, is hampered by the limited space available for fixation [4, 5].

The domination of species under 4mm among midia colonies fixated on a hard substrate is overwhelming – 61.48%. This numeric domination is the expression of the ecological action of the substrate, which is essentially alive and incomparably larger than the denuded substrate, which is more or less smooth. For the immediate following size class, a very abrupt drop can be observed – 4.6% - which is proof of a very low survival rate. Given the age of the species with lengths between 4 and 24 mm, under 10 months, and in light of the above presented information, it can be concluded that their sum, reported to the average of the total number of population specimens – represents 77.4%. This enormous difference outlines an extremely high mortality rate between the population of the first and the second year, a mortality rate that can be explained by several factors:

- Young specimens, under 20 mm, are primarily consumed by predatory fish (*Gobiidae*);

- As they are fixed to the outer edge of the colony, young specimens are decimated primarily by the mechanic action of water (marine currents, ground swell, and so on);
- The growth of midia specimens is an allometric type of growth, as a result of the pressure created by the growth of older specimens, which completely obliterates smaller specimens, either by crushing or dislocation.

For midia which can be found at higher depths, to the lack of competition for substrate, the hierarchy of size classes among bank midia is completely different. The first and most important characteristic of these differences resides in the much reduced level of participation of the 4 mm size class – approximately 25% of the entire population.

On control surfaces – concrete tiles and chalk blocks – launched at depths of 3.5m, midia colony fixations has a particular dynamics. During one year, densities between 795-1,023/$m^2$ with lengths between 2.1 - 5.7 (average = 4.3 mm) can be registered. The artificial support intended for midia fixation on the mariculture installation is represented by artificial collectors, manufactured out of rhelon rope, suspended in the water mass.

Under normal hydrobiologic conditions, specific to reference seasons, the total and grouped quantity of existing organisms over one metre of natural fixation collectors – after spring reproduction – in the month of June is presented in Fig. 2. The total biomass of epibiosis organisms existing on artificial collectors 3 months after sea launch is 5.209kg/1collectorm (Fig.3).

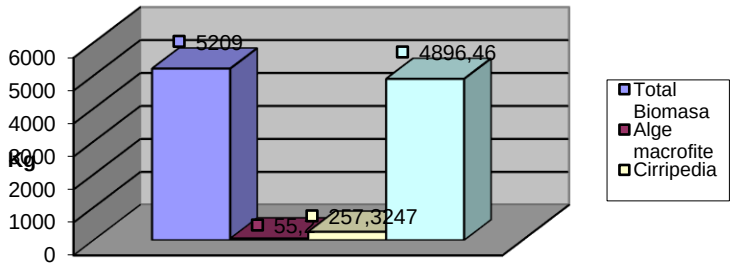


Fig. 2. Total and grouped live organism fixations on artificial collectors fixed to mariculture installations, 3 months after launch (June) [3]

Fig.3. Artificial collector, 7 months after immersion [4, 5]

Among the organisms living on collectors, the predominant population is represented by midia – which account for 94% of the total biomass – followed by cirripedia, with approximately 4,94% of the total. The remainder of the existing biomass – approximately 1% - is represented by macrophytic algae and other epibiosis invertebrates.

In what regards the collectors from mariculture installations, the predominant population is represented by midia, which account for 90% of the biomass, followed by cirripedia with about 8% of the total population. Seasonal algae represent about 1.5%, while the remainder of 0.5% of the total biomass is represented by invertebrate epibiosis organisms.

During the cold season, due to specific hydroclimatic changes characterizing the unsheltered marine areas of the Black Sea coast, high waves and particularly due to strong marine currents which influence the artificial collectors, approximately 80% of the fixated biological material is removed. In order to prevent these unwanted phenomena, the artificial collectors are picked out – 60% of the biomass is removed – and they are covered in rhelon net bags.

**Conclusions**

- The biochemical content of the harvested midia from the Nordic areas of the shore is higher for all analysed parameters (proteins, sugars, lipids) than in midia harvested from Southern areas. These quantitative biochemical differences come to prove, once again, that our seashore is rich in physiological species with superior nutritious qualities.
- In what regards the biochemical content of midia, alongside elements with nutritious value, it is evidenced that they also have a high content of amino acid. The concentration of some essential amino acids in midia meat is net superior to numerous similar products, currently used for human consumptions.
- The high content of nutritious biochemical compounds (proteins, sugars, and lipids), to which one can add the presence of vitamins and amino acids, outlines the high nutritious value of midia from the Romanian coast of the Black Sea, but also the possibility of using them for extracting active principles with medical uses.

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