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**Marine organisms model species for the assessment
of biological, environmental and economic impacts
on marine aquaculture in Campania**



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PhD thesis

**“Marine organisms model species for the assessment of biological,
environmental and economic impacts
on marine aquaculture in Campania”**

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Campanian region has an important mussel farming tradition, since the Cuman and Greek domination around 700 A.C. through the Bourbons until today. Mussels and the linked supply chain were always been present in the socio-economic scenario of the regional coastal area. Today mussel production in Campania represents almost all the aquaculture total production, resulting one of the most productive Italian regions in this sector. In order to evaluate biological, environmental and economic impacts on marine aquaculture, mussels of the genus *Mytilus* were chosen as model species.

Mussels are perfect model organisms for their biological and physiological characteristics; they are bioengineering species, sedentary organisms, filter feeders, widespread all over the world, easy to keep in laboratories and important food source. Besides food source, thanks to their features mussels provide important ecosystem services as regulating the water column, supporting the food web and provisioning cultural services. Moreover, recently, are becoming source of important bioactive compounds, revealing to be organisms with a high potentiality in several applications.

Different kind of stressors, anthropogenic as well as natural stressors, can impact, negatively or positively, on mussels and consequently on the ecosystem services they provide. Aims of the thesis are the evaluation of the effects of three different stressors on mussels supply chain: food frauds, ocean acidification and the grafting operation.

Food frauds, the act of defrauding buyers of food and food ingredients for economic gain, can threaten the Campanian mussel supply chain. Unhealthy storage conditions, species substitutions, lack of label and informations on the product origin are all ordinary risks when buying mussels. The threats are both for human health than for the local economy of the honest mussel farmers. In order to investigate on the situation of the Campanian markets, *Mytilus galloprovincialis* mussels, the native species of the Mediterranean Sea, were sampled in different fish markets, local mussel farms and in their local natural environment. Mussels were genetically characterized in order to assess the species and their origins using the molecular markers COI, 16S, PAPM and 28S. The final aim was the attempt of the genetic identification of a local Campanian mussel, intended to officially recognize such local excellence product considering all its productions steps, from the seed recruitment to the marketing. Investigation on this topic has shown that Campanian local markets are not highly affected by the food frauds of species substitutions but is difficult define the situation for the other type of fraud, the origin declaration. Just using simple molecular biology tools was not possible identify different mussel populations and define the genetic characterization of the local *Mytilus galloprovincialis* species. Further investigations are essential in order to identify a simple, fast and cheap method for mussels origin identification.

Mussels supply chain could be also affected by other kind of human impacts, not only in Campania region but on a global scale. Global changes can induce important vital alterations in aquatic systems, the increasing amounts of CO₂ in the oceans, known as the phenomenon of Ocean Acidification, affect our life via influencing the environment and our economy. Ocean acidification and other anthropogenic stressors can were already proved to cause negatively or positively changes on coastal dynamics, in marine organisms and consequently to the ecosystems services that they provide. Ocean acidification effects were tested on *Mytilus unguiculatus*, a pacific mussel widely bread in the Chinese Sea with similar anatomy and physiology to *M. galloprovincialis*. *Mytilus unguiculatus* has been exposed to different pH values (7.4 and 7.8) and then were analyzed the respective physiological parameters (O₂ consumption and NH₄⁺ excretion), gene expression of NKA and NHE8 (both involved in the acid-base regulation mechanisms), free amino acids from mantle and gills with UPLC analysis, shell characteristics with AAS analysis, SEM pictures and X- ray testing. *Mytilus unguiculatus* easily survive in 7.8 pH conditions but further investigations (different life stages, longer exposure time, additional genes expression) are needed to better understand the effects of Ocean Acidification on this species and other species as the Mediterranean *Mytilus galloprovincialis*.

However an anthropogenic stressor for certain organisms could have a positive impact on the linked aquaculture economy. It is the case of the induced grafting operation on the pearl molluscs, in order to produce a pearl. Since the first decade of 1900 pearls production is an industrialized process, there are some bivalves of the pacific area widely used in this manufacturing production. Molluscs are able to produce pearls in response to a natural stressors (the famous grain of sand, a small piece of broken shell, a parasite or a small animal) causing an injury in the mantle of the damaged mollusc. In the “classical pearl molluscs” pearl production is human surgically induced, imitating what happens in nature and using a nucleus of mother-of-pearl. In a similar way the Campanian mussel *Mytilus galloprovincialis* could react producing a pearl too. The local mussel could be a “new pearl molluscs” and pearls productions would be fully included in the well-established Campanian gemstone market. As for mussels farming activity, Campania region has an ancient coral manufacturing tradition, hosting in the southwestern coast of the Gulf of Naples the “the world’s capital of coral”.

In conclusion, mussels have been further appreciated as model organisms in different application fields; food frauds can affect negatively the Campanian market and new investigations are needed in order to evaluate their origin; mussels seem to easily survive to the predicted future acidified oceans; finally, mussels have great potentials, among their innovative applications they could become “new pearl molluscs”. In order to carry on and improve the millennial Campanian mussel farming tradition, it is crucial enhance and promote Campanian mussels as excellent local products, promoting new productions and encourage buyers to make a conscious choice, both for enhancing local mussel farmers than for reserving the environment for the future generations