

BREEDING OF BLACK SEA MUSSELS AND OYSTERS AS A BUSINESS**A. Livinskyi***Odessa State Agrarian University***V. Zamlynskyi***Odessa National Polytechnic University*

The work substantiates the need for sustainable development of industrial mariculture in the context of the global shortage of safe food. The current state of the aquaculture and seafood market was investigated and proposals for the development of the industry were formulated. As a result of the analysis of approaches to the cultivation and breeding of such main objects of industrial mariculture as the Black Sea mussels and oysters, the need for a structural transformation of the industry in accordance with the global concept of sustainable development of the agri-food complex and food security was clarified. The relevance of the creation of oyster-mussel farms in the Black Sea as a component of the aquaculture industry and business for breeding bivalve molluscs has been proven. The analysis of the production of seafood, in particular mussels and oysters, both in the world and in the countries of the European Union.

Key words: *aquaculture, mariculture, seafood, oyster and mussel farm, marine ecosystem-based management, food demand, production growth, structural transformation, environmental benefit, sustainable seafood strategy, sustainability, organic products.*

INTRODUCTION. Seafood, according to many studies, will tend to rise in price and demand more in the next 10-50 years than its competitors for the production of animal protein in a balanced healthy diet. Growing or catching fish and seafood in the ocean or on the high seas requires the use of special expensive equipment, as well as the hiring of experienced fishermen and personnel, and there is also the problem of its decline in the ocean population. The development of aquaculture is a direct consequence of the progressive degradation of arable land areas. Therefore, it is relevant today to design underwater farms for breeding marine fish and aquatic organisms without harm to its population. To quickly get a large amount of seafood, it can be grown directly in the sea by artificial means - in large aquariums or on specialized farms. The solution of our priority tasks will give investors good competitive advantages in this business, the world community will be provided with sea food, and aquatic resources will receive prospects for their development in accordance with humanitarian and environmental standards to prevent large-scale depletion of limited natural resources.

LITERATURE REVIEW. Analysis of recent publications and research. Many domestic and foreign scientists studied the development of mariculture in the Black Sea: Bagrov A.N., Boreyko V.I., Borzhevsky P.P., Grinzhevsky M.V., Danilov V.N., Korelsky V.F., Mamontov Yu.P., Murin V.A., Patin S.A., Stasishen M.S., Turkulov V.N., Chizhova L.N., Yarkina N.N., Boyd S., Immink A., Muir JK, Pillay T. VR, Shehaden Z. studies, highlighted in scientific and methodological publications of these scientists, are significant, but are mainly aimed at the development of biological resources of the sea, technical and environmental problems of marine fishing, therefore, research on the prospects of artificial cultivation of the Black Sea mussels remains relevant and oysters of various types on the basis of the creation of oyster-mussel farms and justification of the economic attractiveness of mariculture [1]. Mariculture plays a significant role in achieving food security, reduces dependence on natural fish stocks, contributes to employment of the population, development of small and medium-sized businesses, and economic development. Therefore, there is a need to substantiate the feasibility of restoring the maritime business in Ukraine.

DISCUSSION. Aquaculture (artificial cultivation, processing and sale of aquatic biological resources: fish and seafood) plays an important role in the food sector and can cause economic, social and environmental changes in food systems not only in Ukraine but throughout the world. The global coronavirus pandemic has significantly suspended globalization processes, increasing social autonomy, which affected the volume of seafood trade. Global expectations imply a long-term localization of business, a decrease in the number of employees and distance from large urbanization objects, which

implies the need to develop a new business model for fish resources in the context of sustainable development, environmental and social significance of the safest food products.

The capacity of the fish and seafood market is still very far from saturation and increases in proportion to population growth and is predicted as one of the most dynamically growing among all food products by its useful properties. The volume of the seafood and seafood market is about 3 thousand tons per year. Currently, from several dozen commercial species of algae, only a few species are harvested in small volumes, and from 50 species of bivalve mollusks, no more than 6-8 species are harvested. The existing Aqua culture of fishing and other marine bioresources is far from ideal. The constant imbalance of fishing, along with other negative human impacts on flora and fauna, leads to interference in the existing natural balance of the aquatic ecosystem. Currently, for the development of aquatic culture, it is necessary to consider territories that have favorable climatic conditions for breeding and growing in coastal waters not only fish, but also scallops, mussels, rapans, shrimps, oysters, trepang, kelp, algae and some other valuable species of hydrobionts, possessing valuable pharmacological properties (hemolytic, cytotoxic, antifungal and immunomodulating activity, plan their artificial reproduction and pasture cultivation while preserving the ecosystem. [6,7]

Among the numerous business ideas, a modern entrepreneur should pay attention to such as the creation of an oyster and mussel farm in the Black Sea, the product of which is in increasing demand, while the supply is very limited. Despite the fact that there is a growth in entrepreneurship in the country, niches for organizing a very profitable business have not yet been practically occupied.

In the 70s and 80s, centuries came in the south of Ukraine, mussels and oysters were grown. This was done by specialists from Crimea, Odessa and Kherson regions. However, nowadays mariculture in the state is developing very slowly.

To restore the technology of breeding and growing oysters, mussels in Ukraine began at the beginning of the 2000s. The first farm was opened in Crimea, and the second in 2014 in the Kherson region. Today such farms can be counted on one hand. The production volumes of mussels and oysters do not even cover the domestic market yet.

On the Black and Azov Seas, at least 20-30 thousand tons of mussels and other shellfish can be produced annually, and the domestic market needs this delicacy product. But it is unlikely that there will be great success in foreign markets, where the Chileans are among the leaders in terms of price and quality. But oysters have a chance. In the future, the largest is the Chinese market. Scientists predict that by 2030-2035. Oysters on the Atlantic coast will disappear, and since 2008, molluscs have experienced increased mortality through a virus that infects up to 50% of oysters.

Oysters are the most commonly cultivated molluscs. Previously, they were caught in the Atlantic Ocean and the seas of the North Pacific Ocean. Recently, due to changes in the living conditions of mollusks and intensive fishing, the distribution areas have decreased. Today, 95% of commercial oysters are cultivated, which are grown in natural conditions. The main cultivated species of bivalve molluscs is the giant oyster. Also in the Black Sea, they grow the Crimean oyster, Tauride oyster, Crimean Claire oyster, Black Sea oyster and Crimean pearl barley oyster.

The Crimean oyster is grown from French spat. Differs in a unique, special, slightly salty taste and denser texture. It is appreciated all over the world and is in particular demand. Tauride oyster - the culture is grown from the Far Eastern spat, but in the less salty Black Sea, the taste of the oyster is pleasantly salty. High quality meat, from beige to black in color, contains a lot of trace elements useful for humans. Crimean oyster Claire is a flat oyster; it is grown from Zarubinsky spat. Oysters have a spicy aroma and a pronounced salty taste. Delicate meat of light beige tones is a seafood delicacy and has many fans. The Crimean pearl barley oyster is very tasty, has a mild taste, at the same time sweetish and salty, meat of high fat content. It goes very well with white wines. The Black Sea oyster is a kind of European, it has excellent taste. The giant oyster is the most abundant in the world and has an increased resistance to disease. It has been grown in Ukraine since the beginning of the 80s.

Currently, the world production of mariculture exceeds 6 million tons per year, of which 84% (5.4 million tons) come from Asian countries, 13.2% (0.8 million tons) from Europe, 1.7% (0, 1 million tons) African and 1.1% (0.07 million tons) – American [4].

According to the species composition, world production of mariculture is distributed as follows (million tons): fish - 37.1%, molluscs - 36.7%, seaweed - 25%, crustaceans - less than 1% [3].

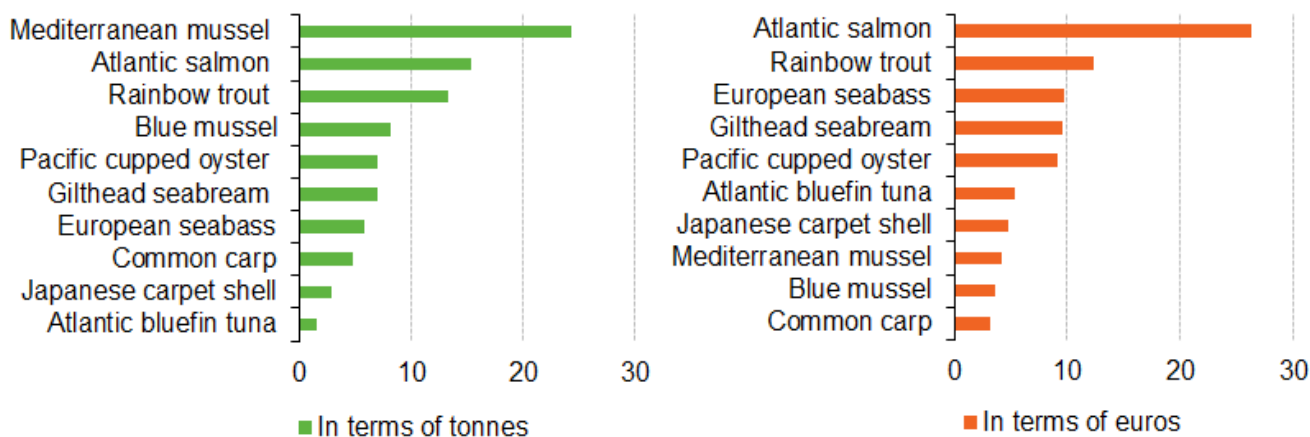
Considering that molluscs and algae are predominantly fish farmed, it can be assumed that the production of mariculture accounts for about two thirds of the total volume of aquaculture.

Many countries pay serious attention to the development and further growth of aquaculture, including mariculture. Programs are being developed and implemented, issues of socio-economic plan and technical equipment, improving the professionalism of production personnel, and marketing of the products obtained are envisaged. Such programs have been developed in Norway, the USA, Japan and Europe. In the countries of the European Union, the specialization of mariculture has developed mainly in two groups of mollusks - oysters and mussels. (Table 1).

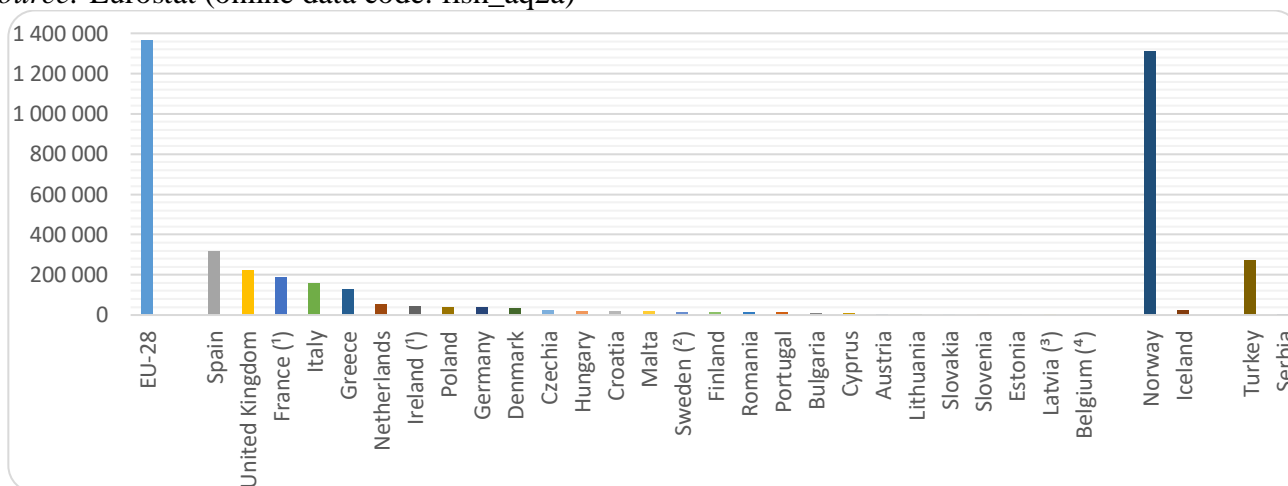
Table 1. Production of aquaculture at the edge of the EU
(1000 tons in a live vase)

	2000	2014	2015	2016	2017	2018	2019
European Union	1406	1276	1275	1246	1225	1183	1367
Belgium	2	0	1	0	0	0	0
Bulgaria	4	3	8	7	7	11	9.8
Czech R	19	20	20	21	21	19	21.7
Dania	44	39	32	32	34	32	34.3
Germany	66	45	41	39	27	25	36.1
Estonian	0	1	1	0	1	1	0.87
Ireland	51	60	46	44	36	34	43.2
Greece	95	106	121	111	109	114	125.6
Spain	309	221	254	274	267	226	315
France	267	245	203	194	205	200	188.6
Croatia	7	11	16	17	14	14	17
Italy	217	181	154	164	137	141	156
Cyprus	2	2	4	5	4	5	7
Latvia	0	1	1	1	1	1	0.78
Lithuania	2	2	3	2	3	4	3.4
Luxembourg	0	0	0	0	0	0	0
Hungary	13	14	14	16	15	14	18
Malta	2	5	7	4	7	9	16
Netherlands	75	71	67	44	46	47	51
Austria	3	2	2	3	3	3	3.8
Poland	36	38	37	26	33	33	36.5
Portugal	8	7	8	9	10	8	12.5
Romania	10	7	9	8	10	10	12.8
Slovenia	1	1	1	1	1	1	1.7
Slovakia	1	1	1	1	1	1	2.6
Finland	15	14	12	11	13	14	14.6
Sweden	5	6	11	13	14	13	14.8
Great Britain	152	173	201	199	206	203	222.2
Iceland	4	8	5	5	7	7	2
Norway	491	661	1020	1145	1321	1248	1308

At the same time, oyster cultivation prevails in France and Germany, and mussels in Italy, Spain, and the Netherlands. The three largest aquaculture producers among the EU Member States were Spain, Norway and France, which together accounted for more than half (53%) of the total EU aquaculture production in 2019 (page 1,2). In Europe, mussels are the most farmed, accounting for over a third (about 400,000 tons) of all aquaculture production in terms of weight, while trout and Atlantic salmon account for about 15% in comparison. In France, the largest volumes of cultivation of oysters (38%), blue mussels (30%), rainbow trout (15%) and mussels (7%) [2].



Page 1. Main species in aquaculture production, EU-28, 2019 (% of total aquaculture production).
 Source: Eurostat (online data code: fish_aq2a)



Page 2. Aquaculture production, 2019 (tonnes of live weight).
 Source: Eurostat (online data code: fish_aq2a)

If we talk about the conduct of aquaculture as a business in Ukraine, with the aim of growing, breeding mussels and oysters, creating oyster-mussel farms, it is necessary to highlight 4 areas of their use: 1 - individual consumption; 2 - catering and food industry; 3 - pharmaceutical industry; 4 - feed and fertilizers.

According to the Ukrainian Research Institute of Nutrition, the physiologically grounded rate of consumption of proteins of water origin is 20 kg / person / year. To do this, it is necessary to produce up to 1 million tons of fish and seafood annually. However, their actual consumption does not exceed 2-4 kg / year. It is estimated that the potential market of mussels in Ukraine is about 145 thousand tons / year, and it is satisfied mainly by import from other countries. The development of this market is hampered by the depletion of the natural resources of the Ukrainian sea shelf and the lack of industrial mariculture. The overall balance of the experimental mussel farm with an area of 0.5 hectares showed that mussels consume 20,840 kg of dry matter of feed, 873 m³ of oxygen and emit 1220 kg of feces, the yield is up to 50 t / ha, which is 20-30 times higher than the biomass yield of mussels in natural conditions. Mussel feces are an integral part of the nutrient chain by detritus feeders, which are included in other nutritional chains, and when grown on an industrial scale, mussels can be processed into highly efficient fertilizers [5].

We must say that in modern environmental conditions, there are certain risks of industrial production of bivalves. So, in the Black Sea, the risks in the mussel and oyster farming are in the deterioration of the quality of sea water as a result of anthropogenic activity (pollution by sewage,

pesticides, eutrophication outbreaks) and natural factors - depletion of the food supply, oxygen kills occurring in highly productive water areas. The best development of mussels occurs when the concentration of the nutrient mass of microalgae is up to 4-6 mg / l, the optimal range of salts for the Black Sea mussel is 12-25 ppm (12-25 g of salt per 1000 ml of water). In terms of salt concentration lower than 11 and higher than 40 ppm, there is a sharp inhibition of the development of not only mussels, but also oysters. The growth of bivalves stops when the water is saturated with oxygen up to 80%. The productivity of the oyster-mussel farm is also influenced by other factors - primary and secondary settling of larvae on collectors, a sharp change in the salt composition of water, temperature changes, poisoning with hydrogen sulfide or ammonia, silting, the spread of their natural predator - rapan. Therefore, the selection of a water area for mussel and oyster mariculture is a complex task, taking into account possible risks. It should be borne in mind that oysters are very sensitive to diseases that are provoked by pathogens or parasites. However, world practice shows that the development of the mussel-oyster economy is real, taking into account possible risks and on the basis of modern world technologies. The calculations show that for the creation of modern oyster-mussel farms with an area of 200 hectares with a new land-based infrastructure, investment funds in the Black Sea bays will amount to about 2.8 million US dollars. The payback of modern enterprises is in 3 years with a profitability of more than 900% (excluding taxes). In addition, up to 200 jobs will be created for the local population by running such an economy. The implementation of a project to create oyster-mussel farms in the Black Sea will create a new industry in the national economy of Ukraine. It will fully satisfy the domestic market of Ukraine and will allow a part of the mussel and oyster products to be exported to international markets. The industrial production of mariculture will include microalgae and plankton in the economic cycle, the uncontrolled development of which can pose a threat of biological pollution of sea water.

CONCLUSIONS. From the presented material, it can be concluded that the application of the proposed measures for the development and creation of oyster-mussel farms will lead to the revival of industrial mariculture in the south of Ukraine, the achievement of performance indicators that meet world standards, improve the livelihoods of the adjacent urbanization areas and the overall economic progress of the country, strengthen the organization system, control and management of the aquatic biological resources sector. The urgency of activating the search for advanced aquaculture technologies, in particular, mariculture, is necessary to provide food for the Ukrainian population and enter the world market. This is favored by climatic conditions (warmer winters), good logistics and improved ecological conditions of the Black Sea. The development of aquaculture is a direct consequence of the progressive degradation of land suitable for agriculture, as well as an alternative to expensive products of European countries, sanctioned products from Russia and often unsafe products with a high use of medicines and hormones from China. The most important feature of modern aquaculture is the development of integrated technologies for the joint simultaneous cultivation of several groups of cultivated organisms of mariculture in the Black Sea and its bays in the context of promoting these products as organic.

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РОЗВЕДЕННЯ ЧОРНОМОРСЬКИХ МІДІЙ ТА УСТРИЦЬ ЯК БІЗНЕС

Лівінський А., Замлінський В.

В роботі аргументована необхідність сталого розвитку промислової марикультури в контексті глобального дефіциту безпечних продуктів харчування. Досліджено сучасний стан ринку аквакультури та морепродуктів і сформульовані пропозиції щодо розвитку галузі. В результаті аналізу підходів до вирощування та розведення таких основних об'єктів промислової марикультури як чорноморські мідії та устриці, з'ясована необхідність структурної перебудови галузі відповідно до світової концепцією сталого розвитку агропромислового комплексу та продовольчою безпекою. Доведено актуальність створення в акваторії Чорного моря устрично-мідійних ферм як складової галузі аквакультури і ведення бізнесу по розведенню двостулкових моллюсків. Проведено аналіз виробництва морепродуктів, зокрема мідій та устриць, як в світі так і в країнах Євросоюзу.

Ключові слова: аквакультура, марикультура, морепродукти, устрично-мідійна ферма, попит на продукти харчування, зростання виробництва, структурні перетворення, екологічна вигода, стійка стратегія виробництва морепродуктів, екологічність, органічна продукція.

РОЗВЕДЕНИЕ ЧЕРНОМОРСКИХ МИДИЙ И УСТРИЦ КАК БИЗНЕС

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В работе аргументирована необходимость устойчивого развития промышленной марикультуры в контексте глобального дефицита безопасных продуктов питания. Исследовано современное состояние рынка аквакультуры и морепродуктов и сформулированы предложения по развитию отрасли. В результате анализа подходов к выращиванию и разведению таких основных объектов промышленной марикультуры как черноморские мидии и устрицы, выяснена необходимость структурного преобразования отрасли в соответствии с мировой концепцией устойчивого развития агропродовольственного комплекса и продовольственной безопасностью. Раскрыта актуальность создания в акватории Черного моря устрично-мидийных ферм как составляющей отрасли аквакультуры и ведения бизнеса по разведению двухстворчатых моллюсков. Проведён анализ производства морепродуктов, в частности мидий и устриц, как в мире, так и в странах Евросоюза.

Ключевые слова: аквакультура, марикультура, морепродукты, устрично-мидийная ферма, спрос на продукты питания, рост производства, структурные преобразования, экологическая выгода, устойчивая стратегия производства морепродуктов, экологичность, органическая продукція.