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Дискусии

MODULAR AND FLOATING MARINE ECOLOGICAL COMPLEX

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The article provides a brief description of novel structures designed to combat global warming - marine ecological complexes, presented in three variants: stationary, modular and floating ecological complexes. This paper presents the modular and floating ecological complex. Each complex is comprised of one or more artificial reefs, mussel farms and artificial islands. A concise overview of their characteristics and capabilities is given, emphasizing their most prominent advantages in comparison to analogous modern marine facilities. Their potential to be used an a large scale by all maritime nations to transform the seas and oceans from previously untapped resource into the most cost-effective, efficient and lucrative means of overcoming global warming and its adverse consequences is emphasized. It is recommended that the complexes be created, tested and deployed without delay in order to recover the Bulgarian coast and shelf from the bio-geo-ecological catastrophe. Bulgaria will thus demonstrate to the rest of the world how to swiftly, effectively and profitably overcome a major natural disaster of our century. Through these complexes, the marine bio-geo-ecological problems of the Bulgarian Black Sea area will be addressed initially for using them for faster and high-quality implementation of the projects on the problems of the respective sections, areas and regions. The patents of the complexes were created in the NGO "EKOS" (Expert Club on the Environment).

Keywords: global warming, artificial reef, mussel farm, artificial island, modular ecological complex, floating ecological complex – catamarans and trimarans.

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МОДУЛНИ И ПЛАВАЩИ ЕКОЛОГИЧНИ КОМПЛЕКСИ

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Статията дава кратка информация за новите съоръжения за противодействие на глобалното затопляне – морските екологични комплекси, представени в три варианта: стационарен, модулен и плаващ екологичен комплекс. В настоящата статия се представят модулният и плаващият екологичен комплекс. Всеки комплекс се състои от един или повече изкуствени рифове, ферми за миди и изкуствени острови. Прави се кратка характеристика на техните качества и възможности, като се изтъкват най-важните им предимства пред аналогичните съвременни морски съоръжения. Подчертава се възможността им, при масова употреба от всички морски държави, да трансформират моретата и океаните от неизползвано досега в най-евтиното, ефективно и доходно средство на човечеството за преодоляване на глобалното затопляне и неговите ужасяващи следствия. Препоръчва се незабавното създаване, експериментиране и внедряване на комплексите с оглед спешното извеждане на българското прибрежие и шелф от био-геоекологичната катастрофа. С това България ще даде пример за бързо, ефикасно и максимално доходоносно справяне с най-опасното природно бедствие на нашия век. Чрез тези комплекси ще се решават всички морски био-геоекологични проблеми на българската акватория на Черно море, те ще се използват за по-бързото и качествено реализиране на проектите по проблемите на съответните участъци, райони и региони. Патентите на комплексите са създадени в НПО „ЕКОС“ (Експертен Клуб по Околната Среда).

***Ключови думи*:** глобално затопляне, изкуствен риф, ферма за миди, изкуствен остров, модулен екологичен комплекс, плаващ екологичен комплекс – катамарани и тримарани.

MARINE ECOLOGICAL COMPLEXES

It is already well known that over the last fifty years the Bulgarian Black Sea coastal zone and shelf have experienced a bio-geo-ecological catastrophe that minimized the use of their resources (Parlichev, 1996, 2000; Parlichev, Peychev et al. 2013; Parlichev, Stoykov, 2014; Parlichev, 2016; Tsvetkov et al., 2021). Considering this situation and, in particular, the ways out of it, the authors gradually arrived at the idea of integrating in one facility the beneficial attributes of artificial reefs, mussel farms and artificial islands, which eventually led to the formulation of the concept of marine ecological complexes, a novel type of marine facilities (Parlichev D., G. Parlichev 2020, 2022, 2023b; Parlichev D., G. Parlichev, 2023c):

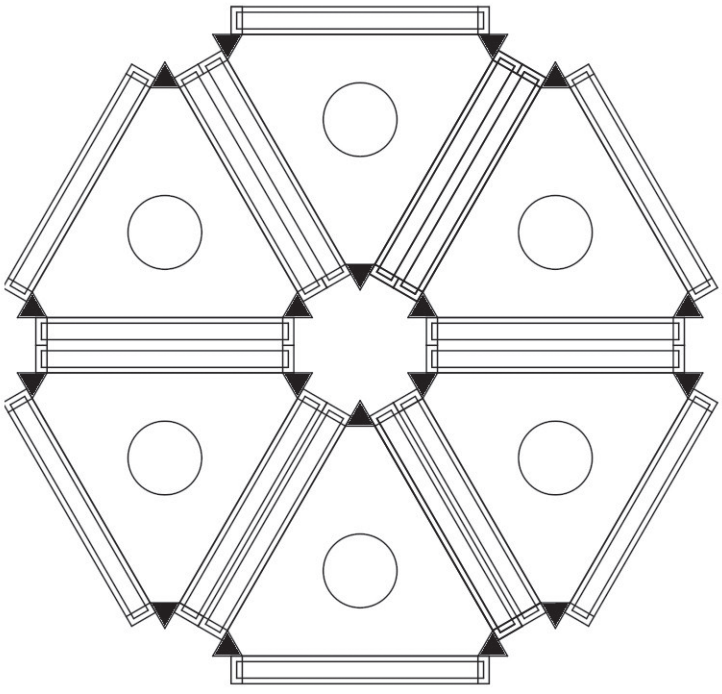

Fig. 1

II. Modular ecological complex (Fig. 1, Fig. 2, Fig. 3)

Fig. 2 shows top view an artificial reef of a modular ecological complex composed of six modules, situated among and surrounded by two-tiered mussel farms. Fig. 3 illustrates three marine ports A, B and C on the shelf, 10 km east of Varna (18–19 m depth). Fig. 4 shows a series of linearly extended structures from modular complexes A, B, C and D. It is evident that a large number of ecological structures of different size, configuration, orientation and purpose (some with impermeable walls) could be constructed from them, depending on local conditions, the requirements of the owners and the interests of the coastal settlement.

III. Floating ecological complex - a) Catamaran (Fig. 4)

Fig. 4 shows the top view of a floating ecological complex - catamaran. Its two side hulls are visible, containing the bodies of artificial reefs on top of which the artificial islands are mounted. They end in hollow, elongated, isosceles triangular prisms supporting an artificial islands above the sea level surface. The two-tiered mussel farms are located in between. The catamaran is designed to produce 250 and 500 tons of mussels.

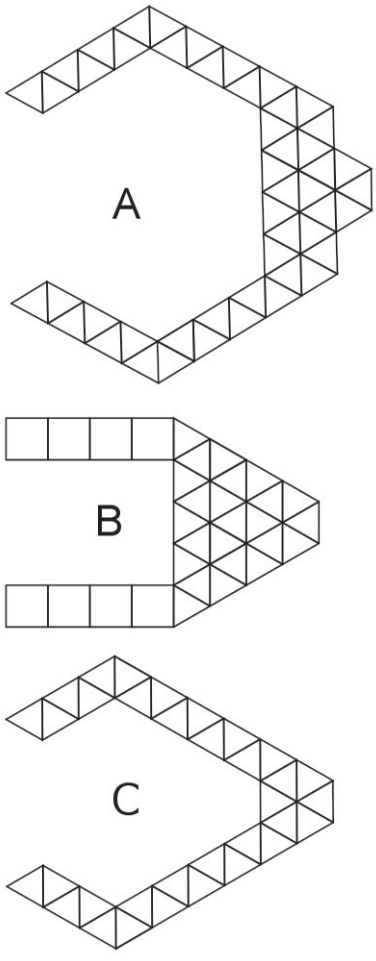

Fig. 2

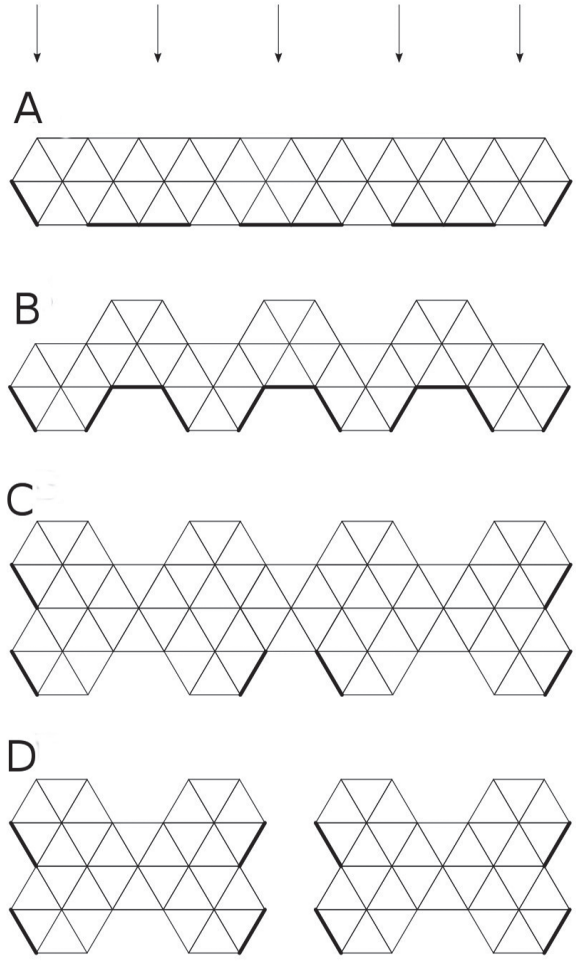

Fig. 3

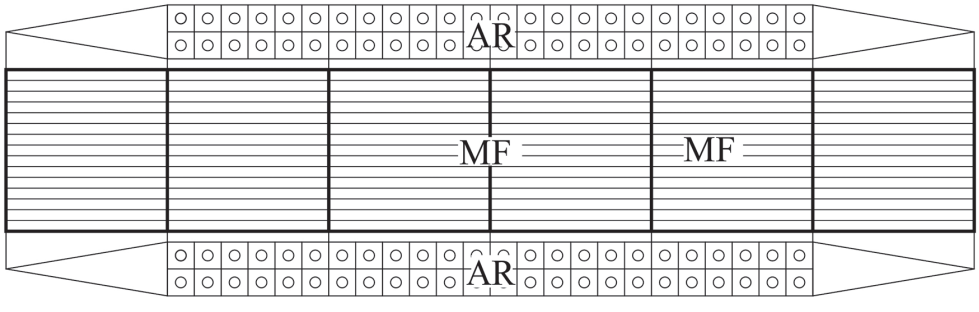

Fig. 4.

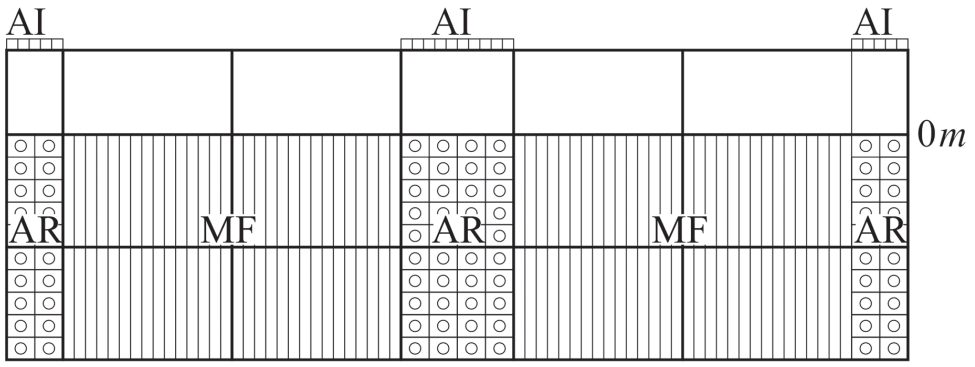

Fig. 5.

Floating ecological complex - b) trimaran (Fig. 5)

Fig. 5 shows the vertical cross-section of a trimaran, where the artificial reefs are depicted by a central one and two reefs on either side, with artificial islands situated above them and four two-tiered mussel farms in between. The trimaran is designed to produce 1,000 tons of mussels.

The economic feasibility of developing such floating mussel culture farms has been proven abroad (OOS Group, 2021).

BRIEF CHARACTERISTICS OF THE COMPLEXES

- In general, marine ecological complexes consist of at least one artificial reef, one mussel farm and one artificial island, resulting in a tripling of the benefits of the organically interconnected facilities (this is readily apparent if the structures are used separately).

- In the marine ecological complexes, the artificial reef, mussel farm and artificial island can vary from one to several, and from two or three-tiers in different complexes, which increases several times their biological production.

- The stationary and modular complexes can be combined into larger structures which increases their production capacity and resistance to waves and currents. Which of these are used, and to what extent, depends on the owner's interests and the characteristics of the marine environment.

- The labyrinthine nature (internal complexity) of the structures allows for numerous modifications, enabling them to adapt flexibly to the specific conditions of individual marine sites.

- If the harvest at a site is lower than anticipated, the stationary and modular complexes can be transported every year, and the floating complexes can be readily relocated via the "complex anchor" and using a floating crane to a site with a larger harvest.

- Marine ecological complexes provide an extensive hard substrate for larval attachment and smaller mobile organisms, thus concentrating the flora and fauna in the 12 m surface layer of the world's ocean (a zone that is also rich in phytoplankton, the primary food source for mussels), facilitating mussel harvesting and wild fisheries.

- Perhaps the most important feature of the complexes is that, while the stationary and modular complexes will be used offshore and on the upper part of the shelf (up to 30 m deep), the floating complexes (catamarans and trimarans), thanks to the "complex anchor", will dominate the whole shelf, and without an anchor they will sail over all the abysses, facilitated by the surplus of cheap electricity (due to the much shorter towers) obtained from the numerous wind turbines on them.

- The porosity of the complexes provides good wave and current permeability in the 12 m surface layer. They never become silted due to self-cleaning through the wide central floor and ceiling openings, increasing in size downwards.

- The ability of catamarans and trimarans (above the shelf) to move in a circle around their anchor over an area a hundred times larger than their own will bring positive changes to the pelagic and benthic ecosystems and landscapes in the area.

- The ability control the complexes using the Internet will allow to be attended as required – for supervision, repairs, harvesting, sport fishing, etc.

- The advent of modern communications has enabled the operation of these complexes without the need for human intervention, ensuring their timely arrival at the optimal location for harvesting.

- They will be able to perform additional functions: of wind farms, fishing bases, research sites, tourist destinations, detached protection (Parlichev D., G. Parlichev, 2023a), etc. at no extra cost.

- They will provide an unprecedented development of marine tourism and recreation, relieving and diversifying the hot and congested land resorts in the summer.

- Their most attractive aspect is that their use against global warming, instead of substantial financial losses, will bring substantial gains to their owners in Bulgaria. This is in contrast to the other countries, where all measures against global warming have so far been associated with huge costs.

- This will also scale the transition from experimental to mass production of the complexes - panels, beams, collectors, connectors, likely manufactured from new types of special plastics, easily assembled on land and installed at the desired location, packaged and easily transported or exported abroad.

The features of the marine ecological complexes listed so far (1/7 of the known positive features and capabilities) will increase their efficiency and profitability over time to an extent unimaginable for other similar marine facilities.

MAJOR PROBLEMS SOLVED

The features of marine ecological complexes described above (and not described 6/7) will allow them to successfully address the following most important problems:

1. The bio-ecological problem will be resolved directly and completely by all ecological complexes with a large area of hard substrate for the attachment of low trophic level species that depend on it. Its presence will facilitate an increase the biodiversity and production in the areas where the complexes are placed. The labyrinthine nature of the artificial reefs will provide mobile species with refuges, hiding places, spawning grounds, larval sources, food depots and other necessities for their survival. Higher densities of complexes will create fishing grounds and areas where catches will be many times higher than in areas without complexes.

2. The geo-ecological problem of the adjacent coast will be solved by segmented offshore coastal protection, implemented by stationary or modular ecological complexes. The fallen mussels and their shells will be moved towards the shore by the wave action and generate shell-sand beaches. The prevailing wave direction and currents will support long-shore sediment transport, creating beaches on one or both of the adjacent coastlines, thus reducing coastal erosion and gravitational processes affecting the cliff sections of the coast.

3. The coastal protection will be provided directly by the shell-sand beaches and indirectly by the detached, near or offshore, continuous or segmented, stationary or modular marine ecological complexes. The structures will split and transform the wave, whose energy will be further reduced by the lee-side wave diffraction and will not threaten the coast (Parlichev, D., G. Parlichev, 2020; Parlichev D., G. Parlichev, 2023a).

4. The energy problem will be solved by numerous wind turbines, mainly on catamarans and trimarans with "complex anchors" sailing over the shelf or sailing without anchors over the abysses of the world ocean. These will be mobile wind turbines which, unlike the fixed ones in Denmark, will provide the inexpensive electricity (with numerous and much shorter towers).

5. The food scarcity problem will be solved in parallel with the increase in the number of ecological complexes, which may exceed 10,000 on the Bulgarian shelf (outside the marine traffic routes). Higher-quality and cheaper marine products will gradually replace lower-quality and more expensive animal products. The catch of mussels, fish and other marine organisms can quickly satisfy the country's domestic needs, while the quantities remaining for export will increase annually.

6. The ecological climate problem will be solved directly from the annual harvest of mussels - from the stationary complexes (mussels - 160 *t*, shells -

80 *t*, CO_2 – 35.2 *t*, savings – $21,120), from the modular complexes (mussels – 115 *t*, shells – 57.5 *t*, CO_2 – 25.3 *t*, savings – $15,180), from the floating complexes – catamarans (mussels – 500 *t*, shells – 250 *t*, CO_2 – 110 *t*, savings $66,000), trimarans (mussels – 1,000 *t*, shells – 500 *t*, CO_2 – 220 *t*, savings – $132,000). The process of CO_2 reduction from water and air will be carried out by all marine complexes, with mussels mainly absorbing CO_2 and transforming it into $CaCO_3$ forming their shells. The process has been elucidated by Houghton (1996), according to Henry's law of partial pressure (Uzunov, Kovachev, 2002). The same was used by D. Parlichev (2018) to explain the shell-sand beaches along the Dobrudja coast between cape Sivriburun and cape Shabla, perfectly protecting the cliffed coast from the waves (illegal sand extraction established by the author during seasonal expeditions of the Institute of Oceanology temporarily terminated this role). Here, the shoreline is an area where mussels absorb CO_2 from the water and air as "biological pumps" (Houghton, 1996) and transform it into the $CaCO_3$ of their shells. Marine ecological complexes would convert the entire surface of the World Ocean into such a zone. They will precisely ensure the eradication of global warming if we are not too late in creating them.

7. The economic problem – to date, technologies to extract CO_2 from the air have been developed abroad, but at prices that do not allow the process to be scaled up for production (Young et. al, 2023). The problem of disposal of the toxic gas that has already been captured is also practically unresolved. Domestically, both problems have been solved in the best possible way - CO_2 will be absorbed continuously and free of charge from the water and air by marine ecological complexes and converted into the $CaCO_3$ of the mussel shells used to create the beaches.

8. Sea level rise is a direct consequence of the rapidly accelerating melting of glaciers in Antarctica, Greenland and the highest mountains of the continents, which has become catastrophic in recent years. It could raise sea levels by up to 5 m. This means that by the end of the century, hundreds of cities such as Burgas and Varna will be partially submerged, dozens of megacities such as New York, San Francisco, Sydney, Istanbul, Cairo, etc. will be half submerged, and cities such as Amsterdam, Venice, etc., which are already below the sea level, are likely to disappear. Some countries on coral reefs in the Pacific will also disappear. The losses of the different countries already exceed USD 13 trillion a year. So far, humanity has not invented anything that can stop and reverse this process. Only marine ecological complexes can do this, provided that they are developed, tested and implemented by all maritime nations in a timely manner. However, the Bulgarian leadership and scientific institutions have so far shown no interest in this national and global problem.

9. Science as a productive force - the need for the creation and practical use of marine ecological complexes makes it necessary to organize science in such a way that it is forced to carry out certain productive processes: design,

supervision of the construction of complexes, their experimentation and possible modification, their behaviour in extreme coditions, comparison of the actual and expected harvest, etc., which make science a productive force. Therefore, only with the emergence of the new "Institute of Marine Ecology and Resources - Varna" (IMER) will allow us to talk seriously about marine science in Varna. The abuses and irresponsibility of the management of the three marine institutes in Varna, the Bulgarian Black Sea coast and the three Black Sea districts have suffered incredible losses.

10. Monitoring of the marine environment will become effective through the deployment of marine ecological complexes. It will follow a pre-defined methodology tailored to the specific research or practical tasks of the related projects. Monitoring both the environment and the complexes will allow potential increases of the mussel harvest. The integration of these two forms of monitoring will make marine ecosystems and landscapes more controllable and manageable.

11. From enrichment to salvation - the advantages of marine ecological complexes over all other marine structures are that they will transform the fight against global warming from losing into most profitable human activity rendering their proprietors wealthy and then millionaires in a few years. This ensures that the complexes will receive immediate support and application abroad. In contrast to Bulgaria, where the state and science leaders have inexplicably neglected new developments in science, particularly those that are of crucial importance to humanity and modern civilization.

CONCLUSIONS, PROPOSALS, RECOMMENDATIONS, PERSPECTIVES:

1. The sharply accelerated temperature rise on a planetary scale will very quickly bring the Earth to the critical limit (according to the authors - around mid-century), after which the global ecological climate catastrophe will become irreversible and life impossible. This calls for a strengthened and empowered UN, with greater capacity to implement conservation measures at the global level. This includes timely cessation to the extraction of fossil fuels, an end to all military conflicts and the neutralization of aggressors, shift of all modes of transport to electric vehicles powered by renewable energy, and the implementation of comprehensive measures to suppress the fires that are turning the planet's forests from a source of O_2 into a source of CO_2.

2. A new type of marine complexes, comprising three variants is proposed allowing to harness the most powerful mechanism against the climate and ecological catastrophe - the world ocean, which is in a severe state of O_2 deficiency and CO_2 excess. It is imperative to promptly design, build, test and

deploy the complexes to extricate the Bulgarian Black Sea region from the bio-geo-ecological catastrophe which will demonstrate their potential to solve the marine challenges facing humanity, as well as the ominous ecological and climate problem.

3. It is proposed to immediately transform the Institute of Fisheries Resources - Varna into the "Institute of Marine Ecology and Resources" (IMER) under the Ministry of Environment and Water and to equip it with everything necessary to solve marine environmental problems in Bulgaria. It will build, experiment and implement the described complexes and, at least initially, on the basis of its own experience, it will direct the world marine ecology towards the most economical and profitable solution of the problems. This flagship institute will shorten the time needed to achieve a turnaround in the solution of the vital climate-ecological problem of humanity. This will make the marine science in Varna, which has brought the Bulgarian Black Sea coast to the bio-geo-ecological disaster and ruined the economy of the coastal areas, unnecessary. Because Bulgaria has no use for the majority of the scientists it pays to pursue only their financial and career interests through science.

4. The protection of the marine environment and coastal zone in the Black Sea can be facilitated through cooperation with scientific institutes in other countries of the Black Sea region, in particular with Romania due to similar marine and coastal conditions. This will enable the scaling up of the marine ecological complexes project and the application of the method at the level of the Black Sea region. Successful trials will demonstrate the benefits of implementing the proposed facilities and facilitate their dissemination globally.

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