DOI: https://doi.org/10.30525/2256-0742/2024-10-3-318-326

ASPECTS OF SCIENTIFIC RESEARCH IN UNIVERSAL ENVIRONMENTAL TREATIES: LEGAL AND ECONOMIC ANALYSIS

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Abstract. The article emphasises that aspects of international legal cooperation in the field of scientific research have not yet been the subject of a systematic, comprehensive scientific study either in the context of international law doctrine or in relevant publications. The *subject* of the study is the legal regulation of scientific research in universal international environmental treaties, with the aim of identifying the specific features of such international legal mechanisms. The paper examines the challenges and paradoxes faced by international environmental law in regulating scientific research as a process, as well as in balancing scientific research with the practical needs for appropriate resources. The research uses hermeneutical, prognostic, comparative and systemic analysis of relevant international treaties as components of the modern system of international law. It applies a complex set of *methods*, including analysis and synthesis, structural and formal-legal methods, as well as scientific deduction and induction approaches. The combination of these methods provides a thorough examination of how international environmental treaties regulate scientific research. The methodology includes a hermeneutic approach to interpret the language and provisions of various environmental treaties, a predictive approach to forecast potential developments and the outcomes of current regulation, a comparative analysis to identify similarities and differences between different treaties, and a systems analysis to understand how these treaties fit into the broader system of international law. Taken together, these methods provide a reliable basis for assessing the current state and future directions of international legal cooperation in environmental research. The main *objective* of the article is to reveal the unique characteristics and complexities inherent in the international legal mechanisms governing scientific research under environmental treaties. It aims to highlight the current challenges and paradoxes faced by international environmental law in this context. These include the need to address global environmental problems with often limited and unreliable scientific data, the need to respect and encourage scientific research, and the imperative to balance the search for scientific knowledge with the practical needs of natural resources. The results of the study show that environmental conventions reflect several important challenges. One of the main challenges is to address global environmental issues in the face of a lack of reliable scientific information, while respecting scientific research and its results. Another crucial challenge is to maintain a balance between promoting scientific research and meeting the practical resource needs of humanity. The author posits that international environmental law sources represent an enduring endeavour to achieve equilibrium in the formation of convention bodies. This equilibrium strives to reconcile the sovereign interests of participating states with the necessity of maintaining a high level of expertise within relevant commissions and committees. In conclusion, the paper emphasises the necessity for the continuous development and refinement of legal regulation pertaining to scientific research within the field of international environmental law. This is in order to effectively address the dynamic and complex interplay between scientific advancement and environmental sustainability.

Keywords: environment, conventional bodies, science, scientific ethics, scientific research, transboundary impact.

JEL Classification: Q56, I20, O30

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1. Introduction

The current aspects of international legal cooperation and related intergovernmental cooperation with r espect to scientific research at the universal and regional levels have not yet been the subject of systematic and comprehensive scholarly investigation within the framework of contemporary international legal doctrine or in relevant domestic and foreign scholarly publications.

Concurrently, the elements of regulating scientific activity in the context of universal sources of international environmental law, including the regulation of processes, forms, and mechanisms of scientific research within relevant acts, are of exceptional relevance and significant scientific novelty.

Accordingly, the subject of this article is the legal regulation of scientific research in universal international environmental treaties, with the objective of identifying the specificities of such international legal mechanisms.

To achieve this goal, the following main tasks of scientific research should be implemented:

– To identify the challenges and paradoxes faced by international environmental law in regulating scientific research as a continuous process that does not always guarantee a reliable result at a particular moment;
– to consider the issue of maintaining a balance between scientific research and the practical needs of mankind in obtaining relevant biological and mineral resources within the framework of relevant agreements;
– to outline aspects of the regulatory delineation of research activities and the applied format of research related to the intensification of resource extraction, environmental pollution or the emergence of new challenges for humanity;
– to determine the specifics of the process of finding a balance in the formation of convention bodies, which should reconcile the interests of the states parties, while ensuring the appropriate level of professionalism of the staff.

Among Ukrainian researchers, relevant issues have been addressed in their publications by B. V. Babin, K. V. Hromovenko, A. O. Zadorozhnyi, S. V. Kivalov, and O. M. Plotnikov (Babin, Plotnikov, 2022), but comprehensive and monographic studies of these issues have not yet been conducted. Some references to attempts to regulate scientific research in the environmental dimension were found in the activities of the International Maritime Organization (Babin, Chvaliuk, Plotnikov, 2021; Babin, Plotnikov, Prykhodko, 2023), the Food and Agriculture Organization of the UN (Babin, 2019; Babin, Chvaliuk, Plotnikov, 2021), and certain other universal institutions (Babin, 2014; Babin, 2023), but these references were extremely fragmented.

Relevant issues were raised in the materials submitted by expert institutions to various UN Special Rapporteurs. Among them are the Special Rapporteurs on cultural rights, A. Xanthaki, on the right to education, F. Shaheed, on toxic substances and human rights, M. A. Orellana, and on the right to water and sanitation, P. Arrocho-Agudo. They attempted to summarise the relevant developments on the right to science and the conduct of systematic environmental scientific research in the international legal dimension.

It should be noted that the Special Rapporteur, Professor A. Xanthaki, in her own report A/HRC/55/44 to the UN Human Rights Council in 2024 on the "Right to Participate in Science", emphasised that many international agreements, which are not part of the international human rights system, also contain science-related provisions. Some of these agreements provide guarantees of information, participation, education and awareness, as well as the distribution of benefits and responsibilities. A. Xanthaki included the Convention on Biological Diversity, the UN Framework Convention on Climate Change and subsequent climate change agreements, the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, and numerous conventions and protocols related to toxic substances (Xanthaki, 2024).

At the same time, Special Rapporteur A. Xanthaki emphasised the urgent need for science-institutional and science-political interaction based on trust, as well as the need for urgent action to combat misinformation and erroneous information in the field of science, while respecting and protecting human rights. As scientific decisions are aimed at overcoming many future crises, the UN Special Rapporteur added, it is crucial to guarantee the autonomy and integrity of scientists and to ensure respect for human rights in their work on scientific issues (Xanthaki, 2024).

However, these proposals have not yet been systematically implemented even at the doctrinal level and in the report A/HRC/55/44 itself as the current key document on the international legal dimension of scientific activities, so that the aspects of norms of international environmental law have not been highlighted. Moreover, these aspects have not yet been systematically addressed in the works of contemporary authors who have studied aspects of scientific activities in international law, particularly in the human rights dimension. These include, among others, the works of K. Achermann, S. Besson, M. Plozza, L. Shaver and the publications on the human right to science by A. Bodgio and C. Romano.

2. Methodology

To obtain new and high-quality scientific results and to fully achieve the purpose and objectives of

this article, it is necessary to outline specific issues of universal regulation of processes, forms and mechanisms of scientific research in the context of the relevant acts of international environmental law. To achieve this goal, it is necessary to conduct a comparative and systematic analysis of the relevant documents as components of the modern system of international legal regulation and, accordingly, to conduct a comparative and systematic analysis of the relevant treaty documents as an integral and significant component of the modern system of international law. With regard to the phenomenon of challenges and paradoxes faced by international economic law in the context of regulation of scientific research as a process, an appropriate set of scientific methods of analysis and synthesis should be applied.

In order to address the question of compliance in relevant agreements, it is essential to consider the balance between scientific research and humanity's practical need for obtaining biological and mineral resources. This can be achieved by employing structural and comparative methods. With regard to the differentiation of scientific research activities and the format of research in the context of intensifying resource extraction, increasing pollution, and the emergence of new challenges for humanity, formal-legal, prognostic, and hermeneutic methods have been utilised in their entirety.

With regard to the delimitation of the normative reflection of the balance-seeking process in the formation of conventional bodies, which must reconcile the interests of the participating states while ensuring the necessary level of expertise of the personnel, it is necessary to establish primarily programmatic and systemic methods and approaches of scientific deduction and induction. In this regard, it is crucial to identify authentic texts of international environmental treaties available in the official resources of international structures, for which a search and systematisation of relevant normative sources should be carried out.

Concerning such a format of normative sources, it is necessary to conduct a consistent structural search for facts and forms of reflection of scientific categories and scientific activity, and at the same time to compare the described organisational and functional models of the activities of conventional structures and units, individual officials with the real situation and practical state of affairs in the activities of the relevant supranational bodies.

3. Presentation of the Main Material

It is notable that the Vienna Convention for the Protection of the Ozone Layer of March 22, 1985, addresses the inherent limitations of scientific knowledge, which is inherently incomplete and unable to fully anticipate the complexities of environmental challenges. The 1985 Convention, in its preamble, asserts that measures for the protection of human health and the environment from adverse effects resulting from human activities that may alter the state of the ozone layer should be "based on relevant scientific and technical considerations" (Vienna Convention for the Protection of the Ozone Layer). The Montreal Protocol on Substances that Deplete the Ozone Layer of 1987, which was adopted as a development of the 1985 Convention, placed particular emphasis in its preamble on the importance of promoting international cooperation in the research and development of science and technology relating to the control and reduction of emissions of substances that deplete the ozone layer, bearing in mind in particular the needs of developing countries (Montreal Protocol on Substances that Deplete the Ozone Layer 1987).

This approach to scientific progress and scientific activity was further developed in the United Nations Framework Convention on Climate Change of May 9, 1992. The preamble of this convention states that "steps required to understand and address climate change will be environmentally, socially and economically most effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in these areas" (United Nations Framework Convention on Climate Change).

Furthermore, the 1992 Framework Convention required states to promote and engage in scientific research, systematic observations, and the creation of databases related to the climate system. This was done with the aim of deepening knowledge, reducing or eliminating uncertainties regarding the causes, effects, magnitude, and timing of climate change, and ensuring the training of appropriate scientific personnel.

Moreover, the 1992 Framework Convention, in Article 9, established a distinct subsidiary body for consultation on scientific and technical matters. This body is tasked with "providing the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention" (United Nations Framework Convention on Climate Change). In accordance with the principles set forth in this treaty, the body in question is to be interdisciplinary in nature and shall comprise duly qualified representatives from governments with expertise in the pertinent fields of knowledge.

Another notable illustration of such regulatory measures is the Convention on Biological Diversity of 1992. The preamble of this convention underscores the scientific importance of biological diversity and its constituent elements, and asserts the necessity for the development of scientific, technical, and institutional capabilities to facilitate the

acquisition of fundamental knowledge upon which appropriate measures can be planned and implemented (Convention on Biological Diversity).

It is noteworthy that the preamble of the 1992 Convention further emphasises that "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat" (Convention on Biological Diversity). This serves to illustrate the attitude of universal international law towards the criteria and principles for assessing the results of relevant scientific research.

It is also pertinent to consider the role of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity, which was adopted on January 29, 2000. The objective of this Protocol is to ensure the appropriate level of protection in the field of safe transfer, handling, and use of living modified organisms obtained through modern biotechnology.

In accordance with the stipulations set forth in this Protocol, a country to which genetically modified organisms are imported may request that the importing party undertake a review of a previously made decision on movement if the exporting party deems that pertinent additional scientific or technical information has become available. Article 20 of this Protocol established a Biosafety Clearing-House, whose purpose included facilitating the exchange of scientific, technical, environmental and legal information on, and experience with, living modified organisms (Cartagena Protocol on Biosafety to the Convention on Biological Diversity).

Within the system of treaties, several universal instruments of international law have evolved that specifically address aspects of nature conservation and regulate scientific activities in their own right; a prominent example is the agreements adopted for the development of the Antarctic Treaty. One such agreement is the 1972 Convention for the Conservation of Antarctic Seals, which recognises that "in order to improve scientific knowledge and thus to place exploitation on a rational basis, every effort should be made both to encourage biological and other research into Antarctic seal populations and to obtain information from such research and from statistics on future sealing operations with a view to formulating further appropriate regulations" (Convention for the Conservation of Antarctic Seals).

The success of the mechanisms established by this Convention contributed to the formation of the subsequent and broader Convention on the Conservation of Antarctic Marine Living Resources of 1980, which in its preamble recognised the need to "increase knowledge of the Antarctic marine ecosystem and its components so that decisions on exploitation may be based on sound scientific information" and the need to establish an appropriate mechanism for coordinating measures and scientific research necessary for the conservation of Antarctic marine living resources (Convention for the Conservation of Antarctic Marine Living Resources).

Notably, this 1980 Convention, in addition to the fairly standard mechanism of establishing a special intergovernmental commission, also establishes a separate Scientific Committee for the Conservation of Antarctic Marine Living Resources, which is an advisory body to the Commission. The Convention provides that the Commission shall consider the reports of the Scientific Committee and, in the exercise of its functions, shall take full account of the recommendations and advice of the Scientific Committee (Convention for the Conservation of Antarctic Marine Living Resources).

The subsequent treaty in the pertinent context was the Convention on the Regulation of Antarctic Mineral Resource Activities of 1988. This treaty places particular emphasis on the distinctive ecological and scientific value of Antarctica, stipulating that any activities related to its mineral resources must be conducted in a manner that is consistent with the objectives of scientific research in the region. Furthermore, the 1988 Convention makes a clear distinction between activities related to mineral resources and scientific research, as defined in Article 3 of the Antarctic Treaty.

It is noteworthy that, despite the aforementioned reservation, such activities may involve geological, geochemical, and geophysical surveys and field observations, as well as the use of remote sensing methods. However, these activities are not formally defined as scientific research and do not have corresponding guarantees of freedom of implementation (Convention on the Regulation of Antarctic Mineral Resource Activities).

In addition to the aforementioned Committee, the 1988 Convention provides for the operation of the Antarctic Mineral Resources Commission, which should actively participate in significant scientific, technical or environmental research under this Treaty. To this end, the Commission should facilitate the collection and exchange of scientific information and research projects necessary for the prediction, detection and assessment of possible impacts on the Antarctic environment of activities related to Antarctic mineral resources, including the monitoring of key ecological parameters and components of the ecosystem.

The 1988 Convention contains specific requirements for the composition of the above-mentioned Advisory Committee, stating that each Contracting State shall be represented by one representative with relevant scientific, technical or environmental competence, who may be accompanied by assistant representatives,

as well as experts and advisers (Convention on the Regulation of Antarctic Mineral Resource Activities).

It is also worth mentioning the provisions of the 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol), which in its preamble draws attention to the "unique opportunities Antarctica offers for scientific observation and research on processes of global and regional importance".

This Protocol defines Antarctica as a "natural reserve dedicated to peace and science". Furthermore, Article 3 of the Protocol recognises the importance of Antarctica as a region for the conduct of scientific research, which should be one of the main factors taken into account in the planning and implementation of any activity in this geographical area (Protocol on Environmental Protection to the Antarctic Treaty, signed in Madrid on October 4, 1991).

According to the Protocol, all activities in Antarctica should be planned and carried out in such a way as to give priority to scientific activities, and such activities, including those provided for in scientific research programmes, should be modified, suspended or terminated if they have, or are likely to have, adverse effects on the Antarctic environment or on ecosystems that depend on or are associated with it (Protocol on Environmental Protection to the Antarctic Treaty, signed in Madrid on October 4, 1991).

Another similar example is the Agreement on the Conservation of Polar Bears of November 15, 1973, which states in Article 2 that states shall manage polar bear populations in accordance with reliable conservation practices based on the best available scientific data. At the same time, Article 3 of this Agreement allows countries to harvest polar bears "for bona fide scientific purposes" (Agreement on the Conservation of Polar Bears).

In addition, reference should be made to the Agreement establishing the Indian Ocean Tuna Commission of November 25, 1993, concluded under the auspices of the FAO and in furtherance of the United Nations Convention on the Law of the Sea. Article 5 of this Agreement assigns to the Commission the task of collecting, analysing and disseminating scientific information and statistical data on catches and fishing effort and other data relating to the conservation and management of the relevant biological resources and fisheries. It also requires the Commission to take appropriate measures, based on scientific evidence, to "collect, analyse and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of resources and to fisheries based on those resources" (Agreement for the Establishment of the Indian Ocean Tuna Commission).

The issue of scientific research for conservation purposes has also been addressed in detail in other documents, particularly in relation to transboundary impact assessment. One example is the 1991 Convention on Environmental Impact Assessment in a Transboundary Context, Article 9 of which requires that States pay particular attention to the development or more active implementation of specific research programmes aimed at improving existing methods of qualitative and quantitative assessment of the potential impacts of proposed activities (Convention on Environmental Impact Assessment in a Transboundary Context (with appendices)).

It is also pertinent to cite the stipulations of Article 5 of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which was adopted on March 17, 1992. This Article calls upon states to collaborate in the pursuit of effective methods for the prevention, limitation, and reduction of transboundary impact through research and development initiatives. In order to achieve this, countries should, on a bilateral or multilateral basis, implement or activate, if necessary, specific research programmes, in accordance with the scientific research activities of relevant international forums and in alignment with the directions defined by this Convention (Convention on the Protection and Use of Transboundary Watercourses and International Lakes (with annexes)).

In addition to this agreement, the Convention on the Transboundary Effects of Industrial Accidents of 1992 was signed in Helsinki. Article 14 of this Convention obliges states to "initiate and cooperate in the conduct of methods and for the prevention of, preparedness for and response to industrial accidents". Furthermore, states are required to "encourage and actively encourage scientific and technological research into less hazardous aimed at limiting accident hazards and preventing and the consequences of industrial accidents" (Convention on the Transboundary Effects of Industrial Accidents (with annexes)).

It is also pertinent to consider the Stockholm Convention on Persistent Organic Pollutants, adopted on 22 May 2001. Among other things, this Convention introduces the principle that the lack of full scientific certainty shall not prevent the taking of action in risk regulation assessment.

It is in this context that, on the basis of this Convention, the Committee may decide to include a particular chemical in the Annexes to the Convention and to determine appropriate regulatory measures for it in the event of insufficient scientific certainty, based on the precautionary principle. In addition, the document incorporates technical innovations and changes in scientific knowledge and understanding of certain issues into the introduced concept of best available techniques (Stockholm Convention on Persistent Organic Pollutants (with annexes)).

It is also crucial to cite the 1972 Convention Concerning the Protection of the World Cultural

and Natural Heritage, which was adopted under the auspices of UNESCO. This convention stipulates that an effective system of collective protection of sites of outstanding universal, cultural, and natural significance must be established on a permanent basis in accordance with modern scientific methods.

The treaty acknowledges the necessity for appropriate scientific and technical "international assistance and cooperation" in Article 4. Concurrently, it directs states to pursue the advancement of scientific and technical developments and research, as well as the refinement of methodologies that facilitate the elimination of threats to their cultural and natural heritage. Additionally, it encourages the implementation of scientific measures for the identification, protection, preservation, promotion, and restoration of this heritage. Scientific research in this field is also strongly encouraged (Convention for the Protection of the World Cultural and Natural Heritage).

It is important to acknowledge the interconnection between the subject of scientific research and scientific studies in international environmental law and the concept of sustainable development, as well as the correlation with human rights in the context of universal declarations adopted at UN conferences.

This link is most evident in the Stockholm Declaration of the 1972 United Nations Conference on the Human Environment, which emphasised that "the rapid acceleration of science and technology has given man the power to modify his environment in countless ways and on an unprecedented scale". At the same time, just a few sentences later, the Declaration recognised that "with social progress and advances in production, science and technology, man's ability to improve the environment is increasing day by day" (Convention for the Conservation of Antarctic Marine Living Resources).

Scientific activities are mentioned in two principles of this Declaration: according to Principle 18, "science and technology, as part of their contribution to economic and social development, must be used for the identification, prevention and control of environmental risks and for the solution of environmental problems and for the common good of mankind". And according to Principle 20, "scientific research and development related to environmental problems, both national and multinational, must be encouraged in all countries, especially developing countries", and to this end "the free flow of up-to-date scientific information and the transfer of experience must be encouraged and assisted in order to facilitate the solution of environmental problems" (Declaration on the Human Environment).

The next foundational document in this vein, the 1992 Rio Declaration on Environment and Development, refers to scientific activities in Principle 9, which states that states should cooperate to strengthen national capacities for sustainable development "by improving scientific understanding through the exchange of scientific and technological information and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies" (Rio Declaration on Environment and Development, 13 June 1992).

In this dimension, it is also important to mention the Sustainable Development Goals (SDGs) as the main directions for the development of countries, adopted at the UN Summit on Sustainable Development for the period from 2015 to 2030, which include 17 global goals corresponding to 169 targets. Among these goals, targets 9.5 and 9.6, in particular, aim to promote scientific research, including by promoting innovation activities by 2030 and by significantly increasing the number of people employed in scientific and research and development activities per 1 million people, as well as public and private expenditure on such activities (Sustainable Development Goals).

4. Conclusions and Results

Thus, in the sectoral dimension at the universal level, scientific research has found its regulation mainly in the treaties of international environmental law. These numerous conventions reflect a number of challenges and paradoxes faced by international l aw; first and foremost, the need to address global challenges such as global warming or the spread of genetically modified organisms in a context of limited available and reliable scientific information, while at the same time respecting scientific research and the results already obtained.

A major contradiction is seen in the need to balance scientific research with humanity's practical need to extract relevant biological and mineral resources. Equally important is the challenge of reconciling the need for the exchange and dissemination of scientific data with the confidentiality of scientific information linked to economic and industrial activities or of strategic value to the country concerned.

These challenges intersect with the issue of the legal demarcation between scientific research, which is undoubtedly beneficial to humanity and supported by international law, and the applied form of research, which often contributes to the intensification of resource extraction, pollution or the emergence of new challenges to humanity, such as genetically modified organisms and similar phenomena. This contradiction is seen as one of the reasons for the relatively limited use of the category of "science" in universal conventional acts of international law.

In the procedural context, the sources of international environmental law include the search for a balance in the formation of conventional bodies,

which must reconcile the sovereign interests of the contracting parties with the need to maintain an appropriate level of expertise within the relevant commissions and committees. In addition, environmental conventions have recognised the need for cooperation in scientific activities both at the intergovernmental level and with scientific and research institutions, often of a non-governmental nature. Moreover, virtually all universal instruments of international law establish special interests and preferences for developing countries with respect to scientific research.

5. Further Scientific Inquiries

The further development of relevant normative models and their doctrinal reflection should become the subject of additional scientific research, while the development of corresponding universal international environmental standards should become the basis for new scientific research. The main goal of such further research should be the ways and forms of implementation of the standards of organisation of scientific activity embodied in universal international environmental agreements in the framework of bilateral agreements of Ukraine on environmental protection and organisation of scientific activity, as well as the subsequent reflection of such international standards, mechanisms and requirements in the further development of Ukrainian national legislation.

The relevant subsequent perspectives of systemic scientific research have acquired exceptional importance, taking into account both the existing limitations and, at the same time, the rather extensive variability of the identified bilateral agreements of Ukraine in the field of environmental protection and scientific cooperation. Additionally, the conservatism of current scientific research and the obsolescence of relevant domestic legislation should be noted, both in terms of interaction with international organisations and conventional bodies, and in terms of the supranational dimension of systemic scientific research.

The urgent need for further intensification and systematisation of scientific research and expert work in the corresponding dimension is underlined by the expansion of project activities of relevant conventional bodies and international environmental NGOs in Ukraine. In addition, the institutional strengthening of the presence of specific international institutions investigating aspects of environmental protection, environmental crimes and ecocide in Ukraine under the conditions of massive Russia's aggression has become particularly important.

At the same time, in today's complex conditions, the counteraction to destructive manifestations and provocations of aggressor states and other violators of international law, including the misuse of relevant mechanisms of environmental activities and organisation of scientific cooperation, traced in international structures, acquires special importance. Therefore, the aspects of further improvement of international nature conservation mechanisms to effectively counter such provocations gain special importance.

The further development of doctrinal reflection on the state of affairs regarding international standards of scientific activity in the environmental dimension may also have a corresponding influence on the gradual formation of a scientific basis for the development of specific universal international treaty documents on the systemic regulation of scientific research.

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Received on: 15th of June, 2024
Accepted on: 19th of August, 2024
Published on: 20th of September, 2024