



Legal Support of Environmental Safety with Targeted and Non-Targeted Changes in the Genome of Living Organisms

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Abstract

the paper explores social relations for targeted and non-targeted changes in the genome of living organisms based on the analysis of the work of Russian and foreign geneticists, biochemists, biotechnologists, bioecologists, molecular biologists and microbiologists. Ecological risks from targeted (genetic research, biotechnology, genetic engineering, experimental mutagenesis, genomic selection, etc.) and non-targeted (under the influence of the consequences of the negative impact on the environment) genome changes that are subject to an account upon environmental regulation of corresponding public relations are identified. It is advisable to provide in the legal support of genomic research the incentives (tax incentives, credit incentives, public-private partnerships, etc.) of targeted change in the genome, which allows solving social, economic, food and environmental problems. To prevent environmental risks, it is worthwhile to provide a system of legal prohibitions and restrictions when conducting any genomic research, as well as legal measures, means and methods aimed at protecting the natural environment, ensuring human environmental safety and rational nature management. The expediency of organizing an ecological genetic monitoring and cytogenetic monitoring service to determine the mutagenic potential of the environment has been proved. The analysis of genetic data is recommended to be used when making managerial decisions in the area under consideration.

Keywords: Environmental and legal regulation, Genomic research, Environmental safety, Targeted change in the genome, Non-targeted change in the genome

1 Introduction

In the Strategy for Scientific and Technological Development of the Russian Federation approved by Decree of the President of the Russian Federation No. 642 dated December 1, 2016, the following are among the biggest challenges for society, the state and science:

- An increase in anthropogenic pressures on the environment to a scale that threatens the reproduction of natural resources, and the associated increase in risks to the life and health of citizens associated with their inefficient use;

- The need to ensure food security and food independence of Russia, the competitiveness of domestic products on world food markets, reduction of technological risks in the agricultural sector.

Genomic research is capable of partially solving the identified major problems of social, economic, food, and environmental nature. The forecast of scientific and technological development of the Russian Federation for

the period until 2030, approved by the Government of the Russian Federation, indicates that the prospects for the development of biotechnologies determine such challenges as preventing biodiversity loss; climate change and scarcity of agricultural land; urbanization and increasing pressure on the environment; distribution of genetically modified foods.

The above Forecast also draws attention to the dependence of the intensive development of genomic, proteomic and postgenomic technologies on the need to ensure food security; preservation of resource potential; countering the spread of various types of diseases of humans and animals; obtaining biomaterials from renewable raw materials to replace traditional industries and the emergence of new products with unique properties; restoration of rare and endangered species of flora and fauna; conservation of biological resources of the oceans and many other circumstances. Recently, research has been actively conducted in the field of high-performance genome analysis methods, bioinformatics methods for processing genomic analysis data, regulating genome expression, genomic biomarkers, etc.

The purpose of this work: to identify the features of the legal support of environmental safety with a targeted and

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non-targeted change in the genome of living organisms.

2 Materials and Methods

The identification of the peculiarity's characteristic to the legal provision of environmental safety with targeted and non-targeted changes in the genome of living organisms was based on an analysis of Russian political and legal documents and the works of various geneticists, biochemists, biotechnologists, bioecologists, molecular biologists and microbiologists (*M. Asad, J.C. Avise, K. Dearfield, H.M. Kim, P. Nyman, N.J. Ouborg, C.S. Riesenfeld, J. Robinson, Stepanauskas R., et al.*). Our studies devoted to the developments of scientists of natural sciences in genomic research made it possible for us to formulate proposals for the legal support of the corresponding block of public relations.

The methodological basis of the study was the dialectical method which made it possible to learn in indissoluble unity and in a general connection the peculiarities of the legal provision of environmental safety with a targeted and non-targeted change in the genome of living organisms. The achievement of the goal set in the introduction was also promoted by logical methods in the form of analysis and synthesis, induction and deduction, comparison and generalization, analogy and typology. The formal legal technique helped to clarify the significance of the proposed new laws aimed at ensuring environmental safety in conducting relevant genomic research.

3 Results

We believe that the legal provision of environmental safety in carrying out genomic research should be based on the separation of relations concerning genomic research depending on targeted and non-targeted changes in the genome. The specified classification basis takes into account the specifics of the object and the subject of environmental legal relations in the field of genomic research.

Non-targeted genome change does not depend directly on the will of people but occurs under the influence of the consequences of a negative impact on the natural environment. So, it has been proved by applied scientists that environmental pollution poses a threat to the stability of the biota genome and the human genome. This circumstance necessitates studying the mechanisms of mutagenicity of various pollutants and conducting population-genetic studies to assess their real risk to the population and ecological systems (1, 2) with subsequent legal "registration" of the relevant relations.

Of no less importance are the genotoxic contaminant bioindication capacities and the study of the effects from contaminants at the genomic level. For example, cytogenetic disorders (the frequency of hypo- and hyperdiploid cells and chromosomal aberrations) can be used as a bioindicator of environmental pollution (3-5). Subsequently, such bioindication can be recognized as a legal criterion for the "favourableness" of the natural environment or ecological safety of humans.

A purposeful change in the genome of a living

organism (biotechnology, genetic engineering, experimental mutagenesis, genomic selection, etc.) can affect natural patterns, processes, and phenomena, especially when it comes to environmental genomics (population ecogenomics, community genomics, landscape genomics, etc.). Manipulations with the genomes of viruses and phages can pose an even greater danger to biota. These circumstances should be the basis for the environmental and legal regulation of genomic research.

It is necessary to take into account the constant rapid development of molecular biology. New interconnected disciplines appear, including genomics, proteomics, transcriptomics, etc. New relations are emerging that require independent legal interpretation, especially from the standpoint of natural resource, agricultural and environmental legislation as a legal framework for environmental and food security.

Thus, a rather large block of diverse relations arises, covering the field of genomic research, which require their legalisation. At the same time, it should be thought out and taken into account that there are many environmental risks in addition to the significant advantages of biotechnologies for various segments of the economy, human social security, and environmental safety.

The development of a legal concept for the impact on participants in relations in the field of genomic research should be based on a legal assessment of the occurrence of adverse environmental consequences. Legal measures, means and methods of biological and physical protection during genomic research need a separate study, as well as the ability of the latter to serve for an assessment of the genetic consequences of environmental pollution.

4 Discussion

The most neighbouring area of genomics and ecology is environmental genomics, which includes a whole range of environmental genetic disciplines: landscape genomics, population ecogenomics, community genomics, nature protection genomics, toxicogenomics, ecological epigenomics, symbiogenetics, speciation ecogenomics, etc. Beyond the environmental genomics there are only applied disciplines exploring the ecological aspects of biomedical and agricultural genomics, with the area of intersection with the considered relations.

Ecological genomics is aimed at studying the structure and functioning of the genome in order to gain an understanding of the relationship between the body and its biotic and abiotic environment (6). Landscape genomics studies the effect of landscape variables on genomic and genic flows and other microevolutionary processes that determine the genetic coherence and variability of populations (7, 8, 28). The focus of population ecogenomics is the gene pool of populations and its change both in space and in time (9). Community genomics is focused on genomics and genetics of species interactions and their environmental and evolutionary consequences (10). Nature protection genomics studies small isolated populations that are threatened by a decrease in genetic diversity resulting from genetic drift and inbreeding (11, 12, 26, 27). The given scientific directions of ecogenomics partially demonstrate a wide range of relations on genomic

research in the field of environmental protection, ensuring human environmental safety and rational nature management.

E.Ya. Tetushkin developed approaches and software tools for the joint analysis of genomic and landscape variables, allowing those genomic regions to detect that affect adaptation, which facilitates the planning of environmental measures and the prediction of the fate of biological species with the predicted changes in the environment. For a joint analysis of genomic, environmental, and landscape variables as such, a special network platform was created as part of the GEOME project, the purpose of which is to facilitate research in the field of landscape genomics (8). These circumstances serve as evidence of the need for analysis of genomic data to make managerial decisions in the field of nature conservation, ensuring human environmental safety and rational nature management.

Scientists from the Republic of Kazakhstan studied the patterns of accumulation and migration of oil products and heavy metals in the environment and in the body of test objects, as well as the induction of mutagenic changes at the subcellular level (chromosomal abnormalities), and their effect on the stability of the genome of natural populations (13,29,30). The results of this study are theoretically significant for the mechanisms of formation of chromosomal mutations induced by environmental factors (as the basis for preserving the gene pools of natural populations for the sustainable development of ecosystems), and practically for the legal organization of the natural environment genetic monitoring and cytogenetic monitoring service to determine environmental mutagenic potential.

Environmental geneticists associate genomic manipulation with the ecological plasticity of crops. Thus, a study of the molecular structure of genes that control the synthesis of storage proteins and their organization on the chromosomes, as well as the structure of the common wheat genome have revealed the molecular mechanisms of the genome's variability and its reorganization in response to a sharp change in living conditions and cultivation technologies (14,31). Therefore, the change in the state of the natural genomes of various types of agricultural plants after the introduction of foreign genes is aimed at improving the quality and quantity of the resulting crops. However, legal regulation should take into account that changes in the genomes of agricultural species in order to increase biodiversity can adversely affect the development of plant and animal communities.

In the field of experimental mutagenesis, a number of foreign scientists have proved that small doses of mutagen concentrations are more effective and efficient in causing polygenic variability (15-17). The effect of small doses of mutagens is also one of the components involved in the problem of the mutagenic hazard of environmental pollution since the effects of the exposure to micro amounts of chemical compounds on the microbial population, higher plants, animals, and humans remain unknown (18,25). Therefore, the right regulation of experimental mutagenesis should be based on a balance of socially beneficial effect and possible adverse environmental consequences,

especially as a result of varying the dose volume of mutagens.

Metagenomics is recognised as one of the areas of ecological genomics. It involves DNA analysis of the studied microbial community (19,21,22). The advantage of metagenomics is its universal applicability to the analysis of any community from which the necessary amount of DNA can be isolated. The method of genome sequencing of a single cell genome, which allows analysing the genome of an individual strain of a microorganism, is recognized as a certain "antipode" to metagenomics methods (20,23,24). Therefore, the legal regulation of metagenomic research should be based on the sustainability of communities of living organisms.

5 Summary

Legal support of environmental safety during genomic research should be carried out along the delineation of social relations associated with targeted and non-targeted changes in the genome of living organisms. The distinguished public relations are characterized by a significant specificity, which should be taken into account when developing environmental and legal regulation.

In the legal support of genomic research, it is advisable to provide legal incentives (tax incentives, credit incentives, public-private partnerships, etc.) of all the positive and useful characteristics of the relevant relationships identified above. For environmental risks already identified, as well as those discovered later, it is worthwhile to provide for a system of legal prohibitions and restrictions, as well as legal measures, means and methods aimed at protecting the natural environment, maintaining human environmental safety and rational nature management. In addition, the analysis of genetic data must be used when making managerial decisions in this area.

6 Conclusion

The development of genomic, proteomic and postgenomic technologies is necessary to solve social, economic, food and environmental problems. At the same time, it is important by legal means to ensure the optimal balance between the positive effect of genomic achievements and the possible negative impact of genetic modifications on humans and the natural environment.

Conflict Of Interest

The author confirms that the data presented do not contain a conflict of interest.

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