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GREAT EXTINCTIONS PLACE IN THE NEW ECOLOGICAL PARADIGM

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У статті показано важливість знання щодо причин та наслідків Великих вимирань у формуванні нової екологічної парадигми. Описано методологічні засади палеоекологічних досліджень. Проаналізовано скам'янілі рештки, знайдені безпосередньо авторами на теренах України.

***Ключові слова**: палеоекологія, вимирання, парадигма, екологічна катастрофа.*

Introduction

The outstanding characteristic of the twentieth century is to recognize it as an era of ecological crisis (environmental disaster). Ecocatastrophical effects become ominous axioms of time but the statement itself is not enough for changes to better life. They encourage reflecting upon the further evolution of humanity, finding ways to overcome crises etc.

Fiction writers described the many horrific pictures of "life" after life death, imaging industrial and intellectual development of mankind, excessive human intervention in nature as the reasons for such death. But not only man is responsible for environmental crisis. Some causes of environmental disaster lie in the time dimension of so-called natural geophysical processes that occur on Earth, regardless of the mankind.

Researchers were always interested in past, present and future of the Earth. Researchers looking for answers to the question: how the Earth was formed? Why did some animals die out and the others appear? What caused the extinction of animals? Not knowing the past, we cannot predict the future. Examining the processes that occurred millions of years ago is necessary to know and explain the processes occurring today.

Attempts to determine the causes of the ecological crisis, which were not directly related to human activities, comprise *the relevance of the research topic.*

The purpose of this study is to analyze the causes and consequences of the Great extinctions, to determine their place in the new environmental paradigm.

Data analysis and publications

At the end of the twentieth century, a new ecological paradigm appeared which was formulated in contrast to the paradigm of human exclusivity [1, p. 20]. Distinctive features of the new paradigm are the recognition: of technological progress but it warns against unlimited faith in him, that people are the species with a special place among others but it is still one among other types of mutually dependent beings; severe attention to biophysical factors of human activity [1, p. 21]. As can be seen, the modern study of environmental problems is concentrated upon the impact of various factors of human activity on the natural ecosystem relationships and the biosphere as a whole. The time when mankind did not exist became beyond the subject of environmental issues in general.

Deterioration of environmental issues actualized researches in various scientific areas. The relatively new branches of science that are actively developing today are environmental geology and paleoecology. Environmental geology is the science of geological cycle studying the ecological system of the lithosphere, the laws of its formation and spatio-temporal changes under the influence of natural and anthropogenic factors due to biota activity and first of all the man who is named the geological environment.

Paleoecology can be defined as a part of environmental geology. The subject of its research is the relationship between living organisms and environment in the past, before the times of appearance of man on the Earth.

It is the most detailed model construction of possible environment of living organisms still found today as fossils that will take into account the complex links between environmental factors such as temperature, food, and the degree of sunlight. Paleoecological study is also useful for understanding the dynamics of ecosystems changes and to recover the former industrialized ecosystems.

As was shown by I. Bogdanov, the "paleoecology" notion is almost never used in scientific community [2]. But it is not true.

V.A. Kovalevsky began the first researches in this area in 70th of XIX century. As another example, Hecker R.F. published the book “Instructions on paleoecology researches” in 1954 [3].

Methodological foundations for Great extinctions causes analysis

Fossils of geological past were not a new subject of scientific study. It was French naturalist J.L. Cuvier who formulated exploring animal fossils of the Paris Basin in the nineteenth century the principles of catastrophe theory, according to which each geological period had its fauna and flora and ended with a huge upheaval, disaster, during which everything on earth was died and the new living world arose through a new creative act.

The "disaster" and "catastrophe theory" notions were introduced by R. Tom and K. Ziman in the late 1960s and early 1970s ("catastrophe" in this context means a sharp qualitative change in an object with a smooth change of quantitative parameters of which it depends).

Catastrophe theory in a slightly different interpretation can be transformed onto modern human life, for example, the ecological crisis. Large extinctions itself are ecological crises that were not caused by technogenic factors. Large extinction is the result of a single natural-historical process. According to M. Rutten, now the Earth is in sufficiently stable state and causes of the past catastrophes have no influence [4, p. 22].

Catastrophism postulates fundamental differences between present and past, i.e. before and after the disaster.

There is another theory, which is almost impossible to distinguish with catastrophism. It is actualism. Actualism (uniformism) methodology includes the principle of equivalence of geological processes and states. Processes that we see now are the same as they were in the distant geological times. It means that direct scientific results of modern geological processes studying are applicable to events that took place on our planet hundreds of millions and billions of years ago.

Disclaim against catastrophism ideas was not final. It was partially revived in the form of so-called neocatastrofism in the first half of the twentieth century. Neocatastrophism was formulated as an idea of simultaneous folding phases and orogenesis throughout the world, interrupting a long period of relatively slow evolution of the Earth crust.

Causes of the Great extinctions

Namely man-made not natural factors suppose to lead to the modern warming. However, nobody has been able to quantify the impact of anthropogenic factors on the ecosystem of our planet clearly yet. Carbon dioxide content is higher in urban areas due to transport than in the Earth's atmosphere in general. All transport emissions throughout the world are not so large to exert a major influence on the atmosphere composition. It should be kept in mind that the exchange of carbon dioxide between the atmosphere and the oceans is by several orders of magnitude higher than emissions of this gas in the atmosphere due to human activities. Of course, man-made human impact on the environment takes place and will increase over time, but humanity even concentrated on man-made activities is not able to change the Earth's climate [5].

At the end of the Paleozoic era (300-270 million years ago) during the transition from long-term glaciel to global warming on Earth, CO_2 content in the atmosphere was approximately equal to the present at the beginning and then was increased by 10 times. With temperature growth the nature of terrestrial vegetation in the tropics was changed. It became more drought resistant. Analysis of the events that took place in that distant era may be useful in predicting the situation in the future. If humanity will burn all available fossil fuels, CO_2 content in the atmosphere will rise from the current 0.036% to 0.2% which is about the level of the end Paleozoic era [6].

Age-related variations in the geomagnetic field (field inversions and excursions), "control" sometimes the appearance of a sudden warming, as well as the stages of abrupt changes in biological evolution of the Earth.

Throughout the history of the Earth geomagnetic field repeatedly changed its polarity. The polarity inversion led to sections of sedimentary and volcanic strata dissected by alternating zones of forward and reverses magnetization. There were times when inversions occur several times per million years, but there were also long periods of "calm" when tens of millions of years magnetic field retained its polarity [7].

The hypothesis of a strong effect of inversion of the Earth's magnetic field on the development of organic life, especially at the times of a catastrophic global extinction was proposed back to the 60s of the twentieth century [8]. The biota evolution was associated with the destruction of the magnetic

screen, a sharp increase in radiation at the moment of inversion and the direct mutagenic effect of the weakened magnetic field.

Of particular relevance these researches acquired in recent years, when scientific papers on the future inversion of the geomagnetic field have been published. It is possible that inversion can occur during the life of the next generations and will be a disaster for human civilization. In particular, a few years ago the Canadian popular science magazine «Discovery» compiled a list of the twenty greatest dangers where inversion took sixth place [9].

Development of catastrophism showed the important influence of space on the life evolution, one manifestation of which the periodic bombardment of the Earth by large meteorites should be considered. Even rhythm of this phenomenon was shown: repeatitive "great cosmic bombardment" was fixed every 26 million years for Meso-Cenozoic eras.

According to the modern theory of the planets, the following stages of the Earth formation can be defined schematically. The first stage is the formation of the Earth as a planet accompanied by falling asteroids and meteorites (about 100 million years).

At first, the Earth was heated. A layer where the rocks were molten was at the depth of several tens of kilometers. These melts poured out on the earth's surface. Thus, the stage of "bombardment" of the Earth was changed to a long time stage of almost continuous volcanic eruptions, which formed the original crust. The second or geological stage of the Earth evolution started since that time.

Geologists and geophysicists are in fierce debates about causes of separation of continents by oceans. It is the formation of the continents from supercontinent Monogea (~2.5 billion y.a.) was the third stage of the Earth development, which to some extent continues even now, as evidenced by the different types of tectonic movements on the continents. However, the Earth entered into the fourth stage of evolution that can rightfully be called oceanic apparently from the Paleozoic era, approximately 0,5-0,3 billion y. a. The most important feature of this stage of life on our planet is the destroy of a powerful continental crust and turning it into a thin (5-7 km) oceanic.

Thus, the causes of Great extinctions were: 1) changes in physico-chemical properties of the Earth's atmosphere, 2) changes in the magnetic field of the Earth, magnetic poles on Earth, 3) geological activity of the crust - tectonics of lithospheric plates, and 4) the effect of cosmic processes and bodies. Each of these reasons together or separately contributed to the fact that even before the time of the appearance of man, flora and fauna of the Earth was significantly and drastically changed.

General characteristics of the so-called Great extinctions

Large extinctions are catastrophic processes that accompanied by a significant decrease in populations of living beings on the planet.

It is known that the first living organisms appeared about 3.8 billion y.a. This was archeae and cyaenobacteria that were prokaryotes. About 2.5 billion y.a. appeared the first eukaryotes.

Extinctions when the degree of evolution was very low, not as noticeable as the extinctions of macrofauna, which appear only about 600 million y.a. When there was almost no predation, another "risk factor" was minimal – it was no competition with more advanced organisms. This factor will play a major role in the next mass extinctions of macrofauna.

The first so-called macrofaunistical extinction was extinction of vendobionts (advanced multicellular organisms) that existed in ediakar 600 million years ago, all of them died without descendants, but it is believed that some of them gave rise to modern Metazoa groups.

After the so-called Cambrian biological explosion, life on Earth has changed. For the first time there was a competition - it has increased with the increase in the number of animal species. There was also predation, some species began to eat other metazoans of that time when they were without other food.

In general, one can specify two types of extinctions: *local*, when only a small number of populations in a particular territory die and *mass extinctions* when all or almost all representatives of many taxa throughout the world die.

In addition to the above mentioned reasons of catastrophic extinctions, there were also biological reasons — species competition — natural selection and evolution.

One can define the following mass extinctions in the Phanerozoic eon: 1) arheocyatha on the border of earlier and middle Cambrian (509-490 million y.a.), 2) ancient invertebrates between Ordovician and Silurian (443 million y.a.), 3) reduced diversity of trilobites, graptolites, echinoderms, tabulata, nautiloids on the edge of the Silurian and Devonian (418 million y.a.), 4) the reduced diversity of

graptolites, seascorpions, trilobites, nautiloid at the edge of the Devonian and Carboniferous (360 million y.a.), 5) Fusulinida, trilobites, tabulata, tetracorals, almost all Paleozoic brachiopods, Goniotitida, nautiloids with straight shells, ancient sea urchins and ancient crinoids, Paleozoic fish, Pteridospermatophyta, kordaits at the edge of the Permian and Triassic (251 million years ago), 6) conodonts became extinct along with many Paleozoic relics at the edge of the Triassic and Jurassic (200 million y.a.), 7) rudists, ammonites, belemnites, Inoceramids, dinosaurs, Globotrunkanida (foraminifera) at the edge of Paleogene and Cretaceous (65 million y.a.).

The causes of some extinctions can be mentioned. There are two versions about the causes of ordovician extinction. The first is that the gamma-ray burst was far away in space attended by a series of disasters from climate change to increasing the strength of hurricanes and falling temperatures to form glaciers. But there is no evidence that something like that was happen. The leading hypothesis among scientists is the hypothesis of volcanic activity growth, which led to the same results.

Permian extinction is supposed to be the strongest. According to the recent estimates, about 65% of all families on Earth were died. The reasons were, most likely, volcanic eruptions, called the Siberian trapps. The most of synapsyda, labiryntodonta, on land and trilobites, baktrytoidea, and lots of fish in seas were died.

Triassic extinction was probably caused by geological events that the Eurasian and North American tectonic plates were flow out. Synapsyds all became extinct, and labiryntodonts with Orthoceratids too.

The most famous of the five extinctions is a time when dinosaurs became extinct (Cretaceous extinction). There is no compromise among scientists about the causes of this extinction. One of the popular hypotheses is impact one is considered, i.e. when a large asteroid fell on earth and caused a series of disasters such as earthquakes and acid rains. But there is a problem that impact hypothesis could explain only partially the extinction of dinosaurs and marine and flying reptiles, but not could not explain extinction of ammonites, many bivalves and plankton groups. So perhaps it would be more correct to assume that this extinction was caused by a gradual change of biomes.

Some role in vertebrate extinction at the end of the Cretaceous period played cooling and the associated calcium deficiency, productive biomes fall due to changes in atmospheric composition. Crisis of terrestrial biomes (including freshwater), which began 50 million years before the Cretaceous extinction was the driving force of this extinction. This influenced on life on land further.

The study of Mesozoic environmental crisis is useful for understanding the current trends in the biosphere, as there are many relics such as cockroaches and many more now. All this is reminiscent of the situation of mid-Cretaceous period.

Evidences of large extinctions in the territory of Ukraine

Among the variety of organisms that lived in the past only a small part was preserved in a fossil state. Ukraine is not exception. Unfortunately, information on known paleontological findings is fragmentary and incomplete. There are virtually no referrals, review papers devoted to the study of the prehistoric world of Ukraine as a whole.

Generally fossils found on the territory of Ukraine correspond to findings in other countries. However, there are exceptions. One such exception is *Nemiana simplex*, whose fossils were found in Ukraine by Ukrainian scientist. For later times (Pleistocene) many fossils of hairy rhinoceros and mammoth were found in Ukraine.

Despite the limited data on prehistoric life forms on the territory of our country, Ukraine prehistoric world is very interesting and requires further study.

Almost everyone who was in Kiev was at the “University” metro station and saw the busts of eminent scientists, but few have pointed out that polished slice of ammonite shells unmarked under the bust A.M. Gorky.

Kiev land is also rich in fossils. Even fossilized shark teeth, bones of mammoths and more can be found on the banks of the Dnieper. Kyiv region has always attracted the attention of geologists.

Kiev Dnieper region is a stratotypical area for Kiev worlds in general, Kiev regiostage middle Eocene Dnieper-Donets depression Northern Ukraine.

The territory of Kyiv is located in the marginal zone of major geological structural units of Ukraine the Dnieper-Donets basin on its south-western slope, where the depth of the crystalline fundament of the depression is about 500 m

Near the “Pozniaky” metro station in Kiev there is a part of the alluvial sand prepared for further building. The sand from the bottom of the Dnieper

and lakes mixed in time, is a paradise for paleontologists. People called this place Kiev Sahara. Kiev Sahara is quite large. In its central part, where there was a lake on the horizon barely visible buildings and trees, as befits a desert. This desert is full of fossilized remains of sharks as well as mammals.

Authors found many fossils, including shark teeth on the alluvial sands of Kyiv [10]. It is very strange at first sight. Since the mainstream of the Dnieper was formed in the Quaternary period (~ 12 thousand y. a.), and fossils belong to animals that existed in Paleogene (55-35 million y. a.). However, this fact can be explained by blurring the Dnieper River waters of Paleogene sediments which met on her way to form incoherent sediments of constant water flow - alluvium. In addition, the presence among the fossils remains of marine bony fishes and sharks indicates that during the Paleogene the territory of Kyiv was the sea. The remains of animals (solitary corals tetracorals, crinoidea, bryozoa, brachiopods, etc.), which could not exist in Kyiv during Paleogene, were also found in alluvial sands. These deposits may have been introduced from Moscow syneclise by glacier - morainic deposits.

Unfortunately, there are no internationally recognized stratotypical cuts, which help to define the absolute age of rocks falling at the edge between periods, epochs, tiers (so-called golden nail) in Ukraine. However, there are evidencea of extinctions, including the Podillya and the Crimea. Maastricht Crimea is very diverse: in chalk and limestone deposits there are many fossils - nautilid, fish, bivalves, marine reptiles etc., so all the typical marine fauna during the Cretaceous mass extinction. Also, it is interesting to note that the difference between Maastricht and Paleocene sediments is negligible. It lies mainly in the absence of marine reptiles and ammonites in Paleocene.

Sediments of earlier Paleozoic era (Silurian and Devonian periods) are very common in the Podillya region. The significant differences between fauna of these periods confirm the change (extinction) of some species because there was regression of the sea. In some places (Ternopil region) fauna of the upper Silurian and Lower Devonian is the same with typical composition: Orthoceratida, brachiopods and rare corals. In others (e.g. Kamenetz-Podilsky region)it is opposite: upper Silurian - coral reefs, rare brachiopods and cephalopods, and bottom devonian - almost exclusively fish. Thus, even in a minor scale extinctions in the territory of Ukraine significant fauna differences are observed.

Conclusions

The man is able to prevent a catastrophe, but it can also cause it. Therefore, in-depth and comprehensive study of natural phenomena in their complex relationship is one of the main research directions. To manage nature properly, one must know it well.

The results obtained have both practical and theoretical importance. The mastery of causes of environmental disasters that have occurred before the time of appearance of man can be used in the interpretation of the causes of the current environmental crisis and the development of the general concept ecologism. Knowledge about the Great extinctions (knowledge of the past) must be taken into account in the development of new environmental paradigm, because it is an event and push for the knowledge about the present and the knowledge about the future.

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МЕСТО ВЕЛИКИХ ВЫМИРАНИЙ В НОВОЙ ЭКОЛОГИЧЕСКОЙ ПАРАДИГМЕ

В статье показана важность знания о причинах и последствиях Великих вымираний, которые произошли еще до возникновения человека, в формировании новой экологической парадигмы. Описаны методологические основы палеоэкологических исследований. Проанализированы окаменелые останки, найденные непосредственно авторами на территории Украины. В разработке новой экологической парадигмы нужно учитывать знания о Великих вымираниях (знание о прошлом), поскольку оно является событием и толчком для знания о настоящем и знания о будущем.

Ключевые слова: палеоэкология, вымирание, парадигма, экологическая катастрофа.

PLACE OF GREAT EXTINCTIONS IN THE NEW ECOLOGICAL PARADIGM

The paper demonstrates importance of the knowledge of the causes and consequences of the Great extinctions that occurred before the origin of man, in the formation of a new environmental paradigm. Were described methodological foundations of paleoecological studies. Were analyzed the fossilized remains found directly by the authors on the territory of Ukraine. In the development of new environmental paradigm is necessary to consider knowledge of the great extinction (the knowledge of the past), because it is an event, that can be used not only to study past, as well as predicting the same events in the future.

Keywords: paleoecology, extinction paradigm, an environmental disaster.