

The Role of Paleontology in the Formation of Scientific World-View

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Abstract Paleontology is the key for getting the knowledge about the history of our planet. Only fossils are the evidences of the origin and long evolution of life on the Earth. Nevertheless, many anti-evolutional theories reappear today as well as at the dawn of scientific cognition of the world. Mass media may be unwittingly promoting those ideas into the social consciousness. The views of catastrophic extinction of some fossil groups recently have become very popular again. In addition, apologists of the catastrophic explanations of extinction ignore many factors of intricate relationships into a biocenosis. The main factors that should be taking into consideration are a protracted period of extinction of any taxonomic group and a selectivity of extinction. Those data contradict the catastrophic ideas in the evolution theory. The main task of the paleontologists is to advocate more profound study of Earth history and the reality of life's evolution on it. Most of the macroevolution's consistent patterns were established after obtaining paleontological data. And now we can demonstrate them on many fossils groups. In this report, we discuss the evolutionary path of Paleozoic foraminifera.

Keywords: *paleontology, evolution, extinction, Fusulinoida, education.*

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1. Introduction

Paleontology is the science about ancient life on the Earth in the long-gone epochs. Nevertheless, it is capable to influence on formation of modern people's world-views who live in a century of high technologies. Without knowledge about the process of origin and development of life on the Earth is impossible to answer fundamental questions about the nature of a human and his place in the surrounding world.

Ideological role of paleontology is caused by its historical essence. Study of geological and biological components is a twin-track process of the knowledge of the history of the Earth, and paleontology acts as a chronicle of evolutionary events, imprinted in fossils. Decryption of these events depends largely on the philosophical position of the researcher. "Natural scientists may adopt whatever attitude they please, they will still be under the domination of philosophy" [1].

In spite of the fact that paleontology studies the past, mostly extinct life forms, it stays actual and modern area of knowledge. In many respects, the media fuel interest in paleontology, particularly in recent years. Scientific-popular films are demonstrated, spectacular show on paleontological motives are created. Life and extinction of giant Mesozoic reptiles are shown particularly impressive. The popularization of paleontological knowledge can only be welcomed. Often, however, in the pursuit of effectiveness those «paleontological shows» are attributed

with incorrect interpretations of the scientific facts. Therefore, the formation of the natural historical outlook in society, which would have contributed to a critical perception by the man of the propagating information, is an urgent task in the sphere of education.

Paleontological data indicate multiple crisis events in the long history of the Earth. Biotic crises events were accompanied by mass extinction of organisms [2]. Scientific interpretation of these events and popularization of the received knowledge is an important task for paleontologists. The purpose of this article is to show and give scientific explanation of the event of the mass extinction at the Paleozoic - Mesozoic boundary on the example of one particular group of organisms, namely the superorder Fusulinoida.

The study of the paleontological objects and their theoretical interpretation finds its reflection in different spheres of knowledge, the main of which: geology, evolution and ecology. Thus, paleontology is an integral part of natural science and influences on formation of scientific look at the surrounding world in our society.

2. Relation between Paleontology and other Natural Sciences

2.1. Paleontology and Geology

Geology studies the processes on the Earth since its formation as a planet. The concept of time was included in Geology with the establishment of Nikolaus Steno the

principle of consistency strata of rocks in 1669 (Steno's principle of superposition). Establishment of the paleontological method in the end of 18th and the beginning of the 19th century played a crucial role in the development of Geology as a historical science. Modern scientific methods set the age of the Earth are about 4.5 billion years [3]. Paleontological method to establish the chronology of the evolution of the Earth is used mainly for the Phanerozoic, although the process of accumulation of knowledge penetrates gradually in earlier epochs. The establishment of the long history of existence of the Earth and life on it is one of the main provisions in Geology, against which aimed the anti-evolutionary concept of the Earth's creation about 6-7 thousand years ago. Incredible, but in the 21st century we are increasingly confronted with the fact that apologists are trying to introduce the Christian myths about the young age of the Earth in the consciousness of people [4].

Significance of paleontology for the Geology is not limited to the issues of geochronology. Its data are used to build global geodynamic reconstructions. Paleontological evidence served in the early 20th century to substantiate the hypothesis of Alfred Wegener on the movement of the continents, which at this time has grown in the scientific theory of tectonics of lithospheric plates [5]. None of the reconstruction of the geological history, as the local area, and the Earth as a whole is impossible without the paleontological data [6].

2.2. Paleontology and Evolution

Ideological role of paleontology is caused by the fact that the paleontological remains are material reflection of the evolution of the organic world. Only paleontology in virtue of its historicity allows to understand and to reconstruct macroevolutionary processes that are inaccessible to direct observation. Paleontological studies allow us to outline the phylogenetic relationships of different taxa and identify the key moments in the evolution, associated with the general geological processes taking place on Earth.

More than 150 years ago Charles Darwin published his book "On the origin of species", which became the base of scientific evolution theory. The most important thing here is the fact that there have been active discussions around the theory of evolution beginning from the time when it appeared and till nowadays. Furthermore, the actions undertaken by so-called "anti-Darwinists" became even more intensive at present.

The first public anti-evolution campaign took place in 1925 in the USA. Now it is known as "Monkey's Trial" [7]. Since then some similar Anti-Darwinistic performances happen regularly in different countries, including Russia. In 2006 in Russia, a fifteen-year-old pupil from Saint Petersburg and her father brought an action against the Ministry of Education and Science because they did not want to admit the fact that modern school textbooks on biology present only the theory of evolution, which, as they said, was incompatible with their real beliefs [8]. All such actions are a form of propagating religion for making influence on people's outlook. Some people call for creationist theories to be taught in European schools alongside or even instead of the theory of evolution. Creationists use some disputable points of

the evolution theory for negating the phenomenon of evolution itself. A favorite argument of the anti-evolutionists is the denial of transitional forms in the fossil record. There are numerous significant research and paleontological evidence of evolution [9,10]. Deny knowledge obtained by many generations of paleontologists is possible by adhering to the anti-evolutionary concept in principle.

Indirectness of knowledge of evolution is the cause of the inconsistency of the proposed hypotheses, establishing regularities in the evolution of up to its complete denial. The recognition of the role of global catastrophes in the mass extinctions of organisms received particularly popular in recent times. Palaeontological data provide clear proof of the evolution of species in the course of time. Fossils are the preserved remains of the organisms, which lived a long time ago. They enable us to reconstruct the history of life on the Earth.

2.3. Paleontology and Ecology

XXI century is the century of steadfast attention to ecology. Environmental problems are discussed at all levels, from the everyday narrow-minded to the international political and scientific. In addition, the problems are of a different order, from the ecological situation of a nearby water body or the forest to the situation of the environment in general on the planet Earth.

Ecologic crises, obviously, there are moments in a mismatch in the sustainability of the system «organism - environment». There are diverse and ambiguous reasons for these mismatches. Recently, the emphasis is on anthropogenic and technogenic impact on the environment, responsible for the ecologic crises. This approach is justified and necessary in the formulation and solving the issues of protection of the nature. However, it does not cover the whole spectrum of problems.

The history of Earth and life on it presents irrefutable evidence of repeated demonstrations of geological and biotic events, which can be considered as ecological crises long before the appearance of man. Thus, there is a possibility, eliminating anthropogenic factor, follow the whole process of emergence, development and consequences of ecological crisis in the history of the Earth. No doubt, this knowledge about the interaction of Geosphere and Biosphere will contribute to the assessment of modern condition of ecological environment and the development of the strategy of the behavior of the human society on the planet. Detection of violations of phylogenesis, gives an idea about biosphere crises in the past. These facts may be used for the global forecast the reaction of the biosphere in response to the impact of human activities in the present time [11].

The problems of mass extinction of organisms in the periods of the environmental crisis in the history of the Earth are interested in both experts, and the simply curious and thoughtful people. Probably, the most impressive event in the history of the Earth was the extinction of giant Mesozoic reptiles. However, the significance of this event exaggerated purely external effect of the imagination. From a scientific point of view, the problems of extinction of even the simplest single-celled organisms are not less complicated and interesting. Moreover, the size of the events of the mass extinction at the end of the Paleozoic

after quantitative characteristics of biodiversity decline was even greater than Late Mesozoic.

3. A Brief History of the Evolution and Extinction of Fusulinoida

Superorder Fusulinoida is the leading group of Late Paleozoic Foraminifera. The large number of fossils and their wide geographical distribution allowed scientists to analyze some general patterns of evolution. The range of almost 95 million years was the time of existence of Fusulinoida. They appeared in the period of early Carboniferous and existed till the end of Late Permian. The high rates of evolution superorder Fusulinoida typical of the time of their existence led to the formation of 6 orders, more than 180 genera and nearly 2,500 species. Fusulinoida are used for developing the detailed Carboniferous and Permian biostratigraphic scales. Figure 1 shows the phylogenic scheme of the superorder Fusulinoida.

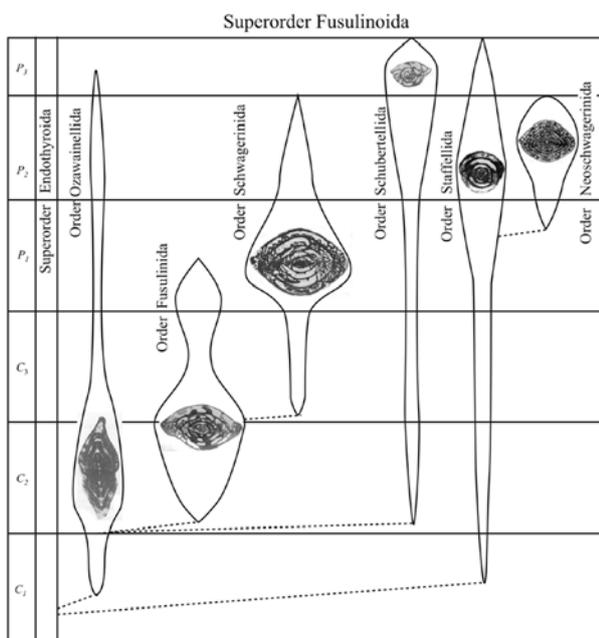


Figure 1. The historical development of the superorder Fusulinoida

In the Late Paleozoic foraminifers, including Fusulinoida, were the inhabitants of marine shallow-shelf and epicontinental seas. They were a part of benthic community, together with other groups of invertebrate organisms, which are dominated by brachiopods, crinoids, corals and bryozoans. The integral parts of these communities were algae, which enriched water with oxygen necessary for vital functions of organisms of the animal kingdom. Controlling abiotic factors of geographical distribution and evolutionary transformations of the shells of foraminifera included the following: the depth of the basin, the character of the ground, hydrodynamic conditions, temperature and hydrochemical composition of water. The dynamics of change of some other taxa can be easily traced throughout the history of existence of Fusulinoida.

Despite of the diversity and extraordinary evolutionary plasticity, Fusulinoida have extinct completely by the end of the Permian epoch. However, some groups of the

foraminifera (Lagenoida, Milioloida), appeared in late Paleozoic, survived this critical boundary and gave a new outbreak of speciation in the Mesozoic era. Obviously, the causes of the extinction of the Fusulinoida should be sought not only in the geological cataclysms, but also in the laws of evolutionary process.

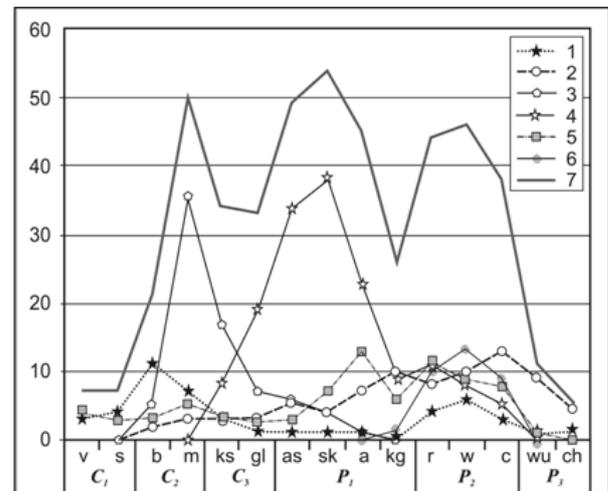


Figure 2. Dynamics of generic diversity of Fusulinoida. Orders: 1 – Ozawaneliida; 2 – Schubertelliida; 3 – Fusulinida; 4 – Schwagerinida; 5 – Staffelliida; 6 – Neoschwagerinida. Superorder Fusulinoida – 7

The analysis of the dynamics of Fusulinoida biodiversity at the genera level allowed allocating phases of the making, flourishing and decline of the phylogenetic development of the superorder [12]. Results of the quantitative analysis of a biodiversity Fusulinoida are presented in the graphic form at the Figure 2. At carrying out of these researches there is accepted the classification of superorder Fusulinoida developed in the end of the XX century by the leading micro paleontologists of Russia [13].

The analysis of the received schedules allows seeing "a scenario" of Fusulinoida development history. The schedule of change of genera number represents a curve with three peaks, approximately equal, but various under the qualitative maintenance. Phases of becoming, maximum development and fading in Fusulinoida phylogenetic course are distinguished.

First two phases (Carboniferous – early Permian) were characterised by the directed adaptive changes. These processes led to ecological differentiation, complication of the structure, increase the size of the Fusulinoida and, as a consequence, the change of the dominant taxon in time.

At the end of the early Permian, when it came to adverse changes in the external environment and a sharp reduction in space, suitable for the existence of Fusulinoida, the processes of extinction touched upon in the first turn of the representatives of the dominant order Schwagerinida. Apparently, long-term directed evolution of Schwagerinida led them to a high degree of specialization and the development of adaptations for the preservation of equilibrium with the environment.

Processes of ecological differentiation of Schwagerinida were accompanied by their morpho-functional specialization, and this became the reason of reduction of them evolutionary plasticity and ability to respond to changes in biotic and abiotic factors. A significant reduction of Schwagerinida at the end of the

early Permian, led to the vacation of environmental space, which was intensively developed by taxons, who had up to this subordinate position in relation to the Scwagerinida.

Moreover, none of that existed at the time units of Fusulinoida not become the dominant, which is characteristic of the phase of deterioration of the superorder in general, when a violation of adaptive balance accompanied by increasing variability. The rate of growth of genera formation Fusulinoida in the middle Permian on the background of aridization climate and reduction of water areas of the shallow sea basins have not prevented their final extinction by the end of the Permian epoch.

The phase of Fusulinoida fading as a whole began at the end of early Permian that was about 20 million years before the termination of the Permian epoch. Thereupon, to speak about extinction of Fusulinoida on the Permian – Triassic boundary as a result of any catastrophic factor influence without the account of internal biotic processes in group is not correctly.

4. Discussion

Considered process of evolution and extinction of the Fusulinoida is just one example that demonstrates the global event of a mass extinction at the end of the Permian. The Late Permian crisis reduced the number of marine invertebrate families by 57% (with perhaps 95% of all species disappearing).

Catastrophic explanations based on the impact of asteroids became very popular at present. For practically all known events of mass extinction, there are their own craters of the impact made by asteroids, which are allegedly responsible for the extinctions. Chicxulub crater, which is located on Yucatan Peninsula, is the most famous of them. It formed about 65 million years ago near the Mesozoic-Cainozoic boundary. Dinosaurs became extinct by that time. Alamo impact in Nevada is associated with the End-Devonian mass extinction. At the same time, the Bedout Imact near Australia is correlated with the end-Permian extinction. Thus, the so-called “Asteroid Hypothesis” has become popular due to the clear and simple connection between the causes and consequences of those events. However, in reality the cases of mass extinction are more complex and many-sided and cannot be explained only by the impact of asteroids.

The intensification of volcanic activity and climatic changes are viewed as possible causes of mass extinctions too. All above-mentioned reasons leading to mass extinctions are abiotic. Nevertheless, there are some biotic particularities of ecosystem communities, which should be taken into consideration for understanding the ecological crises, which took place in the past. Some detailed paleontologic investigations allow us to estimate the state and tendency to changing for any taxonomic group. For example, it is described above for Late Paleozoic Foraminifera.

History of the evolution of Fusulinoida confirms the conclusion about the non-reduction of the causes of extinction to exogenous factors, and the more the catastrophic events exclusively, excluding the internal state of an evolving group of organisms. This conclusion is consistent with the data on other groups of marine invertebrates, the extinction of which is associated with

internal to the biota reasons, which are reinforced by abiotic events [14].

The duration of the phase of decline and extinction of the Fusulinoida, as well as of many other groups of organisms, reflects, apparently, as long-term and consistent global tectonic and climatic changes on Earth. Paleogeographic restructuring and formation of supercontinent Pangea during Permian were decisive factors of climate changes. This period is called the epoch of transition from the cold to warm biosphere [15].

We can say that the process of Fusulinoida extinction was a double-phased one. The first phase of extinction revealed itself in the end of the Middle Permian with the disappearance of the order Neoschwagerinida, which typified the Middle Permian Fusulinoida community. This phase of Fusulinoida extinction at the middle-late Permian boundary occurred, probably, because of short-term global cooling. Researchers named this episode as Kamura cooling event [16]. In the Late Permian generic diversity of Fusulinoida sharply declined and ended their extinction by the end of the Permian epoch.

5. Conclusions

After analyzing the historical path of development of Fusulinoida we can conclude that the reality of evolution; natural biotic and abiotic causes of extinctions; a long-term and many-phased process of mass extinction events contradicted the ideas of catastrophism.

Mass media and various media of communication slightly contribute to dissemination of the ideas of neocatastrophism negating the evolutionary factors of development. The most dangerous is the penetration of them into the sphere of education, into school, colleges and universities, which shape the world-view of modern and especially future society. The Parliamentary Assembly Council of Europe (PACE) calls on education authorities to promote scientific knowledge and teaching of the theory evolution and to oppose any attempts of teaching creationism as a scientific discipline. In 2007 PACE took on board the Resolution 1580 which was called “The dangers of Creationism in Education” [17].

This problem is urgent in many countries, especially after the fundamentals of religion studies introducing in the school program.

Thus, we can say that being the evidence of evolution paleontology occupies a very important place in the system of scientific education. Paleontology is one of the areas capable of shaping the materialistic and dialectical view on the surrounding world that is essential to the forward progress of human society.

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