# PALEONTOLOGY DURING FIFTEEN YEARS

by A. A. Borissiak.*

I.

The significance of paleontology as a branch of geology—so-called stratigraphical paleontology—is enormous. In the problems of geology, which is essentially a historical science, it exposes the most important element—the time element. The paleontological method is still unique, practically applicable for determination of the period of formation of deposits, for determination of the age of a stratum. Paleontological remains are, besides, among the most important symptoms in the reconstruction of conditions of formation of deposits—facies conditions, which produce not only the material for the construction of a paleogeographical chart, but also indications for the search of these or other valuable fossils.

In the Urals, in one of the regions, oil has been found. Where to look for it in other regions of the Urals, i.e., where are there present other strata of the same age and of the same facies that can be shown only by paleontology? Should the core-hole be continued because it did not yet reach the ore-bearing stratum, or should it be abandoned because it had already passed this stratum, which at the given point appeared empty? This can be stated only by paleontology. How the metalliferous belts are arranged in a given mountainous region—that can be told, in a series of cases, in advance by paleontology. The number of such examples can be multiplied infinitely.

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The assemblage of paleontological remains and their scientific treatment is an inalienable treatment of a geologist's work. Every geologist must know how to discriminate, already in the field, among petrifications that he has collected. In order to make correct conclusions, a careful scientific treatment of the collected material is necessary. Up to the revolution, the majority of our great geologists were at the same time great paleontologists, and they worked their material alone.

This order existed and continues to exist at the present time in Western Europe also. This problem was approached differently by American geologists, where the fast tempo of the geological survey, which had been distributed on small geological institutions of individual states, needed a rapid mass identification of the collected material: there have been established there special staffs of paleontologist–identifiers.

In pre-war times, geological survey was done in our country in a centralized order. Small geological cells (bureaux), chains of few Russian universities at that time, which usually did more or less accidental geological surveys in the regions of their provinces—gravitated ultimately to the Petersburg Geological Committee, the sole institution that had the geological work in an organized manner and on a large scale. This in part concerns paleontology. The geological committee was the sole scientific institution that had at its disposition an adequate library, which made possible a correct scientific treatment of the fossil material: even the paleontologists of Moscow had, as they even now have, to travel to Petrograd in order to complete their works.

The concentration of geological forces was disturbed by the revolution, which dispersed geologists to all parts of our country. The Petersburg Committee became deserted. However, in some provincial centers, groups of geologists were rather strong.

Thus there arose sporadically and spontaneously "departments" of the Committee, which, under the conditions of the time, however, could not develop their works. This was the period of greatest decay in paleontological output. In proportion with the decline of the civil war, a reverse flow of scientific forces began—the "gathering of the Committee." Together with that, the waves of a new life, which developed in great strides, reached the committee, making on it progressively more forceful demands.

Together with the growth of geological field works, the question of treatment of paleontological remains arose, not only of those which came in with each year in ever greater mass; but also of those which were accumulated earlier and which lay beneath them. The old individual method of work had necessarily to be preserved among those single paleontologists who remained in separate provincial geological cells. While in the central institution, which had concentrated the enormous part of general geological work and almost all of the paleontological work, the treatment of materials under new conditions demanded also new methods. The need for collective work of specialists became evident. The old staffs, in persons of a series of great specialists, were present. It was absolutely necessary to reorganize their work. But they were quite inadequate for the work according to the new way, which demanded the presence of a sufficient number of specialists in all of the most important groups of fossils. On the other side, a great number of old specialists had simultaneously also geological investigations which occupied them even more in proportion with the development of the tempo of the work of the Geological Committee. It was absolutely necessary to create new staffs of younger generation.

The first trial experiments in this direction were made in 1920, when the Geological Committee invited five students of the Mining Academy for paleontological

work specifically. Next year, the number of invited students increased, and then it grew with each year. A quite considerable number of workers obtained in this way by the paleontological committee fell off yearly, turning to the field survey works (there were not enough surveyors). But the department did not lose them entirely since the majority continued to work in it in succession on a select group of fossils, and thus surveying obtained a stratigrapher who passed a good paleontological school.

As a result, at the end of the 1920's, there actually worked in the Department, simultaneously, 70 to 90 paleontologists (of them, 30 staff paleontologists of the department)—a number unheard of, not only in any Western European country, but even in America. But even this number of paleontologists was not sufficient for the entire material, which was sent by the members of the central institution and in part its departments.

How was the work of this army of paleontologists organized? There were specialists on separate groups, and within each group, specialists on stratigraphic unite. Thus about ten paleontologists worked simultaneously on corals, two to three of them worked on the Devonian and Carboniferous corals, one on the Silurian, one of the Tertiary, etc. In the same way, workers in other groups were distributed. The material obtained, i.e., each fauna that needed treatment was divided into groups, and each group was turned over for treatment to a corresponding specialist. Thereupon, their results were summed up and in such manner was obtained the characterization of fauna so indispensable to stratigraphy. On the other side, the material on a given group was concentrated in the hands of each specialist from all the collections obtained That enabled him to treat it fully and thoroughly: a careful monographic treatment was placed at the

head of the triangle of all paleontological work, since only such a treatment of guaranteed the necessary accuracy of stratigraphic determinations also. It likewise assured the creation of sufficiently authoritative specialists. Among other things, as a result of such a setting of work, the section had in recent years to set up independent field works, both for the collection of complementary material on the fauna treated, and for stratigraphic gaps in those cases when some regions were not covered by the surveying or other field parties.

As mentioned, the work of our paleontologists did not keep quite abreast with the rapid tempo of field work. Nevertheless, its results during the last ten years have been enormous. First of all, they were fused into the corresponding stratigraphic works of our geologists. The treatment of the stratigraphy of the Paleozoic of the Urals and the European part of the Union, the newly formed stratigraphy of various regions of Siberia and Central Asia, Mesozoic stratigraphy of the Crimea and the Caucasus, etc.—all this is to the same degree the result of field investigations as the works of paleontologists. We cannot stop in detail at these results, inasmuch as they will be appraised in connection with the exposition of the results of the geological science in its other regions.

But this is only one side, closely connected, more correctly, conditioned, by the achievements in the region of monographic descriptive works. As has already been mentioned above, all the activity of the Paleontological Section was based on the monographic treatment of separate groups of fossils. A detailed treatment of paleontological remains is, according to the nature of our science, a tedious work that can

be measured in years. Nevertheless, the paleontological section gave in a comparatively short time, a great investment into the monographic paleontological literature.*

The significance of such monographic works consists in the fact that they, while enlarging our knowledge of this or another group, make it more effective with regard to guiding fossils. In this regard, different groups of fossils are far from being in an identical situation. If some of them, the most frequent, were treated detailly in about a hundred monographs, their classification sometimes, from the point of view of the biological systematics, takes even disfigured forms, when into the basis of species and diversities, an individual variability is thrown other groups, which interested less Western European or American geologists, are kept completely in the back-ground, and the world literature on them counts only some ten articles. The great diversity of sedimental formations in the expanse of our Union knows such cases also, and not rare when such "forgotten" groups were solely represented in the deposits; but because they were so little worked out, they could not tell anything to the geologist. One of the great merits of the Paleontological Section is the conquest of several such groups, which as a result obtained a stratigraphic significance. It is enough to point to Archaeocyatha, Stromatopora, Tabulata, Polizoa, Gastropoda, and others.

Archaeocyatha represent a very diffused fauna in our Asiatic Cambrian deposits. Their first discovery, toward the end of the last century in the crystalline limestone of Siberia, made a revolution in the conception of the geology of northern Asia; one after another their new localities were discovered, since the geologist began to look more carefully upon limestones, which up to that time had the reputation of being "mute."

* Yearly production of the paleontological section was expressed numerically by thirty to forty large and small descriptive works.

Together with that, those masses, which up to then were usually considered as "Archaiac", became known as Cambrian. The geology of Siberia became, as it were, rejuvenated. Its "ancient crown of the head" became reduced, and the history of the entire northern part of Asia became different.

Archaeocyatha alone represent a very interesting group, unique among the fossils which do not fit in any of the existing animal types. There was very little literature on this group. The largest articles referred to the Sicilian and the Australian forms. The working out of the enormous materials collected during the last ten years in Cambrian deposits of the Asiatic part of the U.S.S.R. uncovered for us a whole world of forms up to then unknown, and it gave us quite a detailed classification of them. This work cannot be considered finished, because in spite of all the detail of systematics, we do not have a stratigraphic characterization of forms that would allow us to apply them for a fine stratigraphy. At the present time they give only a rough stratigraphic determination. This is because archaeocyathous limestones represent a facies in which are rarely found in other earlier known and stratigraphically worked out forms, which could serve as a criterion for the stratigraphic evaluation of separate forms of Archaeocyatha. However, from the pointed out characterization of the archaeocyathic facies, there are exceptions. Such a find of Archaeocyatha in the same place with other forms was already met with in our country, and further finds, will undoubtedly allow of a filling of the gap mentioned.

It is impossible to stop at the other examples of works performed. But it is absolutely necessary to touch on the problem which is facing our workers in the field of stratigraphic paleontology.

According to the present state of the paleontological science, every determination, even a little correct, on which could be based solutions of sometimes very important practical tasks, demands tedious and long work based on a possibly complete literature, and for some groups very wide. The essence of this investigation consists in the reappearance of the given leading fossil on the basis of its literature, which consists in the majority of cases in quite imperfect depictings and descriptions and besides often contradictory. Investigation establishing the history of the given leading fossil, mistakes and fallacies of various authors, will lead to the possibly correct understanding of it for a given time. It will give in such manner the greatest possible reliable comparative material for determination of this or another form in the fauna collected in our country. This work naturally develops the attention of the investigator, it sharpens his observation, ability for a correct and exhausting characterization of symptoms, qualities without which paleontological research is impossible. It is clear, likewise, why a narrow specialization is unavoidable, which has been mentioned above. In the result the work of geologist-stratigrapher is in difficult conditions of dependence on the mentioned long and complex investigation of the paleontological material. Naturally the thought arises, is it not possible once for all to fortify the results of such monographic investigation, making them generally available and in such manner freeing the subsequent workers from a repetition of the tedious work. Thus the thought arises of creation of "Maps of leading fossils," which every stratigrapher could use in his work.

There is a justified prejudice among the specialists against such maps. Their objections can nevertheless be removed under two conditions, if such a (atlas) map is considered not as final, but as a completion of a definite stage in the study of a given

form or fauna, supposing a further more perfect work, and, secondly, if such a map is composed by a great specialist for whom such an account is easy. Besides the map should contain not only distinct pictures; but also carefully composed descriptions which should help to see the symptons of a given form which otherwise could easily slip out of attention of an observer not enough experienced. It is quite natural that such maps completing a definite stage of study, can appear only as the result of an intensive study of the corresponding faunas.

The described organization of our paleontological works, its results, characterized above, represent a sufficiently solid basis for a summary work of this kind. The first attempts at a composition of a working map of leading fossils were made by the Moscow Petrol-Oil Institute, which printed several citations on the faunas of separate layers of the Caucasian oil-bearing Tertiary deposits. At the present time, this work is done on a large scale, i.e., it comprises all the most important groups both of plant and of animal remains for the entire sedimentary mass of the Union, by the Academy of Sciences. This work, which is being done by the collective of our greatest specialists, will be a worthy completion of a systematic monographic treatment of fossil faunas which has been had during many years, which naturally should not be stopped in the future.

II.

Let us consider now the relation of descriptive monographic works on stratigraphic paleontology to paleontological works of biological character. In his investigations, a paleontologist-stratigrapher, or the problems of systematics and fascial evaluation of the objects of his research must rely on the data of zoology and botany. His

objects are not only the leading fossils, but at the same time the remains of once living organisms, documents, on the basis of which, can be reconstructed the history of the organic world. As biological objects, they are subject to study from a biological point of view. Thus, together with the stratigraphic paleontology as a geological science, there are created biological sciences, Paleo-zoology and paleo-botany.

Let us stop in the region of Paleozoology, which were formally expressed in the creation in 1930 of a special Paleozoological Institute in the institutional system of the Academy of Sciences. This institute unified and arranged that large work which in the region of paleozoology, mainly vertebrate, the Academy led during the last fifteen-twenty years. At the time these works were caused by the discovery of a series of rich and diverse locations. In recent times to them were added the works on invertebrates (insects, Echinodermata) on excellent materials, which our sedimentary mass produced. However, not only the presence of materials alone served as a basis for the creation of the new institute, but also the great revival of works in this region of science in connection with the successes of a new so-called paleobiological method. (Biological explanation of morphological types, in our country too; works of the Acadamician B. P. Sushkin and others.) It was necessary to create conditions (by the organization of the institute) for development of a theoretical science, which promised to throw new light upon the processes of animal evolution.

The task of paleozoology is reconstruction of the history of animal world on the basis of fossil remains. Such is the concrete expression, which in paleozoology obtains the basic problem of natural science—the problem of evolution. Together with two other morphological sciences, comparative anatomy and comparative embryology, work on the

problem of evolution on the contemporary material—paleozoology contains the basis of evolutionary study. And those phylogenetic series which under favorable circumstances (in collections of fossil remains from successive layers) are formed by paleozoologist, allow us to approach to the solution of problems connected with the methods of variability and controlling its regularities.

Paleozoology, as a biological science, is making, so to say, its first steps before our eyes. We have all the reason to expect that it will produce exclusively valuable material for reappearance of regularities of evolution for reconstruction of the process of development—the main basis both for our world understanding and the creative work of the biologist on the creation of forms. The basic problem of paleozoology, the problem of evolution, falls into a series of sub-problems: the problem of the form and its changes (morphology), the problem of species (systematics), the problem intercalation of organism and environment (biology) and others.

What are our basic achievements in the field of this science? It has been already that most important works in the region of invertebrates refer to two types, Echinodermata and Articulata. The complex skeleton of Echinodermata, expressing many traits of the internal structure of the animal is a rather late (i.e. already in the regions of the historical period of the development of faunas, accessible to our study), differentiation of the type—all this is favorable to the study of fossil representatives of this type and to exposition of their history. As for the insects, a favorable circumstance for the study of their history is the fact that in a fossil state their wings are predominantly preserved, which at the same time serve as the basic systematic organ. In the regions of the Union, the most interesting finds are the numerous remains of insects from the Lower

Jurassic clays of Caratan. But of even greater interest is our Permian entomofauna (Tikhic gory on the river Kama; Tvan gora in the Arkhangelsk region), very rich (over 100 species), showing the genetic relations with the North American (Kansas) and with the "Gondwanan" (Australia). This fauna gave especially valuable material on dragonflies, explaining their evolution and the fibers of their wings. Beside that, there has been established a series of new orders, and the systematic position of others has been explained and so on.

Especially interesting material was given by the terrestrial vertebrates. Already at the end of the last century, the famous locatlity of Permian reptiles of Northern Dvina was known. Later were discovered large locations of Upper Tertiary mammals in the south of Ruwian plain, and then a whole series of locations of mammals and lower vertebrates in Central Asia and other places of the Union. Systematic investigations, led by the Academy of Sciences during the last ten years, are gradually explaining the picture of our locations, so diversified (we have remains of terrestrial vertebrates in deposits of all systems from the Permian to the Quaternary) and placing our country to one of the first place; in abundance of paleozoological material.

The locations are not only worked, i.e., the material is being collected, but they are also studied. The study of locations aims at an explanation of the burial conditions and formation of thanatocoenoses. These are the tasks which are afield before the paleozoological institute.

Let us stop now briefly at the results of the scientific treatment of materials collected. First of all, it exposed the basic forms, which enter into the composition of the Permian and Triassic faunas, both among Stegocephalia (Dinosauria, Seimuria) and

reptiles (Pareiasauria, Dicynodonta, Gorgonopsida, and others). The morphology of these forms, their ecology, their systematic position, have been worked out. The connection with other contemporary faunas and ways of migration have been established. General physico-geographical conditions of burial have been established.

Thus we approach the reconstruction of pictures of the past life which interchanged in long past geological ages on the area of our Union. Further on, materials, not only ours, but contemporary foreign ones in the collections of museums of Europe and America, several general problems of the history of terrestrial vertebrates were set up and solved.

Thanks to the high technical preparation attained by us—thanks to the fact that the preparation is done not blindly but with the knowledge of the object to be prepares or even by a specialist—such details of the structure of the skeleton and crania were discovered which are usually lost or unobserved. These details allowed of an introduction of essential corrections into the prevalent phylogenetical ideas. The materials studied by us are related to comparatively late times in the history of terrestrial vertebrates, when their individual groups represented stems which are well individualized, in part Stegocephalia digressed much from reptiles. Therefore among out faunas, there are no representatives of common ancestors of reptiles and amphibia as it was thought earlier. These parts of branches of the genealogical tree, which correspond to our Permian and Triassic layers, do not have, as yet, extensions downward, which would unite them with common ancestors. These oldest ancestors must be sought in older layers which in our country have not given, as yet, fossil remains of vertebrates. Judging by those examples of such finds, which we do not have in the west, we can expect them in our country, for

instance, in deposits of the productive mass of the Moscow basin or in other analogous layers.

A theoretical significance of such finds would be enormous. Therefore, the regions of distribution of the deposits mentioned should be the object of a special attention of searching parties of the Paleozoological Institute.

On the other side, among the Permian-Triassic faunas are found the first precursors of higher vertebrates—mammals. One of such forms (*Permocynodon*) has been found in Northern Dvina. Every bone of the cranium of this animal bears transitional traits from a reptilian type to a mammalian type.

Our Jurassic and Cretaceous faunas have, as yet, not been studied. However, we have remains of terrestrial Mesozoic vertebrates and often in a large quantity certain locations usually contain only diversified parts of skeletons washed up from the native assemblages of entire skeletons. Our attention should be directed to a search for these basic locations which offer an incomparably more valuable scientific material.

The oldest Tertiary deposits have not produced, as yet, remains of vertebrates. In the vicinity, in Central Asia, these deposits contain the most interesting faunas, which undoubtedly we also have, and they will be found in further searches in the regions of Central Asia.

Faunas of mammals are known in our country beginning with the Upper Oligocene in various horizons, and ending in Tertiary layers of various ages. These faunas represent in general the same succession of forms as in Western Europe. Along with this, in Central Asia, they contain not a few peculiar forms, among them—as it often happens in Asia—gigantic forms. Especially rich material is produced by the so-called

*Hipparion* fauna, the location of which extends in a series of ages of the upper Miocene and lower Pliocene Epochs, and thus they give material for its history. Our finds, in the meantime, enlarged considerably a certain area of distribution of this fauna.

Not stopping at separate interesting forms of which the most conspicuous is the find of *Semantor*, we shall only touch on two families, for the history of which our materials gave the largest. These are rhinoceroses and Proboscidea. The excellent materials from our various locations—in great part entire skeletons—allowed us to complement and make more accurate the history of a whole series of branches of the genealogical tree of rhinoceroses. Beside that, they exposed a new special branch, earlier unknown, of gigantic Baluchitheria, whose charactetistic was given by our material, which gave a complete skeleton (of Indricotheria) although without an entire cranium, while other finds of the representatives of the same branch (Mongolia, Balochistan) consisted of only separate, incomplete parts of the skeleton. Of a special interest is the first complete skeleton of the primitive upper Oligocene rhinoceros from the Old World (Aceratheria). It for the first time allowed of a separation of genuine rhinoceroses from their various side branches and to contrast rhinoceroses of the Old World with the cone temporary ancestral forms of rhinoceroses of the New World.

For the history of Proboscidea, our material first of all establishes the fact that after their oldest forms which appeared in Northern Africa (Moeritheria, *Paleomastodon*) migrated to Asia, they formed there a second powerful center of development which gave at once various branches which were in part represented by large forms. And from here, some forms, mostly the small ones of the race, migrated to the west to Europe and later to

the east to North America. It is impossible to mention here all the details of this process, which sometimes can be illustrated by very interesting and special forms.

Let us stop our attention at one more field of our work. On the wide expanses of our Union in geological epoch closer to us, there lived those herbivorous and predatory mammals which gave man material for domestication. The fossil remains of these animals as well as the remains of those of them which were already domesticated by prehistoric man, and which are found together with the implements and tools in his quarters give for the history of domesticated animals such material, the like of which is nowhere in the world. One of the real tasks is to reconstruct according to these remains the history of domestic animals and to expose the degree of relation of the wild form related to them, which could be used for domestication. This task has been introduced last year into the group of works of the Paleozoological Institute which thereby was included together with a whole series of other scientific investigating Institutions, into the complex elaboration of the problem of origin of domesticated animals.

The past life is preserved in the strata of the Earth's crust, not only in the form of petrification well known to us, i.e., remains of skeletons of extinct animals; but also in the form of other "traces of life." These are, above all, traces literally left by the walking or crawling animal on soft grounds. Then, materials by which can be judged how did the life proceed under what conditions existed these or other animals, give us firstly, observations of the mutual position of petrifications in matrix (the so-called Tanatocerosis) and secondly, the study of the character of deposits, containing petrifications. The field of observations of such "traces of life" forms a special branch of paleozoology which is called paleobiology in a wide sense. It gives wider bases for a

biological interpretation of forms; it discovers new ways for reconstruction of the picture of past life. Successes of paleozoology during the last years are due to this new paleobiological method of study of past life.

Paleobiological observations in the field, requiring great biological preparation, are not done by geologists during the collection of fossils with stratigraphic aims. They require special expeditious which were for the first time organized last year on the area of our Union by the Paleozoological Institute. These expeditions gave highly interesting materials for reconstruction of the pictures of life in the Devonian Period. Extensive materials of these expeditions are still being worked out.

Such are, in short, in the form of a short, bare scheme, the fundamental achievements in the field of paleozoology, obtained almost exclusively by small forces of the Paleozoological Institute which has just begun to be organized. They do not correspond at all to those colossal possibilities which our locations present and the exploitation of which form our task in the coming years.