THE CARCASSES OF THE MAMMOTH AND RHINOCEROS FOUND IN THE FROZEN GROUND OF SIBERIA

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ARTICLE I

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CONTENTS

PREFACE

THE present paper was primarily in the form of an address delivered, in 1921, by the writer before the Geological Department of the Tôhocu Imperial University of Sendaï, Japan. Never failing interest in this subject, perhaps even increased during the last few years, brought the writer to a decision to elaborate and complete the address referred to and publish it in a form of an article. The accomplishment of this task happened to be more difficult and took more time than the writer expected, and two more books on the same subject had appeared in meantime, before the writer was through with his work. These books are: "The Mammoth and Mammoth Hunting in Northeast Siberia" by Basset Digby, published in London, England, in 1926, and Pfizenmayer, E. W., "Mammutleichen und Urwaldmenschen in Nordost-Sibirien," published in Leipzig, Germany, also in 1926. The question was naturally aroused, if a new treatise on the same subject would be worth publication. After some consideration the writer has decided to finish and publish his work. If he was right, or wrong in doing so, it is to an eventual reader to decide.

The difficulties in accomplishing this paper were chiefly dependent upon the lack of special literature on this subject. Although the writer had the opportunity to use in Pittsburgh the Library of the Carnegie Museum and the Carnegie Public Library, in New York libraries of the American Museum of Natural History and of the American Geographical Society, in Washington, D. C. libraries of Congress and of the U. S. National Museum, in Chicago the Public Library, the John Crerar Library, and the Chicago University Library, he still lacked a great deal of important data, because in all these libraries Russian publications have been very incomplete and fragmentary. This paper, in the form in which it is now published, could be written only owing to the kind help of the Russian friends of the writer. Among them R. Th. Gekker and A. I. Tolmachoff delivered a number of different publications and data not easily available otherwise. The writer feels especially obliged to R. Th. Gekker, Curator of the Geological Museum of the Russian Academy of Sciences in St. Petersburg, who did a great deal of work in the libraries and archives of that city and supplied the writer with a number of quotations from different Russian publications which the writer lacked and which were impossible to secure from Russia. Through R. Th. Gekker the writer has received also from A. A. Byelinizki-Birula, Director of the Zoological Museum of the Russian Academy of Sciences, very important data on the fossil Siberian rhinoceros belonging to the collection of that museum. E. E. Ahnert delivered valuable information on the localities of the mammoth in the Russian Far East and in Northern Manchuria; also the literature on the subject, referring to these regions of Eastern Asia. These few lines are a weak expression of the gratitude of the writer to these gentlemen.

In spite of all this assistance the writer has been still unable to procure a number of publications which he would have liked to consult for his work. To get them, mostly from Russia, required so much time that the accomplishment of the paper would have been

postponed indefinitely. Very often the writer was forced to make reference to some works only through the other authors who had had the chance to use these works before. Such a reference is always marked accordingly in the present paper. Especially important in this direction was Howorth's book "The Mammoth and the Flood," in which an amazing amount of literary data has been brought together by that author. In all these cases the reference to volumes, pages, etc., of the original work belongs to the auxiliary author. The writer feels necessary to emphasize that, because he had a chance to compare some quotations with an original work and discovered a few mistakes, which usually were not real errors, but dependent only upon the difference of edition of quoted works.

INTRODUCTION

In no other country of the world are the remnants of the mammoth and, to a lesser extent, of the diluvial rhinoceros and of other fossil mammals of the same geological age so familiar to everybody, as they are in Siberia. In no other country, except Siberia, have these remnants such an economic importance. Since time out of mind fossil ivory was used by natives, in their simple housekeeping, for very different purposes as a hard homogeneous material which could be worked about so easily as wood and in many cases could replace metals very conveniently. It is quite possible that the mammoth was hunted by the primitive man armed with spears and arrows made of ivory. Fossil ivory since the dawn of civilization has been used also for artistic purposes, for the making of small decorative objects often of great perfection and beauty, also for sculpture.[1] Good pictures of Yakutish ivory work are given by Pfizenmayer in his book. Bones have been used for different purposes as well. Of the ribs of the mammoth, for example, Yakuts used to make spoons.[2] Fossil bones were also much used in Russia for making animal charcoal. In the stores of bone-burning factories it was possible to fish out good specimens of bones of extinct animals, of course, without any reference to a locality.[3] Thin plates cut from the horns of the fossil rhinoceros are elastic in the highest degree. They were, therefore, much used by Yucaguirs of Northeastern Siberia to line their bows, and very eagerly sought for.[4] Spoons, forks, pipes, etc., are made of these horns as well.[5] Meat of the mammoth used to be not only devoured by dogs and wild animals, but also utilized by natives in their fox traps, chiefly because of its peculiar strong smell.[6]

The mammoth has been very common in the Siberian folklore. As a child the present writer was told that the mammoth had been such a large animal that Noah could not take it in his ark during the Deluge. Another story told was that the mammoth had been saved by Noah in the ark, but perished later, after it left the ark. Soaked soil could not bear such a ponderous animal and it sank into the underground where it has been found. Other stories suggest that the sunken mammoth is still alive and dwells in the underground. Many of these stories were published by travelers through Siberia of the seventeenth and eighteenth centuries. Mixed with the legends were real and correct data on the mammoth founded on direct observations. Explanations of the extinction of the mammoth, of preservation of its frozen carcasses, etc., told to travelers by ignorant local people, often corresponded to those given later by European students. For example, the Russian inhabitants of Western Siberia told Ysbrand Ides that the mammoth was very similar to the recent elephant, but its tusks were stronger and not so straight. The animal lived in Siberia before Noah's Flood, when the climate was warmer. The drowned floating bodies

[1] Howorth, H. H., "The Mammoth and the Flood," p. 50. Pfizenmayer, E. W., "Mammutleichen," p. 258, plate facing p. 280.

[2] Bunge, A., "Die Lena-Expedition," S. 51.

[3] Tscherski, I. D., "Beschreibung der Sammlung," S. 396.

[4] Erman, Ad., "Reise um die Erde," II, S. 263. Spasski, G., "Zoological Discoveries in Northeastern Siberia," p. 352.

[5] Pfizenmayer, E. W., "Mammutleichen," S. 244.

[6] Kutomanov, G. N., "Rapport sur une mission," p. 380.

were, after the Flood, forced into subterranean cavities, became frozen and preserved in this way, because after the Flood climate became colder. Y. Ides points out that the former warm climate is not a necessary condition to explain this event, because the bodies could be brought by Flood from the southern countries for many hundreds of miles.[1] In other cases he was told by Siberian natives that the discovery of carcasses of the mammoth on high shores was the result of their accidental appearance to the surface from the underground where the animal used to dwell beyond the influence of air and light which were supposed to be deadly to it.

Discovery of bones of *Elephas* and *Rhinoceros* became a great puzzle to scientists and laymen alike in Europe, as everybody compared them to animals of warm climate and could not imagine that these bones were remnants of animals found on the very place where they once lived. In his book "The Mammoth and the Flood" Howorth carefully brought together the different explanations of these discoveries that prevailed at that time in Europe, having now, of course, only an historical interest.

A still greater puzzle were frozen carcasses of the mammoth which had been known in Siberia and China centuries before mammoth bones were found in Europe; but European scientists learned of them only after the conquering of Siberia by Russians. The explanations of these discoveries by Siberian natives and Chinese philosophers, reflected in local folklore, proved to their credit that they considered these remnants belonged to animals which lived in the same region, although in quite unusual conditions.

When Siberian localities became known to Europe, and in Europe itself were found more remnants of the mammoth than were possible to explain by referring to the elephants of Hannibal run astray a.s.o., the Noachian Deluge was used to explain the means by which anything might be transported. Some scientists accepted the theory that the Deluge had transported floating bodies of dead animals, as did Pallas in his description of the discovery of the *Rhinoceros*. Others believed that the animals were driven before the approaching Deluge into inhospitable country and perished there, or were trapped and killed by the Flood. In Pallas' time the frozen ground of Siberia was an established fact, and he simply accepted the theory that the same conditions prevailed there during the Deluge as well. "C'est pourquoi l'animal transportée des pays méridionaux à l'époque du déluge pouvait se conserver," said he.[2]

Although a great naturalist and a good and punctilious observer, Pallas did not try to imagine the method of transportation, for thousands of miles, of carcasses, or the mechanism of their enclosure in frozen ground. Deluge was something mysterious and miraculous, as well as everything connected with it, and there was no room for an exact scientific inquiry.

When Cuvier showed that the mammoth and fossil rhinoceros were specifically different from recent tropical animals, and that both were well protected against cold with a fur, especially heavy in the case of the mammoth, the theory of their tropical origin was replaced by the quite logical conclusion that both had been natives of the country where their carcasses were found. But as their domicile in the Arctic appeared improbable, it was suggested that their home had been in Central Siberia, and from there their remnants and whole carcasses were floated down by the great Siberian rivers, Ob, Yenisei, Lena, etc.,[3]

[1] Ides, Y. E., "Three Years Travels," p. 26.
[2] Pallas, P. S., "Voyages du Professeur Pallas, V.," p. 215.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 60.

and in this way distributed over the whole of Siberia. This theory met with strong criticism. Cuvier [1] emphasized that the bones found in the Far North exhibited no marks of detrition. Hedenström [2] also suggested that carcasses carried by rivers must have been destroyed long before their arrival in their present localities in the North. It was also shown that, conforming to this theory, remnants must be more numerous in Southern Siberia than in Northern one, which is contrary to the fact. By the end of the eighteenth century it was also well established that the northern race of the mammoth had been distinguished by its smaller size from that found in Southern Siberia. The "floating" theory was supported by Lyell and, in somewhat limited form, by Middendorff and Bunge in its application to some special cases. It could be not applied to the carcasses of mammoth undoubtedly buried on the very spot where they met their death, discovery of which has proved beyond doubt that the mammoth was living in those regions of Northern Siberia. As in the tundra ground along with these carcasses were discovered remnants of trees and bushes which in the Age of the mammoth had been grown within the area of recent tundra, it was suggested that the mammoth used to live in Arctic Siberia under milder climatic conditions than the present ones. The change of climate for the worse, i.e. for the present condition, was the cause of the extinction of the mammoth. In such a general form these suggestions may be still found in textbooks, but they could not be reconciled with all the observed facts referring to the Mammoth-localities, when considered in detail. A desperate attempt to bring about such a reconciliation was made by Howorth, but he was forced to resurrect the theory of cataclysms and take recourse to the Flood, a fervent, although solitary, advocate of which he remained till his death, in 1923. According to Howorth, the mammoth used to live in the same areas of Northern and Southern Siberia where its carcasses have been found; these areas enjoyed at that time much milder climate. Then occurred the Flood, and the mammoths perished by drowning, their carcasses becoming buried in silt. "Immediately afterwards the same ground became frozen, and the same climate became Arctic, and this not gradually and in accordance with some slowly continuous astronomical or cosmical changes, but suddenly and per saltem." [3] According to Tscherski,[4] Howorth's ideas about the sudden extermination of the mammoth were also temporarily accepted by Lapparent. In later editions of his book Lapparent attributes the extinction of the mammoth only to a gradual increase in the coldness of the North Siberian climate, connected with the decrease of the supply of food.[5]

The discovery of frozen carcasses of the mammoth within the circumpolar region has been explained in a singular way by Gardner, the author of the theory on Central Sun, according to which our Earth is represented as something similar to a nutshell with the kernel removed. The shell is opened on both poles with apertures of some size. In the centre of such an empty ball is located an inner sun giving light and warmth to the inner side of the shell and provoking there a life more or less similar, or more or less different from this one on the surface of the globe. The mammoth is still living on the inner side of the earth shell. Sometimes it happens to approach the opening on the North Pole and

[1] Cuvier, G., "Recherches sur les ossements fossiles," I, p. 202.
[2] Hedenström, M., "Otrivki o Sibiri," p. 122.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 96.
[4] Tscherski, I. D., "Beschreibung der Sammlung," S. 463, a footnote.
[5] Lapparent, A., "Traité de Géologie," 5 ed., p. 1686.

carelessly walks out to the surface of the earth. Immediately it is killed by Arctic conditions, its carcass becomes frozen and in such a way remains preserved for generations in surprisingly fresh conditions.[1]

The study of the mammoth made great advancement during the present century, chiefly owing to a few successful expeditions commissioned to the Northeastern Siberia by the Russian Academy of Sciences. The greatest of them is the establishment of the fact that the mammoth used to live in climatic conditions closely corresponding to the present ones. In the recent literature the so-called mammoth-question is usually considered from this point of view.

[1] Gardner, M. B., "A Journey to the Earth's Interior," p. 47.

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IVORY INDUSTRY IN NORTHERN SIBERIA

Fossil ivory was called in Siberia "Mamontova Kost,"[1] meaning "Bone of the mammoth," the name which is still used. Not so common is another picturesque name, connected with ivory localities on islands and on bottom of sea. "Ribya Kost," which means "Fish Bone."[2] Fossil ivory has been exported from Siberia and European Russia since very ancient times. For the last two centuries this trade has been carried on quite regularly, giving the local population a very decent income. Being important economically this industry has contributed very much to the accumulation of information about the mammoth. Owing to ivory the mammoth became known a very long time ago. Ivory hunters had discovered all the localities of frozen carcasses of this animal which were later examined by scientists, and some of which found their way into different museums. The statistics of the trade are also very interesting, as they give a fairly good idea of the number of mammoths which were discovered in different times. Some details and figures concerning the ivory industry of Siberia would be, therefore, not superfluous in the present paper.

The first mention of the mammoth is found in Chinese ceremonial books of the fourth century B.C.[3] It was certainly connected with fossil ivory brought from Siberia to China at that remote time. There are later records of fossil ivory exported from Russia to Southern Europe and Central Asia in the tenth century.[4] This ivory was, probably, not from Siberia, but used to be found on the Wolga River near the location of the present town of Simbirsk.[5] Of Siberian ivory was made, presumably, the throne of the Great Mogol Khan Kuyuk, which shows that in the thirteenth century fossil ivory was known in Mongolia in large amounts.[6] There is no exact data as to the export of Siberian ivory to China, but, probably, since the old days this commerce was carried on for centuries in a very regular way. Concerning this trade in the seventeenth and eighteenth centuries Stralenberg speaks of it as of a very common thing. Says he in his work: "A great many of these teeth which are white are carried for sale to China."[7] Ysbrand Ides also mentions

[1] Howorth, H. H., "The Mammoth in Siberia," p. 413.
[2] Howorth, H. H., "The Mammoth and the Flood," p. 29.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 78.
[4] Howorth, H. H., "The Mammoth and the Flood," p. 80.
[5] Pallas, P. S., "Voyages du Professeur Pallas," I, p. 214.
[6] Howorth, H. H., "The Mammoth and the Flood," p. 79.
[7] Howorth, H. H., "The Mammoth and the Flood," p. 52.

mammoth teeth as an important item of trade carried on by Russian dwellers in a northern town on the Yenisei River.[1]

In Western Europe the first fossil ivory became known in 1611 when a mammoth tusk was brought to London by one Jonas Logan, who had bought it from Samoyeds on the Pechora River.[2] In European Russia, although fossil ivory had been abundantly found for a very long time, it became a regular commodity only after the conquest of Siberia by Ermak in 1582. How important fossil ivory had been considered at that time is very conspicuously proved by the desire of Russian Czars to monopolize this trade.[3] The ivory industry in Siberia has developed on a very considerable scale since the middle of eighteenth century, after the discovery of the first island in the group of New Siberian Islands, christened later the Bolshoi Lyakhov Island, in 1712, by the cossack Vagin,[4] and its exploration by the Siberian trader Lyakhov, in 1770. After this followed the discovery of other islands of the same group, by Lyakhov and other Siberian cossacks and trappers.[5] Probably, these islands were known and exploited, as ivory mines, much earlier. At least Avril, who traveled in Russia in 1685, learned from a Russian whom he calls Mushim Pushkun, the Voevoda of Smolensk and former Intendant of the Government of Siberia "that at the mouth of the Lena there was a spacious island very well peopled, and which is no less considerable for hunting the Behemot, an amphibious animal, whose teeth are in great esteem." [6] Mushim Pushkun, probably, was referring to the mammoth, but not to the walrus, as it would be possible to suggest, because, according to Nordenskiöld,[7] the walrus is not found between Khatanga and Chaun Bay. The walrus has been not exterminated here recently, as the same fact was already stated by Erman.[8] The New Siberian Islands used to be visited yearly in summer by ivory hunters, who were going to the islands in spring and returning in the fall, crossing the straits both ways on sledges with dog teams. They did not make any excavation or digging to any extent, but were just looking for ivory in the cliffs along the seashore, on rivers and creeks, on lakes, or collecting ivory in shallow places in sea near the islands. If such a hunter happened to come across a tusk protruding from the cliff, but still firmly fixed in the ground by the other end, he put a mark on it, the claim of his possession never being disputed or ignored by other hunters, and he could come to the same spot the next year, or two years later.

Statistics available on the ivory industry of Siberia are very incomplete, often covering widely separated periods. Nevertheless they give a very good idea about the immense number of mammoths discovered and still buried in the frozen ground of Siberia. Thus, North-Siberian cossack Sannikov brought, in 1809, from the New Siberian Islands 250 poods (9000 lbs.) of ivory, which corresponds approximately to the amount of ivory from 80–100 animals. Another ivory collector returned, in 1821, from the same islands with a double amount of ivory, 500 poods (18000 lbs.). After Stschukin, about 1000 poods (36000 lbs.) of ivory used to be sold at Yakutsk every year during the first half of nineteenth century, but twice within the period of time between 1825 and 1831 this amount reached 2000

[1] Ides, Y. E., "Three Years Travels," p. 107.
[2] Howorth, H. H., "The Mammoth and the Flood," p. 48.
[3] Cuvier, H., "Recherches sur les ossements fossiles, I," p. 142.
[4] Toll, Ed., "A Sketch of the Geology of New Siberian Islands," p. 2.
[5] Toll, Ed., "A Sketch of the Geology of New Siberian Islands," p. 2.
[6] Howorth, H. H., "The Mammoth and the Flood," p. 49.
[7] Nordenskiöld, A. E., "Die Umsegelung Asiens und Europa, I," S. 405.
[8] Erman, Ad., "Reise um die Erde, II," S. 264.

poods (72000 lbs.). Besides this trade at Yakutsk, there were from 80 to 100 poods (2880–3600 lbs.) sold at Turukhansk, 75–100 poods (2700–3600 lbs.) at Obdorsk, and some found its way also to Tobolsk.[1] Middendorff[2] supposing that the ivory of at least 100 mammoths was delivered yearly to market, estimated the number of animals which had been discovered for two hundred years before his time at 20000, a figure which has been considered much too low by Nordenskiöld.[3] Argentov, in 1857, and Klutrov, in 1856, speak of great boats on the Lena River laden with mammoth ivory.[4]

In 1872, 1630 very fine mammoth-tusks were brought to England; and in 1873, 1140 were brought, weighing from 140 to 160 lbs. each.[5] Not all of the mammoth ivory coming to England is good, perhaps a half being rotten; specimens, however, are found as perfect and in as fine conditions, as if recently killed.[6] Digby who had a chance to see plenty of tusks at Yakutsk and on the Lena River, says that "A great deal of the stuff (tusks) is fit only for burning, to make India ink, and is not worth the heavy cost of transport abroad for that,"[7] but also that "Two or three that I examined were as modern elephant tusks. They must have come straight out of clean ice."[8]

In the period of time from 1887 to 1893 was sold annually at Yakutsk 1100–1750 poods (39960–63000 lbs.) of ivory for the price of 24–37 rubles a pood (33–51 cents a pound); from 1894 to 1897 was sold there in different years 1460–1750 poods (52560–62700 lbs.) for 29–35 rubles a pood (40–48 cents a pound). The yearly yield of fossil ivory has gradually decreased during the last decades, although in 1910 there were sold at Yakutsk 1900 poods (68400 lbs.), and in 1913 (the latest available figures) 1600 poods (57600 lbs.) for the average price of 53 rubles a pood (73 cents a pound). In the same year was delivered to Yakutsk from the embouchure of the Lena River 1300 poods (46800 lbs.) of ivory. The price of ivory on the northern shore of Siberia at the same time was 40–75 rubles a pood, the difference depended upon the quality of ivory, thus closely corresponding to the price at Yakutsk; while in European markets (in London) it was at least ten times higher. An average yearly figure for ivory sold at Yakutsk is estimated by local statisticians at 1500 poods (54000 lbs.). Supposing that every animal could deliver an average of 8 poods (288 lbs.) of ivory; they estimate that every year 187 mammoths must be found to supply the market with the given amount of ivory and that during the two and a half centuries, since the Russian occupation of the country at least 46750 animals must have been discovered.[9]

As a pair of tusks only in rare cases weighs 8 poods, and as the tusks from New Siberian Islands as well as from the northern shore of mainland, which make the bulk of those sold at Yakutsk, are never over 3 poods of weight each, the average weight given above cannot

[1] Howorth, H. H., "The Mammoth and the Flood," p. 51–52.
[2] Middendorff, A. Th., Sibirische Reise, IV," I, S. 278–279.
[3] Nordenskiöld, A. E., "Die Umseglung Asiens und Europa," I, S. 365.
[4] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 278–279.
[5] Howorth, H. H., "The Mammoth and the Flood," p. 52.
[6] "Encyclopedia Britannica, XI.," edition, XV, p. 92.
[7] Digby, B., "The Mammoth," p. 154.
[8] Digby, B., "The Mammoth," p. 176.
[9] The figures for the last thirty years have been brought together in Yakutskaya Okraina, August 12, 1912, a newspaper published at Yakutsk. These data are reprinted and somewhat supplemented in a Russian article by W. M. Zenzinov, "Sketches on the Trade in the North of the Territory of Yakutsk, Moscow," 1916, pp. 70–71. In his article "With an Exile in Arctic Siberia" (National Geographic Magazine, XLVI, 1924) the same author, speaking of fossil ivory (p. 718), says: "In the past century the yield has been estimated at from 20 to 30 tons." According to Pfizenmayer (Mammutleichen, S. 256) the northern merchant Sannicov estimated, in 1908, the yearly yield as 2000 poods, or 72000 lbs.

be taken as such. Accordingly the number of animals delivering yearly fossil ivory to market must be higher and not lower than 250 specimens.

The second figure, 46750 animals, appears to be exaggerated, because the export of ivory in the seventeenth and eighteenth centuries was certainly smaller than during the last hundred years, and the same average figure of animals found every year should not be taken for the whole period of 250 years. But the average number of animals discovered every year, 187, has been found, as notes above, too low for the last hundred or hundred and fifty years (since the starting of the ivory industry on the New Siberian Islands). Not all the discovered mammoths had delivered a marketable ivory, therefore not all were included in the number of yearly discovered animals. In ancient days ivory was used much more for domestic purposes than now, and a smaller export did not mean discovery of fewer animals. Taking all that into consideration, the above figure cannot be considered exaggerated, but rather a small one.

Some data in Pfizenmayer's book could even bring one to the conclusion that the above figures are too small, but there is in the book a *lapsus calami* which needs a correction. According to Pfizenmayer, Bunge's expedition to the New Siberian Islands collected during three summers, in 1882–1884, in the islands Lyakhov, Kotelni, and Fadyev about 2500 first grade tusks.[1] It would correspond to 1250 animals, or 417 as an average for a year, a figure exceeding that given above twice and even much more, if one would take into consideration that along with "Erstklassige Mammutstosszähne" must also have been found poorly preserved ones, that the figures given by the present writer refer to the ivory industry of the whole Northeastern Siberia, not to the New Siberian Islands alone, and that the expedition referred to was in the islands only for the summer of 1886, as in 1882–1884 Bunge was engaged in another expedition to the delta of Lena. As matter of fact the figure 2500 refers to all bones and tusks collected by both expeditions referred to,[2] among which the bones of the mammoth were present only in a small proportion. On the next page of his book [3] Pfizenmayer gives statistics in part repeating those brought together by the writer in this paper, in part closely corresponding to them, but does not try to bring these data in reconciliation with his figure of 2500 tusks collected by Bunge's expedition.

All these figures show how common are the remnants of mammoth in the frozen ground of Siberia, and how common the animal must have been in its time. From the technical point of view it is of interest to mention that Siberian localities have been considered "inexhaustible as a coalfield and in future, perhaps, the only source of animal ivory." [4]

[1] Pfizenmayer, E. W., "Mammutleichen," S. 255.
[2] Tscherski, I. D., "Beschreibung der Sammlung," S. 2.
[3] Pfizenmayer, E. W., "Mammutleichen," S. 256.
[4] "Encyclopedia Britannica, XI.," Edition XV, p. 92.

HUNTING FOR THE MAMMOTH

BEING so familiar in Russia the remnants of the mammoth very early attracted the attention of Russian scientists and students who had come to that country from abroad. Peter the Great, with whose name are connected many innovations in the intellectual life of Russia, was also interested in these remnants and issued, for example, an order to find out to which animal belonged the mammoth horns.[1] Another decree ordered that the bones of mammoth must be delivered to the Kunstkamera, the name of the first scientific Museum in Russia, which has been developed now into a number of museums of the Russian Academy of Sciences.

Since that time the study of the mammoth has become a tradition of the Russian Academy of Sciences which, during the two hundred years of its existence, has sent scientific expeditions to different parts of Siberia to examine the localities of carcasses of mammoths, the discovery of which from time to time was reported to the Academy. In these undertakings the Academy was invariably supported by the Russian Government, all expenses of the expeditions being always paid by the state treasury.

To promote discoveries of this kind the Academy promised a money premium to every discoverer of skeletons or carcasses of large fossil animals, if such a discovery would be immediately reported to St. Petersburg. A special announcement worked out by Baer, Brandt, and Middendorff referring to the discoveries of this kind and to the promised premium was sent, in 1860, by the Academy to the Governor of the Archangel Government, to the General-Governor of Eastern Siberia and to the General-Governor of Western Siberia. In 1880, the same leaflet was reprinted and distributed, through Government officials, travelers, traders, etc., among the population of Northern Siberia. The text of this announcement translated into English is as follows:

"Bones of gigantic prediluvial animals, as of the mammoth and others, happen to be found in tundras of Siberia, on the shores of streams, rivers, and lakes, as well as on the sea coast where, during a flood, or tide, bluffs are underwashed, and landslides originate. Among all these bones are utilized only tusks, called also horns or moustaches, which traders used to purchase. Besides that, so-called bird talons (in reality they are the horns of a prediluvial rhinoceros) are used in construction of bows. The other bones of these prediluvial animals do not find any utilization and decay on the tundra where they happen to be found here and there. They are absolutely valueless and are not worth a mention.

"Sometimes it happens also that out of frozen ground appears a complete skeleton of a prediluvial beast, bone by bone, properly arranged, not disconnected bones only. Such skeletons while within the ground and in complete order, even without any visible horns, are very much needed by scientists. If such skeletons should be found anywhere, the Academy would send a scientist to examine them on the very spot. The Academy therefore promises everybody, a native, hunter, trader, or official alike, that it will pay a premium of a hundred rubles to the first one who finds such a complete skeleton, and, having marked the spot, at once reports the matter to the next, his chief. The latter one will immediately

[1] "The Pacific Russian Scientific Investigations, Geology," by A. Kryshtofovich, p. 41.

report to the Governor of his province. In the report it is necessary to explain the locality as clearly as possible, to give the distances from some known town, or village, or hut, to tell of which river is the stream, on the shore of which has been found the skeleton, the tributary.

"Do not report any groundless gossip.

"If after the examination by the scientist commissioned by the Academy, the skeleton is recognized to be very good, the Academy will pay to the discoverer of the skeleton, besides the hundred rubles already paid, fifty rubles more. The discoverer is also at liberty to sell the tusks to whom he wishes. If, as it has happened now and then, the prediluvial beast should appear complete with meat and hide, it would be a great opportunity. It would be necessary to hurry the report. If the commissioner of the Academy should find even a little of the meat and hide not decayed, the Academy will pay three hundred rubles to the discoverer of the prediluvial beast, who at once reported the matter.

"Besides that the commissioner would report to the Academy, if anybody should get a honorary reward for his work and zeal in the interests of the cause."

The premium has not met with as much success as had been expected. It took a long time to bring the news of the premium to the knowledge of the people in the Far North of Siberia. Besides that, the natives, the first discoverers of frozen carcasses of ancient animals, were usually not very enthusiastic to hunt for the promised 300 rubles, or even for 1000 rubles when the premium was increased to this amount by the Siberian General-Governor Anuchin.[1] They thought the premium could not recompense them for all the troubles connected with the arrival of an expedition and with the travel of government officials, as they had the chance to learn by sad experience during the Adams' expedition to the delta of Lena River, in 1806, which had given the local population much trouble. A good example of this behavior is the history of the well-preserved carcass of the mammoth found by natives, in 1857, at the mouth of Lena River, on the Mostak Island, but not reported at all to authorities or to the Academy of Sciences either. When Ispravnik (a chief of police) of Verkhoyansk district happened to learn of this discovery and asked for details, he was told that the carcass had been destroyed and carried away with water, after which he, naturally, did no further questioning.[2] As matter of fact the remnants of this mammoth were found by Bunge twenty-five years later, on the same spot. Even Bunge was not told about it immediately after his arrival at the Lena Delta, although he asked particularly for mammoth carcasses. He learned of this mammoth, perhaps, only for the reason that it was impossible to keep any longer a secret, the mammoth was located only twenty-five miles southwest of the meteorological station of the expedition. In the same way Maydell during his hunting for the mammoth more than once came across an unwillingness to say anything of carcasses of mammoth, which attitude, in his opinion, "had been the result of the Adams' expedition, which is still remembered resentfully by all the Yakuts; so that, whenever possible, they conceal all finds, fearing to be forced to work and provide haulage."[3] Remnants of a mammoth found on the Kolyma River, of which Maydell learned during this journey, had been known to natives for some three years, but had been kept secret by them, as they were fearing to be compelled to dig out the bones

[1] Toll, Ed., "Die fossile Eislager," S. 81.
[2] Bunge, A., "Die Lena-Expedition," S. 51.
[3] Maydell's letter to Dr. L. Schrenck, of February 19, 1869, reprinted in Digby, B., "The Mammoth," p. 83.

and transport them. They had also forbidden the Yakut, who was in Maydell's service to acquaint him with the find.[1]

The natives were also not very anxious to look for the frozen carcasses, because in their superstition they believe that such a discovery sometimes could have bad consequences for the discoverer. Adams, while on his expedition, was told, for example, about a Tungus who died, with all his family, after he had had the bad luck to look at a frozen mammoth.[2] Even in recent times the native who came across the Beresovca mammoth was much afraid of his discovery. Pfizenmayer tells us in his book that during the excavation work on the River Beresovca the expedition used to be visited by natives. While on his last visit a Lamut, who in meantime became a good friend of the party, in saying good-by, expressed his hope and sincere wish that Pfizenmayer would be saved of any wretchedness on account of the carcass of the mammoth.[3] Even local Russian populations are not less, or only a little less, superstitious as compared with the natives. When, seven years later, Pfizenmayer again visited Northern Siberia he was told of the misfortunes affecting almost everybody who had been in any way connected with the discovery and excavation of the Beresovca mammoth. The cossack Yavlovski, who had reported this mammoth, became insane and perished as the result of drunkenness. Ispravnik (chief of police) Horn who had visited the locality and reported the matter to the Academy of Sciences, died shortly after, only two days before the day he was to receive a cross of honor bestowed on him by the Czar for his service in this case. The untimely death of the leader of the expedition, Herz, who passed away two years after the expedition, was attributed also to the mammoth. The good health of Pfizenmayer gave the people no trouble, as they believed his sad fate was only postponed for a while.[4]

At the same time, the natives are hunting very eagerly for ivory, which, perhaps, proves that the discovery of carcasses of the mammoth is not such a common thing, as of its skeleton, skull, and isolated bones, which provoke no respect from the local people.

News of the discovery of frozen carcasses used to reach the outside world only when a rumor became known to local traders, priests, or Government officials, the people who could expect to earn something from every expedition, much more from a successful one, without danger of losing anything in any case. It was only the good will of a Government officer which caused him to forward farther a report on a carcass found by natives or hunters, as he must be more or less sure that the matter was worthy of attention, and that he would not be reprimanded by his chief, the Governor of his province, through whom was carried on all the correspondence with St. Petersburg. Therefore, they were acting differently. Some of them, probably afraid of possible troubles, used to try to conceal discoveries and urged the natives not to report them, even ordering the latter whipped[5] when they were not willing to keep the matter secret. Other more ambitious officials were sometimes too eager to report immediately a new-found carcass without having checked the discovery. Only a few of them could be given credit for a preliminary investigation of the locality where a frozen animal had been reported found by natives. As

[1] Maydell's letter to Dr. L. Schrenck, of April 17, 1870, reprinted in Digby, B., "The Mammoth," p. 97.
[2] Howorth, H. H., "The Mammoth and the Flood," p. 83.
[3] Pfizenmayer, E. W., "Mammutleichen," S. 164.
[4] Pfizenmayer, E. W., "Mammutleichen," S. 221.
[5] Toll, Ed., "The fossil Glaciers of New Siberian Islands," Russian Edition published by the Russian Geographical Society in 1897, p. 123.

matter of fact, in most cases no carcass was found at all by the expeditions commissioned by the Academy of Sciences to the reported localities, although they had a good chance to accomplish a great deal of scientific work and contributed much to the knowledge of the mammoth. At the same time almost every expedition to Northern Siberia used to come across the remnants of mammoth which often had been known to local people for years, but were never reported to the Academy, although some of them, perhaps, had been discovered in very good conditions. So far as the writer is able to recollect, the premium referred to, during a hundred years of hunting for mammoth, was paid only once, for the discovery of the famous mammoth from the Beresovca River. Cossack Yavlovski who had reported this discovery to the Academy, received in premium a thousand rubles which on the same evening he gambled away. He was also rewarded with a silver medal.[1]

The rumor of the discovery of the Beresovca mammoth, its successful transportation to St. Petersburg, pecuniary and other rewards given for the discovery and for the work accomplished later, spread very quickly over Northern Siberia, often in an exaggerated form, and gave an impetus to the hunting for mammoths and to a rather undesirable marketing of found or supposed finds of carcasses. Having been afraid that the speculation could go too far and in some cases contribute to the destruction of found carcasses, the Academy, in 1910, worked out a new law proclaiming as national property all the carcasses of the Pleistocene animals found in the frozen ground of Siberia, as well as in other parts of Russia.[2] Once found they have to be reported at once to authorities and delivered to Russian scientific institutes. The discoverer must be awarded with the premium in amount 300–500 rubles plus the market price of tusks, if they should be present. After some alterations the law was worked out in the following form in which it was submitted, in 1914, to the Gosudarstvennaya Duma, by which, however, it was not passed, because its regular work has been interrupted since the World War and Russian Revolution.

1. The complete carcasses, or their parts, as well as all the remnants of the mammoth, extinct rhinoceros, and other extinct animals are a national property.

2. Everybody who happens to find the above mentioned remnants is obliged to report to the local executives, and through them, or directly, to the Imperial Academy of Sciences, Imperial Universities, Geological Committee of the Department of Commerce and Industry, Catherine II School of Mines in St. Petersburg and at Ecaterinoslav, or any other Government Institution in possession of geological and zoological museums or collections.

3. Local executives must guard the remnants of extinct animals before the arrival of people commissioned to dig them out.

4. Everybody who discovers such remnants and reports them, will be remunerated according to regulations which formerly were published by the Senate.

5. Systematic excavation of the remnants of large vertebrates on the State lands is permitted to all Government Institutions mentioned above in p. 2, also to Russian Natural Science Societies. All collections become a property of organizations which were paying for the expenses of excavation. Private individuals may be granted the privilege of carrying on the same work only in exceptional cases, every time with special permission by the Minister of Education and with the consent of Departments interested in this matter.

[1] Pfizenmayer, E. W., "Mammutleichen," S. 188.

[2] Meeting of the Physico-Mathematic Section of the Russian Academy of Sciences, March 3, 1910: Bull. Acad. Sc., IV, p. 587, St. Petersburg, 1910.

6. Excavation of remnants of extinct animals on private lands may be carried on only with the permission of the proprietors of these lands. In cases of exceptional scientific importance when such a permission would not be granted, institutions and societies mentioned above in p. 2 are at liberty to request an expropriation of localities of remnants referred to on basis of article 575 and later civil laws (Russian Code, Vol. X, part 1, edition 1900 and 1912).

7. An export of the remnants of animals mentioned in p. 1 is granted only by permission of the Minister of Education and with the consent of Departments interested in this matter.

At very last time Academy of Sciences published and distributed a new announcement. It has on top a picture of a mammoth wandering on the snow covered shore of a river or lake. Its content is as follows.

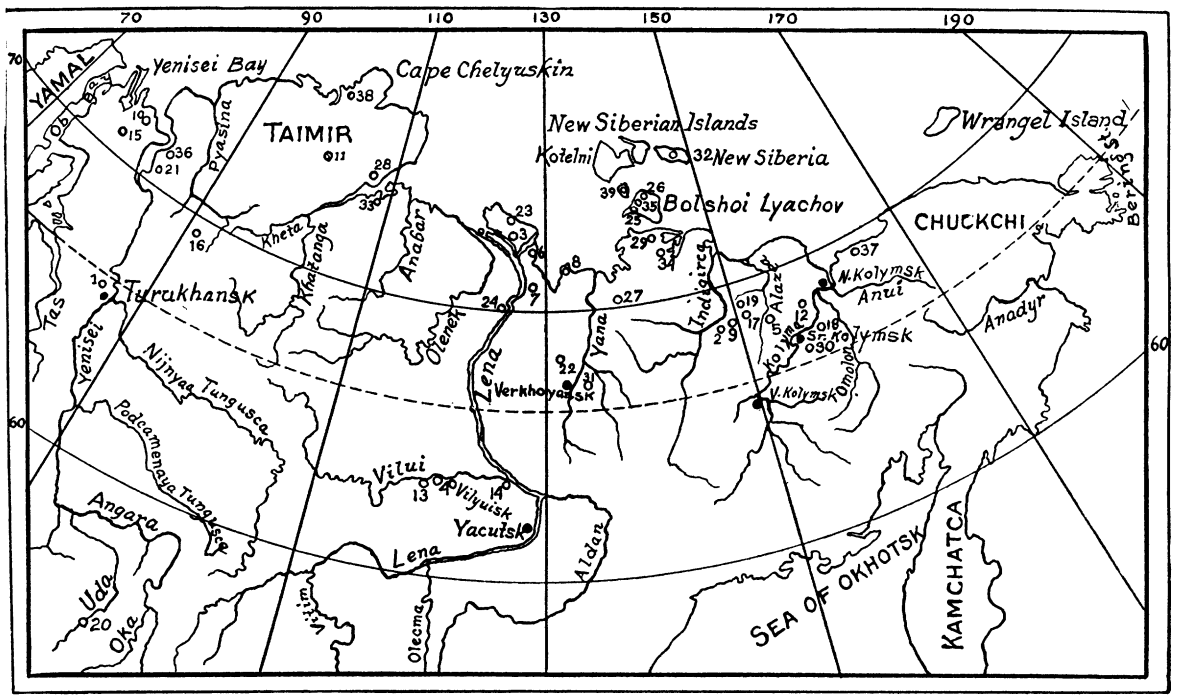
On the discovery of fossil animals.

While collecting mammoth bone, you can come across a carcass, skeleton, or skull of some animal unfamiliar to you, or not living more in your region, as, for example, of a mammoth, rhinoceros, wild ox, wild horse, wild sheep, washed out somewhere in a ravine, near rivers and streams, also on sea shore, or appeared within a landslide. Such a discovery has a great scientific interest. Therefore the Yakutsk Commission of the Academy of Sciences announce that every prompt report of such a discovery will be rewarded. A reporter will receive, according to scientific value of found remnants, *a cash reward up to 500 rubles and different fabrics, tobacco and food supplies up to the value of 200 rubles.*

The expeditions at different times sent by the Academy to Northern Siberia were hunting for the mammoth. The wooly rhinoceros (*Rhinoceros tichorhinus* Fisch.) found in the same conditions, used to attract less attention and was reported only in rare cases, perhaps, because its remnants have only a small commercial value in comparison with the mammoth. Besides, carcasses of rhinoceros are found more rarely. Carcasses of other animals, as of the musk, ox, horse, etc., must be very common in the frozen ground of Siberia, but local people usually do not pay any attention to them, and stories of their discoveries used to be told only occasionally to the scientists who happened to visit the particular spot where such an animal had been found.

A few preliminary remarks are necessary concerning the frozen ground of Siberia, in which are found frozen carcasses. It is necessary to distinguish the frozen ground, i.e. sand, clay, etc., transformed, with the water frozen within, into a peculiar rock, and pure ice found in frozen ground in masses of very different dimensions, from thin layers and small lumps to the accumulations composing large mounds. Frozen ground, inclusive ice, is dependent, as to its origin, upon climatic conditions: the average annual temperature below the freezing point, and dry climate connected with scarcity of snow in winter. The origin of ground ice, besides that, is dependent upon some special conditions, the discussion of which would be beyond limits of the present article.

MAP OF LOCALITIES



List of Localities of Frozen Carcasses Given on the Map

1. Ysbrand Ydes, 1692...Mammoth
2. Messerschmidt, 1724...Mammoth
3. Adams, 1780.....Mammoth
4. Pallas, 1771.....Rhinoceros
5. Sarychev, 1787.....Mammoth
6. Adams, 1799.....Mammoth
7. Adams, 1797.....Mammoth
8. Potapov, 1800.....Mammoth
9. Rozhin, 1839.....Mammoth
10. Mochulsky, 1839.....Mammoth
11. Middendorff, 1843.....Mammoth
12. Khitrovo, 1854.....Mammoth
13. Stubendorff, 1858.....Rhinoceros
14. Kolesov, 1863.....Mammoth?
15. Schmidt, 1864.....Mammoth
16. Schmidt, 1866.....Mammoth
17. Maydell, 1867.....Mammoth
18. Maydell, 1870.....Mammoth
19. Maydell, 1870.....Mammoth
20. Tscherski, 1875.....Rhinoceros
21. Nordenskiöld, 1876....Mammoth
22. Gorokhov, 1877 .....Rhinoceros
23. Bunge, 1857.....Mammoth
24. Bunge, 1879.....Mammoth
25. Bunge, 1866.....Mammoth
26. Toll, 1860.....Mammoth
27. Toll, 1863.....Mammoth
28. Burimovich, 1899.....Mammoth
29. Toll, 1891.....Mammoth
30. Herz, 1900.....Mammoth
31. Pfizenmayer, 1901.....Rhinoceros
32. Brusnev, 1903.....Mammoth
33. Tolmachoff, 1905.....Mammoth
34. Vollosovich, 1907.....Mammoth
35. Stenbok-Fermor, 1906..Mammoth
36. Kootomanov, 1909....Mammoth
37. Soloviev, 1910.....Mammoth
38. Transehe, 1915.....Mammoth
39. Andrews, 1923.....Mammoth

RECORDED DISCOVERIES OF THE CARCASSES OF THE MAMMOTH AND RHINOCEROS

TRAVELERS of the seventeenth and eighteenth centuries, when dealing with Siberia, give a lot of information on the carcasses of mammoths found in the frozen ground of Siberia, including the descriptions of a few particular discoveries which are recorded in the following. Even speaking of different legends on the mammoth among the natives and Russians in Siberia they give much information referring not to the legendary animal, but to real carcasses of it which from time to time used to be found in different parts of Siberia.

Witsen during his stay in Russia, in 1686, brought together a lot of information on the mammoth, which refers to the carcass of the animal. He says that a mammoth was of a dark-brown color and emitted a great stench. Its tail was like a horse, and its feet short.[1]

The first direct mention of a carcass of a mammoth discovered in the frozen ground of Siberia belongs to Ysbrand Ides who, in 1692, was sent by Peter the Great as an envoy to China (1).[2] On his way through Siberia he had along with him a man who used to travel annually for the collection of fossil ivory, and who told him he had once found a head of a mammoth in a piece of frozen earth which had tumbled down.[3] The soft parts of the head were putrefied, but the bones were still colored with blood. He found also a frozen foot of the girth of a man, which with the assistance of his companions he cut off and took to Turukhansk. With some difficulty he also broke out the teeth which, he said, were placed before the mouth like those of an elephant. The mention of Turukhansk brings Nordenskiöld to the conclusion that the mammoth under consideration was found somewhere on the lower Yenisei, or anyhow not very far from this river.[4] To this mammoth, probably, Pfizenmayer refers,[5] while speaking of the carcass of a mammoth found by cossacks, in 1692, on the River Yenisei. Ydes was already familiar with the fact that these elephants used to be found on high banks of rivers, imbedded in the frozen ground from which they were washed out during the spring flood. Remnants of the mammoth (tongues and legs, as mentioned by Ides) happened to be found particularly often on the shores of the rivers Yenisei, Turukhan, Mangamzea, Lena and near Yakutsk, to as far as the Frozen Sea.

J. B. Müller, one of the Swedish prisoners of war in Siberia, in his memoir on the customs of Ostyaks, published in 1720, among other stories on the mammoth speaks of the bloody bones of this animal and of clotted blood within the cavities of its bones.[6]

Laurence Lange, in his narrative of a journey to China, speaking of the mammoth, reports that several people assured him that they had seen the bodies of this animal with flesh and blood still remaining.[7]

[1] Howorth, H. H., "The Mammoth and the Flood," pp. 74 and 80.
[2] Figure in brackets in this, as in other similar cases, refers to the number of locality on the map.
[3] Ides, Y. E., "Three Years Travels," p. 25.
[4] Nordenskiöld, A. E., "Die Umseglung Asiens und Europa," I, S. 365.
[5] Pfizenmayer, E. W., "Mammutleichen," S. 23.
[6] Howorth, H. H., "The Mammoth and the Flood," pp. 75 and 80.
[7] Howorth, H. H., "The Mammoth and the Flood," pp. 74 and 80.

Tatischev, the Chief of the Altaï Mining District at the beginning of the eighteenth century, speaks also of the mammoth bones still colored with blood, which used to be found by natives.[1]

Dr. D. G. Messerschmidt who had been sent by Peter the Great to Siberia on a special mission, to study its natural history, brought back a short report on remnants of the carcass of a mammoth found on the Indigirca River along with the skeleton of another mammoth (2). For some reason he found it necessary to get a solemn confirmation of this discovery written by an eye-witness in the following form:[2]

"Whereas Mr. Messerschmidt entreated me to let him know where the head of the mammoth with its teeth and other parts were found; as I was an eye-witness to the digging it up I thought proper to give him this short account thereof in writing. That head was found by a certain Russian soldier, Vasili Erlov, on the eastern bank of the river Indigirca, not far from the rivulet Volocovoi Ruchei. After it was discovered, I, being at leisure, was present and eye-witness to the digging up of this skeleton or bones; and further likewise on the other bank of the same river, which bank is named Sztanoiyar, I saw a piece of skin putrefied, appearing out of the side of a sand-hill, which was pretty large, thick-set, and brown, somewhat resembling goat's hair, which skin I could not take for that of a goat, but of a Behamoth; inasmuch as I could not appropriate it to any animal that I knew. This I certify by this Latin testimonial for the present and even hold it my duty to give a more circumstantial verbal account whenever Her Imperial Majesty shall be graciously pleased to lay Her royal commands on me."

Dated at Irkutsk, Feb. 10, 1724. (Signed) Michael Wolochowich.

Khariton Laptev during his cruising, in 1739, along the northern coast of Siberia, east of the Lena River, had the opportunity to hear much about the discovery of mammoth corpses, as well as to observe their remnants in the ground. "On the banks of several rivers on the tundra whole mammoths with their tusks are dug out with thick hides on them. Their hair and bodies are, however, rotten, while the bones, except the tusks, are also decaying," says he in a rather general way. In a short description of some fossil heads given by him we recognize not the mammoth, but a rhinoceros.[3]

During his expedition to the delta of Lena River, in 1806, Adams was told by a Tungus that an animal similar to that examined by Adams, covered with hair, had been discovered a number of years before at the mouth of Lena River (3). The Tungus who had been unlucky enough to look at the animal had died immediately, with all his family. The recorded discovery, probably, took place sometime during the second half of the eighteenth century.[4]

It happened to be the carcass of a rhinoceros (*Rhinoceros tichorhinus* Fisch.) found, in 1771, by Yakuts on Vilui River, about 25 miles above the small town Vilyuisk,[5] which was not only discovered or mentioned by some traveler, but for the first time a part of it, although not the whole (a head, two legs, and a piece of hide), was delivered to St. Petersburg and deposited at the Museum of the Academy. The importance of this discovery was admirably expressed by Cuvier, who said: "Il est heureux du moins que les parties

[1] Howorth, H. H., "The Mammoth and the Flood," pp. 76 and 80.
[2] Howorth, H. H., "The Mammoth and the Flood," p. 81.
[3] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 277.
[4] Howorth, H. H., "The Mammoth and the Flood," p. 83; Middendorff, A. Th., "Sibirische Reise, IV," I, S. 276.
[5] Pallas, P. S., "Voyages du Professeur Pallas, V," pp. 215–218.

les plus essentielles de ce monuments d'un genre et d'une date si extraordinaire, soient désormais à l'abri de la destruction." [1] A forefoot and the upper part of a hind leg later were burned through careless drying.[2] The animal was found on the low shore of the river, partly embedded in sand, and had been preserved in frozen sandy ground on the high banks of the river (4). The head and legs were chopped off by aborigines and sent to Yakutsk and Irkutsk. The head and two legs (anterior and posterior one) were delivered to Irkutsk where Pallas at that time happened to be, and he immediately brought together all available information concerning the locality and described the remnants.[3] According to Pfizenmayer these precious remnants were presented to the Empress Cathrine II for the Kunstkamera by the Archbishop of Tobolsk.[4]

In 1787 a carcass of a mammoth was found on the Alazea River. The discovery was reported to the Captain Sarychev of the Russian Navy who at that time traveled from Sredne-Kolymsk to Yakutsk. It was described as a skeleton of a great animal of which only one half was visible, washed out of the sand bank of the Alazea River (5). It was about the size of an elephant, was found in an upright position, still retained its skin, and, in some places, its hair. A recent heavy fall of snow, combined with the necessity of making a long detour prevented Sarychev from visiting the locality, and from allowing his companion, Dr. Merck, to go over there, although the latter was very anxious to investigate the locality.[5]

The first carcass of a mammoth, the remnants of which have found their way into museums, had been found, in 1799, in the delta of the Lena River, at the latitude of 72° and 130° east of Greenwich, near the Cape Bycov (6) by a Tungus named Shumakhov who had noticed at first only an indeterminable, but queer looking mass within the frozen ground on a cliff. After that he used to visit the place every year and observe it, as more and more of the animal appeared out of the ground. On the fifth year the cliff underthawed, and the carcass slipped down to the sandy shore where it could be well examined. At that time Tungus chopped off its tusks and bartered them for a value of fifty rubles. About the same time the carcass had been seen by a local trader, by name Boltunov, who described [6] it and prepared a rough, schematical drawing of the animal, which, as an original or a copy, was sent by Adams to Blumenbach at Göttingen and later was reproduced by Baer.[7]

In 1806 to Yakutsk happened to come the zoologist, M. F. Adams, a member of the Russian Academy of Sciences, who at that time traveled through Siberia with Count Golovin, Russian Ambassador to Pekin. Adams learned about the discovery of the carcass and immediately left for the Lena delta. In the meantime the carcass suffered very much. The trunk which Boltunov had well described, was no longer there, nor was the short (about 10 inches long) tail. Of two ears, each over ten inches long, was found only one. One eye was found still keeping its color, destroyed later in the process of drying out. Other soft parts, with the exception of the skin on the head, on a foot, and on the side on

[1] Cuvier, G., "Recherches sur les ossements fossiles, II," I, p. 88.
[2] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 272.
[3] Pallas, P. S., "De reliquiis animalium exoticorum. After Tscherski, I. D., Beschreibung der Sammlung," S. 3.
[4] Pfizenmayer, E. W., "Mammutleichen," S. 243.
[5] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 277.
[6] Published by Severgin (in Russian) in Tekhnologicheski Journal, 111, 4, p. 162, St. Petersburg, 1806. After Baer, K. E., Neue auffindung eines vollständigen Mammuths, S. 278.
[7] Baer, K. E., "Fortsetzung der Berichte über die Expedition," plate.

which the animal had lain, had been destroyed completely by wild animals and dogs which local Yakuts had fed on Mammoth meat during the shortage of dog food. Shumakhov described the animal to Adams as very well fed and fat. It was a male with a long mane. The part of the hide preserved in the ground was covered with thick hair. Adams secured a portion of this hide which was so heavy that ten men with difficulty dragged it to the bank. He also collected about a pood (36 lbs.) of long hair, which lay scattered about the ground round about.

This carcass of the mammoth undoubtedly was the best one ever found. If a scientist could have arrived at the locality during the first four years when the Tungus discoverer used to watch patiently his animal still frozen in the ground within the cliff, he could have examined the body just in the condition in which it had been buried, without any more recent damage.

The tusks of the animal had been cut in pieces and sold in Moscow, a long time before it was examined by Adams. After the Adams inquiry, they were found to be ten feet long and weighed 360 pounds. To complete the skeleton, Adams had purchased at Yakutsk two tusks and fixed them later to the skeleton. According to Pfizenmayer [1] they had been restored (when and where (?)) from fragments (three in the right tusk, two in the left one), the interstices between filled up with some mastic so perfect that this nature of the tusks has been never noticed before, and Brandt even emphasized that the tusks were of a single piece, although not belonging to the specimen.[2] Pohlig, who had the chance to examine remnants of the mammoth at the St. Petersburg Zoological Museum, also failed to notice the composite character of the tusks, but showed that both of them had been taken from different and smaller specimens than the Adams mammoth.[3] In spite of that, the position of the tusks, which Adams fixed without much reason in such a way that the ends were widely separated and turned over to the right and left sides respectively, became commonly known and generally recognized. It happened, perhaps, because of the reproduction of the picture of the Adams mammoth by Cuvier who sanctioned the restoration, not having been able to discover all its defects.[4] As it was proved about a hundred years later, the tusks of the mammoth were approaching each other at their distal ends.[5] With the exception of tusks and a forefoot the skeleton was nearly complete. Bones at Yakutsk were cleaned by Adams from meat and ligaments by boiling.

Besides those possessed by the Zoological Museum of the Russian Academy of Sciences, a few pieces of skin and some hair, through the Russian Ambassador Golovin, found their way into the Natural Science Museum at Stuttgart, Germany,[6] and some also were sent to Sir Joseph Bancs and deposited by him at the Royal College of Surgeons in London.[7] A piece of the hide happened to be at the Zoological Museum in Berlin, where its hair was examined and described by Möbius.[8] Middendorff also saw hair of this mammoth at the University Museum in Moscow.[9]

[1] Pfizenmayer, E., "Morphologie von Elephas primigenius Blum.," S. 540. Also Mammutleichen, S. 240.

[2] Brandt, J. F., "Mittheilungen über die Gestalt," S. 96, footnote.

[3] Pohlig, H., "Monographie über die fossilen Elephanten," S. 323 and 388. After Pfizenmayer, E. W., "Mammutleichen," S. 241.

[4] Cuvier, G., "Recherches sur les ossements fossiles," 1, pl. xl.

[5] Pfizenmayer, E., "Morphologie von Elephas primigenius Blum.," S. 531.

[6] Brandt, J. F., "Finige Wörte über die Haardecke des Mammuths," S. 348.

[7] Middendorff, A. Th., "Sibirische Reise," IV, 1, S. 278.

[8] Möbius, K., "Die Beharung des Mammuts. After Pfizenmayer, E., Morphologie von Elephas primigenius Blum.," S. 527.

[9] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 278.

The description of the locality as given by Adams [1] was not quite exact and provoked the false idea that the mammoth had been buried in ice. Toll proved later that this mammoth, as many others, was found in frozen ground, and the ice mentioned by Adams had been within ice cliffs near by the locality and underlain the mammoth bearing layer of frozen ground.[2] In spite of that, Pfizenmayer again speaks of this mammoth as of one found "within a gigantic piece of fossil coast-ice." [3] However, in another place he suggests that the animal had plunged into a crevasse and had been buried there within silt quickly frozen under a low temperature.[4] Adams also examined the nearby shore hills in one of which his mammoth had been found. They were covered on the top with tundra from which protruded the pieces of buried wood and plenty of tusks of mammoth in a surprisingly good state of preservation.

According to the Russian mining engineer Zlobin who visited the place in 1830, with a companion of Adams, trader Belcov, and later told Middendorff [5] of his observations, the mammoth had been found in a secondary location, as the carcass had slipped down the hill 35 feet high.[6]

The last time the locality was examined was during the Lena expedition, 1882–1884, by A. A. Bunge, who gave a detailed geographical and geological description of the Bycov Peninsula called Tumus or Tumul Peninsula by Yakuts.[7] According to Bunge the peninsula is a part of the delta of the Lena River, the carcass of the Adams mammoth was therefore buried within old river deposits and had been brought to its burial place by the Lena River, as were of course, the remnants of other Post-Pliocene mammals found here. Toll denies the delta origin of the Bycov Peninsula and considers it a part of the northern shore of Siberia, having the same geological structure a long distance east of the mouth of the Lena River.[8] As the shore referred to is composed mostly of silt and has been originated by means of the work of rivers, the question on the Bycov Peninsula, as a part of the delta of the Lena River, arouses only an academic interest.

Describing the locality of his mammoth, Adams speaks also of another carcass of a mammoth found two years before his own discovery, on the banks of the Lena River, a long way from the sea (7). This locality was not visited by him or by anyone else, and the carcass referred to has been lost to science.[9]

Tilesius,[10] while on his way to Kamchatka in 1805, was told by one Potapov, a Russian seaman, that a short time before, i.e. at the very beginning of the nineteenth century, the latter had seen on the shores of the Polar Sea, a mammoth with skin (8). Potapov presented Tilesius with a bunch of the hair from this carcass, which Tilesius in turn sent on to Blumenbach.

Shortly after the Adams expedition, in 1809, a Russian Government official, Hedenström by name, visited and later described the New Siberian Islands.[11] He was not a

[1] Adams, M., "Relation abrégée d'un voyage à la mer glaciale." The writer consulted the Russian translation of this article published in the *Sibirski Vestnik*, 1820, X, p. 307, St. Petersburg, 1920.
[2] Toll, Ed., "Die fossilen Eislager," S. 9.
[3] Pfizenmayer, E. W., "Mammutleichen," S. 24.
[4] Pfizenmayer, E. W., "Mammutleichen," S. 132.
[5] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 294.
[6] Brandt, J. F., "Mittheilungen über die Gestalt," S. 103.
[7] Bunge, A., "Die Lena Expedition," S. 40–46.
[8] Toll, Ed., "Die fossilen Eislager," S. 14.
[9] Howorth, H. H., "The Mammoth and the Flood," p. 83.
[10] Howorth, H. H., "The Mammoth and the Flood," p. 83.
[11] Hedenström, M., "Travel to the Ice Sea," Hedenström, M., "Otrivki o Sibiri," p. 129.

scientist and was not looking for the carcasses of a mammoth, but could not pass by abundant fossil bones preserved just so well as the bones of recent animals could be. In a rather humorous way he tells, how he collected a large sack of bones of a mammoth, still containing marrow, with the intention of bringing them back and utilizing their fat for some pharmaceutic purpose, or for perfumery. During his travel home the bones by chance happened to be brought into a house and put too closely to a fire with the result that the fat flowed out, and Hedenström was deprived the opportunity to prepare a sensational "Pommade à Mammouth" to use his expression. This sad story shows very well, how fresh the remnants of these animals used to be. He was surprised that the marrow "in spite of its old age" did not emit a putrid scent.[1]

Maydell during his travels in Northeastern Siberia was told that nearly thirty years before, i.e. about in 1839, an ivory hunter by the name of Rozhin had found a carcass of a mammoth on the Shangin River, a tributary of river Indigirka, about a hundred miles above its embouchure (9). The mammoth had been found in an upright position with its head and forefeet, all covered with hair, protruding from the bluff. The remnant, i.e. the largest part of the carcass, had been still preserved within ground. Nothing else was known later about this specimen, probably, one of the best, which has been therefore lost to science.[2]

In 1839 a partially destroyed frozen carcass of a mammoth had been found by Samoyeds on Tas River, as it was reported by them, washed out of the bank of the river. Speaking of the animal they told, among other things, about a black tongue of the length of a month-old reindeer calf, which could have been nothing else than a trunk, afterwards destroyed completely. They also spoke of the flapping ears of the animal. At that time a Russian entomologist Mochulsky happened to be at Tobolsk and to learn about this discovery. He undertook the necessary steps to save for science what was possible to save. A merchant of Berezof, Trofimof, visited the locality and brought to Obdorsk the parts of the skeleton, some hair, probably, from the mane of the animal, and a few pounds of flesh. From Obdorsk these remnants have found their way into the Museum of the University of Moscow.[3] Soft parts were collected and delivered in a shapeless heap. They were microscopically examined and described by Glebov [4] who found within them tissues, hide, fat, and brain. The remnants of the dried brain were sent on from Moscow to the St. Petersburg Academy of Sciences. The locality was given by Trofimov on the left side of the Yenisei River, about fifty miles from its mouth, not far from the river itself. According to Schmidt, who had also the chance to visit these regions, the specimen under consideration had been found near Zimovie Krestovskoye close to the Arctic Sea (10).

During his travel in Northern Siberia, in 1843, Middendorff chanced to discover the remnants of a half-grown mammoth, which he found on the Taimir River, near the mouth of the latter, at the latitude of about 75° (11). The skeleton was fairly complete and intact, but the bones of it were rotten, softened, and covered with black, fatty soil over an inch thick. As an organic substance was found in this soil later, it probably had originated from the soft parts of the carcass. The animal laid on the left side in a layer of sand and

[1] Hedenström, M., "Otrivki o Sibiri," p. 121.
[2] Maydell, G., "Reisen und Forschungen im Jakutischen Gebiet," I, S. 426, Anm. 77.
[3] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 272, Anmerkung.
[4] Gleboff, Recherches microscopiques sur les parties molles du mammouth: after Middendorff, A. Th., "Sibirische Reise, IV," I, S. 272, Anmerkung.

clay, 5 to 7 feet below the surface, on a bank of the river, which was 42 feet high and composed of coarse sand, with boulders. In the opinion of Middendorff the mammoth in this particular case had not been buried on the very spot of his death, but its carcass had been brought by the river to its present location from more southern parts of Siberia.[1]

In 1848, the carcass of a mammoth was reported found on the Indigirca River by Benkendorff, a member of a Russian topographical expedition to Northern Siberia. The carcass, as it was told, was detached from the frozen banks of the river, and was careering about in the flood, when Benkendorff came across, secured it with a rope, examined the body, also the content of its stomach, but lost it when a sudden rush of water carried it away.[2] No attention is paid to this "discovery" in papers on the Mammoth of Russian scientists, as for example, by Baer, Brandt, Schrenck, Schmidt. Howorth quite correctly considers it a fiction written just for a boys' book.[3] The article was reprinted by Middendorff,[4] but he only "wished not to deprive pleasure to his readers." Such an expedition never took place to this part of Siberia. The first steamer arrived to the Lena River only with the Nordenskiöld expedition in the "Vega," in 1881. However, the mentioning of this article is necessary, because, apparently, sometimes it happened to be considered not quite from the point of view advocated by the writer.[5]

In 1854 the Museum of Geographical Society at Irkutsk, Siberia, got a foot of a mammoth from the Archbishop Nil, covered with hair. It was an only remnant of the carcass of the mammoth which had been found, presumably, in very good condition a few years before on the Kolyma River (12) by the local missionary Khitrovo who reported the matter to his chief and sent him a foot. The Archbishop, on the advice of one Stschukin, who learned about this discovery, presented it to the Museum of the Geographical Society at Irkutsk. Here the foot was seen by Schmidt who visited Irkutsk during his Mammoth expedition. The mammoth in this particular case had fallen down into the river from the underwashed shore cliff. Khitrovo reported also a putrid scent noticeable near the locality.[6]

In 1858, on the Vilui River, eighty miles above the town Vilyuisk, near the place known as Kentik (13), had been washed out a complete skeleton of *Rhinoceros tichorhinus* Fischer along with some soft parts, for example, six pectoral vertebrae of it were firmly connected by ligaments. These remnants were presented by Stubendorff, the Governor of the Territory of Yakutsk, to the Irkutsk Museum and then given over to the Russian Academy of Sciences. The Rhinoceros described by Pallas, perhaps, had been found at the same locality.[7]

In 1866 the Academy was told that about three years before Yakuts had found on Vilui River, near the mouth of the latter, the remnants of a large animal, mammoth or rhinoceros, covered with a skin, which they reported to the Yakutsk trader Kolesov (14). No investigation was made by Kolesov, or by the Academy either, which left all the business in the care of the East Siberian Branch of the Russian Geographical Society at Irkutsk.

[1] Middendorff, A. Th., "Sibirische Reise, I," Ss. 205–206; Bd. IV, I, Ss. 275, 284.
[2] Körber, Ph., "Kosmos für die Jugend."
[3] Howorth, H. H., "The Mammoth and the Flood," p. 90.
[4] Middendorff, A. Th., "Sibirische Reise," Bd. IV, Th. II, S. 1081.
[5] Sucachev, V. N., "Examination of Plant Remnants," p. 2.
[6] Brandt, J. F., "Zur Lebensgeschichte des Mammuth," Anhang, pp. 117–118. Also: Brandt, J. F., "Einige Wörte zur Ergänzung," p. 362.
[7] Tscherski, I. D., "Beschreibung der Sammlung," S. 31.

So far as is known, nothing was done by this scientific body either, and the carcass, if there was one, was destroyed and lost.[1]

In the same year, the Academy got word of the remnants of a mammoth found in 1864 by a Yurak (a native tribe of Northern Siberia) in the tundras between Taz and Yenisei Rivers, at the source of the River Gida (15), where he was looking for his reindeers and came across the tusk of a mammoth protruding out of the ground.[2] After some digging he discovered the head of a mammoth. He broke, or cut off a tusk, took a piece of skin, and brought all to Dudinka, a small Russian settlement on the lower Yenisei River, where it provoked a sensation unfavorable to the better preservation of such discoveries, as some people visited the locality and tried to dig out something more, destroying what had not been already destroyed. The rumor of the new found mammoth spread over Siberia and reached one Gulyaev, who at that time happened to be at Barnaul, a small town in the Altaï Region, but who had some personal connections with the far northern inhabitants. He was interested in science, and immediately appreciated the importance of this discovery: so he reported it to a member of the Academy, Dr. Baer, who brought the matter to the attention of the Academy which was thus notified of the discovery just two years after the mammoth had been found.[3] The Academy immediately decided to send over an expedition in charge of Fr. Schmidt, afterwards a member of the Academy. For this expedition, 4800 rubles [4] were assigned by the Russian State Treasury. As the particular spot where the mammoth had been found was not quite certain, Fr. Schmidt was advised to watch in the tundras for the smell which could be originated from the rotten remnants of a mammoth.[5]

Schmidt's expedition, so far as the carcass of the mammoth was concerned, was a complete failure, a few isolated and broken bones, pieces of skin and plenty of hair being all that was brought to St. Petersburg, but Schmidt collected very important data on the locality itself. For the first time a geological section of the Post-Pliocene strata was established for Northern Siberia and the relations between the mammoth-bearing strata and other ones, especially the deposits of Arctic transgression were determined. Concerning the locality of his mammoth, Fr. Schmidt came to the conclusion that the animal had been buried on the very spot where it had died, or had been moved only a very little.[6]

While in the North Fr. Schmidt learned of another skeleton of the mammoth found in the Avamskaya Tundra and eventually secured a number of bones and a quantity of the hair from this specimen (16). The lot consisted of foot-long hairs, probably from the mane, and short wooly hairs, two inches long.[7]

In 1867, a Tungus, by the name of Phoca, came across a foot of a mammoth protruding more than two feet from the ground, in the tundras between the rivers Alazea and Indigirca in Northeastern Siberia (17). There was neither meat nor skin preserved, but only liga-

[1] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., March 22, 1866: Mem. Ac. Sc., IX, p. 166, St. Petersburg, 1866.

[2] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., January 11, 1866: Mem. Acad. Sc., IX, p. 81, St. Petersburg, 1866.

[3] Baer, K. F., "Neue Auffindung eines vollständigen Mammuths," p. 230. Baer, K. E., "Fortsetzung der Berichte über die Expedition," p. 513.

[4] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., February 8, 1866: Mem. Acad. Sc., IX, p. 87, St. Petersburg, 1866.

[5] A personal communication of late Fr. Schmidt, to the writer.

[6] Schmidt, Fr., "Vorläufige Mittheilung." Schmidt, Fr., "Resultate der Mammuthexpedition."

[7] Howorth, H. H., "The Mammoth and the Flood," p. 87.

ments were found, besides the bones. The next year the same native visited the locality again, was unable to find the foot of the previous year, but discovered a small part of another one.

At that time happened G. Maydell to be traveling in Northeastern Siberia. The Academy after it had learned, from the Ispravnik (chief of police) of the Verkhoyansk District, of this discovery, asked Maydell to examine the locality discovered by Tungus Phoca, and assigned for this purpose 1500 rubles. The locality was fixed by Maydell on the small river Kovshechya (Zuskendunu in Tungusic, Khomos-Urakh in Yacutish) which enters the Arctic Sea about 40 miles west of Alazea River. The Kovshechya River is composed of two branches: the eastern one, by name Ulakhan-Khomos-Uryakh, and the western one known as Alshygy-Khomos-Uryakh, on which the mammoth was found. A reliable man, sent to the spot by Maydell, found only a foot, a piece of skin, and a skull frozen in the ground on the bottom of the valley. The man thought that the carcass of the mammoth had been washed out of the cliff, fallen down into the stream, and gradually been destroyed by water.[1]

The Kovshechya River had been mentioned by Wrangel's expedition, under the name Vshivaya or Pila, as a river which washed down off its shores many mammoth bones.[2] All this part of Northern Siberia has been known since ancient times to be extremely rich in remnants of large fossil animals. Here has been found, for example, in 1787, the mammoth mentioned above.

It was hardly surprising, therefore, that, in 1870, Maydell learned of another mammoth found on the right side of the Kolyma River (18), between Nijne-Kolymsk and Sredne-Kolymsk towns, as well as of the third one discovered at a small creek, Shadran (19), 25 miles west of the first locality on river Kovshechnaya. At the second locality there were found only bones of the animal, piled together. At the third place Maydell found a foot and a part of another one, also a layer composed of the hair of a mammoth mixed with earth. The remnants were found here in a narrow edge-like divide between two runs, and were also washed out by water. In Maydell's opinion in this case the carcass of a mammoth had fallen into the creek, gradually decayed, and at last been destroyed by the stream.[3]

In 1875, Tscherski, commissioned by the Siberian Branch of the Russian Geographical Society, happened to explore, in Southern Siberia at the latitude about 54° 25′ and about 98° 35′ E., a cave located about 40 miles south of Town Nijne-Udinsk, therefore known in Russian literature as the Nijne-Udinsk Cave. In frozen ground within the cave, among the remnants of various animals, he found a piece of hide covered with hair, which he identified *Rhinoceros tichorhinus* Fischer (20). Although this remnant could be not compared with the carcasses formerly found in Northern Siberia, it certainly is worthy of mention on account of its geographical position, so far distant from the northern localities.[4]

In 1876, Nordenskiöld collected a few bones and pieces of the hide of a mammoth shown to him by natives on the Yenisei River, at the latitude 71° 28′, at the mouth of the

[1] Maydell, G., "Reisen und Forschungen im Jakutischen Gebiet."

[2] Wrangel, F., "Narrative of an Expedition," p. 220.

[3] Schrenck, L., "Bericht über neuerdings im Norden Sibiriens angeblich zum Vorschein gekommene Mammuthe," Ss. 147–173. Maydell's letters published in this article have been reprinted by Digby in his book. Descriptions of the localities, with some comments, is given also by Toll in "Die fossilen Eislager," pp. 18–25.

[4] Bull. East Siberian Branch, Russian Geogr. Soc., Irkutsk, VI, 5 and 6, p. 211; VII, 2 and 3, p. 78; X, 1 and 2, p. 28. After Tscherski, I. D., "Beschreibung der Sammlung," S. 12.

Mesenkin River (21). The hide was 20–25 mm. thick and appeared to be naturally tanned. Presumably these remnants had been washed out of a tundra bank by the Mesenkin River. In the neighborhood was found also a skull of the musk-sheep.[1]

In 1877, the Academy got a rather vague report on a carcass of a mammoth, presumably, discovered in the Kuznetzki Alatau Mountains in Southern Siberia. Zoologist Polyacov immediately left St. Petersburg for Altaï in charge of an expedition for which the Academy had assigned a thousand rubles.[2] The locality was said to be in the valley of a small creek, Nicolca, a tributary of the Kundat River, which flows into Kiya River, at the gold placer Zolotoi Bugorok. What was considered the skin of a mammoth appeared to be mountain-leather, a mineral aggregate, which had been found immediately underlying the goldbearing sand layer, about 15 feet below the surface.[3] The chief of the local police, through whose hands had passed all the news of the mammoth discovery, and who had officially checked the report, felt that he was responsible for Polyacov's expedition and scolded the discoverer, a Siberian peasant. The chief especially reproached and treated him as a liar for the statement that the latter ate "the skin," which consideration had, probably, been for the chief a decisive argument as to the reality of the mammoth find and a sufficient reason for reporting the discovery to the Academy. The man obstinately affirmed he truly had eaten the supposed skin, but added: "seasoned with butter, what is not possible to eat."

In 1877, a carcass of a *Rhinoceros tichorhinus* Fischer perfectly preserved, with skin and hair, had been found by Yacut Gorokhov at the latitude of about 68° 30′ on the Khalbugaï Creek which flows from the right side into river Bytentaï, a left tributary of the Yana River (22). With the assistance of his son, Gorokhov chopped off a foot and the head of the animal, but left the body, which was destroyed the next year by spring water. The head was sent to Irkutsk Museum of the East Siberian Branch of the Russian Geographical Society, where it was identified and described by Tscherski.[4] The further history of this remarkable relic is certainly worth recording. In 1879 the great Irkutsk fire destroyed the Museum along with all collections and the library. The head of the rhinoceros escaped the same fate only because of the fact that a few months before it had been sent to the anthropological exhibition in Moscow. After the exhibition the head was transferred to St. Petersburg, to the Academy to which it was presented by the Irkutsk Branch of the Russian Geographical Society.[5] At the present time this specimen is exhibited at the Zoological Museum of the Academy, just in the same condition, as was brought to Irkutsk from Northern Siberia, i.e. dried, or mummified. The history of this rhinoceros is not quite correctly given by Pfizenmayer.[6] According to him the carcass was discovered in 1879. Gorokhov sent the head to some merchant at Irkutsk, and this one presented it to the Academy. By L. Schrenck, differing with Tscherski, this rhinoceros was identified

[1] Nordenskiöld, A. E., "Die Umseglung Asiens und Europas," I, S. 371.

[2] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., May 3, 1877: Mem. Academy Sc., XXX, p. 50, St. Petersburg, 1877.

[3] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., September 27, 1877: Mem. Acad. Sc., XXX, p. 81, St. Petersburg, 1877.

[4] Bull. East Siberian Branch, Russian Geographical Society, Irkutsk, IX, 5 and 6; X, 1 and 2. After Tscherski, I. D., "Beschreibung der Sammlung," S. 12.

[5] Meetings of the Physico-Mathematic Section of the Russian Academy Sc., August 28 and September 25, 1879: Mem. Acad. Sc., XXXV, pp. 111 and 116, St. Petersburg, 1879.

[6] Pfizenmayer, E. W., "Mammutleichen," S. 243.

as *Rhinoceros merckii* Jaeg.;[1] but Tscherski later verified his first identification.[2] Schrenck also suggested that this rhinoceros, like the recent one, had been deprived of fur. As Pfizenmayer has shown, the hair was destroyed, probably, through careless transportation of the head for more than two thousand miles.[3] In 1885, the locality was examined by Toll who gave its detailed description. According to Toll the carcass was washed out owing to very high level of water in the year of discovery, when the high shore of the river was underwashed, and the carcass slipped to the lower shore. In Toll's opinion the carcass was buried in the old river channel where it had been brought by the water. In other words the locality belonged to the higher, older terrace of the river.[4]

During the Lena expedition, in 1882–1884, commissioned by the Russian Academy of Sciences for the meteorological work in Northern Siberia to the mouth of the Lena River, where a special meteorological station was built up for this purpose,[5] a member of the expedition, Dr. Bunge, did a great deal of exploration and travel in the delta and paid much attention to the localities of carcasses of mammoth. He visited and closely examined the locality of the Adams mammoth. He also investigated the locality of the mammoth found, in 1857, by natives at Island Mostakh (23), but not reported to authorities and destroyed as much by natural causes as by man.[6] When this mammoth had been found its head, bearing tusks, which had appeared out of the ground first, was chopped off and sold to the local trader, Shakhurdin. The skin, according to natives, was about two inches thick, and so well preserved that it could be used to make dog harnesses. The fat was a little yellowish on the surface, but snow white deeper. It was used by natives to lubricate small local boats known as vyetca. The flesh, pink on the surface, was bright red deeper. The natives did not try to eat any of it themselves.[7] During a number of years and with the assistance of dogs and wild animals the carcass, probably one of the best ever found, was destroyed completely, and Bunge after excavating (in the meantime the carcass has been covered with sand), could collect only fragments of bones bearing the traces of axes, plenty of hair, remnants of food from the stomach of the animal, excrement, remnants of fat and of ligaments. According to Bunge, it was a young animal. The examination of the excrement of this mammoth, made by Famintzin, proved the presence of a vegetable matter within, but gave no particularly important results.[8]

At the same time Bunge learned of another mammoth found, in 1879, on Moloda Creek, a left tributary of the Lena River, above the settlement Sictakh, more than 400 miles up the river from the meteorological station (24). Here also, from a sandy bluff, at first appeared the head of the animal, the tusks of which were chopped off immediately. Bunge was unable to visit the locality, and this mammoth has been lost to science. It had never been reported to authorities.

In 1885–1886 the Academy commissioned Bunge and Toll to go to the New

[1] Schrenck, L., "Der erste Fund einer Leiche von *Rhinoceros Merkii* Jaeg." After Tscherski, I. D., "Beschreibung der Sammlung," S. 12.

[2] Tscherski, I. D., "Beschreibung der Sammlung," S. 13.

[3] Pfizenmayer, E. W., "Mammutleichen," S. 245.

[4] Toll, Ed., "Die fossilen Eislager," S. 36.

[5] It was the Russian share in a great scientific enterprise undertaken at that time by different countries in Arctic regions.

[6] Bunge, A., "Die Lena Expedition," S. 52–96 (Nachrichten über Mammuthcadaver im Unteren Lena-Gebiet).

[7] Bunge, A., "Die Lena Expedition," S. 51.

[8] "Meeting of Physico-Mathematic Section of the Russian Academy Sc., January 21, 1886: Mem. Acad. Sc., LII," p. 173, St. Petersburg, 1886.

Siberian Islands. The expedition examined also the adjacent part of Arctic Siberia.[1] During their trips each of the travelers happened to come across remnants of mammoth. In no case were they complete, but the observations made on the spot contributed a great deal to the natural history of the mammoth.

Pieces of skin and plenty of hair of a mammoth were found by Bunge protruding out of a frozen bluff on the coast of Bolshoi Lyakhov Island (25). Destroyed and incomplete bones of the same specimen were found below the spot. The marrow within the bones was chalk-like, but fresh enough to be immediately devoured by dogs. Presumably it was a complete carcass of a mammoth a few years before the arrival of the expedition.[2] Bunge's guide told him that a few years before, he had found at the bottom of the same bluff a complete carcass of a musk ox which he was able to describe so well that it was no trouble for Bunge to identify the animal. Carcasses of different animals, skeletons and isolated bones used to fall out of the bluff during the whole warm season. After a while bodies and skeletons used to be destroyed by warmth, streams of water running from the bluff, and by the waves of sea. Temporarily, bones can be buried again, plunging in the soft ground at the bottom of the bluff, ground originating from the mud streams running from the face of the bluff, or being covered with mud. Owing to the presence of a frozen ground below the thawed surface, large bones, such as the tusks of a mammoth, cannot plunge deeply, but small bones are usually buried completely. Later they can be washed out by waves and easily collected, at low tide, which usually is provoked by a favorable wind, when the shallow sea around the New Siberian Islands dries out to a great distance. A great amount of ivory used to be collected in this way by ivory-hunters. Traveling along the shore Bunge noticed also an odor of decomposition in the thawed ground, which is in his opinion, probably, peculiar for all the earthy deposits of the New Siberian Islands.

Another locality was visited by Toll on the northern shore of the Bolshoi Lyakhov Island (26). A mammoth had been discovered there by the hunter Boyarski, in 1860. Boyarski accompanied Toll to the very spot and only for this reason could the latter examine the locality, as no remnants of animal were present. The part of the bluff containing the carcass of the mammoth had been completely destroyed about 1863. The mammoth had been found by Boyarski in an upright position, frozen within the clay and sand pockets located between two ice masses composing here the cliff, and with its posterior part protruding out of the bluff.[3]

Toll, in 1886, also examined a locality of a mammoth on the mainland, at the latitude of 70° 20′, on the Boryurakh Creek, a right tributary of the Chendon River which enters the Arctic Sea about a hundred miles east of river Yana (27). Only fragments of bones, a few of soft parts, and hair were found in this locality examined by the expedition 23 years after the mammoth, probably a head only, had been discovered by Tungus Sleptzov who carelessly had chopped off the tusks and destroyed the specimen. In Toll's opinion, in this case incomplete remnants of a mammoth had been buried on the ice of flood ice, i.e. aufeis, when during the flood season they were covered with silt and later frozen within.[4]

Besides remnants of the mammoth Bunge-Toll's expedition collected also a number

[1] Beiträge zur Kenntniss des Russischen Reiches, III Folge, Bd. III, after Toll, Ed., "Die fossilen Eislager," S. 49.
[2] Toll, Ed., "Die fossile Eislager," S. 50.
[3] Toll, Ed., "Die fossilen Eislager," S. 53.
[4] Toll, Ed., "Die fossilen Eislager," S. 40.

of bones of other Post-Tertiary mammals which were identified and described in detail by Tscherski.[1]

In 1889 a discovery of a complete mammoth was reported to the Academy by the General-Governor of Eastern Siberia, as found somewhere near river Anabar in Turukhansk district of Northern Siberia.[2] Information following gave the locality on the Balakhna River near Khatanga Bay (28) at the latitude 73°. The Academy commissioned Toll to investigate this locality, but owing to the condition of his health he could not enter this enterprise.[3] A few years later, in 1893, he happened to be in these regions, but did not mention this locality. Probably, it was a rumor of no importance. This mammoth sometimes has been mentioned as the Burimovich mammoth.[4] Burimovich was the Ispravnik (chief of police) of Turukhansk district, who first has delivered the news of this discovery.

In 1891, Tscherski offered a new plan of mammoth-hunting according to which a scientist must stay in the Far North of Siberia for a couple of years and in this way to have an opportunity of checking immediately all reported discoveries of carcasses of mammoth.[5] For a scientist it would be a voluntary exile which Tscherski elected for himself, his wife, and their son of eleven years of age, when, in 1891, he left St. Petersburg for Northeastern Siberia with the intention of staying there for four years. He expected to do a regular geological work and at the same time to listen to all rumors referring to mammoth-localities. Very unfortunately his health was broken at that time and the next year he died during the boat travel down the Kolyma River.[6]

Tscherski had no chance to learn of any new mammoths, or to discover one himself either, although just at this time, in 1891, a mammoth has been discovered in Northern Siberia, on the Sanga-Yurakh River, about 250 miles east of the settlement Ust-Yansk (29), and the discovery reported to the Academy by a local trader Sannikov. Word about it was sent over to Tscherski,[7] but he could not get it. This locality was examined, in 1893, by Toll who was commissioned by the Academy to accomplish, so far as it was possible, and as time and money permitted, the work which had been started by the late Tscherski. Toll found only destroyed bones, pieces of hairy skin, and much of hair, all deposited within the alluvium of the Sanga-Yurakh River. The carcass of the animal in this case had been washed out by the river many years before, and the locality had no special interest even from a geological point of view.[8]

Probably the most important discovery of a mammoth was made, in 1900, in Northeastern Siberia, about 200 miles northeast of the small town Sredne-Kolymsk, on the river Beresovca, the right tributary of the Kolyma River (30). As usual the discoverer was a native, Lamut S. Tarabukin. In August, 1900 while hunting for a reindeer he came across a tusk of a mammoth weighing about 166 English pounds. Looking for another tusk he

[1] Tscherski, I. D., "Beschreibung der Sammlung."

[2] "Meetings of Physico-Mathematic Section of the Russian Academy Sc., April 25 and September 5, 1889: Mem. Acad. Sc., LXXI," pp. 79 and 127, St. Petersburg, 1890.

[3] Toll, Ed., "Eine Reise nach den Neusibirischen Inseln," S. 132.

[4] Digby, B., "The Mammoth," map.

[5] Tscherski, I. D., "Beschreibung der Sammlung," S. 454.

[6] On the last days of the Siberian Traveler I. D. Tscherski.

[7] "Meeting of the Physico-Mathematic Section of the Russian Academy Sc., January 15, 1892: Mem. Acad. Sc., XLIX," p. 54, St. Petersburg, 1892.

[8] Toll, Ed., "Eine Reise nach den Neusibirischen Inseln."

discovered a well preserved head of a mammoth bearing only one tusk of much smaller dimensions than the first one, about 63 lbs. as it was found later.

As Lamuts believe that the excavation of a mammoth produces sickness, Tarabukin was rather afraid of his discovery, did not touch the carcass, but returned immediately to his camp and told two other Lamuts about the mammoth. The next day they visited the locality, chopped off the tusk, but did not touch the carcass. Examining the locality, the Lamuts came to conclusion that the head of the animal had appeared out of the ground during the previous season, i.e. in 1899. The tusks were later sold to a Russian cossack, Yavlovski, who learned about the mammoth on that occasion from the Lamuts, and persuaded them to show him the locality. After the discovery had been checked, Yavlovski received from the Lamuts their claim to the mammoth, reported the matter to local authorities and, through their assistance, to the Academy. The carcass he covered for a while with sand and stones. The news of this mammoth arrived to St. Petersburg in April, 1901. It was immediately resolved to send an expedition composed of three people: the leader, a zoologist, O. Herz, a taxidermist, E. Pfizenmayer, and a geologist, D. Selivanov. 16300 rubles were assigned to the Academy from the State treasury for this expedition. Later this sum was increased by a few thousand rubles, a part of which was given by the Grand Duke Constantine, the President of the Academy at that time, who returned to the Academy his salary of the President to cover some extra expenses of the expedition.

The expedition left St. Petersburg on May 3/16, 1901, in June arrived in Yakutsk and immediately left for Sredne-Kolymsk. During the summer the country is practically impassable, and usually nobody tries to cover the distance, about 1500 miles, between Yakutsk and Sredne-Kolymsk except in winter, when horse and reindeer sledges are used. During the summer the journey can be made only on horseback, using pack horses for carrying baggage. The expedition took more than three months to cover these 1500 miles. The drawbacks and difficulties of such a trip could be appreciated only by one who himself had the misfortune to travel through the same region and under the same conditions. The geologist of the expedition, a young strong man, but lacking sufficient training, was completely broken down and stopped all work about at the end of the journey, when less than a hundred miles separated him from the mammoth. A lively description of this journey has been given by Pfizenmayer in his book,[1] often quoted by the writer.

The work of excavation was carried on with great energy and skill and accomplished in a month, between September 11/24 and October 11/24. Soft parts were treated in the usual way, but great part brought to St. Petersburg frozen and only later prepared for a permanent preservation. Thanks to the Russian winter it was also possible to bring to St. Petersburg two large pieces of ground ice from the locality and have time, before the warm season, for their examination by the writer.

The mammoth was found in the best imaginable condition and comparatively little spoiled by wild animals. It has been exhibited in the Zoological Museum of the Academy as a stuffed animal with the skeleton exhibited nearby separately. The pose given to the specimen corresponds to that in which the animal was found, as if trying with its last strength to go out of some trap into which it had happened to fall. Perhaps the animal had broken through into a crevice, as thought Herz,[2] or plunged into soft ground, as sug-

[1] Pfizenmayer, E. W., "Mammutleichen."
[2] Herz, O. F., "Frozen Mammoth in Siberia," p. 617.

gested by the writer,[1] while on its pasture-ground, and died of injuries received (the pelvis, a forefoot and a few ribs were found broken, as well as the indication of a strong hemorrhage) and also of suffocation in mud. The death by suffocation is proved by the erected male genital, a condition inexplicable in any other way. However, the carcass was found, not on the very spot where the animal had perished, but within the landslide which, along with the carcass, slid down from the upper border of the high terrace of river Beresovca,[2] these slides caused by the thawing of rock ice underlying the tundra. The flesh was so fresh and appealing that dogs devoured every piece thrown to them. Such investigations as those on the histology of stomach tissues were accomplished later with great ease. Blood, collected in great masses, owing to hemorrhage, was found to be in such a good state of preservation that it could be examined about as easily as the blood of recent animals.[3] According to Pfizenmayer it was even possible to establish the relationship of blood of the mammoth and the Indian elephant.[4] Concerning the preservation of blood it is necessary to mention that Neuville and Gautrelet, who examined the blood of the mammoth from the Bolshoï Lyakhov Island in the Museum of Paris, in a nearly similar state of preservation, do not confirm the conclusions of Russian students as to the extremely unaltered character of the blood.[5]

It is beyond the limits of the present paper to speak of all the scientific work done on the remnants of this mammoth.[6] As to the shape of the animal, in the Beresovca mammoth have been discovered a number of new characters. The tail of the mammoth was found to be much shorter than that of the Indian elephant, but much thicker in its basal part. Connected with the tail the mammoth had a peculiar cover of the anus in the form of a fold of the skin. Differing from other elephants the feet of the mammoth had only four toes each. The spiral-like tusks were not turned towards the outside, but had their ends directed inwards and downwards. The animal probably had no mane, as usually suggested in descriptions of the mammoth.[7] It is also necessary to mention that the Beresovca mammoth has been identified by Hay on the basis of description by Zalensky,[8] as a new species, *Elephas beresovkius* sp. n.[9]

In a rather unusual way a few remnants of this mammoth have found their way into the U. S. National Museum which purchased them, in 1922, from Pfizenmayer. Everything collected during the Beresovca expedition was the property of the Academy. Pfizenmayer had no right to keep in his hands the specimens referred to, much less to sell them.[1]

During his travel to the Beresovca River, in 1901, Pfizenmayer discovered near the small town Verkhoyansk, in the bed of the Khoptolog Run (31), a skull and other bones of a destroyed skeleton of a *Rhinoceros tichorhinus* Fischer, which still preserved a few remnants of ligaments and other soft parts.[10,11]

[1] Tolmatschow, I. P., "Bodeneis vom Fluss Beresovka," S. 444.
[2] Pfizenmayer, E. W., "Mammutleichen," S. 128.
[3] Bialinitzki-Birula, T. A., "Observations histologiques," p. 10; Zaleskii, W. W., "Etude microscopique," p. 33.
[4] Pfizenmayer, E. W., "Mammutleichen," S. 165.
[5] Neuville, H. et, J. Gautrelet, "Observations faites sur le sang du Mammouth," p. 108.
[6] Different articles written on this mammoth, or in connection with it, were published by the Russian Academy of Sciences, in Russian, in a set under general title, "Resultats scientifiques de l'expédition organisée par l'Académie Impériale des Sciences pour la fouille du Mammouth, trouvé sur la rivière Bèrèzowka en 1901."
[7] Pfizenmayer, E., "Beitrag zur Morphologie von *Elephas primigenius* Blum.," S. 527.
[8] Zalenskii, W. W., "Osteological and Odontological Researches."
[9] Hay, O. P., "Observations on Some Extinct Elephants," p. 4.
[10] Report of the U. S. National Museum for the year, ending June 30, 1922, p. 80.
[11] Pfizenmayer, E. W., "Mammutleichen," S. 85.

In 1903, Engineer Brusnev, a member of the Russian Arctic Expedition, during his travel on Island Novaya Sibir came across the remnants of a mammoth (32). After two days of work he realized that no carcass was present, as he found only some odoriferous badly putrefied flesh, among other remnants part of a decayed trunk, a broken tusk and plenty of hair mixed up with clay.[1]

The writer, during his Khatanga expedition, in 1905, found on the southeastern coast of the Khatanga Bay, at the latitude about 73° 15′, bones of the pelvis and of a hind foot of a mammoth protruding out of frozen bluff in a more or less upright position (33). Although the presence of, at least, a complete head, or a skull could be suggested here, no excavations were made, as the expedition was short of time, had few people and no tools. As a special expedition could arrive over there only in the next year, or even two years after the visit referred to, and the moment was very unfavorable for finding necessary funds, no arrangement was made later in St. Petersburg, and no expedition was sent to dig out these remnants which, therefore, have been lost for science.

A rich locality of fossil ivory discovered by Lyakhov, in 1750, "between rivers Khatanga and Anabar" probably had been found on the southeastern shore of the Khatanga Bay.[2]

In 1907, the Governor of the Territory of Yakutsk reported to the Academy a new mammoth found by a Lamut, V. Dyacov (34), on the shore of the river Sanga-Yurakh (the same river where a mammoth-locality was examined by Toll, in 1893), about 200 miles northeast of a small Russian settlement Kosachye on river Yana.[3] In February, 1908, the Academy sent over an expedition in charge of geologist C. A. Vollosovich along with the taxidermist E. Pfizenmayer, for which purpose was assigned by the State treasury a sum of 16928 rubles.

From the time of the first report of the discovery, the locality was guarded, by the order of the Governor. In spite of that, the carcass was found in rather poor condition, many parts missing, and all scattered around, although in Vollosovich's opinion it was found just on the very spot where the animal had found its end, trapped in a mud stream after hopelessly having tried to free itself from the treacherous catch.[4] In Pfizenmayer's opinion this locality was secondary. Primarily, the carcass had been frozen in ground on the slope of hills bordering the valley on the right side, near the locality. The carcass was uncovered by spring water, gradually washed out, and brought down into the run bed, where it was found and examined by the expedition.[5] According to Vollosovich much of the carcass had been destroyed by wild animals immediately after the death of the mammoth and before it was protected by a cover of mud. In Pfizenmayer's opinion ice foxes used to feast upon the carcass after it was uncovered.

Of special interest in this case was the discovery of remnants of a trunk which at that time was not known exactly, in the mammoth. Worthy of mention also is the comparatively small size of this mammoth, although it was a full grown animal. Pfizenmayer suggested that it must have been a female,[6] which is supported by Nasonov,[7] but even for

[1] Brusnev, M., Report of the Leader of an Expedition to New Siberian Islands, p. 192.

[2] "Account of Russian Sea Travels," p. 168. Wrangel, F., "Narrative of an Expedition," p. 460.

[3] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., January 8, 1908: Bull. Acad. Sc., II, p. 339, St. Petersburg, 1908.

[4] Vollosovich, C. A., "On the digging out of the Sanga-Yurakh Mammoth, in 1908," p. 453.

[5] Pfizenmayer, E. W., "Mammutleichen," S. 225.

[6] Pfizenmayer, E. W., "Mammutleichen," S. 227.

[7] Nasonov, N. V., "On the Remnants of the Carcass of the Mammoth from the Sanga-Yurakh River," p. 1320.

a female it was an undersized individual. Vollosovich considered such a decrease in the size of the mammoth as an indication of the beginning of the extinction of the race.[1]

According to Digby a lock of the hair of this mammoth can be seen in an exhibition case at the British Museum in London.[2]

While in the North, Vollosovich heard a rumor of another well preserved mammoth found, in 1906, by a trader, A. Gorokhov, on the Bolshoï Lyakhov Island, at the source of the Eterikan Creek (35). Here in the valley of a small nearly dry run was discovered the skull of the animal, frozen in the ground and still covered here and there with a hairy hide. A trunk, "a tube about seven feet long," as it was described by Gorokhov, also covered with skin was found as well, but for some reason he chopped it off, and broke out a tusk as well. As the presence in the ground of other remains of the mammoth appeared very probable, Vollosovich asked the party of ivory hunters, who were ready to leave for this island, to find this locality again (Gorokhov had died in the meantime) and collect the best preserved parts of the mammoth. To finance this undertaking Vollosovich borrowed money from local people, expecting that all the expenses would be covered later by the Academy.

In 1908 the hunters found the locality and remnants of the mammoth, still buried within the frozen ground of the run, and started the excavation. A new party continued the work in 1909 and finished it in 1910, but was unable, because of shortage of dogs, to bring everything to the continent and left behind a part of remnants. Digby is certainly right in saying: "The problem of hunting ivory in the New Siberians is less the difficulty of finding tusks than the difficulty of getting them away." [3] During the summer of 1910 the mammoth was preserved for some time in the frozen ground on the lower Lena, then with the last steamer sent over to Yakutsk and in December forwarded to St. Petersburg, where it was kept for a few years in a refrigerator. In the meantime a piece of hide covered with hair was sent to Paris.[4]

According to the report of the collectors, the carcass was found lying on the left side which, still frozen in ground, was therefore better preserved. The upper part of the carcass, probably, had been destroyed shortly after the death of the mammoth by wild animals. From this mammoth were delivered to St. Petersburg: a skull with the left tusk, upper lip and the left eye; the most important parts of the skeleton; pieces of skin from the head and back, with the left ear; skin from the hip, with the tail, also from different parts of body; penis and a few lumps of putrefied meat; four feet of which the left hind one had been preserved completely down from the knee, the other ones only in their lower parts. The hair of this mammoth has been distinguished by the great variety in color on different parts of body, as well as by the length of hairs, which has been explained by Vollosovich as a result of the seasonal change of hair, and as an indication that the animal had perished late in the summer. The remnants of the food from the stomach were not well collected, perhaps even mixed up with plant-fragments brought to the place with water later. Anyhow, they are similar to those found within the stomach of the Beresovca mammoth and mostly consist of grass and of a little moss. The well preserved feet of this mammoth have very peculiar hoofs, such as are found now in the cattle dwelling on the wet ground.

[1] Vollosovich, C. A., "On the Digging out of the Sanga-Yurakh Mammoth in 1908," p. 456.
[2] Digby, B., "The Mammoth," p. 212.
[3] Digby, B., "The Mammoth," p. 151.
[4] Vollosovitch, C. A., "Le mammouth de l'ile Bolchoï Lakhovsky," p. 310.

It was a good adaptation for marshy pasturages, but made mud streams, originating from the thawing ground, more dangerous for the mammoth than for its contemporaries. In Vollosovich's opinion this mammoth, like that of Sankha-Yurakh, had found its end in a stream of mud.[1]

The further fate of this mammoth is worth relating. For a long time Vollosovich could not get from the Academy the reimbursement of money spent for this supplementary and successful expedition. Being unable to get out of trouble he asked a friend of his, Count Stenbok-Fermor, for assistance. The latter immediately paid the whole sum of money, but, in 1914, presented the mammoth to the Jardin des Plants in Paris.[2] The reason for such a generous gift was the hope of being decorated with the Légion d'Honneur and, in the capacity of a possessor of this decoration, of having at his funeral a military band playing.[3] For some peculiar reason the gentleman was as much interested in this band as in the decoration itself. According to Digby the mounting of the skeleton of this mammoth is nearing completion at the Paris Museum.[4] Among the papers published in France on this mammoth it is necessary to mention this one by Depéret and Mayet[5] who have made a new subspecies *Elephas primigenius sibiricus* D. & M. If the mammoth of Siberia has to be considered specifically different from the Blumenbach's species, this name, conforming to the rules of priority, must be replaced by that offered by Hay a year before—*Elephas beresovkius* Hay.[6]

In 1909, the Academy learned of a mammoth found by a Samoyed in the tundras east of the Yenisei River not far from the small settlement Golchikha, who sold his find to a Russian trader.[7] The locality was then examined by the local trader, Byegichev, who located it at the sources of Creeks Kazachya and Poperechnaya, about 20 miles northeast of river Yenisei (36). He reported to the Academy[8] that the mammoth primarily had, probably, been in very good condition, but later the carcass was greatly damaged by wild animals and natives. After this disappointing report the locality was left by the Academy without any further attention.

In 1912, a new discovery from the same locality was reported to the Academy by a local merchant, Kucherencov, who described the mammoth as well preserved. In 1913, the locality was examined by Kutomanov commissioned by the Academy.[9] He found the carcass completely destroyed and could collect only the skull without tusks, isolated bones of the skeleton, pieces of hide, hair a.s.o. He was told that shortly after the discovery of the mammoth a piece of flesh had been sent to the local museum at Yeniseisk. The flesh was fresh and fat. He was unable to find it later at the Yeniseisk Museum. Kutomanov could positively establish the fact that this mammoth had been found, in 1908, by an Yurakh who sold it to a Russian trader. As matter of fact the latter did not know what

[1] Vollosovitch, C. A., "Le Mammouth de l'ile Bolchoï Lakhovsky," p. 325.

[2] "La Nature, 42 Année, I Sém., No. 2128 (Mars 7, 1914)," p. 240.

[3] A personal communication to the writer by the late Vollosovich, like a number of other details given in the above history of this mammoth, which Vollosovich's article partly lacks.

[4] Digby, B., "The Mammoth," p. 212.

[5] Depéret, Ch. et L. Mayet, "Monographie des Eléphants pliocènes."

[6] Hay, O. P., "Observations on Some Extinct Elephants."

[7] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., April 29, 1909: Bull. Acad. Sc., III, p. 809, St. Petersburg, 1909.

[8] Meeting of the Physico-Mathematic Section of the Russian Academy Sc., May 26, 1910: Bull. Acad. Sc., IV, p. 1158, St. Petersburg, 1910.

[9] Kutomanov, G. N., "Rapport sur une mission," p. 377.

to do with his purchase and after his death the mammoth became again *res nullius*. The rediscovery of the mammoth, in 1912, was provoked only by the more enterprising nature of Kucherencov who at that time became interested in this business. Although the report by Kutomanov did not definitely state that his mammoth and that reported to the Academy, in 1909, are the same, and although there are some differences in the nationalities of discoverers mentioned in both cases, as well as in the names of purchasers of the mammoth, there can be little doubt about it. Some uncertainty in this relation could be perhaps explained by the fact that not everything concerning this discovery has been reflected in the publications of the Academy, and some correspondence between the scientists connected with this body and local people remained private. As a matter of fact the Academy, in organizing the expedition of Kutomanov, was hunting for the same mammoth to which no attention had been paid two years before.

The poor condition in which the mammoth was finally found put an end to all the speculation and to the many groundless hopes aroused in connection with its discovery. At the same time it automatically finished all the claims and, perhaps, saved the Academy possible trouble. To avoid this in the future the Academy worked out a special law, as had been told above, protecting fossil remnants from possible speculation.

In 1911, the Academy got news of a skull of a mammoth found by natives on the shore of the Arctic Ocean on the east side of the Cape Maly Baranov.[1] As usual the tusks were broken off immediately and sold to a local trader, Soloviev, who visited the locality and through local officials reported the matter to the Academy (37). He saw only the skull, but was unable to dig deeper. As all the correspondence on this subject stopped after the first letters received by the Academy from Yacutsk, and official reports, it is suggested that after closer examination the locality was not found worthy of attention. It might, perhaps, be of some interest to mention that an official who was much impressed by the small size of tusks, only about 25 lbs., expressed an opinion that the mammoth, probably, used to change periodically its tusks like the reindeer does horns. Thus, the mammoth under consideration had young tusks not yet grown adult size.

In 1915, during the spring and summer excursions (May–July) of the Hydrographic Expedition of the Arctic Ocean, under Capt. B. A. Vilkitzki, a frozen carcass of a mammoth, with tusks eight feet long, was discovered in the Haffner Fiord, on the northern cape of the entrance into the fiord, at the northern latitude of about 76° 30′ and longitude 116° 15′ East (38). The coasts here are frozen earthen banks, 30–50 feet in height, covered with hilly tundra. No attempt at excavation was made by the party which had discovered the locality.[2]

A very fine skull of a Siberian mammoth, probably female, was purchased, in 1923, by the British Museum from ivory merchants.[3] It was probably found in the New Siberian Islands (39). The skull still contains the remnants of ligaments. The ivory of the tusks, both of which were present in their natural position, making this specimen especially interesting, "is in an extraordinary fresh condition."

In the summer of 1926 information was given by a visitor to the Zoological Museum

[1] Meetings of the Physico-Mathematic Section of the Russian Academy Sc., January 19, 1911, and March 9, 1911: Bull. Acad. Sc., V, pp. 272, 282 and 480, 487, St. Petersburg, 1911.

[2] Transehe, N. A., "The Siberian Sea Road," p. 391. For most of the details the writer is obliged to personal communication by Transehe.

[3] Andrews, C. W., "Note on the Skull and Mandible of Siberian Mammoth."

of the Academy about the remnants of the carcass of the mammoth found, in 1922, by gold prospectors in Transbaikalia, in frozen ground on the Kara River, the left tributary of the river Shilka. The Academy immediately sent to the locality the geologist, R. Ph. Gecker, who found a skull and fragments of tusks buried seven meters below the surface, within the frozen drift deposited by the Kara River.[1]

[1] Information Bulletin published by the Russian Academy of Sciences, No. 8, October 1, 1926, p. 2; (No. 11, November 20, 1926), p. 11.

ORGANIZATION OF THE EXPEDITIONS AFTER THE MAMMOTH AND RHINOCEROS

IN THE preceding description the writer has brought together thirty-nine discoveries known to him of carcasses of mammoth and rhinoceros found in the frozen ground of Siberia during a period of time covering more than 225 years. In this number are not included, although mentioned above, Benkendorff's mammoth, 1846, the report on which was undoubtedly a fiction; Polyacov's mammoth, 1877, when no mammoth was found at all; and Gecker's mammoth, 1922. In the latter case only parts of a skeleton were found. All recorded cases are of very different values, so far as the preservation of carcasses is concerned. A few of them refer to more or less complete carcasses, most of them only to parts. In some cases only bones were found, with a few remnants of soft parts, or hair, pieces of skin, or of meat alone. From a purely theoretical point of view, the preservation of a complete carcass, or of a few ligaments on bones, or of a piece of hide, is exactly the same phenomenon, dependent upon the same special conditions, which has to be explained in the same way. For this reason discoveries of a more or less complete carcass of a mammoth, or of isolated and small remnants of soft parts have been treated alike by the writer.

The number of all discoveries is certainly very small. In a country where the ivory of, at least, 250 animals is collected yearly, the greatest part of it out of frozen ground, the number would be increased hundreds or thousands of times, if it were possible to register all the cases in which soft parts were found along with bones. The abundance of remnants of these animals is shown by the fact that near the cliffs in which carcasses are found, one usually perceives a putrid smell, although no rotten remnants may be seen. In Pfizenmayer's opinion too, the carcasses must appear oftener than they are reported.[1]

The number of possible discoveries cannot be correctly appreciated by the number of reported cases. It is quite certain that only a small part of such discoveries used to be reported. Superstition, dread of troubles connected with the arrival of an expedition and with participation in its work (which, for the local population, often used to be compulsory), the meager chance of getting a premium, etc., usually led the discoverer to content himself with picking up only the tusks of a mammoth, leaving the carcass undisturbed, if he had found one. It is also more than certain that the remnants of mammoth or rhinoceros discovered, even taking into account those which were known to local population, but not reported to officials, might be only a part of all possible discoveries of this kind on the shores of numberless creeks, rivers, and lakes of Northern Siberia. Immense areas of that country are so sparsely populated that, according to available Russian statistics, in many regions there, every individual has to his or her account "over" a hundred square versts (about 44 square miles) of land. As the settled population is concentrated along the rivers, and even nomads are not distributed uniformly, waste areas are practically deserts, only occasionally visited. During summer, the most favorable time for the discovery of frozen carcasses, all journeys of any length are practically stopped, except the travel by boat on rivers and lakes, or along the sea shore. All occasional summer trips from

[1] Pfizenmayer, E. W., "Mammutleichen," S. 149.

temporary dwellings are necessarily very short. All long wanderings of the nomads, dependent upon their reindeer, used to be made during the spring and fall, and usually followed well established routes. Winter travel between dwellings also varies very little in different years. Besides, the winter season when the country is covered with snow for nine months, is especially unfavorable for such discoveries. Even professional ivory hunters used to work in rather limited area, visited year after year. Thus the chance is very small of coming across a frozen animal which has just appeared out of the ground, and many remnants of this kind must be destroyed by putrefication, wild animals, and flood water before they are discovered by anyone. All these facts suggest that the chance of discovering a good specimen of a frozen mammoth or rhinoceros is still present, and could be increased by a rational organization of scientific expeditions to the Northern Siberia. So far the history of most of the expeditions which the Academy used to send to the mammoth-localities every time a rumor of a discovery reached St. Petersburg, has been a series of bitter disappointments for the Academy and for the scientists commissioned by the Academy, who, after long and hard travel over thousands of miles, arrived at the places only to dig out a few bones and poor remnants of soft parts. It was usually not an absolute waste of time, money, and work only because the commissioned scientists used the opportunity to make far reaching researches into unknown or very little known areas of Northern Siberia. In this way they contributed much to the knowledge of the mammoth, although they had rather poor luck in completing the museum material relating to this animal.

The reasons for such ill luck vary a great deal. It was customary to attribute the misfortune to the belated arrival of an expedition to the reported locality. As a matter of fact, this was a true cause only in the case of the Adams mammoth which had been discovered, probably, in perfect condition and was decaying for seven years. In other cases the discoverer reported remnants which had been washed out from a primary locality a long time before, destroyed, while uncovered and buried again. It was also unreasonable to speak of delay when a locality was examined by an expedition twenty or more years after the discovery of a carcass by local people. In other cases a carcass had been more or less destroyed immediately after the death of the animal, and only poor remnants were left. These were reported by discoverers incapable of appreciating all the different conditions and who, in most cases, could not prove the reality and value of a discovery without excavating, at great expense and with danger of spoiling a locality. It distinctly shows that the expeditions sent after mammoths and dependent exclusively upon the data delivered by local people might only in rare cases be expected to be successful, as the discovery of a carcass even in such a case would be always a matter of chance.

As has been mentioned above, in 1891, Tscherski presented a new plan for hunting the mammoth, according to which a scientist must stay for a while in the mammoth-country watching for the possible discovery of a new carcass. This plan appeared as a result of the experience of practically all the expeditions to Northern Siberia, everyone of which chanced to come across the remnants of a mammoth-carcass which had never been reported to Russian officials and remained unknown to anybody except a few natives. A good example of the importance of a scientist being present on the spot was Maydell, who, in a short time was able to examine three localities of mammoths the report of anyone of which would have been sufficient to send a special and expensive expedition from St. Petersburg. Having recognized the localities as worthless, Maydell saved for the Academy a

great deal of trouble and money. The rationality of the plan was criticized by Toll,[1] chiefly in connection with social and general conditions of Northern Siberia; but Tscherski's plan was certainly sound, as well as his idea of doing the mammoth-hunting in connection with broad geological and geographical investigations of the country. It could give good results, however, only if a scientist were able to cover with his trips a large area of the country under investigation, and come in contact with as many natives, especially ivory hunters, as possible. Certainly, an expedition must be directed to the most promising localities, as, for example, the New Siberian Islands and the Arctic shores of the Territory of Yacutsk, areas regularly visited by ivory hunters with whom is always possible to make some arrangement concerning skeletons and carcasses of mammoths, rhinoceros, etc. to the mutual interest of science and of the ivory hunter himself. The latter usually is interested only in tusks of a mammoth. Breaking them off out of the ground, he usually does not pay much attention to what has been concealed in the ground behind the tusks. It could be a skull of a mammoth, a skeleton, or even a carcass. He never has any means of making an excavation to decide this question, and only if he found a carcass in a land slide or some soft parts protruding out of the ground, would he report the matter to a trader or a Government official. A scientific expedition sent after the mammoth has to make mammoth-hunting just as interesting commercially to an ivory hunter, as is the collecting of tusks. But even if he were interested in the excavation of a mammoth or a rhinoceros and supplied with all the necessary means of making excavations, an ivory hunter could not become a substitute for a scientific expedition, for which there would still be much to do. In spite of the fact that many scientists have examined mammoth-localities, the conditions in which the carcasses used to be found, the geology of the localities, etc., there is still much uncertainty in regard to many questions connected with the mammoth and the conditions of its localities, as well as with the geology of mammoth bearing strata. It was partly dependent upon the fact that in most cases scientific expeditions were dealing only with natural outcrops and had very little chance to make large excavations, deep pits, or drillings to get the materials which would replace speculations with firmly established facts. Scientific expeditions sent after the mammoth must, therefore, be familiar with the score of all problems connected with the mammoth and mammoth-localities, and well supplied with all the necessary instruments and machinery for detailed investigation of localities. They will certainly have a greater chance than the former expeditions had of discovering the carcasses of a mammoth or rhinoceros and, even in case of failure in this particular direction, would be able to make a number of important observations on the occurrence of the mammoth, and to make general investigations of this little-known country.

Lately Tscherski's plan has been again advocated by Pfizenmayer. In his opinion a scientist must establish himself at Verkhoyansk, which he selected as the most central point in Northeastern Siberia, and from there organize expeditions to reported localities of mammoth-carcasses.[2]

[1] Toll, Ed., "The fossill Glaciers of New Siberian Islands." Russian edition published by the Russian Geographical Society, p. 123. St. Petersburg, 1897.

[2] Pfizenmayer, E. W., "Mammutleichen," S. 321.

GEOGRAPHICAL DISTRIBUTION OF THE MAMMOTH

THE geographical distribution of the remnants of the mammoth, rhinoceros, and their contemporaries is very extensive. Pallas said [1] that in all Asiatic Russia, from the Don as far as the peninsula of Chukchis, there was not a river or a stream, especially of those flowing in the plains, on the banks, or in the bed of which there have not been found bones of elephants, or of other animals foreign to the present climate. This statement might be supplemented, as to the west the mammoth and its companions can be traced as far as the Pyrenees, and to the east, over the Bering Strait, into Alaska.

In Eastern Siberia the mammoth has been found as far north as the Taimir Peninsula, in the latitude 76° 47′ [2] and on Bennet Island,[3] in the latitude 76° 38′. In the southern part of Eastern Siberia the mammoth was found in Transbaïkalia, i.e. about 27 degrees south of the most northern points of its distribution. A "mammoth" discovered in a number of places in Northern Manchuria does not belong to *Elephas primigenius* Blum., but to another fossil species.[4] The remnants are not distributed equally over this immense area, but increase in number towards the northern regions of the country. On the New Siberian Islands they used to be found, along with the remnants of other extinct Post-Tertiary mammals, in such an extreme abundance [5] that these islands might be called a real cemetery, or, because of the abundance of tusks, found there, an ivory mine. Digby suggests, however, that mammoth-bones are by no means scarce in Southern Siberia either.[6] These differences in distribution may be attributed only in part to the more favorable conditions for preservation in Arctic regions of Siberia, as compared with its more southern sections. The accumulation of fossil remnants within the river deposits in the Far North might be partly explained by the drifting of complete carcasses and bones by ancient rivers. It might also be connected with seasonal migrations of the mammoth. But both of these agents would have had only a limited extension, because the mammoth of the New Siberian Islands and of the Arctic shore of the mainland belonged to a special race distinguishable from the South Siberian variety by its smaller size, most plainly shown by the smaller size of its tusks. According to Hedenström, tusks are smaller and lighter in weight the further one advances towards the North, so that it is a rare occurrence on the islands to find a tusk of more than three poods in weight, whereas on the continent they are said to weigh as much as twelve poods.[7] Hedenström's data, referring to the northern race of the mammoth, were checked later by Middendorff.[8] The small size of the mammoth found on the Sanga-Yurakh River has been emphasized by Nasonov and Vollosovich.[9]

The frozen carcasses of the mammoth have, up to the present time, been found exclusively in the northern part of Eastern Siberia, the most western localities among them

[1] Howorth, H. H., "The Mammoth and the Flood," p. 54.
[2] Wrangel, F., "Narrative of an Expedition," p. 436.
[3] Toll, E. V., "Short Report for the Period June 7 to November 8, 1902," p. 158.
[4] Tolmatchew, V. I., "Remains of a Mammoth found in Manchuria," p. 5.
[5] Hedenström, M., "Otrivki o Sibiri," p. 122.
[6] Digby, B., "The Mammoth," p. 52.
[7] Hedenström, M., "Otrivki o Sibiri," p. 122.
[8] Middendorff, A. Th., "Sibirische Reise, IV," I, S. 278.
[9] Cmp. above, p. 37.

being on the Yenisei River, or only a few miles west of it (Schmidt's mammoth—16). The Beresovca mammoth is usually considered as the easternmost frozen carcass,[1] but soft parts of this animal have also been found in the frozen ground of Alaska, although not in such good condition as those in Siberia.[2]

In Western Siberia the remnants of the mammoth are known from the extreme North to the shore of Lake Aral,[3] in about 45° latitude. They belong, here, to the typical *Elephas primigenius* Blum., as the writer had an opportunity of verifying.[4] Frozen carcasses of the mammoth have not yet been found in Western Siberia, and all known remnants are represented by more or less complete parts of the skeleton.

In Northern Europe the remnants of the mammoth are known east of the White Sea, where in the basin of the Pechora River they are just as numerous as in corresponding parts of Western Siberia, being represented, however, only by bones. West of the White Sea and of Lakes Onega and Ladoga, remnants of the mammoth are rare. According to Lyell, Sweden and Scandinavia in general, probably, even lacked the mammoth. The rare specimens of mammoth-bones found there were, in his opinion, brought there by ice or otherwise.[5]

Such a distribution of the mammoth could not be governed only by chance, but must depend upon some natural cause which might be, perhaps, connected with the Scandinavian ice sheet which the mammoth tried, so far as was possible, to avoid. As the remnants of the mammoth have been found within the glaciated part of Europe, the animal must have wandered great distances following the retreat or advance of the Scandinavian glacier. The waste plains of Northeastern Siberia were never covered with the ice-sheet of a glacier, and mammoths, as well as their contemporaries could wander unmolested over their pasturages, perhaps, migrating according to seasons. Long existence under fixed physico-geographical conditions allowed the uninterrupted progress of evolution, and resulted in the development of a new race of Siberian mammoth somewhat different from the typical European *Elephas primigenius* Blum. This was suggested a long time ago by Howorth [6] and also mentioned by Russian students; but the distinguishing characters of the Siberian form have been formulated only during the last few years [7] almost simultaneously, although independently, by Hay who described, in 1922, a new species, *Elephas beresovkius* Hay, and by Depéret and Mayet who established, in 1923, a new variety or subspecies, *Elephas primigenius sibiricus* D. & M. The North Siberian mammoth originated from the South Siberian or European form in just the same way, as the latter had originated from *Elephas trogontherii* Pohlig and *Elephas antiquus* Falc., i.e. through the further decrease in the size of the dental plates and in the thickness of the layers of enamel.

Of the thirty-nine recorded discoveries thirty-four refer to the mammoth and five to the rhinoceros. This relation can be explained not only by the fact that the rhinoceros used to receive less attention from the ivory hunters, but probably also by the greater rarity of the former; and it must also be dependent upon the original habits of both animals. It was often noticed that remnants of the mammoth are frequently found together in great

[1] Digby, B., "The Mammoth," p. 139.
[2] Digby, B., "The Mammoth," p. 142.
[3] Cuvier, G., "Recherches sur les ossements fossiles, I," p. 151.
[4] Tolmachoff, I., "In Berg's Lake Aral," p. 521.
[5] Howorth, H. H., "The Mammoth and the Flood," p. 101.
[6] Howorth, H. H., "The Mammoth and the Flood," p. 56.
[7] Cmp. above, p. 38.

masses, according to Matiushkin "forming immense local accumulations which become both richer and more extensive the further one advances to the north," [1] and that those of the rhinoceros are found separately. It makes plausible the suggestion that the habits of these extinct animals closely corresponded with those of recent elephants, which usually wander in herds, and of recent rhinoceroses which prefer solitude.

[1] Wrangel, F., "Narrative of an Expedition," p. 179.

VEGETATION AND CLIMATE OF ARCTIC SIBERIA DURING THE AGE OF THE MAMMOTH

Associated with bones and carcasses of the mammoth and other animals different plant remnants used to be found in the same horizon. The first Russian colonists in the Northern Siberia discovered in the tundra, far from the present forest, remnants of trees buried in the ground, which they used to call Adamovchina and to distinguish from Noevchina, the latter name being applied to drift wood carried out into the ocean by Siberian rivers.[1] On the island of New Siberia Hedenström discovered immense accumulations of buried trees and, referring to them, called the bluffs on the shore "The Wooden Hills."[2] Middendorff, Schmidt, Toll, Vollosovich a.o. had opportunities of collecting, within the tundra ground, leaves, roots and fine branches of plants like *Alnus fruticosa* and *Betula alba*, which are not to be found there now, but grow in more southern latitudes. These facts brought local people and scientists alike to the conclusion that it had not been very long since trees used to grow within the recent tundra region much farther north than they do now. Not all of the observations were found to prove this theory, however. For example, plants of "The Wooden Hills" have been found to be of Miocene age. Many of the trees found in the tundra ground did not grow there, but were brought by rivers, or sea currents, deposited in the tundra, and are now found far from the shore, due to the uplift of these areas. In spite of that, there still remains a number of facts which undoubtedly argue for a more northern limit of forests in Arctic Siberia during the time shortly preceding the present one. The next quite natural conclusion was that the climate of Arctic Siberia at that time was milder than it is now. Howorth[3] was even ready to attribute to Northern Siberia, during the Age of the mammoth, a climate corresponding to the recent one of Lithuania. This was certainly a great exaggeration not corresponding with the known facts. No one of scientists who were familiar with the recent and subfossil flora of Northern Siberia was going so far. The shifting of the forest limits could be measured only through a few degrees of latitude, and subfossil forest flora found in the ground of the recent tundra is represented by Arctic and Subarctic flora, not by that of more moderate regions. Considering these facts, any theory as to a milder climate in that time should, in the opinion of the writer, be accepted only with great reservations. The advancement of the tundra towards the South may be dependent not only upon the change of climate for the worse, but upon other physico-geographical conditions as well. Northern Siberia, in spite of its severity of climate, has the northern forest limit in all the world, going towards the North beyond the parallel of 72° and in protected places, as in the Khatanga valley, jutting out towards the North about twenty minutes more. From here in both (western and eastern) directions the forests retreat southwards. In Northeastern Siberia, on the Chukchi Peninsula, only poor shrubs are known, and these in protected places, near the Polar Circle, i.e. more than six degrees south as compared with the valley of the Khatanga River. At the same time, the average yearly temperature of the Chukchi

[1] Adams, "Travel: Sibirski Vestnik, 1820, part X," p. 324.
[2] Hedenström, M., "Otrivki o Sibiri," p. 128.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 561.

Peninsula is higher than that in the North of Central Siberia. The forest line in Northern Siberia follows, roughly speaking, the Arctic coast, but nowhere approaches the ocean. We can imagine that, if the northern shore of the Chukchi Peninsula were to increase, for two–three degrees of latitude, it would be accompanied by an advancement of forests towards the North and their encroachment upon the tundra. When *Alnus fruticosa* was growing on the New Siberian Islands they were connected with the continent which at that time thus had protruded about four degrees farther north as compared with the recent shore line of the mainland. The retreat of the forests might have been caused by the separation of the New Siberian Islands, although the climate, generally speaking, can have suffered very little change, if any.

Some data referring to the flora of the Age of the mammoth have also been received through the examination of remnants of undigested food found in the mouth and stomach of the mammoths and rhinoceroses. The first investigations of this kind refer to the Siberian fossil rhinoceros and had as material a very small amount of vegetable matter found on the teeth of the animal and examined by a number of observers. Brandt found bits of coniferous wood and remains of a seed. Meyer found the seed of an *Ephedra*. Mercklin distinguished the wood of a willow. Schmalhausen found remains of monocotyledons and dicotyledons, and recognized traces of graminaceous plant, and of an ericaceous one, the latter probably *Vaccinium Vitis Idaea*. Among the remains of coniferae were those of a *Picea* (*?obovata*), of an *Abies* (*?sibirica*), of a *Larix* (*?sibirica*). There were also found the remains of a *Betula*, of a *Salix*, and of an *Ephedra*. All these plants are still growing in Siberia.[1] Tscherski also came to the same conclusion after his work on the same subject.[2]

Although, according to Wright, "The stomachs of some of the mammoths have been found containing leaves of trees whose present habitat is hundreds of miles south of the locality where the animal perished," [3] as matter of fact, the first detailed examination of undigested food from the stomach of a mammoth was made only after the discovery of the Beresovca mammoth. Previously, Famintzin [4] had examined the excrement of a mammoth, brought by Bunge from the Lena River, but the investigation proved only the presence of vegetable matter without any particular result. In the remnant of food found in the stomach of the Beresovca mammoth Sucachev [5] identified: *Hypnum fluitans* (Dill) L., *Aulacomnium turgidum* (Wahlnb.) Schwaegr., *Alopecurus alpinus* Sm., *Beckmannia cruciformis* (L.) Host., *Agropyrum cristatum* (L.) Bess., *Hordeum violaceum* Boiss. & Huet., *Carex lagopina* Wahlenb., *Ranunculus acris* L., *Oxytropis sordida* (Willd.) Trautv. All of these species are typical representatives of a meadow flora of Northern Siberia at the present day. Leaves and branches of bushes were not found, although they had been not lacking on the shores of Beresovca. In summer the mammoth was a grass-eater who, like the recent reindeer, preferred this food to any other. It certainly had no difficulty in picking up even the lowest grass of the tundra with its trunk, and, probably, never tried to "Graze close to the tundra like oxen" which, according to Howorth,[6] would make its

[1] Howorth, H. H., "The Mammoth in Siberia," p. 557.

[2] Bull. East Siberian Branch of the Russian Geographical Society, VII, Nos. 4–5, Irkutsk, 1876. After Tscherski, I. D., "Beschreibung der Sammlung," S. 453 and 458.

[3] Wright, G. F., "Asiatic Russia, II," p. 579.

[4] Meeting of Physico-Mathematic Section of the Russian Academy Sc., January 21, 1886: Mem. Acad. Sc., LII, p. 173, St. Petersburg, 1886.

[5] Sucachev, V. N., "Examination of Plant Remnants," p. 15.

[6] Howorth, H. H., "The Mammoth and the Flood," p. 59.

existence in the tundra impossible. This selective taste of the animal does not permit possible conclusions to be drawn from these data without any reservations, but, so far as the examined plants are concerned, we can join Osborn's statement that the climate at that time was not milder, nor more frigid than that prevailing now in this part of Siberia.[1] On the strength of his new investigations, A. I. Tolmachoff also emphasizes a close similarity of the present flora of Northern Eurasia with that of the Age of the mammoth.[2] Plants in the stomach of the mammoth from the Bolshoï Lyakhov Island were poorly preserved and not as well collected as in that from Beresovca; but they were also represented by grasses and, perhaps, some moss, and again corresponded with the flora of the recent tundra. Both mammoths referred to had perished during late summer, or early fall, as has been shown by the remnants of their food examined. During winter time, the food of the mammoth would have been composed of leaves, small branches, and bark of trees, probably reindeer moss often growing on trees, etc. The remnants of plants described from the teeth of the Siberian fossil rhinoceros might correspond to the winter diet of these animals. To find this food, the mammoth had to leave the tundras and migrate for a few hundred miles towards the South, to the forests, as reindeers do at the present time.

Thus, if the retreat of the forests in Northern Siberia may be considered an established fact, we do not find that the mammoth enjoyed a milder climate, or was in need of it for its existence. So far as food is considered, it suffered, probably, no privations, because in nearly all cases of carcasses of mammoth, discovered, they belonged to well fed and often fat animals, of robust health.[3]

Not only the examination of flora supports the theory of climatic conditions in the Age of the mammoth similar to the present ones of the Northern Siberia, but also the discovery of frozen carcasses of the mammoth and rhinoceros, the origin of which we cannot understand as the result of any other conditions than those of an Arctic or Subarctic climate. The presence of frozen ground, for example, appears to be quite indispensable.

We could certainly easily imagine the mammoth living comfortably in a much milder climate, as suggested by Howorth, but we can just so well imagine the evolution of the mammoth being the result of its adaptation to gradually changing climatic conditions. As suggested by Tscherski,[4] climatic conditions in Northern Siberia were changing for the worse, very slowly and gradually; and the mammoth, living in the same area for a long time, could have easily and without having suffered any harm adapted to new conditions. However, such a process of adaptation must have been accomplished in very ancient times, as the mammoth was undoubtedly already well adapted to the surrounding conditions of severe Siberian climate, probably no less than is the recent reindeer. Referring to a doubt of the possibility of so large an animal finding enough food in the tundra, the writer likes to remember the surprise of Nordenskiöld when the latter found that reindeers, killed during his expedition in Spitzbergen, in October, 1872, were so fat that their necks were not sharply separated from the heads. Nordenskiöld's question, "How this animal can collect such a mass of fat in Spitzbergen where the vegetation is so scanty and the summer so short" [5] may be answered only by the statement that we cannot always understand the limits of adaptation of wild animals to surrounding conditions.

[1] Osborn, H. F., "Age of Mammals," p. 420.
[2] Personal communication to the writer.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 178.
[4] Tscherski, I. D., "Beschreibung der Sammlung," S. 475.
[5] Nordenskiöld, A. E., "The Arctic Voyages," p. 200.

It cannot be denied that the idea of the Siberian mammoth as a northern animal undoubtedly has gained ground during the last few years. It is shown, for example, by restorations in which the mammoth is almost always pictured in a winter environment, walking over ice and snow through a stunted Arctic forest. Depéret and Mayet who described the mammoth of the Bolshoï Lyakhov Island, attributed to it not only an adaptation to Arctic conditions, but even an Arctic origin. Its distribution to the South they connect with the increased coldness of climate southwards, following the advance of the ice of the Glacial age. "Nous sommes amenés par ce raisonment à admettre pour le Mammouth Sibérien une origine et une centre de dispersion tout differents de de ceux du Mammouth normal, et à le considerer comme un *rameau spécial* indépendent, d'origine nordique (Asie septentrionale), dont les représentants se sont avancés plus ou moins loin vers le Sud, à la faveur du grand refroidissement final du Quaternaire." [1]

[1] Depéret, Ch. et L. Mayet, "Monographe des Eléphants pliocènes," p. 190.

GEOLOGY OF THE MAMMOTH AND RHINOCEROS LOCALITIES

EVERYWHERE carcasses of the mammoth and rhinoceros were found, they had been buried within the frozen ground of tundra near its upper surface and usually on comparatively elevated points, on the top of bluffs, etc. This has long been known and, according to Wrangel, "The best mammoth bones are found at a certain depth below the surface" and "more in elevations situated near higher hills than along the low coast, or on the flat tundra." [1] Often mammoth localities are on the highest points of the tundra. The occurrence of the mammoth at high levels was also noticed in Alaska on the cliffs in the Kotzebue Sound, which in their features closely correspond with the cliffs on the shores of the New Siberian Islands, or on the Arctic coast of Northeast Siberia.[2] Bones and tusks of the mammoth were also often found protruding from the ground on a high tundra. Excavation often disclosed the remnants of a complete animal which had been buried there. Carcasses and isolated bones also used to be found on the bottom of valleys, or on tide-flats, as near the New Siberian Islands, having been washed out of cliffs or rolled down in frozen masses by underwashing of the cliffs by spring floods. Examples of this mode of occurrence are the rhinoceros found, in 1877, on the Khalbugaï Creek, and the Adams mammoth which slipped down to the beach after the cliff had been underwashed.

Mammoth-bearing drift deposits sometimes have a thickness tens of feet, sometimes they are spread out in comparatively thin layers. In some localities, as in the one of Schmidt's mammoth have been discovered, underneath these deposits, the sediments of the last Arctic transgression. In Northeastern Siberia they are usually underlain by layers of rock ice, and very often, in this case, are reduced to a thickness of only two or three feet. An inaccurate expression by Adams created the idea that his mammoth had been frozen within ice. But after the detailed consideration of this matter by Toll there is no more doubt that this mammoth like others had been frozen within the driftground underlain by rock ice. Theoretically, it is possible to imagine carcasses enclosed within ice, but as matter of fact, neither mammoth nor rhinoceros was ever found in such conditions, as Howorth has already emphasized.[3]

The uppermost position of mammoth-bearing deposits, covering sediments of the Arctic transgression, corresponds exactly with the systematic position of the Siberian mammoth as the youngest member of the group of fossil elephants. In European Russia where the mammoth-bearing strata often are found together with moraines, or are partly composed of glacial material, the true mammoth belongs to the upper Glacial stage, and the European mammoth must have been a contemporary of the Siberian one, or perhaps the latter was the successor of the European one, but not vice versa. Elephant bones discovered in European Russia within the older morainique material were identified as *Elephas trogontherii* Pohlig.[4] The position of the mammoth within the youngest part of the mammoth-bearing horizon was also emphasized by Tscherski.[5]

[1] Wrangel, F., "Narrative of an Expedition," p. 275.
[2] Howorth, H. H., "The Mammoth and the Flood," p. 266.
[3] Howorth, H. H., "The Sudden Extinction of the Mammoth," p. 313.
[4] Tolmatschow, I. P., "Fouilles de l'*Elephas trogontherii* Pohl.," p. 259.
[5] Tscherski, I. D., "Beschreibung der Sammlung," S. 40, footnote.

The strata in which are buried the bones and carcasses of mammoths, rhinoceroses, and other extinct mammals and remnants of plants, are represented by sandy, clayish, or loamy sediments of different thickness. Marine shells or marine mammals have never been discovered in them, and these sediments may be only of fresh water or terrestrial origin. The writer, having examined the geological specimens brought from the locality of the Beresovca mammoth, could realize that the earth strata in which the carcass was found had, to a great extent, taken their origin from the drift brought by rain and snow water from the neighboring hills, surmounting the river terrace on which the mammoth was found.[1] Where similar orographic conditions are present, tundra ground could easily originate in this way. But all open tundras of Arctic Siberia usually lack these conditions. In a few cases, also within the tundra ground, lake sediments were discovered. In most cases tundra deposits are formed in connection with the work of rivers which carry to the sea great amounts of silt which are deposited in deltas, or within estuaries and bays, and distributed along the shore. The greatest part of the Arctic shores of Eurasia is undoubtedly composed of materials delivered from the mainland by rivers. Owing to recent changes of sea level, in some places, for example, in Lena Delta, river deposits have been found 200 and more feet above the sea level. The close connection of tundra deposits with river drift on the Yenisei River was mentioned by Nordenskiöld.[2] He emphasizes also the fact that shells, when they are found in the tundra sand, all belong to living types of the Arctic sea.

The shores of Arctic Eurasia have not only been uplifted, but partly have been submerged as well, with the result that the New Siberian Islands, for example, which not a very long time ago were parts of the continent, have now been not only separated from it, but even partly destroyed by the victorious sea-waves. Mammoth-bearing strata of the New Siberian Islands originally were undoubtedly dependent upon the silt brought from the mainland by Siberian rivers, and connected with the corresponding sediments on the shore of the continent. Toll considered it possible to reconstruct the former channels of rivers between the New Siberian Islands and the mainland,[3] although it was rather against his suggestion as to the origin of the rock ice of the New Siberian Islands, which in his opinion, is a remnant of the Glacial ice sheet. Also, on the mainland the mammoth was not always found in recent river valleys, or within deltas, but, just as on the islands, in the sediments deposited by former rivers the channels of which were obliterated later. Certainly some remnants of the mammoth were found outside of any river valleys, as, for example, on Kotelny Island where they were discovered by Toll[4] about 1000 feet above sea level, and where animals had perished during their wanderings over divides.

In spite of the work of a number of keen students who had the chance to visit and examine mammoth localities, there is no unanimous opinion as to the composition of Post-Tertiary strata of North Siberia, the origin of different horizons, their relations to each other, and consequently, the stratigraphic position of the mammoth horizon. A lot of confusion is also caused by the presence of rock ice among the Post-Tertiary strata of Northern Siberia and by the difference of opinion as to its origin and its stratigraphic importance. In Toll's opinion, rock ice, as already has been mentioned

[1] Tolmatschow, I. P., "Bodeneis vom Fluss Beresovka," S. 448.
[2] Nordenskiöld, A. E., "The Arctic Voyages," p. 331.
[3] Toll, Ed., "Die fossilen Eislager," S. 79.
[4] Toll, Ed., "Die fossilen Eislager," S. 62.

above, is a remnant of the Glacial ice sheet, and it underlies the mammoth-bearing strata. As in Western Siberia these strata cover the sediments of Arctic transgression, the latter one and rock ice may be correlated with each other; therefore, the mammoth-bearing deposits (called also the mammoth-horizon or tundra-horizon) appear to be the uppermost horizon among the Post-Tertiary strata, as has been stated above.[1] Vollosovich, who had an opportunity to examine the same localities, as Toll had done, has distinguished two horizons of rock ice, which he has called Lower and Upper ice, both separated by the loam horizon which he has also called the mammoth-horizon, because, in his opinion the mammoth and rhinoceros have been limited to this horizon. To this horizon exclusively he also attributed the remnants of *Alnus fruticosa*, *Betula alba*, etc. The origin of the Lower ice he connects with the Ice Age of the Northern Hemisphere, although he is not so decisive to its glacial nature, as was Toll. The Upper ice must, therefore, belong to the second Glacial period, although it may be not a remnant of a former glacier either, and the mammoth-horizon belongs to the Interglacial period. He has also given the following scheme of the Post-Tertiary history of the New Siberian Islands, starting from the bottom.[2]

1. Lower rock ice of the Bolshoï Lyakhov Island corresponding with the greatest glaciation of the North.

2. Loam sediments containing remnants of poor meadow and shrubbery flora.

3. Loam deposits with *Alnus fruticosa*, *Betula alba*, and grasses. Mammoth and rhinoceros the most important mammals.

4. Upper ice. Dying out of gigantic mammals.

5. Loam deposits with *Betula nana* and *Salix* (different species). Many sporophytes in the meadow flora. Horse as the most important mammal. Beginning of the Arctic transgression.

6. Loam deposits with rare *Betula nana* and common *Salix polaris*. Musk ox and deers. Arctic transgression, with *Yoldia arctica*. Separation of the New Siberian Islands from the mainland.

7. Emergence of islands of New Siberia and Thadeevsky. Retreating of the sea and tendency towards the connection of islands with the continent. The recent tundra flora. Dominant mammal, reindeer.

This scheme was from the beginning complicated a little by the discovery on the island of New Siberia of rock ice covered and underlain with sediments of Arctic transgression.[3] Considering rock ice as a horizon of independent stratigraphical position, as, indeed, Toll and Vollosovich did, it would be necessary to speak of two Arctic transgressions of different age, which are not included in the above scheme.

According to Vollosovich's scheme the mammoth belongs to an older horizon than has been accepted in this paper; a horizon which is not only older than the Arctic transgression, but even precedes the second Glacial period. Owing to the difference of opinion as to the stratigraphic importance of rock ice and especially to its correlation with different glaciations, it is more convenient to pay attention only to the relations of the mammoth horizon to the Arctic transgression, a real and infallible measure stick of Post-Tertiary stratigraphy of Arctic Eurasia, which in Western Siberia was found below the mammoth-bearing strata. Vollosovich did not try to reconcile his scheme with this firmly established

[1] Toll, Ed., "Die fossilen Eislager," S. 76.
[2] Pavlova, M., "Description of Fossil Mammals," p. 36.
[3] Pavlova, M., "Description of Fossil Mammals," p. 38.

fact. Neither did he explain the difference of opinion concerning *Alnus fruticosa* which in the New Siberian Islands had been discovered first by Toll in the ground of the upper recent tundra, where the latter located, of course, the mammoth-horizon. Vollosovich did not correct, either, statements which he must consider erroneous in the observations by Toll. The rich ivory localities in some parts of Kotelny Island, ivory collected on the surface of tundra, Vollosovich is inclined to consider originated from the older tundra uncovered or only slightly covered there with new sediments.[1]

Such a change of the stratigraphic position of the mammoth is not supported paleontologically. As was stated above, the Siberian mammoth, by its specific characters, belongs to the youngest generation in its family. In the position suggested by the above scheme, it would have had to approach older elephants, nearer to *Elephas trogontherii* Pohlig, or even be replaced by the latter form.

Unhappily for the scheme referred to, it has a very insufficient foundation, as it is only an interpretation of the observations by Vollosovich on an ice cliff on the shore of Bolshoï Lyakhov Island. The ice outcrops here twice, in the upper part of the cliff in the form of a nearly vertical wall, and in the lower, more regular slope of the shore, near the sea. Both outcrops are separated from each other by irregular accumulations of drift which, in Vollosovich's opinion correspond to an intermediate layer, to his mammoth-horizon. However, in the opinion of other explorers, who had the opportunity of observing the same or similar ice cliffs in different parts of Arctic Siberia, these drift accumulations had originated from the streams of mud running down, caused by the thawing of the ice cliff, are only deposited on the slope and do not separate Upper and Lower ice layers which are connected below the accumulation of drift. The difference in profile of both parts of the outcrop is explained by the fact that the lower part of the ice, when not underwashed by sea waves, in spring remains covered with snow for a long time after the upper part had been exposed to direct sun rays, being also protected in summer with deposited silt. As the result of such a condition the upper part is thawing much more quickly and retreating farther from the shore than the lower one. As matter of fact, the same ice cliff on Bolshoï Lyakhov Island was examined by Toll who discovered, within the silt deposits on the slope, remnants of *Alnus fruticosa*, but did not hesitate to consider them washed out from the ground of upper recent tundra and brought down by mud streams. He disregarded the idea of the stratigraphic independence of loam deposits on the slope and of the different Lower and Upper ice layers. According to Vollosovich, the deposits of his mammoth-horizon originated from mud streams as the result of thawing of rock ice, but it was the old Lower ice and old tundra on its surface, which delivered these streams of mud. All plant remnants found by Vollosovich were buried in a secondary location, and he never had a chance to examine the old tundra ground in its primary condition, but always in the form of such mud stream deposits. The mammoth horizon, after Vollosovich, is sometimes covered with lake deposits, and sometimes underlain with them, as, for example, at the locality of the mammoth on the river Sanga-Yurakh, where rock ice was absent.

Vollosovich's suggestion brings to attention a very important question, but his data are not of the sort to be taken without reservations. Besides the difference of opinion between Vollosovich and Toll, mentioned above, as to the geology of Bolshoï Lyakhov Island, there is another between Vollosovich and Pfizenmayer, concerning the locality on the Sanga-Yurakh River, a secondary one in the opinion of the latter.[2] Vollosovich's

[1] Vollosovitch, C. A., "Le mammouth de l'ile Bolchoï Lakhovsky," p. 315.
[2] Cmp. above, p. 36.

observations must first be checked on the very spot before changing the stratigraphic position of the mammoth-horizon, so far established as the highest one among the Post-Tertiary strata in Northern Siberia and elsewhere.[1]

The old tundra ground must have originated, according to Vollosovich, from the silt brought down from the surmounting Tertiary hills, i.e. in the same way as have the earth strata on the terrace of Beresovca River, in rather exceptional conditions, which cannot exist elsewhere, as has been explained above. The origin of deposits of the upper recent tundra is not considered by him at all, but, probably, he was ready to explain it in the same way and meet, therefore, the same objections which are made to the universal application of this kind of explanation.

Great confusion also exists concerning rock ice. The writer cannot consider this problem just now, but would like to emphasize the fact that Toll's suggestions on the glacial nature of rock ice must be completely abandoned. Rock ice is a product of recent climatic conditions of Northern Siberia and would originate whenever these conditions prevailed. Its origin, therefore, was not confined to any particular geological moment, and rock ice must not be considered as a well-defined horizon. Among many theories trying to explain its origin no one could be recognized as being fully satisfactory in all cases, although every one of them is good for some particular case. In some instances, rock ice may be even younger than the strata within or below which it happens to be found, being in this case in the nature of a dyke, even of an intrusive one.

[1] Depéret, Ch. et L. Mayet, Monographie des Eléphants pliocènes.

CONDITIONS OF PRESERVATION OF FROZEN CARCASSES OF THE MAMMOTH AND RHINOCEROS

The most difficult part of the mammoth question is to find out the ways in which a carcass could be quickly buried and saved from decaying. It appears quite mysterious, if one tries to look for possible explanation in the familiar conditions of a moderate climate; but can be easily understood, if one takes into consideration the climate of recent Arctic Siberia which corresponds to the climate of the Age of mammoth, as has been shown above.

During his travel in Siberia, Middendorff,[1] on the shore of the Sea of Okhotsk, came across the carcass of a whale which had been buried within the drift accumulated by waves and preserved so well that a few weeks later its fat was found good enough to be used for food. An animal protected in this way from wolves and foxes could stay till the next winter, be frozen and have a chance to remain intact for a long time. Middendorff suggested that the carcass of a mammoth like that found by him on the Taimir River could be brought down a river to its mouth, covered here with silt, frozen, and preserved in the frozen ground, for an indefinite length of time. Middendorff's theory certainly could be considered valid for the localities in deltas and mouths of rivers, or on a sea shore. Bunge enlarged on Middendorff's theory by suggesting that an already frozen carcass of a mammoth could drift and be buried in the same way.[2] During his Vega travel Nordenskiöld chanced to discover in the ground, on the sea shore of the Chukchi Peninsula, remnants of a whale which had been buried and preserved in just the way explained by Middendorff. It was a skeleton of *Balaena Mysticelus* still partially covered with skin and with deep red, almost fresh, flesh adhering to those parts of it which were frozen in the ground. According to Chukchis, no whale had stranded there in the memory of man, therefore the animal must have been buried many scores of years before. Nordenskiöld, describing this discovery, as an example of protection against putrefaction of flesh of gigantic sea animals by means of preservation in the frozen soil of Siberia, refers to it, as "a parallel to the mammoth mummies, though from a considerably more recent period." [3]

Localities in which a mammoth obviously was found buried on the very spot where it had died, could not be explained according to Middendorff and Bunge; but a very satisfactory explanation, in the opinion of the writer, was offered a long time ago by J. E. Brandt and then enlarged upon and completed by other scientists. Brandt was very much impressed by the fact that remnants of the mammoth, carcasses and skeletons alike, sometimes were found in poses which indicated that the animals had perished standing upright, as though they had bogged. In the case of the skeleton of a mammoth found in such a pose near Moscow, Russia, Brandt suggested that the animal must have sunk into soft mud.[4] Concerning conditions of preservation he says: "Wurde das Moskauer Government damals einen ewig gefrorenen Boden besessen haben und noch bis auf heute besitzen

[1] Middendorff, A. Th., "Sibirische Reise, I," I, S. 236.
[2] Bunge, A., "Die Lena Expedition," S. 46.
[3] Nordenskiöld, A. E., "Die Umseglung Asiens und Europas, I," S. 476.
[4] Howorth, H. H., "The Mammoth and the Flood," p. 158.

ähnlich wie der Norden Sibiriens, so würde das fragliche Mammuth wohl als ganzes Cadaver zum Vorschein gekommen sein." Such accidental plunging into soft ground Brandt considered as one of the most important reasons of the death of the mammoth. If it happened in the fall, the carcass could be frozen shortly after and thus preserved for a long time. A very important supplement to this theory was made by Al. Brandt who suggested that the mammoth could be trapped in streams of mud having originated through landslides.[1]

The present writer in his description of the geology of the locality of the mammoth on river Beresovca suggested that the animal had been trapped in soft ground when pasturing on the river terrace. As a matter of fact, the swamps and bogs of a moderate climate, with their treacherous pits, in Northern Siberia, owing to the permanently frozen ground, could exist only in quite exceptional conditions, as those observed by Pfizenmayer in the Yana Region.[2] As Pfizenmayer speaks also of a permanently frozen ground there, thawing, in the summer, only 50–70 centimeters from the surface, it is rather difficult to understand from his description the possibility of existence of the swamps referred to. Al. Brandt's allusion to mud streams, mentioned above, certainly, has, therefore, a special importance for Northern Siberia, where such streams used to originate through the melting of frozen ground and of rock ice which is always covered with loam layers, as well as having loam masses included within the ice itself. Mud originated in this way is very soft and at the same time extremely sticky. A few inches of it are practically impassable for a man, a foot or a little more was, probably, sufficient to stop a mammoth. During his first travel to Northern Siberia Vollosovich happened to be trapped in such a stream which he tried to cross. After some unsuccessful attempts he was released only with assistance of his guides. The next morning he examined the treacherous spot and found his tracks firmly frozen under a new layer of mud.[3] A mammoth once trapped within the mud must have succumbed after a short, desperate, but unsuccessful struggle, during which the Beresovca mammoth, for example, had broken its pelvis and other bones. Recent animals, horses and cows, once trapped in mud, very quickly give up any resistance and remain immovable, waiting for their fate, even though uninjured. Once trapped in a moving mud stream the body of a mammoth made a kind of a dam against which the mud piled up until it could overflow the body and finally suffocate the animal. As long as the latter was alive and could move a little, it was protected against the attacks of wild animals. The mud cover used to give some protection later as well. If the accident happened in the fall, the covering of the carcass and its freezing could go on hand in hand, and in a short time the carcass would be completely frozen. In Vollosovich's opinion, the mammoth collected by him on the Sanga-Yurakh River had perished and had been buried in this way.[4] He arrived at the same conclusion as to the mammoth from Bolshoï Lyakhov Island. The death from suffocation of the latter specimen was proved in the same way as in the case of the Beresovca mammoth, through the erection of its penis.[5] The death from asphyxia was proved also for *Rhinoceros tichorhinus* Fischer from Vilui, an examination of the head of which revealed

[1] Brandt, Al., "Kurze Bemerkung über aufrecht stehende Mammuthleichen." After Fr. Schmidt, "Vorläufige Mittheilung," S. 97.

[2] Pfizenmayer, E. W., "Mammutleichen," S. 94.

[3] Personal communication to the writer by the late Vollosovich.

[4] Vollosovich, C. A., "On the Digging out of the Sanga-Yurakh Mammoth, in 1908," p. 453.

[5] Vollossovitch, C. A., "Le mammouth de l'ile Bolchoï Lakhovsky," p. 337.

that the blood-vessels and the fine capillaries were filled up with brown coagulated blood, which in many places still preserved its red color.[1] The death from suffocation was suggested for the specimen of rhinoceros from the Khalbugaï Creek as well.[2] It is certainly not possible to find out, in either case, if asphyxia was the result of entrapment within mud, or of drowning.

In the sixties of the last century the Russian Academy of Sciences was hunting for mammoths in Western and Eastern Siberia. On each expedition, Schmidt and Maydell, respectively, came across only poor remnants of mammoth, although Maydell had a chance to visit three different localities. All hopes of discovering a complete new carcass were apparently frustrated. It brought Schrenck to conclusion that, although remnants of mammoth with soft parts are very common in Northern Siberia, complete carcasses are extremely rare and required the death of an animal and preservation of its carcass under quite exceptional conditions. As the only complete carcass of a mammoth known at that time, was that of the Adams mammoth, found, as it was erroneously suggested, enclosed within ice, Schrenck describes the probable conditions in which mammoths (and rhinoceroses) perished, and in which their carcasses were preserved, in the following way: mammoths in their wandering happened to break through large accumulations of snow in narrow valleys, canyons, or under cliffs. Once plunged down, they were unable to get out, and gradually sank deeper and deeper and became well protected against the warmth of the next summer, as well as against wild animals, and preserved complete for a number of years to come.[3] As has been mentioned above, the Adams mammoth was not found within ice, but in frozen ground. The head of *Rhinoceros tichorhinus* Fischer from the Khalbugaï Creek, whose lack of any soil particles brought Schrenck to the conclusion that this animal had also been found within ice, was washed twice or three times before its arrival at St. Petersburg, and this animal had also been found in frozen ground.[4] With the exception of these two specimens no one has been known whose death and preservation could be explained in the way described by Schrenck. Besides, the physico-geographical conditions required by the theory have been nowhere known in Siberia, and it is rather difficult to imagine them having existed there in former periods. Howorth correctly emphasized this fact.[5]

In spite of that, Schrenck's theory has found some adherents. Bunge [6] thought that in this way could have originated the carcasses found in deltas to which they had been drifted, frozen, from the upper part of streams. Nehring [7] also considered such accidents quite possible, and Kayser is ready to recognize Nehring's explanation as well.[8] In recent times Schrenck's theory has been accepted without any reservation by Digby. According to his book "The cold-stored mammoths and wooly rhinos that have survived in flesh-and-blood . . . were just a very few which happened to fall into a deep, steep-sided crevasse, filled with snow, on the eve of, or during, a blizzard, which filled in the hole behind them, when they themselves did not fill it in by their struggles." [9] On the basis

[1] Howorth, H. H., "The Mammoth and the Flood," p. 184.
[2] Howorth, H. H., "The Mammoth and the Flood," p. 185.
[3] Schrenck, L., "Bericht über neuerdings in Norden Sibiriens angeblich zum Vorschein gekommene Mammuthe," S. 173.
[4] Toll, Ed., "Die fossilen Eislager," S. 39 and 48.
[5] Howorth, H. H., "The Mammoth and the Flood," p. 95.
[6] Bunge, A., "Die Lena Expedition," S. 46.
[7] Toll, Ed., "Die fossilen Eislager," S. 81.
[8] Kayser, Em., "Formations-Kunde," S. 525.
[9] Digby, B., "The Mammoth," pp. 55 and 138.

of the same theory Digby explains why the frozen rhinoceros is less often found than the mammoth. "Rhinoceros being built like the bows of a ship could drive a tunnel in snow to the open end of the gully. Therefore it is seldom found cold-storaged. . . . Other contemporaries of mammoth were not heavy enough to go snowdrift, or managed to tunnel out." [1]

Although carcasses of extinct animals have not been found enclosed within ice, it is of some interest to mention that an animal could meet death and become enclosed within ice in the so-called aufeis,[2] which has a wide distribution in Northeastern Siberia and sometimes covers surfaces of many square miles with a layer of ice often of a great thickness, which can easily last over summer, or even for an indefinite number of years. It was considered impossible by Howorth [3] who, probably, was not very familiar with this phenomenon and while having said that "the ice in the rivers is completely melted during the summer," he referred to the usual winter ice cover of rivers in moderate climate. Under certain conditions, for example, after heavy snow, the aufeis would be passable only with difficulty, and such a heavy animal as the mammoth could be easily trapped within it, and doomed to destruction. The carcass could be covered with water which, at a temperature many degrees below zero, would be quickly transformed into ice, and preserved for an indefinite time. The aufeis might be covered with drift and transformed into rock ice. In number of years, the rock ice might be perhaps destroyed through a gradual deepening of the particular valley, and the carcass would be found buried in frozen ground on the terrace of a river.[4]

To explain the way in which carcasses were enclosed into ice, as well as the origin of ice itself other theories were also offered, which are certainly only of historical interest now. For example, according to Gümbel,[5] the carcasses of extinct animals found in Northern Siberia were brought over there from Southern Siberia enclosed within the ice, presumably, of ancient glaciers. Heer [6] also found possible such a transportation of carcasses enclosed within ice. The destruction of an animal and its preservation within glacier ice could take place in just the same way, as it sometimes happens to unhappy glacier climbers of our days. According to James Geikie, during the Glacial epoch great snow drifts accumulated and became consolidated. Over this ice, mosses and lichens crept until a tundra was formed over solid ice, a condition to be noted in some places now. Later this ice may melt away in places leaving the tundra apparently firm. In such traps as these many of the great animals might be caught and perish.[7] Trapped in this way a mammoth, or other animal, could become frozen very quickly. Maydell mentioned such traps in the tundra over the crevices in rock ice,[8] and Herz explained the death of the Beresovca mammoth by its plunging into an ice crevice.[9] But even in such a case a mammoth would be buried in frozen ground; and only under quite exceptional conditions be found entombed within ice, when it had been, for example, covered with snow during a blizzard.

[1] Digby, B., "The Mammoth," p. 58.
[2] The name along with its German spelling has been introduced into American literature by Leffingwell: U. S. G. S. Prof. Paper 109, p. 158.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 95.
[4] Toll, Ed., "Die fossilen Eislager," S. 39.
[5] Tscherski, I. D., "Beschreibung der Sammlung," S. 49, footnote.
[6] Tscherski, I. D., "Beschreibung der Sammlung," S. 463, footnote.
[7] Wright, G. F., "Asiatic Russia, II," p. 580.
[8] Toll, Ed., "Die fossilen Eislager," S. 22.
[9] Herz, O. F., "Frozen Mammoth in Siberia," p. 617.

In spite of the similarity to a real ice-box, of the frozen ground of Northern Siberia, and of the possibility for the carcasses enclosed within to be preserved almost indefinitely, there are still some details in the matter which need an explanation. Between the moment of the death of a mammoth and that of its transformation into a frozen carcass and burial within the natural refrigerator must have passed some time during which the carcass surely suffered some decay, although current opinion attributes to the meat of a mammoth an almost absolute freshness. Howorth, for example, compares it with "the flesh recently taken out of an Esquimaux cache or a Yakut subterranean meat-save." [1] As matter of fact such freshness is a legend. The only proof of it is bright red color of flesh and white or yellowish of fat, and the fact that the flesh used to be devoured with avidity by dogs and wild animals. But the same meat was absolutely unpalatable for an adventurous scientist. All stories published in newspapers of this country of a dinner in St. Petersburg where the meat of the Beresovca mammoth was served, are a hundred per cent invention.[2] All travelers also used to say that the carcasses of the mammoth as a rule had an intolerable putrid smell. As in no case a scientist had a chance to examine mammoth flesh immediately after the animal had been discovered, but usually a year, two, or more later, it appeared correct to attribute these conditions to putrefaction which took place after the uncovering of a carcass. But a strong smell is peculiar to the mammoth localities and to the ground within which remnants are buried, even when they are concealed within and, presumably, still firmly frozen. No process of decay is possible under temperatures below the freezing point, and in the case of the mammoth, rhinoceros, etc., it did not take place; because if it had, after many thousand years of decaying even though it were a gradual process, no soft parts would have been preserved. The smell in the ground may, therefore, be the result of the putrefaction started immediately after the death of an animal, before it became permanently frozen, and may be called fossil as well as a carcass itself. The putrid smell of a mammoth is different from that of other putrefied flesh, but more penetrating and very appealing to wild animals. For this reason the flesh of the mammoth is often used by natives as bait in their fox traps. An examination of the flesh and fat of the mammoth from Beresovca River has also shown that they suffered a deeply penetrating chemical alteration as a result of the very slow decay which was going on, probably, in an airtight medium.[3] It would be possible to refer these alterations to the time immediately following the death of an animal when it was, for example, covered with drift, but not yet definitely frozen, or was for a while in water, etc. Like common decay these chemical processes had to be suspended so soon as ground and the carcass became firmly frozen.

Decay of organic matter in Arctic climate, so far as results are concerned, is going on differently than putrefaction in moderate climate, and much more slowly. A good illustration of that has been given by the Adams mammoth which was examined four years after it had slipped down to the shore and had, all this time, remained uncovered. Its carcass had suffered very much, but chiefly through wild animals and dogs. A few soft parts happened to remain intact, were gradually dried out and in this form brought to St. Petersburg. The Beresovca mammoth also remained uncovered and not well protected for two summers, before the arrival of an expedition. In Arctic regions the highest summer

[1] Howorth, H. H., "The Mammoth and the Flood," p. 93.
[2] Gardner, M. B., "A Journey to the Earth's Interior," p. 44.
[3] Bialinitzki-Birula, F. A., "Observations histologiques," p. 19.

temperature of the air is still lower than in moderate ones. The warm time of a year is much shorter and is practically confined to the nightless period of summer. During other summer time warm days are alternating with cold nights when the temperature often goes down towards freezing. The process of putrefaction goes on very slowly in Arctic regions also, because of the great purity of air and, perhaps, also due to the absence of insects. In Green Harbor, on Spitzbergen Islands, Nordenskiöld, in 1868, saw on the shore twenty-four white-whales killed by fishing vessels. Although the carcasses were "exposed day and night to the direct action of the sun's rays, there was no sign of putrefaction, and the entomologist of the expedition could not capture a single fly or other flesh-loving insect upon them." [1] More recently air in Novaya Zemlya was found practically germless.[2] In Northeastern Siberia putrefaction is also delayed because of the very dry climate which, so far as the amount of precipitation is concerned, might be compared with the steppes and deserts of Middle Asiatic territories east of the Caspian Sea. In such conditions sometimes a carcass of an animal could stay over the warm season without becoming very much decayed. Much depends upon the time when an animal died. If it happened during early spring or winter, and the carcass were not exposed to direct action of the sunshine, during the spring it would thaw in the day time and freeze again at night, drying out all the time, days and nights alike, without undergoing putrefaction, as it would happen in a warm region; putrefaction is handicapped by the sterilization produced by the night freezing. In this way a carcass might be mummified, completely or partly, before the warmest time of the year and better resist decaying processes in the summer. Fall offers the same or perhaps better conditions, because a carcass would be partly mummified before winter, making the whole period favorable to preservation, longer.

How important all these processes are, and how they delay putrefaction, has been proved by everyday experience and often profitably utilized. Traveling in the mountains of Southern Siberia the writer, for example, realized that the supply of meat could be kept in fresh, or in quite palatable condition, if the meat every night were taken out of bags or other containers and hung up to be freely affected by the night breeze and decreased temperature. North Siberian natives utilize the early spring time to prepare dried meat. They cut fresh meat taken for drying into pieces or strips and hang up in the shade, never under the sun rays, in places with good circulation of air, affected by the breeze. The meat remains frozen the greatest part of the day, but thaws a little about noon when it becomes affected by warm dry air. The days grow longer, and the meat every day thaws for a longer time, but every day it also becomes dryer and dryer. In about two or three months the meat is ready and may be used raw, boiled, or grilled in every form being quite a palatable product, suitable for preservation for an indefinite time.

The writer also chanced to find, in 1905, near Lake Yesei, in Northern Siberia, at the latitude about 68° 30′ and 102° East of Greenwich, a body of Tungus-shaman transformed into a mummy by the climatic conditions referred to. The body was found well dried, in a so-called "hanging-tomb," a strong wooden coffin fixed on a wooden structure three or four feet above ground, where it had been buried more than fifty years before. Brought to St. Petersburg and placed in a museum this body has remained without any noticeable decay, although in entirely different climatic conditions.

[1] Nordenskiöld, A. E., "The Arctic Voyages," p. 137.
[2] Science, LXIX, No. 1789, Suppl., p. XIV.

The recent climate of Northern Siberia is such that we easily can imagine conditions under which a carcass of an animal died on the land would last over summer, without complete decay, become frozen during fall and winter and, if covered with silt, landslides, etc., be preserved within the frozen ground for an indefinite number of years. It is, therefore, unnecessary to look for different physico-geographical conditions, when the recent Siberian ones so readily explain the origin and preservation of the carcasses of the mammoth. As we have seen before, such conditions were prevailing at the Age of the mammoth in Siberia. The burial of some mammoths was considered above in the case of the animals trapped in mud. As has been shown by the plants found in its stomach, it happened during late summer or early fall, when the middle part of summer was already over, nights had started to lengthen, and mud streams were at their greatest size, being easy traps and giving good conditions for a comparatively quick burial. In this case wild animals were contributing more to the destruction of the carcass than decay. The mammoth examined by Vollosovich on the Sanga-Yurakh River had been spoiled by ice-foxes immediately after its death and before it was buried. But even in the case of a mammoth trapped within mud, only the upper surface of the carcass was available for a feast, and this became smaller and smaller due to the continuing flow of mud over it. Usually a carcass could only be spoiled by devourers and only occasionally completely destroyed. Animals perished in winter, since they were frozen, were more or less protected against the attack of wild animals by the hardness of their frozen carcass, which increased with the lowering of temperature. They were also covered with snow drifted over the obstacle.

In recent Siberia we also meet physico-geographical conditions under which a carcass will undergo very slow decay, probably much slower than on the land, and at the same time will have nearly perfect protection against different carnivores. These conditions must have existed in the Age of the mammoth, and recent observations can be applied to the mammoth. An animal could plunge through the ice of a river or lake, or simply drown, and its carcass, under the climatic conditions of Siberia, and due to the presence of frozen ground, could be frozen to the bottom and eventually covered with silt. It could also be moved by the stream along the bottom, or later, on acquiring buoyancy, drift down the river and be buried again on the bottom or shore of a river, lake or sea. Owing to the low temperature of water in North Siberian rivers the decaying of a drowned carcass must go on very slowly in it. If a carcass happened to be covered with silt, it must have been at that time in fairly fresh condition. After such a covering, the process of decomposition must be retarded still more. To all these phenomena, details of which are dependent upon the nature of North Siberian rivers, surprisingly little attention was paid until recently. Occasionally, and in very unusual and tragic conditions, the writer was able to realize all the importance of the events referred to for the question under consideration.

In 1920, during the Russian civil war, thousands of people were killed at Nicolaevsk, a small town on the Amur River, and hundreds of bodies thrown into the river, under the ice in winter, overboard from a tug in the spring. The killing stopped only in June when the destroyed town was abandoned by the population. In July of the same year the writer happened to be at Nicolaevsk and for seventeen days stayed on board of a steamer occasionally anchored near the very spot where the killing had been going on in winter and spring. Every day we could observe floating bodies which had left the bottom, where they had lain for a few months, and were drifting down the river. Some of them later

were found on the shores, others, probably, brought to the sea, or sunk again. The number of bodies which left the bottom during seventeen days was estimated at about 150. It was, therefore, a regular phenomenon not an occasional event. In some way the bodies were fixed to the bottom during a few months, presumably frozen there, because every time, as the body was observed coming to the surface at the first moment, it gave an impression of jumping out of the water, as if it had been freed only due to some excess of buoyancy. The cold water into which the bodies has been thrown preserved them for a number of months very little decomposed, if changed at all; only in the middle of summer, when the water became warmed through, did decomposition start. The preserving properties of cold water are well known in Northern Siberia. Matyushkin tells us that in hunting for reindeers, crossing rivers on their way back from the North in the middle of August, "The deer which have been killed are sunk in the river, the ice-cold water of which preserves them for several days, till there is time to prepare them for winter use." [1] The floating bodies on the Amur River were all badly decomposed, but hardly more than, in usual conditions, a body drowned for a week or two would be. If they were frozen in the ground and discovered thousands of years later, they certainly would be considered very well preserved. All these events were observed in Southern Siberia which enjoys a comparatively moderate climate. In Northern Siberia the bodies could remain on the bottom all through the summer, be buried within the drift accumulated around an obstacle, and preserved frozen for an indefinite number of years to come. After thousands of centuries the river could deepen its channel and abandon the former one. In this case the carcass buried in the way referred to, would be found on the river terrace, or, speaking more broadly, within old river deposits, like the Adams mammoth, Khalbugaï rhinoceros, etc. Such happenings certainly could not be considered as every day events, but, neither were they unusual or exceptional. A distribution of the skeletons of fossil animals in old river channels has been established not once. Such is, for example, a very known locality of *Iguanodons* at Bernissart, Belgium. One of the most interesting localities of this kind was discovered more than a quarter of a century ago in Northern Russia, on the shore of the river Syeverhaya Dvina, where a number of perfectly preserved skeletons of Permian reptiles and amphibians were found within the bed of an ancient river, filled up completely with drift. All the skeletons were found enclosed in peculiar concretions in most cases reproducing fairly well the general shape of an animal. They were oriented at the locality all in the same way, undoubtedly according to the direction of a flow, and there could be no doubt about their transportation by a river. Animals had probably drowned and were preserved in the cold water from very quick decomposition, as well as from attack by wild animals. In the writer's opinion it was even possible that they were buried as carcasses, and that the origin of the concretions was connected with a gradual decaying of soft parts. In the case of the mammoth, we also have examples of such a concretion *in statu nascendi*. This was the Middendorff mammoth found on the Taimir River, soft parts of which were already replaced by mineral material containing some organic substance. If this mammoth were protected against destruction, its skeleton in due time could be found enclosed within a concretion more or less similar to those from the river Syevernaya Dvina. We can suggest a still closer analogy between the conditions of preservation of mammoth carcasses within the river drift and those of the Permian fauna in the Syevernaya Dvina

[1] Wrangell, F., "Narrative of an Expedition," p. 186.

Territory, because in both cases climatic conditions, presumably, were somewhat similar. Permian animals were found there within the region of the *Glossopteris* flora, a product of a rather cold climate. Besides that, Amalitzki, to whose credit belongs the discovery of this fauna, was ready to attribute a glacial morainic origin to some parts of the Permian strata outcropping in the Syevernaya Dvina Region. This conclusion is certainly apt to bring a number of far-reaching suggestions concerning this Permian fauna, but it would be beyond the limits of the present paper to dwell longer on them.

As follows from the review just accomplished, among the many theories offered and supported by different scientists in trying to explain the conditions of death, burial, and preservation of carcasses of the mammoth and rhinoceros, some are absolutely improbable, others probable, but not supported by facts, and two not only can stand criticism, but are supported by real observations. These two explanations accepted by the writer are: the mammoth had perished and had been buried in mud streams caused by the thawing of frozen ground and rock ice; or, the mammoth had drowned in rivers or lakes, especially during winter or early spring, been frozen to the bottom, and buried in drift on the very spot, or drifted down stream, often as a frozen carcass, and buried somewhere in the lower part of the rivers within their deltas, or embouchure sediments. The examples of the first case are the mammoths found on the Beresovca River, on Sanga-Yurakh River, and on the Bolshoï Lyakhov Island. The examples of the second case are the Taimir mammoth of Middendorff, the Lena mammoth of Adams, rhinoceroses found on the Vilui and Khalbugaï Rivers, and perhaps, at least partly, carcasses found on the New Siberian Islands. Because of all the conditions already considered, one would not expect, in the first case, to find a carcass perfectly preserved and unmolested by wild animals. But such localities give a better idea about the surroundings of the mammoth, its habits, and its geological position. In the second case one might expect to find the carcass of a mammoth in perfect condition, so far as its preservation was concerned. But geological and other data which are collected in such localities could not be compared with those achieved in the first case, and such localities have to be considered as secondary ones.

EXTINCTION OF THE MAMMOTH

THE writer has already said [1] a few words on the extinction of the mammoth and given a short review of different explanations of this phenomenon, all of which have now only an historic interest and can only be called fantastic, comparatively recent theories of Howorth and Gardner included. In a rather curious way these theories repeat, in somewhat modernized form, the tales of Siberian natives, reflected in Siberian folklore, and old Chinese traditions. Unfortunately we are unable to replace them by new ones which could harmonize with all accumulated data and stand criticism from different quarters, but must be satisfied with more or less probable suggestions. It seems to the writer that most of the students who had a chance to work on the mammoth-question came to the same sad conclusion. The problem is extremely difficult. We must explain the extinction of an animal which was living in great numbers, apparently very prosperously, over a large area, in variable physico-geographical conditions to which it was well adapted, and which died out in a very short time, geologically speaking. The difficulty of problem, perhaps, is well illustrated by the fact that Arctic scientific travelers from whom it would be more natural to expect a solution, are very cautious in their speculations. If they sometimes used to touch on the question of the extinction of the mammoth and its contemporaries, they did not consider it for the whole mammoth-country, but were referring only to some limited area. In the same way, Russian scientists familiar with the problem did not try to find its general solution. Brandt and Schrenck, for example, used to consider an accidental extermination of an individual mammoth and did not approach the problem of the extinction of species. Middendorff and Schmidt dealt with the living conditions of the mammoth-habitat in the extreme North of Siberia. Toll and Vollosovich tried to understand the extinction of the mammoth and other Post-Pliocene mammals, but took into consideration only the territory of the New Siberian Islands, which does not clear up the whole question Tscherski and Pavlova, who identified and described the fossil mammals from the New Siberian Islands and Arctic part of the mainland, also considered the problem of extinction in connection with the change of climate, but were not more successful than their predecessors. Pavlova has recognized that the problem still waits for new observations on the spot and for new data, to be solved more or less satisfactorily, a hope which still remains frustrated. A number of different universal theories explaining the extinction of the mammoth were offered usually by scientists who were not familiar enough with the mammoth-question in detail and could not appreciate all the present and former conditions of the regions in which the mammoth had lived. It is also necessary to mention that the extinction was considered by many scientists to be a result of an extermination which, in the opinion of the writer, is mostly incorrect. Extermination destroys an individual, extinction—a species. The former works in one generation, the latter goes on through many generations. Extermination is a result of some exterior agents, usually is local and could not result in an extinction of a species over a large area, except in catastrophes like those which were previously advocated.

[1] Cmp. Introduction.

The recent explanations of the extinction of the mammoth may be placed in the three following categories: (1) Destruction by man; (2) defects of organization having resulted in poor adaptation to surrounding conditions; (3) change of physico-geographical conditions.

Extermination by man has been eagerly advocated recently by Digby [1] who follows L. Laloy in this.[2] It went on by hunting and direct killing, or by pursuing and pushing the mammoths into inhospitable parts of the country, where they were destroyed by the unfavorable physico-geographical conditions. Such ideas appeared more than once before, but were always discarded as unreasonable.[3] Human society in Post-Pliocene was too scarce to be dangerous to huge flocks of mammoths distributed over large areas. Northern Siberia was, probably, no more populous than now. Accordingly, Reid [4] accepted the extermination of the mammoth by man only in Europe. In Siberia, in his opinion, the mammoth was gradually killed by the increase of cold and want of food. According to Pfizenmayer, extermination of the mammoth by man took place in Middle Siberia where it had come from the North because of the change of climate.[5] The primitive man was armed very poorly and, probably, was more inclined to avoid the big brute than to chase it. The ancient natives of Siberia had plenty of other game more available than the mammoth, like their recent African brothers who, according to Digby,[6] "surrounded by mealie gardens, fowls and great herds of antelope, left the great-tusked trampling brutes alone." To African natives the elephant was, probably, more dangerous than they to it; and, perhaps, the elephant used to kill as many natives as they kill elephants.[7] The extermination of the recent elephant in Africa started only since the arrival of the white man with his rifle and a great outside market for ivory. In a picturesque way, Digby describes how the prehistoric man caught the mammoth [8] in booby traps exactly in the same way as do African natives nowadays, although the making of a large pit in the frozen Siberian ground offered almost insurmountable difficulties, and natural clefts suitable for this purpose were practically absent there. Extermination of the American bison, which Digby compares with that of the mammoth was also accomplished by white intruders. American Indians lived for centuries along with these animals, had plenty of food and skins, but were in no danger of being deprived of this storage in the years to come. As matter of fact, primitive man always was and has been very wise as to the utilization of natural resources. He never used to kill more animals than he needed for his household and knew exactly his needs. Only the intervention of cultured colonists who opened a market for game, skins, and furs, could make a native forget his wise economy. Unmolested, or only seldom attacked by man, the mammoth had no serious enemies among his carnivorous contemporaries either.[9]

Concerning the defective adaptation to surrounding conditions, it is necessary to say that in no one case was it possible to discover in the frozen carcasses of the mammoth any bad effects of conditions under which the animal used to live. The animals were always well fed and fat, sometimes too fat, as the Adams mammoth, the belly of which,

[1] Digby, B., "The Mammoth," p. 33.
[2] Laloy, L., "Le régime alimentaire du Mammouth: L'Anthropologie, XVII," p. 234, Paris, 1906.
[3] Howorth, H. H., "The Mammoth and the Flood," p. 172.
[4] Reid, Cl., "The Sudden Extinction of the Mammoth," p. 44.
[5] Pfizenmayer, E. W., "Mammutleichen," S. 148.
[6] Digby, B., "The Mammoth," p. 65.
[7] Neuville, H., "On the Extinction of the Mammoth," p. 328, footnote.
[8] Digby, B., "The Mammoth," p. 65.
[9] Howorth, H. H., "The Mammoth and the Flood," p. 172.

according to its native discoverer, was below its knees.[1] The animal must have had a comfortable living, which, under the conditions of the Arctic climate, was possible only if it were well adapted to those conditions. It must have been well protected against cold and been able to find plenty of food. Vollosovich pointed out the undersized dimensions of his Sanga-Yurakh mammoth as a prophecy of the extinction of the race.[2] We certainly must recognize the fact that a regular decrease in size affecting a species is a danger-signal, but we must not consider the small-sized races of a species as groups becoming extinct. In many cases a decrease in size may be an adaptation to some special conditions, not dangerous, but favorable for the race. We do not know whether this was the case with the mammoth and its northern race, but might suggest so, on the ground of analogy to the recent reindeer which might be compared with the mammoth, so far as its geographical distribution, character of living, and feeding habits are concerned. The reindeer living in the forests of Northern Siberia belongs to so-called *Tungusian* or *Lamutian* race which is higher, heavier, and stronger than different races bred along the Arctic coast of Europa and Asia. Only this race can be used for riding even by a heavy man, but we have no ground for considering the northern race as a dying one. It is just as well adapted to the Arctic conditions, and the writer was told by Siberian natives that in the fall, when the tundra is covered with the first snow, it finds its food more easily than does the southern one. Still smaller is the Spitzbergen race which lives very well in those desolate Arctic islands.[3]

In recent times, the large curved tusks of the mammoth attracted the attention of some scientists, as the thing which had given the mammoth less resistance as compared with Indian and African elephants. It was suggested that formerly the mammoth used to live in the forest, where it had ample opportunity to rub its tusks upon trees and prevent them from growing beyond limits.[4] Then it migrated to the tundra, and its tusks started to grow more than necessary and brought about its extinction. In a similar way a squirrel which was fed on a soft food could be killed by the unlimited growth of its incisors. As a matter of fact, the mammoth never completely abandoned forests for the tundra, but stayed in forests or wandered in the tundras alike. Besides that and quite contrary to the theory, the tusks of the more southern and therefore forest-loving variety were larger than those of the tundra dweller. Curiously enough, according to Howorth, "The arboreal nature of the food of the mammoth is again proved by the inordinate length of its tusks as contrasted with the short tusks of the grass-eating Indian elephant." [5]

After the histological examination of the skin of the Siberian mammoth, Neuville came to the conclusion that the animal, in spite of its heavy fur, had, in its skin, a very poor protection against cold.[6] At the same time it was unable to leave the country, which on account of cold had become very unhospitable for it, because the structure of its feet did not allow the mammoth quick locomotion. In a special article the writer tried to show that the histological structure of the skin of the mammoth, as described by Neuville, was a good adaptation and protection against a low temperature,[7] not to mention the fur itself which exactly corresponded to the fur of other Arctic animals.[8] The structure of the

[1] "Sibirski Vestnik, 1920, part X," p. 320.
[2] Vollosovich, C. A., "On the Digging out of the Sanga-Yurakh Mammoth, in 1908," p. 456.
[3] Nordenskiöld, A. E., "The Arctic Voyages," p. 86.
[4] Neuville, H., "On the Extinction of the Mammoth," p. 333, footnote.
[5] Howorth, H. H., "The Mammoth and the Flood," p. 69.
[6] Neuville, H., "On the Extinction of the Mammoth," p. 336.
[7] Tolmachoff, I. P., "Note on the Extinction of the Mammoth," p. 68.
[8] Pfizenmayer, E. W., "Mammutleichen," S. 229.

feet was also a very good adaptation to the soft ground of the mammoth pasturages.[1] As to its walking abilities, they also were, probably, not so bad. Toll found bones of the mammoth on the central plateau of Kotelny Island, about a thousand feet above sea level, and remarked that the mammoth must have been a good walker.[2]

All theories as to a defective organization of the mammoth which presumably brought it to extinction, meet a very strong objection in the fact that the mammoth was not the only animal which had lived and died out in Northern Siberia since the Post-Pliocene. *Rhinoceros tichorhinus* Fischer was its typical companion, as well as a number of other animals abundantly found in different parts of Siberia, among other places also on the New Siberian Islands. The effects of organization destructive for one species could not be responsible for the extinction of another one, but, as a matter of fact, all these animals died out more or less simultaneously and probably from the same cause. It is easy to understand therefore that the explanation of extinction of this fauna through the action of changed physico-geographical conditions acquired more and more supporters.

It was mentioned above that during the Post-Pliocene, forests in Siberia, probably, penetrated farther towards the North than now, and the climate of Northern Siberia was somewhat milder than the present one. The influence of this change, not a very great one, anyway, must not be overestimated for the simple reason that it could affect only the most northern limit of the distribution of Post-Pliocene mammals. Change of climate could only go on very gradually and slowly, and animals affected by it had plenty of time to become adapted to new conditions, or to migrate southwards and to find conditions corresponding to their former habitat. Concerning the mammoth we saw above that it, probably, lived happily through all changes of climate and did not suffer at all from the severe climate of its last days. It also had enough food all the time. Direct influence of changed climate could not, therefore, be considered responsible for the extinction of the mammoth, and we have to examine it in connection with other events. In the opinion of Toll, the dying out of the mammoth and its contemporaries on the New Siberian Islands could be caused by the separation of the islands from the mainland,[3] this in connection with the change of climate for the worse and the decrease of food, lack of which could not be filled through migration, produced very unfavorable conditions of living, especially of feeding the very abundant mammalian fauna of islands and resulted in its extermination. According to Vollosovich, extinction of the mammoth and rhinoceros on the New Siberian Islands had been already accomplished before the separation of islands from the mainland, thus could have been affected only by the change of climate connected with the decrease of food.[4] If the separation of the islands from the continent and each other were complete, it could also bring their animal population to painless extinction by the close interbreeding so fatal to small separated communities. But this interbreeding could not have been so close as to become destructive. Besides, the islands for about eight or nine months remain firmly connected with the mainland, as well as together, by frozen sea. A seasonal migration of reindeers to the islands and back to the continent is going on now regularly every year, and Toll met a flock of them, about thirty animals, so far north as the Bennet Island.[5] In

[1] Vollossovitch, C. A., "Le mammouth de l'ile Bolchoï Lakhovsky," p. 336.
[2] Toll, Ed., "Die fossilen Eislager," p. 62.
[3] Toll, Ed., "Sketch of the Geology of New Siberian Islands," p. 15.
[4] Pavlova, M., "Description of Fossil Mammals," p. 36.
[5] Toll, Ed., "Short Report for the Period June 7 to November 8, 1902," p. 158.

the same way certainly the migration of the mammoth and its contemporaries went on. It is also probable that the abundance of the former fauna on the New Siberian Islands was not as great as it appears to be, owing to the great profusion of fossil remnants; because a large part of them has been found there in a secondary locality, having been brought from the adjacent parts of the continent by ancient rivers.

To these migrations between islands and mainland, as well as between different islands perhaps, may be applied the speculations of Wright referring to the plunging, through ice, of animals during the early fall and late spring migrations.[1] Such accidents were quite possible, as they happen now, but they had nothing to do with the extinction of the mammoth. According to Bell, change of climate for the worse was contributing to the extinction of the mammoth chiefly in connection with its accustomed migrations. In his words: "As the climate gradually became more and more severe, and the summers shorter and shorter, the inertia of this migratory spirit continued, and large herds of mammoth from time to time were caught in the fearful blizzards, so common now during the early autumn in Northern Siberia, and perished from cold and hunger." [2] Such accidents could also take place, but they did not help much towards the general extinction of the mammoth and, as a matter of fact, were independent of the change of climate referred to. In the North they could happen, even if the climate were much milder than the present one. With increasing coldness of climate the distance of migrations must become shorter. Besides, the change of climate was not so great as to have a noticeable influence upon the duration of warm season.

Thus, no one of three possible lines of explanation of extinction of the mammoth can stand criticism and give a satisfactory solution of problem which, in the opinion of the writer, must be considered from a quite different point of view, namely, as an example of a very well-known phenomenon of extinction, in different geological periods, of species, genera, families and even of faunas. In all these cases a group of animals was replaced by another one, when physico-geographical conditions did not become destructive for the former, which was sufficiently proved by the survival of the isolated representatives of the first group. In this way mammals in Tertiary came into possession of the position which during the Mesozoic was the indisputable property of reptiles. Lower Paleozoic seas used to swarm with trilobites as did the Mesozoic ones with ammonites, and both these groups died out without any special reason. Explanation given by different paleontologists of the extinction of these groups do not satisfy us any more than those referring to the extinction of the mammoth. For example, the extinction of trilobites has often been explained by the appearance in the Lower Paleozoic of fishes which fed on trilobites. The latter could be exterminated in this way, but such an extinction must have a character of a momentary catastrophe when suffering animals would be destroyed in no time, geologically speaking. We know that the extinction of trilobites was going on through a number of geological periods, and they were extinguished like a lamp which gradually has less and less oil. This oil in the case of an organism is its vital force or, more exactly, its ability to reproduce. Replacement of reptiles by mammals is a still more mysterious phenomenon, as we lack the evidence of any direct struggle between the two groups. We may say that mammals have taken in nature the place already abandoned by reptiles, or

[1] Wright, G. F., "Asiatic Russia, II," p. 581.
[2] Wright, G. F., "Asiatic Russia, II," p. 581.

which the latter were ready to vacate. An appeal to changing climatic conditions, as the cause of extinction in the cases referred to, is usually unsuccessful as well. In most cases we do not know exactly all the conditions of corresponding periods and must suggest something; and in any case those conditions could exterminate a race only in an accidental, catastrophical way. If the change of conditions were going on slowly and gradually, as, of course, would be most natural, organisms would have plenty of time for adaptation to new conditions, or for migration.

It is very important to notice that in all cases extinction was accompanied by the peculiar development of different morphological characters of a given group. It was usually a dernier cri in the development of some structures which an animal or group of animals was striving to develop and perfect during all its life, and which often became developed *ad absurdum*. These structures are well known to paleontologists and have often been considered as cases of over-specialization,[1] being connected with extinction, or as a prophecy of an approaching extinction; measures unconsciously and tentatively taken by organisms to avoid an extinction, "as if heroic efforts were being made to maintain the race." [2] Examples could be given in hundreds among different groups of organisms. We can consider these aberrant structures as inevitable companions of extinction, perhaps, as causes of it. We can suggest that in their struggle to accomplish some peculiar structures, organisms sometimes can exhaust their vital forces and be doomed to destruction. This exhaustion affects the reproductive abilities of an organism and causes a species or group of species to undergo gradual painless extinction without any direct influence of physico-geographical conditions, appearance of new enemies, etc. In connection with this suggestion we must remember the well-known biological fact that lower groups of organisms are much more prolific than the higher ones. The same fact applies to different forms of the same class. The age of puberty appears later among higher organisms than among the lower ones, which decreases the reproductive ability of the former. Highly specialized forms are often sterile. As specialization is a result of adaptation of an individual to given conditions, we arrive to a rather paradoxal conclusion that the great achievement of an individual may become destructive for the species. In such an over-specialization, accompanied by decrease in reproduction which might not become a complete sterility, we must look for a general cause of extinction. Extermination through natural enemies or change of surrounding conditions might be accompanied by extinction only in rare, rather exceptional and usually catastrophical cases. It was, perhaps, just the reason of the complete failure of many attempts to explain extinction in the light of extermination.

Returning to the mammoth, we find in this animal a few characters of extreme specialization, as, for example, the structure of its molars. The type of the structure had started in *Elephas antiquus* Falc. The intermediate form, *Elephas trogontherii* Pohlig, had more numerous dental plates, more closely arranged and covered with thinner enamel. *Elephas primigenius* Blum. is a further step in development in the same direction, especially well expressed in the Siberian variety with its numerous dental plates and a very thin enamel covering. Another over-specialization is in the size and in the form of tusks of the mammoth. The form was such that a mammoth could use its tusks as a recent elephant uses them, probably only while a young animal. For the adult individual they were nearly

[1] Gregory, W. K., "Two Views of the Origin of Man," p. 601.
[2] Schuchert, Charles, "Historical Geology," p. 210.

useless. The mammoth also had a more specialized foot than any other elephant, having only four toes as compared with the five of other elephants.[1] Its tail had a form which could be only explained as a special adaptation against cold. For the same purpose was developed a separated cover of the anus, in the form of a skin fold,[2] and the fur of the animal. No doubt, individually the mammoth was not weaker, or more poorly adapted, to its living conditions than its ancestors, but, being the last member in a particular line of evolution, it was thus doomed to extinction, by causes which were not external, but concealed in the character of the species itself, in its decreased ability of reproduction. Probably the similar consideration might be applied to the fossil rhinoceros which was very different from its recent tropical relatives, having been, like the mammoth, wonderfully adapted to the severe climate of Siberia.

The fate of the mammoth and rhinoceros was shared by a number of their contemporaries. The same considerations might be applied to all of them, but, as matter of fact, we know less about them than about the mammoth and rhinoceros who overshadowed their less imposing companions. We do not know even, how exactly they might be called contemporaries. The only geologist who tried to find a proper place in a geological succession for different Pleistocene mammals of the New Siberian Islands, where this fauna has been known better than anywhere in Siberia, was Vollosovich. But, as has been shown above, his geological scheme may not be accepted without checking, and his distribution of fossil mammals must also be revised before it can be depended upon. Besides that, Bunge, Toll, and Vollosovich did not distinguish between primary and secondary localities of fossil mammals in the New Siberian Islands. Our knowledge of different fossil mammals there is very unequal. We have, for example, little doubt that the musk ox was an Arctic animal, like its recent representatives, and that it used to live and die out along with the mammoth and rhinoceros. But we know, for example, very little about the tiger the remnants of which were found in the New Siberian Islands. Was it also an animal well adapted to Arctic conditions, or did it lack such an adaptation, making the change of climate referred to above fatal for it? Did it formerly live in the New Siberian Islands, or were the few bones found brought over there by rivers?

The writer does not pretend that his explanation of the extinction of the mammoth is anything more than a suggestion which appears to him more or less plausible. He would like only to emphasize once more that the extinction of species is seldom dependent upon the same causes as an extermination of individuals belonging to this species. In many cases and, probably, in most cases the cause of extinction may be entirely different from the cause of destruction of an individual. A race might be not weakened at all, might even become stronger than before and be doomed to destruction because of high specialization which affects the ability of reproduction and brings species, apparently vigorous, to extinction. High specialization in some particular line or lines, perhaps all characters which tend to bring an individual to a high perfection, at the same time may be fatal for the corresponding species.

[1] Pfizenmayer, E. W., "Mammutleichen," S. 153 and 239.
[2] Pfizenmayer, E. W., "Mammutleichen," the picture facing p. 161.

BIBLIOGRAPHY ON THE MAMMOTH AND FOSSIL RHINOCEROS OF SIBERIA[1]

Account of Russian Sea Travels from the Siberian Rivers to the Arctic Sea: Sibirski Vestnik, 1822, XVII, pp. 39–48, 117–128, 185–196; XVIII, pp. 305–314, 379–398; XIX, pp. 167–180 (in Russian).

ADAMS, M.—Relation d'un voyage à la mer glaciale et decouverte des restes d'un mamouth: Journal du Nord, XXXII, p. 633, St. Pétersbourg, 1807.

ANDREWS, C. W.—Note on the Skull and Mandible of Siberian Mammoth exhibited in the British Museum (Natural History): Ann. Mag. Nat. Hist., 9 Ser., XII, pp. 322–325, London, 1923.

BAER, K. E.—Neue Auffindung eines vollständigen Mammuths, mit der Haut und den Weichttheilen, in Eisboden Sibiriens, in der Nähe der Bucht des Tas: Bull. Acad. Sc., X, pp. 230–296, St. Petersburg, 1866.

BAER, K. E.—Fortsetzung der Berichte über die Expedition zur Aufsuchung des angekündigten Mammuths: Bull. Acad. Sc., X, pp. 513–534, St. Petersburg, 1866.

BIALINITZKI-BIRULA, F. A.—Observations histologiques et microchimiques sur les tissus du Mammouth: Resultats scientifiques de l'expédition organisée par l'Académie Imperiale des Sciences pour la fouillée du Mammouth trouvé sur la rivière Bérézowka en 1901, II, pp. 10–14, St. Pétersbourg, 1909 (in Russian).

BOLTUNOV.—Description of the Lena Mammoth: Technologuicheski Journal, III, p. 162, St. Petersburg, 1806 (in Russian).

BRANDT, AL.—Kurze Bemerkung über aufrecht stehende Mammuthleichen: Bull. Soc. Nat. Moscou, III, p. 97, Moscow, 1867.

BRANDT, J. F.—Mittheilungen über die Gestalt und Unterscheidungsmerkmale des Mammuth oder Mamont (*Elephas primigenius*): Bull. Acad. Sc., X, pp. 93–111, St. Petersburg, 1866.

BRANDT, J. F.—Zur Lebensgeschichte des Mammuth: Bull. Acad. Sc., X, pp. 111–118, St. Petersburg, 1866.

BRANDT, J. F.—Einige Wörte zur Ergänzung meiner Mittheilungen über die Naturgeschichte des Mammuths: Bull. Acad. Sc., X, pp. 361–364, St. Petersburg, 1866.

BRANDT, J. F.—Einige Wörte über die Haardecke des Mammuth in Bezug auf gefällige schriftliche Mittheilung des Hrn. Professor O. Fraas über die im Stuttgarten Königl. Naturalienkabinet aufbewahrten Haut- und Haarreste des fraglichen Thieres: Bull. Acad. Sc., XV, pp. 347–351, St. Petersburg, 1871.

BRUSNEV, M.—Report of the Leader of the Baron Toll Relief Expedition to the New Siberian Islands: Bull. Acad. Sc., XX, Phys. Math. Section, pp. 161–194, St. Petersburg, 1904 (in Russian).

BUNGE, A.—Die Lena Expedition 1881–1884: Beobachtungen der Russischen Polarstation an der Lenamündung, I, Anhang, S. 1–96, St. Petersburg, 1885.

BUNGE, A. UND E. TOLL—Expedition nach den Neusibirischen Inseln und dem Jana-Lande: Beiträge zur Kenntniss des Russischen Reiches, III Folge, III, S. 1–363, 6 Karten, St. Petersburg, 1887.

CUVIER, G.—Recherches sur les ossements fossiles, où l'on retablit les charactères des plusieurs animaux dont les révolutions du globe ont détruit les espèces. Troisième édition, I and II, Paris, 1825.

DEPÉRET, CH. ET L. MAYET—Monographie des eléphants pliocènes de L'Europe et de l'Afrique du Nord: Annales de l'Université de Lyon, n.s., Iéfasc. 43, pp. 89–224, Lyon et Paris, 1923.

DIGBY, BASSET—The Mammoth and Mammoth-Hunting in Northeast Siberia, pp. 1–224, with photographs and a map, London, 1926.

Encyclopedia Britannica, XI Edition, Cambridge, England, 1911.

ERMAN, AD.—Reise um die Erde durch Nord-Asien und die beide Oceane in den Jahren 1828, 1829, und 1830, Abtheilung I, Historischer Bericht, I–III, Berlin, 1833–1848.

FAMINTZIN, A. S.—On the Excrement of the Mammoth: Mem. Acad. Sc., LII, p. 173, St. Petersburg, 1886 (in Russian).

GARDNER, MARSHALL B.—A Journey to the Earth's Interior or Have the Poles Really Been Discovered, pp. 1–69, Aurora, Illinois, 1913.

Germless Island in the Polar Seas: Science, LXIX, No. 1789, Suppl., p. XIV, 1929.

GLEBOV—Recherches microscopiques sur les parties molles du Mammouth: Bull. Soc. Nat. Moscou, XIX, p. 108, Moscou, 1846.

GREGORY, W. K.—Two Views of the Origin of Man: Science, LXV, No. 1695, p. 601, New York, 1927.

HAY, OLIVER P.—Observations on Some Extinct Elephants, pp. 1–19, Washington, D. C., 1922.

HEDENSTRÖM, M.—Travel to the Ice Sea and to the Islands Situated East of the Lena Embouchure: Sibirski Vestnik, 1822, XVII, pp. 27–38, 99–116, 171–184; XVIII, pp. 245–258, 291–304, 359–378; XIX, pp. 1–18, 85–106 (in Russian).

HEDENSTRÖM, M.—Otrivki o Sibiri, St. Petersburg, 1830 (in Russian).

HERZ, O. F.—Frozen Mammoth in Siberia: Ann. Rep. Smithsonian Institution for the Year ending June 30, 1903, pp. 611–625, Washington, 1904.

HOWORTH, HENRY H.—The Mammoth in Siberia: Geol. Magazine, VII, pp. 408–414, 491–501, 550–561, London, 1880.

HOWORTH, HENRY H.—The Sudden Extinction of the Mammoth: Geol. Magazine, VIII, pp. 309–315, 569–572, London, 1881.

HOWORTH, H. H.—The Mammoth and the Flood, pp. I–XXXII, 1–464, London, 1887.

IDES, YSBRAND E.—Three Years Travels from Moscow over Land to China, London, 1706 (English edition).

KAYSER, EMANUEL—Lehrbuch der geologischen Formationskunde, 6 and 7 Auflage, I and II, Stuttgart, 1923 and 1924.

KÖRBER, PH.—Kosmos für die Jugend. Blick in die Schöpfung der Welt und in die Kulturgeschichte der Menschheit vom Anfang bis zum Gegenwart: Nürnberg, 1862.

[1] Only the papers quoted in this article are mentioned in this list.

KUTOMANOV, G. N.—Rapport sur une mission à l'embouchure du Eniseij pour les fouillée du cadavre d'un mammouth: Bull. Acad. Sc., VIII, pp. 377–388, St. Petersburg, 1914 (in Russian).

LALOY, L.—Le régime alimentaire du Mammouth: L'Anthropologie, XVII, p. 234, Paris, 1906.

LANG, HERBERT—Problems and Facts about Frozen Siberian Mammoths (*Elephas primigenius*) and their Ivory: Zoologica, IV, pp. 25–53, New York, 1925.

LAPPARENT, A.—Traité de géologie, 5-ième édition, Paris, 1906.

LEFFINGWELL, ERNEST DE K.—The Canning River Region, Northern Alaska: U. S. Geol. Survey Prof. Paper 109, pp. 1–251, Washington, 1919.

MAYDELL, GERHARD—Reisen und Forschungen im Jakutischen Gebiet Ost-Sibiriens in den Jahren 1861–1871, I and II, St. Petersburg, 1893 and 1896.

MIDDENDORFF, A. TH.—Reise in den äussersten Norden und Osten Sibiriens während der Jahre 1843–44 mit allerhöchsten Genehmigung auf Veranlassung der Akademie der Wissenschaften zu St. Petersburg, ausgefuhrt und in Verbindung mit vielen Gelehrten herausgegeben, I–IV, St. Petersburg, 1848–1885.

MÖBIUS, K.—Die Beharung des Mammut und der lebenden Elephanten, vergleichend untersucht: Sitzungberichte Berliner Acad. Wiss., Berlin, 1892.

NEUVILLE, H.—De l'extinction du Mammouth: L'Anthropologie, XXIX, pp. 193–212, Paris, 1918–1919.

NEUVILLE, H.—On the Extinction of the Mammoth: Ann. Report, Smithsonian Inst., 1919, pp. 327–338, pls. I–III, Washington, 1921.

NEUVILLE, H. ET J. GAUTRELET—Observations faites sur le sang du Mammouth offert au Musée par le Compte Stenbock-Fermor: Bull. Mus. Nat. Hist. Nat., XX, pp. 106–109, pl. 1, Paris, 1914.

NORDENSKIÖLD, A. E.—The Arctic Voyages of Adolf Erick Nordenskiöld, 1858–1879, pp. I–XIV, 1–447, with illustrations and maps, London, 1879.

NORDENSKIÖLD, A. E.—Die Umsegelung Asiens und Europas auf der Vega, I and II, Leipzig, 1882.

OSBORN, HENRY FAIRFIELD—The Age of Mammals in Europe, Asia and North America, illustrated, pp. I–XVII, 1–635, New York, 1910.

Pacific (The)—Russian Scientific Investigations: Acad. Sc. U. S. S. R., pp. 1–190, with maps and portraits, Leningrad, 1926.

PALLAS, P. S.—Voyages du Professeur Pallas dans plusieurs provinces de l'empire de Russie et dans l'Asie septentrionale, I–VIII et Atlas, Paris, 1794.

PALLAS, P. S.—De reliquiis excticorum per Asiam borealem repertis complementum: Novi Commentarii Acad. Sc., XVII, St. Petersburg, 1772.

PAVLOVA, MARY—Description of Fossil Mammals Collected by the Russian Arctic Expedition, 1900–1903: Mem. Acad. Sc., Physico-Math. Section, XXI, No. 1, St. Petersburg, 1906 (in Russian).

PFIZENMAYER, E. W.—Beitrag zur Morphologie von *Elephas primigenius* und Erklärung meines Rekonstruktionversuchs: Verhandl. Min. Ges., II Ser., Bd. XLIII, Ss. 521–542, 1 Taf., 5 Fig., St. Petersburg, 1905.

PFIZENMAYER, E.—A Contribution to the Morphology of the Mammoth, *Elephas primigenius* Blumenbach; with an Explanation of my Attempt at a Restoration: Ann. Rep. Smithsonian Institution for the year ending June 30, 1906, pp. 321–333, Washington, 1907.

PFIZENMAYER, E. W.—Mammutleichen und Urwaldmenschen in Nordost-Sibirien, S. 1–341, mit 118 Abbildungen und 3 Karten, Leipzig, 1926.

POHLIG, H.—Dentition und Craniologie des *Elephas antiquus* Falc. mit Beiträgen über *Elephas primigenius* Blum. und *Elephas meridionalis* Nesti: Nova Acta Academiae Caesareae Leop. Carol., LIII, No. 1; LVII, No. 5, Ss. 1–472, Taf. I–XVII, textfig. Halle, 1888 (1889) to 1891 (1892).

REID, CL.—The Sudden Extinction of the Mammoth: Geol. Magazine, IX, pp. 43–44, London, 1882.

SCHMIDT, FR.—Vorläufige Mittheilung über die wissenschaftliche Resultate der Expedition zur Aufsuchung eines angekündigten Mammuthkadavers: Bull. Acad. Sc., XIII, Ss. 97–130, St. Petersburg, 1869.

SCHMIDT, FR.—Wissenschaftliche Resultate der zur Aufsuchung eines angekündigten Mammuthkadavers von der Kaiserlichen Akademie der Wissenschaften an den unteren Jenissei ausgesandten Expedition: Mem. Acad. Sc., VII Ser., XVIII, No. 1, Ss. 1–169, 5 Taf., Eine Karte, Textfiguren, St. Petersburg, 1872.

SCHRENCK, L.—Bericht über neuerdingst im Norden Sibiriens angeblich zum Vorschein gekommene Mammuthe, nach briefliche Mittheilung des Herrn Gerhard v. Maydell nebst Bemerkungen über den Modus der Erhaltung und die vermeintliche Häufigkeit ganzer Mammuthleichen: Bull. Acad. Sc., XVI, Ss. 147–173, St. Petersburg, 1871.

SCHUCHERT, CHARLES—Historical Geology, New York, 1924.

SPASSKI, G.—Zoological Discoveries in Northeastern Siberia: Sibirski Vestnik, 1822, XVIII, pp. 349–354 (in Russian).

SUKACHEV, V. N.—Examination of Plant Remnants Found Within the Food of the Mammoth Discovered on the Beresovca River, Territory of Yakutsk: Resultats scientifiques de l'expédition organisée par l'Academie Imperiale des Sciences pour la fouilée du Mammouth, trouvé sur la rivière Bérézovka en 1901, III, pp. 1–18, pls. I–IV, 2 figs., Petrograd, 1914 (in Russian).

TILESIUS VON TILENAU, W. G.—De sceleto mammonteo Sibirico anno 1797 effosso: Mem. Acad. Sc., V ser., V, St. Petersburg, 1812.

TOLL, ED.—Mittheilung über eine Reise nach den Neusibirischen Inseln und längst der Eismeerekuste ausgeführt im Jahre 1893: Petermann's Mitth., XL, Ss. 131–139, 155–159, Gotha, 1894.

TOLL, ED.—Die fossile Eislager und ihre Beziehung zu den Mammuthleichen: Mem. Acad. Sc., VII Ser., XLII, No. 13, St. Petersburg, 1895.

TOLL, ED.—A Sketch of the Geology of the New Siberian Islands and the most important Problems of the Exploration of Arctic Regions: Mem. Acad. Sc., VIII Ser., Phys. Math. Sect., IX, 1, pp. 1–20, 2 maps, St. Petersburg, 1899 (in Russian)..

TOLL, E. V.—A Short Report for the Period of June 7 to November 8, 1902: Bull. Acad. Sc., Phys. Math. Sect., XX, pp. 158–160, 2 plates, St. Petersburg, 1904 (in Russian and German).

TOLMATSCHOW, I. P.—Fouilles dans le gouvernement de Nijni-Novgorod à la recherche des restes d'un exemplaire de l'*Elephas trogontherii* Pohlig: Bull. Acad. Sc., XVIII, Phys. Math. Sect., pp. 251–262, St. Petersburg, 1903 (in Russian).

TOLMATSCHOW, I. P.—Bodeneis vom Fluss Beresovka: Verh. Min. Ges., II Ser., XL, Ss. 415–452, Taf. V–VIII, 4 Fig., St. Petersburg, 1903.

TOLMACHOFF, I. P.—On a Mammoth from Lake Aral, in Berg's Lake of Aral: Bull. Turkestan Branch, Russian Geographical Society, V, p. 521, St. Petersburg, 1908 (in Russian).

TOLMACHOFF, I. P.—Note on the Extinction of the Mammoth in Siberia: Am. Journ. Sc., XIV, pp. 66–69, New Haven, 1927.

TOLMATCHEW, V. I.—Remains of a Mammoth found in Manchuria: Review of the Manchuria Research Society, No. 6, pp. 1–5, Harbin, 1926 (in Russian).

TRANSEHE, N. A.—The Siberian Sea Road. The Work of the Russian Hydrographical Expedition to the Arctic 1910–1915: Geogr. Review, XV, pp. 367–398, figs. 1–33, a map, New York, 1925.

TSCHERSKI, I. D.—Beschreibung der Sammlung posttertiärer Säugethiere (Die wissenschaftliche Resultate der von der Kaiserlichen Akademie der Wissenschaften zur Erforschung des Janalandes und der Neusibirischen Inseln in den Jahren 1885 und 1886 ausgesandten Expedition): Mem. Acad. Sc., VII Ser., XL, 1, S. I–V, 1–511, 6 Taf., 2 Figs., St. Petersburg, 1890.

TSCHERSKI, I. D.—On the Last Days of the Siberian Traveler I. D. Tscherski: Mem. Acad. Sc., LXXII, pp. 1–7, St. Petersburg, 1893 (in Russian).

VOLLOSOVICH, C. A.—On the Digging Out of the Sanga-Yurakh Mammoth, in 1908: Bull. Acad. Sc., III, pp. 437–458, St. Petersburg, 1909 (in Russian).

VOLLOSSOVITCH, C. A.—Le mammouth de l'ile Bolchoï Lakhovsky (Iles de la Nouvelle Sibérie): Verh. Min. Ges., II Ser., L, pp. 305–338, pls. XII–XVI, 1 fig., St. Petersburg, 1915 (in Russian).

WRANGEL, FERDINAND—Narrative of an Expedition to the Polar Sea in the years 1820, 1821, 1822 and 1823, Second Edition by Edw. Sabine, pp. I–XIX, 1–525, 1 map, London, 1844.

WRIGHT, G. F.—Asiatic Russia, with Maps and Illustrations, I and II, New York, 1902.

Yakutskaya Okraina, a Newspaper, Yakutsk, 1912 (in Russian).

ZALENSKII, W. W.—Osteological and Odontological Researches on the Mammoth (*Elephas primigenius* Blum.) and Elephants (*El. indicus* L. and *El. africanus* Blum.): Resultats scientifiques de l'expédition organisée par l'Académie Impériale des Sciences pour la fouille du mammouth, trouvé sur la rivière Bérézowka en 1901, I, pp. 1–124, pls. 1–24, St. Petersburg, 1903 (in Russian).

ZALENSKY, W.—Ueber die Haupteresultate der Erforschung des im Jahre 1901 am Ufer der Beresowka entdeckten männlichen Mammutcadavers: C. R. d. Séances du Sixième Congrès Internationale de Zoologie, pp. 67–86, Berne, 1904.

ZALENSKIJ, W. W.—Études microscopiques de quelques organes du mammouth: Resultats scientifiques de l'expédition organisée par l'Académie Impériale des Sciences pour la fouille du mammouth, trouvé sur la rivière Bérézowka en 1901, II, St. Petersburg, 1909 (in Russian).

ZENZINOV, V. M.—On the Trade in the North of the Territory of Yakutsk, Moscow, 1916 (in Russian).

ZENZINOV, W. M.—With an Exile in Arctic Siberia. The Narrative of a Russian who was compelled to turn Polar Explorer for two Years: Nat. Geogr. Mag., XLVI, pp. 695–718, Washington, 1924.

INDEX