Scientific Thought as a Planetary Phenomenon

V. I. Vernadsky

1936–1938

Translated from Russion by Pavel M. Penev for the LaRouche movement.
October 20, 2010–present

Contents

Remarks to the Electronic Edition . . .

V. I. Vernadsky Electronic Archive
HTTP://VERNADSKY.LIB.RU

The present electronic edition of V. I. Vendasky's book *Scientific Thought as a Planetary Phenomenon*[i] was being prepared according to the editionВладимир Иванович Вернадский. *Научная мысль как планетное явление*. Russian. Ed. by А. Л. Яншин. Наука, 1991 at the end of 1999.

The first four chapters were prepared by April, 2000, and added to the Maxim Moshkov library (http://lib.ru/FILOSOF/WERNADSKIJ/). These first chapters were carefully proofread and, I hope, contain very few printing errors.

The fifth and sixth chapters were proofread (also quite carefully, though not as well as the first four) by the end of November, 2000. They were published on the server of the Electronic Archive (http://vernadsky.lib.ru), but were not sent to the Moshkov library in the hope that the remaining four chapters would be prepared sufficiently quickly.

Unfortunately, because of insufficient time, the work on the remaining chapters kept dragging on and on, to the point that I decided to use the electronic version of these chapters, which was prepared by the Russian Foundation for Fundamental Research[ii] from the edition Владимир Иванович Вернадский. *Научная мысль как планетное явление*. Russian. Vol. 1. Научное знание. Научное творчество. Научная мысль. Дубна: Феникс, 1997. URL: http://elibrary.ru/books/vernadsky/obl.htm.

However, comparing these two editions, it seemed to me, that the earlier one, from 1991, was much closer to the original text of V. I. Vernadsky. The 1997 edition is filled with slight editorial corrections, which, though nowhere (it seems) distort Vernadsky's meaning, nevertheless, quite strongly change his manner of exrpession, and that in such a way that at these places the mind is often just tripped up, and it is at once apparent that Vladimir Ivanovich could not have written in that manner. It is, therefore, necessary to streighten out chapters 7–10 according to the 1991 edition with time. It is also necessary to proofread all chapters once again, and correct any remaining errors.

I include the introductions of the editors of both editions at the begining of this book, which tell about the history of the writing of Vladimir Ivanovich's book, as well as about the history of its hard and quite controversial publication.

For commercial use of the electronic edition of *Scientific Thought as a Planetary Phenomenon*, or (which would be just terrific ;-) for aid with its proofreading, contact me at the address indicated on the http://vernadsky.lib.ru server.

Note: The electronic edition is being prepared in the LaTeXformat; it is necessary to update that version, and not the derived HTML version in the Maxim Moshkov library when proofreading.

Sergey Mingaleev[iii]
October 16, 2001

[i] Научная мысль как планетное явление

[ii] Росийским Фондом фундаментальных исследований

[iii] Сергей Мингалеев

Preface and remarks by A. L. Yanshin ...

A. L. Yanshin
Chairman of the Committe of the Academy of Sciences of the USSR for the Exploitation of the Scientific Heritage of Academician V. I. Vernadsky[I]

F. T. Yanshina
Director-founder of the museum home of Academician V. I. Vernadsky

The electronic version of the preface and the remarks was prepared from the edition in the book Владимир Иванович Вернадский. Научная мысль как планетное явление. *Russian. Ed. by А. Л. Яншин. Наука, 1991.*

Preface

The name of Vladimir Ivanovich Vernadsky has become widely known in our country. There is nobody with even the slightest degree of education, who hasn't read, if not Vernadsky's works, then, at least, numerous newspaper and magazine articles about him and his work.

There is a Vernadsky Avenue in Moscow. One of the largest institutes at the Academy of Sciences of the USSR, the Institute of Geochemistry and Analytical Chemistry,[i] bears his name. There is a Committee for the Exploitation of the Scientific Heritage of Academician V. I. Vernadsky, which publishes its own circular, at the Presidium of the Academy of Sciences of the USSR. Branches of that Committee work in Leningrad and in Kiev. There have been grants under Vernadsky's name established at Moscow, Leningrad, Kiev, and Simferopol University. National scientific centers for the study of the work of this prominent thinker and for its application to the solution of contemporary problems exist in Odessa, Rostov-na-Don, Erevan, Simferopol, Ivanov, and in other cities in the USSR, and abroad—in Prague, Oldenburg and Berlin.[1]

[I] Комиссия по разработке научного наследия академика В. И. Вернадского

[i] Институт геохимии и аналитической химии

[1] Also named after V. I. Vernadsky are: the National Geological Museum,[ii] the National Public University of Biospheric Studies,[iii] the Central Scientific Library of the AS UkrSSR,[iv] the Student Sociological Center "Noosphere",[v] the peak in the basin of Podkamennaya Tunguska River, the crater on the dark

[ii] Государственный геологический музей

[iii] Всесоюзный народный университет биосферных знаний

[iv] Центральная научная библиотека АН УССР

[v] Студенческий социологический центр "Ноосфера"

V. I. Vernadsky's 125th birthday was celebrated in March 1988 in our country, as well as abroad (in Prague and in Berlin).

The celebrations srpead very widely. An exhibition dedicated to his work was opened on January 15, 1988 at the Exhibition of the Achievements of the National Economy.[viii] Scientific symposia on different directions of V. I. Vernadsky's research took place successively in Leningrad, Kiev, and Moscow with the participation of foreign scientists from March 3 to 11. A commemorative conference took place in Balshoy Theatre[ix] in Moscow on his birthaday, March 12, with the participtation of public organizations. Separate conferences and scientific sessions took place during the same days in Ivanov, Odessa, Simferopol, Rostov-na-Don, Yerevan, Baku, Almaty,[x] Novosibirsk, Irkutsk, and in many other scientific centers of the nation. The proposal to create an International V. I. Vernadsky[xi] Fund for subsidizing the translation of his works in other languages, finding materials about him in foreign archives, and the invitation of scientists from foreign nations to the USSR for reports and lectures on the contemporary development of scientific problems noted by V. I. Vernadsky was accepted.[2] Articles about him, and his multifaceted scientific work have appeared in almost all Soviet and international newspapers and magazines.

Publishing house *Nauka*[xii] released 4 volumes of works by V. I. Vernadsky, as well as his *Письма Н. Е. Вернадской: 1886–1889* (*Letters to N. E. Vernadskaya: 1886–1889*), including the book *Философские мысли натуралиста* (*Philosophical Thoughts of the Naturalist*), in which the work *Scientific Thought as a Planetary Phenomenon* was republished as a first part, now published with reconstructions of all those passages, abridged for its first edition in 1977, according to the archived original manuscript, before the very anniversary in February, 1988. The book was released in a 20,000 run. The whole run was bought out during the very first days after its appearance in the bookstores' windows. A barrage of letters requesting the release of an additional run of *Философские мысли натуралиста* (*Philosophical Thoughts of the Naturalist*), or at least of its first part, was received at the Scientific-publishing council of the Academy of Sciences of the USSR.[xiii]

The appearance of *Философские мысли натуралиста* (*Philosophical Thoughts of the Naturalist*) in 1988 found a broad positive response from the press. For example, the article "Неизвестный Вернадский" (*The Unknown Vernadsky*) was published in the journal "Известия" (*The Bulletin*) from September 29, 1988, in which the author F. Lukyanov[xiv] wrote:

> The name of academician Vladimir Ivanovich Vernadsky (1863–1945) cannot be

side of the Moon, the peninsula in Eastern Antarctica near the Sea of Astronauts,[i] the forest on the island of Paramushir (Kuril Island), the subglacial forests in Eastern Antarctica, the underwater volcano in the Atlantic Ocean, the mine in the region of Lake Baikal, the mineral Vernadit,[ii] the diatomaceous algae, research vessel "Academician Vernadsky" of AS UkrSSR, the steamboat "Geologist Vernadsy"[iii] of the Kama River Shipping company,[iv] the Vernadsky village near Simferopol, the Vernadsky railway station on the Kazan line, the subway stop "Vernadsky Avenue" in Moscow, the Biosphere Museum at the Leningrad branch of the Institute of the History of Natural Science and Technology of the AS USSR. A V. I. Vernadsky monument has been erected in Kiev, a memorial plate is in place on the old building of Moscow State University M. V. Lomonosov,[v] on Vernadsky Avenue in Moscow, on the building of Leningrad State University,[vi] as well as on the building of the Kiev State University T. G. Shevchenko.[vii] V. I. Vernadsky grants are awarded for exceptional scientific work in the areas of mineralogy, geochemistry and astrochemistry by the Academy of Sciences of the USSR and by the Academy of Sciences of the UkrSSR. A golden medal named after him has been established by the Academy of Sciences of the USSR.

[viii] ВДНХ, from выставка достижений народного хозяйства
[ix] Большой театр
[x] Алма-Ате
[i] Море Космонавтов
[ii] вернадит, $Mn^{4+}, Fe^{3+}, Ca, NaS(O, OH)_{2n} \cdot H_2O$
[iii] Геолог Вернадский
[iv] Камское речное пароходство
[v] МГУ им. М. В. Ломоносова
[vi] Ленинградского государственного университета
[vii] Киевского государственного университета им. Т. Г. Шевченко

[2] See the information at the end of the book.

[xi] Международного фонда В. И. Вернадского
[xii] Наука
[xiii] Научно-издательский совет АН СССР
[xiv] Ф. Лукьянов

called unknown to the Soviet reader. However, he is still known among us in his homeland mainly as a scientist-naturalist, a historian of science, and is almost unknown as a thinker, a philosopher, even though his philosophical heritage has become a recognized phenomenon of European and world scientific thought long ago.

The just-released book by V. I. Vernadsky from publishing house *Наука* (*Science*) *Философские мысли натуралиста* (*Philosophical Thoughts of the Naturalist*) finally presents him to[I] our reading public as a philosopher and thinker. This book is, in essence, the first realization of a complete, unabridged publication of the essential works of the Russian thinker, above all the fundamental work *Scientific Thought as a Planetary Phenomenon*, written in the period between the 1880s and 1940s, which has either completely disappeared, or has long ago become a bibliographic rarity.

During the preparation of the present edition of V. I. Vernadsky's *Научная мысль как планетное явление* for publication its text was compared with the manuscript of S. N. Zhidovinov[i] once again, with the help of collaborators from the Archive of the Academy of Sciences of the USSR,[ii] which enabled the correction of some small inaccuracies, unnoticed in the previous editions, as well as the restoration of the author's style, orthography, and punctuation where possible.

What does the book offered to the reader's attention present? It is necessary to shortly pause for a look at the development of V. I. Vernadsky's ideas, which have found their fullest reflection in this work, to answer this question.

It follows from letters to his wife Natalya Egorovna,[iii] and to a few scientists, as well as from preserved diaries of Vladimir Ivanovich, that his attention was attracted by the ever-increasing technological might of mankind, which became comparable in its scale to the most formiddable geological processes, already in his early years, i. e. already at the end of the last century. This activity irreversibly changes the face of the whole Earth, of all of its nature in the physical-geographical and chemical aspect. (V. I. Vernadsky didn't yet use the term 'biosphere' at that time.)

Such thoughts occurred not only to V. I. Vernadsky. He mentions his predecessors and contemporaries in this aspect in his later works with his characteristic courtesy.[iv] The American geologist Charles Schuchert proposed viewing the contemporary epoch as the beginning of a new, psychozoic age of the history of the Earth, emphasizing the significance of the psychological activity of mankind as a geological factor with this name, in 1933.[3] Our Russian scientist A. P. Pavlov, who invited V. I. Vernadsky to teach mineralogy at Moscow University in 1890, also thought that a new geological period in the Earth's history began with the appearance of man on it, which he proposed to call anthropogenic (from the Greek word 'anthropos'—man).[4] There were also other statements of similar character at the end of the past, and the beginning of the present century.

However, V. I. Vernadsky, not satisfied with general statements, began dilligent labor on a quantitative estimate of the scale of human activity. V. I. Vernadsky noted the minerals and new chemical compounds formed as a result of mankind's industrial activity, and gave the first estimates of the total volume and mass of such 'technogenic' minerals already in his *Mineralogy* courses,[II] which were being republished, with additions every time, during the years of his work at Moscow University (between 1891 and 1912).

[I] omitting 'и'

[i] С. Н. Жидовиновым
[ii] Архива АН СССР
[iii] Наталье Егоровне

[3] Charles Schuchert and Carl Owen Dunbar. *A Text Book of Geology*. New York, 1933. ISBN: B000EVHHNI, p. 80.

[4] Алексей Петрович Павлов. "Ледниковые и межледниковые эпохи Европы в связи с историей ископаемого человека". In: *Академическая речь* 2 (1922).

[II] See [57, 65, 67, 66, 68, 69, 72, 70, 71].

[iv] щепетильностью

He started publishing his *Опыт описательной минералогии* (*Essay on Descriptive Mineralogy*),[I] subsequently encompassing all native elements, including gases, as well as their sulphuric[i] and selenious[ii] compounds, in 1908. In these installments, which were later collected in the 2nd and 3rd volume of *V. I. Vernadsky's Selected Works* (1955 and 1959),[II] he includes, within the description of almost every mineral, or its groups, a separate section titled "Mankind's Work",[iii] or "Mankind's Activity",[iv] in which he gives numbers for their global extraction and refining, and communicates information about the direct and indirect influence of human activity on the formation and distribution of one or another mineral or chemical compound (for example, hydrogen sulphide).

V. I. Vernadsky published *The History of Natural Waters*,[v] which he himself viewed as the second volume of the *History of Minerals of the Earth's Crust*,[vi] in two books in 1933, and 1934.[III] He dedicates quite a few pages to the conscious, and unconscious influence of mankind on the geographical distribution, and on the composition of all waters on the Earth in this work. Vernadsky had concluded even then that

> the pristine rivers are quickly disappearing, or have disappeared, and have been replaced by a new type of formation, new waters, which had not existed earlier. A transformation of the natural waters, and the simultaneous creation of new cultural rivers, lakes, reservoirs, coastal sea formations, soil solutions is going on on the vast territory of Eurasia, and in the last century also in America and in Australia—in the whole biosphere.
>
> This process reaches inward, changes the mode of the interstitial waters[vii] of the biosphere and stratisphere. The transformation of vadose water—ground water[viii] has been going on for millenia, then started the transformation of interstitial artesian waters[ix] by boring and ore mining. Now its effect reaches more than two kilometers below the Earth's surface.
>
> The old species of surface, interstitial waters, soil waters, and springs[x] are disappearing and changing throughout the whole biosphere, new cultural waters are emerging.[5]

Parallel to the study of the influence of mankind's activity on the changing of Earth's nature, V. I. Vernadsky began developing the study of the biosphere—that envelope of the Earth, in which 'living matter' is concentrated—already in 1914–1916. He didn't like the unnecessary coinage of words, the creation of new terms, but had magnificent knowledge of all world scientific literature, and employed its terminology extensively. Such was the case with the term 'biosphere'. It was first used by the French scientist Jean-Baptiste Lamarck[xi] in a work on hydrogeology to refer to the complex of living organisms inhabiting the globe, already in 1804.[IV] The Austrian geologist Eduard Sueß,[xii] and the German scientist Johannes

[I] See [83, 84, 85, 86].

[II] I. e. [51, 52].

[III] I. e. [47, 48]. The third book of the series, published in 1936, is [49].

[i] сернистые

[ii] селенистые

[iii] Труд человека

[iv] Деятельность человека

[v] *Историю природных вод*

[vi] *Истории минералов земной коры*

[5] Владимир Иванович Вернадский. In: *Избранные сочинения*. Vol. 4: *Общие вопросы минералогии и история минералов земной коры*. 1. Москва: Изд-во АН СССР, 1959, p. 85.

[IV] From what was available on the Internet, it seems that the reference is to Lamarck's 1802 *Hydrogéologie* where, in the last but one paragraph of the foreword, Lamarck seems to say that a good physics of the Earth requires studying three aspects of it, which share the same physical body: the atmosphere (meteorology), the Earth's crust (hydrogeology), and that of living bodies (biology). The name 'biosphere', however, does not seem to be used there.

[vii] режим пластовых вод

[viii] верховодок—вод грунтовых

[ix] вод пластовых напорных

[x] старые виды поверхностных, пластовых вод, вод почв и источников

[xi] Жаном Батистом Ламарком, a.k.a. Жан Батист Пьер Антуан де Моне Ламарк (Jean-Baptiste Pierre Antoine de Monet, Chevalier de Lamarck).

[xii] Эдуард Зюсс

Walther[i] used it at the end of the 19th c., again with a meaning similar to Lamarck's concept. V. I. Vernadsky introduced a completely different, far deeper meaning to this term. He introduced the term 'living matter' for the complex of living organisms inhabiting the Earth, but called biosphere that environment in which this living matter is located, i. e. the whole water envelope of the Earth, since living organisms exist at even the greatest depths of the World Ocean, the lower part of the atmosphere, where insects, birds, and people fly, as well as the top part of the solid envelope of the Earth—the lithosphere, where living bacteria can be encountered in underground waters at depths on the order of 2 km, and man has now penetrated to even greater depths, exceeding 3 km, with his shafts in the regions of gold deposits in India, South Africa, and Brazil. There is a 'film of life',[ii] where the concentration of living matter is maximum, in the biosphere. This is the land surface, the soils, and the top layers of the World Ocean's waters. The amount of living matter in the biosphere rapidly diminishes with distance above and below it.

V. I. Verndasky estimated the total amount of living matter in the contemporary biosphere of the Earth, established the magnitude of the energy locked up in it, carefully studied the process of absorption of solar energy with the aid of chlorophyll in green plants on land, and algae in the World Ocean, traced its transformation, and its influence on the generation of many 'vadose'[iii] minerals, characteristic only of the biosphere, clarified the character of solar energy's entry into the depths of the Earth with the deposits of organic matter created by it, and analyzed all transformations which occur in living, bioinert, and inert, as he called them, matter of this most important envelope of the Earth for mankind.

V. I. Vernadsky presented the results of his studies in numerous articles, in the book *Биосфера* (*Biosphere*), which was first published in 1926, and has been subsequently reprinted a few times, and in the fundamental work *Химическое строение биосферы земли и ее окружения* (*The Chemical Structure of the Earth's Biosphere, and its Surroundings*), which was first published after the author's death, in 1965. Many articles, brochures, and books dedicated to V. I. Vernadsky's teachings about the biosphere, to its detailed presentation, to commentary on it, and, unfortunately, only partially, to its development, have appeared in the Soviet and in the foreign press in connection with the increased attention to the tasks of the preservation of nature[iv] during the past decade. There is, therefore, no need to delve into it in the foreword to the present book. It is, however, important to emphasize that V. I. Vernadsky viewed human activity as a process imposed on the biosphere, foreign to it by its nature from the beginning. We can suppose that the technogenic character of this human activity, interfering much with the naturally occurring course of natural phenomena,[v] contradicting them, prompted him to have such thoughts.

We can judge of the [view of the][I] 'imposed',[vi] foreign character of mankind's industrial activity from numerous statements of V. I. Vernadsky even in his works from the beginning of the thirties. So, he wrote in the mentioned *History of Natural Waters* about technogenic solid minerals, and waters: "These new chemical compounds—'artificial', i. e. created with the participation of the will and the consciousness of man, can, for now, be put aside in the study of the history of natural bodies".[6,II]

[i] Иоган Вальтер
[ii] пленка жизни
[iii] "вадозных"

[6] Вернадский, p. 87.

[I] Interpolated to express the implied meaning. [—Pav]
[II] Here's what [47, §133] actually says:

> **§133.** We are now living at only the very beginning of the Psychozoic Age. It is impossible to encompass its results completely.
>
> We are still in a transitional period. However, we cannot leave without attention an on-rushing force changing the history and composition of natural waters.
>
> Problems of the quantification—in all varieties—of the change of natural waters by human culture have come to the fore, it being necessary to reconstruct the character of those waters, which existed a hundred thousand, and more, years ago, as well as in the previous geological periods. These problems have hardly

[iv] охраны природы
[v] естественный ход природных процессов
[vi] "наложенном"

However, V. I. Vernadsky arrived at the unavoidable conclusion about the evolution of the Earth's biosphere, about the quantitative and the qualitative change of its main component part—living matter, about the stages of the biosphere's evolution in the last decade of his life. Such a course of thoughts brought him to the conclusion that the emergence of man, and the impact of his activity on the surrounding natural environment is not an accident, is not an 'imposed' process on the natural course of events, but is, rather, a definite, lawful stage of the evolution of the biosphere. This stage has to lead to the condition that the Earth's biosphere must transition into a new state, which he proposed to call 'noosphere' (from the Greek word 'noos'[ii]—mind), under the influence of scientific thought, and the collective labor of unified mankind, directed toward the satisfaction of all of its material and spiritual necessities. V. I. Vernadsky did not invent this term, nor the term 'biosphere' himself. He lectured on biogeochemistry and the development of the biosphere at Collège de France from 1922 to 1926 during his long foreign assignment, and the French mathematician Édouard Le Roy, student of these lectures, published an article about them in 1927, in which he employed, for the first time, the term 'noosphere', used by other French scientists and by V. I. Vernadsky further on.

The work *Scientific Thought as a Planetary Phenomenon*, judging from the diaries of V. I. Vernadsky and from his letters, was written mainly in 1937–1938, i. e. during the most tragic years of our history. V. I. Vernadsky was far from indifferent to the events of those days. His friends and students were repressed. Trying to prove their innocence, and the erroneousness of their arrests, he wrote letters to J. V. Stalin, N. I. Ezhov, and L. P. Beria. His diaries from these years are filled with heavy words. But the book, written by him for the future generations, was permeated by optimism, faith in the triumph of human reason.

It is hard to completely characterize the content of the book. It is significantly broader than the book's title, though the idea of the global significance of scientific thought permeates it from beginning to end, and connects all of its parts. Essentially, this book is an introduction to the teaching of the noosphere. Many places in it are dedicated to the analysis of the conception of this term. Along with that, the role of mankind in the development of the biosphere is painted with the broad strokes of a great painter, the concept of living matter and its state of organization, of the evolution of the biosphere and the inevitability of its gradual transformation into the noosphere, of the conditions neccessary for such a transition, of the basic stages of development of human culture and its further destiny, of biogeochemistry as a main scientific area of the study of the biosphere, of the fun-

been touched upon, but they can be encompassed by scientific thought, and it is necessary to strive toward their resolution, and have them in mind in studying the history of natural waters.

We find ourselves in the same condition, which we run into in other branches of mineralogy,—with the emergence of new natural compounds created by culture, changing the history of natural bodies of the same, or of similar composition. I already regarded that in the history of metals (I, §267 etc.); and the same is reflected in the history of natural gases (CO_2, SO_3, H_2S and so forth). These new types of chemical compounds—'artificial', i. e. created with the participation of the will and consciousness of man, can, for now, be left aside in studying the history of natural bodies.

But this is, obviously, a temporary solution to the problem. We must never fail to take into account the products of human work in the history of numerous minerals, for example, carbon dioxide. We must neither fail to take them into account in the history of natural waters. However, on the other hand, it is impossible to include it completely in our present considerations. A host of waters connected with engineering are constantly and quickly changing,—are temporary, transitional phenomena. Many of the new waters are negligible in mass—are rare, quickly disappearing 'minerals'.

I will consider these new waters—a creation of cultural life—only in so far as this is necessary for understanding the essential main features of the history of natural waters. This, however, is, of course, only a temporary solution of the question—this is the intrinsic[i] path of the naturalist, seeking the important, but not a logical sequence, in the complex phenomenon, real at a given moment.

[—Pav]

[i] исконный

[ii] "ноос"

damental differences between the living and the inert matter of this evelope of the Earth is given.

The work *Scientific Thought as a Planetary Phenomenon* occupies a special place among the works of V. I. Vernadsky. It is distinguished by an unusual breadth of the range of questions considered in it, and by the specific character of the main problems examined. The breadth of the views of their author about things, and the significance of the scale on which he poses questions have always been inherent to V. I. Vernadsky's works. However, these qualities of the scientist have been brought to a most prominent and powerful expression in the work being published. Nature, human society, scientific thought are examined in their indissoluble unity, and the reality surrounding us is painted in a truly universal[i] vastness.

Scientific Thought as a Planetary Phenomenon—this is an apex of V. I. Vernadsky's work, a grandiose, in its intention, summary of his meditations on the destiny of scientific knowledge, on the relationship between science and philosophy, on the future of mankind. It can be characterized as an impressive, though unfinished, synthesis of the ideas being developed by the scientist in the last period of his life.

Deep thoughts about the evolution of mankind on geological and socio-historical scales of time are contained in the book. It must be admitted that this is the first attempt in world literature to generalize the evolution of our planet as a single cosmic, geological, biogenic, and anthropogenic process. The leading transformative role of science and the socially organized labor of mankind in the present and future of the planet is revealed in the work. Scientific thought, science is viewed and analyzed as the most important force of transformation and evolution of the planet.

We must not fail to note that the book offered to the reader's attention has also a deeply philosophical content. V. I. Vernadsky was not simply intrested in philosophy, but studied the works of philosophers of various schools and currents thoroughly since his teenage years. He considered the collection and generalization of scientific facts as inseparable from the philosophical understanding of the reached scientific conclusions, which is especially distincly evident from his diaries and his correspondence.

Already in 1902, beginning his work on the history of the development of human culture, he wrote to his wife Natalya Egorovna: "I view the significance of philosophy in the development of human knowledge entirely differently from the majority of naturalists, and ascribe an enormous, fruitful signicance to it. It seems to me that these are two sides of the same process—completely unavoidable and inseparable sides. They are separated only in our minds. Were one of them to die away, the living growth of the other would cease... Philosophy always concludes *germs,* sometimes even anticipates whole areas of the future development of science, and, only thanks to the simultaneous work of the human mind in this area as well, correct criticism of the unavoidably over-simplified notions of science is produced. Such significance of philosophy, as the roots and vital atmosphere of scientific endeavor, can be precisely and clearly traced in the history of the development of scientific thought."[7]

V. I. Vernadsky stayed true to the principle presented in this letter his whole life. Statements with similar meaning can be found in numerous other letters and works of his, especially in the many publications on the history of scientific knowledge. All of them are permeated by philosophical conceptualizations of the presented material.

However, we, it seems, unexpectedly encounter different statements of V. I. Vernadsky's, which separate philosophy from scientific knowledge, and even mention it alongside religion, in works, letters, and diaries from the 30s. In order to understand this, it is necessary to take into account that in the given case we are talking about the dominant in those years philosophy of vulgar dialectical materialism, ordering not only the representatives of the social sciences, but also natural scientists what conclusions and inferences to make, in order for them to completely correspond to the philosophical "laws". V. I. Vernad-

[i] вселенской, i. e., also, 'ecumenical' (see chapter 3).

[7] С. Р. Микулинский. "В. И. Вернадский как историк науки". Russian. In: Владимир Иванович Вернадский. *Труды по всеобщей истории науки.* 2-е изд. Москва: Наука, 1988, p. 21. ISBN: 5-02-003324-3. URL: http://vernadsky.name/wp-content/uploads/2013/01/trudi-po-vseobshei-istorii-nauki.pdf (visited on 05/05/2013).

sky could not accept such a philosophy, for which he was criticized by A. M. Deborin, who accused him of idealism.[8] V. I. Vernadsky responded to this criticism with great dignity, even though it painfully wounded his pride.[9] He always thought that an unbiased collection of as many facts about the topic of investigation as possible, their subsequent objective generalization, and, only afterward, a philosophical understanding must be the basis for every investigation. By the way, V. I. Vernadsky regarded Karl Marx as a scientist with great respect precisely because a great amount of thoroughly and conscientiously collected material lay at the foundation of the *Capital*.

The development of V. I. Vernadsky's philosophical views is reviewed more in depth in the article "From the Editorial Board" in the mentioned book *Философские мысли натуралиста* (*Philosophical Thoughts of the Naturalist*). Wide-ranging commentaries on the work *Scientific Thought as a Planetary Phenomenon* were published in that book, as well as in the form of appendices, articles by B. M. Kedrov, I. V. Kuznetsov, S. R. Mikulinskiy, and A. L. Yanshin written at various times, in which the questions of V. I. Vernadsky's worldview and his teaching about the gradual transition of the biosphere into the noosphere are reviewed from different points of view.

. . .

[8] Абрам Моисеевич Деборин. "Проблема времени в освещении акад. Вернадского". In: *Известия Академии наук СССР*. 7th ser. 4 (1932), pp. 543–569. URL: http://e-heritage.ru/ras/view/publication/general.html?id=46669387 (visited on 07/07/2013)

[9] Владимир Иванович Вернадский. "По поводу критических замечаний акад. А.М. Деборина". In: *Известия Академии наук СССР*. 7th ser. 3 (1933), pp. 395–407. URL: http://nasledie.enip.ras.ru/ras/view/publication/general.html?id=46591586 (visited on 07/07/2013)

Part I

Scientific Thought and Scientific Work as a Geological Force in the Biosphere

Chapter 1

Man and mankind in the biosphere as a lawful part of its living matter, part of its organization. Physical-chemical and geometric heterogeneity of the biosphere: the fundamental organizational distinction—material-energetic and temporal—of its living matter from its inert matter. Evolution of the species, and evolution of the biosphere. The manifestation of a new geological force in the biosphere—the scientific thought of social mankind. Its manifestation is related to the ice age, in which we live, to one of the geological phenomena repeating in the history of the planet, whose cause exceeds the bounds of the Earth's crust.

§1. Man, as well as everything living, is not a self-sufficient, independent of the environment natural object. However, even natural scientists in our time, counterposing human beings and living organisms in general to the environment of their life, very often do not take this into account. But the inseparability between living organism and its environment cannot presently raise any doubt among contemporary naturalists. The biogeochemist proceeds from it, and strives to understand, express, and establish this functional dependence precisely, and as deeply as possible. Philosophers and contemporary philosophy predominantly do not take into account this functional dependence of man, as a natural object, and mankind, as a natural phenomenon, on the environment of their life and thought.

Philosophy cannot sufficiently take this into account, as it proceeds from the laws of the mind, which is, in one way or another, a final and self-sufficient criterion for it (even in those cases, like religious and mystical philosophies, in which the reach of the mind is, in fact, limited).

The contemporary scientist, proceeding from the recognition of the reality of one's surroundings, of the world subject to one's investigation—nature, the cosmos, or world reality,[1]—cannot adopt this point of view as a basis for scientific work.

[Thus,][I] because one presently knows with scientific precision that man is *not* located on a structureless surface of the Earth, is *not* located in direct contact with cosmic space in a structureless nature, which is not lawfully connected with him. True, even

[1] I will talk about the reality of the cosmos, instead of that of nature, here and further. The concept nature, if we take it in a historical aspect, is a complex concept. It very often encompasses only the biosphere, and it is more convenient to use it with just this meaning, or even not to use it at all (§6). This would correspond to the vast majority of the uses of this concept historically in natural science and in literature. The concept 'cosmos' can be, perhaps, more conveniently applied to only the part of reality encompassed by science, a philosophically pluralistic conception of reality is possible at that, where there would be no single criterion for the cosmos.

[I] Interpolated for meaning in English.

the deeply penetrating contemporary naturalist often, out of routine and under the influence of philosophy, forgets this, and does not take it into account in his thought, and does not identify this.

Man and mankind are most closely connected, above all, with the living matter inhabiting our planet, from which they cannot, in reality, be isolated by any physical process. That is possible only in thought.

§2. The concept of life and the living is clear to us in everyday life, and cannot raise scientifically serious doubts in the actual manifestations of it, and in natural objects corresponding to it—in natural bodies. It was only in the 20$^{\text{th}}$ century, [with the discovery of] filter-passing viruses, that there appeared facts in science compelling us for the first time to ask seriously—not philosophically, but scientifically—the question: Are we dealing with a living natural body, or with a non-living natural body—an inert one?

With viruses the doubt is cast by scientific observations, rather than philosophical notions. In this consists the great scientific significance of their study. That is presently on a right and firm path. The doubt will be resolved, and nothing, except a more precise notion of *living organism*, would give, with this approach couldn't fail to give . . .*

Along with this, however, we encounter another kind of doubt in *science*, arising from philosophical and religious searches. For example, phenomena concerning the material-energetic environment of manifestations, which are philosophically *common* to both living and inert natural bodies, are scientifically studied in the works of the Bose Institute in Calcutta.[i†] They are not characteristic of, but are weakly expressed in inert natural bodies, are strongly manifested in living ones, but are common to both.

This area, if it exists in the form in which Bose tried to establish it, of phenomena common to inert and living natural bodies, introduces nothing new in the sharp distinction between them. The distinction must manifest itself in this area, as well, if only its existence would be proven.

We must approach phenomena here, as well, not in the aspect in which Bose approached them, not as phenomena of *life*, but as phenomena of living natural bodies, of *living matter*.

To avoid any misunderstanding, I shall avoid the concepts 'life', and 'living' in all further exposition, since, if we proceeded from those [phenomena],[II] we would inevitably go beyond the limits of the phenomena of life studied in science, into a foreign area or science—the area of philosophy, or, as is taking place in the Bose Institute, into a new area of new material-energetic manifestations common to all natural bodies of the biosphere, one lying outside the bounds of the fundamental question of living organism, and living matter, which we are presently interested in.

I shall, therefore, avoid the terms and concepts 'life', and 'living', and limit the area which is subject to our investigation to the concepts *'living natural body'*, and *'living matter'*. Each living organism *in the biosphere*—natural object—is a living natural body. *The living matter of the biosphere is the complex of living organisms in it.*

'Living matter', so defined, is a concept, completely precise, and fully encompassing the objects studied by biology and biogeochemistry. It is simple, clear, and cannot raise any doubt. We study only the living organism and its complexes in science. They are scientifically identical with the concept of life.

§3. Man, like every living natural (or naturally-occurring)[iii] body, is inseparably connected with a certain geological envelope of our planet—*the biosphere*, clearly distinct from the rest of its envelopes, with a structure which is determined by its specific

*Incomplete sentence in the original.

†The Bose Institute[I] in Calcutta was founded by the Indian scientist Acharya Jagadish Chandra Bose[ii] (1858–1937) in 1917. The institute studied the problems of physics, biophysics, inorganic and organic chemistry, biochemistry, the physiology of plants, selection, microbiology, etc. [—*Ed.*]

[I] http://www.boseinst.ernet.in/index.html

[i] Института Бозе в Калькутте

[ii] Бозе Джегдиш Чандра

[II] inserted by transl. [—*Pav*]

[iii] природное (или естественное)

state of organization,[I] and occupying a lawfully expressible place in it as a distinct part of the whole.

Living matter, just like the biosphere, possesses its peculiar state of organization, and can be viewed as a lawfully expressible *function of the biosphere.*

A state of organization is not a mechanism. It sharply differs from a mechanism in that it is constantly in a state of becoming,[II] of motion of all of its smallest material and energetic particles. We can express this state of organization in the course of time—in a generalization of mechanics, and in a simplified model—as being such that none of its points (material or energetic) lawfully returns to, [or]* ends up in a place, [or] a point of the biosphere, which it occupied at any earlier moment. It can return to one of them only on the order of mathematical accident, of very small probability.

The Earth's envelope, the biosphere, embracing the whole globe, has clearly distinct dimensions, [and] is determined to a large degree by the existence of living matter in it—*populating*[i] it. There is a constant material and energetic exchange, materially expressed in the motion of atoms brought about by living matter, between its inert non-living part, its inert natural bodies, and the living matter inhabiting it. This exchange in the course of time is expressed as lawfully changing, constantly tending toward the stability of an *equilibrium.*[ii] It permeates the whole biosphere, and this *biogenic flow of atoms*[iii] creates the biosphere to a large extent. The biosphere is thus connected inseparably and inherently with the living matter populating it throughout the whole duration of geological time.

The planetary, cosmic significance of living matter is distinctly expressed in this biogenic flow of atoms, and in the energy connected with it. That, since the biosphere is that single envelope of the Earth, in which cosmic energy, cosmic radiation, mainly radiation from the Sun, which maintains the dynamic equilibrium, the state of organization: biosphere ↔ livingmatter, constantly penetrates.

The biosphere stretches from the surface of the geoid up to the boundary of the stratosphere, penetrating into it; it, however, would be unlikely to be able to reach the ionosphere—the Earth's electromagnetic vacuum, which is just now entering the scientific consciousness. Living matter reaches below the surface of the geoid into the stratisphere, and into the top regions of the metamorphic, and of the granitic envelope. It rises up to 20–25 km above the surface of the geoid, and extends down to 4–5 km below that level on average. These boundaries change in the course of time, and, there are places of, it is true, small extent, where they are far beyond these. Apparently, living matter must reach deeper than 11 km at places in the depths of the ocean, and its presence has been established deeper than 6 km.† We are just now living through the penetration of mankind, always inseparable from other organisms—insects, plants, microbes,—into the stratosphere, and by this means living matter has already exceeded 40 km above the surface of the geoid, and is quiclky rising.

Evidently, a process of incessant expansion of the boundaries of the biosphere: its population by living matter, is observable in the course of geological time.

§4. *The state of organization of the biosphere*—the state of organization of living matter—must be viewed as an equilibrium, which is changeable, always oscillating around a precisely expressible mean, not in historical, but in geological time. The shifts,

*Phrases like this have been inserted for more familiar reading to today's audience. Otherwise, Vernadsky's style often includes restating a phrase with a slight change in meaning to communicate an intended range of ambiguity: a style which can be better understood as coming from a living speaker, rather than from a page of reference 'facts'. [—*Pav*]

[I] организованностью, i. e. organizedness, or being (constantly) organized. [—*Pav*]

[II] становлении, e. g. formation. [—*Pav*]

[i] заселена

[ii] равновесием

[iii] биогенный ток атомов

† Ocean floor organisms have indeed been observed at all depths of the world ocean, including at greater than 11 km. (See Георгий Михайлович Беляев. *Донная фауна наибольших глубин (ультраабиссали) Мирового океана.* Наука, 1966. URL: http://books.google.com/books?id=G0Y_AAAAYAAJ; Георгий Михайлович Беляев. *Глубоководные океанические желоба и их фауна.* Ed. by М. Е. Виноградов. Наука, 1989. URL: http://www.biblus.ru/Default.aspx?book=555b0a1f4.) [—*Ed.*]

or oscillations of this mean are constantly manifested not in historical, but rather in geological time. In the course of geological time, in the cyclical processes which are characteristic of the biogeochemical state of organization, no point (for example, atom or chemical element) ever returns to a position identical with a previous one for eons.

This characteristic of the biosphere was expressed very prominently and vividly by Leibniz [1646–1716] in one of his philosophical reflections, it seems to me, in the *Theodicy*.[I] At the end of the 18$^{\text{th}}$ c., Leibniz recounts, he was among a large company from the high society in a large garden, and speaking of the infinite variety of nature, and of the infinite perfectability of the mind's precision,[i] indicated that two leaves of any tree or plant are never completely identical. All efforts of the large company to find such leaves were, of course, in vain. Leibniz was reflecting here not as an observer of nature, discovering this phenomenon for the first time, but as en erudite, taking it from his readings. It is possible to trace that precisely this example of the leaves appeared in philosophical folklore centuries earlier.[2]

This is manifested for us in everyday life in [individual] *identity*,[ii] in the absence of two identical individuals, indistinguishable from one another. It is manifested in biology in the fact that every mean *individuum*[iii] of living matter is *chemically distinct* in its chemical compounds, as, obviously, also in its chemical elements having *their own* specific compounds.

§5. Especially characteristic in the structure of *the biosphere is its physical-chemical, and geometric* (§47) *heterogeneity*. It consists of living and inert matter, which are sharply separate in their genesis and structure throughout all of geological time. Living organisms, i. e. all living matter, are born from living matter, [and] form generations in the course of time, which never arise directly, outside of such a living organism, from any possible inert matter on the planet. There is, however, an inherent, unceasing connection[iv] between inert and living matter, which can be expressed as an incessant biogenic flow of atoms from the living matter into the inert matter of the biosphere, and vice versa. This biogenic flow of atoms is originated by living matter. It is expressed in its always unceasing breathing, feeding, reproducing, etc.

This heterogeneity in the biosphere, unceasing throughout all geological time, is the main dominant factor, strongly distinguishing it from all other envelopes of the globe.

It goes deeper than the phenomena usually studied in natural science—to the properties of space-time, which scientific thought has approached only in our time, in the 20$^{\text{th}}$ c.

Living matter encompasses the whole biosphere, creates it, and changes it, but amounts to a small part of it by mass, and by volume. Inert, non-living matter is strongly dominant; greatly diluted gases dominate by volume, hard rocks, and, to a lesser degree, the liquid salt water of the world ocean—by mass. Living matter, even in the greatest concentrations, in exceptional cases with insignificant masses, amounts to tens of percent of the biosphere's matter, and amounts to hardly one–two hundredths of a percent by mass on average. Geologically, however, it is the greatest force in the biosphere, and determines, as we can see, all processes occurring in it, and accumulates vast free energy, creating the main geologically manifesting force in the biosphere, whose power still cannot be quantitatively determined, but, possibly, exceeds all other geological manifestations in the biosphere.

In connection with this, it is convenient to introduce a few basic concepts which we will be dealing with in all of the following exposition.

§6. Such are the concepts connected with the concepts of natural body (natural object),[v] and natural

[2] See, for example, Тит Лукреций Кар. *О природе вещей*. 1913, кн. 2, с. 54. (E. g., Titus Lucretius Carus. *On the Nature of Things*. Trans. by John Selby Watson. H.G. Bohn, 1851. URL: http://books.google.com/books?id=intROeJdmdMC, book 2. —*Pav*)

[I] See [24, 23].

[i] бесконечной четкости ума
[ii] личности
[iii] индивидуум

[iv] непрерывная, никогда не прекращающаяся связь
[v] природного тела (природного объекта)

phenomenon.[i] They have often been referred to as naturally-occurring bodies or phenomena.[ii]

Living matter is a natural body or phenomenon in the biosphere. The concepts *natural body or natural phenomenon*, little logically studied, are main concepts of natural science. There is no need to delve into their logical analysis for our purposes. These are bodies or phenomena, formed by natural processes,—*natural objects*.

Living organisms, living matter, are not the only natural bodies of the biosphere, but rather the main mass of the biosphere's matter is in the form of non-living bodies or phenomena, which I will be referring to as *inert*.[iii] Such are, for example, gases, the atmosphere, rocks, a chemical element, an atom, quartz, serpentine, etc.

In addition to living and inert natural bodies, its lawful structures, heterogeneous natural bodies, such as soils, silts, surface waters, the very biosphere, etc., which consist of living and inert natural bodies existing at the same time, forming complex, lawful inert-living structures,[iv] play a great role in the biosphere. I will be calling these complex natural bodies *bioinert* natural bodies.[v]

The difference between living and inert natural bodies is so great, as we shall see further on, that the transformation of one into the other is never and nowhere observed in terrestrial processes; we encounter them nowhere and never in scientific work. As we shall see, such a process is deeper than the physical-chemical phenomena known to us.

The related *heterogeneity of the biosphere's structure*, the sharp distinction between its matter and its energy in the form of living, and inert natural bodies, is its main manifestation.

§7. One of the manifestations of this heterogeneity of the biosphere consist in the fact that processes occur completely differently in living matter than in inert matter, if they are viewed in the aspect of time. They take place on the scale of *historical time*[vi] in living matter, on the scale of *geological time*,[vii] whose 'second' is under decamyriads, i. e. a hundred thousand years of historical time,[3] in inert matter. This difference is expressed even more sharply outside the boundaries of the biosphere, and we observe in the litosphere, for the predominant part of its matter, a state of organization in which the majority of atoms, as radioactive studies show, are immobile, do not mix, noticably for us, in the course of tens of thousands of decamyriads—a span of time now accessible to our measurement.

Not long ago the view that geologists cannot study the manifestation of geologically long changes, occurring in the age of mankind's existence, dominated. In the times of my youth we learned and thought that the change in climate, orography, the emergence of new species of organisms are not, as a general rule, detected in geological studies, are not *current phenomena*[viii] for the geologist. Now this conceptual circumstance of the naturalist has sharply changed, and we can see ever more, and more emphatically the geological forces around us. This coincided, hardly by accident, with the penetration of the conviction of the geological significance of Homo sapiens in the scientific consciousness, with the detection of a new state of the biosphere—the noosphere—and is one of the forms of its manifestation. This is, of course, connected, above all, with the increase in precision in the natural scientific work and thought in the domain of the biosphere, where living matter plays a major role.

The sharply distinct manifestation of living from inert in the aspect of time in the biosphere, with all of its significance, is a special expression of a far greater phenomenon, reflected in the biosphere at every step.

[i] природного явления
[ii] естественные тела или явления
[iii] косными
[iv] косно-живые структуры
[v] биокосными природными телами

[3] On decamyriads see Владимир Иванович Вернадский. "О некоторых очередных проблемах радиогеологии". Russian. In: *Известия Российской академии наук*. 7th ser. 1 (1935), pp. 1–18. URL: http://mi.mathnet.ru/izv4652 (visited on 07/30/2012), [as well as Владимир Иванович Вернадский. "О некоторых очередных проблемах радиогеологии". In: *Избранные сочинения*. Vol. 1: *Очерки геохимии и статьи по геохимии и радиологии*. Москва: Изд-во АН СССР, 1954, p. 659].

[vi] *исторического времени*
[vii] *геологического времени*
[viii] текущим явлением

§8. The living matter of the biosphere sharply differs from its inert matter in two main processes, which have an immense geological significance, and give the biosphere a completely different shape, which does not exist in any other envelope of the planet. These two processes are manifested only against the background of geological time. They never cease, and never go backwards.

First, *the power of the expression of living matter in the biosphere grows* in the course of geological time, the significance of living matter in the biosphere, and its influence on the inert matter of the biosphere increases. This process is little taken into account to this day. I will have to deal with it all the time further on.

Another process, known to all, and having imprinted a deepest impression on all scientific thought of the 19th and 20th centuries since the middle of the 19th century, has attracted far more attention, and has been studied much more. This is the process of *the evolution of species* in the course of geological time—the sharp change in the living natural bodies themselves.

We observe a sharp change in the natural bodies themselves in the course of geological time only in living matter. Some organisms turn into others, die out, as we say, or change fundamentally.

Living matter is *plastic*, changes, adapts to changes in its environment, but also, possibly, has its own evolutionary process, manifested in changes in the course of geological time, independent of the changes in the environment. This is, perhaps, indicated by the incessant growth, with intermissions, of the central nervous system of animals in its significance in the biosphere, and in the depth of the reflection of living matter in its surroundings,[4] in the former's penetration into the latter, in the course of geological time.

The plasticity of living matter is, obviously, a very complex phenomenon, as there are organisms which do not change in their morphological and physiological structure noticeably for us for hundreds of millions of years, up to five hundred million and more, over myriads of generations. These are the so-called *persistents*[i,*]—a phenomenon in biology which has been, unfortunately, extremely little studied. Nevertheless, we observe in them, as a phenomenon common to living matter, a *plastic evolutionary* process, for which there is not even a symptom in inert natural bodies. In these latter we see the same minerals, the same formation processes, the same rocks, and so forth *now,* which were there *two billion years, and more, ago.*

The evolutionary process of living matter encompasses the whole biosphere incessantly during all geological time and, in different ways, less strongly, still affects its inert natural bodies. With this we already can, and must talk about *the evolutionary process of the biosphere itself,* occurring in the inert mass[ii] of its inert and living natural bodies, changing visibly in the course of geological time.

The reflection of living matter in its surrounding environment changes sharply due to the evolution of species, ongoing constantly, and never ceasing. Thanks to this process, evolution—change—is transferred to the natural bioinert and biogenic bodies, which play a major role in the biosphere—to soils, to surface and underground waters (in seas, lakes, rivers, etc.), to coal, bitumen, limestones, organogenic ores, and so forth. The soils and rivers of the Devonian, for example, are different from the soils [and rivers][I] of the Tertiery, and of our period. This is an area of new phenomena, hardly taken into account by scientific thought. *The evolution of species turns into an evolution of the biosphere.*

§9. The evolutionary process has acquired, in addition, a special geological significance thanks to the

[4] That the evolution of nervous tissue is incessantly ongoing in the course of geological time has been indicated more than once, but, as far as I know, it has not been completely analyzed scientifically and philosophically. As the question here is not about a hypothesis, and not about a theory, the fact of its evolution cannot be denied—there can only be objections to its explanation. The recognition of Redi's principle limits the number of explanations.

[*] persistents... See Владимир Иванович Вернадский. *Химическое строение биосферы земли и ее окружения.* Наука, 1965. URL: http://books.google.com/books?id=mXP4uAAACAAJ, p. 269. [—*Ed.*]

[I] Interpolated from the implied meaning. [—*Pav*]

[i] персистенты. These seem to be popularly known as *living fossils* today. [—*Pav*]

[ii] инертной массе

fact that it has created a new geological force—the scientific thought of social mankind.[i]

We are now fully living through its prominent entry in the geological history of the planet. The intensive growth of the influence of a single species of living matter[ii]—civilized mankind—on the biosphere is observable during the last millenia. The biosphere is transitioning into a new state—*into the noosphere*—under the influence of scientific thought and human labor.

Mankind is encopassing the whole planet, is distinguishing itself, is diverging from other living organisms as a new, unprecedented geological force by a lawful motion, stretching one–two million years, with an ever-increasing in its manifestation rate. An ever-growing set of inert natural bodies, *new for the biosphere,* and new, great natural phenomena are being created by this means in the biosphere at a speed comparable to that of reproduction, expressible by a geometric progression in the course of time.

The biosphere is changing drastically in front of our eyes. And there can harldy be any doubt that its transformation, manifested in this way, by scientific thought through organized human labor is not an arbitrary phenomenon,[iii] depending on the will of man, but is a tempestuous *natural process,*[iv] whose roots lie deep, and had been prepared by an evolutionary process whose duration is calculated in the hundreds of millions of years.

Man must understand, as only a scientific, but not a philosophical or a religious conception of the world can encompass this, that *he is not an arbitrary, independent of its surroundings*—biosphere and noosphere—freely-acting natural phenomenon. He comprises an unavoidable manifestation of a great natural process, lawfully stretching throughout the course of, at least, two billion years.

In the present times, under the influence of the surrounding horrors of life, along with an unprecedented flowering of scientific thought, it has become necessary to hear of the approach of barbarity, of the breakdown of civilization, of the self-annihilation of mankind. These attitudes, and these reasonings appear to me to be consequences of insufficiently deep penetration into our surroundings. Scientific thought not having entered everyday life yet, we are still living under the strong influence of philosophical and religious habits, not corresponding to the reality of contemporary knowledge, which we still have not grown out of.

Scientific knowledge, being manifested as a geological force creating the noosphere, cannot lead to results, which contradict that geological process, whose creation it is. This is not an arbitrary phenomenon—its roots are extremely deep.

§10. This process is connected with the creation of the human brain. It was detected in the history of science in the form of an empirical generalization by the profound American naturalist, great geologist, zoologist, paleontologist, and mineralogist J. D. Dana [1813–1895] in New Haven. He published his conclusion almost 80 years ago. Strangely, this generalization has not entered daily life to this day, has been almost forgotten, and has not undergone the necessary development to this day. I will return to this later. Here I will note that Dana presented his empirical generalization in the language of philosophy and theology, and it, it seems, was connected to conceptions, scientifically unacceptable today.

Speaking in contemporary scientific language, Dana noted that a more and more advanced—central nervous system—*brain* than that which existed earlier on our planet is manifested [in] some parts of its inhabitants in the course of geological time. This process, called *encephalization* by him, never goes backward, [even though] it ceases many times, sometimes for many millions of years. The process is, therefore, expressed by a polar temporal vector, whose direction does not change. We shall see that the geometrical state of space[v] occupied by living matter is also characterized by polar vectors, that there is no place for straight lines in it.

[i] научную мысль социального человечества

[ii] одного видового живого вещества

[iii] случайное явление, i. e. also chance phenomenon, or accidental phenomenon

[iv] стихийный *природный процесс*

[v] геометрическое состояние пространства

The evolution of the biosphere is connected with *the intensification of the evolutionary process* of living matter.

We now know that critical periods in the history of the terrestrial crust are emerging, in which geological activity, in the most diverse of its manifestations, is increasing in its rate. This increase is, of course, unnoticeable in historical time, and can be noted scientifically only on the scale of geological time.

These periods can be considered *critical* in the history of the planet, and everything is indicating that they are occasioned by deep, from the standpoint of the Earth's crust, processes, apparently exceeding its boundaries. A simultaneous increase in volcanic, orogenic, glacial phenomena, marine transgressions, and other geological processes simultaneously encompassing a great part of the biosphere throughout its whole extent has been observed.* The evolutionary process coincides in its intensification, in its greatest changes with these periods. Most important and great changes in the structure of living matter, which are a clear expression of the depth of the geological significance of this plastic reflection of living matter in the resulting changes of the planet, were created in these periods.

There is no theory, precise scientific explanation of this main phenomenon in the history of the planet. It emerged empirically, and unconsciously—penetrated science unnoticed, and its history has remained unwritten. A major role in it played American geologists, specifically, J. D. Dana. It has pervaded the scientific thought of our century.

It is, however, possible, and necessary to approach it with measure and number. The geological length of its duration can be measured, and, in this way, the change in the rate of geological processes can be characterized numerically. This is one of the immediate tasks of radiogeology.

§11. While this remains uncompleted, we must note, and take into account that the process of evolution of the biosphere, its transition into *the noosphere*, clearly manifests an acceleration in the rate of geological processes. The changes, which are presently manifesting themselves in the biosphere through the course of [the last] several *thousand years* in connection with the growth of scientific thought and the social activity of mankind, have never existed in the history of the biosphere before.

Such, at the very least, are the conceptions which we can now derive from the study of the course of evolution of organisms during geological time. Decamyriads[ii] are much less than a historical time's second for geological time. Consequently, a thousand years on a geological scale would be more than 300 million years of geological time. This does not contradict [the existence of the periods of][I] the great changes of the biosphere which took place, for example, in the Cambrian, when calcareous skeletal parts emerged

*More precise stratigraphic studies, done in various parts of our planet during the 45-year post-war period require us to modify our conception of 'critical ages' in the history of the Earth somewhat. Orogenic phenomena, as well as marine transgressions, turned out to have occurred at greatly different times on different continents, and even in different parts of the same massive continent. [See Александр Леонидович Яншин. "Тектоника Евразии. Объяснительная записка к Тектонической карте Евразии". In: *Тектоническая карта Евразии* (1966); Александр Леонидович Яншин. "О так называемых мировых трансгрессиях и регрессиях". In: *Бюллетень МОИП* 48.2 (1973).] However, there undoubtedly were outbreaks of volcanic activity on the territories of contemporary continents in the history of the Earth. Judging from the estimates produced by A. B. Ronov[i] of the mass of volcanic products, they took place throughout the last 600 million years in the middle Devonian, at the end of the Carboniferous–beginning of the Permian, at the end of the Triassic, and to a less significant degree in the middle Cretaceous, and in the Neogene. Each such outbreak of volcanism led to a planetary change in the composition of the atmosphere—to an increase in its CO_2 content, and to a decrease of the oxygen content, which brought, on the one hand, a decrease of temperature, leading to the formation of polar ice caps, and, on the other,—an intense development of vegetation, and the return of oxygen to the atmosphere, as a result of the processes of photosynthesis. [See Михаил Иванович Будыко. *Климат и жизнь*. Москва, 1974] Apparently, "most important, and great changes in the structure of living matter" were created in these periods, i. e. they were 'critical' in the sense in which V. I. Vernadsky used this word. [—*Ed.*]

[i] А. Б. Роновым

[I] Interpolated from implied meaning.

[ii] декамириада

in microscopic marine organisms, or [in] the Paleocene, when the fauna of mammals grew.* We must not fail to keep in mind that the time we are living through corresponds, geologically, to such a critical period, since the ice age has still not ended—the rate of change is, nevertheless, so slow that man could not notice it.

Man and mankind, his kingdom in the biosphere lie completely in this period, and do not exceed its boundaries.

A picture of the evolution of the biosphere since the Algonkian, and, more sharply, since the Cambrian, over 500–800 million years can be given. The biosphere transitioned into a new evolutionary state[i] more than once. New geological manifestations, which had never existed before, emerged. This occurred, for example, in the Cambrian, when large organisms with calcium skeletons came into existence, and in the Tertiary (or, possibly, at the end of the Cretaceous), 15–80 million years ago, when our forests and steppes were coming into existence, and the life of large mammals developed. We have also been living through this presently, for the past 10–20 thousand years, when man, having developed scientific thought in a social environment, has been creating a new geological force in the biosphere, unprecedented in it. The biosphere has transitioned into, or, more precisely, is transitioning into *a new evolutionary state—into the noosphere*—is being transformed by the scientific thought of social mankind.

§12. The irreversibility of the evolutionary process is a manifestation of the characteristic distinction of living matter in the geological history of the planet from its inert naturally-occurring bodies and processes. It can be seen that this irreversibility is connected to the special properites of the space occupied by the bodies of living organisms, to its special geometric structure, as P. Curie said, with its special *state of space.*[ii] L. Pasteur first understood the fundamental significance of this phenomenon, which he inadequately called dissymmetry, in 1862.[5] He studied this phenomenon in another aspect, in the inequality between left and right phenomena in the organism, in the existence of left-handedness and right-handedness[iii] for it.[6] Right-handedness and left-handedness can be manifested geometrically only in a space, in which vectors are polar and enantiomorphic. The lack of straight lines, and the strongly expressed curvature of the forms of life is, apparently, connected to this geometrical property. I will return

*Numerous findings of small mammals are now known from the deposits of different horizons of the Upper, and the top strata of the Lower Cretaceous, and the most ancient remains of primitive mammals have been observed already in Triassic deposits. However, the intensive evolutionary development of this class of vertebrates began after the dying out of the dinosaurs in the Paleocene, by which the boundary between the Cretaceous and the Paleogene in the history of the Earth is determined to a large degree. [—*Ed.*]

[i] эволюционное состояние

[5] The principle was formulated by P. Curie (1859–1906), but was understood and expressed completely clearly and intuitively by L. Pasteur (1822–1895). I have delimited it here as a special principle (Louis Pasteur. *Dissymétrie moléculaire*. French. Vol. 1. Paris: Masson, 1922. URL: http://www.biodiversitylibrary.org/item/103132 (visited on 08/10/2012); Pierre Curie. *Oeuvres de Pierre Curie*. Paris: Gauthier-Villars, 1908).

[6] It is striking that the phenomenon of 'left-handedness' and 'right-handedness' remained outside of philosophical and mathematical thought, even though individual great philosophers and mathematicians, like Kant and Gauss, approached it. Pasteur was a complete innovator in thought, and it is extremely important that he arrived at this phenomenon, and to the recognition of its significance proceeding from experiment and observation. Curie proceeded from Pasteur's ideas, but developed them from a physical standpoint. On the significance of these ideas for life see Владимир Иванович Вернадский. *Биогеохимические очерки (1922–1932)*. Изд-во Академии наук СССР, 1940. URL: http://books.google.com/books?id=37cIHAAACAAJ [A large part of them was published in the book Владимир Иванович Вернадский and Всеволод Всеволодович Добровольский. "Труды по биогеохимии и геохимии почв". In: Библиотека трудов академика В.И. Вернадского. Наука, 1992. URL: http://books.google.com/books?id=LeA2AAAAMAAJ, pp. 22–271]; Владимир Иванович Вернадский. *Значение биогеохимии для изучения биосферы*. Russian. .В. 1. Проблемы биогеохимии. Академии наук СССР, 1934, pp. 9–10. URL: http://goraknig.org/estestvennye_nauki/?kniga=MTQ2MTQxNA__ [Владимир Иванович Вернадский. "Проблемы биогеохимии". In: vol. 16. Труды Биогеохимической лаборатории. Изд-во Академии наук СССР, 1980, pp. 10–54].

[ii] *состоянием пространства*

[iii] правизны и левизны

to this question further on, but I consider it necessary to note presently that we are, apparently, dealing with a space, not corresponding to Euclidean space, but to one of the forms of Riemannian space, inside organisms.

We are presently justified to admit the manifestation of the geometrical properties corresponding to all three forms of geometry—Euclidean, Lobachevskian and Riemannian—in the space in which we are living. Further investigation will show whether such a conclusion, logically completely uncontradictable, is correct.[7] Unfortunately, the great amount of empirical observations, relevant here and scientifically established, has not been assimilated in its significance by biologists, and has not entered into their scientific world outlook. Meanwhile, as P. Curie showed, such a special state of space cannot occur in the usual space without special circumstances; a dissymetrical phenomenon, speaking his language, must always result from such a dyssimetrical cause. The fundamental empirical generalization that living originates only from living, and an organism is born from an organism corresponds to this. This is manifested geologically in the fact that we observe an impassable boundary between living and inert naturally-occurring bodies and processes in the biosphere, which is not observable in any other terrestrial envelope. There are two sharply materially [and] energetically distinct media, mutually penetrating and exchanging their constituent atoms, connected with the biogenic flow of chemical elements, in it. I will return to this phenomenon in more detail further on.

§13. We are currently living through an extraordinary manifestation of living matter in the biosphere, genetically connected with the emergence of *Homo sapiens* thousands of years ago, the creation, in this way, of a new geological force, *scientific thought,* dramatically increasing the influence of living matter on the evolution of the biosphere. Completely encompassed by living matter, the biosphere is increasing the geological force of living matter to an, apparently, unlimited degree, and, being transformed by the scientific thought of *Homo sapiens,* is transitioning into one of its new states—*into the noosphere.*

As a manifestation of living matter, scientific thought *cannot be* in essence a reversible phenomenon—it can stop in the course of its motion, but, once created and manifested in the evolution of the biosphere, it carries in itself the ability of unlimited development in the course of time. The course of scientific thought in this respect, for example in the creation of machines, is, as has been remarked long ago, completely analogous to the course of the reproduction of organisms.

There is no irreversibility in the inert medium of the biosphere. Reversible cyclical physico-chemical, and geochemical processes strongly predominate in it. Living matter enters in them with its physico-chemical manifestations of dissonance.*

[7] Mathematical thought has admitted the equal permissibility of the search for the manifestations of non-Euclidean geometry in the reality surrounding us long ago. Perhaps, the thought of this was clear to Euclid himself when he separated the parallel postulate from his axioms. Lobachevsky (1793–1856) was striving to prove the existence of the triangles introduced by him, proceeding from the rejection of this postulate, for cosmic space. It seems to me that H. Poincaré (Jules Henri Poincaré. *La Science et l'hypothèse*. French. Bibliothèque de philosophie scientifique. Paris: Flammarion, 1902. URL: http://echo.mpiwg-berlin.mpg.de/ECHOdocuViewfull?pn=5&url=/mpiwg/online/permanent/einstein_exhibition/sources / N9B38CEE / pageimg & viewMode = images & mode = imagepath (visited on 08/10/2012), pp. 3, 66) most prominently emphasized the possibility of searches for the manifestations of non-Euclidean geometry in our physical environment. This question raised no doubt with the ferment of thought,[i] occasioned by A. Einstein (Albert Einstein. *Geometrie und Erfahrung. Erweiterte Fassung des Festvortrages gehalten an der Preussischen Akademie der Wissenschaften zu Berlin am 27. Januar 1921.* German. Berlin: Julius Springer, 1921. URL: http://name.umdl.umich.edu/ABR1192.0001.001 (visited on 08/10/2012)). It can be objected that in these cases it was admitted, as it were, *tacito consensu* (by a tacit agreement) that geometry, of this form or another, is the same in all reality, while, as in the given case, we are dealing with a geometrical heterogeneity of the space in our reality. The space of life is different from the space of inert matter. I cannot see any basis for presuming such an admission contradictory to the foundations of our exact knowledge.

[i] брожении мысли

*The Earth as a whole has an irreversible development, as well, as is shown by the work with radioactive determination of the age of the rocks of the early Precambrian. Biological evolution is strongly distinguished by a different rate of development (Александр Леонидович Яншин. *Эволюция геологических*

The growth of scientific thought, closely connected with the growth of man's population of the biosphere—his reproduction, and his cultures of living matter in the biosphere,—must be limited by the foreign living matter of the environment, and must exert a *pressure* on it. For this growth is connected to the quantity of rapidly increasing living matter, directly and indirectly participating in scientific work.

This growth and the pressure connected to it is ever increasing, due to the fact that the activity of the mass of created machines, whose increase in the noosphere is subject to the same laws as those of the reproduction of living matter itself, i. e. is expressed by a geometrical progression, is dramatically manifested in this work.

As the reproduction of organisms is manifested in the *pressure* of living matter in the biosphere, the course of the geological manifestation of scientific thought puts pressure, by the instruments created by it, on the inert medium of the biosphere containing it, creating the noosphere, the kingdom of reason.

The history of scientific thought, of scientific knowledge, of its historical course is being manifested in a new aspect, which has not been sufficiently recognized to this day. It must never be viewed as simply the history of one of the humanities. This history is, at the same time, *the history of the creation a new geological force—scientific thought,—in the biosphere,* not present in the biosphere before. This is the history of manifestation of a new geological factor, of a new expression of the biosphere's state of ogranization, forming tempestuously, as a natural phenomenon during the last few tens of thousands of years. It is not arbitrary, as every natural phenomenon, it is lawful, as the paleontological process, creating the brain of *Homo sapiens* and that social environment, in which scientific thought, a new geological, consciously directed, force is being created as a consequence of this environment, as a natural phenomenon connected with it, is lawful in the course of time.

But the history of scientific knowledge, even as a history of one of the humanities, is still unrecognized and unwritten. There is not a single attempt to do that. It has just begun to exceed the limits of 'biblical' time for us only in the recent years, the existence of *a single center* of its emergence, somewhere in the region of the future Mediterranean culture eighty thousand years ago, has started to become clear. We are beginning to detect, to establish unexpected for us, completely forgotten scientific facts lived through by mankind, only with great gaps from cultural remains, attempting to encompass them by new empirical generalizations.[8]

процессов в истории Земли. Ленинград: Наука, 1988). [*—Ed.*]

[8] The rapid change in our knowledge thanks to archeological excavations allows us to hope for very great changes in the near future.

Chapter 2

Manifestation of the historical moment mankind is currently living through as a geological process. Evolution of the species of living matter and evolution of the biosphere into the noosphere. This evolution cannot be stopped by the course of global human history. Scientific thought and mankind's daily lives as expressions of it.

§14. We are not yet conscious of, we are not yet living the realization of the full consequences of the astonishing, unprecedented times that mankind has entered during the 20th century.

We are living at the threshold of an extremely important, fundamentally new epoch in the existence of mankind, in mankind's history on our planet.

Mankind has, for the first time, encompassed the whole surface envelope of the planet—the whole biosphere, all parts of the planet connected to life—with human life, with human culture.

We are present at, and are actively participating in the creation of a new *geological factor* in the biosphere, unprecedented in its power and in its unity.

It has been scientifically established for the last 20–30 thousand years, but has been clearly manifested at an ever increasing rate only during the last millenium.

The envelopment of the whole surface of the biosphere by a unified social species of the animal kingdom—by *mankind*—has been completed after many hundreds of thousands of years of unstoppable, tempestuous striving for it. There is no corner on Earth inaccessible to mankind. There is no limit to our possible population growth. Man, through scientific thought and through his life, socially organized into states, and guided by technology, is creating a new *biogenic force* in the biosphere, which is guiding his population growth and creating favorable conditions for his population in parts of the biosphere, earlier impenetrable to human life, and even in places where there was no life before.

Theoretically, we cannot foresee a limit to mankind's potential, if we only take into account the effect of generations; every geological factor is fully manifested in the biosphere only in the effect of generations of living beings, only in geological time. With the rapidly increasing precision of scientific work—in this case, of the methodology of scientific observation,—we can now clearly establish, and study the increase of this new, principally currently emerging, geological force in historical time.

Mankind is a unified whole, and even if that is recognized by the vast majority, this unity manifests itself in forms of human life, which actually deepen and strengthen it without being noticed by man, impetuously, [as a result of] an unconscious striving for it. Human life, with all of its variety, has become indivisible, unified. An event, ocurring in a forsaken corner on land or in the ocean, is reflected, and has consequences, major or minor, in a multitude of other places, all over the Earth. The telegraph, telephone, radio, airplanes, aerostats[I] encompass the

[I] An aerostat is an object that can stay stationary in air,

globe. Communication is ever easier and faster. Its organization increases, turbulently grows, every year.

We can clearly see that this is the beginning of a tempestuous movement, of a natural phenomenon, which cannot be stopped by the accidents of human history. Here the relation between historical processes and the paleontological history of the manifestation of Homo sapiens is expressed, maybe for the first time. That process—*the complete colonization of the biosphere* by mankind—arises from the course of the history of scientific thought, which is inseparably connected with the speed of communication, with the achievements of transportation technology, with the ability of thoughts to be communicated *instantaneously*, and to be discussed everywhere on the planet simultaneously.

The fight, which is being carried out against this main historical current, is forcing even its ideological opponents to obey it. Government formations, ideologically rejecting the equality and unity of all people, are attempting, lacking no resources, to halt its impetuous manifestation; but it can hardly be doubted that these utopian dreams would fail to last. This transformation will inevitably come to pass in the course of time, sooner or later, since the creation of the noosphere out of the biosphere is a natural phenomenon, fundamentally deeper and more powerful than human history. It necessitates the manifestation of mankind as a unified whole. This is its inevitable requirement.

Ours is a new stage in the history of the planet, which does not allow comparison with past history without corrections. It is so, because this stage is creating fundamental *novelty* in the history of the whole Earth, and not just in the history of mankind.

Man has actually recognized for the first time that he is a citizen of the *planet* and that he can—must—think and act in a new aspect, not only in the aspect of individual personalities, nuclear or extended families, nations or their unions, but also in a *planetary aspect*. He, like everything living, can think and act in a planetary aspect only in the region of life—in *the biosphere*, in a certain earth envelope, with which he is inseparably and lawfully connected, and outside of which he cannot go. His existence is a function of it. He carries it everywhere with himself. And he inevitably changes it lawfully and unceasingly.

bacause it is lighter than it, such as a baloon or a dirigible.

§15. Simultaneously with mankind's complete envelopment of the surface of the biosphere—with its complete colonization,—which is closely connected with the achievements of scientfic thought, i.e. with the course of scientific thought in time, a scientific generalization, which scientifically reveals the character of the historical moment mankind is currently living through in a new way, has been formed in *geology*.

Mankind's geological role has been cast anew in the understanding of geologists. True, the recognition of the geological significance of our social life has been expressed in a less clear form long ago, much earlier in the history of scientific thought. However, at the beginning of our century C. Schuchert [1858–1942] in New Haven,[1] and A. P. Pavlov (1854–1929) in Moscow[2] independently accounted, geologically anew, for the long-known change which the emergence of human civilization introduces into the environment, onto the face of the Earth. They considered it possible to take this manifestation of Homo sapiens as the basis for distinguishing *a new geological epoch,* along with the tectonic and orogenic data which usually determine such divisions.

They correctly tried to split the Pleistocene Epoch, defining its end by the beginning of the manifestation of mankind (during the recent hundred-somethng thousand years—say a few decamyriads ago), and separating the latter in its own geological epoch: *psychozoic,* according to Schuchert; *anthropogenic,* according to A. P. Pavlov.

Actually Ch. Schuchert and A. P. Pavlov deepened and made more precise, brought into the established in modern geology divisions of the history of the Earth, a conculsion, which was made much before them, and which did not contradict the empiri-

[1] Schuchert and Dunbar, *A Text Book of Geology*, p. 80.

[2] Алексей Петрович Павлов. *Геологическая история европейских земель и море в связи с историей ископаемого человека.* Russian. Академия наук СССР, 1936. URL: http://books.google.com/books?id=0aTpHAAACAAJ, с. 105 и сл.

cal scientific work. This conclusion was clearly recognized by one of the creators of contemporary geology, L. Agassiz (1807–1873), based on the paleontological history of *life*. He established the special geological *epoch of mankind* already in 1851.

However, Agassiz relied not on geological facts, but rather, to a great extent, on the common religious conviction so strong during the age of natural science before Darwin; he started from the special position of man in the universe.[3]

The geology in the middle of the 19th century, and the geology at the beginning of the 20th century are incomparable in their power and scientific justification, and the epoch of mankind of Agassiz is not scientifically comparable with the epoch of Schuchert-Pavlov.

Already earlier, when geology was just being created and its basic concepts did not yet exist, G. Buffon (1707–1788) notably expressed that same geological epoch of mankind at the end of the 18th century. He proceeded from the ideas of the philosophy of the Enlightenment, advancing the significance of reason in the conception of the universe.

The definite difference between these homonymous concepts is clear from the fact that Agassiz assumed the geological age of the World to be the biblical duration of the existence of the Earth—six–seven thousand years,—Buffon thought about an age of more that 127 thousand years, Schuchert and Pavlov—of more than a billion years.

§16. We have already met with similar conceptions in philosophy long ago. Conceptions, which have been reached in another way—not by way of precise scientific observation and experimentation, like that of C. Schuchert, A. P. Pavlov, L. Agassiz (and J. Dana, who knew about the generalizations of Agassiz), but by way of philosophical searches and intuition.

The philosophical worldview creates, in general, as well as in particular, that environment, in which scientific thought takes place and develops. To a significant extent, it determines and gives rise to scientific thought, itself being changed by its achievements.

The philosophers relied on free, it seemed to them, in their expression ideas, on the searches of confused human thought, of human consciousness, which wouldn't reconcile with reality. However, man unavoidably built his ideal world in the brutal framework of surrounding nature, the environment of his life, the biosphere, with which he has a deep connection, independent of his will, which he did not, and still does not, understand.

We find, in the history of philosophy, already many centuries before our age, intuitions and constructs, which could be connected to scientific empirical conclusions, if we translate the thoughts—intuitions—that have reached us into the realm of real scientific facts of our time. We lose their roots in the past. A few of the philosophical searches in India, many centuries ago,—the philosophy of the Upanishads—can be interpreted in such a way, if we translate them into the realm of 20th century science.[4]

Analogous conceptions existed in another, smaller, cultural area, partly overlapping, but later, which was isolated from the Indian one for a significant part of the time: in the circle of the Helenic Mediterranean civilization. We can trace the germs of these conceptions going back almost two and a half thousand years ago. The significance of science and scientists for the government of the polis in political and social thought is clearly manifested in Helenic thought, and is notably expressed in the concept of the sate, [given by] Plato [427–347].

It cannot, it seems, be denied, but the condition of the sources, reaching us in fragments, also does not allow us to confirm precisely, that after Aristotle [384–322] these ideas were still alive during the Helenic age of Alexander the Great [356–323], when, a few centuries after the destruction of the Persian

[3] Agassiz expressed that idea in a polemical work directed against Darwinism (Louis Agassiz. *An Essay of Classification*. London: Longman, Brown, Green, Longmans, & Roberts, 1859. URL: http://books.google.com/books?id=QXkLAAAAMAAJ). It is possible that this is related to why the work did not reach, [despite] the many important reflections in it, the influence it could have had.

[4] The philosophy of The East, mainly of India, in connection with the new creative work there, taking place under the influence of the introduction of Western science in Indian culture, is of much greater interest for life sciences than Western philosophy, which is deeply permeated—even in its materialistic parts—by deep echoes of Judeo-Christian religious searches.

kingdom, a close exchange of ideas and knowledge between Helenic and Indian civilization was established. A connection between them and Chaldean scientific thought, which went back a few millenia before Helenic and Indian thought, was established at the same time. The history of scientific work and thought during this remarkable age is just beginning to come to light.

Better known is the influence of the Helenic political and social ideas. We can trace their historical influence exactly in the historical process of modern science and of the civilization of the European West, which replaced the theocratic ideological structure of the Middle Ages. We can see their growth in pactice, and with clarity only during the 16th–17th centuries, in the conceptions and constructs of F. Bacon (1561–1626), who prominently advanced the idea of the power of man over nature as the aim of modern science.

In the 18th century, in 1780, G. Buffon posed the manifestation of man's control of nature *as part of the history of the planet* not as an idea, but as an observable natural phenomenon. He relied on the hypothetical reconstruction of the planet's past, connected with philosophical intuition and theory, rather than on precisely observed facts—but he was looking for them. His ideas were adopted by philosophical and political thought, and, undoubtedly, exerted their influence on the course of scientific thought. Geologists from the end of the 18th–beginning of the 19th century often relied on them in their current scientific work.

§17. The scientific constructs of Schuchert and Pavlov and all the scientific work which—to a significant degree unconsciously—preceded them are essentially distinct from these philosophical constructs, which, however (this can be established historically), undoubtedly influence the course of geological thought, though unable to give it a firm basis.

It is clear from the generalizations of Schuchert and Pavlov that the main influence of human thought as a geological factor is expressed in its scientific manifestation: it mainly builds and guides the technical work of mankind, which is transforming the biosphere.

Both of the indicated geologists were able to make their generalizations, above all, because mankind was able to colonize the whole planet in their time. No organism except him, save for microscopic species and, possibly, a few graminoids, has encompassed such an area in populating the planet. However, mankind has accomplished this in a different way. He thought scientifically and transformed the biosphere through labor, adapted it to himself and himself created the conditions for the manifestation of his characteristic biogeochemical energy of reproduction. Such population of the whole planet became clear at the beginning of the 20th century, and it could be considered a fact since about the first quarter of that century, which is being confirmed every year in front of our eyes. It became possible only thanks to the drastic change of the conditions of life connected with the emergence of a new ideology, with the drastic change in the tasks of government life, with the scientific growth of technology, which were being carried out at the very same time.

As J. Ortega y Gasset[5] correctly remarked, the 19th century in Europe, and over the whole world since its second half, was a historical period when the significance of the vital interests of the masses of population occupied first place in practice and ideology in their consciousness and in the consciousness of government people for the first time in wold history. It was dramatically manifested in everyday life for the first time. A new ideology was based on the consciousness of the population masses stepping onto the historical stage as a social force for the first time. It is beginning to encompass all mankind—every language without exception—at a rapidly increasing rate.

It will show in its real significance only in the course of time.

The social-political ideological shift was dramatically manifested in the 20th century mainly thanks to scientific work, thanks to the scientific determination and clarification of the social tasks of mankind, and of the form of his organization.

§18. The question of the better organization of life and of the means by which it could be accom-

[5] José Ortega y Gasset. "The Revolt of the Masses". In:

plished has been raised numerous times during the multi-thousand-year historical tragedy full of blood, suffering, crime, destitution, hardship, which we call world history. Man has not accepted the conditions of his life.

The exit from these searches has been resolved differently, and we can see numerous (and how many have disappeared without trace!) searches—philosophical, religious, artistic and scientific. For millenia they have been, and are being created in every corner where human society has existed.

The world history of mankind has been lived and recreated for a significant part of the human population, and the places and times full of suffering, evil, slaughter, hunger, and destitution for the majority have been an unsolvable mystery from a *human* point of view of sensibility and goodness. In general, innumerable philosophical and religious attempts during the course of millenia have not reached a unified explanation.

All solutions reached in such a way transfer and have transferred the question in a different plane—from the domain of brutal reality, into the domain of ideal constructs. Various forms of countless religious-philosophcal solutions, which are indeed related to the notion of individual immortality, in one or another form, in the literal meaning of the word, or in its future resurrection in new conditions, where evil, suffering and disasters would not exist, or where these would be distributed justly, have been found. The notion of metempsychosis, solving the question not from a personal standpoint, but from the standpoint of all living matter, is the deepest. It, having emerged a few millenia ago, is still alive and vivid for many hundreds of millions of people to this day. And there is, perhaps, nothing it contradicts contemporary scientific notions in. The course of scientifc thought has nowhere run up against the conclusions from this notion.

All of these notions—with all of their distance, sometimes, from precise scientific knowledge—are a powerful social factor over the course of millenia, strongly reflected in the process of the evolution of the biosphere into the noosphere, far from being, however, decisive, or somehow distinguished from other factors in its creation at the same time. In the course of tens of thousands of years, they have, in this aspect, sometimes played the main role, have sometimes disappeared among others, have moved into the background, could have been left neglected.

§19. Because this same historical process of world history is reflected in the nature surrounding man in another way[;][I] it is possible and necessary to approach it purely scientifically, leaving aside any notions which do not result from scientific facts.

Archeologists, geologists, and biologists are now having such an approach to the study of world history, leaving without consideration of any of the millenia-old notions of philosophy and religion, not taking them into account, creating a new scientific understanding of the historical process of man's life. Geologists, deepening the study of the history of our planet, of the Pleistocene, of the Ice Age, have collected a vast amount of scientific facts, manifesting the reflection of the life of human societies—in the end, of civilized mankind—on the geological processes of our planet, in fact, of the biosphere. Without its evaluation from the standpoint of good and evil, without regard for the ethical or philosophical aspect, scientific work, scientific thought is establishing a new fact of primary geological significance in the history of the planet. This fact consists of the detection of a new *Psychozoic* or *Anthropogenic geological Age,* created by the historical process. In fact, it is defined planetologically by the emergence of mankind.

None of the countless—geological, philosophical, or religious—notions of the significance of mankind, and the significance of human history play any [significant] role in this scientific generalization. They can be left aside without any concerns. Science does not have to take them into account.

§20. Approaching the analysis of this scientific generalization, we should note that its duration can be estimated as millions of years, while the historical process of human societies encompasses a few decamyriads, hundreds of thousands of years, of it.

London, 1932, p. 19

[I] The source Russian version has a full stop here.

It is necessary, most of all, to stress a few preconditions, which determine this generalization.

First, is *the unity and equality, in essence, in principle, of all people*, of all races. This is expressed biologically in the detection of all people in the geological process *as a unified whole* with respect to the rest of the living population of the planet.

And this is despite the possibility, and, even, probability of the emergence of the different human races from different species of the genus *Homo*. This difference likely does not reach deeper, to the various animal predecessors of the genus *Homo*. We cannot, however, deny it. Such unity with respect to all other life has been, in general, maintained throughout all of world history, even though it was absent, or almost absent at times, and in places in special cases. We are encountering such manifestations still today, but the general tempestuous process is not changed by this.

The geological significance of mankind was manifested for the first time in connection with this. Apparently, already hundreds of millenia ago, when man acquired control over fire and began making the first instruments, he laid the foundation of his advantage over the higher animals, the fight with which occupied a major part of his history, and was, theoretically, finally ended a few centuries ago with the discovery of firearms. Man must take special care in the 20^{th} c. not to allow the extinction of all animals—large mammals and reptiles,—which he would like to preserve because of some or other considerations. Many tens of millenia earlier, however, close to his emergence, he was that force, new on our planet, which occupied an important place along with other earlier species, in bringing the extinction of species of large animals. It is quite possible that he did not differ much from numerous other gregarious predators at that time.

§21. Much more important, from a geological point of view, was another shift, slowly taking place tens of thousands of years ago—the domestication of herd animals and the cultivation of cultured plant races. Man started changind the living world around him, and creating for himself a new, previously non-existent living nature by this means. The great significance of this was manifested in another way—in the fact that he saved himself from hunger in a new way, known to only a limited degree among animals,—the conscious, creative safeguard against hunger—and, consequently, created the possibility for his unlimited reproduction.

At that time, perhaps, ten–twenty thousand years ago, thanks to this possibility, the possibility for the formation of large settlements (towns and villages), and, consequently, the possibility for the formation of government structures, completely essentially different from those special forms which arise from blood relations, was first established. The idea of the unity of mankind received here in reality, although, obviously, unconsciously, even greater possibilities for its development.

Thanks to the discovery of fire, man was able to survive the Ice Age—those great changes and variations of the climate and the state of the biosphere, which are now being scientifically uncovered before us in the alterations with the so-called interglacial periods—at least, three in number—in the Northern Hemisphere. He survived them, even though numerous other lage mammals disappeared then from the face of the Earth. It is possible that he aided their extinction.

The Ice Age has not ended, and extends to the present time. We are living in an interglacial period—the warming is still continuing,—but man has adapted to these conditions so well that he does not notice the Ice Age. The Scandinavian Glacier thawed in the location of St. Petersburg and Moscow a few thousand years ago when man had already developed domestication and agriculture.*

Hundreds of thousands of generations passed in the history of mankind during the Ice Age.

However, we can hardly doubt today that man (probably, not the genus Homo) existed already much earlier—at latest, at the end of the Pliocene, a few million years aro. The Piltdown Man in Southern England at the end of the Pliocene, morphologically different from contemporary man, already possessed

*The time of the maximum of the last glaciation is determined today to be 18–20 thousand years ago by the method of carbon dating. It did not reach Moscow, but only the Valdai Hills; the ice cover thawed about 10–12 thousand years ago in the outskirts of Leningrad. [—*Ed.*]

stone implements, and, obviously, unpreserved implements out of wood, and, possibly, bone. His brain apparatus was as developed as in contemporary man.* The Sinanthropus of Northern China, living, apparently, at the beginning of the Post-Pliocene in an area where the glacier, apparently, did not reach, controlled fire and possessed implements.†

It is possible that A. P. Pavlov was quite right when he supposed that the Ice Age, the first glaciation of the Northern Hemisphere, began at the end of the Pliocene, and at that time a new organism, possessing an exceptional central nervous system, which led, in the end, to the development of cognition, and is now being manifested in the transition of the *biosphere into the noosphere,* emerged in the conditions approaching the severe ones of glaciation.

Apparently, all morphologically different types of man, the different genera and species were already communicating with each other, were distinct from the general mass of living matter from the beginning, possessed creative work of a drastically different character than that of surrounding life, and could interbreed with each other. *The unity of mankind was developing tempestuously* in this way. Apparently, Osborn[6] was right that man on the border between the Pliocene and the Post-Pliocene, still lacking permanent settlements, possessed great mobility, traveled from place to place, was recognizing and manifesting his strong distinctness—strove toward independence from his surroundings [environment].

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*The skull from the Piltdown cave, constructed from fragmentary remains in 1912 by Charles Dawson, was fabricated either by him, or by other irresponsible anthropologists. It is a skull of an entirely contemporary person with jaws of a hominid ape. (Francis Clark Howell. *Early Man.* LIFE Nature Library. Time Life, 1965. URL: http://www.amazon.com/EARLY-MAN-Life-Nature-Library/dp/B000I1PZB0 (visited on 07/08/2013)) [—*Ed.*]

†Sinanthropus lived 350–400 thousand years ago, i. e. in the middle of the Pleistocene, somewhat later than V. I. Vernadsky thought. However, his supposition that the genus Homo existed already "a few million years ago", turned out to be correct. The famous excavations of Dr. L. Leakey in the Olduvai Gorge on the border of Kenya and Tanzania, widely covered in scientific and popular science journals, showed that primitive man in Eastern Africa, classified as the peculiar species of Homo habilis (handyman), undoubtedly lived 1,800–1,900 thousand years ago. The later discoveries of R. Leakey on the eastern shore of Lake Rudolph led to the wide-spread oppinion that man lived already 3 million years ago in Eastern Africa, although that number is not credible, since the fragmentary remains of the skull were found in scree, and it is not known what layer they originate from. The contemporary species Homo sapiens (wise man) emerged 40–45 thousand years ago not in Africa, but in the fairly northern latitudes of Europe and Asia, probably not without the influence of, and adaptation to the extreme conditionns of the Ice Age. (See Ирина Константиновна Иванова. *Геологический возраст ископаемого человека.* Russian. Наука, 1965. URL: http://books.google.com/books/about/%D0%93%D0%B5%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D1%87%D0%B5%D1%81%D0%BA%D0%B8%D0%B9_%D0%B2%D0%BE%D0%B7%D1%80%D0%B0%D1%81.html?id=MOzISAAACAAJ (visited on 07/08/2013); also in German: Irina Konstaninowna Ivanova. *Das geologische Alter des fossilen Menschen.* German. Stuttgart, 1972. ISBN: 9783170790292.) [—*Ed.*]

[6]Henry Fairfield Osborn. *The age of mammals in Europe, Asia and North America.* New York, 1910. URL: http://archive.org/details/ageofmammalsineu00osbo (visited on 07/08/2013)

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§34. Science, therefore, is by no means a logical construct, a truth-seeking apparatus. Scientific truth can never be known by logic, but rather only by living. *Action* is a characteristic of scientific thought. Scientific thought—scientific work—scientific knowledge occurs in the thick of life, from which it is inseparable, and by its very existence gives rise to its own active manifestations, which themselves are not only means of disseminating scientific knowledge, but also create the countless forms of its detection, give rise to countless major and minor sources of the growth of scientific knowledge.

The human individual, even in the time of our state of organization of science, is, thus, far from always the creator of scientific ideas and scientific knowledge; the research scientist, living a life of purely scientific work, of large or small extent, is *one* of the creators of scientific knowledge. Individual people, connected to scientifically important, but often foreign to science, considerations, revealing scientific facts and scientific generalizations, sometimes fundamental and decisive, hypotheses and theories widely used in science, come forward accidentally, i. e. by the means of everyday life, out of the thick of life along with the scientist.

Such scientific work and scientific searches, proceeding from actions outside the scientific, consciously organized work of mankind, is the active-scientific manifestation of the living of the human cognitive environment at a given time, a manifestation of life's scientific environment. The part of the scientific structure of the new scientific thought, introduced in science in this way, is by its mass, and by its importance for the outcome of history comparable, it seems to me, to what is introduced into science by the scientists consciously working on it, to what is revealed by the consciously organized scientific work. Without the simultaneous existence of scientific organization and a scientific environment, this ubiquitous form of mankind's scientific work, tempestuously unconscious, disappears and is forgotten to a large extent, as this occurred in the regions of Mediterranean civilization over the course of long centuries in the Christianized Roman Empire, in Persian, Arabic, Berber, Germanic, Slavic, and Celtic societies of Western Europe, in connection with the national breakdown of the government formations existing in them during the 4^{th}–12^{th} c. AD, and, often, later. Science loses its achievements in the course of time, and tempestuously comes back to them.

The history of science, and the history of mankind, reveals such events at every step. The flourishing of Hellenic science left aside, and did not make use of, used late (after millennia) such achievements of everyday Chaldean science, as, for example, Babylonian algebra.

§35. This means—the introduction of scientific discoveries, foreign to *the scientific searches of the individual personality*, to which life gives rise everywhere, and their incorporation into the organized manifestation of the scientific work of scientists, the scientific apparatus of a given time,—however, is not the only means by which the living environment impacts science.

This, in and of itself collective, [and,] from a scientific point of view, unconscious work,[7] *in the course of historical time* and through the changes occurring in this way, creates the new and important, which can be registered and can become the result of scientific achievements of primary importance, as, for example, were the circumnavigation of the Earth, the discovery of America, the fall of the Persian Kingdom (destroyed by Alexander the Great), as well as the Chinese kingdoms and Central Asian cultural centers, the defeat of Genghis Khan, the victory of the Christian church and religion, the emergence of Mohammedanism and its religious-political identification, as well as other major and minor events of political life.

No less, but, often, rather more powerful have been those changes, which have occurred in economic life,

[7] Uncoscious in the sense that the scientific result, or phenomenon of life, which creates the scientifically important or necessary fact (or generalization), did not have *that goal* at its creation or manifestation.

in agriculture, or in individual manifestations of success in everyday life, like, for example, the introduction of the camel (dromedary) in the desert and semidesert areas of Northern Africa,[8] and the discovery of printing in the Rhenish countries in Europe.[9]

Along with these tempestuous phenomena, whose consequences for scientific thought were not considered at their creation by mankind, to an equal, and sometimes, perhaps, greater degree, scientific thought itself—the scientific discoveries of individual thinkers and scientists, which change mankind's world-view, like Copernicus, Newton, Linnaeus, Darwin, Pasteur, P. Curie—is acting in the biosphere. In some cases this was done consciously, in others—unexpectedly for the scientist oneself, as occurred before our eyes with A. Becquerel [1852–1908], discovering radioactivity in 1896,[10] or with H. Ørsted [1777–1851], detecting electromagnetism,[11] or with L. Galvani [1737–1798], discovering the galvanic current.[12]

Maxwell, Lavoisier, Ampere, Faraday, Darwin, Dokuchaev, Mendeleev and many others encompassed great scientific revelations, worked creatively to bring them into being in full consciousness of their fundamental significance for life, but unexpected for their contemporaries.[13]

Their thought—consciously for them—influenced the thick of life; here the applied creations arising in this way, in a new form, unexpectedly and unsurmisedly for their contemporaries, often after the deaths of their creators, were reflected anew in scientific work, overturned mankind's everyday life, [and] created new, unexpected sources of scientific knowledge.

Along with them, in the same way, through the thick of life, through the environment, inventors, among them, often, people with little scientific literacy—from all social classes and circles, often people having no connection with or interest in the search for scientific truth,—are creating a new, analogous cycle of scientific problems.[14]

§36. From everything said so far we can see that *it is possible to make* conclusions of great scientific significance, namely:

1. The course of scientific work is that force by which man changes the biosphere in which he lives.
2. This manifestation of the biosphere's changing is an inevitable, concomitant phenomenon to the growth of scientific thought.
3. This change of the biosphere occurs independently of human will, tempestuously, as a naturally-occurring phenomenon.
4. And since the environment of life is an organized envelope of the planet—the biosphere,—the introduction, in the course of its geologically long

[8] Charles André Julien. *Histoire de l'Afrique du Nord: Tunisie, Algérie, Maroc*. French. Bibliothèque Historique. Paris: Payot, 1931. URL: http://books.google.com/books?id=MQohAAAAMAAJ (visited on 02/22/2013), p. 178. See Stéphane Gsell. "La Tripolitaine et le Sahara au IIIe siècle de notre ère". In: *Memoires de l'Académie des Inscriptions* 43 (1926);[I] Emile-Félix Gautier. *L'islamisation de l'Afrique du Nord. Les siècles obscurs du Maghreb*. French. Bibliothèque historique. Paris: Payot, 1927. URL: http://books.google.com/books?id=FVgbAAAAIAAJ (visited on 02/22/2013), p. 181 for the significance of this phenomenon.

[9] We must never forget that the printing press was discovered in Korea a few centuries before Coster and Gutenberg, and was widely used in the Chinese kingdom. There, however, the factor which gave it a living power did not exist: active scientific work was lacking in Korea and China at the time.

[10] Becquerel himself thought that he took up Uranium only because it was studied by his father and grandfather (§55).

[11] Ørsted discovered electromagnetism in 1820. (Hans Christian Oersted and A. Larson. *The Discovery of Electromagnetism Made in the Year 1820*. Copenhagen: H. H. Thieles bogtrykkeri, 1920. URL: http://books.google.com/books?id=1A82AQAAMAAJ (visited on 03/01/2013).)

[12] The phenomenon discovered by Galvani was correctly explained by Volta. Galvani's explanation was incorrect, but "galvanism," with incalculable consequences before the study of electricity, was discovered by him. (See Jean-Louis Alibert. *Eloge historique de Louis Galvani*. Ed. by Louis Ravier, Charles-François Caille, and Richard. Paris, 1801. URL: http://www.sudoc.fr/055375979 (visited on 03/01/2013) about him.)

[13] It is interesting that the significance of these discoveries in their application to life was admitted decades after the deaths of Maxwell, Lavoisier, Faraday, Mendeleev, [and] Ampere.

[14] R. Arkwright... [Arkwright, Richard (1732–1792)—English mechanic, inventor of the spinning frame. —*Ed.*];

[I] According to Wikipedia[!] the Académie des Inscriptions et Belles-Lettres was founded by Jean-Baptiste Colbert, and Jean Sylvain Bailly was its member.

existence, of a new factor of change—the scientific work of mankind—in it is the natural process of the transition of the biosphere into a new phase, into a new state—into the noosphere.

5. We can see this more clearly in the historical moment we are living through than could be seen earlier. "Nature's law" is being revealed before us now. New sciences—geochemistry and biogeochemistry—are making the expression of a few important characteristics of the process mathematically possible.

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Zénobe Théophile Gramme. . . [Gramme (1826–1901)—Belgian electrical engineer, one of the inventors of the dynamo. —*Ed.*]

Chapter 3

The movement of scientific thought in the 20th century, and its significance in the geological history of the biosphere. Its main characteristics: explosion of scientific work, change in the understanding of the fundamentals of reality, ecumenicism, and efficient, social manifestation of science.

§47. What is presently occurring in the scientific movement can only be compared with that scientific movement from the past of science, which was connected with the birth of Greek philosophy and science in the 6th–7th c. BC.

Unfortunately, so far we cannot clearly imagine that accumulation of scientific knowledge which the ancient Greeks had amassed at the time when scientific thought manifested itself in their environment, and when it, for the first time, acquired a scientific-philosophical structure, outside of religious, cosmogonic and poetical constructs—when the scientific method was created for the first time in the Hellenic city civilization of the polis—logic and theoretical mathematics applied to life, when the search for scientific truth became a reality, as a goal for itself in the life of the individual in a social environment.

The circumstances of this, as history has shown, momentous event in mankind's life, and in the evolution of the biosphere are, to a large extent, mysterious and the history of scientific knowledge is being clarified slowly, but nevertheless ever deeper. Clear is only a general sketch of the accumulation of scientific knowledge of the Hellenic environment at that time, the achievements of the thinkers of Hellenic science, who lived at the time, and what they received from the previous generations of Hellenic civilization. We are slowly beginning to understand this. This is on the one hand.

And on the other hand, the conceptions about what the Greeks received from great civilizations preceding them—Asia Minor, Cretan, Chaldean (Mesopotamian), Ancient Egypt, India—are now starting to drastically change.

Unfortunately, only a *miniscule part* of Hellenic scientific literature has reached us. The major researchers have left no trace in the literature accessible to us, or only fragmentary indications of their scientific work has reached us.

True, a large part of the complete works of Plato has reached us, as well as a significant part of Aristotle's scientific works, however, many of the latter's works, fundamental from the standpoint of the scientific search, have been lost. Especially unfortunate, from this standpoint, is the loss of the works of major scientists, in whose output scientific thought and the scientific method entered the age of flourishing and synthesis of Hellenic science—Alcmaeon (500 BC), Leucippus (430 BC), Democritus (420–370 BC), Hippocrates of Chios (450–430 BC), Philolaus (5th century BC) and many others, from whom only miniscule fragments, or nothing but names have remained.

The loss of the first attempts at histories of scientific work and thought, which were written closest to

the centuries of its manifestation, may be even more unfortunate. Partly distorted, and in an incomplete form, this work has reached us in the form of nameless essentials, sometimes adapted and skewed in the course of the many centuries after their publication. But the originals of Xenocrates' (397–314) history of Geometry, Eudemus of Rhodes' (circa 320) history of science, Theophrastus' (372–288) historical books, and others have been lost in the historical course of Greko-Roman civilization by the time of our age—during the centuries closest to it, almost a thousand years ago.

In essence, the basic fund of Helenic science—what I call a *scientific apparatus*[1]—has reached us in miniscule fragments, passing, on top of it, through many centuries, in the remains of Aristotle's and Theophrastus's works on the history of natural sciences, as well as in the works of Greek mathematicians. Nevertheless, it exerted tremendous influence on the Renaissance and on the creation of Western European science in the 15th–17th centuries. Our modern science has been created, to a significant extent, relying on and starting from this fund's achievements, developing the ideas and knowledge laid out in it. Broken for centuries, that already during the time of the Roman Empire, the threads were restored in the 17th century.

§48. The recent course of the history of science requires us to change our conceptions of that pre-Hellenic heritage, from which Hellenic science sprouted, as I already indicated (§42).

The Greeks have everywhere pointed to the great knowledge, which they had received from Egypt, Chaldea, the East. We must now admit that they were correct. Science had already existed before them—the science of the "Chaldeans", reaching back beyond millenia BC, is only now being uncovered before us—in fragments, proving beyond any doubt its long unsuspected, until our time, force (§42).

It is now becoming clear that we must attribute a much more real significance, than has been recently done, to the numerous indications by ancient scientists and writers of the fact that the creators of Hellenic science and philosophy took into consideration, proceeded in their creative work from the achievements of scientists and thinkers from Egypt, Chaldea, Arian and non-Arian civilizations of the East.

Babylonian scientists worked together with Greek ones in the course of several centuries. At the same time, the new flourishing of Babylonian astronomy occurred in the centuries closest to our age. Gradually, in the course of several generations, they merged into the Hellenic cultural environment and equally suffered the unfavorable for science circumstances of that time (§40). Undoubtedly, the knowledge received from the scientists of that time was used by the Greeks during the period of this dialogue.

Undoubtedly, what was harnessed and used by them was very significant by that time—especially if we consider the multimillenial experience and the multimillenial tradition of seafaring, engineering, agriculture, irrigation works, military art, government organization and everyday life.

For centuries Greek science worked in direct contact with Chaldean and Egyptian science, was merging with them. Though it is possible that creative thought in Egyptian science died out during that time—this didn't happen with Chaldean science (§42).

Hellenic science, in the age of its birth, is a direct continuation of the intense creative thought of pre-Hellenic science. This fact is acknowledged, but still not assimilated, in the history of science.

The "miracle" of Hellenic civilization—a historical process, whose results are clear, but whose course cannot be precisely traced—was a historical process like others. It had a solid basis in the past. Only its result in its achievement—the rate at which it was achieved—turned out to be singular in time, and exceptional in its consequences in the noosphere.

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[1] Владимир Иванович Вернадский. *О коренном материально-энергетическом отличии живых и косных естественных тел биосферы*. Russian. .Вып. 2. Проблемы биогеохимии. Академии наук СССР, 1939. URL: http://goraknig.org/estestvennye_nauki/?kniga=MTQ2MTQxMw__pp. 9–10 (Problems of Biogeochemistry II)

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Part II

On Scientific Truths

Part III

New Scientific Knowledge and the Transition of the Biosphere into the Noosphere

Chapter 7

The structure of scientific knowledge as a manifestation of the noosphere, the geologically new state of the biosphere resulting from this knowledge. The historical course of the planetary manifestation of Homo sapiens by means of its creation of a new form of cultural biogeochemical energy, and the noosphere associated with it.

100. The sciences of the biosphere and its objects, i.e. all humanities without exception, natural sciences, in the term's own meaning, (botany, zoology, geology, mineralogy, etc.), all engineering sciences—applied sciences in the general meaning of the term—are areas of knowledge, which are maximally accessible to mankind's scientific thought. Here millions of millions of incessantly scientifically established and systematized facts, which are the results of organized scientific work, are concentrated, and are unstoppably increasing, quickly and consciously, with every generation, beginning with the 15th–17th centuries.

In particular, the scientific disciplines of the constitution of means of scientific knowledge, inseparable from the biosphere, can be viewed scientifically as a geological factor, as a manifestation of the biosphere's organization. These are sciences "of the spiritual" work of the human individual in one's social environment, sciences of the brain and organs of sense, the problems of psychology and logic. They give rise to the search for the fundamental laws of human scientific knowledge, that power which has, in our geological age, transformed the biosphere encompassed by mankind into a natural body, new in its geological and biological processes—into a new state, into the noosphere,[1] to whose consideration I shall return below.[2]

Its emergence in the history of the planet, beginning intensively (on the scale of historical time) a few tens of thousands of years ago, is an event of great importance in the history of our planet, connected, in the first place, with the growth of sciences about the biosphere, and is, obviously, not accidental.[3]

We can say that, in this manner, the biosphere is the main area of scientific knowledge, even if we are only now beginning to differentiate it scientifically from our surrounding reality.

101. It is clear from what has been said, that the biosphere corresponds to that, which in the thought

[1] Edouard Le Roy. "Les origines humaines et l'evolution de l'intelligence". French. In: *La noosphere et l'hominisation*. Paris, 1928, pp. 37–57

[2] See Владимир Иванович Вернадский and А.А. Ярошевский. "Химическое строение биосферы Земли и ее окружения". Russian. In: Наука, 1987. URL: http://books.google.com/books?id=0rVeAAAAIAAJ, Гл. 21

[3] I will return to this process later. Here I only note Le Roy's thought (1928): "Deux grands faits, devant l'esquels tous les autres samblent presque svanouir, dominent dans l'histoire passe de la Terre : la vitalisation de la matire, puis l'hominisation de la vie."—Op. cit., p.47. "Two major facts, in comparison to which all others seem almost unnoticeable, predominate in the history of the Earth: the vitalization of matter, and the humanization of life. The first one is hypothetical, but the beginning of the second is clearly visible."

of naturalists and in most of philosophical thought, in the cases where they were not concerned with the Cosmos as a whole but remained within the limits of the Earth, corresponds to Nature as usually understood, the Nature of the naturalist in particular.

However, this nature is not amorphous and shapeless, as it has been considered for centuries, but has definite, very precisely delineated structure,[4] which must, as such, be reflected, and considered in all conclusions and results concerning Nature.

It is especially important in scientific research that this is not forgotten and that it is taken into account, since unconsciously, opposing the human individual to Nature, the scientist and thinker gives in to the greatness of Nature above the human individual.

But life in all of its manifestations, the manifestation of the human individual included, radically changes the biosphere in such a degree that not only the agglomeration of indivisible units of life, but, in a few problems, also the single human individual in the noosphere could not be left without attention in the biosphere.

102. Living nature[I] is a main characteristic of the manifestation of the biosphere, it is the very distinction of the biosphere from the other earth envelopes. The structure of the biosphere is characterized, first of all, and most of all, by life.

We shall see further on (§135) that between the physical-geometrical properties of living organisms—they are manifested in the form of their agglomerations in the biosphere—living matter, and those properties of inert matter, which constitutes the dominant part of the biosphere by weight and by number of atoms, there is in several respects an impassible gulf. Living matter is a carrier and creator of free energy absent from any other earth envelope on such a scale. This free energy—biogeochemical

[4] This "structure" is very peculiar. It is not a mechanism or anything motionless. It is dynamic, always variable, moving, changing at every moment, and never returning to a previous type of equilibrium. It is closest to a living organism, differing, however, from it in the physical-geometrical state of its space. The space of the biosphere is physically-geometrically inhomogeneous. I think that it is convenient to define this structure by means of a special concept of organization. See Владимир Иванович Вернадский. *Значение биогеохимии для изучения биосферы*. Russian. .В. 1. Проблемы биогеохимии. Академии наук СССР, 1934, pp. 9–10. URL: http : / / goraknig . org / estestvennye _ nauki / ?kniga = MTQ2MTQxNA _ _; Владимир Иванович Вернадский. "Проблемы биогеохимии". In: vol. 16. Труды Биогеохимической лаборатории. Изд-во Академии наук СССР, 1980, pp. 10–54.

[I] A literal translation of the Russian expression for the living part of nature.

energy[5]—encompasses the whole biosphere and generally determines all of its history. It gives rise to and sharply changes the intensity of the migration of chemical elements constituting the biosphere, and determines their geological significance.

A new form of this energy, even greater in its intensity and complexity, has been created and has been quickly increasing in its significance in the domain of living matter during the last ten thousand years. This new form of energy, connected with the activity of human societies, of the genus Homo and others (Hominidae) close to it, preserves the manifestation of the usual biogeochemical energy, but at the same time gives rise to a new kind of migration of chemical elements, leaving, in its variety and power, the usual biogeochemical energy of living matter on the planet far behind.

This new form of biogeochemical energy, which can be called energy of human culture, or cultural biogeochemical energy, is the form of biogeochemical energy, which is presently creating the noosphere. Later on I shall return to a more detailed presentation of our knowledge of the noosphere and its analysis. But it is now necessary to sketch its manifestation on the planet.

This form of biogeochemical energy is characteristic not only of Homo sapiens, but also of all other living organisms.[6] It is, however, negligible in them in comparison to the usual biogeochemical energy, and has a hardly noticeable effect on the balance of nature, and that only in geological time. It is connected to the psychological activity of organisms, to the development of the brain in the highly developed manifestations of life, and is expressed in a form resulting in the transformation of the biosphere into a noosphere only with the emergence of the human mind.

Its manifestation in mankind's predecessors has been produced, apparently, over hundreds of millions of years, but it could be expressed in the form of a geological force only in our time, when Homo sapiens

[5] The concept of biogeochemical energy was introduced by me in 1925 in a still-unpublished report to the R. Rosenthal fund in Paris. (The fund does not exist any more.) This fund gave me the ability to work without interruption for two years. The concept has been presented by me in print in numerous articles and books:

- Владимир Иванович Вернадский. *Биосфера*. Russian. Научн. Химико-Техн. Издат., отдел В.С.Н.Х., 1926. URL: http://books.google.com/books?id=jvE_SwAACAAJ, pp. 30–48;
- Владимир Иванович Вернадский. "Études biogéochimiques. 1. Sur la vitesse de la transmission de la vie dans la biosphère". French. In: *Известия Российской академии наук*. 6th ser. 20.9 (1926), pp. 727–744. URL: http://mi.mathnet.ru/izv5583 (visited on 07/17/2012); Владимир Иванович Вернадский. "Études biogéochimiques. 2. La vitesse maximum de la transmission de la vie dans la biosphère". French. In: *Известия Российской академии наук*. 6th ser. 21.2 (1927), pp. 241–254. URL: http://mi.mathnet.ru/izv5457 (visited on 07/17/2012);
- Владимир Иванович Вернадский. "О размножении организмов и его значении в механизме биосферы. Статья первая". Russian. In: *Известия Российской академии наук*. 6th ser. 20.9 (1926), pp. 697–726. URL: http://mi.mathnet.ru/izv5582 (visited on 07/17/2012), Владимир Иванович Вернадский. "О размножении организмов и его значении в механизме биосферы. Статья вторая". Russian. In: *Известия Российской академии наук*. 6th ser. 20.12 (1926), pp. 1053–1060. URL: http://mi.mathnet.ru/izv5605 (visited on 07/17/2012);
- Владимир Иванович Вернадский. "Sur la multiplication des organismes et son role dans le mecanisme de la biosphere, Premiere partie". French. In: *Revue générale des sciences pures et appliquées* 37.23 (), pp. 661–698. ISSN: 03705196. URL: http://gallica.bnf.fr/ark:/12148/bpt6k17101g/f665.tableDesMatieres (visited on 07/17/2012); Владимир Иванович Вернадский. "Sur la multiplication des organismes et son role dans le mecanisme de la biosphere, Deuxième partie". French. In: *Revue générale des sciences pures et appliquées* 37.23 (), pp. 700–708. ISSN: 03705196. URL: http://gallica.bnf.fr/ark:/12148/bpt6k17101g/f704.tableDesMatieres (visited on 07/17/2012);
- Владимир Иванович Вернадский. "Бактериофаг и скорость передачи жизни в биосфере". Russian. In: *Природа* 6 (1927), pp. 433–446. ISSN: 0032-874X. URL: http://www.ras.ru/publishing/nature.aspx (visited on 07/17/2012).

[*Ed.*:] For the R. Rosethal fund's report *Живое вещество в биосфере* see: Владимир Иванович Вернадский. *Живое вещество и биосфера*. Наука, 1994. ISBN: 5-02-005754-1, pp. 555–602

[6] Вернадский, *Биосфера*, pp. 30–48. See Вернадский, *Живое вещество и биосфера*, pp. 330–341; Вернадский, "О размножении организмов и его значении в механизме биосферы. Статья первая"; Вернадский, "О размножении организмов и его значении в механизме биосферы. Статья вторая". Published under the title *О размножении организмов и его значении в строении биосферы* in the book Вернадский and Добровольский, "Труды по биогеохимии и геохимии почв", pp. 75–101.

has encompassed with our life and cultural work the whole biosphere.

103. The biogeochemical energy of living matter is determined, above all, by the reproduction of organisms, and by their inevitable tendency, determined by the energetics of the planet, toward a minimum of free energy—it is determined by the fundamental laws of thermodynamics, corresponding to the existence and stability of the planet.

It is expressed in the respiration and feeding of organisms—"laws of nature", which have not been discovered in their mathematical expression to this day, but the task of searching for whose expression was clearly laid out already in 1782 by C. Wolf at the St. Petersburg Academy of Sciences[i] at the time.[7]

Obviously, this biogeochemical energy, in this form, is characteristic of Homo sapiens, as well. It is, as with all other living organisms, a species characteristic,[8] and seems unchangeable to us in the course of historical time. The other form, of "cultural", biogeochemical energy is also unchanging, or hardly changing for other organisms. This other form is expressed in the everyday and in the technical conditions of organisms' life—in their movement, in their daily activity and construction of dwellings, in the transportation of their surrounding matter, etc. It, as I have already indicated, comprises a negligible fraction of their biogeochemical energy.

With mankind, this form of biogeochemical energy, associated with the human mind, grows and increases in the course of time, quickly taking first place. This growth is possibly related to the growth of the mind itself—apparently, a very slow process (if it, in fact, occurs at all)—but mainly—with the increase of the precision and depth of its use, associated with the conscious change of the social setting, and, particularly, with the growth of scientific knowledge.

I shall proceed from the fact that the skeletons of Homo sapiens, including the skull, over a hundred millenia gives us no basis for viewing them as belonging to another species of man. This is admissible only under the condition that the brain of Paleolithic man does not differ in any significant degree in its structure from the brain of contemporary man. At the same time, there is no doubt that the mind of that man from the Paleolithic for this species of Homo cannot bear comparison to the mind of contemporary man. Thence it follows that the mind is a complex social structure, built, for the man of our times, just as for the Paleolithic man, upon the same nervous substrate, but in a different social setting, which is being composed through time (space-time, in essence).

Its change is the basic element, leading, in the end, to the transformation of the biosphere into a noosphere in the obvious manner, above all—through the creation and growth of the scientific understanding of our surroundings.

104. The emergence of cultural biogeochemical energy on our planet is a major factor in its geological history. This had been prepared for through all geological time. The main, decisive process here is the maximum manifestation of the human mind. But this is, in essence, inseparable from all biogeochemical energy of living matter.

The life of the migration of atoms in the living process connects in a unified whole all migrations of atoms of the biosphere's inert matter.

Organisms are alive only while the material and energetic exchange between them and their surrounding biosphere is uninterrupted.[9] Colossal definite chemical cyclical processes of atomic migration, in which living organisms enter as a lawful, inseparable, often main part of the process, are being clarified in the biosphere. These processes are constant in geological time and, for example, the migration of magnesium atoms incorporated in chlorophyll stretches uninterruptedly for at least two billion years through

[7] Владимир Иванович Вернадский. "Химические элементы, их класификация". In: *Избранные сочинения*. Vol. 1: *Очерки геохимии и статьи по геохимии и радиологии*. Москва: Изд-во АН СССР, 1954, p. 50.

[8] On the species charactestic see Владимир Иванович Вернадский. *Considerations generales sur l'etude de la composition chimique de la matiere vivante*. French. Vol. 1. Труды Биогеохимической лаборатории. Изд-во Академии наук СССР, 1930, pp. 5–32.

[9] The complete absence of exchange for the latent forms of life cannot be considered proven, yet. It is extremely slow—and, possibly, in a few cases there is no migration of atoms indeed—it could become noticeable only in geological time.

[i] Петербургской Академии наук

innumerable, genetically related generations of green organisms. Living organisms, uninterruptedly and inseparably connected to the biosphere by such atomic migrations, comprise a lawful part of its structure.

This must never be forgotten in the scientific study of life and in scientific statements about any of its manifestations in Nature. We cannot overlook the fact that an uninterrupted connection—material and energetic of the living organism with the biosphere, a completely definite connection, "geologically eternal", which can be scientifically expressed precisely—is always present in our every scientific approach to life and must be reflected in all of our logical conclusions and results about it.

In moving to the study of the geochemistry of the biosphere we must, first of all, precisely estimate the logical significance of this connection, unavoidably entering all of our constructs related to life. It does not depend on our will, and cannot be excluded from our experiments and observations, but must always be taken into account as something fundamental, inherent in life.

The biosphere must, in this manner, be reflected in all of our scientific statements without exception. It must be manifest in every scientific experiment and scientific observation—and in every thought of the human individual, in every speculation, from which the human individual—even thought—cannot escape.

Therefore, the human mind can be maximally expressed only with the maximum development of the basic form of the biogeochemical energy of mankind, i.e. with its maximum reproduction.

105. The potential for covering the surface of the whole planet by means of reproduction of an organism of a single species is characteristic of all organisms, since the law for reproduction is expressed in the same form for all of them, in the form of a geometrical progression. I have already indicated the major significance of this phenomenon long ago,[10] and I will return to it at the appropriate place in this book.

The phenomenon of covering the whole surface of the planet by a given single species can be seen widely developed for aquatic life in the microscopic plankton of lakes and rivers, and for a few forms of—essentially also aquatic—microbes, from the surface layers of the planet, propagating through the troposphere. Among larger organisms we observe this in almost full measure in a few plants.

This has begun to be manifest for mankind in our times. The whole globe and all the seas have been encompassed by him in the 20th century. Thanks to the success of communications, man can be in constant communication with the whole world, cannot be solitary and get himself lost in the grandiosity of the earth's nature anywhere.

Presently, the number of the human population on Earth has reached unprecedented height, nearing two billion people, despite the fact that murder in the form of war, hunger, malnourishment, constantly affecting hundreds of millions of people, extremely diminishes the course of the process. Negligible time from the geological point of view would be necessary, hardly more than a few hundred years, to end these relics of barbarism. This could be freely done even now; the ability to end this condition is presently in the hands of mankind, and the reasonable will will inevitably go down that path, because it corresponds to the natural tendency of the geological process. It should be so all the more, since the means to do it are increasing rapidly and almost tempestuously. The real significance of population masses, suffering the most from this, is irrepressibly increasing.

The number of people inhabiting the planet began increasing, say, about 15–20 thousand years ago when mankind became less influenced by food shortage in relation to the discovery of agriculture. Apparently it was then, say, about 10–8 thousand years ago that the first population explosion occurred.[11] G. F. Nikolai (in 1918–1919)[12] attempted to esti-

[10] See Вернадский, *Биосфера*, pp. 37–38; Вернадский, *Живое вещество и биосфера*, pp. 335, 413–424; Вернадский, "Études biogéochimiques. 1. Sur la vitesse de la transmission de la vie dans la biosphère"; Вернадский, *Биогеохимические очерки (1922–1932)*, pp. 59–83; Вернадский and Добровольский, "Труды по биогеохимии и геохимии почв", pp. 75–101.

[11] Vere Gordon Childe. In: *Man makes himself*. The Library of Science and Culture. London: Watts & co., 1937, pp. 78–79. URL: http://books.google.com/books?id=vPgYAAAAYAAJ

[12] Georg Friedrich Nikolai. German. In: *Die Biologie des Krieges. 1. Betrachtung eines Naturforschers den Deutschen zur Besinnung*. Vol. 1. Zürich, 1919, p. 54.

mate the actual population increase of mankind and the development of agriculture numerically, the actual population of the planet by mankind. According to his calculations, taking the total territory of the Earth, there are 11.4 people per square kilometer, which constitutes $2.10^{-4}\%$ of the possible population. Considering the amount of energy received from the Sun, agriculture allows 150 people to be sustained per $1\,km^2$, i.e. for the whole Earth (land area) it must be $22.5 \cdot 10^9$ units, i.e. 22–24 times more than live presently.[13] But mankind acquires energy for sustenance and for living not only through agricultural labor. Considering this possibility, Nikolai, for example, estimated that the Earth in the historical age started in our time, using new energy sources, could be populated by three hexillion people ($3 \cdot 10^{16}$), i.e. more than tens of millions of times more than the present number of mankind. These numbers must be highly increased at the present moment, when more than 20 years have passed since Nikolai's calculations, since mankind can, in practice, presently use sources of energy, which Nikolai could not imagine in 1917–1919—energy, connected to the atomic nucleus. Must now say, more simply, that the source of energy, which is encompassed by the human mind in the energetic age of mankind, which we are entering—is practically unlimited. Hence, it is clear that the cultural biogeochemical energy (§17) shares the same characteristic. According to Nikolai's calculations, machines increased mankind's energy more than ten times in his time. We cannot presently give a more precise calculation; however, recent accounts of the American Geological Committee[i] indicate that water power, presently in use all around the world, reached 60 million horsepowers at the end of 1936: it increased by 160 per cent in 16 years, mainly in North America.[14] Thanks to that, we must already increase Nikolai's calculations more than one and a half times.

In essence, all of these calculations about the future, expressed in a numerical form, have no significance, since our knowledge of the energy accessible to mankind is, we can say, rudimentary. Of course, the energy accessible to mankind is not an infinite amount, since it is determined by the size of the biosphere. The limit to the cultural biogeochemical energy is also determined by this.

We shall see (§138) that there is also a limit to the basic biogeochemical energy of mankind—the speed of expansion of life, the limit of mankind's reproduction.

The speed of reproduction[15]—the magnitude V considered, in essence, by Nikolai, is based on the actually observed population of the planet by mankind in unfavorable for his life conditions. We shall also see, further on, that there are still unknown to us phenomena in the biosphere, which lead to a stationary maximum quantity of living units per hectare which can exist in a given geological age in a given condition of the biocenosis.

106. We can record the human population on the planet with any precision only since the beginning of the 19th century. It is still calculated with a high percentage of possible error. Our knowledge has considerably increased during the last 137 years, but can still not be considered having reached the precision which contemporary science may require. For earlier times the numbers are only provisional. Still, they are helping us in the understanding of the occurring process.

The following data may have significance for us in that aspect.

The number of people in the Paleolithic likely reached a few million. It is possible that it began

[13] Georg Friedrich Nikolai. German. In: *Die Biologie des Krieges. 1. Betrachtung eines Naturforschers den Deutschen zur Besinnung*. Vol. 1. Zürich, 1919, p. 60.

[14] "Water—Power of the World". In: *Nature* 141.3557 (1938), p. 31. DOI: 10.1038/141031a0. URL: http://www.nature.com/nature/journal/v141/n3557/abs/141031a0.html (visited on 07/17/2012).

[i] американского Геологического комитета

[15] On the speed of expansion of life see below. See Вернадский, "Études biogéochimiques. 1. Sur la vitesse de la transmission de la vie dans la biosphère"; Вернадский, *Живое вещество и биосфера*, pp. 413–424, 437–444; Вернадский, *Биогеохимические очерки (1922–1932)*, pp. 118–125; Вернадский, *Химическое строение биосферы земли и ее окружения*, Гл. 20.

with one family. However, the opposite view is also possible.[16]

In the Neolithic we are likely dealing with tens of millions on the whole surface of the Earth. It is possible that even in historical time it did not reach a hundred million, or that it did not exceed that number by much.[17]

G. F. Nikolai supposed that the human population of the planet increases by 12 million people annually for 1919, i.e. increases by, say, 30 thousand a day. According to the critical report of the Kulischers (1932)[18] the world population was 850 million in 1800 (A. Fischer takes it to be 775 million). We can assume its number for the white race to be 30 million in 1000, 210 million in 1800, 645 million in 1915. For the whole population in 1900, according to the Kulischers—about 1,700 million, but according to A. Hettner (1929)[19]—1,564 million, and 1,856 million in 1925, according to the same.

That number has evidently reached about two billion, more or less, at present. The population of our country (about 160 million) comprises about 8% of the world population. The world population is rapidly increasing, and, evidently, the percentage of our population is increasing, since its growth is greater than the average population growth. In general, we should expect to significantly exceed 2 billion by the end of the century.

107. The reproduction of organisms, i.e. the manifestation of biogeochemical energy of the first type, without which there is no life, is inseparable from man. However, at his very differentiation from the mass of life on the planet, man had already mastered the use of tools, even if they were very primitive, which allowed him to increase his muscle power, and were the first manifestation of contemporary machines, which distinguished him from the other living organisms. The energy by which they were powered, however, was produced through the feeding and breathing of man's very organism. It has probably been hundreds of thousands of years already since man—genus Homo,—and his predecessors mastered the use of wooden, bone, and stone tools. The skill of making and using those tools was being developed slowly, in the course of many generations, skill—the mind in its first manifestation—was being perfected.

Such tools can be observed already in the most ancient Paleolithic, 250 thousand–500 thousand years ago.

A significant part of the biosphere was living through critical times during that period. Apparently, a radical change—in its water and heat regime—began already in the Pliocene, an ice age began and was developing throughout the whole period. We are, apparently, still living during the dying out of its last manifestation, whether temporary or permanent is still unknown. We can see strong oscillations in the climate during these half a million years; relatively warm periods—continuing for tens and hundreds of thousands of years—replaced in the northern and southern hemispheres periods, during which masses of ice which reached depth of up to a kilometer, for example, in the vicinity of Moscow, moved slowly—on the historical scale. They disappeared a thousand and seven[I] years ago in the Leningrad region, and are still occupying Greenland and Antarctica. Apparently, Homo sapiens, or his closest predecessors, formed not long before the onset of the ice age, or during one of its warm periods. Man survived the coldness during that time with hardship. That was possible thanks to a great discovery in the Paleolithic—the mastery of fire.

This discovery was made in one–two, possibly a few more, places and slowly spread among the population of the Earth. Apparently, we have a general process

[16] See E. Le Roy. [The author's note has not been found. —*Ed.*]

[17] Б. П. Вейнберг. "К двухдесятитысячелетию начала работ по уничтожению океанов. Очерк истории человечество от первобытного состояния до 2230 г." (Научная фантазия). In: Сибирская природа 2. Омск, 1922, p. 21 (assumes a population of 80 million at the beginning of our age).

[18] A. and E. Kulischer. "Kriegs- und Wanderzüge. Weltgeschichte als Völkerbewegung". In: Berlin-Leipzig, 1932, p. 135.

[19] Alfred Hettner. "Der gang der Kultur über die Erde". In: 2 umgearbeitete und erw. Aufl. Leipzig-Berlin: B.G. Teubner, 1929, p. 196. URL: http://books.google.com/books?id=-qkFAAAAMAAJ

[I] The other English translation has seven thousand here, and notes "Now we know that in the environs of Leningrad the ice has disappeared about 12 thousand years ago."

of great discoveries here, where not the mass activity of mankind, smoothing out and amending particularities, but rather the manifestation of the separate human individuality plays a role. We can trace that in the more recent time and in very many cases, as we shall see later (§134).

The discovery of fire is the first case of a living organism mastering and harnessing a force of nature.[20]

This discovery is the foundation, as we shall now see, of all the following increase of mankind, and of our present power.

This increase, however, took place extremely slowly, and it is hard for us to imagine the conditions, under which it could occur. Fire was already known to the ancestors of the genus, or to the predecessors of that species of Hominid, who is building the noosphere. The latest discovery in China reveals the cultural remains of Sinanthropus, which indicate his wide use of fire, apparently, long before the last glaciation of Europe, a hundred thousand years before our time. We presently have no data of any credibility about how that discovery was made by him. Sinanthropus already possessed a mind, had primitive tools, used speech, performed burial rites. This was already a human, but foreign to us in many morphological characteristics. Also, the possibility that he is one of the predecessors of the contemporary human population of China has not been eliminated.[21]

108. The discovery of fire is all the more remarkable because the manifestation of fire and light emission in the biosphere had been a relatively rare phenomenon before mankind, and had manifested mainly when taking up a large space, in the form of cold light, in such forms as airglow, aurora borealis, sheet lightning, stars and planets, noctilucent clouds. The Sun alone, the source of life, was simultaneously a bright manifestation of light and heat, was lighting and heating the planet.

Living organisms had developed a manifestation of cold light long ago. It appeared in such large-scale phenomena as marine bioluminescence, usually taking up hundreds of thousands of square kilometers, or the luminescence in marine depths, whose significance is just beginning to be clarified. Fire, accompanied by high temperature, was manifested in local phenomena, rarely taking up large spaces like volcanic eruptions.

But these colossal on the human scale phenomena, obviously, because of their destructive force, could in no way have aided the discovery of fire. Man had to look for it in closer to him, and less scary and dangerous manifestations of nature than volcanic eruptions, still exceeding mankind in their manifestation of power. We are only beginning to approach using them in practice, in conditions which were inaccessible and unthinkable to Paleolithic man.[22]

He had to look for phenomena giving heat and fire in his surrounding everyday phenomena of life; in his habitat—in the woods, steppes, among living nature, with which he was in close (long forgotten by us) connection. Here he could encounter fire and heat in a safe form in numerous everyday phenomena. These were, on the one hand, fires, the burning of living and dead matter. They were the very sources of fire used by Paleolithic man.

He burned wood, plants, bones, that which produced fire around him without his will. This fire was

[20] Vere Gordon Childe. In: *Man makes himself*. The Library of Science and Culture. London: Watts & co., 1937, p. 56. URL: http://books.google.com/books?id=vPgYAAAAYAAJ. Ср.: James George Frazer. *Myths of the Origin of Fire*. London, 1930. ISBN: 0878170685, 9780878170685.

[21] On Sinanthropus's technology, and on his use of fire see Б. Л. Богаевский. In: *Техника первобытно-коммунискического общества*. История техники 1. Изд-во Академии наук СССР, 1936, pp. 26–27. Pithecanthropus, who lived earlier, at the very beginning of the Pleistocene, hardly more than 550 thousand years ago, also possessed fire. Ср.: Б. Л. Богаевский. In: *Техника первобытно-коммунискического общества*. История техники 1. Изд-во Академии наук СССР, 1936, pp. 11, 67. The use of fire by Pithecanthropus cannot be considered proven, yet, but is very likely.

[22] Mankind has obtained superheated vapor at a $140°C$ temperature as a source of power only in the 20th century with the aid of drilling in Larderello under Le Conte's initiative. Still later, this method was greatly developed in Soffioni, in New Mexico, in Sonoma. Parsons, before his death, worked on an implementable project to obtain an unlimited, from mankind's point of view, source of energy from the inner heat of the earth's crust with the aid of deep drilling. The attempt to obtain energy from the cold depths of the ocean, which the French Academician Claude did not realize only because of criminal hooliganism in 1936, can be considered analogous. Undoubtedly, we have in these phenomena a practically inexhaustible force in mankind's hands.

due to two very different reasons before man's emergence. On the one hand, lightning caused forest fires, or set dry grass on fire. Mankind still suffers from fires caused this way. The natural conditions in the ice age, especially in interglacial ages, could have been even more favorable for lightning phenomena. There was, however, another cause which produced fire independently of mankind.

That was the biological activity of lower organisms, which lead to fires in dry steppes,[23] to the burning of bituminous coal layers, to the burning of peat bogs, which continued throughout a number of human generations and gave a convenient way of obtaining fire. We have direct indications of such bituminous coal fires in Altai, in the Kuznetsk basin, where they occurred in the Pliocene and post-Pliocene, but where they also occurred in historical time, and where we still have to deal with them. The causes of these fires are still not completely clear, but all indications are that it is unlikely that we have phenomena of purely chemical spontaneous combustion, i.e. intensive oxidation of coal fragments with oxygen from the atmosphere, or its spontaneous ignition due to heat released during oxidation of sulphur compounds of iron in the coal.[24]

The most probable source is the biochemical phenomena associated with the biological activity of thermophilic bacteria. We have the direct observations of B. L. Isachenko[ii] and N. I. Malchevskaya[iii][25] for peat bogs in recent times.

This phenomenon presently requires careful study.

109. Such regions of warm winter and summer, as well as places of outlets of heat sources, were precious gifts of nature to Paleolithic man, who had to use them just as they are used, or were used until recently by tribes and peoples that we still find in a living Paleolithic stage.

Man at that time, with his great attentiveness and closeness to nature, undoubtedly noticed such places, and must have been using them, especially in glacial periods.

It is curious that we can observe the use of the same biochemical processes among the instincts of animals. This can be observed in the family of the chickens, with the so-called incubator birds, or large-foots (Megapodiidae) of Oceania and Australia, which make use of the heat of biological decay, i.e. of a bacterial process, for the hatching of chicks form eggs, creating large mounds of sand or dirt mixed with strongly rotting organic remains.[26] These mounds

[23] The spontaneous ignition of dry grass in the steppes, in pampas, in forests has sometimes been denied. Presently the source of fires is almost always man, but there are cases which, it seems to me, undoubtedly indicate the possibility of spontaneous ignition in steppes under the direct action of the sun. The cause remains unclear. About such cases see E. Popping. "Reise in Chile, Peru und auf dem Amazonenstrom während der Jahre 1827–1832". In: vol. 1. Lepzig, 1835, p. 398. Geoffrey Douglas Hale Carpenter. "A Naturalist on Lake Victoria. With an Account of Sleeping Sickness and Tse-tse Fly". In: London, 1920, pp. 76–77. URL: http://archive.org/details/naturalistonlake00carp (visited on 07/17/2012).

[24] See Михаил Антонович Усов. "Состав и тектоника месторождений южного района Кузнецкого каменноугольного бассейна". In: Новониколаевск, 1924, p. 58; Михаил Антонович Усов. "Подземные пожары в Прокопьевском районе". In: *Вестник Западно-Сибирского геолого-разведочного треста* 4 (1933), 34 и сл. В. А. Обручев. "Подземные пожары в Кузнецком бассейне—геологический процесс". Russian. In: *Природа* 3 (1934), pp. 83–85. ISSN: 0032-874X. URL: http://www.ras.ru/publishing/nature.aspx (visited on 07/17/2012). J. F. Hermann[i], who discovered the Kuznetsk bituminous coal basin, already indicated these phenomena in 1796. See B. F. J. Hermann. "Notice sur les charbons de terre dans les environs de Kousnetzk en Siberie". In: *Nova acta Academiae scientiarum Imperialis Petropolitanae* 11 (1793), pp. 376–381. URL: http://archive.org/details/novaactaacademia11petr (visited on 07/17/2012). Cp. B. Jaworsky and L. Radugina. "Die Erdbrände im Kusnezk-Becken und die mit ihnen verbundenen Erscheinungen". In: *Geologische Rundschau* 24 (5 1933). 10.1007/BF01809729, pp. 298–310. ISSN: 0016-7835. URL: http://dx.doi.org/10.1007/BF01809729 (visited on 07/17/2012); В. И. Яворский and Л. К. Радугина. "Каменноугольные пожары в Кузнецком бассейне и связанные с ними явления". Russian. In: *Горный журнал* 10 (1932), p. 55.

[25] See Б. Л. Исаченко and Н. И. Мальчевская. "Биогенное саморазогревание торфяной крошки". Russian. In: *Доклады Академии Наук* 4.8 (1936), p. 364. ISSN: 0869-5652.

[26] See *Птицы*. Russian. 4-е, совершенно переработанное и значительно расширенное издание профессора Отто Цур-Штрассена. Авторизованный перевод под редакцией профессора Психоневрологического института и С.-Петербургского женского медицинского института Н. М. Книповича. Vol. 7. 1912, p. 15.

[i] И. Ф. Герман

[ii] Б. Л. Исаченко

[iii] Н. И. Мальчевская

can reach 4 meters in height, and the temperature in them reaches no less than $44°C$. Apparently, these are the only birds possessing such instincts.

It is possible that ants and termites increase the temperature of their dwellings on purpose.

However, these are weak attempts, incomparable to that planetary revolution, which mankind has produced.

Man has been using the products of life—dry plants—as a source of energy, fire. Numerous myths about its creation have been preserved and created.[27] But most characteristic is the fact that man used, for that purpose, methods which he hardly ever observed to produce fire in the biosphere until his discovery. The most ancient methods were, apparently, the transformation of man's muscle power into heat (strong friction of dry objects), and the making and catching of sparks from stones. A complex system for the preservation of fire was developed in the end in everyday life a hundred, and more, thousand years ago.

The surface of the planet has been changed radically after this discovery. Fireplaces shone, were extinguished and started everywhere, if only man lived there. Mankind was able, thanks to this, to survive the coldness of the glacial period.

Man was producing fire among living nature, subjecting it to burning. In this way, by means of steppe and forest fires, he acquired a force which, in comparison to that of his surrounding animal and plant world, put him above the numerous other organisms and became a prototype of his future. Mankind has mastered other sources of light and heat—electrical energy—only in our time, in the 19th–20th centuries. The planet started shining even more, and we have found ourselves at the beginning of times, whose significance and future still remain outside of our attention.

110.

. . .

[27] See Frazer, *Myths of the Origin of Fire*.

Part IV

The Sciences about Life in the System of Scientific Knowledge

Chapter 10

The biological sciences must come, together with the physical and the chemical sciences, among the sciences encompassing the noosphere.

151. But the contemporary state of biology and its excursions into philosophy are also detrimental to philosophy.

The expectant attitude of the naturalist for the confirmation of philosophy creates among philosophers the impression that precisely the scientists[I], proceeding from their data, accept the basic tenets of the philosophical current of materialism about the lack of fundamental difference between living and inert. Vitalistic notions have remained so far in the past in the general course of biological thought that their real significance hardly influences large-scale work. The overbearing majority of naturalists are far from them.

The philosophers-naturalists, whose significance in contemporary philosophical thought, in its global scope, is minute, receive [from the exact scientists] what seems like firm ground, and calm their doubts. This impacts their creative work, which slowly dies down, and degenerates into dry, formal scholasticism, or into verbal talmudism, especially in such cases as our country, where dialectical materialism is the state philosophy, and is favoured by the mighty support of government power, and by intellectual and practical impossibility of its free criticism and of the free development of any other philosophical views.

However, official dialectical materialism itself, being one of the many forms of this current of philosophical thought, does not possess such freedom, either. And has been, meanwhile, never systematically philosophically worked out to the end, remaining full of unclarity and unthoughtfulness. Its official exposition has changed more than once during the past twenty years, previous ones were declared heretical, and new ones were created. Our philosophers of strict discipline, in which they work, have been obliged to obey without objection, under the threat of persecution and material hardship, these new ones, and to publicly repudiate their previous teachings, admitting their mistakes. It is easy to imagine what result follows, and how fruitfully can one work intellectually in such a severe real environment. As a result, a condition very reminiscent of the condition of the orthodox church under despotism has arisen, with the gradual downfall of lively work, work in this area of philosophy, the exit into safe areas of knowledge, the publication of classics, forebears; a new degeneration of thought has arisen.

152. It seems to me that for these 20 years, except the republication of old works, which were released in the pre-revolutionary period, not a single independent, purely philosophical work has been published, and there are not even histories, based on primary sources, of the creation of dialectical materialism itself.* Such decline of philosophical thought in the

[I] probably a typo, and should be: "exact scientists" [*—Pav*]

*This part of the phrase is crossed out by the author in the manuscript.

area of dialectical materialism in our country, and the seemingly extensive possibilities of its manifestation, are a consequence of the adopted understanding of the goals of philosophy, and of the decrease of deep philosophical work, thanks to the belief among our philosophers that a philosophical truth, which cannot be changed and subjected to doubt any further, has been reached.

Such an idea is, essentially, foreign to both K. Marx and F. Engels, not to mention Feuerbach.

It was developed on Russian soil in the middle of emigration, and grew into a state ideological influence completely unconsciously, its consequences being unexpected for many very prominent freely thinking communists, as well.

The fight of the intellectual circles turned, in the end, imperceptibly and unsuspectedly, into a state philosophy of the winning interpretation of dialectical materialism.

Thanks to the strengthening of one definite current, this has been manifested more and more clearly during the past 10 years.

As a result, we see, or we have, instead, a mass of literature of a transient character, rooting out conscious or unconscious errors and heresies, deviations from the officially accepted state philosophy. On top of that, the state philosophy itself has changed in very important nuances in the accepted interpretation of dialectical materialism. Such a sad state of work in our country in the area of dialectical materialism at the presence of huge material resources, which had never existed for any other philosophy (except for theological ones—Catholic and Muslim philosophies in the Middle Ages), would unavoidably come in another way, as well, thanks to many peculiarities in the structure of state philosophy in our country. On the one hand, thanks to the emigration of intellectual circles, whose significance was already indicated; and, on the other, thanks to the complexity, independent of life in our country, of the environment, in which dialectical materialism was being created.

153. Dialectical materialism, in the form in which it is actually manifested in the history of thought, was never presented coherently by its authors—Marx, Engels, and Ulyanov-Lenin. These were prominent thinkers, and no less prominent political activists. Characteristic of them are a large breadth of scientific knowledge and scientific interests, unusual for political activists. They stood at the level of their time, but at the same time were volitional personalities, organizers of the popular masses. They were actively opposed to, and regarded strongly negatively religious searches, judging them, historically, as a force hostile, in the end, to the interests of the popular masses and to the freedom of scientific work. However, they, at the same time, attributed great significance to philosophical thought, whose primacy over scientific thought did not raise any doubt to them.

Their philosophical ideology was most closely related to their political activity, and left an imprint on their scientific searches and understanding. They were primarily philosophers, spokesmen for aspirations, and organizers of the actions of the popular masses, whose social well-being—on a real planetary basis—was the goal and meaning of their lives. We see, by the example of these people, a real, great impact of the personality not only on the course human history, but, through it, on the noosphere, as well.

Part of the polemical works which their authors—Marx, Engels, Lenin, Stalin—never intended for such a task were laid in the foundation of the Soviet state philosophy; their statements on practical and political questions of life, in which philosophy sometimes occupied a secondary place. Such were, secondly, draft notebooks, extracted from the manuscripts remaining after their deaths, often reports and overview summaries related to the reading of philosophers, which were never historically, scientifically, critically published. They were published by the scientific apparatus and with the obeisance of believing students, and, as always under such circumstances, are full of contradictions, and, in some cases, such as the Engels's *Dialectics of Nature*, the authorship of all of Engels's statements cannot be considered proven. A few works of Marx, and, partly, Engels, have a different character, but they are completely insufficient for the firm establishment of a new philosophy. Marx' and Engels' life work was in another domain. Marx was a prominent scientist, who in the *Kapital* reached his conclusions by an exact scientific pathway, but presented them in the language of Hegelian philosophy, independently reworked by him and Engels, which al-

ready during their lifetimes did not (in general) correspond to current scientific methodology and scientific searches. The prominent mind could permit itself such a peculiar form of presentation.

Already during Marx's lifetime—at the publication of the last volumes of his *Das Kapital*—such a presentation was an obvious anachronism, and it is an even greater one in our time. In essence, of course, what is important is not the form of presentation of the scientific work, but rather the actual methodology, by which what is presented has been reached. The form of Marx's presentation misleads the reader into thinking that what is presented was reached by a philosophical pathway. It is, in reality, only presented that way, but was, in fact, reached by the exact scientific method of the historian and economist-thinker, who Marx was in his scientific work.

It turned into a complete anachronism, since it was transferred from the area of political economy and history into the area of natural and exact sciences. This transfer, which can be observed in the works of both Marx and Engels, acquired an extremely peculiar character with their epigons, having become the state philosophy of a large and strong nation, most closely related to the International.

Thirdly, the situation was worsened by the fact that the authors of these philosophical searches were people, either actually exercising dictatorial power in an unprecedented depth and degree, and considering the philosophical ideology of dialectical materialism as the basis of their political and practical activity, or people, such as Marx and Engels, who are not subject to free criticism in our country for the same reason. Their conclusions are, in fact, accepted as impeccable dogma, defended by the full mechanism of government power.

The stagnation of philosophical thought here, and its transformation into fruitless scholasticism and talmudism, opulently blooming against that background, is a direct consequence of this state of affairs.

This, in essence, great historical phenomenon was prepared in our country by deeply-rooted submissiveness—unchanged during all the transformations of the form of government—to the state religion. The official Orthodoxy in the Tsardom of Russia, as well as in the Russian Empire, prepared the ground for the official philosophy, which replaced it, and which has acquired the clear form of official religion with all of the consequences from that.

154. This, however, is, historically and in essence, only the everyday side of the matter. The ideology and its associated belief at its foundation are far more important.

Dialectical materialism, in sharp contrast to contemporary forms of philosophy, is extremely distant from philosophical scepticism. It is convinced that a universal method rules—an infallible criterion of philosophical and scientific truth. This is the effect of the temperament of its founders Marx and Engels, who succeeded, thanks to their joining the still alive at that time Hegelian philosophy, to impart to their scientific achievements the vibrantly active form of faith, and not only of a philosophical doctrine—to create a political force, able to move the masses and vividly manifest itself in the *Communist Manifesto* of '48—in a brilliant and profound work, reflecting the age of the middle of the last century, when the primacy of philosophy over science dominated ideologically Euro-American civilization.

In contrast to other forms of materialism, with which it is in fundamental disagreement, dialectical materialism is closely related in its genesis and in the basis of its formulations with idealism in its Hegelian form.

It is far from clear, whether it is possible to regard it as free from the influence of such history, and to attribute it completely to the philosophical current of materialism.

As far as I know, this question is historiographically unresolved, and in the manifestation which materialism has in our country, its idealistic basis is strongly emphasized, whereas its materialistic one is an outer appearance.

But this is a debatable area, far from my interests, and from my knowledge, and I would not concern myself with it, if the sharp distinction between the philosophical current of materialism and dialectical materialism did not become completely clear in our country in the aspect which most concerns the naturalist and seriously affects scientific work in our country.

Materialistic philosophy was evidently distinct—and that is where its force lied—from the other philosophical currents of modern times, in the fact that it did not conflict with science, was completely based on its achievements, as far as possible. It generalized and developed them. In essence, it continued that great movement, which developed in the 17th–18th centuries on the basis of the new science, the new philosophy, and the new ways of everyday life and technologies, which were created at that time.

Materialism, in essence, was striving to become a scientific philosophy, or a philosophy of science. It did not succeed in practice, since in its logical conclusions, being part of the philosophy of the Enlightenment from the end of the 18th century, when it clearly occupied a place on the historical stage for the first time, it quickly fell behind the science of the times.

But in the aspect concerned in this book, what is important is not the success, or failure of materialism in its historical manifestation during the age of its flourishing at the end of the 18th century, and in the 1860s, but the foundation of its ideology, which always recognized the primacy of science above philosophy. It considered everything proven by science as obligatory for itself.

The dialectical materialism, created by Marx and Engels, did not accept that, and, in that, sharply distinguished itself from all forms of philosophical materialism, and, from that standpoint, did not differ at all from idealistic Hegelianism.

For that very reason, it is also clearly distinct from philosophical scepticism, which accepts the realistic worldview, as it is manifested scientifically, as the only possibility, and does not recognize, in comparison, either religious, or philosophical views on an equal basis. Philosophical scepticism, in contrast to philosophical materialism, does not recognize the scientific view of reality as its complete view, taking into account the increase of scientific knowledge, and the imperfections of human reason. But for it the scientific achievements at a given historical moment, and at a given form of the human brain have the character of the most precise achievement of reality. Dialectical materialism does not proceed from scientific data, is not limited to their boundaries, is not based on them, but is striving to change and develop them, adapting them to its views, which have as a basis the laws of Hegelian dialectics. It seems to me that this dialectics is so closely related to the whole philosophy of Hegel that through it foreign, from the standpoint of materialism, formulations enter into the spiritual environment of materialism—mystical, distorting to it, such as, for example, the manifestation of dialectics in nature, or in the present case, speaking scientifically, in the biosphere.

The introduction of the dialectics of nature in the philosophical purview of our country, in its official philosophy, during our time of great increase, and significance of science—is a remarkable historical phenomenon.

This has been the form of the post-mortem influence of the works of Marx and Engels, based on faith—officially—but not expressed philosophically, or scientifically, etc. [by them].

155. Effectiveness, i.e. the equal significance of methodological thought and the instructions of the philosophers-dialecticians for current scientific work, is strongly underscored in our philosophical literature, and is introduced into science through the agency of government power.

The philosophers-dialecticians are convinced that they can aid current scientific work with their dialectical method.

They believe in its significance for science, but the manifestation of that belief in reality contradicts it.

It appears to me that this is a misunderstanding. No philosophy has played, or plays, such a role in the history of thought. No philosopher can instruct the scientist in the pathway to take in the methodology of scientific work, especially in our times. The philosopher is not capable of precisely encompassing the complex problems, whose solutions stand today before the naturalist in one's current work. The methods of scientific work in the area of experimental sciences and descriptive natural sciences, and the methods of philosophical work, even in the area of dialectical thought, are expressly different. It seems to me, the two lie in different domains of thought, as far as we are dealing with concrete natural phenomena, i.e. with empirically established facts, and empirical generalizations built upon scientific facts.

It seems to me that the issue here is so clear that no argument is necessary. Our philosophers-dialecticians must not interfere with this area of scientific knowledge for their own benefit. Here, also, their attempt is doomed to failure from early on. Here they are fighting with science on its native terrain.

Science lived through a similar interference of religious thought and religious constructs, erroneous at their roots, during the age of the Renaissance, during the 17th–19th centuries. Though the fight here is not yet over, hardly anybody would deny that victory has remained on the side of science, that the majority of religious constructs of that type remained in the past, or are being reconstructed in their essence, reinterpreted, are shifting from the area of reality into that of personal belief and interpretation. The historical experience was not taken into account by the official philosophers of our country, and they, in their squareness and insufficient scientific literacy, entered into a sharp conflict with scientific thought and work, which are correctly placed ideologically high in our country—on an equal level with dialectical materialism—at the foundation of our system of government.

The weakness of placing "dialectical materialism" at such a height, unavoidably impacts its real power in nation building, does not correspond to reality, and unavoidably proves to be transient.

Conflicts with the actual needs of life are beginning, which must unavoidably have those consequences, which came into being ... supreme ...* in the old Christian nations.

156. I have collided with this kind of circumstances in my scientific work many times, and have even mentioned the struggle of my predecessors in scientific knowledge from the past century in public statements.

In 1934 little-educated philosophers, heading the planning of scientific work of the former Geological Committee[i], erroneously attempted to prove, by means of dialectical materialism, that the determination of geological age by means of radioactivity is based on erroneous theses—dialectically unproven. They thought that the facts and empirical generalizations that radiologists relied upon were dialectically impossible. They were joined by a few geologists, occupying themselves with philosophy, and heading the scientific leadership of the Committee. They held up my work by one-two years, because the Radium Institute[ii], which I headed, was completely unable to get in touch with the work of the Committee geologists, and to put the investigations on a solid basis. In the end, after an uncareful statement at the public session of the Committee by the Vice Scientific Director[iii] professor M. M. Tetyaev[iv], a prominent geologist, publicly indicating the incompatibility between dialectical materialism and the conclusions of radiologists, it was possible to achieve a, now public, discussion on this subject. It was possible to do so, because the whole radiological work of the Committee was under attack by his statement. I was able to intervene in my role as an Acting Chairman[v] of the Committee on Geological Time[vi], having been elected at the Soviet Union Radiological Conference[vii], and to acquire a public debate of this question. This took place under my chairmanship at the premises of the Geological Commitee, where I placed the condition that we, as insufficiently competent in dialectical philosophy, would only address the scientific side of the phenomenon. The striking ignorance of the basic facts and achievements in the area of radiogeology of all philosophers and many geologists became undeniably clear to all at that session, attended by a few hundred geologists and philosophers. We were able to freely develop our work to a large degree thanks to the fact that the philosophical leaders of the Geological Committee soon proved to be heretics according to the official interpretation of dialectical materialism, and were excluded from the Committee. However, they still did harm—weakened our scientific work by a few years.

The phenomenon which was manifested here—errors in the interpretation of dialectical material-

*Illegible in the manuscript.

[i]Геологический комитет

[ii]Радиевый институт

[iii]заместителя директора по научной части

[iv]М. М. Тетяев

[v]и. о. председател

[vi]Комитета по геологическому времени

[vii]Всесоюзной Радиологической конференцией

ism by official representatives of the philosophy—is an everyday and widespread phenomenon of our life. There are a few philosophers, whom it didn't suit to retract the philosophical theses set forth by them, which has been explained by an unconscious mistake, or a conscious one, by a hidden departure from the official philosophy, or, even, by a conscious interference with the government. The wide manifestation of this phenomenon, totalling hundreds of our philosophers-dialecticians, indicates the clear to every scientist difficulty in the application of the dialectical method in the current scientific environment. For, as is clear from §153, there has been not one prominent thinker from among the founders of dialectical materialism throughout the historical course of its development, who has given a complete treatment of this philosophy, thought through to the end. It has been created by them in the dust of fights and polemics, from case to case.

None of them has made a complete presentation, and the attempts by less prominent thinkers, unavoidably proved to be ephemeral. Errors were found in them, they were revoked from circulation, one was to never refer to them. That continued tens of times, and there remained no presentation, which could be considered firm. The present official presentation of both dialectical materialism, and of the history of the Communist Party, whose ideology this is, is dated 1936–1937, and there is no certainty than in a year or two they would not require new reworking.

I have had the occasion to, also, encounter other manifestations of this scientific environment. Inexplicably, the Kant-Laplace hypothesis and the acceptance of the possibility of abiogenesis were connected to dialectical materialism, and their negation was considered unacceptable from a dialectical standpoint. Such a presentation met censorial difficulties. Already in 1936 in my report *On the Problems of Biogeochemistry*, I ran into objections of that kind at the session of the Academy. And I was able to establish the presently unscientific character of the Kant-Laplace hypothesis, and its incompatibility with radiogeological data the next year in my official speech at the International Geological Congress[i] to the tacit agreement of our geologists, including those considering themselves dialecticians.

In this case the question is not about the interference of dialectical materialism with the scientific work of the naturalist in the manner indicated earlier.

Principally, the naturalist cannot deny the correctness and usefulness of the interference of philosophers in one's scientific work in many cases, when what is being dealt with are scientific theories, hypotheses, generalizations of a non-empirical character, cosmogonic constructs. Here the naturalist unavoidably treads upon philosophical terrain.

Even here scientific thought finds itself in a condition, which interferes with its correct scientific work, in our country. In this case, our scientific thought conflicts with an obligatory philosophical dogma, with a definite philosophy, which, as we have seen, has no firm presentation. This dogma, with the lack of free scientific and philosophical investigation in our country, with the extreme centralization of advance censorship, and all means of dissemination of scientific knowledge—by way of printed or spoken word—in the hands of government power, is accepted as obligatory for all, and is introduced in popular life through the full power of government.

1936–1938.

[i] Международном геологическом конгрессе

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