

Mercè Piqueras

INTERNATIONAL MICROBIOLOGY,  
Barcelona, Spain

## Meeting the Biospheres: on the translations of Vernadsky's work

---

### Introduction

The concept of a biosphere comes from putting together data furnished by several disciplines such as biology, geology, chemistry and biochemistry, which link living matter and the matter of the upper layers of the planet. The term *biosphere*, which has been usually attributed to Vladimir Ivanovich Vernadsky (1863–1945), seems to have been coined by Eduard Suess (1831–1914). However, when Suess first used it, in his book *Die Entstehung der Alpen* (1875), he only intended to make a distinction between the lithosphere—which is the upper layer of the Earth, made up by the Earth crust and the Earth upper mantle—, and the thin spherical film where living beings are found [1, 23]. For Suess, the biosphere comprised life and environmental conditions such as temperature, pressure, and chemical compounds. Vernadsky used for the first time the term biosphere in 1924, in his essay *La Géochimie*, which was based on a series of lectures he had given at La Sorbonne in 1922 and 1923. Philosopher and paleontologist Pierre Teilhard de Chardin (1881–1955), philosopher Henri Bergson (1859–1941), and mathematician and philosopher Eduard Le Roy (1870–1954) attended those lectures, and they and Vernadsky influenced to each other's thoughts [1]. It is the concept of biosphere related to biogeochemistry, expressed in *La Géochimie*, that is widely accepted today. Vernadsky understood biosphere as the external envelope of the Earth which is inhabited by living things, and comprises both all the living organisms of the planet and the elements of inorganic nature providing the medium for their habitat. Thus, oxygen, carbon, hydrogen, nitrogen and other elements and chemical compounds involved in the vital process are constituent parts of the biosphere. As are the products of organisms activities, such as animal burrows and lairs, birds' nests, deposits of lime and of fossil fuels. Even water is a component—a major component—of the biosphere [8]. Solar radiation, which is crucial for the maintenance of life on Earth, should be considered also a biosphere's component, and so should products of human activities. In fact, the human species is a major changing force in the current composition of the biosphere.

The study of the biosphere cannot be made only by biologists. To study its components and their interactions, a multidisciplinary approach is needed. However, at Vernadsky's times nobody even thought of interdisciplinarity. His theory was actually far ahead of the times when it arose. By portraying life as a global phenomenon, in which the sun's energy was transformed on Earth into a kind of "green fire"—it referred to photosynthesis—he made an anticipation of global ecology; and he made also an anticipation of the concept of "ecosystem" [7, 29].

---

### Vernadsky and Oparin works

There are two books by Russian authors which have been considered seminal pieces of work in different fields of the life sciences, to which often researchers refer, but which many have not read, at least in full version: *The Biosphere*, by Vernadsky and *The Origin of Life*, by Alexandr Ivanovich Oparin (1894–1980). For many years the only pieces of Vernadsky's writing available in English were two articles published in 1944 and 1945 [31, 32], which already contained a statement of his scientific thought. They were translated by the author's son George Vernadsky, by then a historian at Yale University, with the help of young limnologist G. Evelyn Hutchinson (1903–1991), who took a great interest in Vernadsky's theories on the relationship between biological communities and the nonliving components of their environment. Hutchinson applied this ideas to the study of biogeochemical processes taking place in a small self-contained ecological system: Linsley Pond, near New Haven, Connecticut [6]. The first English edition of *The Biosphere*, published by Synergetic Press (Arizona) came out in 1986 (see Table 1 for other editions of the book in different languages). This was an abridged version, for it was so the French source from which it had been translated. Although abridged, it was a most valuable publication, since it allowed English-speaking audiences to get directly acquainted with Vernadsky's most famous piece of writing. Besides, a typescript of an entire English version of *The Biosphere*, with the only indication of the translator's name—David Langmuir—had been circulating among Bostonian and New Yorker Vernadsky's followers. Science editor Peter N. Nevrumont rescued that translation, and

**Table 1** Different editions of V. I. Vernadsky's *Biosphere*

Language	Title	Year	City	Publisher	Pages
Russian	<i>Biosfera</i>	1926	Leningrad	Nauch	
	<i>Izdatel'stvo; Izbrannye Sochineniya</i> (Selected Works)	1960	St. Petesburg Moscow	Izdatel'stvo Akedemiya Nauk SSSR	pp. 7–102
	<i>Biosfera</i>	1967	Mysl' (Moscow)	Nauka	115 pp.
	<i>Biosfera i Noosfera</i>	1989	Moscow	Nauka	115 pp.
	<i>Zhivoe Veshchestvo i Biosfera</i> (Living Matter and the Biosphere)	1994	Moscow	Nauka	pp. 315–401
French	<i>La Biosphère</i>	1929	Paris	F. Alcan	232 pp.
Serbo-Croatian	<i>Biosfera</i>	1960	Beograd	Kultura	233 pp.
Italian	<i>La Biosfera</i>	1960	Como (Italy)	Red Edizioni	128 pp.
English	<i>The Biosphere*</i>	1986	Oracle (Arizona)	Synergetic Press	82 pp.
	<i>The Biosphere</i>	1997	New York	Copernicus (Springer-Verlag)	192 pp.
Spanish	<i>La Biosfera</i>	1997	Madrid	Fundación Argentaria-Visor	218 pp.

\* Abridged version based on the French edition of 1929.

in 1997 he has finally had it published by Copernicus Books of Springer-Verlag. Almost at the same time, also the Spanish *La Biosfera* was published by Fundación Argentaria, in its series “Economía y Naturaleza” (Economy and Nature).

Regarding Oparin's *The Origin of Life*, in 1924 the author had a small book published under the same name which contained his theory on the origin of life by chemical evolution. It was released at the end of 1923, even though the edition's year printed on the book is 1924 [11]. And it was meant to spread materialistic ideas among workers; in fact, on top of the first page, the famous motto of the Communist Manifesto “workers of all the world unite” could be seen. Through Kliment Arkadievich Timiryazev, a Russian scientist expert on Darwinism, who had been expelled from the University of Moscow for political reasons, Oparin embraced Darwin's theory of evolution, and concluded that heterotrophy should be the first kind of metabolism to have emerged on Earth. As Oparin himself stated later, Vernadsky's works showing the biological origin of the oxygen present nowadays in the Earth's atmosphere had been of great help to him to develop his theory [12]. On the other hand, although Vernadsky was acquainted with Oparin's work, he sees Earth as a planet on which life has always been present, it being a characteristic inherent to the essence of the planet itself [25]. He is referring to Redi's principle of 1669: “All the living are born from the living” when he states that “living organisms have always sprung from living organisms during the whole of geological history”. In 1936 Oparin published, also in Russian, a more elaborated theory on the origin of life, favored by personnel, social factors, and also social, political circumstances. The English translation, which was to become a classical reference, was published by MacMillan (New York) in 1938 [27]. Soon later, however, World War II started, and researchers from contending countries turned their interests into topics much more practical than the origin of life. Only in the mid 1950s, following the Miller experiment [26], did prebiotic chemistry emerge as a discipline on its own, giving rise to a new era for the studies on the origin of life.

## Lovelock, Gaia and the biosphere

In 1941, Manchester University newly graduated in Chemistry, James E. Lovelock, knew by his own experience what being a researcher in wartime meant. He had found a job at the British National Institute for Medical Research (NIMR) in London. Like other scientific institutions in the country, the NIMR had been compelled to do short-term research on subjects of immediate application, such as the measurement of blood pressure under water, the spread of upper respiratory infections in the US Bomber crew at a British base, and the measurement of infrared radiation from flash and flame [17]. By then, not only were Lovelock's scientific interests far from those of Vernadsky, but he did not even know the Russian's work. It was Lovelock's later research carried out as a consultant to the NASA Jet Propulsion Laboratory (JPL) in Pasadena, California, which made him turn to topics closely related to Vernadsky's own research. At the JPL, Lovelock, who was already well acquainted with terrestrial atmospheric chemistry, had been requested to develop experiments for the detection of life on other planets. He had noticed that the Earth's atmosphere was very far from any kind of chemical equilibrium; abundant oxygen coexisted with methane and other reactive gases, which would have been impossible on a lifeless planet. Other features of the Earth's atmosphere such as the abundance of nitrogen and water were anomalies difficult to explain only by geochemistry [21]. So, he thought that the presence of life on other planets could be checked by searching for chemical disequilibria in the planetary atmospheres, that were not explainable by the laws of chemistry [7, 14].

The astronomical information available in the 1960s allowed to know the atmospheric compositions of other planets, and what Lovelock predicted, after having analyzed Venus and Mars atmospheres, was not exactly what NASA would like him to have found out. The atmospheres of both planets—the Earth's closest neighbor planets—had similar compositions [18], and

were both in chemical equilibrium, which suggested that no life should exist on their surfaces. (Currently, the lacking of life on the surface is no longer associated with a lifeless planet, since it has been shown that life—at least in Earth—can exist in rocks at depth of several kilometers from the surface [5].) So close seemed to be the interactions between life and the Earth's atmosphere, that the latter could be considered an extension of life itself. Like the fur of a cat or the shell of a snail, the air we breath is not alive, but is made by living cells [17]. The foundations of Lovelock's Gaia theory (by then just a hypothesis), which stated that the Earth could be regarded as a single living system, lay in the observation of the interactions among the components of the biosphere: all living beings, the atmosphere, the oceans and the soils. If the Earth were to act as a living system, it should have some kinds of homeostatic regulatory mechanisms, as any living beings does. Since Lovelock published his first articles on Gaia in 1972 [15, 16], researchers from different fields, such as microbiology, geology, meteorology, physics, oceanography, mathematics and computer sciences, have joined him in his "Quest for Gaia", trying to find evidences for his hypothesis.

---

## What's in a name?

Lovelock's has never pretended to have introduced a new concept with his Gaia theory. As he often mentions, Scottish geologist James Hutton (1726–1797) referred to geological phenomena as the *Earth's physiology*. In 1925, Alfred Lotka stated that the evolution of organisms could not be separated from the evolution of their physical environment [21]. G. Evelyn Hutchinson claimed also the biosphere's self-regulation, and, during the late 1950s, biological oceanographer Alfred Redfield discussed the idea that the chemistry of aquatic ecosystems be regulated by organic activities [6]. More recently other scientists noticed the interactions among living beings and their environment. Rachel Carson (1908–1964) started the second chapter of her seminal book *Silent Spring* with this statement: "The history of life on earth has been a history of interaction between living things and their surroundings" [2]. Eugene Odum, although cautious towards Gaia, supported the idea that the biosphere is a homeostatic or cybernetic system of living and nonliving components. He also understood the major role played by bacteria in some ecosystems, and emphasized the "crying need" for microbial ecologists [6].

Lovelock might not have known that the name "Gaia" had already been used by someone else to name the mutual interactions between life and Earth. In fact, "Gaia or Life and Earth" was the title of the lecture which Dutch microbiologist Lourens G. M. Baas Becking (1895–1963) gave in his inaugural address as professor of general botany at the University of Leiden in 1931 [28]. American biologist Lynn Margulis, first collaborator of Lovelock to provide him with the biological evidences that account for chemical, geological changes on the

Earth surface, stated that Lovelock had considered telling his hypothesis the "Biocybernetic Universal System Tendency/Homeostasis" [24]. It was Lovelock's neighbor, novelist William Golding, that suggested him that, if Earth was alive, what better than to call it Gaia, the name of the Greeks' Earth Goddess? [20].

Lovelock's concept of Gaia, or maybe his metaphor of considering the Earth as a single organism, awakened intolerance and controversy among some sectors of the scientific community as well as among some science journalists, who either misunderstood the theory or saw in it teleological connotations. *The New York Times Magazine* called him "Britain's whole Earth guru" [10]. *Science 81*—do not confuse with the weekly *Science*—published an accurate article on Lovelock, which described very well the work of Lovelock and the scientific basis for his Gaia theory. All this, however, was concealed under the mischievous title "The maverick and the Earth Goddess". Lynn Margulis does not like to be considered a supporter of "the controversial hypothesis that the Earth is a single living organism". She thinks the metaphor leads to goddesses, mysticism and other misconceptions about Earth [24]. There is a big difference between an ecosystem—the Earth is an ecosystem or a sum of many ecosystems—and an organism.

---

## Gaia versus geophysiology

Gradually, research studies on topics such as atmospheric chemistry, microbial ecology, oceanography and earth sciences provided more and more evidences to predictions that had been made from Lovelock's Gaian point of view [3, 13, 19, 30]. An early mathematical model—Daisyworld—was followed by others much more sophisticated. In 1988, an interdisciplinary conference organized by the American Geophysical Union, with the only purpose of discussing Gaia, was the starting point for a new era. As stated on the conference's report published on *Science* [9], Gaia had become "respectable". However, Lovelock wanted to deprive his theory of any religious philosophical meaning, and coined the word geophysiology, with which he intended to replace Gaia [21]. As a researcher on atmospheric chemistry and inventor of the electron capture detector (ECD)—the most sensitive, easily portable and inexpensive analytical device able to detect substances present in the atmosphere at concentrations as low as parts per trillion ( $10^{-12}$ ) [22]—, his task had already been recognized, and in 1974 he had been elected Fellow of the Royal Society, the highest honor a British scientist can be awarded in his own country. Over the 1990s Lovelock's Gaia theory has also received wide recognition. Under the support of Oxford Green College former Warden, Sir Crispin Tickell (currently chancellor of the University of Kent), the first Gaia in Oxford Meeting was held in spring 1994 (Gaia in Oxford III will be held in spring 1999). An international meeting on Gaia will also be

held at the University of Valencia, Spain, in 2000. Besides, Lovelock has received honorary Doctorates and has been the recipient, among other awards, of the 1996 Volvo Prize for the Environment, and the 1997 Blue Planet Prize.

One of the conclusions of the Gaia in Oxford II Meeting, held in 1996, was the necessity to set up an international society which gathered scientists and others who shared an interest and concern for the Earth. On the morning of February 9, 1998—an unusually sunny winter day in London—the Royal Society welcomed Gaia followers arrived from different countries to attend the launching of Gaia, The Society for Research and Education in Earth System Science. The new society, based at the University of East London,\* is co-presided by James Lovelock and Lynn Margulis. Speakers at the Gaia Society launching session were the above mentioned Sir Crispin Tickell, philosopher Mary Midgley, Tyler Volk (New York University), Chris Rapley (British Antarctic Survey Director, and former Executive Director of the International Geosphere-Biosphere Programme), and Peter Liss (University of East Anglia, UK), not to mention Lovelock himself. Harvard Sociobiology Professor Edward O. Wilson, who was not able to travel to London, sent a video in which he expressed his best wishes to the new Society. In his speech, Lovelock told the audience he had decided to keep the Gaia name for his theory because people seemed to have eventually understood that Gaia was a metaphor which had nothing to do either with religion or with any kind of New Age cult. He uses Gaia just the same way Richard Dawkins has used the term “selfish gene” as a metaphor to refer to adaptive behaviors that include the sacrifice of individuals “for the sake of the species.” The main goal of the Gaia Society is to promote the study of the Earth as an inter-connected living system, by integrating knowledge from different scientific fields such as biology, geology, chemistry, physics and computer sciences.

## The latest Biospheres

The two recent new translations of *The Biosphere* (English and Spanish) have both particular features that make them milestones in scientific edition. The American edition (Fig. 1) is the first published English translation of the entire text (with the author’s prefaces to both 1926 Russian edition and 1928 French edition), and contains extensive, accurate annotations by American geologist Mark A. S. McMenamin to explain the structure of Vernadsky’s arguments. Besides, it also includes a foreword co-signed by an international panel of scientists that share an interest in global biological issues; an excellent introduction («The Invisibility of the Vernadskian Revolution») by Swiss philosopher and science historian Jacques Grinevald,

which places the book in its historical context; a half-page preface by the translator, and a note on translation and transliteration by the above mentioned McMenamin. The book has also two appendixes (a biographical chronology of Vernadsky, compiled by Grinevald, and a list of Vernadsky’s publications in English, compiled by A. V. Lapo) as well as an extensive bibliography.



**Fig. 1** Cover of *The Biosphere*. Completed Annotated Edition. A Peter Nevraumont Book. Copernicus/Springer-Verlag, New York, 1997. 192 pp. ISBN 0-387-98268-X

Grinevald, who is among those that have contributed the most to disseminate Vernadsky’s thought and works, has collaborated also in the Spanish *La Biosfera*, producing a most useful biblio-biographical chronology of the Russian researcher. The seventeen pages devoted to Vernadsky’s biography, besides making the reader acquainted with the Russian scientist’s life, allows him or her to follow the development of Vernadsky’s scientific thought. The book contains an appendix which is the text of a lecture given by Vernadsky at the Society of Naturalists of Leningrad in 1928, and an article also by the author (“The biosphere and the noösphere”), which was published in

\*Gaia: The Society for Research and Education in Earth System Science. Executive Secretary: Philip George. Dept. of Environmental Sciences. University of East London. Romford Road. London E15 4LZ, UK. E-mail: Gaia@uel.ac.uk

*American Scientist* in 1945 [32]. In the case of the Spanish edition, it is not usual that institutions dealing with financial activities publish scientific books, at least books of the kind of *La Biosfera* (Fig. 2), written by a foreign author dead more than fifty years ago—to whom it is not necessary to pay any official homage—and which deals with a subject apparently far from economy. However, the more one knows about ecology and economy, the more similarities one can find between these two disciplines.

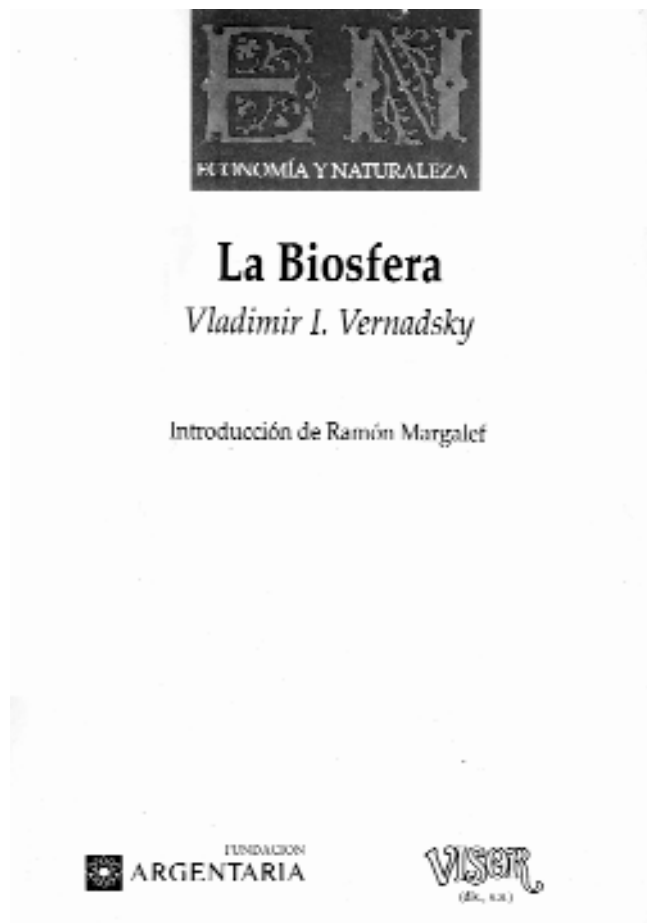


Fig. 2 Cover of *La Biosfera*. Vladimir I. Vernadsky. Fundación Argentaria - Visor Dis., Madrid, 1997. 218 pp. ISBN 84-7774-979-5

Among the best pages in the Spanish *La Biosfera* is the ten-page Introduction by Professor Ramon Margalef (University of Barcelona). He comments on what is obsolete in Vernadsky's work, but at the same time praises the freshness and current interest of some of his ideas, as well as the value of *The Biosphere*, which offered for the first time a planetary vision of life. This is the concept called now

“global ecology”, and handled by current Gaia followers. As most of Margalef's writings and lectures, his text sparkles with wit and erudition; not to mention with piercing criticism, not against the book he introduces, but against the current lack of interest for popular science in Spain, except for the “rubbish” offered by the mass media. Margalef misses good Spanish translations of seminal books by creative authors, mainly on physics and biology, which was a trend around 1930. He finally expresses his wish that *La Biosfera* makes its readers reflect on the history of ideas, on the conflicts that time bring to people, and on the reciprocal influences which might take place and should be promoted between the “two cultures”.

## References

1. Acot P, Camarasa JM, Folch R, Halffter G (1998) Pensar la biosfera. In: Biosfera. Els humans en els àmbits biològics del món, Vol. 11. Enciclopèdia Catalana, Barcelona
2. Carson R (1962) Silent Spring. Houghton Mifflin Company, Boston
3. Charlson RJ, Lovelock JE, Andreas MO, Warren SG (1987) Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate. *Nature* 326:655–661
4. Grinevald J. (1997) Cronología bio-bibliográfica de V. I. Vernadsky. In: V. I. Vernadsky, *La Biosfera*, Fundación Argentaria - Visor Dis, Madrid
5. Guerrero R, Margulis L (1998) Stone soup. *The Sciences* 38:34–38.
6. Hagen JB (1992) An Entangled Bank. *The Origins of Ecosystem Ecology*. Rutgers University Press, New Brunswick
7. Hitchcock DR, Lovelock JE (1967) Life detection by atmospheric analysis. *Icarus* 7:149–159
8. Kamshilov MM (1976) Evolution of the Biosphere (translated from the Russian). Mir Publishers, Moscow
9. Kerr RA (1988) No longer willful, Gaia becomes respectable. *Science* 240:393–395
10. Lawrence EJ (1986) Britain's whole Earth guru. *The New York Times Magazine*, Nov. 23, pp 67, 95–97, 106
11. Lazcano A, Oparin AI (1992a) La chispa de la vida. Pangea Editores, México
12. Lazcano A (1992b). Origins of Life: The Historical Development of Recent Theories. In: Margulis L, Olendzenski L (eds) *Environmental Evolution. Effects of the Origin and Evolution of Life on Planet Earth*. The MIT Press, Cambridge, MA, pp 58–69
13. Lenton TM (1998) Gaia and natural selection. *Nature* 394:439–447
14. Lovelock JE (1965) A physical basis for life detection experiments. *Nature* 207: 568–569
15. Lovelock JE, Lodge JP (1972a) Oxygen: the contemporary atmosphere. *Atmospheric Environment* 6:575–578
16. Lovelock, JE (1972b) Gaia as seen through atmosphere. *Atmospheric Environment* 6:579–580.
17. Lovelock JE (1979a) The independent practice of science. *New Scientist*, Sept 6:714–717
18. Lovelock JE (1979b) Gaia. A New Look at Life on Earth. Oxford University Press, Oxford, UK
19. Lovelock JE, Whitfield M (1982) The life span of the biosphere. *Nature* 296:561–563
20. Lovelock JE (1988) *The Ages of Gaia: A Biography of Our Living Earth*. W. W. Norton & Company, New York
21. Lovelock JE (1990) Hands up for the Gaia hypothesis. *Nature* 344: 100–102

22. Lovelock JE (1997) Midwife to the greens: the electron capture detector. *Microbiología SEM* 13:11–22
23. Margalef R (1997) Introducción. In Vernadsky, VI. *La biosfera*. Fundación Argentaria-Visa Dis. Madrid, 1997, pp. 9–18
24. Margulis L (1991) *Living by Gaia*. In: White J (ed) *Talking on the Water. Conversations About Nature and Creativity*. Sierra Club, San Francisco, pp 57–77
25. McMenamin MAS (1998) *Annotations to Vernadsky, V. I. The Biosphere*. Copernicus Springer-Verlag, New York, 199.
26. Miller SL (1953) A production of amino acids under possible primitive earth conditions. *Science* 117:528–529
27. Oparin AI (1953) *The Origin of Life* (Republication of the 1938 edition with the addition of a new Introduction by the translator). Dover Pub., New York
28. Quispel A (1998) Lourens G. M. Baas Beeking (1895–1963). Inspiration for many biologists. *Internatl Microbiol* 1:69–72
29. Sagan D (1991) *Biospheres: Metamorphosis of Planet Earth*. Mc Graw-Hill, New York
30. Schwartzman DW, Volk T (1989) Biotic enhancement of weathering and the habitability of Earth. *Nature* 340:457–460
31. Vernadsky VI (1944) Problems in biochemistry, II: The fundamental matter-energy difference between the living and the inert natural bodies of the biosphere. *Transactions of the Connecticut Academy of Arts & Sciences* 36:483–517
32. Vernadsky VI (1945) The biosphere and the noosphere. *American Scientist* 33:1–12