UNESCO - Kalinga Prize Winner- 1976

Alexander Ivanovich Oparin

[Darwin of the 20th Century]

Soviet Biologist and Bio-Chemist
Acclaimed as one of the Greatest Authorities on the Origin of Life.

[Born : March 2, 1894 in the Old Russian City Uglitsch (Jaroslavl), located to borders of the Volga River
Died : April 21, 1980, Moscow]

There is no fundamental difference between a living Organism and Lifeless mater. The complex combination of manifestations and properties so characteristics of life must have arisen in the process of the evolution of matter.

….Alexander Oparin

Oparin, Aleksandr Ivanovich (1894-1980)
A Brief Biographical Profile

Russian biochemist who, in 1924, wrote a pamphlet on the origin of life (based on ideas presented at the Russian Botanical Society in 1922) and provided what Bernal called "the first and principal modern appreciation of the problem". His writings only reached the West, however, in the late 1930s[1].

Although Oparin began by reviewing the various panspermia theories, he was primarily interested in how life initially began. He asserted.

> *There is no fundamental difference between a living organism and lifeless matter. The complex combination of manifestations and properties so characteristic of life must have arisen in the process of the evolution of matter.*

But what was that process? Taking into account the recent discovery of methane in the atmospheres of Jupiter and the other giant planets, Oparin postulated that the infant Earth had possessed a strongly reducing atmosphere, containing methane, ammonia, hydrogen, and water vapor. In his opinion, these were the raw materials for the evolution of life.

> *At first there were the simple solutions of organic substances, the behavior of which was governed by the properties of their component atoms and the arrangement of those atoms in the molecular structure. But gradually, as the result of growth and increased complexity of the molecules, new properties have come into being and a new colloidal-chemical order was imposed on the more simple organic chemical relations. These newer properties wee determined by the spatial arrangement and mutual relationship of the molecules…In this process biological orderliness already comes into prominence. Competition, speed of growth, struggle for existence and, finally, natural selection determined such a form of material organization which is characteristic of living things of the present time.*

Oparin outlined a way in which basic organic chemicals might form into microscopic localized systems-possible precursors of cells-from which primitive living things could develop. He cited the work done by de Jong on coacervates and other experimental studies, including his own, into organic chemicals which, in solution, may spontaneously form droplets and layers. Oparin suggested that different types of coacervates might have formed in the Earth's primordial ocean and, subsequently, been subject to a selection process leading eventually to life.

References

1. Oparin, A.I. The Origin of Life. New York: Dover (1952) (first published in 1938).
2. Oparin, A., and V. Fesenkov. Life in the Universe. New York: Twayne Publishers (1961).

Alexander Ivanovich Oparin was a Soviet biochemist and author of the theory of the origin of life. His other major works were in fields of biochemical grounds for vegetable raw material processing and enzyme reactions in plant cells. He showed that many food production processes are based on the biocatalysis and developed foundations of the industrial biochemistry in the USSR. [1]

Life :

Oparin was born in Uglich. He graduated from the Moscow State University in 1917. In 1924 he put forward a theory of life on Earth developing through gradual chemical evolution of carbon-based molecules in *primeval soup*. In 1935, he along with academician Aleksei Bakh, founded the Biochemistry Institute by the USSR

Academy of Sciences. [1] In 1939 Oparin became a Corresponding Member of the USSR Academy of Sciences, and in 1946 – a full member of the Academy. In 1940s and 1950s he supported pseudo-scientific theories of Trofim Lysenko and Olga Lepshinskaya, who made claims about "the origin of cells from noncellular matter", and 'taking the party line' helped his career[2]. In 1970, he was elected President of the International Society for the Study of the Origins of Life. On his passing on April 21, 1980, he was interred in Novodevichy Cemetery in Moscow.

Oparin became Heor of Socialist Labour in 1969, received the Lenin Prize in 1974 and was awarded the Lomonosov Gold Medal in 1979 "for outstanding achievements in biochemistry". He was also awarded five Orders of Lenin.

Theory of the origin of life :

Oparin sometimes is called "Darwin of the 20th century." Although he began by reviewing the various panspermia theories, he was primarily interested in how life initially began. As early as 1922, he asserted the following tenets:

1. There is no fundamental difference between a living organism and lifeless matter. The complex combination of manifestations and properties so characteristic of life must have arisen in the process of the evolution of matter.
2. Taking into account the recent discovery of methane in the atmospheres of Jupiter and the other giant planets, Oparin postulated that the infant Earth had possessed a strongly reducing atmosphere, containing methane, ammonia, hydrogen, and water vapor. In his opinion, these wee the raw materials for the evolution of life.
3. At first there were the simple solutions of organic substances, the behavior of which was governed by the properties of their component atoms and the arrangement of those atoms in the molecular structure. But gradually, as the result of growth and increased complexity of the molecules, new properties have come into being and a new colloidal-chemical order was imposed on the more simple organic chemical relations. These newer properties were determined by the spatial arrangement and mutual relationship of the molecules.
4. In this process biological orderliness already comes into prominence. Competition, speed of growth, struggle for existence and, finally, natural selection determined such a form of material organization which is characteristic of living things of the present time.

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While Oparin was unable to do extensive experiments to investigate any of these ideas, scientists were later able to . In 1953, for example, Stanley Miller performed what is perhaps the first experiment to investigate whether chemical self-organization would have been possible on the early earth. He showed that by mixing many of the components of a reducing atmosphere, it was possible to synthesize familiar organic compounds such as amino acids that were more complex than the molecules that were present at the beginning of the experiment.

Bibliography and references :

- Oparin, A.I. The Origin of Life. Moscow: Moscow Worker publisher, 1924 (inRussian)
  - English translation: Oparin, A.I. The Origin of Life. New York: Dover (1952) (first translation published in 1938).
- Oparin, A., Fesenkov, V.Life in the Universe. Moscow: USSR Academy of Sciences publisher, 3rd edition, 1965 (in Russian)
  - English translation: Oparin, A., and V. Fesenkov. Life in the Universe. New York: Twayne Publishers (1961).

Major works :

- "The External Factors in Enzyme Interactions Within a Plant Cell"
- "The Origin of Life on Earth"
- "Life, Its Nature, Origin and Evolution"
- "The History of the Theory of Genesis and Evolution of Life"

Footnotes :

1. Great Soviet Encyclopedia, 3rd edition, available online here (http://slovari.yandex.ru/art.xml?art=bse/00055/25700.htm)
2. Vadim J. Birstein. The Perversion of Knowledge : The True Story of Soviet Science. Westview Press (2004) ISBN 0-813-34280-5

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Alexander Ivanovich Oparin

Russian Biochemist **He Postulated and He Wrote The Origin of the Life** **(1894-1980)**

Alexander Ivanovich Oparin was Russian of birth, vegetal physiologist or race, biochemist by vocation. He was born in 1894 in Uglich. He studied, and later he taught, in the University of Moscow. The theory that he developed in years 20 was the germ of the present vision on the origin of the life.

When Oparin was university student, the Russian biologists taught that the first alive beings had been autótrofos (able to make its own food, as the plants), and they had formed by spontaneous generation from grumos of coal. To Oparin, that had read and accepted the Theory of the Evolution of Darwin, the idea did not close to him. " I did no manage to imagine the sudden appearance of a photosynthetic cell from dioxide of carbon, nitrogen and water- Oparin wrote- . For that reason, I reached the conclusion that first they must have arisen, by means of a nonbiological process, the organic substances of which they formed, more ahead, the first alive beings, organisms that were heterótrofos in the beginning and were fed on the organic substances of the atmosphere."

On 3rd March 1922, Oparin presented/displayed his position in a meeting of the Russian Botanical Society, of which he was member. He listened and reprobated with equal courtesy. It was a theoretical speculation that lacked experimental support.

Without losing heart, Oparin wrote a titled booklet the origin of the life. With certain reluctance, and in spite of the full rejection of a scientific referee, the work was published by the publishing house Moscovita Worker. It was left on sale in November of 1923 (although it had been date of 1924 edition). It was sold well. Soon one became a bibliographical peculiarity. Outside Russia one practically did not spread until 1965.

Of the simple thing to the complex :

In 1936, Oparin presented/displayed a version reviews and extended of the Origin of the life. He maintained: the carbon thrown by vocanos was combined with water steam, forming bydrocarbons. In the ocean, those molecules became more complex and they crowded Little by little in called gotitas coacervados-acervus, in Latin, means pile-., the coacervados ones were acquiring the characteristics of the alive cells. Those cells were anaeróbicos microbes, because at that time there was no oxygen in the atmosphere.

Oparin explained the origin of the life in terms of physical and chemical processes. A progression of simplest to most complex. It broke therefore the vicious circle that affirmed that the present substances in the alive beings only could be made by the alive beings. The second version of the origin of the life was translated to the English by the North American publishing house Mac Millan, in 1938.

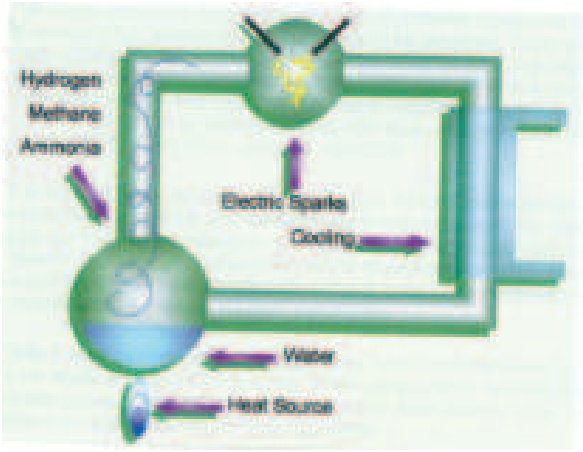
His theory was experienced with validity by Stanely Miller in 1953, like part of his doctoral thesis directed by H. Urey, obtaining to obtain complex organic compounds after reproducing the primitive conditions of the planet in an apparatus designed to the effect.

ORIGINS OF LIFE

The theory put forth to explain the origins of the Universe, our solar system, and our planet is called the **Big Bang Theory**. The Big Bang Theory IS NOT EVOLUTION! (The theory of evolution deals with living organisms, once they have come into existence.) The Big Bang theory says that all mater in the Universe was, at one time, concentrated in a giant mass (a black hole?) that blew apart about 10-20 bya (billion years ago) and is still expanding. About 5 bya, some of the matter condensed until forces were so strong that thermonuclear reactions began, and this was the origin of our sun. A disk-shaped cloud of matter orbiting the sun subsequently condensed into the planets. Thus, about 4.6 bya, the planets coalesced, and it is thought that Earth began as cold world. Later, due to whatever factors, the planet heated up enough to melt and sort into layers by density (core, mantle, crust). It is thought that the very first **atmosphere**

may have been hydrogen gas, but since that is so light weight and very chemically reactive, most of it would have floated off into space or reacted with other substances, thus would have been rapidly dissipated.

Alexander Ivanovich Oparin (publ. 1936), a Russian scientist, in *The Origins of Life,* described hypothetical conditions which he felt would have been necessary for life to first come into existence on early Earth. This, thus, is referred to as the



Oparin Hypothesis. He theorized that the first atmosphere was made largely of water vapor (H_2O), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen (N_2), methane (CH_4), and ammonia (NH_3). As the surface of Earth cooled again, torrential rains of this mixture formed the first seas, the "primordial soup." Some think this may be what conditions are like, even now, on Venus. Lightening, ultraviolet (UV) radiation, volcanic action all were more intense than they are now.

Several possible steps/stages were suggested to get from there to living organisms. The first step is thought to have been the **abiotic** synthesis (**syn**=with, together; **thesis**=an arranging) of organic **monomers**, in other words, putting inorganic chemicals like methane, carbon dioxide, and ammonia together to form simple organic chemicals like amino acids, simple sugars, fatty acids, and nucleic acids. This portion of the hypothesis was later tested by an experiment done by Stanley Miller as a grad student under Harold Urey in 1953. He used a sterile, enclosed system consisting of a flask

over a heat source, a spark chamber, and various other tubing (see illustration). He added sterile H_2O, H_2, CH_4,and NH_3 to the sealed system. Heat was applied under the flask to simulate volcanic action, and this was enough to turn a significant portion of the water into steam. A spark chamber periodically discharged electricity into the gasses to simulate lightening. In the return tube, the mixture was cooled to condense the water back into liquid, along with any organic compounds that might have formed from the mixture. Water and all the gasses Miller included are all "clear," thus his experiment started out with transparent water and transparent gasses. However, after only one week, Miller had a brown, murky soup. Subsequent chemical analysis showed the presence of a number of amino acids and other organic compounds. Other researchers have since tried similar experiments with slight variations in the initial mix of chemicals added, and by now, all 20 amino acids, and a number of sugars, lipids, and nucleotides have been obtained in this manner. From this experiment, scientists generalize that if this can happen in a lab, it could have happened in a similar way on early Earth. Note that ALL that was made here was simple organic chemicals!

The next step in going from non-living to living is thought to have been the abiotic synthesis of organic **polymers,** possibly using hot sand or finely divided clay as a catalyst (**cata**=down, downward; **lysis**=loosen, break apart), a substance which helps a chemical reaction to go without being consumed in that reaction, which caused **dehydration synthesis** to occur, thereby joining the smaller molecules into larger **macromolecules** such as proteins, carbohydrates, RNA or lipids.

Thirdly, it is thought that non-living aggregates of these polymers formed. These may have exhibited some properties characteristic of living organisms, but were NOT ALIVE, and did not have all the properties of living organisms. In a research laboratory, scientists have seen mixtures of proteins, lipids, and carbohydrates form globules. If the proteins involved happen to be enzymes, these globules can even carry on "metabolic"activity, although they have no means to replicate themselves. Simultaneous to this, the genetic code would have to have arisen. Several widely-accepted theories as to how this may have happened include the possibly involvement of damp, zinc-containing clay as a catalyst to help the nucleotides polymerize first into RNA, and later into DNA.

It is thought, then, that about 4.1 to 3.5 bya, the first **prokaryotes,** organisms without a true nucleus (like bacteria) came into existence. It is difficult to pinpoint a date for this because bacteria don't have skeletons to leave behind. The first "fossils" (remains of colonies/secretions) of prokaryotes seem to be this age. These would have been very simple cells without many of the organelles present in modern cells, especially modern eukaryotes.

Note that while some of these steps have been demonstrated in a lab, **Nobaoy Has Ever Made a Living Cell in a lab.** While people have demonstrated bits and pieces of this process, the whole process has never been done in a lab. Rather, this is a theory of how things might have happened.

Once the first cells, the first living organisms, the first prokaryotes came into existence, then the Theory of Evolution takes over to provide an explanation for how (not why) these primitive cells diversified into the five kingdoms of life which we recognize today.

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SKETCHES TO A PORTRAIT OF A.I. OPARIN

by

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(Lecture presented at the Opening of the International Symposium "Biochemistry of the 21st Century: Problems and Frontiers", devoted to The One Hundredth Anniversary of the Birth of A.I. Oparin, Moscow, May 13-18, 1995.)

My first encounter with Aleksandr Ivanovich Oparin occurred at Moscow University 72 years ago, and at that time I could not expect that it would start our long-lasting acquitance that extended for so many years and was ended only by his death. On that day long ago I, certainly, did not expect that myself, a former student of Alexandra Ivanovich and an old man today, would be invited to speak at the meeting by which the Academy of Sciences commemorates Professor Oparin's centennial. I want to share with you my memories of those events and encounters of the earlier days which shed light on the personality of Alexandra Ivanovich. Other lecturers will present to you more fundamental tributes of the esteem with which they regard Aleksandr Ivanovich Oparin both as a researcher and an administrator. I want to limit my talk to a few episodes to help you to understand the personality of Aleksandr Ivanovich, his demeanor and his habits.

It was the early spring of 1922 when I first met Aleksandr Ivanovich. The air of Moscow was still full of instability and discontent. The city was cool, starving, uneasy and, by times, dark. Nevertheless, at Moscow Univesity, which was located at that time on Bolshaya Nikitskaya Street, life was proceeding, mostly thanks to the chivalrous attitude of the professors and all the University personnel to their *alma mater.*

One day, when we, the second year students of the Chair of Plant Physiology, had a laboratory class in a big hall of the department, the head and Chair of the department Professor Krasheninnikov, accompanied by an imposing young man, entered the room. This striking young man wore a stylish sport suit of European cut. There was a small Vandyke goatee on the stranger's face, and, what was quite uncommon for that time, he wore a bow tie. In addition, the man pronounced the sound "O" in an accented manner, "as a foreigner" – we first guessed.

In fact, this strong "O" in his speech was a remnant from his native Yaroslavl accent. The bow tie needs a special comment because it was an immutable detail of the Oparin's attire for his whole life. This tie more than just suited him – indeed, it was almost a part of his per-sonality, one that added some aura of self-confidence and authority to his whole demeanor. Many times later I had a chance to be convinced of the correctness of this observation. Over the years, though Aleksandr Ivanovich Oparin aged, very rarely did he ever change his bow tie for a regular one. Let us come back, however, to that day in 1922,

to a moment when a new professor, whose elegant appearance had evoked such curiosity in the students, assumed the Chair of Plant Physiology.

In those days our clothes were poor. We wore Russian felt boots, warm jackets, soldier's capotes, shabby coats, etc. Some of us had bags sown onto the backs of our coats like a materialized symbol of the owner's hope to obtain his food ration, one that consisted mostly of millet and herring. Against such a background, the young well-dressed stranger who had entered our class together with Professor Krasheninnikov looked absolutely imposing.

This man was Aleksandr Ivanovich Oparin. He had graduated from Moscow University, had worked for several years in the chemical industry and that day, after a business trip abroad, was coming back to his *alma mater.* It was he who had to instruct us in laboratory courses and tutor our diploma work.

The return to Moscow University of Aleksandr Ivanovich Oparin was a really important event not only to the Chair, but to the development of plant physiology in the whole country as well. His activity truly helped to transform this science from a descriptive discipline into an experimentally and physicochemically oriented one. By that time a distinct trend had already appeared in the science, namely, to investigate the internal organization of physiological processes. To ovefcome past practice some energy barriers existed; plant physiology needed to absorb more from the more precise disciplines, first of all, from biochemistry. Aleksandr Ivanovich, who was a well educated chemist, soon started to apply this novel trend to train plant physiology students. To propagate it, he started a new lecture course "The Enzymes" that immediately attracted the attention both of the students and the professors of diverse departments.

More biochemical experiments were added to laboratory courses for students, and Aleksandr Ivanovich persisted in his attempts to introduce more biochemical knowledge to future plant physiologists. Occasionally his fervent activity led to unusual consequences. Once, when checking our knowledge in a laboratory class, Aleksandr Ivanovich discovered, to his dismay, just how poor was our biochemical and chemical background. The problem was that, according to the syllabus that then existed, plant physiology was taught to the second year students, while lectures and laboratory courses of organic chemistry started only in the third year. This situation elicited strong opposition from Aleksandr Ivanovich: to him it was nonsence to teach plant physiology to those totally ignorant in principles of biochemistry. In particular, he once told me after conversation in class: "Today is Tuesday, the next class will be on Friday. Please, learn organic chemistry and do pay special attention to the chemistry of carbohydrates, amino acids, - and proteins. And on Friday we will meet again." It was clear, even then, that despite all my 'attempts, I could not in such a short time learn such a large among of organic chemistry. Yet the urgent character of his assignment clearly showed me that modernization of the old merry plant physiology on the foundation of biochemistry could not be delayed any longer. Later Aleksandr Ivanovich used to recall this episode with a smile. To him it was a harsh but efficient way to overcome an energy barrier existing in the mentality of a young student that could help him to realize the true problems and demands of the area.

As years rolled by, Aleksandr Ivanovich Oparin acquired broad fame as a biochemist who founded in this country technological biochemistry, an area in which scientific principles underlie the conversion of plant materials into useful products, and, finally, as the author of the world-famous theory of the origin of life. The audience may not know, however, that for a long time, deep within his being, Aleksandr Ivanovich considered himself a plant physiologist and regarded this area as the base for other experimental biology disciplines. I remember how in the 30s, when Aleksandr Ivanovich was a Deputy Director of the Institute of Biochemistry, he once said to his closest associates (Professors B.A.Rubin, N.M.Sissakyan and myself): "Today, when biochemistry and biophysics are developing so rapidly, we should not forget that by education we all are plant physiologists and that our final goal

should not be limited by detection of new reactions or metabolites existing in plant materials. We need to find what their place and role is in the organism's life, i.e., in development, nutrition, and environmental responses. The researchers working in new areas of experimental biology used to ignore this principle, but such an integration will be very important for the progress of agriculture, technology, and medicine."

Aleksandr Ivanovich payed much attention to technological biochemistry and, more precisely, to the biochemistry of plant raw materials conversion. His interest caused an unambigous response from his colleagues. Although he was ever strongly supported by Academician A.N.Bach, his activity was greeted by a condescending smile in academic circles: people regreted that such a gifted person would waste his talent on a surrogate for real science. Most of the professorate shared this view. To go against this current in a medium of whose part he was and whose opinion respected, Aleksandr Ivanovich had to display a strong nature. Nevertheless, people working in the food industry, especially those close to production processes, were his supporters and they enthusiastically helped him in his attempts to improve these technologies by using the principles of science. Finally, there was a third group, the skeptics. Some of them rejected, *a priori,* the intervention of science into their area. Others, mostly managers of state owned companies and factories, initially displayed readiness to support his (and our) intentions, but they did this just up to the moment they needed to reach the required conclusion- a decision to change or to modify their obsolete technologies. However, after this moment, these people tried to discredit results of the group of "change-causing" biochemists and, thus, to avoid the troubles connected with reorganization processes. They demonstrated complete indifference to the results of their work and Aleksandr Ivanovich had to fight much against them.

Because of all this opposition, valuable results obtained by Aleksandr Ivanovich and his colleagues in collaboration with personnel of tobacco and vine production factories, sugar refineries and bakeries, despite all their best efforts, were not sufficiently adopted in industry.

Tea production was a novel branch of national industry and active attempts were made to establish biochemical studies in this area. After these works had lasted for several years, the laboratories appeared in some tea factories to monoitor the fermentation process. After the Oparin team had finished its works, these laboratories, however, were closed. The existing system paralyzed the initiative, it taught people to fear any risk, and it reinforced indifference to the results of their work.

As a leader and a senior among his collaborators, Aleksandr Ivanovich had two faces. As a head of research he treated his laboratory associates rather formally and never encouraged idle talk. A stranger coming to his lab might feel some distance and even the estrangement that existed between a boss and his personnel. All researchers got much independence and usually their initiative was appreciated. He visited the laboratories not each day and usually just for a short time. Nevertheless, Aleksandr Ivanovich was ever well-informed on the research in progress. When problems appeared, he never hurried with help, but recommended the researcher to think more for himself and to analyze the literature sources more fully. This way to manage people may have been harsh, but, at the same time, it was quite efficient for training mature scientists.

In actuality, however, Aleksandr Ivanovich was an affable person who was close to his associates. We felt this warmth, especially, after we had started our trips to sugar refineries or to the tea factories in Georgia. The unaccustomed living conditions united us around our boss. In such a situation we found how friendly, witty, and broadly educated a person was Aleksandr Ivanovich, and what good company he was.

His imposing demeanor used to impress local people, especially those of Georgia where one's deportment is so highly rated. One summer we were working in Adzharia. News about a famous Moscow scholar, who wore gold rimmed spectacles and who came escorted by other less important scientists

to disclose all secrets of tea production, immediately spread from the Anasseuli hill, the place where the Institute of Tea Research was located. The rumor pentrated to neighboring villages and reached small farms scattered on hills.

One Sunday our whole group, headed by Aleksandr Ivanovich and accompanied by some Georgian students, went for a walk to a scenic place in the foothills. The day was hot, and after ascending a hill we got tired. For a buoyant Georgian, the Institute's supply manager, to climb this hill was much casier than for Aleksandr Ivanovich. This Georgian, a convinced sketic of science, said ironically to Aleksandr Ivanovich: "I feel, it is much easier to write your books than to climb hills, is it not true, Professor?" Unexpetedly, Aleksandr Ivanovich who to that moment had become fairly tired, now felt himself quite hurt.

Happily, soon we reached a small farm and asked permission from its owner, an old Adzharian peasant, to drink water from his well and to gather plums from an old wild tree full of ripe fruits. The peasant spoke almost no Russian and our Georgian companions had to interpret. AT first the man was rather indifferent, and just said that he did not object to our presence. But after the old peasant had been told that the man he was talking to was the famous Oparin, his attitude immediately changed and he invited all us to be his guests of honor. Aleksandr Ivanovich wanted to pass to his garden and went to a gate, but the peasant started to protest most emphatically. He called his two adult sons and ordered them to destroy a fence at the place where Aleksandr Ivanovich was standing. Then he was triumphantly led directly into the garden. Events developed in a more and more ceremonial way. Aleksandr Ivanovich was invited to sit in the shadow of a big tree and two grandsons helped him off with his shoes. Then came an old lady, probably the peasant's wife, followed by two her daughters-in-law, with a jar full of water and a clean towel. The old lady bent her knees before Aleksandr Ivanovich and started to wash his feet, totally ignoring his protests. After the ablution ceremony had finished, the young ladies cleaned his shoes and put them on him. Then the old peasant and his elder son returned from the house via a porch holding a tray with small glasses of very strong plum spirit ("cha-cha"). The most important moment was approaching: the whole family, including little children, gathered on the steps, and the old man said a speech which, after that which had gone before, needs no translation. We finished the day at eheir Georgian dinner table, full of foods and good wines, many toasts were proposed, and Aleksandr Ivanovich delivered a very nice speech on the occasion.

Before leaving, we asked the Georgian students who had escorted us, how we should compensate the peasant for his expenses. They insisted that in order not to hurt this man, we should not even try to do it; by their fear we easily realized that for him, this generous Georgian peasant, all this reception was a matter of honor. At parting Aleksandr Ivanovich invited the old man to come to Moscow and promised to send him a book on how life had emerged on the Earth. (I have a feeling that at this moment Aleksandr Ivanovich victoriously glanced at the skeptical supply manager). The peasant, in his turn, said that he was proud that Professor Oparin had been his guest and that he could receive him in a proper way. He was going to tell his friends and relatives how the Professor had invited him to Moscow. His plans were to come together with his youngest son to look for a Russian fiancée for him. The book, he said, will be kept in his house to show to friends and visitors. The events that came, and the war totally disturbed these plans.

Aleksandr Ivanovich was an energetic person, one who did not like when planned events were delayed or destroyed. At the same time, he managed to organize his work in a way such that his associates were responsible for most of the routine laboratory duties. Therefore, despite of his numerous activities, he had enough time for thinking and relaxing. Aleksandr Ivanovich highly valued his order of the day and hated to disturb it. In particular, he never wanted to abandon his habitual siesta. Without it he would lose his vigor and would become irritable.

I want to recall one more episode I witnessed. It happened during our trip to a tea factory located in an isolated part of Georgia. To come there we had first to change trains, than take a full and jarring bus and, at last, to walk about two kilometers. It was morning when we reached the factory and its director. He did not express too much enthusiasm when meeting us.

Apparently, Aleksandr Ivanovich did not pay attention to this slight. After he and director had changed pleasantries on the difficulties of travel, he left the director's office and was in their laboratory up to noon. An important meeting had been arranged after lunch, and directors of many neighboring tea factories were expected to come. Local authorities were going to arrive too. At this meeting Aleksandr Ivanovich had to deliver a lecture to illustrate the significance of biochemical monitoring for industrial tea fermentation. After lunch there was no time and apparently no place for his siesta. Aleksandr Ivanovich easily settled this problem in his own way. He came out to the empty factory yard and went to its edge where a big tree was standing. Then he put two newspapers on the ground in the shadow of this tree; laid himself down on these papers with all possible comfort; took off his gold rimmed spectacles; and fell asleep.

The respect to him was so great that both the personnel and the local authorities were totally shocked by this action. A circle of spectators surrounded the tree, keeping a good distance from it. They commented on the situation in low voices, so as not to disturb the sleeping professor. After half hour or so Aleksandr Ivanovich woke up, threw the newspapers into a trash box, and in his best spirits went to a workshop where a meeting was just about to start. In a short time, news of this event spread over all tea factories of the area and even reached Tbilisi. As a result, the local factory's director was repreimanded by his boss, head of a state-owned company. I am still curious as to what dominated in this episode: an attachment to a habitual order of the day, or the reproach to the factory's administration for a not-too-hospitale reception, probably both. Later Aleksandr Ivanovich never mentioned this story in our circle.

In official environments, such as big receptions or international conferences, Aleksandr Ivanovich was always full of dignity, even of elegance. Always wearing a well tailored and suited – to-season costume, with his immutable bow tie, he was ever attracting people's attention at any aseembly. Personnel of big international hotels especially treated him with distinction. The experienced eyes of those people easily recognized him as a VIP, probably a financial or political boss. They ever tried to surround Aleksandr Ivanovich by special attention and provide for him additional comfort that could be a too expensive pleasure, and by time it really caused troubles for Aleksandr Ivanovich. But that could be a" subject of another talk. I have already trespassed your time and now will finish my talk about Aleksandr Ivanovich.

These my memories are just fragmentary ones. My deficiencies come not only from the weakness of me as a lecturer, but as well from the fact that single speech can hardly outline the full image of such a versatile personality as that of Aleksander Ivanovich. I do hope, however, that my sketches will help the audience, especially those who did not know Aleksandr Ivanovich well, or did not know him at all, to get some impression of this man, who was with no doubt an outstanding figure of the Russian intelligentsia. This man never lost his individuality and, at the same time, he actively influenced life and the needs of his, and our, long suffering country.

Source : *Evolutionary Biochemistry and Related Areas of Physicochemical Biology*

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THE ORIGIN OF LIFE : FROM OPARIN TO THE PRESENT

by

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(Lecture presented at the Opening of the International Symposium "Biochemistry of the 21st Century: Problems and Frontiers", devoted to The One Hundredth Anniversary of the Birth of A.I. Oparin, Moscow, May 13-18, 1995, Professor Cyril Ponnamperuma died December 22, 1994)

It is indeed a great privilege for me to commemorate one of the greatest scientists the world has ever known, Aleksandr Ivanovich Oparin. We are gathered here as friends, as students, and as scientists who have followed in his footsteps and have tried to emulate a man of rare 'intelligence, perception and ability. In the words of the poet

"he doth bestride this narrow world
like a Colossus, and we petty men
walk under his huge legs, and peep about
to find dishonorable graves".

Indeed Aleksandr Ivanovich Oparin was a giant among scientists.

The contribution he has made to our knowledge is beyond our ability to assess. Generations of future scientists would do justice to his work. A single book by Oparin revolutionized our thinking on one of the most profound subjects that science has investigated the origins of life. In 1924 as a young biochemist working at the University of Heidelberg he organized his thinking and published the paper "Proiskhozhdenie Zhizni". This treatise indeed had the germ of a true intellectual revolution. His book on the origin of life written in 1938 was translated into English by Sergius Magulis. The moment this book reached the English speaking audience it was devoured as no other book in the scientific world had been. Noble prize-winning scientist George Wald described how as graduate students they stopped their lab work when this book arrived. They read it privately in groups to absorb the new thinking and understanding of one of the most difficult problems of all science.

Why was it that Oparin made such a difference? Many books have been written on similar subjects before by others. The answer lies in the fact that Oparin was an unusual scholar. He looked upon a problem which was philosophical in essence but brought to bear upon it, history and all science. His book referred liberally to the philosophy of Aristotle of ancient Greece and brought to bear upon in the work of the Christian savant Augustine and described in detail the scientific work of Louis Pasteur. Although a biochemist by training Oparin moved freely from Astronomy to Chemistry, from Geology to Biology. Indeed, he personified the true student of chemical evolution as described to us by J.D.

Bernal who said, “Even the formulation of this problem is beyond the reach of any one scientist. Such a scientist would have to be at the same time a competent mathematician, physicist and experienced organic chemist. He should have a very extensive knowledge of geology, geophysics and geochemistry and besides all this be absolutely at home in all biological disciplines.” What Bernal wrote in 1948 Oparin had already revealed in the twenties. His vast knowledge of chemistry, biology, and astronomy was brought to bear on this one subject when he looked at the basic question of life’s origin from every point of view.

Pardon me for striking a personal note today. It was my great pleasure first, to have met Aleksandr Ivanovich Oparin at the Wakulla Springs Conference in 1963, which was convened by Sidney Fox.After the first memorable meeting on the origin of life held in Moscow in 1957, the Wakulla Springs gathering stood out as the landmark. NASA has just begun its work on exobiology. The National Academy of Sciences of the United States had set down the search for extraterrestrial life as the prime goal of space biology. Great activity sprung up from many angles especially in relationship of the origin of life to the possible existence of life beyond the Earth. At this conference also present was another great thinker in this field, J.B.S. Haldane. To us who were then novices in the knowledge of the field of the origins of life there Oparin stood as a giant. From Wakulla Springs, we moved to our next highlight in this sequence, at Cortina D’Ampezzo a meeting organized by the International Radiation Research Conference in the beautiful setting of the Dolomites. At a special symposium on the Origin of Life I was privileged to be associated with Oparin. It was at this meeting that, in his room overlooking the craggy hills that Sidney Fox and I sat with him and laid the groundwork of the future Society for the Study of the Origin of Life . This international group which today numbers about 500 all over the world was born in that beautiful setting with Aleksandr Ivanovich Oparin as President, Sidney Fox as Vice-President, and me as the Secretary. From Cortina began a whole series of meetings. Aleksandr Ivanovich travelled to California to the NASA Ames Research Center where he spent a most profitable period interacting with the scientists, lecturing at all the major institutes and being recognized by generations of scientists as a man who had opened the doors to the study of the most important problem of all science, the origins of life. Oparin was a frequent visitor to the Laboratory of Chemical Evolution at College Park where he participated in the Colloquia on Chemical Evolution. In 1977 after the Viking Landing on Mars was held a meeting in Kyoto. Oparin stood among his fellow scientists as the Father of the Field. It was at this meeting that the International Society decided to establish the award of the Oparin medal to be given for the best performance on the Origins of Life. At a subsequent meeting held in Jerusalem in the year 1980, I was privileged to have received the first Oparin Medal.

From a scientific point of view, one of the greatest contributions that Aleksandr Ivanovich made was his careful analysis of the nature of the primitive atmosphere. He suggested that the carbides may have given rise to hydrocarbons. Indeed, the carbides may have come from meteorites that have fallen to the earth. The presence of hydrocarbons in meteorites have been established by Wohler when he analyzed a piece of the Kaba in 1857. Oparin’s professor who was himself a student of Mendeleev had suggested that the carbides from the crust of the earth and reacting directly with water may have given rise to hydrocarbons and here then was a source of the reduced carbon necessary for the organic molecules.

He realized that amino acids had to have reduced nitrogen and he argued that the primitive atmosphere had to be non-oxidizing. As a matter of fact, he

concentrated very heavily on the possible role of the CN fragment. This is today remarkable in the light of the organic chemistry related to chemical evolution which has revealed how hydrogen cyanide is a key molecule in the synthesis of the bases and the amino acid. Oparin looked at the whole question of polymerization. Here he was able to correlate some of the organic chemical work of Berthelot and others. He alluded to the question of asymmetry which is even today one of the most vexed problems in all of chemical evolution. He looked at the protein linkages and suggested that they may have been a basis of the colloidal systems which eventually led to the coacervates and then to the cells. We thus have an opportunity in considering his work to go from the atoms to the molecules to the polymer to the enzymes and to the very origin of the cells.

While emphasizing the need for the study of the chemistry of the cyanide molecule Oparin realized that fundamentally the main question had to do with organization. According to him, "at first there were the simple solutions of organic substance whose behavior was governed by the properties of their component atoms and arrangement of these atoms in the molecular structure. But gradually as a result of growth and increasing complexity of the molecule new properties were coming to be and a new colloidal chemical order, was imposed on the most simple organic chemical relations. These new properties are determined by the spatial arrangement and mutual relationship of the molecule. In this process biological order is already coming into prominence." Taking his cue from the work of the Dutch physical chemist Bungenberg do Jong, Oparin looked at the formation and concentration of materials from dilute solutions. He realized that coacervates could easily be contained under laboratory conditions by the simple mixing of solution of different proteins and other substances of high molecular at ordinary temperature and in most cases with very little acidity. Molecules taking part in coacervate formation which were previously distributed evenly throughout the solvent. They now appear to unite with one another at particular points in the liquid space to form swarms of clumps that separate them from the solution until they reach a particular size. They appear to be very well defined. Indeed here are the coacervates which could have been the forerunners of the modern cells.

In the monumental studies that he did on the coacervate droplets he showed that they could have an internal structure which are quite different form those found in simple droplets of liquid. In a series of very comprehensive experiments he showed how easily these reactions could take place within the coacervates. Indeed in some of them he showed how enzymatic reactions could be possible. The whole school of Russian scientists who worked on coacervates owe their knowledge and their background to the first experiments of Aleksandr Ivanovich Oparin. He argued further that from these molecules complete multi-molecular systems could have been formed. The condition of these coacervates was determined not simply by the external medium but also by the specific internal organization more than space and time. Many suggestions have been made about the possible origin of the cell. No model fits so well as the coacervates and for this work we owe a debt of gratitude to Oparin.

Oparin's reflections on the origin of life led to the possibility of life beyond the earth. Oparin had postulated that the condition suitable for the origins of life had existed on the primitive earth. Modern astronomy tells us that there are billions of other possibilities for planets in the universe. If this is indeed the case, life must exist elsewhere in the universe. Great efforts have been made in the search for life beyond the earth. Our analysis of meteorites has given us the very building blocks of life. Amino acids and bases have been found in many

meteorites, the Murchison especially which was a landmark in the study of carbonaceous chondrites. Radio astronomers directing their telescopes to the interstellar medium have found a whole array of organic molecules. Something which was earlier considered unthinkable we find today in the interstellar medium. Organic matter appears to be abundant in the universe. The universe appears to be in the process of generating life. If that is indeed the case then life must exist elsewhere in the universe.

In 1976 to celebrate the 200th anniversary of the birth of the United States, two spacecraft were landed on Mars, the Viking I and Viking II. Samples of Martian soil were analyzed. No organic matter was found, however the biology experiment seem to indicate some kind of microbial activity. This result at that time was dismissed since there was no evidence of organic matter but after all these years of analysis and speculation we seem to consider now the possibility that there was indeed some microbial activity on Mars.

Today our search for life beyond this earth has led the radio astronomers to explore the possibility of extraterrestrial intelligent signals. We must concede that life elsewhere must have evolved to the point of intelligence and the extraterrestrial beings must have a technology perhaps equal to or more superior than ours. Signals emanating from their radio sources may eventually demonstrate to us that there is life out there. This entire space odyssey from the molecule to the microbe to the living organism to the possibility of extraterrestrial intelligence can all be traced to the work of Aleksandr Ivanovich Oparin whom we celebrate today. In retrospect we might say that what Darwin was to biological evolution, Oparin was to chemical evolution.

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HUMAN HISTORY AND EVOLUTION: FROM DARWIN TO MY STUDENTS

by

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1. THE TEETH ARE IN MY POCKET !

During the autumn of 1976, Academician Oparin and his charming effervescent wife, Nina Petrovna, spent two months at University of California at Los Angeles (UCLA) where Aleksandr Ivanovich served as a Senior Visiting Professor in my laboratory. For that academic term, I had organized a special course, "Major Events in the History of Life", each week devoted to an important development in biological evolution. Professor Oparin led off with his standard enthusiastic lecture on the origin of life; the next week I discussed the "early history of life"; and in subsequent weeks a series of distinguished scientists dealt with such topics as "the origin of animals" (presented by the Steve Stanely of Johns Hopkins University), "the origin and evolution of the earliest land plants" (Harlan Banks, Cornell University), "dinosaurs and the history of vertebrates" (Everett Olson, UCLA) and, toward the end of the ten-week term, "the nature of the evolutionary process" (Ernst Mayr, Harvard University).

Academician Oparin was, of course, internationally famous; understandably, quite a number of my faculty colleagues wanted to meet him. I therefore organized a series of weekly cocktail parties, every Tuesday evening at my home, so that my colleagues and their wives could meet the Oparins and the other lecturers. It was a taxing term, with numerous visitors in addition to the Oparins, and after four or five weeks of frantic activity I was worn out. I came home from the lab early one Tuesday afternoon and crawled into bed, planning to get a couple of hours of rest before the evening's festivities. About twenty minutes later, the phone rang; it was Nina Petrovna – Aleksandr Ivanovich had broken the dental bridge that held his teeth together. What should they do? I rushed over to the Oparins' apartment. Aleksandr Ivanovich greeted me at the door. In my "best" Russian, I said: "Gidyeh vashee zubee?" (Where are your teeth?) Eyes sparking, he laughed and patted his shirt pocket: "Vuh karmanyeh!" (In the pocket!) He could speak, but he couldn't chew!

Before I had left home, I had called our family dentist; I was in luck- his schedule was open. I took the Oparins to the dentist for an emergency visit. While I sat (and snoozed) in the waiting room, the dentist worked on Oparin's teeth (with Nina Petrovna by his side, translating for her beleaguered husband). After nearly three hours (and implantation of some $400 worth of finely worked gold), the bridge

had been rebuilt. I was gratified, but I was apprehensive – the cost was likely to be $1000 or more, the Oparins had no health insurance (dental service being free to citizens of the Soviet Union), and because they were my guests it would have been improper for me to have expected them to pay. In private, I told the dentist that I would pay the costs, personally, but that it would be easiest for me if I could cover the costs Over a period of several months, preferably in installments of perhaps $250 each. He replied: "Oh no, that's not necessary. I have a long – established rule of not charging visitors for emergency dental work –it would spoil their California vacation!" I was astounded. This was one of the most humane gestures that I had ever seen!

The three of us arrived at my home on time for the Tuesday evening cocktail party; Academician Oparin and Nina Petrovna immediately returned to their normal jovial spirits, as though nothing unusual had happened. I did n't know at the time whether the Oparins realized just how generous the dentist had been – but I suspect that they did, because I later learned that upon their return to Moscow they sent the dentist a sterling silver samovar, a splendid gift to symbolize their feelings of Soviet – American friendship.

2. HUMAN HISTORY AND EVOLUTION : FROM DARWIN TO MY STUDENTS

It was important to me that UCLA students have an opportunity to meet and talk with Academician Oparin during his visit. I therefore invited 12 or 15 students each week to have lunch with the Oparins, and arranged for a translator (my former Russian teacher) to be present so that there could be useful conversation. On one of those occasions, I asked Aleksandr Ivanovich to tell the students how it was that he had become interested in the problem of the origin of life. In answer, he told the following story, one that speaks not only of Oparin's personal history but that also illustrate the human side of science.

Aleksandr Ivanovich was brought up in Uglitch, a few hundred kilometers east of Moscow. In the early 1900s, in Oparin's youth, Uglitch was not yet industrialized, a rural center that for the most part lacked paved streets. As a result of competitive examinations taken during their senior year in high school, Aleksandr Ivanovich and a classmate had been accepted to attend Moscow State University . During the spring of that year, 1912, the local science teacher arranged for them to spend a day visiting the university. On the appointed day, however, they missed the morning train; when they arrived at the university, late in the afternoon, they had time to attend only one lecture. Because his rural background had stimulated a keen interest in botany, the young Oparin chose to attend the lecture of K.A. Timiryazev (1843-1920), the foremost Russian botanist of the day and (unlike some biologists in Czarist Russia) a confirmed Darwinian evolutionist. Professor Timirya-zev, then an eldery man, spent the lecture telling how he, early in his career, had become a proponent of Darwin's views. About 1870, little more than a decade after publication of The Origin of Species, Timiryazev, then in his late 20s and a recen graduate of Moscow State University, had traveled to Downe House, Darwin's home in Kent, on the outskirts of London, hoping to meet and talk with the great evolutionist. Darwin was ill (as he often was in his middle and later life), but Timiryazev was persistent; he returned daily for more than a week and, finally, Darwin granted him an audience. They walked the "sand path" behind Downe House, the pebbled track through the woods where Darwin often went to think, and they talked of evolution. Timiryazev became convinced; Darwin must be right! The youthful Oparin, too, was soon convinced, but as he sat listening to Professor Timiryazev, he noticed what he thought was a gap in the evolutionary story-

Darwin had focused largely on the evolution of animals and Timiryazev was a specialist in the evolution of plants; but where did animals and plant come from? How did life originate? As Academician Oparin recounted to the students around the lunch table, "Darwin had written the book, but it was missing its very first chapter" – the crucial introduction to the evolutionary story that Aleksandr Ivanovich sought to write throughout his illustrious career.

My recollections of that luncheon are vivid. It was amazing to realize that there was a direct human lineage from Darwin as an old man to Timiryazev in his youth, from an aging Timiryazev to an aspiring young Oparin, and from an elderly Oparin to us! The short human path that linked us to Charles Darwin was awe inspiring. The students were thrilled! And so was I!

A photograph of Academician Oparin surrounded by those students hangs in a place of honor on my office wall . Aleksandr Ivanovich and Nina Petrovna were generous, and kind, and inspiring to me and my students. They are remembered. They are missed.

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A GREAT ENCYCLOPEDIST OF THE TWENTIETH CENTURY

by

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It is often difficult to properly assess the contributions of scientists to society during their lifetime, especially if you work with them and see them every day. It seems that they are like us and even have certain weaknesses. Only later, after their death, their role in the advancement of science becomes absolutely clear and their activity can be appraised objectively.

I met Aleksandr Ivanovich Oparin in 1969, when we were invited to the 6th Meeting of the Federation of European Biochemical Societies in Madrid and found ourselves aboard a plane flying from Moscow to Paris, where we had to change to the Spanish airline.

As I got to know Academician Oparin, I noted two characteristics in him. On one hand, the outwardly cool mask concealed an inquisitive and zealous soul responding to various events of everyday life. Oparin displayed an ingenuous perception of events and keen interest in art. On the other hand, he was a distinguished scientist whose works had gained world recognition and who demonstrated great persistence in attaining his goals.

We spent a day in Paris before flying to Madrid, I remember the tireless energy of Aleksandr Ivanovich, how he wanted to share his impressions with me, take me to places dear to his heart, visit an exhibition of impressionists, etc. Though I was much younger, I did not have enough strength to do everything he wanted.

I felt the popularity and high scientific authority of Academician Oparin immediately after we set foot on Spanish soil. After we went down the ramp, I was pushed away by a crowd of people who had come to welcome the guests. Some students, having learned that the Academician was "the very Oparin they had heard about" asked for his autograph. The main organizer of the congress, Nobel Prize holder Severo Ochoa, presented his respect to Aleksandr Ivanovich. The Academician was given many such honors throughout the congress.

The range of Oparin's scientific interest was extremely wide. He substantially contributed to enzymology and is rightly considered a founder of industrial biochemistry in Russia. But the theory of the origin of life, highly appreciated by the world's scientific community was Oparin's crucial work, which gave impetus to all his activities.

This problem is extremely complex. The human mind cannot realize it fully, just as it cannot grasp infinity and relations of various forms of matter. The earthbound world is highly limited and concrete. That is the reason why the human thought can only originate from a real situation and lean upon the

experience which has been accumulating from generation to generation.

We should give credit to A.I. Oparin just for his ambitious attempt to solve this problem using the data of physical chemistry and conforming to mere common sense. Though we are aware of the fact that this approach is not the only one.

A.I. Oparin greatly contributed to the development of the A.N. Bach Institute of Biochemistry. In the grueling years of Soviet Science, especially biology, he managed to preserve the Institute and to recruit outstanding biochemists, many of which later were at the head of scientific institutions. I mean Academicians V.A.Engelhardt, A.L.Kursanov, A.A.Baev, A.N.Belozersky, A.S.Spirin, A.A.Krasnovsky, N.M.Sisakyan and many others.

Oparin's activities gained general recognition during the lifetime of the scientist.

A.I. Oparin took an active part in organization of the International Society for the Study of the Origin of Life (ISSOL). An International Oparin Medal awarded for outstanding work in the field of evolutionary biochemistry and the origin of life was instituted by ISSOL in 1977 during the lifetime of the scientist.

Just in those days J.Farley wrote a book entitled *"The Spontaneous Generation Debate: From Descartes to Oparin"* (Baltimire: Johns Hopkins Univ. Press. 226 pp.), stressing, in his way, the outstanding role of the Russian scientist and ranking him with the greatest thinkers of humankind.

Not long before his death, A.I. Oparin came to Mexico and was very much surprised when he was invited to a secondary school where he saw soccer players in T-shirts with his name on. The school was named in his honor.

Fourteen years have passed since the death of A.I.Oparin, but the mail addressed to him is still coming.

The name of Academician Oparin has firmly received a place in the history of science and I am absolutely convinced that humankind will remember him for many centuries.

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A.I. OPARIN: PERSONAL ENCOUNTERS AND REMINISCENES

by
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1. Introduction

When I was first asked by Professor B.F. Poglazov to write a personal article on Oparin, I accepted the invitation with pleasure, only to find out later that it is much easier to write about one's laboratory experiments, than to search your own mental files to remember accurately the past experiences of one's life. Therefore, this is a limited account of the different times that I had the opportunity to visit Moscow, or other places of the globe, and paticipate in scientific meetings together with A.I. Oparin. He was always accompanied by his charming wife Nina Petrovna and I also had at my side my companion and beloved late wife Paquita. In general, the meetings were in the area of biochemistry and more specifically, they were concerned with the problem of the origin and early evolution of life, to which Oparin had dedicated all his professional life.

I will not review the historical developments concerning the ideas and theories on the origin of life, or the scientific accomplishments of Oparin in this field. This has been done by Professor A.Lazcano in an article in this volume which offers an excellent balanced biographical perspective on Oparin, and his theory [1]. In addition, it provides key historical references in this subject matter. As Professor Lazcano has said, A.I. Oparin contributed not only the first critical scientific theory of the origin of life but also reasonable ideas about early biological evolution. Of course the best sources of scientific information on Oparin's original theory are to be found in three books. A short one which was published in Russian in 1924, translated into English and published as part of J.D.Bernal's book [2]. The second more complete book was published in Russian in 1936, and in English in 1938 [3], book which can be read profitably even today by experts in the field. The third thoroughly revised and enlarged edition was published in English in 1957 [4]. As it is well known, it was precisely in the 1950-1960 decade that, the first two successful experimental tests supporting Oparin's theory of chemical evolution of the synthesis of biochemical compounds under possible primitive Earth conditions were carried out in Miller's [5], and in my own laboratory [6].

Other interesting insights about Oparin's theory and experimental work can be glanced from the record of the presentations and discussions where Oparin participated, which include those held in Moscow (1961), Wakulla Springs, Florida (1963), Tokyo (1967), Madrid (1969), Pont-d-Mousson (1970), Barcelona (1973) and again Moscow (1974), city which we visited on several occasions.

2. MOSCOW 1961

This was the first time that my wife and I visited Moscow. It was on occasion of the celebration of the Fifth International Congress of Biochemistry,

organized by the USSR Biochemical Society under the auspices of the International Union of Biochemistry and other institutions. The President of the Congress was A.I.Oparin, and it was held at the University of Moscow from the 10 through the 16 of August in 1961. Without question, this was one of the major international congresses ever held in Moscow where some two thousand scientists participated. In it, Marshall Nirenberg, presented the experimental studies deciphering the genetic code, a major breakthrough in biochemistry, which caught the audience by surprise since Niremberg's abstract [7], sent well in advance, did not make any mention of such an important discovery. There was a Symposium on Evolutionary Biochemistry (Symposium HI) presided by S.Ochoa and directed by A.I. Oparin where Oparin made an interesting presentation on the "Origin and Evolution of Metabolism", and a regular session (Section 28) on biogeochemistry. In the latter, I presented our recent findings on the formation of purines under plausible primitive Earth conditions [8]. Also in this session, a young Russian researcher G.P.Vdovykin presented his interesting work on the organic matter found in meteorites, work that since then, he has continued systematically and published in a book in Russian in 1967, translated to English and published by NASA in 1970 [9]. It is of interest that in this meeting, Professor Oparin and his coworkers Serebrovskaya and Auerman also presented one of the earliest papers on the "Synthesis of Polyadenylic Acid in Coacervate" [10], where the enzyme polynucleotide phosphorylase discovered by Ochoa and Grunberg-Manage was included in coarcervate drops which had a surrounding medium of ADP. This was probably one of the first published demonstrations that coacervate drops can act as realistic models of protocells.

On 'occasion of this meeting, I also met Academician Vasily Fesenkov from whom I had earlier received reprints and other information on the Tunguska explosion. This occurred in Siberia in the morning (7.17 am) of June 30, 1908, and apparently according to I.S.Astapovich and other authors [11], it was caused by a small comet, or a comet fragment, exploding in the atmosphere, above the epicenter of a forest region which was flattened within a 50 km diameter or more. Recent findings on the presence of ammonium formate in the 1908 sedimentary layers of Greenland ice appear to confirm the earlier information I received from Vasily Fesenkov, which is briefly discussed in Section 6. They also attest to the global magnitude of the explosion.

It turned out that earlier observations and other cometary and laboratory data [6] had previously inspired me to develop the theory on the role of coments in the formation of biochemical compounds on the primitive Earth [12]. This appears to be one of the realistic alternatives available for the origin of life on Earth, if the Earth – Moon system was formed by a single major impact which led to extensive melting of the Earth and the Moon, and the subsequent loss of any water and light biogenic elements to interplanetary space [13]. The new theory [12] is complementary to Oparin's chemical evolution theory of the origin of life [4], but it emphasizes the exogenous cosmic source of water and organic compounds from comets, during the late – accretion phase of formation of the Earth [13].

This first meeting in Moscow became also a memorable event for us, since our last son David, now a physicist working at the Los Alamos Laboratory, N.M., where the first atomic bomb test was performed, was almost born in Moscow, when we arrived there after a long trip from the USA. Fortunately, the false alarm was easily resolved, and I remember with pleasure the dinner that we were offered by Professor Oparin on behalf of the USSR Academy of Sciences attended by Nina Petrovna, and members of the Moscow, Leningrad and other branches of the Academy of Sciences and several foreign scientists.

During the dinner, a surprise took place when the main dish was presented, which had the strange shape of a conical ballistic configuration and a nice brown color on the surface. Professor Oparin

announced before starting that we should be very careful since it was an atomic bomb. Curious, unbelieving looks were exchanged between my wife, myself and other foreign scientists. In fact, it turned out to be a juicy treat. Apparently, it was a deboned big leg of turkey or chicken within a toasted dough cover, with butter inside, under high pressure. A not too careful use of the knife may have led to a minor explosion. Needless to say, there were no victims or damage done to anyone. Any surprised guest was easily cured with vodka first and champagne later.

3. WAKULIA SPRINGS 1963

After the first special symposium or conference on the Origin of Life which has been held in Moscow in 1957 and published in 1959 [14], the next major conference was held at Wakulla Springs, Florida on October 27-30, 1963 and published in 1965 [15]. An interesting meeting was organized by Professor S.W. Fox with the help of the Nationla Aeronautics and Space Administration, Drs. F.H.Quimby, R.S.Young and others. Perhaps the singularity that characterized this USA meeting was the presence of two of the foremost pioneers in the studies of origin of life form the old continent Professors A.I. Oparin and J.B.S. Haldane," and a group of well known biochemists and active researchers in the field from the United States, Japan, and other parts of the world.

Professor Akabori pointed out to Dr. Fox that it was a happy coincidence of terminology that this conference was held at Wakulla Springs, since the first four letters of Wakulla are those of the Japanese word "Waku" which signifies spontaneous life. In this line of thought, one is also reminded of the Sanskrit word "Jeewanu" that the ancient Hindus in the Vedas considered as fundamental particles of life [16], which according to legend, they could be self-organized to generate spontaneously living systems.

In his introductory lecture Professor Oparin remarked how the view of the spontaneous generation of life, which we inherited from remote antiquity and classical Greece was perpetuated through history until the last three centuries.As we know these simplistic ideas, were refuted by the experimental work of Spallanzani and Pasteur. Oparin judged these two scientists with a scientific heroism comparable to that of Copernicus. The old beliefs were fostered by the supposed "common sense" observations which are readily misinterpreted. In these two cases, they are the apparent rotation of the Sun around the Earth, and the apparent spontaneous formation of living beings from decaying organic matter.

Oparin also reminded us that Dawinian evolutionists made the problem more acute since they demanded an answer to the question of the origin of the primordial organism from which all others developed. And eventhough Tyndall, Shaeffer and Timiryazev assured an evolutionary origin from inorganic nature they found themselves at an impass and within a vicious circle, since the generally accepted view was that all organic substances can arise only biogenetically from living organisms, in spits of Wohler synthesis of urea from ammonium cyanate. He then referred to the composition of the primitive Earth that was the source of reduced organic compounds in the primordial soup, necessary for the origin of life. But Oparin's major presentation was on the pathways of the primary development of metabolism and artificial modeling of protocells in coacervate drops. Oparin emphasized, as a major point, that it was not so much how the primeval "soup" was formed but rather how the first organism arose out of this primitive sterile organic environment. In this context, Professor Haldane considered a replicative RNA molecule as one of the possible first blueprints of life.

Aside from the many scientific questions which were debated, there was an interesting observation which I made when we took a bus trip to the forested surroundings of the site. Upon arriving at a certain point, the bus stopped. I remained still and observant for a moment, and I saw how without any previous

directions, Prof. Oparin, Nina Petrovna and the whole crowd started to walk in mass in one direction. It was in the direction of the shore of the lake, that is , in the direction of the water. Eventually, most of us touched the water with our hands. I could not but reflect on this magnetic attraction or atavism that must be genetically ingrained in our brains since the earliest origins of life.

The celebration of the 70th anniversary of A.I. Oparin's birth, took place in Moscow in 1964. I was asked by Professor Kretovich to send a paper for Oparin's 70th Year Jubilee. I was pleased to do so, and the article [17] became part of the book published in Russian in 1964. Professor Oparin was kind to send me a warm greeting with a copy of the book, which contains many articles of scientists working on the origin and evolution of life.

4. TOKYO 1967

The Seventh International Congress of Biochemistry was held in Tokyo on August 20-25, 1967, and was organized by the Science Council of Japan under auspices of the International Union of Biochemistry. The opening remarks were made by Shiro Akabori [18] President of the Congress. The two major addresses were given by Severe Ochoa, President of the International Union of Biochemistry (IUB) and by A.I.Oparin Vice-President of IUB.

As we know, Professor Akabori had worked on the abiotic synthesis of polypeptides, experiments which left a strong impression on Professor Oparin. Professor Ochoa, in addition of having a strong interest on the origin of life as related to me in 1952 [19], had discovered , with Grunberg-Manago, polynucleotide phosphorylase, enzyme which Oparin successfully used in his first enzymatic experiments with cbacervates. A Colloquium on meteorites, Precambrian sediments and origin of life was organized where Elso Barghoorn, Cyril Ponnamperuma and I participated, and a program on "Life in the Universe" was aired by Japanese Television where we were interviewed.

But perhaps what I remember most pleasantly of this Congress is the dinner to which Professor Akabori and his wife invited Professor Oparin, Nina Petrovna, my wife Paquita and I. It is not easy to sit for dinner without chairs, but, we somehow managed in a reasonable comfortable manner sitting on the floor in a traditional Japanese restaurant. With our joyful wives, we were three men with common interests on the origin of life, notwithstanding the fact that according to my wife, she had more experience on the origin of human life than me. At any rate, being concerned about the roots of things, I used this relaxed occasion to ask Professor Oparin how did he come to the idea of studying the origin of life.

Even though, I probably should have known it, it was nonetheless a pleasant surprise for me to hear directly from him that the roots were to be found in D. Mendeleev. According to Oparin, Mendeleev thought that the origin of petroleum was the result of the passage of water from the deep interior of the Earth through geological formations where iron carbides exist. Presumably, the hydrolysis of iron carbides by superheated steam under pressure led to the formation of the hydrocarbons which constitute petroleum, Oparin made an extension of this reasoning. If petroleum is so rich in organic matter, why could not be the primitive Earth a planet where extensive abilogical synthesis of the organic compounds necessary for life took place. Of course, we know now that petroleum has a biological origin, but the beautiful irony of this extrapolation is how, from a wrong hypothesis one can be led to a good one.

At any rate, Mendeleev's proposal was not completely wrong since experiments done some time ago in my laboratory with iron and other metal carbides demonstrate how a sequence of saturated and unsaturated linear hydrocarbons, namely alkanes and alkenes from C, through C_8, can enequivocally be synthesized by hydrogenolysis of pure metal carbides by means of deuterium chloride [20], as well as, by laser interactions, avoiding

contamination problems, probably form the Coal used to make cast iron, encountered by previous workers using instead of pure carbides cast iron and hydrochloric acid.

At any rate, the irony of Oparin being inspired by Mendeleev's incorrect assumption together with my own independent involvement with the idea to study the origin of life [19] inspired by a biochemically incorrect assumption [21] demonstrates the creative importance of a hypothesis, whether completely correct or not, to develop breakthroughs in the obtention of new scientific knowledge. This is one of the fundamental premises of Karl Popper on the philosophy of science, and it also reveals the role of intuition, serendipity and the tortuous and winding roads of scientific discovery.

5. MADRID 1969

The first meeting in Spain of the Federation of European Biochemical Societies (FEES) [22] was organized by the Spanish Biochemical Society and held in Madrid during the 7 to the 11 of April of 1969. One of the major problems encountered in international biochemical meetings is the large number of abstracts which are usually submitted for presentation. For instance, in the 7th International Congress of Biochemistry held in Tokyo, Japan, due to the lack of available time, the number of papers for oral presentation had to be limited to about 500 out of the 2,000 which were contributed. The president of the scientific committee of the FEBS meeting in Madrid, Dr. Alberto Sols was one of the first to solve this problem by introducing a new idea. That is, the presentation of papers in poster sessions. In this way, more than one thousand papers were presented at this meeting. Since then, this has turned out to be a practical method which is followed in most of the large scientific congresses and meetings.

In this meeting, I helped to organize a small symposium on biochemical evolution to which Professor Oparin and other scientists participated. Professor L.Orgel presented a paper on the "Template – Directed Synthesis of Oligonucleotides" [23] and Professor Oparin in his paper on "Model Investigations on Coacervates" [24] suggested three stages of protobiont evolution (1) the formation of coenzymes and enzymes (2) the formation of the nucleic acid genetic code and (3) the organization of supermolecular structures leading to cellular organisms. Oparin and his wife, Nina Petrovna, had been looking forward to this visit to Spain, which they apparently enjoyed tremendously, and used the spare time going shopping in the many new stores, in the center of the city, which were near to the site of the meeting.

Prior to the 1969 FEBS meeting in Madrid, I had organized with the collaboration of A.P.Kimball, a Symposium on Proteins and Nucleic Acids, in April 1968, at the University of Houston. There were a number of leading biochemists and other scientists working in areas germane to biochemical evolution from the USA and other parts of the world. The preparation of the book of this meeting was delayed and was not published until 1971 [25]. It contains the articles which were presented by the different authors that participated in the Houston Symposium. It also contains several complete articles of the papers that were presented at the FEES meeting in Madrid. They follow a very comprehensive paper by A.I. Oparin significantly expanding his presentation at the Madrid 1969 FEBS meeting . Oparin's elegant paper contains all the details of the research work that he had done on coacervates using different kinds of enzymes included in them.

Thus, he described interesting reactions on the synthesis of polynucleotides, polysaccharides, as well as on NADPH oxidation-reduction reactions which occurred at a faster rate within coacervate droplets than in the external medium, thus mimicking intracellular biological processes.

As a personal note, the Houston Symposium and book were the forerunner of some twenty analogous meetings and books on biochemistry and other research related to the orgin of life, that with the

collaboration of colleagues, I have organized and edited over the past two decades.

6. PONT-A-MOUSSON 1970

Rene Buvet and Cyril 'Ponnamperuma organized the Third International Conference on the Origin of Life' on April 19-25, 1970, at Pont-a-Mousson, where Oparin and, other scientist from different countries participated. The corresponding book was also published in 1971 [26]. Aside from Oparin's introduction on the present state and prospects of the origin of life problem and many interesting presentation, there was a short paper by Vasily Fesenkov [27] about organic substances in the Universe. Academician Fesenkov did also refer briefly to the Tunguska cometary collision which occurred in 1908. It is interesting to note that in the neighboring areas to the flattened forest, along the trail of the comet, the trees grew several times faster in 1909 and 1910 than in the past. A massive injection of cometary matter, particularly ammonium salts, in line with the earlier mentioned findings of ammonium formate in the 1908 Greenland ice sedimentary layers, would readily explain it.

Perhaps, the distinguishing feature of this gathering was the fact that it was held in an old French Monastery and this allowed plenty of time for reflection and personal exchanges. It should be pointed out that in this relaxed atmosphere, what had been in the mind of several scientists was crystallized there. Namely, the creation, or founding, of the International Society for the Study of the Origin of Life (ISSOL). Dr. A.I. Oparin was elected President, Dr. M.Florkin and S.W.Fox, Vice Presidents, Dr. R.Buvet, Treasurer and Dr. R.S.Young, Secretary. The Society was incorporated in the State of Maryland, USA, as a non-profit scientific corporation, thanks to the dedication and efforts of Dr. Young, then Chief of the Exobiology Program of NASA. Therefore, in the future, there would be an entity responsible for promoting research in this field and organizing meetings of the Society in different parts of the world. The idea was enthusiastically accepted by all the participants and attendees.

Expressing my enthusiastic approval an interest, I used this opportunity to request that I would be pleased to organize on behalf of the Autonomous University of Barcelona, the first meeting of the ISSOL in Barcelona, Spain. In Barcelona, I would have the help of a number of biochemical colleagues, with whom I have organized several international biochemical meetings and other scientific colloquia.

7. BARCELONA 1973

As it has been seen, the birth of ISSOL was also the result of a process of gradual evolution, for it had been preceded by a number of scientific meetings. Among them, three major ones which were explicitly devoted to the study of the problem of the origin of life, following the principle first stated by Oparin. Namely, that the problem of the emergence of life on Earth should be amenable to be treated by the scientific method and experimental chemical research. Theses three major preceding meetings, or International Conferences, as they have been called, were held in Moscow in 1957, Wakulla Springs in 1963, and Pont-a-Mousson in 1970. Thus for solidarity with its roots we called the Barcelona gathering, the first ISSOL meeting and also the 4th International Conference on the Origin of Life (4 ICOL). The two volumes of its proceedings were published in 1974 [28].

The first ISSOL meeting was organized uder the honorary chairmanship of Professor S.Ochoa and it was held at the Congress Hall of the city of Barcelona from June 25 through 28. On the first day, during the introductory session, Professors Oparin, Calvin, Urey and Miller were conferred the medal and title of Honorary Councilors of the Higher Council for Scientific Research of Spain. Perhaps, this was one of the moments that I enjoyed most, from a human point of view. As it turned out, the president of the Council of Research of Spain was Father A.Romanya, S.J., a well known and respected man in Catalonia, acting as representative of a country,

Spain, still ruled by the "grace of God" as the coins used to say of Generalisimo Franco. When I was observing Father Romanyd bestow the above medal and title on Profesors Oparin, Calvin, Urey and Miller, for their excellence in studies on the origin of life, I did feel a pleasant sensation of human respect and admiration among the persons involved above any personal feelings or beliefs, or mutual understanding and recognition, which I will always cherish and remember.

As is well known, the first ISSOL meeting was held in honor of Professors A.I.Oparin, Melvin Calvin and H.C.Urey and the proceedings of the meeting [28] were dedicated to the memory of several pioneering scientists that passed away in the recent past, J.B.S. Haldae (1964), J.D.Bemal (1971) A.Katzir-Katchalsky (1972) and W.Vishniac (1973). It would be inappropriate and pointless for me to attempt to single out the major papers which were presented, except to say that I enjoyed the lectures by Professors A.I.Oparin, George Wald and many others, and it was gratifying to see the enthusiastic participation of Professors M.Calvin, W.F.Libby, S.Ochoa, Sir Robert Robinson, H.C. Urey and G.Wald and many other good friends, Perhaps, another scientific communication activity that may be mentioned is that there was a Spanish Television program where I had the opportunity to interview Professors Carl Sagan, H.P.Klein, T.Own, R.S.Young, K.Biemann and other scientist involved with the forthcoming NASA Viking mission for the exploration of the planet Mars.

I should not forget to mention, however, another less scientific matter which was relevant to this encounter. The poster that was used for the first meeting of the ISSOL in Barcelona, in 1973, and reproduced 20 years later, in the seventh meeting of the ISSOL in the same city, was painted by Salvador Dali, in Paris. I was in Barcelona and I called him. He said come over to see me this forthcoming Thursday. On Thursday, after I arrived in Paris and visited him in the hotel, he asked me to join him for lunch at Maxim's and then in attending a lecture by a Fench professor about holography, and to my surprise, and the end of the lecture Dali asked me to say a few concluding remarks, which fortuously I managed to do. Then he said, come over tomorrow and I will have the painting for you.

Those that have seen the poster may remember and have probably guessed that it represents the still unresolved problems of chirality in living systems. The two crystals in the poster are crystals of laevo-and dextro-quartz, taken precisely from Fig. 13, of page 190, of Oparin's book, on the "Origin of Life on the Earth" published in 1957 [4]. To my amzement Dali had Oparin's book in his Paris hotel suite. The only difference purposedly done, is that he transposed the order of the crystals. As you will have noticed, in addition, the crystals appear to emerge from an oozing soup in the form of the typical Dali's deformable or protoplasmic watches, which also mark the time of evolution. Between the crystals there is a warmish type of DNA, that seems to climb up. Above the dextro-quartz crystal, there is a figure of what appears to be a meditating "feminine" angel, and above the laevo-crystal a man pointing to the future under Dali's crown. The man appears to grasp a giant and colorful butterfly wing, as if it were Dalf in one of his dreams preparing to fly into the stars.

Needless to say, I was thrilled when I got the painting and returned to Barcelona. The painter was also thrilled to receive us when I arranged, at the time of the Barcelona 1973 first ISSOL meeting, a visit of the Oparins accompanies by a few scientists to his surrealistic Catalonian house in the picturesque town of Cadaques, on the Mediterranean shores of the Costa Brava. I believe there were very joyful moments for the Oparins and all of us in this visit to the Dali's unique fisherman's house.

8. MOSCOW 1974

A particularly enjoyable meeting was that held in Moscow, August 2-7, 1974, organized by the A.N.Bach Institute of Biochemistry under the title The International Seminar "The Origin of Life" in order

to commemorate the 50th anniversary of the publication of Oparins' first book, published with the same title, in 1924. The chairman of the organizing committee was A.S.Spirin and there were a great number of Russian researchers, and a select group of scientists from all over the world.

I particularly enjoyed the lecture by A.S.Spirin about "Cell-free systems of Polypeptide Biosynthesis and some Approaches to the Evolution of Translation Apparatus". I believe it was the first time that I saw the importance of ribonucleic acid as a possible catalyst of protein synthesis in the practical absence of proteins. These investigations on the unique role of RNA are being pursued today by other scientists, which are testing the real possibilities of what has been called the "RNA World" by Walter Gilbert and others. Eventhough interesting strides have been made by H.Noller on ribosomes, and G.Joyce and J.Szostak on the molecular evolution of RNA molecules, it remains to be seen whether the RNA molecules will completely be self – sufficient to carry out the genetic information and catalyze at the same time their own synthesis in the total absence of enzymes.

The seminar lectures were so well organized that there was plenty of time for leisure. I remember that we had an excellent dinner in a Moscow restaurant on the top of a high building. We had a nice orquestra playing at end of the meeting and the people danced lively. It was so enjoyable, that when after several musical pieces, the orquestra left, I felt that we were still in a cordial mood to continue dancing. At this point, I asked Nina Petrovna who was sitting next to me, how come, the orquestra has stopped playing? There are many people here that would like to continue dancing. Five minutes later, the orquestra arrived again and started to play until we were almost exhausted. I will never forget this beautiful gesture by the late Oparins and I am sure that all the other persons felt the same way.

9. REFLECTIONS ON OPARIN AND THE ISSOL

Life goes on, and the Oparins, that unique, unforgettable, and wonderful Russian couple passed away a few years ago. There is no question that they have left an imprint in the hearts of many people all over the world, and that their memory is going to endure in the minds of human mortals for generations to come. What is natural in most of us, namely pursuing our research, it must decidedly go on. In Oparin we have a good example to follow. Let me trace a few steps back and move forward to the present. To those of us concerned with life and its origin and evolution, it is interesting to note that the young Oparin had an outstanding Russian scientist K.A.Timiryazev as professor. K.A. Timiryazev was a Darwinian evolutionist, who visited Charles Darwin in England and who was very critical against the defenders of spontaneous generation. If Mendeleev's hypothesis indirectly inspired in Oparin his early concepts and ideas on the origin of life, the spontaneous generation pseudoscientists forced him to look profoundly to our cosmic environment in order to be able to provide the solid scientific hypothesis that Darwin's theory of evolution required.

In this context one is led to reflect on the contrast between the replication of genes, and the replication of ideas, or "memes", as Richard Dawkins [29] has called them. According to Dawkins, "memes" replicate or are transmitted faster than genes, and presumably are more permanent. Therefore, one immediately realizes that Oparins' theory on the origin of life, in a similar way as Newton's law of gravity, or Darwin's theory on the evolution of species, will be in the minds of future humans when our genes and those of our colleagues will be significantly diluted, if not lost, in the genetic pool of future generations. I guess this is one of the characteristics of human life (knowledge and its transmission), which places us in a unique place in the universe. Thus, since Oparin, left us, we have marched on and continued pushing his ideas forward, by hard work in the laboratory and getting

together to exchange our views in meetings of the ISSOL and in other conferences and places.

Concerning the recent past of our Society, and just to refresh our memories, in Pont- a –Mousson took place the inception of the ISSOL, and A.I.Oparin was elected the first President (1974-78). Since then he has been succeded in the presidency by F.Egami (1978-83), C.Ponnamperuma (1983-86), S.L.Miller (1986-1989) and J.Oro (1989-1993). The current Presidnet is J.Ferris (1993-1996). The ISSOL has met at Barcelona (1973), Kyoto (1977), Jerusalem (1980), Mainz (1983), Berkeley (1986), Prague (1989), and again in Barcelona (1993). In 1977, A.I.Oparin was named Presient Emeritus of the ISSOL. In the 7th ISSOL meeting, which coincided with the 20th anniversary of the first ISSOL meeting, and also with the one-hundredth anniversary of the birth of Professor H.C.Urey [30], Dr. R.S.Young [31] gave an introductory lecture on "The Origin and Early Evolution of ISSOL", where the key role of A.I. Oparin and other scientists involved in the organization of the Society was briefly described.

In the year 1994, during the one hundred anniversary of Oparin's birth, we met in Moscow honoring his memory . A brief summary of this symposium has appeared in the ISSOL Newsletter [32]. There have been similar meetings honoring him in other parts of the world, which the limited space available does not allow me to mention them here. The next ISSOL meeting is planned for Orleans, France in 1996, and is being organized by A. Brack. It is obvious that we have not solved the problem of the origin of life, but the march is still going on, and it will keep us scientists continuously busy in attempting to get the final answer some day. As we know, the three major riddles of our existence are the origin of the universe, the origin of life, as well as , the mystery of the human mind. The situation is good for future generations of scientists, and who knows, perhaps some day we may get the answers from extraterrestrial civilizations [33] by interstellar communication. Indeed, the 20th century has been a remarkable century, but it may be surpassed by the 21st century, if the answers to the above three fundamental questions are finally elucidated.

10. EPILOGUE AND DEDICATION

In closing I would like to add a few simple words as an epilogue. The passion, depth of inquiry, breath of knowledge and single minded dedication of Oparin to devote all of his life to finding and describing a rational and scientific theory for the origin of life on the Earth [3,4] is an exemplary quality of the man as a scientist and thinker.

For their human value let me quote two brief statements from the opening addresses of Oparin and Ochoa at the 7th International Congress of Biochemistry held in Tokyo, in 1967, after the opening remarks made by Prof. Shiro Akabori [18]. Oparin said, "Life is indeed the most beautiful and the most important of all that exists on our planet, the earth. Then it is no strange matter that the mind of man is forever fascinated with such problems as the essential nature of life, the organization of living mater, or the origin and development of life". Ochoa in closing his address he stated: "Let us enjoy the pleasure of meeting with our friends and colleagues from all over the world in a spirit of understanding and cooperation. We all pursue the same goal, to understand life at the molecular level. Let us hope that we may pursue this goal in peace and harmony for our own benefit and for the benefit of mankind."

I believe these two complementary statements beautifully summarize the wisdom and goodness of these two great men, excellent friends of mine, to whom, together with their respective late wives Nina Petrovna and Carmen, as well as, to my late wife Paquita, I would like to dedicate this paper to their memory.

Acknowledgements

I would like to express my gratitude to Professor B.F. Poglazov and Dr. M.S. Kritsky for having invited me to the 1994 hundredth anniversary of the birth of A.I. Oparin and for their wonderful hospitality, as well as, for their patience. There is no question that

it was an occasion to meet col-leagues, old and new friends nad make new acquaintances so that I will remember this visit for time to come. I also would like to acknowledge some biographical information received from Professor Lieble, and to thank L.Soria, LAvalos and C.Nacario for their help in preparing this manuscript.

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A.I. OPARIN : LIFE IN SCIENCE

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A.I. Oparin was the creator of a well – known theory of the origin of life. He was one of the brilliant scientists who founded the evolutionary and comparative branches of biochemistry, enzymology, plant biochemistry and biochemistry of subcellular structures. He was the key person in building industrial biochemistry in Russia, an outstanding scholar and organizer of science, and an eminent public figure.

Oparin was born in the city of Uglich and spent his early childhood in a picturesque place on the Volga bank. During his school years he collected herbaria, and conducted simple experiments on plants. Aleksandr Ivanovich Oparin kept this first love until the end of his life. At his country house near Zvenigorod, not far from Moscow, he cultivated rare sorts of roses and grew a wonderful "winter garden" with splendid monstera and other tropical plants on the veranda. It sounds quite logical that it was a branch meeting of the All – Russia Botanical Society, where the first presentation of Oparin's hypothesis about the origin of life on the Earth took place in 1922. Later, he also paid much attention to the biochemistry of plants and the biochemical basis of the processes of vegetable raw materials and was pround of having been elected an honorary member of the All-Union Botanical Society.

In his youth, Aleksandr Oparin was deeply impressed by *The Life of Plants,* a work by K.A. Timiryazev, whom he considered his first teacher. While studying at high school, he listened to Timiryazev's popular lectures, read works on Darwinism with keen interest, and became a staunch advocate of the theory of evolution. After graduating from the 2nd Moscow high school in 1912, Aleksandr entered Department of Physics and Mathematics of Moscow University. Being a Student of the Division of Natural Sciences, he chose plant physiology as a specialty. By this time, Timiryazev had to leave his chair because of repressive actions undertaken by education minister Kasso at the University. The chair was accepted by a disciple of Timiryazev, Decent F.N. Krasheninnikov, who acquainted Aleksandr Oparin with the man he admired in his youth. Thus, Oparin got a unique opportunity to discuss his master thesis with the outstanding scientist.

Research in the comparative biochemistry of redox processes in simple algae, carried out by Oparin in his university years, led him to study the chemical basis of the evolution of life and to work out the basic foundations of its origin on Earth. He did a great service to science by convincingly showing the possibility of an experimental approach to solving

this problem and by the prospects it opened up. Previously, it had been considered a purely philosophical problem having nearly nothing to do with methods adopted in natural sciences. Professor M. Bunge of McGill University regarded Oparin's hypothesis as brilliant. It may be argued, he wrote, that the hypotheses of Einstein and Oparin or an electronic computer are each more ingenious creations than Michelangelo's David, Shakespeare' Hamlet, or Bach's Mattheus Passion [1].

Oparin is the author of dozens of books, both scientific and popular, on the origin of life. To understand his theory it is very important to clearly see the specific features of these works. Three parts can be singled out in them: the historical and philosophical analysis of the problem, the fundamentals of the theory proposed by the scientist, and the "scenario of the origin of life", that is, the description of hypothetical processes that led to the formation of simple organisms. During almost, 60 years of work on his theory (1922-1980), Oparin barely changed its basic propositions. He only formulated them more precisely. At the same time, as research on the origin of life and in related fields of natural science developed further, the description of the hypothetical succession of stages that had led to the origin of the primary biosphere underwent substantial changes toward making it concrete and detailed and took new factors into account. However, the "third part" of Oparins' works can hardly be regarded as the theory of the origin of life, as it is often done by those who call it "coacervate", or the theory of the origin of life without nucleic acids, etc. It is merely an illustration of possible manifestations of its basic propositions. In Oparin's last works, nucleic acids occupied their proper place in the theory of the origin of life, whereas coacervate droplets were cited only as a possible model for laboratory research in a number of prebiological processes [2, 3]. The main principles of Oparin's hypothesis were first formulated in his public report in 1922 and in his book, The Origin of Life, published in 1924. The British crystallographist John Bernal stressed the importance of this small book (only 71 pages): "It can be seen that Oparin's assay contains in itself the germs of a new programme in chemical and biological research. It was a programme that he largely carried out himself in the ensuing years, but it also inspired the work of many other people. The essential thing in the first place in not to solve the problem, but to see them. This is true of the greatest of all scientists, Newton, Lavoisier, Pasteur. This paper is important because it is a starting –point for all the others" [4].

The essence of Oparin's theory lies in recognizing the objective character of the origin of life as the result of a prolonged chemical evolution of carbon compounds that led to the appearance of organic compounds, including polymer ones, and a subsequent natural selection at the level of multimolecular formation shaping from these compounds, which turned out to be prebiological structures isolated from the external medium but constantly interacting with it. The power of Oparin's scientific prevision can be fully estimated if we recall the level of natural science in the early 20th century. The view on metabolism and its evolution was in an embryonic state. Most scientists were convinced that bioorganic compounds could form only as a result of photosynthesis. Simple algae were considered as primary organisms, though their structure is rather complex and, therefore, they could barely develop from any prebiological processes. Comparing fragmentary data on metabolism in autdtrophs and heterotrophs, Oparin came to the conclusion that it was common for these groups of organisms and that, in the process of evolution, autotrophs could grow out of heterotrophs owing to the appearance of several additional reactions closely connected with the basic metabolism. He

concluded from this that heterotrophs were primary organisms and that the formation and accumulation of main biologically important compounds as a result of abiogenic (chemical) syntheses were essential for their origin. The young scientist predicted that the primary formation of simple organic substances was possible and claimed that they would be discovered on cosmic bodies in conditions ruling out their biogenic origin. Research, carried out much later, fully confirmed this proposition of his theory. As American astrophysicist Richard Young noted, "The striking things about Oparin's early views on the origin of life problem was that indeed they were consmological in scope. He considered the origin of life to be an integral part of the early evolution of a planet… From the early papers he was able to draw some remarkably cogent conclusion which, even by comparison with data available today, holds up remarkably well" [5].

The theory of the origin of life provided a foundation for evolutionary biochemistry and a theoretical basis for cosmochemical exploration of the universe and the search for life in it. Experiments conducted in different laboratories in the early 1950s confirmed that, under the action of various sources of energy and under conditions imitating the possible spectrum of such on the primary Earth, all biologically important compounds can be produced through synthesis of simple inorganic compounds. According to Oparin's theory, the abiogenic synthesis of protein – like compounds had to result in the formation of microstructures differing in their composition and consequently evolutionizing in different ways. This hypothesis, put forward by the scientist as early as 1922, was proved by experiments and substantiated in his laboratory only in the mid-1980s, due to the latest achievements in the chemistry of high molecular compounds.

Oparin's theory gave an impetus to scientific research in various fields: biochemistry and paleontology, chemistry and astronomy, physics and geology. As a result, the search for ways and laws of the origin of life has developed into an independent branch of modern natural sciences. Regional and international symposia on this problem have been held regularly since 1957. The International Society for the Study of the Origin of Life (ISSOL) was founded at the Third International Conference on the Origin of Life in 1970. Academician Oparin was elected its first President. At a conference in Kyoto, Japan in 1977,he was elected honorary President of the Society. On the initiative of American researchers, the same conference instituted an international A.I. Oparin medal. It is awarded for outstanding contributions to the study of the origin of life. Thanks to the fundamental works of Aleksandr Oparin, Russian scientists are currently the indisputable leaders in the above-mentioned fields of modern natural science.

However, Academician Oparin was not concerned only with the riddle of the origin of life. The range of his scientific interests was extremely wide. He was in a comparative study of the globular proteins from plants. Then, Oparin made a chemical study of plant respiration. As a result, together with Academician AN. Bach, he laid the foundation for plant biochemistry in Russia. Aleksandr Oparin was also interested in evolutionary and comparative biochemistry, and substantially contributed to this field of science. He was the first to note the significance of the reversible sorption of enzymes on intracellular membranes for the regulation of their catalytic activity. He is rightly considered the founder of industrial biochemistry in Russian science. In the 1930s, procedure for prolonged strange of the sugar beet was worked out under Oparin's direction. This brought a great economic effect. His pioneer research was essential for developing biochemical basis of tea production, laid the enzymological basis for the baking of bread, and proved valuable in almost

all fields of practical biochemistry: brewing, cheese and winemaking, the production of vitamins and enzyme preparations, etc.

Aleksandr Oparin was a brilliant scientist as well as an outstanding teacher. He began his lecturer career in 1921 and then headed the Department of Plant Biochemistry (1942- 1964). Until the end of his life he was a professor at Moscow State University, Moscow Institute of Food Industry, and a number of other institutes. I was lucky to listen to his lectures on plant biochemistry (1956-1957) for third-year students of Biological- Soil Department, Moscow State University. Oparin's global evolutionary approach to the structure of polymers produced an amazingly strong impression. He had a striking ability to disclose in the complex formulas of bioorganic compounds the evolutionary logic of their construction from simpler molecular "blocks". Because of this, such formula was easily retained in the memory of listeners. I also still remember the seminars that Oparin conducted for students working on their master theses. He could easily see the main point of their work as well as weak points within research. It was then easy to clearly formulate experiments needed to remove the shortcomings. Aleksandr Oparin could quickly and exactly select the most essential point of any question or problem. He preserved this ability all his life through. This explains his talent as a popularizer of science: he could clearly expound the most complex scientific problems in a way comprehensible even to housekeepers. He did not "simplify" a question, but only made it easier to understand; he illustrated scientific terms using bright and substantive images. The scientist never refused to address schoolchildren or other nonspecialists interested in the problem of the origin of life, and seriously prepared for such lectures. **In 1976 he was awarded the International Kalinga Prize (UNESCO) as the Best Popularizer of Science.**

In 1939, Oparin was elected a Corresponding Member and, in 1946, a Full Member of the USSR Academy of Sciences. He also displayed outstanding abilities as an organizer of Soviet science. In 1935, jointly with A.N.Bach, he founded the Academy's first Institute of Biochemistry and led the work of its staff as deputy director and laboratory chief. From 1946 to the end of his life he was the director of this institute. In the grueling years of Soviet science, especially biology, Oparin was deputy Academician – Secretary (1945-1948) and then Academician – Secretary of the Department of Biological Sciences and a Presidium Member of the USSR Academy of Sciences (1948-1955). Precisely in those years, at Moscow University's Department of Plant Biochemistry headed by Oparin and in the Institute of Biochemistry run by him, an entire group of scientists led by A.N.Belozerskii continued to study the DNA in bacteria and plants. There is no denying, however, that in the long run, through his authority and diplomatic skill, he contributed to the origin of Russia's molecular genetics that was hated by the ideology of that time. Moreover, research in nucleic acids which later formed the basic for Rusian molecular biology and genosystematics was conducted openly, not underground, for Belozerskii remained both laboratory head at the Institute of Biochemistry and Oparin's deputy at Moscow University's Department of Plant Biochemistry. Oparin held a well thought-out argument: since nucleic acids are found in all organisms they must be studied. Lysenko, one of the most dark person in the history of Russian Science, had nothing to say against this. The only thing he "could not understand" is why they are called acids. (I heard it myself at his lecture for Moscow University students.) First of all, Lysenko said, it is not a liquid but a white powder (to make him believe that it exists, he was given a test – tube with a preparation of the nucleic acid). Secondly, he "firmly knows that an acid is something that hisses". Doubts that he

was “swindled” probably remained in his heart, but the authority of Academinican Oparin compelled Lysenko to put up with this “strange, slippery, and alien trend” in plant biochemistry.

Aleksandr Oparin was the founder and first Prsident of the All-Union Biochemical Society, Chairman of the National Committee of Soviet Biochemists, Vice President of the International Biochemical Union, a member of the International Committee on Space Research (COSPAR), Editor-in-Chief of *Doklady Akademii Nauk* SSSR (Proceedings of the USSR Academy of Sciences), and a member of the editorial boards of many domestic and international journals. He also succeeded in the sphere of public activities. He was a member of the Presidium of the Supreme Soviet of the Russian Federation, of the World Federation of Scientific Workers, of the World Peace Council, and of many other organizations. Oparin took all of his affairs seriously whether scientific, educational, or public. He never hurried anywhere and was never late for anything. Whether he went to a lecture or a speech, or an airport or railway station, he always arrived 20 or 30 minutes before the appointed time. Though Oparin occupied rather high and responsible posts all his life through, he was not a member of the Communist Party and spoke ironically of its growing role in the running of the institute during Brezhnev’s times. When the secretary of the local party cell asked the Academician to give an account of the work done in the institute, he replied that, since it was the demand of the district party committee, he was prepared to meet the party bureau member in his office on such –and-such a day and at such – and-such an hour (naturally, at a time different from that “planned” by the bureau).

Oparin enjoyed a very high prestige in the world. His books on the origin of life have been translated and published in virtually all countries. He was invited to the launching of a space station in the United States. In India, the wife of the Academician recalled, a cabdriver assured Oparin that he learned about his theory while studying at school. Aleksandr Oparin was elected a member of a number of foreign academics and scientific societies and an honorary doctor of many foreign universities. He earned many awards, both foreign and domestic, including the Mechnikov Gold Medal, the Lomonosov Gold Medal, and the Lenin Prize for a series of works on the origin of life. The Academician was also awarded the title of Hero of Socialist Labor.

I was lucky to work under the guidance of Alesandr Ivanovich for nearly 15 years. He was exceptionally tactful in dealing with people. For example, when he read publications written jointly with him, he never made changes in the text, but placed dots in pencil on the margin and proposed his “variant” on a separate sheet of paper. If he wanted to talk to anyone, he went to the laboratory himself and never summoned an employee to his office. He did so until last months of his life. Many believed that, for some reason, critical remarks about the theory of the origin of life were inadmissible and that a person who disagreed with any of its propositions automatically became an “enemy” of Oparin. I categorically deny this. In conversations with Oparin, I more than once pointed to theses which, in my opinion, were insufficiently supported by experimental data, or to an erroneous interpretation of the mechanism of one or another process. I always heard one and the same reply: “There is a good field of action for you”. I and many others, including foreign scientists with whom I spoke on this subject, were amazed by the truly encyclopedic character of Oparin’s knowledge and his constant desire to extend and deepen it. Even in the last months of his life, when he was seriously ill, he was a success in grasping the concepts of nonequilibirum thermodynamics reading the book *Self – Organization in Nonequilibrium Systems,* by

G.Nicolis and I.Prigogine, which had recently been published in Russian. Of course, it is impossible to know everything. Something always remains beyond the grasp of one's mind. Mathematics was such a closed field for Aleksandr Ivanovich. Therefore, it is absolutely incredible, however obvious that form Prigogine's work crammed with higher mathematics, he drew a clear physical essence of the processes described by him, assessed the prospects of his approach, and outlined a further redevelopment of his theory in this direction.

Academician Oparin was a bright and versatile person. He loved nature and poetry, read verse with inspiration, liked to receive guests, and was good company and a remarkably observant man with a fine sense of humor. He communicated not only with scientists; he was also friends with singer Ivan Kozlovskii and artist Salvador Dali. A grave illness in the last five years of his life did not influence the behaviour & habits of the scientist. He continued to go to the institute, gave a special lecture course at Moscow State University, and went on missions abroad when his health allowed him to do so. No one (except perhaps his wife) heard him complain that he did not feel well. He was a man of strong will and self-control, and continued to work, with an absolutely clear mind, until the last days of his life. The life of Aleksandr Oparin and his name and contributions created a whole epoch in the history of Russian and World science.

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A.I.OPARIN: THE MAN AND HIS THEORY

by
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He was a man, take him for all in all,
I shall not look upon his like again.
Hamlet, W. Shakespeare

I first met Aleksandr Ivanovich Oparin and his wife of many years, Nina Petrovna, in the spring of 1975 when, with the support of the National University of Mexico, I helped to organize a celebration of the 50th anniversary of the publication of his 1924 book on the origin of life [1]. The attendance to the symposium was completely beyond our expectations. Over three thousand people showed up, not only from Mexico City but also from nearby towns, forcing us to install loudspeakers to provide the crowd assembled outside the hall with at least some idea of the development of the meeting.

What could account for such an overwhelming enthusiasm for A.I.Oparin? The Mexian students, teachers and scientists were driven, in part, by their interest for a theory of life's beginnings that has been taught for many decades in the schools of my country. However, to this day I am convinced that many of those who went to see and hear Oparin were there because they knew they had a unique opportunity of listening to a person who had long before joined the ranks of the classic scientists of evolution.

It is generally believed that when Oparin first wrote about the origin of life, the discussion of this problem had been banished to the realm of useless speculation. As Oparin himself stated in 1974, "when I began to be interested in the problem of the origin of life, in the early 1920s, the whole topic was in a state of crisis. It appeared as if it was a forbidden subject in the world of science. The problem was generally felt to be insoluble in principle using objective scientific research methods. It was felt that it belonged more to the sphere of faith than knowledge and that, for this reason, serious scientists should not waste their time and effort on hopeless attempts to solve the problem"[2].

However, the scientific literature of the first decades of this century shows that many attempts were made by major scientists to understand the appearance of life on Earth [3]. The list covers a rather wide range of explanations that go from the ideas of Pfluger on the role of HCN [4], to those Svante Arrhenius on panspermia [5], and includes also the discussion by E.A.Minchin on the origin of cells [6], R.B.Harvey's suggestion of an heterotrophic emergence of life in a high-temperature thermal spring environment [7], Leonard Troland's hypothesis of a primordial enzyme formed by chance events in the primitive oceans [8], and the sulphocyanic theory on the autotrophic origin of life developed by Alfonso L. Herrera [9]. In addition to

the well-known contribution of John B.S. Haldane [10], there were also the attempts by Thomas and Rollin Chamberlin to understand the part that extraterrestrial organic compounds had played in the early evolution of life [11], as well as Hermann J. Muller's 1926 paper on the abrupt, random formation of a gene endowed with autocatalysis, heterocatalysis and mutability [12], three properties which in his mind defined a minimal living system endowed with reproduction, metabolism, and evolution, respectively.

In spite of their diversity, most of these theories went unnoticed, in part because they were incomplete, speculative schemes largely devoid of direct evidence and not subject to fruitful testing. The recognition that many possible plantations for the origin of life were being developed at the same time that Oparin was suggesting his own ideas, does not diminish the value of the latter. On the contrary, whereas the other alternatives attempted to explain the appearance of life by appealing to unlikely chance events that could not be studied experimentally, or that were in contradiction to what was already known about the basic features of biological systems, Oparin's proposal was based on a large set of observations and results drawn form a variety of scientific disciplines and, as John D. Bernal once wrote, "contained in itself the germs of a new progamme in chemical and biological research…[that] inspired the work of other people"[13].

Aleksandr Ivanovich Oparin was born in Uglich, the town which history goes back to the time of Boris Godounov, on March 2, 1894. As a student he was a man of two scientific loves, biochemistry and Darwinism, both of which he learned in the context of natural history and physiology. He soon joined the laboratory of Alexei N. Bach, an eminent scientific and political figures at the Karpov Physico-Chemical Institute. There he worked on photosynthesis and, like most biochemists of his generation, adopted the idea that metabolism is the outcome of oxidation and reduction reactions that were coupled inside the cells.

By then Oparin was already a convinced evolutionist; as an undergraduate he attended the lectures given regularly by Kliment A. Timiryazev [14],a renowned plant physiologist and one of the main promoters of Darwinism in Russia. Because of his ill-health, Timiryazev eventually limited these meetings to small gatherings in his Moscow flat. By the time Oparin graduated from the Moscow University in 1917, he had an academic background that combined natural history, biochemistry, and plant physiology, a knowledge acquired within a research tradition strongly committed to integral approaches in the analysis of natural phenomena. As a young scientist with a keen interest in biology, Oparin was not only familiar with nearly all the literature on evolution available in Russia but, perhaps even more important, also with the Darwinian method of comparative analysis and historical interpretation of life's features.

Although in other countries Darwin's ideas influence had diminished by the turn of the century [15], in Russia they had an enduring prestige that would lead to the popularity of natural selection as a basic evolutionary mechanism and, eventually, to sophisticated theoretical developments [16, 17]. As Mark Adams writes, "in 1939 it would have been difficult to find a country in the world where evolutionary theory was more modern or more widely diffused than it was in the Soviet Union" [17]. This situation underwent dramatic after the 1940s, but until that time, evolutionary thinking was encouraged and promoted. Like many of his fellow students and colleagues, Oparin was well acquainted with Ernst Haeckel's books, in which the transition of the first living beings from the non-living was discussed but always under the assumption that the first forms of life had been autotrophic microbes. A detailed analysis of Oparin's writings shows that throughout his entire life he remained faithful to the haeckelian division of life into three major kingdoms [18]. However, from the very beginning it was impossible

for Oparin to reconcile his knowledge of the sophistication of photosynthesis and the Darwinian credence in a gradual, slow evolution from Oparin to reconcile his knowledge of the sophistication of photosynthesis and the Darwinian credence in a gradual, slow evolution from the simple to the complex, with the suggestion that life had emerged already endowed with an autotrophic metabolism that included enzymes, chlorophy11, and the ability to synthesize organic compounds from CO_2 and water.

Such contradiction led Oparin to extend Darwinian premises from the realm of biology into chemical evolution, i.e., to suggest the bold new idea that life resulted from a process that had begun with the formation of the Earth, the abiotic synthesis of organic compounds, and their organization into colloidal gel-like droplets, from which anaerobic heterotrophic bacteria eventually evolved. By 1921 Oparin's ideas had taken their basic shape, but it was not until the next year when he presented them in a meeting of the Russian Botanical Society in Moscow. As he recalled many years later, some viewed his ideas with hostility and others with indifference, but he never lost the full support of A.N.Bach, his teacher and mentor[14]. This may appear to be somewhat surprising, since Bach was notorious for his rejection of idle speculation – an attitude well illustrated in an anecdote recalled by V.A. Engelhardt [19], in which Bach is credited for declaring that "dear boy, if I were paid for producing theories, I could sit all my life inventing new and better ones. Good theories come from good facts".

What had convinced Bach that Oparin's efforts were not pure speculation was the awareness that even as by 1922 Oparin had not performed a single experiment related to the origin of life, he had already accumulated results and observations drawn from an impressive range of disciplines to articulate a theory attempting to apply Darwinian principles of evolution to inanimate matter. When Oparin published his first book, arguing that the first forms of life had been preceded by a period of abiotic synthesis of organic compounds, it was already known that simple organic molecules such as HCN had been detected in the interstellar medium and in cometary spectra and that organic compounds could be found in meteorites. Many had read about Mendeleev's hypothesis on the inorganic origin of oil and knew of his experiments involving reactions of carbides and nitrides with water. Many biologists shared the then popular idea that protoplasm was nothing but a complex colloid, and it was well known that even the simplest photosynthetic microbes had intricate metabolic pathways-but the first to perform the intellectual feat of ordering all these data in a remarkably coherent scheme of chemical evolution was precisely A.I.Oparin.

From their inception, Oparin's ideas required not only a familiarity with many fields of scientific inquiry but also an unprejudiced mind willing to overcome the frontiers separating them. Oparin had these characteristics, and to them he added what would be a constant in his work: his concern with the historical analysis and the philosophical implications of the discussions on the origin and nature of life. The social environment in which he was embedded played a major role; Oparin belonged to a generation that was not only enjoying the inheritance of the liberal, high-bourgeois cultural and scientific circles of Saint Petersburg and Moscow formed by broad-minded scholars like Pavlov, Vernadsky, and Merezhkovsky, but that was also deeply affected by the vigorous intellectual climate that followed the 1917 Revolution, under which the development of materialistic ideas was strongly encouraged [20-23].

Oparin's 1924 text is the work of a young, bold, and talented researcher plenty of enthusiasm and free of scientific prejudices. In perspective, however, it is really the harbinger of his major work, a 1936 book also called The Origin of Life, whose English translation became available two years later [24]. Written in a graceful and literate prose, this volume is an elegant and convincing long argument supporting the idea of chemical evolution. The influence of this masterpiece cannot be

underscored. As John Farley wrote, it "is probably the most significant book ever published on the origin of life" [22]. Although it soon caught the attention of biologists such as N.H.Horowitz and C.B. van Niel [25], the full significance of Oparin's theory did not became evident until 1952 when his ideas of the primitive reducing environment were discussed by Harold C. Urey from the viewpoint of thermodynamics in a pionerring paper [26] and one year later when Stanley L. Miller performed his now classic abiotic synthesis of amino acids [27]. Indeed, for evolutionary biology 1953 produced an unsurpassed vintage: Watson and Crick suggested their model of the double – helix for DNA molecules, Sanger and his co-workers published the first complete sequence of a protein and, by testing one of the hypothetically crucial stages of transition of chemical evolution with a simulation experiment, Miller founded the field of prebiotic chemistry , a discipline born amid electric discharges.

In the past few years, several hypothesis have challenged the validity of Oparin's scheme. However, in order to assess the plausibility of these alternatives, one should keep in mind that Oparin's theory is not chiefly about a highly reducing primitive atmosphere, nor even about coacervates, but of the gradual origin of life as a result of a number of changes brought about by the emergence of more complex structures. With remarkable insight, Oparin defined the origin of life as a dynamic process subject to continuing historical development, thus providing a framework into which a large number of observations and experiments ranking from astrophysics to microbial metabolism could be studied and ordered in a sequence of events that began with the synthesis of chemical elements inside stars and during supernova explosions, proceeded through the formation of the Earth and the synthesis of organic molecules in the prebiotic environment, and eventually led to the assembly of organic compounds in the first cells.

Like many of his contemporaries, Oparin was not only an spectator but an active participant in several major controversies, some of which were not purely academic; they were part of his political life. Some of Oparin's arguments became major essay or books in which basic issues like the nature of life were thoroughly examined [28], and they deserve further analysis and discussion. Perhaps one of the most significant was his lifelong debate with Hermann J. Muller [29], which led to an entangled discussion in which science, philosophy, and politics were mixed . The development of this long debate is also an important topic for historical research, especially in the light of the recent discovery of the catalytic activities of RNA and the recognition that it must have played a major role during early stages of biological evolution [30]. Does the fact that some RNA molecules can replicate, catelyze an increasingly large range of biochemical reactions, and undergo evolution in vitro imply that Muller's reductionist ideas about primordial life should be resurrected and updated? Part of the answer lies in recognizing that there is no such thing as a "living molecule" [18, 28], but also in the likelihood that RNA itself may be the product of a long (but not necessarily slow) evolution of even older biological systems that were capable of undergoing Darwinian evolution [31]. If this suggestion is valid, then we may be moving the issue of the origin of life into a new unprecedented territory in which luring question may be awaiting.

Oparin was a man of his time: during the 1930s and the 1940s art, literature, and science were extremely idelogized activities, and a large number of distinguished scientists took sides in excruciating debates. Like many of his contemporaries, Oparin was convinced that it was possible to construct entire scientific research programs based on dialectical materialism. We may find his attitude unpalatable, but the understanding of his heritage requires a dispassionate analysis of his achievements, including the recognition that the application of his achievements, including the recognition that the application of his nonreductionist materialistic approach to the question of the origin of life was extremely successful. It would be a gross

mistake to deny Oparin the proper place in the history of biology because of his ideological preferences or his political associations. Rather, what his biography demonstrates in a direct and poignant way is that science is a human endeavour and that there are cases in which major accomplishments may be sometimes mixed with disquieting political attitudes that are difficult to accept. But for all his foibles, Oparin's most profound intellectual compromise was with the understanding of the processes underlying life's beginnings. Perhaps because he was never able to free himself from the spell that the issue of the origin of life had casted on him since his youth, he continued to extend and modify his theory until the end of his life. It is in Oparin's unflagging devotion to the scientific and the philosophical aspects of life's origin to which he dedicated his entire career in which , I like to think, lies the deepest most genuine nature of his personality.

When I met A.I.Oparin 1975,he was an elegant and cordial wise-old scientist in whose eyes the gaze of intellectual curiosity had not been lost. His company was enlightening, and his affability and profound love for his homeland reminded me of Count Ilya Rostov, the good-natured character from Tolstoy's *War and Peace.* Aleksandr Ivanovich was willing to share not only his enthusiasm but also his memoirs, both good and bad, with a young inexpert biologist whom he graciously befriended. It is because of this demonstration of intellectual generosity that I regard him in memory not only with considerable sympathy and admiration, but also with gratitude and fondness for his humanity. How life begun remains an open question, but the ideas that A.I.Oparin suggested and developed have been transformed into a flourishing field in which scientists from many disciplines converge. One hundred years after his birth, and seventy years after he published his first book, we are still debating the significance of his work. *Ars longa, vita brevis.* Is not this, in itself, a major reason to celebrate his enduring legacy?

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TWENTY FIVE YEARS SIDE BY SIDE WITH A DISTINGUISHED SCIENTIST

by

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My reminiscences about A.I.Oparin are a look into the past that highlights the most remarkable events lost in the mists of time. For 25 years I was lucky to not only work with a distinguished scientist, but also to associate with him during out – of-office hours and watch him in different situation, invariably feeling his irresistible charm and admiring the great breadth of his erudition.

It was 1956. I was taking my graduation examination at the Institute of Foreign Languages when I was recommended to Aleksandr Ivanovich Oparin. I was very nervous when I appeared before the famous scientist for the first time. Having talked with me, Professor Oparin explained that he had his hands full, that he needed an assistant, and it would, therefore, be good if I could enter upon my duties the next day. As for the last examination, he complained, either jokingly or seriously, he would have to let me go on that day. And so I began to work at the Bach Institute of Biochemistry.

Oparin was a very elegant and tall man with a sly look in his sparkling gray-blue eyes, always dressed in a neat suit with a bow tie. He spoke retaining unstressed “o” a little, thus betraying that he came from the Volga area. His speech was distinguished by a clear and fine articulation characteristic of lecturers. He was not only Director of the Bach Institute of Biochemistry, but he also was a professor of Moscow State University and delivered lectures till the last days of his life.

I was struck by his self-discipline and organization combined with great demands he made on others. Aleksandr Ivanovich was never late and insisted that Institute’s personnel also came in time. He always arrived at an airport, railway terminus or a lecture beforehand. He demanded that any letter be answered immediately. A.I.Oparin was very careful and meticulous in preparing his public lectures that aroused lively interest among listeners. The audience was usually charmed with his presentation of the theory of the origin of life. At seminars hold in the Institute, research fellows were surprised by his knowledge of the smallest details of various experiments and by his ability to find a weak points. He was a very charming person, but he was formidable in a fit of anger, when his usually sparkling eyes became colder than the Arctic Occan.

Aleksandr Ivanovich often went abroad to scientific congresses and symposis. He was usually accompanied by his wife Nina Petrovna. We, members of the personnel, developed a certain ritual of meeting and seeing him off. Nina Petrovna liked the ritual very much. As a rule, we drove to the airport in two cars. Aleksandr Ivanovich with his wife and myself in the first, and young laboratory associates and numerous bags in the second. We usually arrived earlier than the other. Aleksandr Ivanovich, feeling pleased, made himself confortable in a chair and relaxed, since all the troubles connected with the preparation of his report, slides and baggage were behind. He got accustomed to being recognized by other people (he often spoke on television), and this delighted him. We were also glad to see the Oparins back. Smiling happily, huge Aleksandr Ivanovich slowly descended the ladder after his wife. Having counted the baggage, he made his way to the car, and we all drove them home. The Oparin’s apartment with many antique and beautiful things, matched the vivid master. We took seats at

the table and each of us drank a glass of cognac. Being a biochemist and gourmet, he knew a lot about wines and until the end of his life liked cognac. After an improvised supper, Aleksandr Ivanovich told us about the conference and the host country while Nina Petrovna gave out souvenirs.

A.I. Oparin had a log card index of people with whom he corresponded. In his last few years, New Year's greetings were sent out to more than 600 addresses. The Oparins usually added a few warm words to the standard text that I typed for them. Now, sorting out the cards, I think of many of these people that I also became close to.

In 1957, Oparin organized The First International Symposium on The Origin of Life on the Earth. In those days forums of this kind were rare in our country, but Oparin proved to be a brilliant organizer. He went into every detail of preparations. We, members of his staff, also did our best. The symposium was impressive. Suffice it to enumerate the names of scientists who took part in it: Professors S.Akabori, A.N.Belozersky, A.E.Braunstein, J.D.Bernal, E.Chargaff, M.Florkin, S.W.Fox, H.Fraenkel-Conrat, M.Grunberg-Manago, M.Calvin, S.Miller, P.Mitchell, K.Mothes, L.Pauling, F.Sorm, G.Schramm, F.B.Straub, R.L.M.Synge and many others. Most of foreign guests came to Russia for the first time, and all were pleased with the meeting.

Four years later, the Fifth International Congress of Biochemistry took place in Moscow and A.I.Oparin also presided over its meetings. A new group of scientists visited Moscow. The congress was widely covered in the press. As secretary to the congress president, I barely managed to arrange meetings of correspondents with foreign and Soviet scientists. At this congress A.I. Oparin was elected Vice President of the International Union of Biochemistry.

In succeeding years other international symposia and seminars were held in the USSR. Such events are always a festive occasion in everyday business life, while meetings with celebrated personalities leave indelible impressions.

Professor Bernal, an eminent British physicist – crystallographer, made the acquaintance with Oparin in 1930s. He took great interest in the study of the Origin of life. He wrote The Origin of Life which became one of Oparin's most favorite books. Friendship between the two scientists lasted until the death of John Bernal. Not long before his death, the Oparins stayed with him in London.

Since 1957 the Oparins established close ties with Professor S.W. Fox and his wife Raia, and were invited by them to the United States. Fox is fond of Jazz and went into raptures when he bought Russian balalaika (stringed musical instrument) .

I remember Professor C.Ponnamperuma, a bright and temperamental scientist, deeply concerned with problems of space biology, the study of Mars in particular. At that time, this subject seemed utterly fantastic. Incidentally, Ponnamperuma did much for the publication of Oparin's book in the United Sates. In the last years of his life, Academician Oparin became interested in the space aspect of the origin of life. This interst was stimulate by his contacts with American colleagues, including professors C.Ponnamperuma, R.Young, and P.Klein, who worked for NASA.

At the Fifth International Congress of Biochemistry we made acquaintance with Professor J.Oró, a man of great charm, with a sense of humor and Spanish temperament. After his trip to Moscow, he invited the Oparins to Barcelona, where he acquainted them with Salvador Dali. Oparin enthusiastically spoke about this wonderful artist, who presented an album with reproductions of his paintings to him. Incidentally, one of Dali's drawings became the emblem for conferences on the origin of life (1973, 1993).

I remember with pleasure Professor J.W. Schopf from the University of California. After taking part in one of the international seminars, he came to Moscow to work in the laboratory headed by A.I. Oparin. We all grew fond of the talented, smiling and energetic scientist. He was 33 at that time, and he had already received the highest award given to young American scientists. Professor Schoopf

brilliantly delivered his lectures on microfossils and became not only a guest but a friend of our Institute.

Professor Fujio Egami, Director of the Institute of Life Sciences in Tokyo, was an avid investigator of the problem of the origin of life. After his death, his daughter Fujuko Egami, who is fond of the history of natural sciences, wrote a book about A.I.Oparin. Aleksandr Ivanovich liked to visit the country of Sunrise, where the Japanese scientific community gave him his due.

Antonio Lazcano, a young Mexican scientist, an enthusiast of the problem of the origin of life, came to work at Oparin's laboratory. He was charmed by Oparin's affability and on his initiative Aleksandr Ivanovich was invited to deliver a cycle of lectures at the National Autonomous University in Mexico. He was impressed by this country, and his lectures were a great success.

It would take too much space to enumerate the scientific and friendly ties A.I.Oparin established within the country. Not only scientists but also figures prominent in culture and arts are on this list. The erudition and the breadth of views of Aleksandr Ivanovich made him a fascinating companion. He knew Russian literature, world art and poetry very well, and recited with great skill verses of Pushkin, Voloshin, Akhmatova, Tsvetaeva, Yesenin, Gumilev and Mayakovsky.

Being rather strict and cold at work, Oparin completely changed at home. His wife Nina Petrovna was an extraordinary, energetic, and worldly woman. She often gave suppers by candlelight, and the guests, sitting at the well – laid table, sang romances to the accompaniment of the piano or guitar. Aleksandr Ivanovich loved his dacha (country house), where he put on his sports suit. In winter he wore felt boots there, and seemed to be in his element. Oparin was fond of growing roses. Every fall he carefully covered them with fir branches, and in spring he cut the bushes and watched how they blossomed. On his favorite holiday, New Year's Aleksandr Ivanovich himself decorated a fir tree, dressed as Father Frost (a Russian equivalent of Santa Klaus), gave out presents, and enjoyed himself like a child.

Nina Petrovna was not only his wife, but also his faithful friend and assistant. She knew all about Oparin's activities, was his interpreter during his trips abroad, guarded him against everyday troubles, and took care of him until his last days.

A.I. Oparin was a man of great courage. In the last years when the old age and illnesses made themselves felt, he never complained and continued writing manuscripts and governing the Institute.

A.I. Oparin died on April 21, 1980. He was buried at the Novodevich'e Cemetery in Moscow.

Moscow- Novo-Devichy
Photo Frantisek Zboray

Some of the Books Written by Alexander Oparin

1. **The Origin of Life :**
   This classic of biochemistry offered the first detailed exposition of the theory that living tissue was preceded upon Earth by a long and gradual evolution of nitrogen and carbon compunds. Contents : 1. Theories of Spontaneous Generation of Life. 2. Theories of the Continuity of Life 3. Theories of the Origin of Life at Some Distant Period of the ...
   by used : From $2.90!
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2. **Life, its Nature, Origin and Development**
   buy used: from $6.45!
3. **The Origin of Life on the Earth :**
   buy used : from $8.25!
4. **The Universe :**
   by Oparin, Aleksandr Ivanovich, and Fesenkov, V.G.

   Does life exist throughout the Universe and, in particular, on the planets of our solar system? in this book the authors make an attempt to answer this questin on the basis of the latest information in natural science. This book was originally published in the Soviet Union in 1955, and is useful for its different perspectives on the questions.

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5. **Genesis and Evolutionary Development of life :**
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   by Dose, Klaus, and Oparin, Aleksandr Ivanovich
8. **Proceedings :-**
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9. **Chemical Evolution -** the Structure and Model of the First Cell : Proceedings of the Third Trieste Conference on Chemical Evolution, the Alexander Ivanovich Oparin 100th Anniversary Conference, 29 August - September 1994

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Chemical Evolution - the Structure and Model of the First Cell : Proceedings of the Third Trieste Conference on Chemical Evolution, the Alexander Ivanovich Oparin 100th Anniversar Conference, 29 August September 1994

From the Publisher

Some of the foremost authors in origin -of-life studies have contributed to this volume to provide a timely up-to-date review and evaluation of the recent rapid evolution of theoretical and empirical knowledge in this vast interdisciplinary field of research. In 39 contributions by 95 scientists, many aspects of the origin of the first cell are discussd; exobiology at the level of the solar system and beyond; the early paleontological record; physical, chemical, biological, and informational aspects of the origin and structure of the membrane and of the cell itself. This book is the proceedings of the Third Trieste Conference on Chemical Evolution that took place in 1994, in which scientists from twenty-seven countries joined in a celebration of Alexander Oparin's centenary. Audience: Graduate students and researchers in the many areas of basic, earth, and life sciences that contribute to the study of chemical evolution and the origin of life.

FROM THE CRITICS

Booknews

Attempts to throw light on the first appearance of a biological structure by tracing life forms backward as far as possible and recreating purely chemical processes that migh have led to it. After overviewing the field and the question, the 40 papers cover memebrane formation, in planetary, extraterrestrial, and interstellar conditions; the early paleontological record; and physical, chemical , biological, and information aspects to the beginning of both membrane and cells. Reproduced from typescripts. Annotation c. Book News, Inc., Portland, OR (booknews. com)