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ASTROBIOLOGY: INTEGRATION OF SCIENCES FOR THE WELL-BEING OF OUR CIVILIZATION

This special issue of KOSMOS has been prepared to celebrate the 10th birthday of astrobiology. It is already the second comprehensive publication in Polish language, which has been dedicated to this extremely young scientific discipline. The first one, which appeared in September 2006, is the book „Astrobiology: through cosmic dust to DNA” (FERRARI and SZUSZKIEWICZ 2006), printed by the Scientific Publishing House of the University of Szczecin (Naukowe Wydawnictwo Uniwersytetu Szczecińskiego). This book marked the foundation of the Centre for Advanced Studies in Astrobiology and Related Topics – CASA* (in Polish – Centrum Zaawansowanych Badań w Zakresie Astrobiologii i Dziedzin Pokrewnych) based in Szczecin. It provides an excellent introduction to astrobiology and explains how astrobiology is connected to other scientific disciplines. It is worth mentioning that, while the world literature covering astrobiology is growing and growing, most of it is published in English. We are thus very glad that the Polish reader has the opportunity to read about astrobiology in the own language. Among the monographs and textbooks published in English we would like to recommend: „Astrobiology: A Multidisciplinary Approach” (LUNINE 2005), „Introduction to Astrobiology” (GILMOUR and SEPHTON 2004), „Astrobiology: the Quest for the Conditions of Life” (HORNECK and BAUMSTARK-KHAN 2002). Moreover, there are two regular scientific journals containing the word „astrobiology” in their names: the American „Astrobiology” and the Euro-

pean „International Journal of Astrobiology” – IJA. Articles on astrobiology related issues appear also in the journal „Origins of Life and Evolution of Biospheres” and many others. We would also like to point out to the reader the sixth issue of „Astrobiology” of 2006, where it is possible to find a very useful guide through the literature entitled „The Astrobiology Primer: An Outline of General Knowledge – Version 1, 2006” (MIX *et al.* 2006). Another important reference on this subject is the article „EANA trail guide in astrobiology: search for a second genesis of life” (BRACK *et al.* 2005), published in IJA in 2005, where the present state-of-the-art of the field is given and the main directions for the future astrobiological research in Europe are outlined.

In this special issue we have striven ourselves to offer an introduction to the fascinating themes of astrobiology which could be accessible also to an inexperienced reader. We stress the novelty and the beauty of this discipline and we illustrate how the process of integration of sciences and human activities which is in the spirit of astrobiology will contribute concretely to our common well-being, that means to the well-being of our civilization, which is based on knowledge and modern technologies. We have invited to write a contribution to this work both the authors of the first Polish book on astrobiology, who are associated with the Polish Astrobiology Centre CASA* and scientists who are outside this team, but whose research interests are close to astrobiology and related

topics. It is very likely that, despite our best efforts, we could not reach everybody who might be interested in participating in this initiative. We apologize for that and we hope to improve this point in the future.

Our astrobiological trip will start on the Earth i. e. exactly the place where the task of studying life and its origin is the easiest one. Let us give a look at the ubiquitous microorganisms populating our planet. Our guide through the world of microbes will be Marianna Turkiewicz, who investigates organisms living in extreme conditions and attempts to delimit the range of parameters which are necessary for life to exist. This work is of fundamental importance in astrobiology, because these parameters tell us what and where to search in order to detect possible signs of life outside the Earth. The capability of the organisms to adapt to low temperatures is connected with a production of unique proteins. For this reason, it is of great importance to study the structure of proteins and their properties. Another fundamental problem, which is of interest for astrobiology, is the understanding of how biomolecules „organize” themselves into living beings. The three dimensional protein structure is one of the key points for solving this enigma. In the next article, Marek Cieplak and Joanna I. Sułkowska, using ample samples of proteins deposited in the Protein Data Bank (PDB), show in great detail those properties, which allow us to understand the mechanical processes taking place in cells. The organisms we are studying, trying to understand how their living processes take place, thrive under a variety of environmental conditions. One of these conditions, which was unknown to us hundred years ago, is related to the existence of cosmic rays. It turns out that our Earth is continuously „bombarded” by high-energy particles arriving from the outer space. The nature of cosmic rays and their interaction with the atmosphere of our planet will be explained by Maria Giller. Afterwards the effects of these rays onto living organisms will be analyzed by Marta Deperas-Kamińska, Irena Szumiel and Andrzej Wójcik. Other factors which shape the ecosystem are the fall of meteorites and the collisions with comets and asteroids, in other words the small and big catastrophes. Have these events something to do with the rough periods when many species were dying out? We will learn about that from the article by Adam and Dorota Lipowscy. The study of life

at the molecular level and its global evolution brings us closer to the understanding of the origin of life. Chemistry plays an important role in approaching the final goal and not only chemistry known from the nearest surroundings. This will be the subject of Robert Kołos’ article. In the space we have found complex organic molecules and, quite likely, even the simplest of the amino acids, the glycine. These are the basic building blocks of living organisms, as we know them here on Earth. But our aim is even more ambitious. We are looking not only for building blocks but also for living organisms themselves. Our hopes since long have been connected with Mars. What are the perspectives to find life on Mars now will be presented by Barbara Kremer and Józef Kaźmierczak. The exploration of the Solar System is an ongoing human activity. From more than ten years we know that our planetary system, even if it is still quite unique due to the location of giant gaseous planets far away from the Sun, is not the only one. Till now we have discovered more than 200 planet in our Galaxy and soon we will discover many more. The possibility of existence of the appropriate conditions for the emergence and survival of life around other stars will be considered by Michał Różyczka in his article. Next, together with Jerzy Stelmach we will have a look at these conditions in the context of the whole Universe. At the end we will learn about the history and the biggest achievements in Solar System studies obtained with the help of cosmic missions. Our instruments reached Mars, Venus, Jupiter, Saturn and the satellites orbiting around big gaseous planets. In preparation are the Kepler mission, which will observe planets like our Earth and Phoenix Mars Lander, which will be looking for organic molecules in the Marsian ice. We will be told about cosmic exploration by Zbigniew Kłos and Janusz Zielinski.

Astrobiology which is ten years old now, was born to unify the sciences. In particular, at the beginning the idea was to put together life and planetary sciences. Its potential to integrate different disciplines appeared to be much stronger than what was expected. Astrobiology looks at life in the context of the whole Universe, treats the Earth as a one of many planets. Ten years is a short time for a discipline to mature, however the astrobiological vision of the Universe played already an important role for biology, chemistry and physics. It linked studies of four milliards of

years of life on the Earth with the effort of discovering life outside our planet. It is a vision in which the desire of exploring the external space is balanced by the interior need of understanding how we emerged in the world to which we belong. Such a glance from outside is not only inspiring, but also possesses a freshness which is absent in the case of the single disciplines which compose that multidisciplinary science which is called astrobiology. It leads us to know our planet and defend it against the natural risks to which it is exposed. On the other hand, thanks to the technological developments we will be able to leave the Earth when it will be necessary. In the process of unification of the sciences astrobiology acquired also the ability of cutting out the so-called „spin off” results. Thinking about reaching inaccessible places on Earth, travel in space, extreme conditions with which instruments and people must cope, leads to building new machines, finding new materials and inventing more powerful techniques, which then might be and are used in our everyday life. There are plenty of practical applications of astrobiology and related topics. An extensive discussion on the biotechnological applications will be presented in the article of Marianna Turkiewicz, the first article of this issue. Another example is connected with the necessity of astronauts’ protection against the effects of the ionizing radiations and is given in the text of Marta Deperas-Kamińska, Irena Szumiel and Andrzej Wójcik. Astrobiological studies very often require the usage of advanced computational techniques and fast computers. In a number of articles of this issue it is pointed out what are the benefits of the quick progress in information technologies.

The aim of astrobiology is to understand how life began, how it evolves and how it is distributed in the Universe. What we know for now can be summarized in the following way. We do know one place in which life exist with no doubt, we call it – the plan-

et Earth. In order to find this planet in the labyrinth of almost perfect vacuum spangled with condensations of matter – such as the large scale structure of the Universe may be described – one needs first to identify the Virgo Supercluster of galaxies. In the central part of this supercluster there is a cluster of hundreds of galaxies called the Virgo Cluster. 60 millions light years away, at the edge of the Virgo Supercluster, the Local Group of galaxies is located. It contains few tens of galaxies. Approaching the Local Group we can see three distinct, by their size, objects – three big spiral galaxies: the Milky Way or simply the Galaxy written with capital „G”, the Andromeda Galaxy and the Triangulum Galaxy. Now we shall follow the journey towards the Milky Way. In one of its spiral arms, the Orion arm, we will find a yellow star belonging to the so-called main sequence, classified as G2, the Sun. This star is surrounded by the Oort Cloud, which in its interior part forms the Kuiper Belt. Inside the belt there are planets orbiting the Sun. The third, counting from the star is the planet Earth. Here, a full variety of living forms has evolved, some of them highly specialized. A few civilizations arose and disappeared. The present civilization once again tries to understand its own place in the Universe, its origin and evolution and also the possibility of the existence of life on other planets, around other stars, in different galaxies, clusters and superclusters of galaxies. It is able to study itself and its surroundings, it is able to study its own planet and other objects in the Universe. The present civilization is equipped with an advanced scientific and technological knowledge and understands the necessity of the unification of sciences to cope with challenges which are getting more and more complex and require an interdisciplinary approach in order to be faced successfully. In the articles of this issue of KOSMOS we will see how individual representatives of the modern civilization will approach to the main goal of astrobiology.

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