

G. A. Tikhov, and the Beginnings of Astrobiology

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Even being a young scientific field, astrobiology has an interesting and unexpected history. The Russian astronomer Gavriil Adrianovich Tikhov (1875-1960) was one of the main precursors of astrobiology. Actually, the word "astrobiology" is older than often thought : the definition "the consideration of life in the universe elsewhere than on earth" is yet given by Lafleur in 1941 in a paper entitled "astrobiology". Tikhov's researches gain a new importance in the viewpoint of the future discovery of new terrestrial extrasolar planets.

Study of the Earthshine, then and now. Tikhov studied Earthshine as early as 1914 and concluded that Earth seen from space has to be seen with a pale blue colour because of Rayleigh scattering. More a decade latter, observations of earthshine were made regularly from 1926 by Danjon and collaborators (Danjon 1928, 1954; Dubois 1947). Present observations of Earthshine find again the Rayleigh scattering (Arnold et al. 2002; Woolf et al. 2002). Whereas Tikhov, because of instruments used at this time, concluded that the detection of vegetation is not possible in the ashen light of the Moon, the terrestrial vegetation was detected in the Earthshine by Arnold et al. (2002) and suspected and confirmed later by Woolf et al. (2002).

Birth of astrobotany. The most interesting field of Tikhov's research is certainly the search for vegetation on Mars and extraterrestrial life. For this purpose, he studied optical properties of terrestrial plants and particularly spectra of plants growing in conditions similar to those of Mars, looking for plants without chlorophyll, or with unusual chlorophyll spectra. He created the word "astrobotany" in 1945. The study of reflectance spectra of various plants became so important that in 1947, he founded in Alma-Ata (Kazakhstan) a department of astrobotany composed of young students, biologists and physicists. Some expeditions were sent in high mountains and polar regions, where extreme conditions look those of Mars. Many interesting results obtained are published in a lot of papers (see for example : Tikhov 1947, Tikhov 1955).

From astrobotany to astrobiology and cosmobiology. Assuming that primitive micro-organisms are gifted for a larger adaptability to the environment conditions, astrobotanists started new observations and research fields. They studied extreme conditions of life on Earth, from works of microbiologists and studied in what cases physical conditions of various planets make a primitive life possible. So Astrobotany broadened in Astrobiology, then in Cosmobiology. Tikhov though that life arises inevitably under favorable conditions. In 1949, he published a book named: "Astrobotany" and in 1953, a book named: "Astrobiology" and in 1953 too the word "astrobiology" is used as a keyword by the astronomical bibliographic books *Astronomische Jahresbericht* for a paper of the

astrobotanic departement of the Kasak academy of which he was the director. After the death of Tikhov in 1960, the department of Astrobotany of Alma Ata was dismantled.

Contemporary studies. Other astronomers investigated also the hypothesis of vegetation on Mars, studying chlorophyll spectra, such Slipher (1924), Millman (1939) and Kuiper (1949). Sinton (1957a, 1957b, 1958) studied and compared reflectance of several plants and concluded to the evidence of vegetation on Mars. But his studies concern infrared, where vegetation reflectance spectra can be confused with soil reflectance and unlike Tikhov, he investigated only few plants. The first American symposium in Astrobiology was held in 1957 (Wilson 1958 and following papers).

Present studies and conclusion. Spectral properties of plants have been the subject of hundreds of studies since the middle of the last century and are useful for many fields of science and economy. The word "astrobiology" has been "created" again in the 90's and extensively used since. As said above, astronomers have been recently interested again by detection of chlorophyll, for the detection of life in future terrestrial planets. The techniques, in particular with the apparition of the CCD allowing the study of the Vegetation Red Edge (VRE) of the chlorophyll at 725 nm, have made considerable progress. As astrobiology expands so much and as search for extrasolar life is now a very important question, it can be seen how modern the studies that G. Tikhov carried out more a half century ago appear now. All the fundamental ideas were already existing in the middle part of the XXth century.

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