

KEY ROLE OF WATER AND CARBONATES IN RESPIRATION.

Voeikov V.L.

Faculty of Biology, Lomonosov Moscow State University, Moscow, Russia.

E-mail: vvl@soil.msu.ru

Life on Earth in all its known forms can not exist without aerobic respiration generally defined as oxidation of glucose and fats by oxygen to water and CO₂. From another perspective this process may be looked upon as oxygen reduction to H₂O with hydrogen atoms taken from organic compounds providing for the major part of energy generation, while oxidation of carbon is just a necessary side reaction yielding a “by-product”, CO₂.

It became evident recently that water molecules may split in liquid water even under the action of mechanical forces to $\cdot\text{O}$ and H, producing finally H₂ and O₂. Hence water, the dominating substance in all living things may in principle serve the source of both oxygen and hydrogen. Indeed “water burning” – direct reduction of oxygen with hydrogen atoms donated by water catalyzed by antibodies and some ubiquitous enzymes was recently discovered. Thus oxygen utilization (= respiration) may proceed as sequential reduction of oxygen with hydrogen atoms supplied by two water molecules. As a result two water molecules recover. There is no paradox here because electrons may be supplied only by water belonging to specific (“coherent”, according to E. Del Giudice and G. Preparata) water domains where water is highly polarized, while water arising as the product of oxygen reduction constitutes non-coherent “water gas”. Yet the major “product” of such a process is not water but energy of electronic excitation.

Intermediate products of direct oxygen reduction are highly metastable reactive oxygen species (ROS). Their reactions including dismutation and recombination are accompanied with release of quanta of energy equivalent to the energy of photons belonging to visible and UV-light range of spectrum. In our studies of ultra-weak photon emission from natural artesian waters we indeed observed waves of photon emission from water to which Fe(II) or K₃[Fe(CN)₆] together with luminescence enhancer were added. Superoxide radical and hydrogen peroxide spontaneously generated in water were responsible for significant part of photon emission. However, it turned out that for the development of such processes and their durability the presence of carbonates, primarily bicarbonate is necessary. Bicarbonate ions appear to be important participants and modulators of reactions of ROS that take place in water probably because they are able to react with ROS and turn themselves into active chemical species. This property of carbonates may ensure autocatalytic synthesis of organic compounds under the conditions where energy is supplied by direct oxygen reduction with electrons supplied by water.

The fact that H_2O_2 and products of its interaction with water are important regulators of respiration both at the level of the whole organism as well as at the cellular level is known to physiologists. There is evidence that deficiency of carbonates in the organism results in impairment of respiration. Thus H_2O_2 – the product of full oxidation of organic compounds in the organism is a peculiar catalyst of respiration, rather than its by-product. Our data shows that water “respiration”, even in the simplest aqueous systems, is not fully realized in the absence of carbonates.