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The balance model of oxygen enrichment of atmospheric air

Alexander Popov
Saint Petersburg State University, Saint Petersburg, Russian Federation (paihumic@gmail.com)

The study of turnover of carbon and oxygen is an important line of scientific investigation. This line takes on special significance in conditions of soil degradation, which leads to the excess content of carbon dioxide and, as result, decrease of oxygen in the atmosphere.

The aim of this article is a statement the balance model of oxygen enrichment of atmospheric air (ratio O/C) depending on consumption and assimilation by plants of dissolved organic matter (DOM) and the value of the oxidation-reduction potential (Eh).

Basis of model was the following: green vascular plants are facultative heterotrophic organisms with symbiotic digestion and nutrition. According to the trophology viewpoint, the plant consumption of organic compounds broadens greatly a notion about the plant nutrition and ways of its regulation. In particular, beside the main known cycle of carbon: plant - litter - humus - carbon dioxide - plant, there is the second carbon cycle (turnover of organic compounds): plant - litter - humus - DOM - plant.

The biogeochemical meaning of consumption of organic compounds by plants is that plants build the structural and functional blocks of biological macromolecules in their bodies. It provides receiving of a certain “energy payoff” by plants, which leads to increase of plant biomass by both an inclusion of allochthonous organic molecules in plant tissues, and positive effect of organic compounds on plant metabolic processes.

One more of powerful ecological consequence of a heterotrophic nutrition of green plants is oxygen enrichment of atmospheric air. As the organic molecules in the second biological cycle of carbon are built in plants without considerable chemical change, the atmospheric air is enriched on that amount of oxygen, which would be required on oxidation of the organic molecules absorbed by plants, in result.

It was accepted that: plant-soil system was climax, the plant community was grassy, initial contents of carbon in phytomass was accepted as 1, annually from 60 to 100 % of the plant litter could arrive to the soil; coefficients of humification of both plant litter and DOM were 0.1 (10 %); DOM is formed as a result of hydrolytic destruction of plant litter, newly formed humic substances (HS) and humus; coefficient of possible absorption of DOM by plants - 0.1 (10 %); it was considered that all organic compounds affiliated into DOM had positive physiological effect on green plants; it was accepted that 1 % DOM absorbed by plants increases phytomass on 10 % (for example, at the expense of photosynthesis acceleration); Eh value was changed from 300 to 800 mV; depending on Eh (i) the coefficient of plant litter oxidation was in the range from 0.75 (75 %) to 0.8 (90 %), coefficient of oxidation of DOM and newly formed HS - from 0.85 (85 %) to 0.9 (90 %), and coefficient of humus oxidation from 0 (0 %) to 0.05 (5 %), and (ii) coefficient of hydrolytic destruction of plant litter and newly formed HS was in the range from 0.12 (12 %) to 0.07 (7 %), and coefficient of humus hydrolytic destruction from 0,05 (5 %) to 0 (0 %), accordingly; all dependences were quasilinear.

The following conclusions have been made based on the modeling: (i) both phytomass and oxygen content in atmospheric air were increased with increase of DOM part absorbed by green vascular plants; (ii) the abundance of humus was increased with increase of DOM consumption by green plant (on 5 % at all Eh values) too; (iii) the increase of Eh with 300 to 800 mV led to reduction of oxygen in atmospheric air and to quadruple decrease of the abundance of humus.