THE DEVELOPMENT OF YE. N. IVANOVA'S IDEAS ABOUT THE SOIL GENESIS IN THE REPUBLIC OF KOMI

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The paper is devoted to Yeugenia Nikolaevna Ivanova, an outstanding soil scientist and a founder of soil studies in the Republic of Komi. A brief review of the latest successes achieved by specialists of the Institute of Biology in the Republic of Komi shows the development of Ye.N. Ivanova's ideas presented in her publication entitled "Principal Regularities of the Soil Cover along the North-Pechora Railway" (1952).

Keywords: Ye. N. Ivanova, history of soil investigations, genesis of taiga and tundra soils

> *"Soil scientists of different age and academic status will constantly address to Ye. N. Ivanova's publications, drowning information and ideas for their new achievements in studying the genesis, geography, in classification and soil mapping…"*
>
> V. L. Andronikov

December 12, 2014 is the 125th birthday of Yeugenia Nikolaevna Ivanova, Professor, Doctor of Agricultural Sciences, a brilliant representative of Dokuchaev soil science. She is an eminent soil scientist, geographer, the author of "Soil Classification of the USSR" (1976), recipient of Dokuchaev's Golden Medal and Honored Scientist. Her research interests have been primary in studying the soil cover at the vast territory in the Republic of Komi.

Ye. N. Ivanova was appointed as head of the biological department in Kolskiy Center of the USSR Academy of Sciences in 1934. It was evacuated in Syktyvkar in 1941 and renamed into the S.M. Kirov

Photo 1. Ye. N. Ivanova, Prof. Dr. Sc., an outstanding soil scientist and geographer.

Center of Studies in the Country's North. In 1942-1944 on the instructions of local authorities the soil studies have being carried out under her guidance along the Kotlas-Vorkuta railway 800 km long, intersecting the total territory in the Republic of Komi from southwest to northeast, from southern taiga subzone to tundra zone. Having generalized the obtained results, Yeugenia Nikolaevna was the first to identify the soil-climatic zonality at the studied territory and to specify qualitative differences in processes of automorphic soil formation in different bioclimatic subzones within the zone of podzolic soils as well as in the zone of tundra soils. The studies were accompanied by compiling the soil maps at 1:200 000 scale [16]. Her work entitled "Princi-

pal Regularities in Soil Distribution along the Pechora Railway" was published in 1952.

Based upon this publication allow us to carry on a virtual dialogue with Ye. N. Ivanova, a dialogue through tens years, in which Ye. N. Ivanova's ideas have been developing by her nearest pupil Iya Vasilievna Zaboeva and her successors.

The first Ivanova's idea is that "*the soils of the Komi ASSR have been so far examined insufficiently. The small-scaled studies embraced only the southern and western parts of this Republic".*

Today, in the Republic of Komi the soils continue to be comprehensively examined by specialists of the soil science department in the Institute of Biology in Komi Research Center of Russian Academy of Sciences. The long-term geographical and stationary studies carried out by several generations of soil scientists allowed identifying principal regularities in the development of the soil cover, peculiar properties of taiga and tundra soils, their potential and efficient productivity in the Republic of Komi [3]. The buried, polygenetic soils in Bolshezemelskaya tundra have been studied in detail [34]. The studies aimed to specify the behavior of the topsoil in "warm" and instable permafrost-affected soils became intensified at the territory of southern tundra and forest tundra in the North-East of European Russia. Definite conclusions have been made as resulted from long-term monitoring of the upper layer in tundra soils [28, 29]. New data about the development of different soils within the transitional zone between the tundra and northern taiga have been obtained, new soil types were recognized being absent on old soil maps and in soil classifications [28, 32]. In collaboration with V.V. Dokuchaev Soil Science Institute in Moscow the classification of podzolic soils derived from two-layered deposits has been elaborated; geographical regularities in distribution of these soils have been determined; peculiar morphology, physical and chemical properties, the particle-size distribution and mineralogical composition were thoroughly studied; processes of texture differentiation have been identified [15, 40, 41]. There are new data about the development of diverse soils in middle and southern Timan, including rare and disappeared soils; the recommendations to protect these soils were suggested [44, 47]. Regularities in the soil development were studied at the territory of Polar and Pre-Polar Ural [8, 9]. The zonality of basic processes differentiating the mineral mass in the soil profile was specified [38];

the long-term studies of soddy podzolic soils in southern and middle taiga have been completely finished [18]. Under study was also the soil cover structure within the taiga zone in the Republic of Komi [42].

The peculiar humus formation has been studied in soils of the northern part of European Russia [1], the data about the composition and structure of humic acids have been generalized in order to assess their reaction capacity [25, 26]. Under study were the regularities in the formation of the lipid fraction of the soil organic matter as well as the pool of priority polycyclic aromatic hydrocarbons, the latter being theoretically examined in their distribution within the soil-plant system [12–14]. Peculiar features of the acidity have been found in zonal and subzonal soils. A comparative study of the structure in microscopic fungi complexes was carried out in soils of virgin and human-modified ecosystems within the taiga and tundra zones [36]. The interaction between the conditions for the soil formation in northern floodplain ecosystems and the dynamics of population and composition of microbiota in some groups of invertebrates has been established [23, 25].The two-stage system for accelerating the restoration of biocenoses disturbed by technogenic effects was elaborated and approved in taiga and tundra zones [2]. The results of studying the soils carried out for more than 70 years have been generalized in the fundamental publication "Atlas of Soils in the Republic of Komi" (2010).

"*The latitudinal soil-climatic zonality is clearly expressed in view of climate changing along the railway. From the north to the south the soils are changing from tundra to soddy podzolic ones"* This Ivanova's conception of the soil-climatic zonality and types of podzolic soils divided into subtypes within the taiga zone found its reflection in sheets of the State Soil Map at 1:1 000 000 scale (P-39, P-40, Q-39, Q-40, Q-41), in soil maps of the Komi Republic at 1: 000 000 and 1: 2 000 000 scales. The Soil map is a major source for quantitative and qualitative evaluation of the land resources in this region, a basis for rational land use. There exists a set of ecological maps including the map of possible intensity in the soil self-purification from contamination by organic substances (oil products), the map of potential pollution of the soil cover by toxic microelements, the map of the heavy metal content in soils [3–5, 31]. A set of large-scale vector maps has been prepared for test areas in landscapes characterized by different distribution of permafrost-affected deposits in the North-East of European

Russia; a GIS-technology was elaborated in ArcInfo/ArcViw to study the wet permafrost within the Usa river basin and the total area in the Republic of Komi [30]. Based upon vector maps the carbon pool was calculated [33]. The quantitative and qualitative characteristics of land resources in the Republic of Komi have been given including 5 mln ha of agricultural lands, on which the automorphic podzolic soils are dominated [44]. For every administrative district there are recommendations to improve the water-physical soil properties and to optimize the moisture regime in soils.

In Ye. N. Ivanova's publication it was written that "*the acidity in surface horizons is increasing in podzolic soils resulted from the climate changing towards the north".*

It is worth emphasizing that Ye. N. Ivanova considered the soil as inseparably linked with its geography and the soil formation factors [19]. Following the systematization principle and the soil study at different hierarchical levels it was managed to obtain the further development of this position. Particularly, it was shown that the upper organogenic and eluvial horizons of loamy soils in taiga and tundra zones – the root layer, in which the greatest amount of diverse microbiota is concentrated and the biological substance turnover takes place – the acidity properties and buffering characteristics reveal great changes. They are absent in illuvial horizons due to insignificant transformation of these horizons caused by soil processes. This is evidenced by the absence or the lower content of components represented by products of the soil formation and namely by organic and Al-humus-organic compounds as well as minerals included into the group of soil chlorites [37]. Among the reasons for increasing the acidity in organogenic horizons of the podzolic soil changing towards the north from soddy podzolic to gley-podzolic ones it is necessary to indicate the specific of the biological turnover of such elements that take part in neutralization of soil acidic components as Ca^{2+} Mg^{2+} and K^{+} and, on the other hand, the peculiar formation of low-molecular organic acids. The gley-podzolic soils in northern taiga display a higher content of diverse water-soluble low-molecular organic oxiacids ($pK_o < 4$). The specific of typical podzolic soils in middle taiga is that the amount of aliphatic acids is rather high in them, what is conditioned by a lower rate of their oxidation up to many base carbonic acids and their natural dehydratation under conditions of lower transpiration and higher mois-

ture as compared to typical podzolic soils. The decrease in the content of low-molecular water-soluble organic acids depending on transition of gley-podzolic soils to tundra surface-gley soils is explained by cryogenic processes, decreasing the diversity of plant species and population of acid-forming microorganisms due to the severe temperature regime and changes in the quality and quantity of the organic matter involved into processes of mineralization and humification.

Ye. N. Ivanova indicating a higher mobility of Al ions paid special attention to Fe ions, which play a specific role in the development of biochemical processes in gley-podzolic and tundra soils. In her publication she wrote … *the surface horizons are highly enriched with iron released from soil solutions during oxidation and involved repeatedly into the soil".* The given conclusion is testified by calculations of the thermodynamic equilibrium. Particularly, in organogenic and eluvial horizons, whose salt extract has pH equaled to less than 3.2, compounds of Fe^{3+} play a significant role in the development of exchangeable acidity in soils. Such horizons are inherent to loamy soils situated within the northern and extreme northern taiga with different moisture content as well as to semi-and hydromorphic soils in middle taiga. The migration of water-soluble organic acids including aromatic and aliphatic oxiacids capable to the complex formation stimulates the Fe^{3+} mobilization [36].

However, "*at present, there are few facts to explain the nature of... phenomena and to combine different viewpoints*" (Ivanova, 1952). Paying a tribute of respect to our outstanding teachers – Yeugenia Nikolaevna Ivanova and her nearest pupil Iya Vasilievna Zaboeva, we must recognize as necessary that the soil studies in the Republic of Komi are far from being completed. Our further investigations should be oriented to identify biogeographical and landscape regularities in the development of soils as components of terrestrial ecosystems and mechanisms responsible for their functioning in the Subarctic of the North-East of European Russia.

The present paper would be impossible without participation of our teachers – I.V. Zaboeva, T.A. Sokolova, V.D. Tonkonogov as the nearest pupils of Ye.N. Ivanova. In conclusion, we should like to say that…" Ye.N. Ivanova's works and her thoughts remain a fruitful source for further progress of science. As for young generations, she will be a teacher in science and a striking example of a fruitfully lived life" [45].

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