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USSR Prominent Allelopathy Scientists- Part IV (1937-2023)

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ABSTRACT

The article describes the main achievements and theoretical and practical developments in Allelopathy Research for the period 1937-2023 by scientists of USSR. The main biographical data and achievements of scientific activity of outstanding Soviet scientists in the field of allelopathy are given. -Boris Mikhailovich Mirkin, Pavlo Antonovich Moroz, Nikolay Mikhailovich Matveev, Victoria Vladimirovna Roshchina. These scientists deepened and developed the study of aspects of allelopathic tactics of plants on the example of fruitful perennial plants with the formation of criteria of allelopathic sensitivity and allelopathic tolerance, allelopathic threshold of sensitivity, allelopathic mode of biocenosis and its structure, expanded the substantive concept of allelopathically active compounds (genes) and ways of their existence and distribution in the biocenosis, the concept of aftereffects in monocultures is significantly detailed unchanged cultivation of plants in the same territory, the directions of allelopathic phytoindication are also detailed (P.A. Moroz, N.M. Matveev). The issue of species phytocenology was expanded and adapted from the standpoint of the formation of plant successions, phytocenological pressure in plant populations of different densities and species structure using the approaches of vitality tactics and levels of coenotic interaction of plants (B.M. Mirkin). New aspects of the study of allelopathic activity and allelopathic potential of plants based on the cellular-physiological cycle of neurotransmitter systems of the plant cell (chemoreception, chemosensitization, free-radical processes of chemical interaction, etc.) were initiated (V.V. Roshchina).

Key words*:* Allelopathy, allelopathy scientists, biography**,** Matveev, Mirkin, M.oroz, Roshchina

1. INTRODUCTION

The scientific vision of the biological laws of the world are changing and this is associated with details of processes of the existence of living organisms and complex interactions between them. The transition from the isolation of biological objects in existing systems in certain habitats, based on their mutual influences in the biogeocenosis is basic methodological approach. Perception of development of managed biological systems is to ensure the preservation of biodiversity. Allelopathic research is becoming increasingly important in this regard, it is becoming more complicated, has completely new look at the

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processes. Allelopathic research is mandatory to establish the biological and economic efficiency of various agrophytocenosis, biological control of agricultural fests (Weeds, Insects, Nematode, Fungi) without use of agrochemicals, development of ecologically balanced biogeocenosis in different ecosystems and prevention of allergic reactions etc. (47).

2. BIOGRAPHIES OF PROMINENT ALLELOPATHY SCIENTISTS (1937-2023)

2.1. Boris Mikhailovich Mirkin (1937-2017)

He was a phytocenologist, Doctor of biological sciences (1975), Professor (1976), Honoured Scientist of Russian Federation (1994), Corresponding Member, Academy of Sciences of Republic of Bashkortostan.

Figure 1. Boris Mikhailovich Mirkin.

***Early life and education*:** He was born on July 16, 1937 in Ufa. From 1944 to 1954 he studied in High school. During 1954-1959 he studied at the Kazan State University.

Professional life and contributions to allelopathy: After graduation, he worked in the Department of Botany, Bashkir Agricultural Institute. From 1970 he was Head, laboratory of geobotany, Chief Researcher at the Institute of Biolog Academy of Sciences of the Republic of Bashkortostan. Since 1982, he was Vice-Rector for Research at the Bashkir State University.

In 1971-1987 he headed the Soviet-Mongolian Biological Expeditions in Bashkortostan, the valley of the Amu Darya River (1965), the Mongolian People's Republic (1970-1975), Yakutia (1974, 1976, 1978), the Volga River delta (1982-1985), floodplain of the Amur River (1987).

Since 1995 he was member of the International Association for Vegetation Science (IAVS) and a member of the Editorial Board of the journal, *Folia Geobotanica et. Phytotaxonomica*.

He was the Deputy Chairman Editorial Board of the publishing house "Bashkir Encyclopedia", Member Editorial Boards of the journals *"Biology at School", "Ecology and*

Life", "Agricultural Biology", "Bulletin, Academy of Sciences of Republic of Bashkortostan", "Economics and Management", "Bashkir Ecological Bulletin", Tabigat. He trained 17 Doctors and 60 Candidates of Sciences.

B. Mirkin's scientific interests were geobotany, classification of vegetation, the theory of successions in grass mixtures, the doctrine of anthropogenic transformation of vegetation, competition in biocenosis and the assessment of factors of interspecific interaction of plants. He established the Ufa Geobotanical School (in 1960-1970, Bashkir State University and the Institute of Biology of the Ufa Scientific Center of the Russian Academy of Sciences). The school is working on phytocenology, dynamics and classification of vegetation, models of phytocenosis organization. R. Mackintosh, a prominent American ecologist, called him "an ecologist of philosophy and a metaecologist" for the development of the theory of vegetation classification by Mirkin.

Table 1. Chronology of main events

Dates	Events
1937	Born on on July 16, 1937 in Ufa (Russia)
1944-1954	Schooling
1954-1959	Studied at the Kazan State University
1960-1970	Worked in the Department of Botany, Bashkir Agricultural Institute
1970-2017	Head, laboratory of geobotany, Chief Researcher at the Institute of Biology of the Academy of Sciences of Bashkortostan
1971-1987	Took part in geobotanic expeditions
1975	Defended his Doctoral Dissertation
1976	Received the title of Professor
1994	Received the honorary title of 'Honored Scientist of the Russian Federation'
1995	A member of the International Association for Vegetation Science (IAVS) and a member of the editorial board of the journal Folia Geobotanica et Phytotaxonomica
2017	Expired on 9 August, 2017

He developed fundamental approaches to the classification of vegetation, quantitative methods of plant successions, assessed phytocenological stress of population of species in one area, complex relationships between species during the growth and development, methods of population-species modeling, classification of species life tactics plants and their role in the expression of dominance and suppression of species, the studied design features of complex artificial cenosis, behavioral characteristics of species in mixtures, the ratio of cultivated species and weeds in agrophytocenosis. He laid down and developed fundamental approaches in the structural analysis of vegetation, timed to the nature of soil and climatic parameters of the territory and the typology of the formation of cenosis given the vitality tactics of plants. He developed the issue of species competition in the system of allelopathic research and allelopathic tactics of species in natural cenosis under different soil and climatic factors of their formation and existence.

PUBLICATIONS: Mirkin has published over 100 works, most of which are Articles and Scientific Reviews in Journals, as well as published abroad. He is the author of over 40 Monographs, University and School Textbooks.

Books/Monographs

(i). Grodzinsky, A.M., Mirkin, B.M., Zlobin, Yu.A. and Naumova L.G. (1991). *Dictionary-Reference Book on Agrophytocenology and Meadow Science*. 135 pp. Naukova Dumka, Kiev (Russian).
(ii). Ishbirdin, A.R., Mirkin, B.M., Solomeshch, A.I. and Sakhapov, M.T. (1988). *Syntaxonomy, Ecology and Dynamics of Ruderal Communities in Bashkiria*. 161 pp. BNTs Ural Branch of the USSR Academy of Sciences, Ufa (Russian).
(iii). Mirkin, B.M. (1970). *Introduction to Quantitative Methods of Vegetation Analysis (Abridged Lecture Course for University Biology Students)*. 87 pp. Bashkir State University, Ufa (Russian).
(iv). Mirkin, B.M. (1974). *Regularities in the Development of Vegetation of River Floodplains*. 174 pp. Science, Moscow (Russian).
(v). Mirkin, B.M. (1974). *Theoretical Questions of the Course of General Geobotany*. 110 pp. Bashkir State University, Ufa (Russian).
(vi). Mirkin, B.M. (1981). *Theory and Practice of Phytocenology*. 64 pp. Knowledge, Moscow (Russian).
(vii). Mirkin, B.M. (1985). *Theoretical Foundations of Modern Phytocenology*. 137 pp. Science, Moscow (Russian).
(viii). Mirkin, B.M. (1986). *What are Plant Communities*. 169 pp. Nauka, Moscow (Russian).
(ix). Mirkin, B.M. (1989). *Current State and Development Trends of Vegetation Classification by the Brown-Blancay Method*. *Botany* 128 pp. VINITI, Moscow (Russian).
(x). Mirkin, B.M. (1990). *Ecology of Vegetation of Agricultural Lands in Bashkiria*. 126 pp. Bashknigoizdat: Ufa (Russian).
(xi). Mirikn, B.M. (1991). *Ecology of Natural and Seeded Meadows*. 65 pp. Knowledge, Moscow (Russian).
(xii). Mirkin, B.M., Abramova, L.M. and Ishbirdin, A.R. (1985). *Segetal Communities of Bashkiria*. 155 pp. BFAN USSR: Ufa (Russian).
(xiii). Mirkin, B.M., Gorskaya, T.G. and Grigoriev, I.N. (1987). *The Experience of Analyzing Successions in Grass Mixtures*. 120 pp. BFAN USSR: Ufa (Russian).
(xiv). Mirkin, B.M., Khaziev, F.Kh. and Khaziakhmetov, R.M. (1992). *Sustaining Agroecosystems: History, Concept, Constructive Approach*. 36 pp. BNTs UB RAS, Ufa (Russian).
(xv). Mirkin, B.M. and Naumova, L.G. (1998). *Vegetation Science: (History and Current State of Basic Concepts)*. 413 pp. Gilem: Ufa (Russian).
(xvi). Mirkin, B.M. and Naumova, L.G. (1999). *Ecology of Russia*. 212 pp. Sustainable World: Moscow (Russian).
(xvii). Mirkin, B.M. and Naumova, L.G. (2011). *A Short Course in General Ecology. Part I: Ecology of Species and Populations:* Textbook. 172 pp. Publishing house of BSPU: Ufa (Russian).
(xviii). Mirkin, B.M. and Naumova, L.G. (2011). *A Short Course in General Ecology. Part II: Ecology of Ecosystems and Biosphere*. 154 pp. Textbook. Publishing house of BSPU: Ufa (Russian).

(xix). Mirkin, B.M. and Naumova, L.G. (2012). *The Current State of the Basic Concepts of Vegetation Science*. 488 pp. Gilem: Ufa (Russian).
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(xxi). Mirkin, B.M., Naumova, L.G. and Baranovskaya, T.A. (2005). *Biodiversity in Agricultural Ecosystems: Teaching and Methodological Guide for Rural School Teachers.* 123 pp. Informal advertising: Ufa (Russian).
(xxii). Mirkin, B.M., Naumova, L.G. and Muldashev, A.A. (2001). *Higher Plants: A Short Course in Taxonomy with the Basics of Vegetation Science*. 264 pp. Logos: Moscow (Russian).
(xxiii). Mirkin, B.M., Naumova, L.G. and Solomeshch, A.I. (2002). *Modern Vegetation Science: A Textbook*. 202 pp. Logos: Moscow (Russian).
(xxiv). Mirkin, B.M. and Rosenberg, G.S. (1983). *Explanatory Dictionary of Modern Phytocenology*. 134 pp. Science: Moscow (Russian).
(xxv). Mirkin, B.M. and Rosenberg G.S. (1984). *Phytocenology: Principles and Methods.* 212 pp. Science, Moscow (Russian).
(xxvi). Mirkin, B.M., Rosenberg, G.S. and Naumova, L.G. (1989). *Dictionary of Concepts and Terms of Modern Phytocenology.* 223 pp. Science: Moscow (Russian).
(xxvii). Mirkin, B.M., Yanturin, S.I., Gorskaya, T.G. and Mukatanov, A.Kh. (1994). A*nalysis of Phytoremediation Succession on Saline Soils in Trans-Urals of the Republic of Bashkortostan*. 98 pp. Ufa Scientific Center of the Russian Academy of Sciences, Ufa (Russian).
(xxviii). Mirkin, B.M. and Zlobin, Yu.A. (1990). *Plant Communities of Our Fields*. 64 pp. Knowledge Moscow (Russian).
(xxix). Mirkin, B.M. and Zlobin, Yu.A. (1990). *Agrophytocenology With the Basics of Agroecology*. 80 pp. Bashkir State University, Ufa (Russian).

Research Papers

(i). Mirkin, B.M. and Khanov, F.M. (1970). The problem of classification of agrophytocenosis. In: *Theoretical Problems of Phytocenology and Biocenology.* pp. 117-125. Moscow (Russian).
(ii). Mirkin, B.M. (1984). On paradigms in phytocenology. *Journal of General Biology* **45**(6): 749-758 (Russian).
(iii). Mirkin, B.M. (1990). About plant continuation. *Journal of General Biology* **51**(3): 316-326 (Russian).
(iv). Mirkin, B.M., Martynenko, V.B., Shirokikh, P.S. and Naumova, L.G. (2010). Analysis of the factors that determine the species richness of forest communities in the Southern Urals. *Journal of General Biology* **71**(2): 131-143 (Russian).
(v). Mirkin, B.M. and Naumova, L.G. (1997). Phytocenosis concept: History of discussions and current state. *Journal of General Biology* **58**(2): 106-116 (Russian).
(vi). Mirkin, B.M. and Rosenberg, G.S. (1979). Quantitative methods of classification, ordination and geobotanical indication. In: *Results of Science and Technology, Botany* **3:** 71-137. VINITI: Moscow (Russian).

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(viii). Mirkin, B.M. and Usmanov, I.Yu. (1991). Allelopathy. The state of the theory and methods of study. *Journal of General Biology* **52**: 646-655 (Russian).
(ix). Yamalov, S.M. and Mirkin, B.M. (2010). Floristic and geographic differentiation of true and meadow steppes of the Southern Urals. *Bulletin of the Central Siberian Botanical Garden* **2**(6): 56-62.

2.2. Pavlo Antonovich Moroz (1938-2016)

***Early life and education*:** He was born on April 15, 1938 in village Vilkhovatka Poltava region. He was ecologist, fruit grower, Doctor of biological sciences, Professor. In 1961 he graduated from the Ukrainian Agricultural Academy (now the National University of Life and Environmental Sciences) with a degree in Agronomy.

***Professional life and contributions to allelopathy*:** He worked in the Botanical Garden his entire working life. After graduating from the Faculty of Agronomy, Ukrainian Agricultural Academy with a degree in agronomy, he worked in the Department of Genetics, and from 1963 in the Department of Physiology of Acclimatized Plants. After graduating from the Central Republican Botanical Garden and defending in 1968 candidate's dissertation *'Allelopathic role of precipitation of leaves and root remains of apple and peach'*. Under the guidance of A.M. Grodzinsky's Moroz worked as the Deputy Director (Research), Botanical Garden (1972-1983, 1994-2006) and conducted active scientific, pedagogical and organizational work. In 1981-2005 he was Head, Department of acclimatization of fruit plants. From 2006 until his death in 2016, he was Chief Researcher of this department. In addition, he was Vice President, Ukrainian Botanical Society, Deputy Chairman of the Council of Botanical Gardens of Ukraine, expert of the Ministry of Energy, Deputy Editor-in-Chief of the journal *'Introduction of Plants'.*

Figure 2. Doctor of Biological Sciences, Professor P.A. Moroz.

Moroz studied the allelopathy of orchards, their aftereffects and interactions of traditional and new fruit crops with co-growth into species diversity and productivity of

garden phytocenosis (5,7). As a result of many years of scientific activity, he collected original data on allelopathic activity and allelopathic tolerance of fruit crops. He found that the generative and vegetative organs of fruit plants contain allelopathically active substances (colins) that enter the soil with root secretions, leachates (organic substances that are leached by rain from tree crowns), precipitation and root residues. The main source of colins in garden phytocenosis was the root system (Figures 3-4).

Table 2. Chronology of main events

Dates	Events
1938	Born on April 15, 1938 in village Vilkhovatka, Poltava region (Ukraine)
1945-1956	Schooling
1956-1961	Studied at the Ukrainian Agricultural Academy
1961-1965	Central Republican Botanical Garden, USSR Academy of Sciences
1965-1968	Postgraduate studies at the Central Republican Botanical Garden of the USSR Academy of Sciences
1968	Defence of the candidate's dissertation *'Allelopathic role of precipitation of leaves and root remains of apple and peach'*
1970-1972	Department of scientific and technical information of the Central Republican Botanical Garden of the USSR Academy of Sciences
1972-1983, 1994-2006	Deputy Director (Research), Botanical Garden
1990	Publication of the monograph *'Allelopathy in Fruit Gardens'*
1995	Defence of the doctoral dissertation *'Ecological Aspects of Allelopathic after Effects of Edifiers of Garden Phytocenosis'*
1981-2005	Head, Department of acclimatization of fruit plants
2006-2016	Chief Researcher, Department of acclimatization of fruit plants
2016	Expired on 25 April, 2016

Root exudates accumulate in the rhizosphere and inhibit growth processes, if the donor and acceptor of secretions are of the same species. He showed that the allelopathic activity of fruit plants is mainly due to phenolic compounds, although in actinidia plant (*Actinidia arguta* Siebold & Zucc.), in addition to phenolic substances, contain saponins of triterpene nature and magnolia colins - lignans (schisandrin and its derivatives) (26-27). He expanded the idea of the after effect of plants as one of the types of their relationships in cultural phytocenosis. The results of the study of allelopathic phenomena in orchards, elucidation of the peculiarities of interaction and aftereffects of fruit plants helped P.A. Moroz to put forward the concept of alternate gardening, which is based on modern ideas about the importance of biodiversity in the functioning of ecosystems (2,5-7).

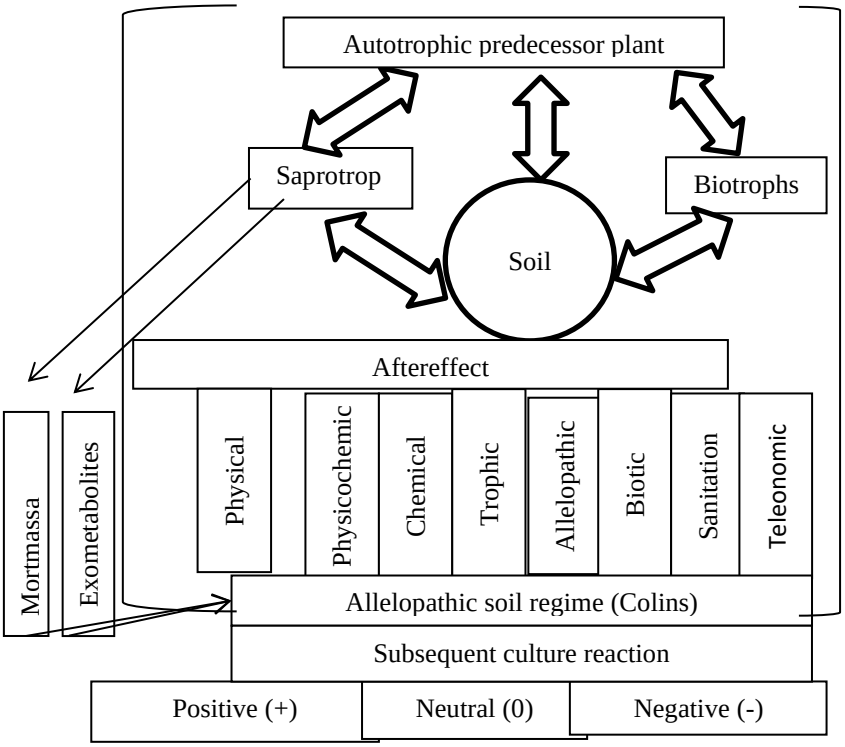

Figure 3. Scheme of the aftereffect of plants in crops phytocenosis (Moroz, 1995 (28)).

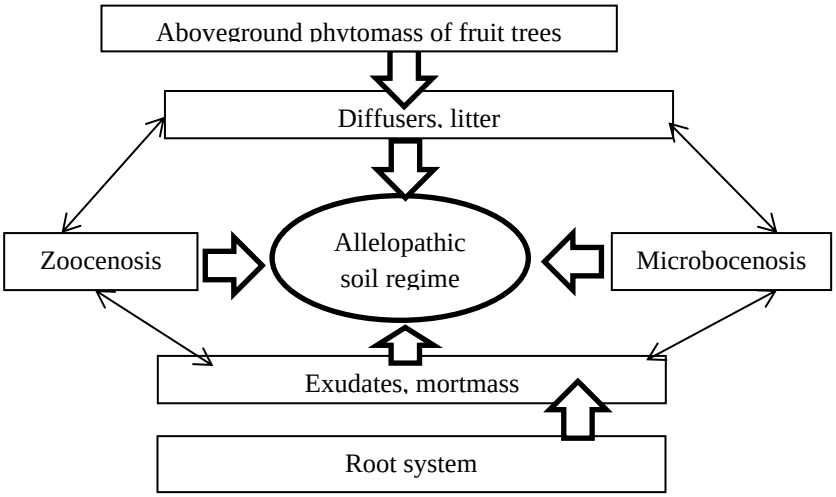

Figure 4. Allelopathic formation scheme regime in garden biogeocenosis (Moroz, 1995 (28)).

His major researches are covered in his doctoral dissertation on *'Ecological Aspects of the Allelopathic Aftereffect of Editors of Garden Phytocenosis',* which he defended in 1995, as well as in his monograph *'Allelopathy in Fruit Gardens'*, awarded the prize, L.P. Symyrenko, Presidium, National Academy of Sciences of Ukraine. Moroz also developed methods for collecting plant secretions (for example, phenolic substances of root secretions were captured with polyamide), determining their activity (test for growth of primary root of fruit seedlings), fractionation with sorbents and organic solvents, extraction of colins from the soil. He found that with a constant culture of fruit trees, the colins of old predecessor plants negatively affect the physiological and biochemical processes of young plants and inhibited their growth (2,27). Moroz suggested ways to overcome soil fatigue in orchards, in particular, by transforming phytocenosis during the 3-4-year period between uprooting and renewal of orchards and the rational of alternation of crops in horticulture or crop rotation of nurseries (27).

He suggested the ways of overcoming soil fatigue in orchards, proposed schemes of rational alternation of fruit crops and crop rotation in nursery, developed a general concept of greening of horticulture, using his own research on the interaction and aftereffects of fruit plants. The results of work formed the basis of his monograph *'Allelopathy in Fruit Gardens'* (1990), awarded the prize, L.P. Symyrenko, National Academy of Sciences of Ukraine; as well as a doctoral dissertation on *'Ecological Aspects of Allelopathic Aftereffects of Edifiers of Garden Phytocenosis'* (1995).

PUBLICATIONS: Experimental data and theoretical generalizations of the author are presented in more than 200 scientific works, including three monographs. Under the scientific guidance of 8 candidate and 3 doctoral dissertations were prepared and defended by P.A. Moroz.

Books/Monographs

(i). Moroz, P.A. (1990). *Allelopathy in Fruit Gardens*. 208 pp. Naukova Dumka: Kiev (Russian).

Dissertations

(i). Moroz, P.A. (1968). *Allelopathic Role of Fallen Leaves and Root Residues of Apple and Peachtree*. *Ph.D. Thesis*. 25 pp. Kiev (Russian).

(ii). Moroz, P.A. (1995). *Ecological Aspects of the Allelopathic Aftereffect of Edificators of Garden Phytocenosis Dissertation PhD*. 374 pp. Kiev. NAS of Ukraine, M.M. Grishko Central botanical garden (Ukrainian).

Research Papers

(i). Moroz, P.A. and Bukolova, T.P. (1977). Florisin in the soil under the apple tree. *Reports, Academy of Sciences of the Ukrainian SSR. Series B* **5**: 447-449 (Russian).

(ii). Moroz, P.A. and Gorinova, V.I. (1982). Florisin and soil fatigue in apple orchards. In: *The Role of Allelopathy in Crop Production* pp. 74-78. Naukova Dumka: Kiev (Russian).

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(v). Moroz, P.A. and Osipova, I.Yu. (2004). Phenolic compounds of litter and roots as a factor of allelopathic interaction of fruit plants. *VI Symposium on Phenolic Compounds: Abstracts* p. 58. Moscow (Russian).
(vi). Moroz, P.A., Osipova, I.Yu. and Grikun, I.N. (1989). The content of phenolic substances in litter and roots of fruit crops. In: *Methodological Problems of Allelopathy* pp. 96-104. Naukova Dumka: Kiev (Russian).
(vii). Moroz, P.A. and Popivshchy, I.I. (1974). Florisin as a chemical trait of the apple tree genus. In: *Physiological and Biochemical Bases of Plant Interaction in Phytocenosis* **5**: 29-31 (Russian).
(viii). Moroz, P.A., Seredyuk, L.S. and Shevchuk, G.N. (1981). Phenolic substances in sick soil from under the apple tree. In: *Chemical Interaction of Plants* pp. 58-62. Naukova Dumka: Kiev (Russian).

2.3. Nikolay Mikhailovich Matveev (1939-2016)

He was a expert in the field of ecology, one of the founders of the Soviet plant allelopathy, Doctor of Biological Sciences, Professor, Academician of the Russian Ecological Academy and Honored Worker of the Higher School of the Russian Federation.

Early life and education: Born on May 12, 1939 in Nyandoma town, Arkhangelsk region (Russia). During 1944-1957, he studied at the Svechenskaya High school. In 1957 he entered the Biological faculty of Dnepropetrovsk State University and graduated in 1962, received a diploma with honors and the qualification "Biologist-botanist, teacher of biology and chemistry of secondary school".

Professional life and contributions to allelopathy: From 1963 to 1968, he worked at the Department of Geobotany and Higher Plants at Dnepropetrovsk University. Under the leadership of A. L. Bel'gard, Matveev begins to study the role of plant exudates in the relationship between woody and herbaceous plants in forest plantations of the steppe zone of Ukraine. Based on the results of these studies, he wrote his first scientific article, published in the "Ukrainian Botanical Journal". During this period, Nikolai Mikhailovich was actively engaged in scientific work and trained at the Institute of Botany, Kiev, Academy of Sciences of the Ukrainian SSR under A.M. Grodzinsky and at the Department of Geobotany Leningrad University under the well-known specialist in allelopathy A.A. Chasovennaya. In 1967 in Faculty of Biology of Dnepropetrovsk University, N.M. Matveev successfully defended his Ph.D. thesis, which reflects fundamentally new approaches to assessing the role of allelopathy in the relationship between woody and herbaceous plants in forestry. From January 1969, he became Associate Professor, Department of Geobotany and Higher Plants. During this period, N.M. Matveev formulated the idea of the allelopathic sensitivity of plants and its quantitative measure - the allelopathic threshold of sensitivity, developed methods for their study and published the first experimental data.

In 1972, N.M. Matveev established the Kuibyshev (now Samara) State University. He was Head, Department of Ecology, Botany and Nature Conservation (until 1993, now

Department of Botany). His students in Botany (1973-1985), in Ecology and Nature protection (1974-1988), an integrated biogeocenological expedition to study natural ecosystems, the Krasnosamar biomonitoring station. He defended his doctoral Dissertation on specialty ecology in 1986 at the Tartu State University. His scientific school in Samara State University, was well known in Volga-Ural region. Matveev trained 4 doctors and 7 candidates of Biological sciences in his department and 3 candidates of Biological sciences.

Figure 5. Nikolay Mikhailovich Matveev.

Table 3. Chronology of main events

Dates	Events
1939	Born on May 12, 1939 at the Nyandoma (now Nyandoma town), Arkhangelsk region (Russia)
1944-1957	Schooling
1957-1962	Student of Biological faculty, Dnepropetrovsk State University
1963-1968	Worked in the Department of Geobotany and Higher Plants at Dnepropetrovsk University
1967	Defended Ph.D. thesis
1968	Transferred to the post of Senior Teacher at Dnepropetrovsk University
1969-1972	Associate Professor, Department of Geobotany and Higher Plants, Dnepropetrovsk University
1972-2016	Professor, Samara State University
1986	Defended doctoral Dissertation on Ecology, Tartu State University
2009	Academician, Russian Ecological Academy
2016	Expired on 19 December, 2016

The scientific research of N.M. Matveev (8-12,29,30) was on: (i). Plant excretions as a factor of the ecological environment in forest biogeocenosis of the steppe zone, (ii). The influence of organic and mineral sludge from metal-working enterprises on the growth and development of plants, (iii). Phytomelioration of industrial territories, (iv). Ecological bases of the accumulation of heavy metals in soil and plants, (v). Biodiversity and biomonitoring of forest, steppe, (vi). Meadow biogeocenosis of the steppe Trans-Volga region, ecology of species cenopopulations of plants, phytoindication of ecotope and biotope in various biogeocenosis. Based on his 30-years allelopathy research in the field and in laboratory conditions, his conclusions were about the specificity and non-specificity of the action of

the allelopathic factors contradict each other and both these actions are manifested simultaneously. The specificity of the action of allelopathically active substances is manifested in the fact that each plant species is characterized by its own amplitude of response to the allelopathic factor with certain values of the points of minimum, optimum and maximum and, therefore, has special allelopathic sensitivity. From this point of view, he identified three groups of species:

(i). **Allelopathically sensitive species:** Do not tolerate the allelopathic regime of closed artificial forest plantations,

(ii) **Allelopathically insensitive species**: Do not tolerate the allelopathic regime of closed forest plantations,

(iii). **Allelopathically tolerant species**: Tolerate allelopathic regime in natural plantings. The first two groups are represented by weeds, steppe and meadow species and the last group is mainly represented by forest species.

He also established the non-specificity of the action of the allelopathic factor manifested in the fact that in all species the nature of reaction to depends on the concentration of allelopathically active substances and can be expressed and can be expressed as graph, on which the growth of the concentration of allopathic substances initially has slow growth of the morphometric response of a certain plant species (reduction in size, lag in linear growth, etc). Upon reaching a certain concentration (called the threshold), the intensity of the reaction increases sharply and reaches a maximum at a certain value, at which the plant completely stops its growth and development. Therefore, such a graph takes the form of a hyperbolic increasing curve and is similar to a similar graph of the vital effects of any abiotic factor on the growth and development of plants with increasing intensity of exposure. Such a graph of the vital activity of species according to the allopathic factor does not always show the points of minimum and optimum, since often low concentrations of allopathically active substances do not cause any reaction. But, in addition to the maximum point, another cardinal point stands out - the allelopathic threshold of sensitivity, which is the minimum concentration of secretions in the environment, above which the inhibition occurred in plants. He concluded that plant secretions that caused allelopathic regime are an integral part of the phytocenosis environment. These factors, play a significant ecological role in the formation of plant communities. The allelopathic regime has direct impact on the selection of ecomorphs and the formation of the coenotic structure of plant communities. Matveev, summarizing the works of Grodzinsky and Chernobrivenko (11), developed the concept that allelopathically active substances in the phytocenosis are component of environment. It is present in each phytocenosis in the allelopathic regime similar to the thermal, water and other ecological regimes. The degree of influence of the allelopathic factor on the plants of the phytocenosis depends on the intensity of the allelopathic regime, which is characterized by the qualitative and quantitative composition of allelopathically active substances in the phytocenosis.

PUBLICATIONS: In total, he published 292 works in the scientific press with a total volume of 6460 pages.

Books/Monographs

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2.4. Victoria Vladimirovna Roshchina

Scientist, Russian Academy of Sciences Institute of Cell Biophysics. Dr. Sciences, Professor, Plant biochemist and physiologist, PhD, senior scientist of Institute of Cell Biophysics in Biological Center of Pushchino, Russia. Interests deal with the action mechanisms of biologically active compounds and the spectral methods of their analysis in plant cells. Her biographical data are based on earlier publications of the co-authors of this article (42,44).

***Early life and education*:** Victoria V. Roshchina was born on 2 March 1949 in Leningrad, Russia. She is daughter of Professor V.D. Roshchina an eminent allelopathy scientist. In 1967-72, she studied at Biology Faculty, Voronezh State University, Voronezh, specialising in Plant Biochemistry and in 1972 received Diploma for her research on Photophosphorylalion test in vivo. Thereafter, she was a post-graduate student for 3-years at the Institute of Photosynthesis, Pushchino. In 1977, she received her Ph.D. degree from Institute of Plant Physiology, USSR Academy of Sciences, Moscow for the research Photosynthetic electron transport on the level of cytochrome-f and plastocyanin.

Figure 6. Dr. Sciences, Professor, PhD Roshchina Victoria Vladimirovna.

***Professional life and allelopathy research*:** She has keen interest in allelopathy since college days, when she conducted research with her mother. Hence her first research paper 'The mechanisms of action of the woody plants extracts on plant membranes' was published in 1970 (31). From 1977 to 1990, Roshchina was a scientist in the Institute of Soil Science and Photosynthesis, Pushchino and worked on regulation of photosynthesis by natural biological regulators, including phytoncides and allelochemicals. Thereafter, she studied mechanisms of biological action of the natural growth regulators, including neurotransmitters, their occurrence and functions in plants (32,33). She identified the metabolites released from *Cicuta virosa* a toxic plant and from *Capsicum annuum*, these metabolites possesses insecticidal properties and are powerful modulators of photosynthetic functions viz., chloroplasts movement and permeability (32).

Besides, the neurotransmitters acetylcholine, catecholamines, serotonin, histamine were found in plant excretions and identified in chloroplasts. In 1989, Victoria and her mother V.D. Roshchina monograph *'The Excretory Function of Higher Plants'* was published in Russian language by Nauka Publishing House, Moscow. In 1993, its revised edition in English was published by Springer-Verlag, Berlin, Germany.

Table 4. Chronology of major events

Dates	Event
1949	Born on March 2, 1949 in Leningrad, Russia
1972	Awarded Diploma, Komarov Botanical Institute, Leningrad
1977	Awarded Ph.D. Degree, Institute of Plant Physiology, Moscow
1977-89	Scientist, Institute of Soil Science and Photosynthesis, Pushchino, Russia
1989	Monograph *Excretory Functions of Higher Plants*, published, Nauka, Moscow
1990	Appointed Professor at Institute of Cell Biophysics, Pushchino, Moscow
1991	Awarded Doctor of Science, Degree
1993	Monograph Revised English edition *Excretory Functions of Higher Plants*, publisher, Springer Verlag, Germany
1994	Started research on cell-cell contacts in allelopathy
2001	Monograph *Neurotransmitters in Plant Life.* Publisher, Science Publishers, Enfield, Plymout, USA
2003	**Books:** (i). Monograph *Ozone and Plant Cell* (2003), Kluwer, Dordrecht. (ii). *Cell Diagnostics: Images, Biophysical and Biochemical Processes in Allelopathy* (Eds. V.V. Roshchina and S.S. Narwal)
2008	Monograph *Fluorescing World of Plant Secreting Cells.* Science Publishers, Enfield, New Hampshire, USA
2014	Monograph *Model Systems to Study the Excretory Function of Higher Plants*. Springer
2019	Book *Neurotransmitters in Plants: Perspectives and Applications.* Taylor & Francis
2020	Monograph *Fluorescence of Living Plant Cells for Phytomedicine Preparations*

In 1990, she moved to Russian Academy of Science, Institute of Cell Biophysics, Pushchino. In 1991, she received the highest degree Doctor of Biology for the research work Biomediators in chloroplasts, dealing with the new concept of the action of neurotransmitters on plant cell. In the same year her monograph *Biomediators in Plants: Acetylcholine and Biogenic Amines* was published in Russian language by Biological Centre of USSR Publishing House, Pushchino.

In 1991-2001, she worked on the study of substances that are part of the neurotransmitter system of plants, publishing in 2001 a monograph *"Neurotransmitters in Plant Life"*. Enfield, Plymouth: Science Publishers'. During 2002-2020, the scientist actively worked on expanding the study of biomediators and the neurotransmitter system of the plant organism, detailing the physiologically active substances that are responsible for the functional activity of these systems. The research is accompanied by the use of the latest methods of luminescence microscopy, laser-scanning confocal microscopy, visualization and chemical

biotesting. In 1993-96, Professor Roshchina for the first time, applied the microspectrofluorometry technique to allelopathy research to study the intact secretory cells, filled with allelochemicals and pollen grains (45). Currently she is developing two concepts related to the mechanisms of cell-cell contacts in allelopathy: (i). The chemosensory characteristics (chemoreception, chemosensibilization, etc) and (ii). The free radical processes in chemical interactions (34-36). In 1997-2020 she studied and put into practice the neurotransmitter system of plants with the identification of transmitter substances, the physiological irritability of plants, including interactions in multispecies and monospecific environments (37-41). She also generalized and deepened the work in the field of excretory function of plants, including some aspects of secretion, which has an impact on the formation of allelopathic potential of plants (34,43). During the same period, the scientist actively developed a methodology to study the interactions of the plant organism as a whole system at the cellular level, including the chemistry of such interactions, which brought allelopathic science to a new level of cell-physiological cycle with full details of the chemistry of this process.

PUBLICATIONS

She is the author of 250 publications including 8-monographs devoted to plant excretory functions, roles of neurotransmitters in plants, ozone influence on plant cells, fluorescence of plant secretory cells.

Books/Monographs

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3. CONCLUSIONS

The activities of famous scientists in the field of allelopathy during the period 1937-2023 should be characterized as a productive stage of the continuation and development of the systemic and multilevel concept of allelopathic interactions of plants. Scientists whose activities are described in this article formed the main criteria for allelopathic tactics of plants from the standpoint of the allelopathic potential of the species, its allelopathic sensitivity and allelopathic tolerance, determined the threshold values of these indicators and factors that determine their implementation in the system of single-component and multi-component coenoses of different duration of phenostage development and life expectancy. The allelochemicals and their biochemical behavior in the air and rhizosphere environment was formed taking into account their chemical structure, edaphic conditions of plant growth and development, the intensity of secretory activity and its typification. Due to this, the criteria for suitability for constant cultivation and the rhythmic alternation of different plant species in crop rotation, the duration and intensity of the aftereffect of species in the cyclic cultivation system were formulated. On this basis, the theoretical basis and practical content of plant phytoindication and phytoremediation systems were essentially laid by analyzing individual groups of biological species in the areas of its economic and agrobiological use. Such research directions allowed to modernize the chemical basis of phytocenological interactions of plants and to improve the concept and structural content of vitality strategies of different plant species, to determine the fundamental patterns of

formation of single-species and multi-species natural and artificial plant successions from the position of their density of placement, in cenosis, survival and levels of suppression due to the main phytostress factors. Methodological and biotest approaches in the study of allelopathic interaction of plants were significantly deepened with the transition to the cellular-physiological level with systemic deciphering of neurotransmitter systems of the plant cell with the analysis of the role in the formation of the allelopathic potential of plants of such processes of intercellular chemical interaction as chemoreception, chemosensitization, free radical processes, etc.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no competing financial interests related to the publication of this manuscript. The research was conducted independently, free from any conflicts of interest that could have biased the findings.

AUTHORS' CONTRIBUTIONS

Both authors approved and finally draft of manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest. All authors agree to publish it.

ETHICAL STATEMENT

This is to inform you that in this study, we have not been involved in any animal and human studies.

4. ACKNOWLEDGEMENTS

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