

USSR Prominent Allelopathy Scientists- Part II (1902-2000)

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CONTENTS

1. INTRODUCTION
2. BIOGRAPHIES OF PROMINENT ALLELOPATHY SCIENTISTS
 - 2.1. Alexander Lucianovich Bel'gard (1902-1992)
 - 2.2. Tikhon Alexandrovich Rabotnov (1904-2000)
 - 2.3. Ivan Naumovich Rakhtenko (1905-1988)
 - 2.4. Anna Alexandrovna Chasovennaya (1911-1993)
 - 2.5. Mikhail Vasilievich Kolesnichenko (1914-1978)
 - 2.6. Valentina Dionis'evna Roshchina (1922-1993)
3. CONCLUSIONS
4. ACKNOWLEDGEMENTS
5. REFERENCES

ABSTRACT

This Review Series pays homage to the contributions of Outstanding Allelopathy Researchers in USSR. It has 4 Parts: Part I (1880-1984), Part II (1904-2000), Part III (1937-2023), Part IV (1937-2023). Part I has been Published in Allelopathy Journal vol 64(2): 95-132, March 2025. The article describes the outstanding results of Allelopathy research (achievements, theoretical and practical developments) during 1902-2000 of USSR scientists. The main biographical data and achievements of scientific activity of outstanding Allelopathy Soviet scientists are given: Alexander Lucianovich Bel'gard, Tikhon Alexandrovich Rabotnov, Ivan Naumovich Rakhtenko, Anna Alexandrovna Chasovennaya, Mikhail Vasilievich Kolesnichenko, Valentina Dionis'evna Roshchina. This group of scientists laid the foundations of (i). Bio- and phytocoenology, (ii). Physiological aspects of allelopathic competitions and its classification, formed directions for the successful introduction of plant species from their possible competitive dominance (T.A. Rabotnov), the influence of root exudates on relations between plants through the rhizosphere, (iii). the basic relations between woody and herbaceous plants and the principles of their landscape combination were determined, (iv). the factors of soil fatigue in perennial vegetation (I.N. Rakhtenko, M.V. Kolesnichenko), (v). Phytoncidal and allelopathic theory of plant interactions in biogeocenoses, (vi). Basis for biotesting of allelopathic effects of plants at the cellular and organismal levels was formed (A.A. Chasovennaya, V.D. Roshchina).

Key words: Allelopathy, Allelopathy scientists, Biography, Chasovennaya, Kolesnichenko, Lucianovich, Rabotnov, Rakhtenko, Roshchina.

1. INTRODUCTION

The scientific vision of the biological laws of the world is changing due to the detailed studies of processes of existence of living organisms and their complex interactions. The

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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 and has completely new look at the processes. Allelopathic research is mandatory to establish the biological and economic efficiency of various agrophytocenoses, biological control of agricultural pests (Weeds, Insects, Nematode, Fungi) without use of agrochemicals, development of ecologically balanced biogeocenoses in different ecosystems and prevention of allergic reactions etc. (55).

2. BIOGRAPHIES OF PROMINENT ALLELOPATHY SCIENTISTS (1904-2019)

2.1. Alexander Lucianovich Bel'gard (1902-1992)

He was specialist in ecology, geobotany, steppe afforestation, doctor of biological sciences, doctor of agricultural sciences, professor of Dnipropetrovsk State University. He founded the Department of Geobotany, Soil Science and Ecology and Allelopathy at the Dnipropetrovsk National University. In 1971, he developed the discipline "Steppe forestry" and it was taught in many higher educational institutions, USSR.

Early life and education: Alexander Lucianovich Bel'gard was born on October 4, 1902 in village Landvarovo, Vilna Province, Russia (now Lentvaris, Lithuania, Trakai District). His father was a foreman in factory. He graduated school in 1920 and completed short-term forestry courses in 1921.

In 1927, he graduated from the Faculty of Biology, Dnipropetrovsk Institute of Public Education (now Dnipropetrovsk National University) and continued his postgraduate studies at the Ukrainian Institute of Applied Botany. In 1927-1930, he specialized in forest geobotany and taught biological disciplines at the Petrovsky vocational school. After graduating, he became assistant at Institute of Social Education, and then associate professor at the Institute of Vocational Education.

In 1932, he established a Biological Station at banks of Samara River, in village Andriyivka, Novomoskovsk district and studied the forests of Samara and Prysamaria. Later the Biological Station became an International Biosphere Hospital in Dnipropetrovsk University. In 1933 he became Head, Department of Geobotany and Higher Plants. From 1935 to 1936, he was Acting Dean, Biology Faculty. In 1937 he defended his dissertation "Geobotanical Essay on the Novomoskovsk Forest" for the degree of Candidate of Biological Sciences.

From August 1941 to April 1944 O.L. Bel'gard together with the staff of the Faculty of Biology and taught biology. He was Head, Department of Geobotany. From 1947 to 1949 he again served as Dean, Biofaculty. In December 1948, he was awarded the degree of Doctor of Biological Sciences.

In 1949, he organized a comprehensive expedition from the Azov Sea to Moldova to study natural and artificial forests of the steppe zone. He established laboratory, at the Oles Honchar to study the problems of allelopathy.



Figure 1. *Alexander Lucianovich Bel'gard.*

He owns a number of scientific developments of steppe forestry, indication geobotany, forest biogeocenology, allelopathy of forest biogeocenoses. He developed the doctrine of ecomorphs that determine the relationship of soil fertility conditions and the competitive relationships between the soil and plants.

The scientist also linked the chemical interaction between plants of their allelopathic potential, which was seen in dominance in certain ecological niches of different phytocenoses. He developed a typology method of artificial steppe forests based on three factors (i). Type of forest vegetation conditions, (ii). Type of ecological structure and (iii). Type of woodland (2-6). This system of forest typology is used in afforestation the steppe zone of Ukraine. He proposed method of ecological analysis of vegetation, based on the scheme of life forms named 'ecomorph' (1-6). In his system, he first used the term 'Cenomorph', which shows the confinement of species to one or another phytocenosis: (i) Sil (Silvaticus) - sylvant (forest species), (ii) St (Stepposus) - stepant (steppe), (iii) Pr (Pratensis) - pratant (meadow), (iv) Pal (Paludosus) - paludant (marsh), (v) Aq (Aquantus) - aquant (water), (vi) Ps (Psammophyton) - psammofant (sandy), (vii) Pt (Petrophyton) - petrophyte (petrant, stony), (viii) Ru (Ruderatus) - ruderant (weed), (ix) H (Halophyton) - halophyte (type of saline soils), (x) Cu (Cultus) - cultivated and others. This system of ecomorphs is applicable not only to characterize forest or other phytocenoses, but also for the ecological characterization of flora of the supracenotic level - individual landscapes, natural complexes, geographical areas, large objects of the natural reserve. It is also applicable to assess the allelopathic competition of species of certain territories and byocenoses (6).

Table 1. Chronology of main events

| Dates | Events |
|-----------|---|
| 1902 | Born on October 4, 1902, village of Landvarovo, Vilna Province, Russia |
| 1920-1921 | Graduated school in 1920 and short-term forestry courses |
| 1922-1927 | Student Faculty of Biology, Dnipropetrovsk Institute of Public Education (now Dnipropetrovsk National University) |
| 1927-1930 | Postgraduate studies in the Dnipropetrovsk Institute of Public Education |
| 1933 | Head, Department of Geobotany and Higher Plants, Dnipropetrovsk State University |
| 1934 | Associate Professor, Dnipropetrovsk State University |
| 1935-1936 | Dean, Biological Faculty, Dnipropetrovsk State University |
| 1937 | Defended dissertation "Geobotanical Essay on the Novomoskovsk Forest" |
| 1941-1944 | Taught biology in High school |
| 1944-1947 | Head, Department of Geobotany, Dnipropetrovsk State University |
| 1947-1949 | Dean, Biofaculty, Dnipropetrovsk State University |
| 1949-1960 | Expeditions on geobotanical studies of steppe zones |
| 1960-1962 | Developed a special training course "Steppe forestry" |
| 1960-1992 | Teaching and scientific activity, Dnipropetrovsk State University |
| 1992 | Expired, 1992 |

Publications: He published more than 350 Research Papers and 15 Monographs.

Books/Monographs

- (i). Bel'gard, A.L. (1950). *Forest Vegetation of the Southeast (Ukrainian SSR)*. 294 pp. Publishing house, Kiev state University, Kiev.
- (ii). Bel'gard, A. L. (1971). *Steppe Forestry*. 336 pp. Lesnaya promt, Moscow (Russian).

Research Papers

- (i). Bel'gard, A.L. (1948). On amphiceneses. *Scientific Notes, Dnepropetrovsk State University* **30**: 87-89 (Russian).
- (ii). Bel'gard, A.L. (1950). *Forest Vegetation in the South-East of Ukraine* pp. 35-37. K. Publishing house of KSU (in Russian).
- (iii) Bel'gard, A.L. (1960). *Introduction to the Typology of Artificial Forests in the Steppe Zone of Ukraine. Artificial forests of Steppe Zone of Ukraine* pp. 33-55. Publishing house of Kharkov University, Kharkov (Russian).
- (iv). Bel'gard, A.L. (1980). Ecological analysis and structure of forest phytocenoses in Steppe. In: *Questions of Biological Diagnostics of Forest Biogeocenoses in Samaria Region* pp. 12-43. Publishing house of Dnepropetrovsk University: Dnepropetrovsk (Russian).
- (v). Bel'gard, A.L. (1986). Artificial forest in the steppe in biogeocenotic lighting. In: *Steppe Forestry and Forest Land Reclamation* pp. 21-26. DGU: Dnepropetrovsk (Russian).
- (vi). Bel'gard, A.L. and Ivanov, V.P. (1970). Sergei Ivanovich Chernobrivenko, 1899-1967. In: *Memory of Founders of the Allelopathy study in USSR* pp. 279-281 (Russian).
- (vii). Bel'gard, A.L. and Markov, M.V. (1987). Introduction to the study of artificial communities. In: *Protection and Rational Use of Protective Forests of the Steppe Zone* pp. 11-19. DGU, Dnepropetrovsk (Russian).

2.2. Tikhon Alexandrovich Rabotnov (1904-2000)

He was most famous specialists in meadow science and cultivation, plant associations and phytocenology.

Early life and education: Born July 24 1904, in Yaroslavl. He graduated from the agronomic faculty of Yaroslavl State University in 1924.

Professional life and contributions to allelopathy: From 1924 to 1967, he worked at State Meadow Institute. He obtained candidate of Agricultural and Biological Sciences in (1936), Doctor of Biological Sciences in (1949) (Doctoral dissertation "*Life Cycle of Perennial Herbaceous Plants and the Phenotypic Composition of their Populations in Meadow Cenoses*"). He was Professor and Head, Department of Geobotany, Faculty of Biology, Moscow State University (1968-1981) and trained more than 30 Candidates of Sciences. He published over 500 scientific papers. Rabotnov was one of the most "quoted" botanists in Russia. A cycle of long-term studies of floodplain and mountain meadows allowed him to formulate a number of fundamental ideas about the population structure of plant communities, which served as the beginning of a new - cenopopulation - direction in the study of the composition and structure of vegetation cover.



Figure 2. *Tikhon Alexandrovich Rabotnov.*

Table 2. Chronology of main events

| Dates | Events |
|-----------|--|
| 1904 | Born July 24 1904 in Yaroslavl, Russia |
| 1920-1924 | Studied at Agronomic Faculty, Yaroslavl State University |
| 1924-1967 | Worked at the State Meadow Institute |
| 1936 | Candidate of Agricultural and Biological Sciences |
| 1949 | Doctor of Biological Sciences |
| 1948-1998 | Teaching at Moscow State University |
| 1968-1981 | Professor and Head, Department of Geobotany, Faculty of Biology, Moscow State University |
| 2000 | Died on September 16, 2000 in Moscow |

He gave an original vision of meadow cenoses, showed the absence of vegetation in them, weak dominant properties, developed phytocoenotypes of meadow plants, classified dynamics of meadows and introduced floristic approaches to study meadow phytocenoses

(26). He classified plant populations according to their age, composition to predict the population dynamics and succession trends (27). He determined the differences between allelopathic influence and competition. Rabotnov understood allelopathy through the influence of some plants on others through specific excretion products, that are important source of minerals for plants. He studied relationship that develops between plants through changes in the biocenotic environment due to removal of growth resources (solar radiation, carbon dioxide, oxygen, water and mineral nutrients). When there is a significant decrease in any of these resources, then allelopathy regulates type of relationship with competition (26,28).

Rabotnov also developed aspects of territorial phytocenology for the interactions in the cenosis between introductory plants and endemic plants. He also did research on plant parasitism and semi-parasitism, patterns of change in plant communities due to changes in environmental factors (26).

PUBLICATIONS:

Books/Monographs

- (i) *Herbaceous Plants of USSR* (1971). In 2 volumes (Ed., T.A. Rabotnov). 487 pp. Mysl, Moscow (Russian).
- (ii). Rabotnov, T.A. (1978). *Phytocenology: Textbook for Biological Faculties of Universities*. 384 pp. Publishing house of Moscow State University, Moscow (Russian).
- (iii). Rabotnov, T.A. (1983). *Phytocenology: Textbook for Universities on Specialties "Biology"*. 2nd ed. 292 pp.: Publishing house of Moscow State University, Moscow (Russian).
- (iv). Rabotnov, T.A. (1984). *Meadow Studies*. 2nd ed. 320 pp.: Publishing house of Moscow State University, Moscow (Russian).
- (v). Rabotnov, T.A. (1992). *Phytocenology: Textbook for Universities*. 3rd ed. 352 pp.: Publishing house of Moscow State University, Moscow (Russian).
- (vi). Rabotnov, T.A. (1992). *Phytozoölogie: Struktur und Dynamik natürlicher Ökosysteme*. 350 pp. Verlag Eugen Ulmer, Stuttgart (German).
- (vii). Rabotnov, T.A. (1995). *History of Phytocenology: Textbook*. 158 pp. Argus, Moscow (Russian).
- (viii). Rabotnov, T.A. (1998). *Experimental Phytocenology: Textbook. Manual for university students in "Biology"*. 240 pp. Moscow: Publishing house of State University, Moscow (Russian).

Research Papers

- (i). Rabotnov, T.A. (1950). Studies of composition of populations for phytocenology purposes. *Vesty Academy of Sciences of the USSR* **1**: 463-483 (Russian).
- (ii). Rabotnov, T.A. (1950). Life cycle of perennial herbaceous plants in meadow cenoses. *Proc. Botanical Institute, USSR Academy of Sciences, Ser. 3. Geobotany* **6**: 410-416 (Russian).
- (iii). Rabotnov, T.A. (1966). Features of the polydominant meadow communities. *Vegetatio* **13**: 109-116.
- (iv). Rabotnov, T.A. (1969). Cenopulations of perennial herbaceous plants in natural cenoses. *Vegetatio* **19**: 87-95.

- (v). Rabotnov, T.A. (1969). Restoration of plants from seeds in USSR meadows. *Herbage Abstracts* **39**: 269-277.
- (vi). Rabotnov, T.A. (1972). Consortia, the importance of their study for phytocenology. *Folia Geobotanica et Phytotaxonomica* **7**: 1-8.
- (vii). Rabotnov, T.A. (1975). About phytocenotypes. *Phytocenology* **2**: 66-72.
- (viii). Rabotnov, T.A. (1978). The methods to study coenotic populations of perennial herbaceous plants. *Soviet Ecological Journal* **9**: 99-105 (Russian).
- (ix). Rabotnov, T.A. (1980). Some problems of the co-evolution of organisms. *Phytocenology* **7**: 1-7.
- (x). Rabotnov, T.A. (1982). Importance of evolutionary approach to study allelopathy. *Soviet Ecological Journal* **12**: 127-130 (Russian).
- (xi). Rabotnov, T.A. (1985). Dynamics of cenotic plant populations. In: *Vegetation Population Structure* pp. 121-142. Junk. Dordrecht.
- (xii). Rabotnov, T.A. (1995). Ecological niche of plants. *Russian Ecological Journal* **26**: 221-222 (Russian).
- (xiii). Rabotnov, T.A., Demin, A.P. (1974). Influence of long-term fertilization on underground parts of meadow plants and phytocenoses. In: *Second International Symposium on the Ecology and Physiology of Root Systems* pp. 243-246. Berlin.

2.3. Ivan Naumovich Rakhteenko (1905-1988)

He was Botanist, Ecologist, Forester, Doctor Bioll Sciences (1961), Professor (1966).

Early life and education: Born on September 21, 1905, village Slepsy, Liozno district, Vitebsk region. Graduated from Forestry Faculty, Belarusian Agricultural Academy (1930).

Professional life and contributions to allelopathy (1935-1941). Senior researcher at the Belarusian Forestry Research Institute. 1942-1944: Director, All-Union Scientific Research Institute of Forestry (Orenburg Region). 1944-1945: Director, Belarusian Research Institute of Forestry. 1946-1955: Senior researcher, All-Union Scientific Research Institute of Forestry (Pushkino, Moscow Region). 1951-1955: Director, Botanical Garden, Academy of Sciences of the BSSR. 1957-1979: Head, Laboratory of Plant Ecology, V.F. Kuprevich Institute of Experimental Botany, Academy of Sciences of the BSSR.



Figure 3. Ivan Naumovich Rakhteenko.

In 1961 he defended his doctoral dissertation on the topic "Growth and Interactions of Root Systems of Woody Plants in Forest Plantations". 1963-1968: Deputy Academician-Secretary, Department of Biological Sciences, Academy of Sciences, BSSR. 1965-1979: Member Editorial Board of Journal "Vesti Academy of Sciences of the BSSR (series of biological sciences)". 1979-1988: Chief researcher at the V.F. Kuprevich Institute of Experimental Botany of the Academy of Sciences of the BSSR.

He studied the root systems ecology of trees, the ecological, physiological and biological interactions of plants in communities (29-35). He investigated the growth, development of root systems of woody plants in various soil conditions, life of active roots, seasonal cycles of absorption and release of mineral nutrients by woody plants roots and their transfer from one plant to another (52). He investigated the interrelations of tree species in forest plantations physiological and biochemical mutual influences of plants in plant communities and mutual influence of root exudates of plants (31).

Table 3. Chronology of main events

| Dates | Events |
|-----------|--|
| 1905 | Born on September 21, 1905 in village of Slepsy, Liozno district, Vitebsk region (now Belarus) |
| 1925-1930 | Studied in Belarusian Agricultural Academy (Forestry faculty) |
| 1935-1941 | Senior researcher at the Belarusian Forestry Research Institute |
| 1942-1944 | Director, All-Union Scientific Research Institute of Forestry (Orenburg Region) |
| 1946-1955 | Senior researcher, All-Union Scientific Research Institute of Forestry (Pushkino, Moscow Region) |
| 1951-1955 | Director, Botanical Garden, Academy of Sciences of the BSSR |
| 1952 | Defended his Candidate Dissertation |
| 1952 | Published Monograph ' <i>Root Systems of Trees and Shrubs</i> ' |
| 1955 | Published Monograph ' <i>Growth and Development of Tree Species Root Systems</i> ' |
| 1961 | Defended his Doctoral Dissertation |
| 1963 | Published Monograph ' <i>Growth and Interactions of Root Systems of Woody Plants</i> ' |
| 1966 | Awarded the title of Professor |
| 1957-1979 | Head, Laboratory of Plant Ecology, V.F. Kuprevich Institute of Experimental Botany, Academy of Sciences of the BSSR |
| 1968-1982 | Published collective Monographs on ' <i>Relationship of Plants in Mixed Cenoses and Regulation of its Growth and Development</i> ' |
| 1979-1988 | Chief researcher, V.F. Kuprevich Institute of Experimental Botany, Academy of Sciences of BSSR |
| 1967 | Expired, 29 June 1988 |

He studied the principles of compatibility of plant species in mixed plantings with higher productivity in comparison with pure plantations (34). He investigated the root nutrition of plants in phytocenoses, seasonal rhythm of absorption of mineral nutrients by individual species of woody and herbaceous plants. The scientist also studied transfer of nutrients from one plant to another and the effects of root exudates on their growth and some physiological processes (36-40). He substantiated the principles of plant selection by ecological, physiological and biochemical parameters for mixed crops and plantings and

also developed recommendations for the sustainable and most productive mixed forests with agricultural crops. He studied the root nutrition and photosynthesis of various plant species during their mixed and separate growth, the effects of root secretions of plants on their growth and physiological processes (34). He identified complex relationships between woody and herbaceous plants on growth and development. He studied the nutrition and metabolism between the plants in natural and artificial phytocenoses and regulate these processes by selecting components ratios in mixed crops and plantings. Using tagged atoms, he laid the foundations to study the physiological and biochemical aspects of plant interactions (36,41).

He is considered one of the 'Founders of Woody Plant Allelopathy' in Soviet Union.

PUBLICATIONS: He published over 200 scientific papers including 8 Monographs.

Books/Monographs

- (i). Rakhteenko, I.N. (1952). *Root Systems of Trees and Shrubs*. 106 pp. Moscow-Leningrad, Goslesbumizdat (Russian).
- (ii). Rakhteenko, I.N. (1955). *Growth and Development of Tree Species Root Systems*. 110 pp. Beijing (Chinese).
- (iii). Rakhteenko, I.N. (1963). *Growth and Interaction of Root Systems of Woody Plants*. 256 pp. Publishing House of the Academy of Sciences of the BSSR, Minsk (Russian).
- (iv). Rakhteenko, I.N., Yakushev, B.I., Krot, L.A., Martinovich, B.S., Yanovich, N.I., Kaurov, I.A., Minko, I.F. and Egorova, R.N. (1968). *Ecological and Physiological Features of Plant Relationships in Plant Communities*. 179 pp. Science and Technology, Minsk (Russian).
- (v). Rakhteenko, I.N., Yakushev, B.I., Martinovich, B.S., Kaurov, I.A., Krot, L.A., Minko, I.F., Egorova, R.N., Kabashnikova, I., Meisner, A.D. and Zabelendik, S.F. (1971). *Root Nutrition of Plants in Phytocenoses*. 251 pp. Science and Technology, Minsk (Russian).
- (vi). Rakhteenko, I.N., Yakushev, B.I., Kaurov, I.A., Martinovich, B.S., Minko, I.F., Krot, L.A., Kabashnikova, I., Budkevich, T.A. and Ermakova, O.O. (1976). *Ecological and Physiological Bases of Plant Interactions in Phytocenoses*. 216 pp. Science and Technology, Minsk (Russian).
- (vii). Rakhteenko, I.N., Yakushev, B.I., Martinovich, B.S., Kaurov, I.A., Minko, I.F., Krot, L.A., Kabashnikova, I., Ermakova, O.O., Budkevich, T.A. and Kapitula, A.N. (1982). *Regulation of Growth, Development and Nutrition of Plants in Phytocenoses*. 229 pp. Science and Technology, Minsk (Russian).
- (viii). Rakhteenko, I.N. and Saveliev, V.V. (1985). *Mineral Fertilizers in Increasing the Productivity of Pine Culture Phytocenoses*. 135 pp. Science and Technology, Minsk (Russian).

Research Papers

- (i). Rakhteenko, I.N. (1952). Influence of foliar feeding with microelements on the growth and some physiological processes of woody plants. *Abstract, Candidate Dissertation*. 24 pp. Academy of Sciences of the BSSR. Institute for Experimental Botany (Russian).

- (ii). Rakhteenko, I.N. (1960). Seasonal growth cycle of active roots of tree species. *Forestry* **9**: 25-26 (in Russian).
- (iii). Rakhteenko, I.N. (1961). Growth and interaction of root systems of woody plants in forest plantations. *Abstract, Doctoral Dissertation*. 47 pp. V.L. Komarova Botanical Institute. AH USSR (Russian).
- (iv). Rakhteenko, I.N. and Kochanovsky, I.N. (1963). Water regime and mineral nutrition of small-leaved linden in conditions of street planting. *Bulletin GBS, USSR Academy of Sciences* **49**: 42-47 (Russian).
- (v). Rakhteenko, I.N. and Krot, L.A. (1965). Lifespan of physiologically active roots of tree species. In: *Plant Growth and Resilience* pp. 121-126. Naukova Dumka, Kiev (Russian).
- (vi). Rakhteenko, I.N. (1983). Growth and productivity of pedunculate oak and small-leaved linden in culture phytocenoses of different composition. *News Academy of Sciences of the BSSR. Series 761* **5**: 3-7 (Russian).

2.4. Anna Alexandrovna Chasovennaya (1911-1993)

Early life and education: Anna Aleksandrovna Chasovennaya was born on February 15, 1911 in village Dikovskaya, Kargopol district, Arkhangelsk region. In 1929, she graduated in Vologda and in 1930 joined the Biology Department, Leningrad University.

Professional life and contributions to allelopathy: In 1932-1933, Anna Alekseandrovna, as junior geobotanist, studies the weeds in fields in Kursk region and in 1934, participated in expedition (led by V.N. Sukachev) to survey of the vegetation of Crimea. In 1935, she graduated from the Department of Geobotany and left for graduate school.



Figure 4. Anna Alexandrovna Chasovennaya.

In 1938, after graduation, she begins to work as junior researcher at All-Union Institute of Plant Protection. In August 1944, she returned to Leningrad and worked as laboratory assistant, Peterhof Biological Institute at Leningrad State University. In May 1945-1949, she became an assistant, Department of Geobotany, Biological Faculty (Biology and Soil) and later became assistant professor. She developed a lecture course "Meadow Studies", with practical classes for students of geobotany. She developed course "Cultural phytocenology" and wrote the textbook "*Fundamentals of Agrophytocenology*" (1975) - the first textbook on the formation and

functioning of artificial plant communities. She showed great interest in relationships between plants in communities and in problems of phytocenology in field crops (8).

Table 4. Chronology of main events

| Dates | Events |
|-----------|--|
| 1911 | Born on February 15, 1911 in village Dikovskaya, Kargopol district, Arkhangelsk region, Russia |
| 1920-1929 | Graduated from school in Vologda |
| 1929-1935 | Student, Faculty of Biology, Leningrad State University |
| 1935-1938 | Postgraduate student, Faculty of Biology, Leningrad State University |
| 1938-1941 | Junior researcher, the All-Union Institute of Plant Protection |
| 1944 | Served as a freelancer in the Soviet army |
| 1944-1945 | Assistant, Peterhof Biological Institute at Leningrad State University |
| 1945-1955 | Assistant, Department of Geobotany, Biological Faculty (Biology and Soil) Leningrad State University |
| 1955-1990 | Assistant Professor, Department Biology and Soil, Leningrad State University |
| 1975 | Published the textbook " <i>Fundamentals of Agrophytocenology</i> " |
| 1993 | Expired on 1993 |

She obtained interesting experimental data on the relationships between plants in the early stages of development in connection with the microflora of the rhizosphere, root exudates, and the influence of predecessors (9,10). Chasovennaya developed her own methodology for such research, as well as an original method for studying the growth and distribution of root systems (13). Proffecor Tokin called her a pioneer in the study in the USSR of the role of phytoncides in the mutual relations of plants in biocenoses (51). The scientist, on the basis of numerous experiments and field observations, formulated a theory of the phytoncidal effect of plants in the phytocenosis. She developed the foundations for the classification of such an effect by isolating substances that directly affect the growth of shoots and roots of different plant species when they grow together. She also pointed to the indirect effects of phytoncides: for example, the phytoncides of one plant can act on microbes that usually settle in the underground parts of another plant, on which its vitality depends (11,12). Phytoncides of a given plant can have a depressing effect on some plant species, and the same phytoncides can, on the contrary, stimulate the vital activity of other plant species (15). The scientist found that phytoncides of different plant species have a different effect on the same type of plant: some inhibit, others stimulate, and still others do not cause changes. Phytoncides can act unequally on the stem and root parts of the seed embryo of the same plant species: inhibit the growth and development of roots, without affecting or weakly affecting the growth and development of shoots; inhibit the growth and development of shoots, slightly affecting the growth of roots (13-17). But there may be no selective action, and phytoncides can inhibit or stimulate the growth and development of all organs. On the basis of experiments, the chapel compiled its own classification of the influence of phytoncides substances, which included 7 groups: (i). Stop or strongly inhibit the growth of roots, (ii). Inhibited root growth, (iii). Inhibited the growth of roots and slightly inhibit the growth of shoots, (iv). Inhibited root growth, but does not inhibit shoot growth, (v). Reduced seed germination, (vi) Does not have noticeable effect and (vii) Stimulate the development of shoots and roots (51).

The Chasovennaya argued that between the plants in nature and in plantings, relationships of "love" and "hatred" and "indifference" are established. The scientist also investigated the phytoncidal activity of species in the cenosis from the standpoint of the cenosis density, its species structure and other aspects of phytocenology. She laid the foundations for correcting cenoses using a specific species structure of cenosis (11).

PUBLICATIONS: She published over 50 scientific papers in the field of phytocenology and some studies of allelopathy.

Books/Monographs

- (i). Chasovennaya, A.A. (1975). *Fundamentals of Agrophytocenology*. 179 pp. Bulletin of Leningrad University, Leningrad (Russian).

Research Papers

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2.5. Mikhail Vasilievich Kolesnichenko (1914-1978)

Early life and education: Mikhail Vasilyevich Kolesnichenko was born on November 16, 1914 in village Donskoye, Trunovsky District, Stavropol Territory. After school, from 1932 to 1933, he studied at FZU, Stavropol. Since 1933-1939, a student of the Voronezh Forestry Institute, he graduated with degree in Forestry Engineer.

Professional life and contributions to allelopathy: From 1939 to 1941, he worked in graduate school, Voronezh Forestry Institute. Because of service in Soviet Army (1941-1946), in 1948 he was appointed Director, Experimental Forestry Institute (Vorontsovka, Voronezh Region) and did PhD on topic: "*Thorn Forest, its History and Current State*" was successfully defended. In 1951, Head Agroforestry Department, All-Union Agri Institute.



Figure 5. Mikhail Vasilievich Kolesnichenko.

Since 1951 he taught the course "Agroforestry" ("Forest reclamation with the basics of forestry") at the agronomic and agrochemical, land management faculties. His long-term research were summarized in Doctoral Dissertation "*Allelopathy of Woody Plants and the Possibility of its Use in Afforestation*", presented for defense at the Kharkov Agricultural

Institute and successfully defended. In April 1953, appointed Scientific Secretary of the Institute. Since 1955, he worked as associate professor, Department of Gardening and agroforestry. In 1968, he was awarded the academic degree of ‘Doctor of Agricultural Sciences’ and in the same year he was awarded the title of Professor, Department of Horticulture and Agroforestry. In 1971-1972, he was Head, Department of Ecology, Physiology and Biochemistry, Central Research Institute of Forest Genetics and Breeding (Voronezh). For many years he was the Chairman, SAC at the Faculty of Biology and Soil Science of the Voronezh State University. He established the northern park, Voronezh Agricultural Institute and for 15 years he was its scientific director. Under his supervision, Ph.D. theses devoted to the study of allelopathy of woody plants were defended by Yu.M. Spakhov, A.S. Spakhova (50), G.I. Lylov, V.I. Chumakov, A.I. Zolotukhin (56,57), V.V. Kryukov.

Kolishnichenko studied aspects of allelopathy of trees and shrubs for the sustainable afforestation, reduction of soil fatigue under forest species, regulation of microbiological activity of soils under forest stands, identification of root secretions of tree species (22). He studied the features of fluocid and allelopathic activity of tree phytocenoses, methods of effective use of tree plantations to ensure the ecological stability of territories (20). He analyzed the nature of plant excretion of tree species in perennial forest plantations and tree-shrub artificial compositions (18,19,22,23).

He selected combinations of tree species, which were highly productive, sustainable in artificial forest plantations and mixture with agricultural crops. He developed new methods to study biochemical interactions (allelopathy), carried out by biologically active substances (phytoncides) released during the plants life. The nature of phytoncides and their quantitative and qualitative chemical composition were studied (22).

Table 5. Chronology of main events

| Dates | Events |
|-----------|---|
| 1914 | Born on November 16, 1914 in village of Donskoye, Trunovsky District, Stavropol Territory, Russia |
| 1922-1933 | Schooling |
| 1933-1939 | Student of the Voronezh Forestry Institute |
| 1947-1951 | Director, Shipovsky Forest Experimental Station USSR Ministry of Forestry |
| 1951 | Defended PhD thesis on the topic: “ <i>Thorn Forest, its History and Current State</i> ” |
| 1951-1953 | Head, Agroforestry Department, All-Union Agricultural Institute |
| 1953-1955 | Scientific Secretary, All-Union Agricultural Institute |
| 1955-1965 | Associate Professor, Department of Gardening and Agroforestry, All-Union Agricultural Institute |
| 1965 | Defended doctoral dissertation “ <i>Allelopathy of Woody Plants and the Possibility of its Use</i> ” |
| 1965-1978 | Vice-rector, All-Union Agricultural Institute. |
| 1971-1972 | Head, Department of Ecology, Physiology and Biochemistry, Central Research Institute of Forest Genetics and Breeding (Voronezh) |
| 1978 | Expired on 16 March, 1978 |

The role of biochemical influences of woody plants in their relationships, increasing the productivity of mixed plantations was revealed. The scientist examined in detail the choice of combinations of woody plants and proposed a new biochemical principle of their combinations (19). He introduced the concepts of “activator species” and “inhibitor species”. In the plantings of the main breed, there must be at least 50 % seats, the activator species 30-40 %, the inhibitor species should not be more than 20 % (22).

PUBLICATIONS: He published over 100 scientific papers.

Books/Monographs

- (i). Kolesnichenko, M.V. (1968). *Biochemical Interactions of Woody Plants*. 150 pp. Lesnaya Promyshlennost, Moscow (Russian).
- (ii). Kolesnichenko, M.V. (1976). *Biochemical Interactions of Woody Plants*. Edition 2 (revised and enlarged). 184 pp. Lesnaya Promyshlennost, Moscow (Russian).

Research Papers

- (i). Kolesnichenko, M.V. (1964). Need to consider the biochemical effects of trees. *Forestry* **9**: 15-19 (Russian).
- (ii). Kolesnichenko, M.V. (1965). *Allelopathy of Woody Plants the Possibility of its Use*. *Ph.D. Thesis*. 31 pp. Kharkiv: Kharkov order of labor red banner V.V. Dokuchaev Agricultural institute (Russian).
- (iii). Kolesnichenko, M.V. (1973). Mutual influence of woody plants through phytoncides. Phytoncides (biological value, properties and application). *VII meeting, Problem of Phytoncides: Abstracts (25-June 27, 1973, Kiev)* (Ed., B.Ye. Aizenman) pp. 9-10. Naukova Dumka, Kiev (Russian).

2.6. Valentina Dionis'evna Roshchina (1922-1993)

Valentina D. Roshchina was Plant Biochemist and Physiologist and studied ‘Plant Excretions and Allelopathy’.

Early life and education: Professor Valentina D. Roshchina was born on 7 April, 1922 in Bryansk, Russia in the family of school teachers. In 1940-46, she was a student of Biology Faculty, Moscow State University, specializing in Plant Biochemistry under the guidance of Profs. A. Oparin and A. Belozerskii. She received her Ph.D. degree in 1951 on yeast biochemistry under the supervision of Prof. G. Seliber in Lesgaft Research Institute, Leningrad.

Professional life and allelopathic research: She started her Academic career in Department of Plant Biochemistry, Moscow University and worked with Professors A.I. Oparin and A.N. Belozersky. Then she worked in Laboratory of Microbiology, Lesgaft Research Institute, Leningrad with Professor G.L. Seliber, where she received her Ph.D in 1951. Her main work as Scientist and Professor was in Botany Department, Forest Institute Voronezh (Now University) from 1952 to 1974. She wrote Text books and Manuals for students. Her book ‘*Plant Cell Physiology*’ (1970) was Text Book in all Universities in USSR. In 1974, she became Professor and Head, Department of Botany at Pedagogical Institute, Voronezh. In 1965-1975, she investigated the woody plant excretions and mechanisms of their action at the cellular level. She showed the sensitivity of some cellular processes to the excretions and water infusions from 30 woody plant spp.



Figure 6. Valentina D. (Dionis'evna) Roshchina.

Based on her research, new cellular biotests were developed for the allelopathic studies: (i). Movement of chloroplasts in the cytoplasmic streaming, (ii). Cytoplasmic viscosity (42), (iii) Membranes (plasmalemma, chloroplasts and tonoplast) permeability (43-45), (iv). Hill reaction in isolated chloroplasts (42,47). At the end of 1960's, she was the first to use Gas Chromatography to analyse the internal gases in woody plants, their volatile and liquid excretions. Some components of excretions (transpiration water and washings from the plant surfaces) showed physiological activity as allelochemicals (44) and were allelopathically active. These compounds were methanol, ethanol, propanol, propanal, other alcohols, aldehydes and phenolic compounds. She developed models, to study the mechanisms of allelopathic and phytoncidic reactions at cellular level. In 1970s, She and Prof. A. Tambiev, Moscow University introduced the term 'Exometabolites' for the allelopathic research (46,47,54).

In 1974, she received degree of Doctor of Science for the Dissertation '*The Exometabolites of Woody Plants and Mechanisms of Their Action*' from the Institute of Plant Physiology, Ukraine Academy of Sciences, Kiev. She published more than 70 research papers. In 1989, her monograph '*Excretory Functions of Higher Plants*' was published (Russian). It included modern views on the plant excretory functions and the chemical interactions in biocenosis. In 1993, its revised edition in English was published by Springer-Verlag, Berlin, Germany. Since 1993 she is working at the Institute of Cell Biophysics, Pushchino, on the role of oxidative processes in the mechanisms of actions of allelochemicals in the cellular membranes damaged by ozone. Later she and her daughter Dr. V.V. Roshchina analyzed the effects of ozone and reactive oxygen forms on cells and individual physiological active compounds and showed that natural concentrations of ozone changed the physiological processes in plants, altering the action of native growth regulators (allelochemicals). In 2003, based on this research, a new Monograph '*Ozone and Plant Cell*' was published in English in 2003 by Kluwer Publishing House, Netherland. She cooperated with her daughter Prof. Victoria V. Roshchina in writing Books related to roles of exometabolites in Allelopathy.

Table 6. Chronology of major events

| Dates | Event |
|-------|---|
| 1922 | Born on April 7, 1922 in Bryansk, Russia |
| 1951 | Awarded Ph.D. Degree, Lesgaft Research Institute, Leningrad, Russia |
| 1951 | Appointed lecturer, Forestry Institute, Voronezh, Russia |
| 1960 | Started research on allelochemicals/phytoncides |
| 1974 | Appointed, Head, Department of Botany, Pedgogical Institute, Voronezh, Russia |
| 1974 | Awarded Doctor of Science Degree, Institute of Plant Physiology, Kiev, Russia |
| 1989 | Monograph Excretory Functions of Higher Plants, published, Nauka, Moscow |
| 1993 | Revised English edition of Monograph Excretory Functions of Higher Plants, Springer Verlag, Berlin, Germany |
| 2019 | Expired on 7 April, 2019 |

Owing to her deep understanding of research on ‘Chemical Communications in Biocenosis on Cellular Level’, many outstanding Allelopathy Scientists viz., Profs. E.L. Rice, Boris Tokin, A.M. Grodzinsky, Mikhail Kolesnichenko, and Vasilii Ivanov were connected to her. Prof. Roshchina presented her fundamental research ‘Physiologically active plants compounds - phytoncides and allelochemicals’ in All Russian Scientific Meetings. She had strong cooperation with leading scientists including Prof. A.M. Grodzinsky, who supported her research on ‘*Mechanisms of Exometabolites Action*’.

3. CONCLUSIONS

The allelopathic schools of the former USSR (period 1902-2000) developed many research areas, still used worldwide. They developed (i). Doctrine of bio- and phytocenoses from the standpoint of complex interaction of plants, (ii). Formation of different levels of competition and its mechanisms and (iii). Classification of these interactions. The concept of biologically active compounds was formulated based on chemistry and levels of influence in intraspecific and interspecific relationships. The concept of rhizospheric relationships of plant species was also introduced and the study of their rhizospheric interaction through root secretions was started. The phytoncides and allelochemicals were studied and developed methods for their bioassay and determine their effects on individual plant species and classification of phytoncides and allelochemicals. The subcellular and cellular levels of allelopathic reactions were studied to understand the competition systems in plants.

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.

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