Perspectives

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Nikolay Vladimirovich Timofeeff-Ressovsky (1900–1981): Twin of the Century of Genetics

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Don't treat science with savage seriousness.
N. V. Timofeeff-Ressovsky

Nikolay Vladimirovich Timofeeff-Ressovsky born September 7, 1900, would now be 100 years old. He was of the same age as the "Century of Genetics." This is especially notable now, at the border between two millennia, "a time to cast away stones, and a time to gather stones together." It is remarkable that the personality and fate of Nikolay V. Timofeeff-Ressovsky, N.V., reflect the most crucial, tragic, and dramatic events of the century.

N. V.'s roots were in the nineteenth century, in Russian history and classics. His genealogy is living Russian history: It contains the Cossaks of the legendary Cossak chief, Stepan Rasin (something of a Robin Hood); the descendants of the Viking Rurik, the founder of the Russian prince dynasties; the admirals of the Russian Navy; the great anarchist Prince Pyotry Kropotkin; and many Russian officers and intellectuals of the nineteenth and twentieth centuries.

The First World War and the Russian Civil War had thrown N.V. into a series of turbulent events and a story deserving of the best Italian literary pen. In 1917 he got to the Southwestern front in a Cossak unit, fought against the Germans as an infantryman, and became a sargeant major in the cavalry. He then worked his way toward home, was kept by an anarchist band in the Ukraine, got out by a miracle, and finally reached Moscow. He was mobilized into the 12th Red Army, retreated with them almost to Moscow, then attacked the White Army of General Denikin in the Russian South, fought against the "wild" Caucasian division, and fell ill with typhoid.

In spite of these cataclysms, being a peripatetic of fortune had not diminished his craving for knowledge and science. Between battles he had studied biology at Moscow University, participated in various intellectual circles, sang as a first bass in the Moscow military chorus, was a load-carrying worker, and finished Moscow University in 1922. Later he talked about this grim period (Timofeeff-Ressovsky 2000, p. 106): "I think, nevertheless, that all in all the life was merry–very few hungry, very few frozen. Rather, people were young, healthy, and vigorous."

In 1922 N.V. began his work as a scientist at the Institute of Experimental Biology with Professor N. K. Koltsov. Nikolay Konstantinovich Koltsov was an outstanding figure in Russian biological science. As early as 1911 at the private Shanyavsky University he had organized a Laboratory and Department of Experimental Biology, the first in the world. In 1916, these became the nucleus of the Institute of Experimental Biology. Here one of the great Russian schools of theoretical and experimental genetics was founded. The oldest pupils and colleagues of Koltsov were S. S. Chetverikov, A. S. Serebrovsky, and V. V. Zavadovsky. Later came N.V., his wife H. A. Timofeeff-Ressovsky, D. D. Romashov, B. L. Astaurov, N. K. Belyaev, S. M. Gershenson, N. P. Dubinin, P. F. Rokitsky, and others, the cream of the new Russian Genetics. N.V. was one of the most talented of Koltsov's students and became the one who was closest to him.

N. K. Koltsov was interested in all of biology. However, in the field of genetics he personally initiated work in three basic directions: phenogenetics, *i.e.*, the genetic basis of ontogenesis; investigation of the rules of mutagenesis; and theoretical genetics, which later became the basis of molecular genetics. In the words of N.V. himself (Timofeeff-Ressovsky 2000), "But actually the excessive popularity and success of so-called molecular genetics—all this was foreshadowed in Koltsov's Institute and reflected in Koltsov's published papers."

The other teacher of N.V. during this period was Sergey S. Chetverikov, one of the founders of theoretical

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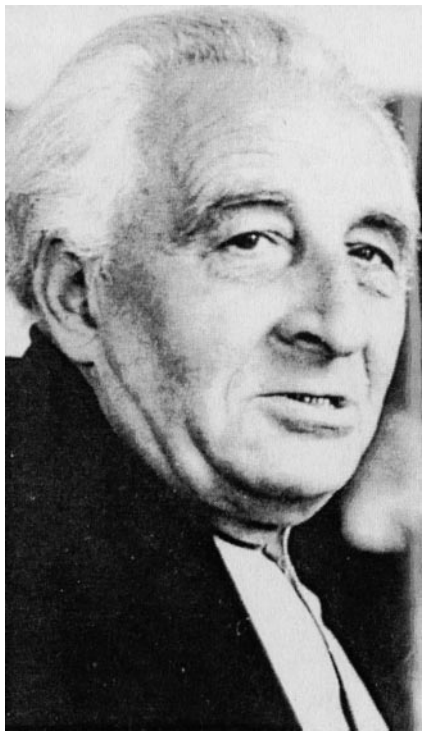

N. V. Timofeef-Ressovsky in his mid-60s.

and experimental population genetics. He was head of a famous "DROSSOOR" (Russian abbreviation of a common rallying cry about Drosophila), where the Moscow school of population genetics was born. In the words of N.V. (Timofeeff-Ressovsky 2000): "Koltsov's Institute had founded the modern school of evolutionary doctrine, that was later, in the 1940s, termed by Julian Huxley the "New Synthesis," the fusion of genetics and classical evolutionary doctrine."

Thus, N.V. was very lucky. Fate brought him together with these outstanding Russian geneticists of the first wave. From them he received the powerful impulse that determined for decades the range of his scientific interests in genetics: phenogenetics; mutagenesis and the molecular nature of the gene; population genetics and the theory of microevolution. Moreover, this impulse was completely original, because during these 7 to 8 years, at a time of wars and revolutions, Russian science was completely isolated from European and world science.

In 1922 this isolation was broken. One of the famous students and co-workers of T. H. Morgan, Herman J. Muller, arrived in Moscow and Petrograd. He introduced his Russian colleagues to the novel results of experimental genetics of the Morgan school, brought reprints of multiple papers, and—especially important—brought a collection of Drosophila lines. Direct contact with the Morgan school completely changed the situation. After this, N.V. began to work with *Drosophila melanogaster* and started the main areas of his work. In this initiative, he came from two Russian schools—that of N. K. Koltsov, who had begun to investigate mutagenesis and phenogenetics of Drosophila, and that of S. S. Chetverikov, who had discovered the reservoir of hereditary variability in natural populations of Drosophila. Coincidentally with Muller's discovery in 1927 of the mutagenic effect of X rays, N.V. started his long-term investigations of radiation genetics and radiobiology.

In 1923–1925 Moscow was the residence of the outstanding German neuropathologist and neuromorphologist, Professor Oskar Vogt, Director of the Brain Research Institute of the Kaiser Wilhelm Society in Berlin. Professor Vogt was a consultant for the medical treatment of the leader of the Russian revolution, V. I. Lenin. After Lenin's death, Vogt helped the Soviet government organize the Brain Institute in Moscow to study Lenin's brain. Several times Vogt visited Koltsov's Institute, was impressed by the high level of studies, and asked Institute members to recommend a young Russian geneticist to organize the Laboratory of Genetics in his Brain Research Institute in Berlin. N. K. Koltsov and Public Health Commissar N. A. Semashko recommended the young married couple, N. V. and H. A. Timofeeff-Ressovsky. They went to Berlin in 1925, and later, in 1929, after completion of the new building for the Institute of Brain Research at Berlin-Buch, N.V. moved there and became the head of the Department of Genetics. In 1937 this Department was reorganized as the Institute of Genetics and Biophysics of the Kaiser Wilhelm Society (analogous to the Academy of Sciences). N.V. became its Director.

N.V. remained in Germany for 20 dramatic years. He experienced exciting hours of contacts with the best biologists and physicists of Germany and elsewhere in Europe and moved into the circle of the most talented researchers of the Copenhagen school of physicists, biophysicists, and geneticists. It is known that at that period the great physicist, Niels Bohr, was very much interested in the effect of high-energy radiation on biological material and also in the relationship between quantum physics and genetics. But after the 1930s, N.V. went through the hard times of Nazism, spent the Second World War in a group of intellectuals in Nazi surroundings, was in continuous danger of arrest, suffered the death of his elder son Dmitrij in the Mauthausen concentration camp, and all this time was a foreigner—a Russian—and so was numbered among the enemies of his adopted homeland.

In 1937 he received an order to return to the USSR. The scientific mission to Germany was over. But from Russia N. K. Koltsov sent the warning that his return could end in his arrest. Two of N.V.'s brothers were already arrested and later perished. N.V. decided not to risk a return to his homeland, but his legal status in Germany was very indefinite: a foreigner without citizenship, bailed out by the Kaiser Wilhelm Society. Despite this diabolical squeeze, N.V. nevertheless did not lose

A cartoon of N.V., drawn by S. Tulkes.

hope of returning home under happier circumstances. In 1937 he refused the invitation of the Rockefeller Foundation to become the Head of the Laboratory of the Carnegie Institute at Cold Spring Harbor. At the end of the War, when the scientific institutes were evacuated from Berlin-Buch to Göttingen, he refused to depart. Together with the Institute, he remained in Berlin to meet the Soviet Army.

The scientific highlights of this period for N.V. were as follows:

A series of classical works on phenogenetics (basic publications: Timofeeff-Ressovsky 1927, 1934a). The concepts of penetrance and expressivity and also of the systemic regulation of the formation of phenotypic traits—the foundation of phenogenetics and the genetics of ontogenesis.

Classical works on the theory of evolution of populations (Timofeeff-Ressovsky and Timofeeff-Ressovsky 1927; Timofeeff-Ressovsky 1939, 1940, 1958; Timofeeff-Ressovsky *et al.* 1975, 1977). The discovery of a large reservoir of hereditary variability in natural populations of Drosophila was the first confirmation of the remarkable early vision of S. S. Chetverikov. The pinnacle of investigation of population-evolutionary processes was the development of the concept of microevolution. N.V. used this term to designate evolutionary processes within species. He built a logical and constructive system of the elements of this concept: The elementary subject of microevolution is the population; the basic evolutionary raw material is mutation; the elementary evolutionary event is a change in genotypic frequencies; the factors of evolution are mutation, fluctuation of population number, isolation, migration, and selection. These ideas were woven together in a synthetic theory of evolution (Timofeeff-Ressovsky 1940, 1958).

A series of basic classical works on radiation genetics and radiology (Timofeeff-Ressovsky 1934b; Möglich *et al.* 1944; Timofeeff-Ressovsky and Zimmer 1947; Timofeeff-Ressovsky *et al.* 1968, 1981). The regularities of dose dependence in treatment by high-energy radiation, discovered by N.V. in Drosophila, provided the foundation for the "hit" theory, radiation biology, and radiation genetics.

The "brainstorm" of Koltsov's problem of the molecular nature of the gene, together with K. Zimmer and M. Delbrück, came to life in the so-called "Classical Green Pamphlet," of which the basic article of Timofeeff-Ressovsky *et al.* (1935) can be considered as the keystone in the formation of molecular genetics. This work was the starting point for E. Schrödinger's (1944) influential book *What Is Life?* and provided further impetus for the development of molecular biology and genetics. The concept of the physical nature of the gene as a macromolecule, the estimation of its size and monomolecular nature, and the concept of template-driven reduplication were later adapted by his pupil and coworker Max Delbrück into the foundations of molecular genetics.

It is appropriate to clear up some aspects of the relations between N.V. and Delbrück. N.V. himself described the development of these events in these words (Vorontsov 1993, pp. 48–49; Timofeeff-Ressovsky 2000, p. 223):

> In the beginning of the 1930s I became a friend of Max Delbrück and, so to say, involved him in our work. He was a pure theoretical physicist, the pupil of Max Born and Niels Bohr. Actually I won him over to theoretical biology. Now he is a major virologist and theoretical biologist in America, a Nobel Prize winner, and on the whole a very remarkable person. At that time he was a young man, and as are all great theorists, was somewhat insolent, but this is excusable. We also treated him insolently, and he acquired our manners very quickly and became quite an acceptable young man.
>
> Henceforth he was invited to our Buch group. And here we made firm contacts. I told him about Koltsov's general concept of molecular biology of genes and chromosomes, and our attempt to prove experimentally the general monomolecularity of the gene. That is to say, this is a joint physico-chemical elementary structure, and not a piece of a butter! Delbrück took part in this work. This was the origin of the Classical Green Pamphlet.

And here is the viewpoint of his colleague Karl Zimmer (1966, p. 37):

> Two or three times a week we met, mostly in Timofeeff-Ressovsky's home in Berlin, where we talked, usually for ten hours or more without any break, taking some food during the session. There is no way of judging who learned most by this exchange of ideas, knowledge and experience, but it is a fact that after some months Delbrück was so deeply interested in quantitative biology, and particularly in genetics, that he stayed in this field permanently.

In other words, as everyone now recognizes, this work followed the brainstorm of Koltsov's problem of the molecular nature of genes. Taking into account the irrepressible personality of N.V., there is no doubt that he alone sowed the seeds. This was summarized by N.V. (Timofeeff-Ressovsky 2000, pp. 240–241):

> From the 1940s I personally did not devote myself to this problem. True, many persons, here and abroad, consider me as something like the grandfather of this approach. This is because the new postwar version of this viewpoint was initiated by Delbrück, and I had implanted the corresponding idea into Delbrück's brain in the 1930s. Actually, it all originated in our "Classical Green Pamphlet" of the Göttingen Scientific Society. And it led him to continue successfully.

The general upshot of these years was scientific maturity. N.V. became a recognized world class scientist. The circle of his scientific intercourse included: physicists N. Bohr, P. Dirac, E. Schrödinger, P. Auget, F. Perrin, W. T. Astbury, and others; biologists H. J. Muller, Th. Dobzhansky, N. I. Vavilov, B. S. Ephrussi, V. I. Vernadsky, C. Darlington, J. B. S. Haldane, T. O. Caspersson, Å. K. Gustafson, and other outstanding scientists of Europe and America. Together with his friend and coworker M. Delbrück, N.V. was a permanent participant in Copenhagen and other seminars of the elite of European science. Together with the French geneticist of Russian origin, Boris Ephrussi, and with the support of the Rockefeller Foundation, he organized annual conferences on genetics, biophysics, and radiation biology. These were continued until 1939, up to the beginning of the War in Europe.

In 1945 Berlin was captured by Soviet troops. N.V. had surrendered his Institute of Genetics and Biophysics to the Soviet Military Administration and for several months continued his work in the same place. During this period he was visited by the head of the Soviet Atomic Project, Deputy Public Internal Affairs Commissar (NKVD) general A. P. Zavenyagin, who together with academician I. V. Kurchatov wished to use N.V.'s experience in their program. There was talk about shifting the base of N.V.'s laboratory to Russia. But shortly afterward events took a tragic turn.

In September of 1945, N.V. was arrested by a different division of the NKVD [according to evidence of the historian of genetics, V. V. Babkov (2000), after denunciation by visitor-scientists!], deported to Moscow, and sentenced to 10 years for failing to return to his homeland. In 1946 he was transferred to Karaganda (Kazakhstan), to one of the most terrible camps of the GULAG. On the way to the camp, in a common cell in Butyrskaya prison, he met another prisoner, A. I. Solzhenitsin, who later described these episodes in his book *Archipelago GULAG* (Solzhenitsyn 1991). There, in the camp, he almost died of hunger, developed dystrophy and pellagra, and almost lost his central vision. The formerly unusually healthy and vigorous person was on the verge of death.

The Atomic Department, represented by A. P. Zavenyagin, could not find him for a long time. According to the evidence of Babkov (2000), the decisive role in saving N.V. was played by the outstanding French physicist, Nobel Prize winner, and participant in the resistance, Frederick Joliot-Curie. He visited Moscow and appealed to the Minister of Internal Affairs, Lavrenty Beria, who controlled all the secret military-scientific projects, about the necessity of saving the great radiobiologist N. V. Timofeeff-Ressovsky and giving him work. It is difficult to say what was decisive, but N.V. was immediately returned to Moscow, located in the best hospital for medical treatment, and after several months, in the spring of 1947, conveyed to the south Urals to organize a large laboratory of radiation-biological investigations.

"Site N 1215" was moved to the town of Sungul. There, N.V. was Head of the Department of Biophysics. And so he came to "sharashka." This term is well known by inhabitants of Soviet Russia to designate the secret scientific and construction laboratories, where many outstanding Soviet engineers, constructors, and scientists, being GULAG prisoners, had elaborated the most modern models of military techniques. The great S. P. Korolev (rockets), A. N. Tupolev, other aero-engineers, and many others had gone through sharashka. The tragic figure of Soviet genetics, academician N. I. Vavilov, did not live until sharashka; he died of hunger in a prison in 1943 (see Crow 1993).

Conditions of living in the site were, for that time, rather good (there were good provisions, and a sanatorium was being built), but for N.V. it was a prison. After long-term medical treatment, he got permission for the arrival of his family and a group of his German coworkers (including K. Zimmer). With them and 50 civilian co-workers, he worked in Sungul up to 1955. After this the site was disbanded, N.V. was discharged, and the Atomic Department generously transferred to him the equipment of his Laboratory for his further use.

The scientific effort of this period was very productive. In 1955 these works were declassified and published. They initiated subsequent cycles of investigations on radiobiology and radioecology in the Urals and in Obninsk. N.V. himself told about this in the following words (Timofeeff-Ressovsky 2000, pp. 371–372):

> Through all the world it is thought that Americans had developed all of medical and water isotopic biology. But all this we had done earlier than the Americans. Approximately at the end of the 1960s and beginning of 1970s I and my students finished the work of this radiation biogeozenology [a word originated by Vernadsky and Sukatchov to describe interactive ecosystems]. Very likely, these works in the Atomic System and in the Miassovo Biostation on the Urals were the most productive in my so-called scientific life.

After his discharge in 1955, N.V. visited the capitals—

Moscow, Leningrad, Kiev. Everywhere he found his old friends, and physicists and geneticists met him with great enthusiasm. He was welcomed by future Nobel Prize winners academicians P. L. Kapitsa, L. D. Landau, I. E. Tamm, biophysicist M. V. Volkenstein, mathematician A. A. Lyapunov, and others. In their institutes and departments they organized N.V.'s reports and lectures; these were a big success. Despite isolation on the "site," N.V. kept himself informed about new problems in genetics and molecular biology, and many discoverers were his old friends.

However, N.V. was refused the opportunity to live and work in the capitals. It is known that in that period academician O. V. Gasenko attempted to bring him to his Institute of Medico-Biological Problems (actually, of Cosmic Medicine) in Moscow, but without success. N.V.'s freedom turned out to be illusory and rather restricted. Then he returned to the Urals and worked there, in Sverdlovsk and on Miassovo Biostation up to 1964, being Head of the Department of Biophysics of the Institute of Biology of the Ural affiliate of the USSR Academy of Science, all without a scientific degree! It is paradoxical that, being a recognized scientist of world class, N.V. had no school diploma (although he left with a gold medal), no university degree, no scientific degrees! The vortex of wars and revolutions swept away all paper evidence of his education. He defended his doctoral dissertation as late as 1963 in Sverdlovsk, and he received his diploma of Doctor of Science only in 1964, after the fall of Nikita Khrushchev and the rehabilitation of genetics in the USSR.

In 1964 N.V. went to his historical homeland—to the Kaluzhskaya District near Moscow. At the scientific center Obninsk, he became head of the Department of Radiation Biology and Genetics of the Institute of Medical Radiology of the USSR AMS (Academy of Medical Sciences). The genetic and radiation investigations were continued with success. However, this niche was crushed in 1969. In the country the long period of stagnation and suppression of dissidents had begun. Zhores Medvedev was the first to be dismissed from his department. Because of heavy official pressure, N.V. was retired with a pension. In December of 1969 Max Delbrück received his Nobel Prize and shortly after he visited Moscow. In his lectures he remembered his friend and teacher and characterized his outstanding role in the origin of molecular biology and genetics (Babkov 2000). There are some data showing that Delbrück had appealed to the President of the USSR Academy of Sciences M. V. Keldysh (Vorontsov 1993). Perhaps this was effective, because just at that time academician O. V. Gasenko was successful in overcoming the invisible barrier and taking N.V. into his Institute as scientific consultant. This was his last working place, where he stayed during the final 11 years of his life. He died on March 28, 1981. An obituary was published in this journal (Medvedev 1982).

All during his long adult life, N.V. stayed with his wife, Helena Alexandrovna Fidler (1898–1973). They were married for more than 50 years. She was everything for him—his love, friend, closest co-worker, and help. She was an excellent experimenter and was co-author of most of his papers. When he was arrested, she stayed on at the Institute in Berlin-Buch and was Deputy Director. When he lost his central vision and capacity to read and write, she became his eyes. During this time, H.A. wrote all his papers, letters, and other written materials. N.V. once told us that during his life he had two great pieces of luck: his teacher, the great N. K. Koltsov, and his wife, Helena Alexandrovna.

It is necessary to mention that after discharge from the GULAG and even after his death, certain conscienceless or motivated persons tried to defame the name of N. V. Timofeeff-Ressovsky under very inadequate quasi-scientific and political propositions (see, for example, Granin 1987; Paul and Krimbas 1992; Korogodin *et al.* 2000; Ratner 2000; Timofeeff-Ressovsky 2000). All these attempts ended in failure. In 1992 N.V. (at last!) was completely legally rehabilitated, his case was dropped, and his sentence was abolished because of the absence of a *corpus delicti*.

During the years of his work in the Urals and in Obninsk, N.V.'s scientific interests began to shift to global biological problems: biosphere and humanity, "biosphere-biogeocenosis-biocenosis-population," radioactive contamination of the biosphere, and basic principles of theoretical biology. In these fields he rose to the level of his great teachers and predecessors, academicians V. I. Vernadsky and V. N. Sukachov. N.V. had developed a harmonious concept of hierarchical levels of biosphere and living nature (Timofeeff-Ressovsky 1970; Tyuryukanov and Fedorov 1996). These works are a crowning achievement of his great talent for generalization.

Furthermore, as far back as the time of his work in the Urals, N.V. encountered the first warning bell of the Chernobyl era. In 1957, in the south Urals near the town of Kyshtym, there was a major explosion contaminating all the surroundings with radioactive waste. The removal of the consequences of this nuclear accident became a state problem. N.V. had fully assessed the danger of radioactive contamination and the necessity of investigating its consequences. He discussed these problems in many of his lectures and reports. V. V. Babkov (2000) asserts that one of these reports impressed academician A. D. Sakharov and induced him to turn his attention to the problem of defending the biosphere and humanity from nuclear weapon tests.

The scientific output of this period has been discussed. But the social sum of N.V.'s activities was no less important. First, he received the complete scientific recognition of Russian and foreign scientists as one of the outstanding biologists of our time. In this period he received the very prestigious Kimber Prize in Genetics in

the United States, the Darwin Prize and the Mendel Prize of the German Academia Leopoldina in Halle, and the Mendel Prize of the Academy of Science of Czechoslovakia. Second, in these years he returned to his homeland all the main results published in Germany (and almost inaccessible in Russia). In particular, he published with his co-workers a series of conclusive books and reviews on evolutionary theory, radiation genetics, and other areas (Timofeeff-Ressovsky 1958, 1996; Timofeeff-Ressovsky *et al.* 1968, 1977, 1981; see also Yablokov 1989). Third, in every place where he had lived and worked, even the investigatory isolation of the KGB in Lubyanka, the common chamber of Butyrskaya prison, and "sharashka" at Sungul, N.V. had organized a school of listeners and pupils. Many of them later became leading Russian and foreign scientists, academicians, and cultural workers. An important role in the education of young scientific generations was played by the Miassovo Summer Schools—Seminars on Genetics and Biophysics (1956–1963) and the Summer Schools near Moscow (1965–1967) that were organized by N.V. with the famous biophysicist L. A. Blumenfeld. I was happy to be a participant in these schools.

Thus, the great cataclysms of the twentieth century put their dramatic imprints on the life and creative work of N.V. Invariably he was at the focus of events: wars and revolutions, totalitarian regimes, the GULAG, and "small Chernobyl"—really, a Hamlet's collection of problems and passions!—but at the same time, at the summits of science, with the exceptional gifts of thinker and scientist, he showed the powerful, true Russian temperament of teacher and enlightener.

It is necessary to underline that the fighting spirit of N.V., his moral principles, his sensation of world and homeland, and his attitude toward science were not broken by the disturbances of his fate. His natural health and cheerfulness were usually dominating, his speech was full of jokes and puns, his energy and artistry permitted no rest. Perhaps the main testament of N.V. to his pupils was his view of science. On the one hand, he revered science as the highest expression of human genius and mind. On the other hand, he always challenged himself, other scientists, and surrounding persons, stimulating them to an attitude toward science as an exciting game of minds. He was a joker of genius who, when at leisure, invented for other people many fine and didactic stories. In other words, he insulated his activity and science from self-adulation, authoritarianism, and overstatement of its proper role. This is relevant for scientists of all times and places.

It is said that academician P. L. Kapitsa recited the following words: "If a scientist is remembered and cited 10 years after his death, it means he is a classic." Twenty years have gone since N.V.'s death, but the interest in his personality and his scientific and conceptual heritage has not diminished. Published in Russia were his works from the German period, the memoirs about him, and his own oral stories (so-called "baiki"). UNESCO announced the year 2000 as the end of the Century of N.V., and memorial conferences were organized in different countries and towns of Russia. It means he is not dead! He is classic!

I thank the friends, co-workers, and pupils of N. V. Timofeeff-Ressovsky for preparation and publication of priceless materials of his life and creative work, which were actively used by the author. They are Vl. I. Ivanov, N. A. Lyapunova, L. A. Blumenfeld, N. N. Vorontsov, A. N. Tyuryukanov, S. E. Shnol, V. V. Babkov, E. S. Sakanyan, V. I. and V. L. Korogodins, D. Granin, and many others. The most important source is the last edition of his oral stories told by N.V. and written down from a dictaphone by his friends during the last decade of his life (Timofeeff-Ressovsky 2000). It is an extremely rare case when the internal world of a great scientist is set before the reader, intact in all its brilliant originality and completeness.

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