ANDREY N. ALEKSEEV'S LIFE IN SCIENCE: A SKETCH OF A SCIENTIST'S PORTRAIT

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ABSTRACT: Andrey Nikolayevich Alekseev (1930–2015) was a prominent Russian expert in medical entomology, epidemiology and parasitology. This paper provides a brief description of his life and work. Professor Alekseev's research career spanned 57 years, resulting in an extensive bibliography that comprises five monographs, 568 original research papers and 10 approved author's certificates. His main research interest was the relationship between blood-sucking arthropods and their hosts.

Andrey Nikolayevich Alekseev was born on December 11, 1930, in Leningrad (now St. Petersburg). His father, Nikolay Mikhailovich Alekseev (1900–1956), a graduate of the Medical Military Academy, was an army doctor. During WWII, Nikolay was arrested as an "enemy of the state" and sent to a prison camp in 1941. After being granted amnesty in 1943, he worked as an assistant head of a military field hospital.

Andrey Nikolayevich wrote about his father[1]: "*...Not until the early 1990s did I manage to get access to the 'file' of my father. From reading it, I learnt that he had been arrested for a conversation with a relative and some friends during the 1941 New Year celebration. My father told them about the horrible losses sustained by the Red Army during the Finnish War (he had worked as a doctor in an aircraft unit). He also said that a war with 'our greatest enemy-friend' Hitler was imminent. When the War began, many officers were arrested for this kind of 'harmless foresight'. After being convicted of Article 58.10 (anti-Soviet propaganda) and sentenced to ten years, he was sent to a prison camp located in the Ural Mountains. In 1943, all officers convicted of similar charges (the ones that had survived up to that point) were sent to the front lines*".

By the end of the war, Lieutenant-Colonel N. Alekseev was the head of a unit at the Medical Corps of the Soviet Army, decorated with the Red Star and the Patriotic War Medal of the 2nd grade. Nikolai worked in the Military Medical Museum of St. Petersburg before dying in 1956. He was completely rehabilitated in October 1991.

Andrey's mother, Zinaida Davydovna Alekseeva-Verbova (1901–1970), was born in St. Petersburg. In the early 1920s she was a famous ballerina and one of the founders of Rhythmic Sportive Gymnastics (RSG) in Russia. After her marriage and childbirth, Zinaida taught RSG and worked as a coach (1935–1941 and 1944–1951) in the Lesgaft Institute of Physical Culture in Leningrad. During the war, she worked in hospitals as a methodologist of medical gymnastics in the cities Sverdlovsk (presently Ekaterinburg) and Frunze (presently Bishkek). Zinaida's achievements as a coach were widely recognised: she created unique exercises for some of the leading gymnasts of the Soviet Union, among whom was Lydia Nazmutdinova, the first Soviet world champion in RSG. Zinaida died in 1970. Andrey's parents were both buried at the Bogoslovskoe Cemetery in St. Petersburg.

A person's character forms during childhood, and Andrey was no exception to this. His happy childhood was interrupted by the war, when he and his mother were evacuated from the besieged Leningrad. He wrote: "*A difficult adult life began, where you were responsible not only for yourself but also for others. My mother was awfully depressed as a result of my father's arrest, naively believing that he, being convicted unjustly, would soon be released. As a result, she took along none of his clothes, which would have helped us a lot in the future, when we had to exchange our scanty wardrobe for bread. Life at the brink of starvation began. It was not as bad, of course, as during the siege [of Leningrad], but a life when one was truly happy to find two potatoes that someone lost in the street. And a very cold life! One of my lively recollections: I am curled up in a ball, legs tucked under myself, sitting on the table (it was a bit warmer there) and reading* The Belly of Paris *by Émile Zola. I was nearly always alone: my mother worked day and night in the hospital where she had a job in a convalescence unit for the wounded*".

Avid reading helped Andrey endure the hardships of evacuation and made the patchy education that he received in various schools of Sverdlovsk and Frunze more rounded. After coming back to Leningrad in 1944, he finished high school summa cum laude in 1948.

[1]The memoirs of Andrey N. Alekseev, cited here and below, are in the private archive of the author.

He wrote about his school years: "*The 7th grade was ahead, with my persistent struggle with mathematics, grammar and punctuation. I prevailed in this struggle—most importantly, prevailed over myself—and achieved my goal, the Gold Medal*".

"*Frankly speaking, I was an indifferent pupil. Primary school was not especially interesting to someone surreptitiously reading* Ninety-three *by Victor Hugo during classes. Reading was my favourite pastime since the early days, with an interest in history and mythology (Greek and otherwise) stemming from it. Long live the mumps! Owing to this illness, I devoured the* Myths in Classical Antiquity *by Shtol, with its excellent prints. At the same time, I read all of Jules Verne, which was available in the library of the Lesgaft Institute where my mother worked. She, who had studied French in gymnasium [a type of secondary school], admired the great French authors and passed this love on to me: Anatole France, Hugo, Rolland, Stendhal were on my reading list before, and especially during, the war. Shortly before it started, I secretly took from my father's bookcase, which was almost always locked,* The Golden Ass *by Apuleius and* Napoleon *by Yevgeny Tarle. The latter impressed me greatly and enlivened my desire to understand historical events and personalities. Looking at the eight volumes of* The History of the 19th Century*, I can hardly believe that I read them in the 8th grade*".

Andrey's dream was to study and do research. His Gold Medal for academic excellence had opened the doors to all Soviet universities to him. He entered the Faculty of Biology and Soil Sciences at the Leningrad State University and, following the advice of his father, the Kirov Military Medical Academy (MMA). During his first university school break, he went to the Biological Station at the Barents Sea for a course of field training. After that, however, the head of the academy, Levon A. Orbeli, forbade the young man to continue simultaneous studies at two institutions. General-Lieutenant Evgeny N. Pavlovsky, the head of the General Biology and Parasitology Department at the MMA, tried to intervene, but without success. Andrey left the university and continued his studies in the MMA. His father wrote: "*Become a doctor and you will always do fine. Pavlovsky's department provides such an excellent training that you will be able to become a biologist without attending the university*".

His father's words came true. Studies in the Academy, under the supervision of General Pavlovsky and Colonel A.B. Gnezdilov, a prominent protozoologist, laid the basis for Andrey's scientific career. His first paper entitled "On the preservation of cysts from human intestine for diagnostic purposes" was published in 1956. During the summer breaks, Andrey took part in the expeditions to Transcaucasia (to research the outbreaks of malaria and pappataci fever among the military troops) and to the mountains of Armenia and the marshes of Azerbaijan (to test repellents under the supervision of Prof. A.B. Gutchevich and Major A.C. Shustov). This field experience helped develop his research skills.

Students of the Academy ended up being united forever by the ties of friendship, supporting each other through life. According to the memories of Andrey's fellow students, the Academy was a "crucible", which promoted teamwork and mutual trust. Dr. Alekseev once remarked that the students formed a single *Volvox*-like organism.

Andrey graduated summa cum laude in 1954, adding his name to the honorary list, displayed in the main building of the Academy. Previously, summa cum laude graduates could automatically enrol into a post-graduate program. However, according to a new order issued in 1953, all graduate students were to be first sent to a military unit. Not even the intervention of E.N. Pavlovsky could change that: Andrey was sent to work at the scientific research institute of the Ministry for Defence of the USSR (1954–1960), first in Zagorsk and then in Kirov. There he carried out experimental research in medical entomology. Parallel to that, he collected entomological materials for his own studies. He devoted his leisure time to reading scientific and historical literature, as well as to studying foreign languages.

After demobilizing from the Army in 1960, Andrey's career as a "civil" scientist had started. During the next eleven years, he was a junior and then a senior researcher in the All-Soviet Scientific Research Institute of Disinfection and Sterilization at the Ministry of Health of the USSR (Moscow). He participated in and organised numerous expeditions, focused on blood-sucking dipterans and other arthropods, to the Volga River, Kazakhstan, the Baikal-Amur Railway and the Russian Far East.

Demobilised military officers in the USSR were given an opportunity to study at a university of their choice in order to acquire a civil profession. Andrey Nikolayevich could not miss this chance. He was a hard-working person: in addition to his work at the institute, the collection of data for his dissertation and partaking in expeditions, he studied at Moscow State University. Andrey graduated from it in 1966 with a diploma in history. His student thesis,

"On the so-called plague in Athens", was published in the prominent *Journal of Ancient History* (Alekseev 1966). Based on his medical and historical knowledge, he argued that a disease that devastated Athens in the second year of the Peloponnesian War (430 BC) was actually not a plague but an epidemic of typhus. It was caused by the influx of villagers into the city, accompanied by a high degree of urbanization and the presence of lice, as well as general anti-sanitary conditions.

In 1962, Andrey defended his Candidate of Medical Sciences thesis titled "Biology of fleas *Ceratophylus consimilis* Wagn. 1898: their role as the transmission vectors of the plague and their sensitivity to insecticides". It was based on the results of his research in Kirov and at the All-Soviet Scientific Research Institute of Disinfection and Sterilization. Andrey identified how the developmental life stages of fleas correlated with the temperature, humidity, the associated host species and the presence of chlorine- and phosphorous-containing insecticides. An important finding, reported in the thesis, was the fleas' ability to consume human blood even in the state of paralysis. This work was used in the development of pest control measures.

While working on the thesis, Andrey demonstrated his talent as an inventor: he developed a device for the fixation, microscopic examination, isolation and automatic counting of live fleas (Alekseev *et al*. 1966). This device made it possible to design experiments with an unlimited number of fleas and, most importantly, made the manipulations of infected fleas much safer. This device was later modified for other blood-suckers and was often used in the field and laboratory studies. Dr. Alekseev and his colleagues also designed other devices, such as an instrument for applying small doses of insecticide directly onto small insects and a tiny magnetic mixer used in the homogenization of a microbe suspension. These devices considerably increased Andrey and his colleagues' research productivity.

Dr. Alekseev was the author and co-author of 10 patents. Several of them were related to the control and prevention of malaria (Meliksetian *et al*. 1986; Alekseev and Galushkina 1985, 1987; Yakubovich *et al*. 1988). He considered malaria prevention an ecological problem: his publications on this topic include educational materials for the United Nations Food and Agriculture Organization (FAO), the UN Environment Programme (UNEP) and the World Health Organization (WHO) (Alekseev 1984a, 1984b, 1990), as well as a review titled "The malaria parasite: mutual relationships with the invertebrate host" (Alekseev [=Alexeyev] 1986).

A device for compulsory feeding of blood-sucking sand flies, simuliid flies, mosquitoes, tabanid flies and ticks designed by Dr. Alekseev was particularly helpful in experimental studies. Using this device, one could feed the insects liquids, thereby infecting them with the desired doses of various infectious agents (Alekseev *et al*. 1966). This was an effective yet safe technique for studying interactions between pathogens and vectors. The first investigations with the use of this device were carried out together with Prof. V.M. Safyanova. The research focused on sand flies—vectors of zoonotic cutaneous leishmaniasis (Alekseev and Safjanova 1966, 1968). The infection of these flies with different doses of promastigotes (in the form of strains isolated from the afflicted humans and reptiles) had an effect on their survival. This work was unique because the authors developed a strain from a single cell, isolated with the help of the Vonbrün micromanipulator (Safjanova and Alekseev 1977) and conducted serological investigations of *Leishmania* clones, which were isolated from the experimentally and naturally infected sand flies. At that time, this method was considered one of the most promising tools in the identification of *Leishmania* (Adler and Theodor 1957; Hertig and McConnet 1963).

The device for compulsory feeding of insects (the so-called "Alekseev's device") was used in a series of elaborate experiments aimed at elucidating the relationship between vectors and agents of various parasitic diseases. This device became popular with researchers: it was used to study the relationships between listeriosis and fleas in Kirghizia (Alekseev *et al*. 1971), the transmission of the Issyk-Kul virus by *Aedes* mosquitoes in Tadzhikistan (Bulychev *et al*. 1979) and in many other studies.

In 1969, Andrey defended his Doctor of Medical Sciences thesis titled "The relationship between blood-sucking arthropods and the agents of human diseases: a qualitative assessment of the 'disease agent–vector' relationship using the method of individually-measured infection in arthropods". In 1970, he became Professor of Entomology.

Dr. Alekseev guided many young researchers: he supervised 16 Candidate of Medical Sciences dissertations and one Doctor of Medical Sciences dissertation. In addition to his work at the All-Soviet Scientific Research Institute of Disinfection and Sterilization (1977–1982), Andrey taught a course in medical entomology at the Central Institute for Doctors' Education.

In 1971, Dr. Alekseev became the head of the Department of Medical Entomology at the Martsinovsky Institute for Medical Parasitology and Tropical Medicine (1971–1986). He also worked there as a consulting research professor during 1992–1993.

During 1984–1986, Andrey summed up his research at the Martsinovsky Institute and the WHO by publishing a monograph titled *Organism of Arthropods as an Environment for Pathogens* (Alekseev and Kondrashova 1985), where he laid out the basis of his "communication theory" (Alekseev 1985). He considered the organism of a disease vector a biotope and suggested five criteria for evaluating a blood-sucker as a vector/reservoir of a pathogen.

Starting in 1986, Andrey Nikolayevich continued his research on parasite–vector relationships at the Laboratory for the Ecology of Arboviruses at the Institute of Poliomyelitis and Viral Encephalitis (the Academy of Medical Sciences of the USSR [Moscow]). Excellent facilities of this laboratory, headed at the time by Prof. S.P. Chunikhin, made it possible to carry out experiments on the effects of viruses on the behaviour of vectors. Andrey's experiments also concerned biocenotic relationships of blood-sucking arthropods with various pathogens during co-infections. The results of these studies were used to develop his theory about the relationship between arthropods' life stages (namely, between the feeding patterns characteristic of different life stages) and the arthropods' effectiveness as pathogen vectors. This theory aimed to explain the mechanisms of how blood-sucking arthropods transmit different groups of vector-borne diseases (Alekseev 1985, 1991, 1992).

After coming back to St. Petersburg, Dr. Alekseev continued his research on the spread of tick-born encephalitis. The most important result of his experimental studies, carried out in the laboratory of Prof. S.P. Chunikhin in Moscow, was the discovery of the emergent properties of vector-borne parasitic systems (Alekseev *et al*. 1992a; Alekseev *et al.* 1992b; Alekseev and Chunikhin 1992c; Alekseev *et al.* 1993). The knowledge of these properties has allowed Dr. Alekseev to estimate the level of a "tick–vector" system's stability in time and space.

For the last 22 years of his life (1992–2014), Andrey N. Alekseev worked at the Zoological Institute of the Russian Academy of Sciences as the head of a research group studying parasitic systems: namely, the research was focused on blood-sucking ixodid ticks in anthropogenic environments (Alekseev *et al.* 2010). These were scientifically fruitful years. Prof. Alekseev developed several theoretical concepts: the emergent properties of parasitic systems (1993), the law of multiple transmission pathways of vector-borne infections (1994), the concept of antagonistic and synergetic relationships of pathogens in multi-component parasitic systems (1998), the concept of specificity of co-infections in ixodid ticks (1999), the patterns of change in the paradigms of estimating the relationships of parasites and disease vectors (Alekseev 2012), patterns related to the genetic composition of arthropod hosts and their ability to transmit vector-borne infections (Semenov *et al.* 2001; Alekseev *et al.* 2007; Jääskeläinen *et al*. 2009, 2010).

These studies were based on the tremendous experience accumulated by Prof. Alekseev during his research of various blood-sucking arthropods. Andrey's latest research involved the use of modern techniques, such as immunofluorescent microscopy, bioenzymatic analysis, molecular-genetic approaches to the identification of disease agents, comparative inversion spectrophotometry, etc. (Alekseev, Dubinina and Jushkova 2010). Using these methods, Prof. Alekseev proved the coexistence and compatibility of seven tick-borne pathogens in unfed adult *Ixodes persulcatus* P. Sch. from north-western Russia (Alekseev *et al.* 2004). He also identified *Anaplasma phagocytophilum* in tick populations of Estonia, the European part of Russia and Belarus (Katargina *et al.* 2012). Prof. Alekseev suggested that heavy metals influenced the metabolism of ixodid ticks and that this phenomenon was epidemiologically important (Morozov *et al.* 2015). He also hypothesised that the proportion of anomalous ticks in a population can be an indicator of anthropogenic pollution and also serve as an indicator of a population's potential to be a disease vector.

One of the last (and unfinished) projects of Prof. Alekseev was the study of tick-borne pathogens in migratory birds during the spring and autumn migrations (Curonian Spit, Kaliningrad Region). It was carried out in cooperation with researchers from the Fringilla Biological Station of the Zoological Institute (Russian Academy of Sciences). The aim of this project was to find out how the changes in the avian migratory routes influenced the distribution of pathogens, including epizootic ones (Movila *et al.* 2013). It was shown that the proportion of dominant pathogens changed with time. The number of ticks infected with borrelia generally decreased, while an opposite trend was noted for rickettsia. These data indicated the possibility of a new vector-species invasion causing the development of new infection foci and the alteration of epidemiological dominants (Movila *et al.* 2011; Movila *et al.* 2014).

The last publication of Prof. Alekseev was devoted to his original research object—fleas. It was a popular scientific book entitled *A Poem to the Flea* (Alekseev and Dubinina 2017).

Prof. Alekseev and his group were involved in many collaborative research projects with European scientists, including the ones aimed at predicting the impact of global warming on the distribution patterns of tick-borne infections. Andrey supervised a joint Russian-Danish program "The investigation of relationships of several disease agents in two species of ticks in different regions of Russia, and the effects of the pathogens on hosts", as well as a collaborative project of Swedish, Russian, Belorussian and Estonian researchers "The prediction of infection risk by mixed tick-borne infections due to an increase of anthropogenic effects". He was also the supervisor of the Fundamental Research Program at the Department of General Biology (Russian Academy of Sciences) entitled "Monitoring the anthropogenic impact on the functioning of a parasite system 'tick-disease agent'".

The achievements of Prof. Alekseev were recognised by the Prominent Russian Scientist Diploma (1994–2000), the Forty Years of Military Forces Medal, For Excellent Service Medal of the 3rd degree, as well as the Excellence in Medical Service Badge. He was the first President of the Society for Parasitology of the Russian Academy of Sciences and remained its Honorary President. He was an expert member of two committees: "Biology of vectors and actions against them" (WHO, 1976–2006) and "Environmental management for vector control" (WHO/FAO/UNEP). Andrey participated in numerous events and missions of the aforementioned organizations as an expert or as an invited speaker: in Sweden (1977–1984), Kenya (1979, 1988), the USA (1979), the Republic of Cuba and Vietnam (1981), Austria (1989), the Czech Republic and France (1990). He was awarded the "International Gold Medal, Russia" (2008) in recognition of his "prominent achievements and contribution in education, biological sciences, parasitology and medicine". After Prof. Alekseev's death, a new species of cockroaches from South India, *Rhabdoblattella alexeevi* sp.n. Anisyutkin, 2016, was named after him. The authors wrote: "*This species is named in honour of the late Prof. Dr. Andrey N. Alekseev (1930–2015), a famous parasitologist and a true Russian intellectual, under whose supervision the authors of the present paper had a pleasure to work*" (Anisyutkin and Yushkova 2016: 49).

In obituaries commemorating the death of Andrey Nikolaevich, many words of sorrow were said about this irreparable loss for the Russian science—the loss of a great scientist, a talented enthusiast, a great colleague and a beautiful person. Below are the words of Sarah Randolph (Prof. of Parasite Ecology (retired), Department of Zoology, the University of Oxford, UK), whom Andrey Nikolaevich has met numerous times while presenting at the Biennial Meetings of the European Tick Study Group: "*I am so sorry to hear of your loss. Andrey was a very special person and it was a great privilege to count myself as one of his friends. I have always thought very warmly of both you and him, and remembered with great pleasure the evening I spent in your flat in St. Petersburg. Amongst the tick researchers around the world, we always recognised that Andrey asked the questions that nobody else even thought of, and often came close to answering them. That is the mark of a very significant scientist and we all benefited from his insight…*" (from the correspondence between Sarah Randolph and Helen Dubinina, the widow of Andrey Alekseev).

Andrey Nikolayevich Alekseev passed away on the 9th of September 2015, at the age of 85. He is buried at the Bogoslovskoe Cemetery in St. Petersburg.

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