GLOBAL WARMING: PATHWAYS TO BACTERIA SPECIATION

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Abstract.

Background. The 2023 conference presented the influence of climate on population movements to the mountains and speciation. Such changes in rodent habitat affect population density and close contacts of microbial carriers, thereby increasing speciation. The aim of our presentation in 2024 is to analyze the epigenetic mechanisms of cells under changing environmental conditions and compare speciation of bacteria in mountain and low wetland landscapes of Bulgaria. Results. Global warming affects epigenetic mechanisms by changing metabolism and communication in microbial populations. Communication processes, increased metabolism and environmental changes increase the possibility of speciation and the formation of epizootics. In Bulgaria, speciation processes are preserved in the Srebarna lowland and are enhanced in the Rila and Pirin mountain landscape. Conclusion. The stability of natural conditions in the lowland preserves the community of soil organisms, and global environmental changes can lead to speciation and an outbreak of tularemia. In the mountains, the variability and diversity of the natural background are the cause of the diversity of tularemia foci.

Key words: soil microbial communities, cell communication, landscapes, mountain background, adaptation and speciation, tularemia

Introduction

Global warming moves populations of animals, birds, insects to cooler places. Birds change their flight routes, large animals head north; small rodents climb the mountains (Carlson et al. 2022). Insects and bacteria move with them. These movements condense groups of animals (Danielyan et al. 2023), create connections in groups and between groups. Changes in habitat lead to the death of some individuals that were unable to adapt and a reduction in the population (Danielyan et al. 2023, Manucharyan 2023).

The radiation background in the mountains comes from the radiation of rocks, the spectrum and activity of which depends on the location in the mountains. The radiation background of rocks is supplemented by cosmic γ- radiation and may include the anthropogenic component of Cs-137 from nuclear power plants. This creates a constant variability in the radiation effect on microbes moving with their rodent hosts. Unicellular organisms are most susceptible to genetic variability and speciation (Platonov et al. 2015), but the proximity of rocks to the earth's surface and mines provide a sufficient dose of exposure for the emergence of new species and subspecies of rodents (Manucharyan 2023a), plants (Sadoyan 2013), and an increased risk of carcinogenesis in humans (Belyeva et al. 2019).

Adaptation is associated with genetic variability (Korogodina et al. 2013, Korogodina et al. 2016), and speciation requires the reproduction of individuals (Koonin 2023). Reproduction is possible when animals move in a diverse mountain landscape. Speciation in the valleys and lowlands requires changes in habitat conditions. Global warming in the valley reduces the number of individuals in the population as a result of death or movement of part of the population to cooler places in the mountains (Popov et al. 2022, Danielyan and Sahakyan 2019).

An important role is played by epigenetic mechanisms, which is associated with low doses of radiation (Mothersill and Seymour 2005, Mothersill and Seymour 2022, Mothersill et al. 2019). These are cellular communication signals, the so-called bystander effect, changes in gene expression, regulation of protein folding, and others. Epigenetic effects are associated with quantum effects, including the corpuscular-wave dualism of biophotons (Matarèse et al. 2023).

In this article, we analyze an influence of global warming on bacterial speciation and the occurrence of tularemia epizootics in Bulgaria. We compare adaptation and speciation in valley and mountain landscapes of Bulgaria, Armenia and Russia. It is shown why tularemia foci occur most frequently in the mountains and how they differ from foci in the lowland. The main laws of bacterial speciation are discussed.

Results

Two types of adaptation. Adaptation depends on environment conditions, which determine variability or uniform stability of cells or organisms (Korogodina et al. 2013). An example of this is the adaptive response of two species of mice in the Southern Urals on the banks of the Techa River. After the Kyshtym radiation accident (1956), a mosaic East Ural radiation trace (1957) was formed (Pozolotina et al 2008) (Fig. 1) and rodents acquired new adaptive properties (Korogodina et al. 2016). Common voles live and run in a mosaic radioactive forest, so the offspring of these rodents has become numerous and diverse, since all embryos survive. In contrast, mole voles spend their lives in burrows on the banks of the river; soil radiation is stable, the offspring of mice is small in number and uniform.

1. East Ural Radiation Trace. Russia

2. Srebarna Nature Reserve. Bulgaria

3. Rila mountains. Bulgaria

4. Mount Aragats, Armenia

In Bulgaria, the bacterium *Francisella tularensis* was brought with muskrat into the humid and lowland zone of the Srebarna Nature Reserve (1962) (Fig. 2) and persists in the soil (Myrtennäs et al. 2016). The new epizootic is appeared due to agricultural reform (1997-2005), which changed environment conditions**.** In the Bulgarian mountains (Fig.3), there is a variety of γ-spectra of the rocks (Table 1) including high content of the Uranium and Radium (Yordanova et al. 2015), and the absorbed dose for mice that are carriers of bacteria is about 1-2 μGy/day in the Rila and Pirin mountains. The tularemia outbreaks are occurred in mountains in 1997 -2005 (Myrtennäs et al. 2016). The scientists suggest that emerging of a new genetic type of tularemia induced outbreaks of tularemia in these regions (Kantardjiev et al 2006). In all cases, the subclades of tularemia bacteria preserve in soil. Thus, diversity is associated with environmental variability, but uniformity is maintained under chronic conditions.

Table 1. Averaged γ-activity, Bq/kg

Bulgaria					Armenia				
	^{238}U	^{226}Ra	^{232}Th	^{40}K		^{226}Ra	^{232}Th	^{40}K	^{137}Cs
North Bulgaria*	33±8	32±10	34±9	456±106	Aragats, 3500 m a.s.l.	31.0	30.0	371.0	62.0*
Sofia field**	26±11	31±10	40±11	447±97	Ararat valley 1000 m a.s.l.	62.0	45.0	654.0	12.0
South Bulgaria	62±24	46±22	58±16	686±215	Ararat valley, 3 km from NPP	62.0	45.0	654.0	19.0**

*Plane area; **semi-mountainous (Yordanova et al 2015, Lazarova et al. 2017)

*Deposition from Chernobyl; **Deposition from Armenian NPP emission (Korogodina et al. 2024)

Low doses: Epigenetic mechanisms. Low impacts need adaptation that associated with epigenetic effects (Mothersill and Seymour 2005). The important feature of low dose impact is that cell membrane reacts to any energy changing in environment (Hamanaka and Chandel 2010). It influences oxidative metabolism (Cao 2018), which affects epigenetic mechanisms. Epigenetic mechanisms include adaptation of protein conformation, gene expression and bystander effect (Mothersill and Seymour 2005, Mothersill et al, 2019, Chankova et al. 2023). Bystander effect transmits a signal from an affected cell to other cells of community (Du et al. 2020). Bystander signal can be represented by microparticles, biophotons and acoustic wave (Mothersill and

Seymour 2022) and can be observed in different systems. Epigenetic modifications adapt cell populations to local and global climate gradients (McCaw et al 2020)

Armenian scientists have studied the impact of the Metsamor nuclear power plant on the community of soil bacteria. They found that small content of ^{137}Cs in the top 5-cm layer of soil (629 Bq/m^2), which can damage only individual bacterial cells, initiates the proliferation and increased resistance of the entire population of one bacterial strain, the extinction of the population of another strain (Khachatryan et al. 2017) and the mutation of plant branch cells (Aroutiounian 2006). In plants, signaling is transmitted from the root to the shoots (Wang et al. 2012), and in the air between the cells of the leaves of the crown (Gustova et al. 2015). The bystander effect in tissues, populations, and communities in soil, water, and air is carried out by biophotons. The coordinated change in community cells and the difference in response in different cell types and subspecies demonstrate the relationship between the external and intracellular environments and the features of cell adaptation mechanisms. Another example from the life of a community is that foci of tularemia bacteria in the soil persist for many decades, forming new species and subspecies. Viruses, like other microorganisms, exist in communities in the soil, in water, and in animal and plant populations (Jansson and Wu 2023). This is possible due to biophotonic communication between different cells, not just bacterial ones. We assume that energy bystander signaling can be transmitted in air, soil, water, and between cells of different organisms.

Biophotons is a part of epigenetic mechanisms. The cell can receive and emit the quantum signals due to particle-wave dualism of biophotons (Matarèse et al. 2023). The exact mechanism of biophoton production is unknown, but it has been established that they are associated with intracellular processes. For example, cell damage stimulates the work of the genome and other cellular mechanisms. Cell activity is accompanied by cell signals to neighbors (the "bystander effect"). Biophotons have been shown to affect the initiation of gene expression, metabolism, and the formation of the intracellular environment (Mothersill and Seymour 2022).

Two types of landscape: lowland and mountain. In lowland Nature Reserve Srebarna, local persistence of *F. tularensis* in the old focus of Srebarna from 1962 to 2005 year (43 years) based on close relationship of subclade 81(1962) and subclade L2(2005) (Myrtennäs et al. 2016, Kantardjiev 2006). The subclades of bacteria are maintained in soil due to close communication of microbes. The new focus of tularemia occurred in connection with agricultural reforms in 1997-2005.

The heterogeneous mountain landscape and its variable γ-background are the cause of genetic changes. Varies signaling and gene expression lead to genetic variability, which is realized in the mountain landscape through speciation. In the Armenian Mount Aragatz (Fig. 4), new species of tularemia (Danielyan and Sahakyan 2019), plants (Sadoyan 2013), and rodents (Manucharyan 2023), appear and are registered. In the Bulgarian Rila and Pyrin mountains new outbreaks (more than 10 outbreaks) have been investigated, which are geographically, ecologically and genetically separated from the old outbreak in Nature Reserve Srebarna. They appeared new (Myrtennäs et al. 2016).

Global warming. Global warming promotes the accumulation of rodents at highlands that increases contacts of rodents and bystander effect in bacteria community. Low γ-background activates the epigenetic mechanisms.

Epigenetic mechanisms induce mutations, which lead to death, new species and subspecies, and reproduction. In valley, the areas of foci of tularemia reduce (Manucharyan 2023), but new epizootics are originated in the highlands (Danielyan et al. 2023). These effects verify species generation in the mountain landscape.

Discussion

Main place for speciation. Many foci of tularemia originate in the mountains, but they are rare on the valley (Danielyan et al. 2023, Manucharyan et al. 2023, Myrtennäs et al. 2016). Mountain landscape is main place for genetic changes and speciation. The reason is that the γ- spectra of natural radiation of rocks are different and lead to genetic variability. Rock radiation is low but activates the epigenetic mechanisms (Korogodina et al 2024): bystander effect, gene expression, protein folding that proposes quantum biophotons. Mutations are fixed during cell reproduction in a diverse mountain landscape. Due to global warming, rodents are moving and grouping in mountains (Danielyan et al. 2023). Close contacts between animals increase communication, bystander effect and biophoton signaling.

Basis laws of speciation. We can suggest basic regularities underlying speciation under climate change. Changes in the environment are associated with death, variability, accumulation, and reproduction. The electromagnetic fields of γ-quanta from rocks, cosmic radiation and man-made sources change cell populations, continuously adapting them and forming new communities (Korogodina et al, 2024). The basic principle of evolution is multilevel learning, including the replication of genetic material and minimizing losses during learning (Koonin 2023). Variability changes the genetic material, and environmental conditions create Darwinian selection of the offspring. These processes we can observe in the bacterial communities

Conclusion

We can propose the main factors that stimulate speciation in the microbial community during global warming. It is grouping of the carriers of microbes in suitable environment conditions. Rodents accummulate in mountains. In mountains, it is low γ- background of rocks with its different energy spectra initiates intracellular epigenetic mechanisms, particularly bystander effect with biophoton signaling. Bacterial populations persist in the soil microbiome, where communication facilitates their sustainable adaptation.

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