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NONSPECIFIC PREVENTION OF PLAGUE IN FOCAL MOUNTAINOUS AREAS

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Summary. It was found that nonspecific prophylaxis carried out by the method of pest control in marmot burrows in areas of high-mountain natural plague foci in the Kyrgyz Republic is an effective means of reducing their epizootic activity. The results of the survey carried out in recent decades confirm the possibility of an epizootic plague occurring independently in populations of mouse-like rodents and in populations of marmots. These facts give us reason to believe that the Tien-Shan natural plague focus is not strictly monohostal as it was considered to be for many years. It was also documented the return of plague enzootic to previously treated areas by introduction of the pathogen from the adjacent focal area, where preventive work was not carried out, although the return of infection took longer than previously expected.

Key words: nonspecific prophylaxis, pest control, highland plague foci, epizootic activity, plague microbe, marmots, fleas, mouse-like rodents.

The plague foci in the territory of Kyrgyzstan is confined mainly to the cold mountain zone of Tien Shan and Pamiro-Alai and are characterized as monohostal where the main carriers of infection are marmots because of their dominant position among other rodents, as the main carriers of fleas (O. Silantievi, R. li ventricosa and C. Lebedevi). This is facilitated by the continuous mosaic of colonies of marmots across relatively large areas, characterized by a significant diversity of environmental conditions. The lack of optimal habitats can promote high mobility of marmots, which results in close interpopulation contact, which provides the possibility of circulation of the plague microbe. The cold, severe climate of the high plateau negatively influences migration activity and delays marmot flea activity.The peculiar microclimate in the deep burrows - high humidity and low temperature without significant seasonal fluctuations - largely determines the life span of fleas and their preservation of the causative agent of plague in their bodies. In some years, the causative agent of the infection is isolated from other warm-blooded animals (narrow-skull and silver voles, gray hamsters, forest mice, steppe polecat, ermine, fox, hare, shrews) and from some representatives of arthropods (ticks; *Ixodes crenulatus*, lice; *Neohaematopinus palaearctus*) but such cases are rare (Bibikov et al., 1961; Tyulembaev et al.,1982).

A great variety of natural conditions in the mountains and obstacles for the dispersal of marmots made it possible isolate the Tien Shan plague focus from other foci in Aksai, Verkhnenaryn and Saryjaz. Using landscape-epizootological zoning, autonomous foci, and the Alai natural focus divided by the areas of foci - mezofoci, differing by the nature of the distribution of the number of main carriers and vectors of the pathogen, the degree of activity of epizootics can be determined (Bibikov et al., 1973; Usenbaev et al., 1985).

The annual registration of epizootics, from 1941 to 1983 and up until the end of non-specific prevention activities in 1989, demonstrated how persistent the presence of the causative agent in the foci was. At the same time, the degree of intensity of epizootics

at the sites were different. Infected marmots averaged 0.5% of the population at each site, and in some years in some areas this figure reached 1% (Bibikov et al., 1973; Usenbaev et al., 1985).

The observed stable and intense epizooty of plague among marmots created the constant threat of human infection. In connection with the current epizootological situation, non-specific prevention has become an important part of a number of sanitary and preventive measures to influence the natural foci of the plague. Preventive measures were carried out by disrupting natural biocenoses focused on parts directly related to the circulation of the plague microbe. Anti-epizootic effect was achieved by reducing the number of main carriers, marmots, and vectors of the plague pathogen.

Non-specific prophylaxis by elimination of marmots was initiated in 1955. The effort focused on killing marmorts across large areas within the natural boundaries of their colonies. Conducted from 1955 to 1972 in the Aksai autonomous region, the focus of the extermination work was on an area of 700 thousand hectares. Two extermination events, in some areas more, did not provide long-term suppression of epizootic activity. Seven years after extermination efforts epizootic plague among marmots continued to occur. In the Saryjaz autonomous region focus on the cultural agent of plague was highlighted in –the three to four years following extermination efforts.

The low antiepizootic efficiency of marmot elimination lead specialists to shift focus to developing another method of preventing plague, aimed at control of the vectors, marmot fleas. During 1957-1970 various insecticides were used in a series of experiments conducted under the direction of S.V. Vishnyakov and V.K. Popov. Results of the experiments showed high Pulicidae mortality and anti-epizootic effectiveness of DDT dust in the field. During the study, the dosage of the drug was established, organizational forms, applied technology for burrow treatment, and production standards were developed. An important positive feature of this method was the ability to preserve marmots as valuable objects for fur trade. The insecticide was introduced into the burrows by shots from the AL-1 dinners, and settled in the courses of the upper tier of the burrow system.

Further transportation of the poison to the places with high concentrations of fleas (nesting chambers of burrows) was completed by animals, who transported dust that adhered to their fur at the opening of the burrow. Persistent targeted and antiepizootic effect was achieved by two consecutive applications of the treatment regularly repeated in the years following the initial treatment year. The highest effect of field disinfection was observed in high-altitude areas, where the number of fleas in marmot nests (in comparison with the pre-work period) decreased by more than 1000 times.

In the areas of the middle reaches on the Gulchinsky site of the Alai natural plague focus the number of fleas decreased by only 68 times.

Across large areas, the method of deep de-infestation of marmot burrows has been used since 1971. The area of the recovered territories using this method by 1989, was 1584,4 thousand has at the Tien Shan natural focus, and 216 thousand has at the Alay natural focus-.

Control over the treated territories was regularly carried out by anti-epidemic teams and zoological groups in each autonomous focus region of Tien Shan, as well as in the Alai natural foci. Long-term control stationary points were organized, taking into account the

typical landscape and biocenotic features characteristic of the treated territories. Over 20 years, from 1974 to 2003, more than 39 800 marmots, 31 252 fleas, 25 814 other animals, 55 472 mites, and 16 393 lice from the healthy territories of the Tianshan natural focus of plague were tested.

Currently, we can say that the experience of the prevention method for thorough insect extermination in the burrows of marmots in the conditions of Tien Shan and Alai natural foci showed positive results .

In the territory of the Aksai autonomous region focal area from 1941 to 1975 before carrying out insect control actions 667 cultures of the causative agent of plague were detected.

After insect control activities, control surveys for the period from 1978 to 2016 detected only 5 cultures of the causative agent of plague (of which two cultures were from gray hamsters and three from their fleas, *A. primaries*). Among the marmots and their ectoparasites specific cultures of the plague pathogen were not detected.

In the Verkhnenarynsky autonomous focal area, before the field pest control programme was implemented, during a 30-year period, 838 crops were isolated. After a deep disinfestation of the burrows of marmots, in the following 11 years at the Bolgart focal site three plague cultures were identified (one from silver vole and two from grey hamsters).

In the 23rd year after working on the Ishtyk-Akshirak plague focal area, nine cultures of the plague pathogen were detected: six from marmots, two from narrow-skulled voles and one culture from a silver vole. At the time of culture collection, the number of fleas of the marmots was in this region at only 20-70% of the original population (Ibragimov & Gavrilova, 2001). An epizootological inspection at the same site in 2015 and 2016 detected two occurrences of the causative agent of plague (one from a marmot and one from a flea) .

In the Saryjaz autonomous focal site in the territory of Kyrgyzstan from 1944 to 1976, 462 cultures of the plague were detected. In 2012 (after 25 years spent using insect eradication in marmot burrows), one of the focal areas detected five occurrences of plague infection (four from marmots and one from grey hamster). In 2013, in the same focal area one case of human infection of with bubonic plague as a result of contact with a sick marmot was registered. In 2014 in the same areathree plague cultures (two from the corpses of marmots and one from a killed marmot with fleas). By this time, the number fleas on main host, marmots, was everywhere restored to the original level of population.

In the Alai focal areas, including the 1975 Gulczinski site, for the period from 1948 to 1981 (prior to the insect eradication programme intiation) 145 cultures of the plague microbe were detected. After initiation of the treatments here in 1982-1983, cultures of plague in these areas were not again identified, although the number of fleas of the marmots in the middle reaches of the Gulchinsky focal area have reached pre-treatment capacity.

Analysis of the results of long-term (over 40 years) epizootological survey of the territory, on which non-specific prophylaxis was carried out by the method of deep disinfestation of marmot burrows, showed that over this period there was no spread of plague from neighbouring areas where insect eradications were not carried out (Ibragimov, 2015).

After the recovery of the natural state of the focal areas were this method was applied, there was a noticeable increase in the frequency of cases of plague occurrence in mouse-like rodents and their ectoparasites without participation in the epizootic process by marmots and their specific ectoparasites. This fact indicates the possibility of occurrence of epizootics among species besides marmots, including species such as mouse-like rodents. Results also suggest that in the Tien-Shan focal area plague is not strictly monohostal, as it was considered to be for many decades (Pole et al., 1996; Pole, 1999; Ibragimov, 2017). Our main conclusion is that the use of non-specific prevention methods for deep disinsection of burrows of marmots in the Alpine conditions of focal areas of the Tian-Shan and Alai is an effective measure to reduce epizootic activity of these mountain foci of plague.

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