JPRS: 15,647

10 October 1962

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COLLECTION OF SCIENTIFIC WORKS

OF THE ELISTA PLAGUE-CONTROL STATION

by B. O. Dzhimbinov, Ts. K. Korsunkiyev et al.

- USSR -

U. S. DEPARTMENT OF COMMERCE
OFFICE OF TECHNICAL SERVICES
JOINT PUBLICATIONS RESEARCH SERVICE
Building T-30
Ohio Dr. and Independence Ave., S.W.
Washington 25, D. C.

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[Following is a complete translation of Sbornik Nauchnykh Rabot Elistinskoy Protivochumnoy Stantsii (English version above), No 1, Shakhty, 1959, pp 1-252.]

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Foreword

The present collection is dedicated to the 350th anniversary of the voluntary entrance of the Kalmyk people into the Russian State.

Historically, the territory of the Kalmyk steppes, located in the Northwest Caspian region was enzootic for plague. Beginning with the 1930's, public health organs set about taking radical measures for improving the plague situation in the natural focus in the Caspian region. Workers of the Elista Plague-Control Station and its departments took an active part in the work.

Generalizing studies and some investigations which are original in their formulations, very important for public health practice, have been included in the present collection. By and large, either work the factual material for which was collected on the territory of Kalmykiya or work done at the plague-control institutions of the Autonomous Republic has been included in this collection. It should be noted that workers of the Elista Plague-Control Station have also been participants and the authors of many works.

The present collection is certainly not without shortcomings; the editorial staff will appreciate hearing comments about them.

The Editorial Staff

350 Years of Indestructible Friendship

B. O. Dzhimbinov

Three hundred and fifty years ago a decisive historic turning point occurred in the life of the Kalmyk people--voluntarily it entered the Russian nation. This noteworthy date is being observed on 22-23 August of this year as a great celebration of the Kalmyk people and of the entire working class of the Autonomous Republic, as a celebration of the indestructible eternal friendship between the Kalmyk people and the great Russian people and the other peoples of the Soviet Union.

When they first came from China the Kalmyks called the tremendous spaces between the Don, Volga and Caspian the "steppe of good hope". And they were not mistaken! Now, on this tremendous territory on which the Kalmytskaya Autonomous Soviet Socialist Republic has developed, a new life is in full swing, full of patriotic inspiration and the desire to gladden the great Fatherland with new progress in the full-scale building of communism.

"I love the Kalmyk steppe, full of poetry and beauty", wrote our contemporary Vitaliy Zakrutkin. The Kalmyks, whose forebears more than three centuries ago forever linked their fates with the fates of the great Russian people, love their steppe with a particular filial love.

The prospects opened by the Twenty-First Congress of the CPSU and which have found a striking expression in the Seven-Year Plan of full-scale building of communism in the Soviet Union evoked unprecedented political enthusiasm and gave rise to an increased industrial output among all the workers of the Republic.

A truly great goal generates great energy. Each new day which we live after the historic Twenty-First Congress of the Party brings us newer and newer facts on how the ideas of the Congress are inspiring and elevating Soviet people to self-sacrificing labor, to glorious deeds.

Look into any sovkhoz or kolkhoz at the present time, any enterprise or structure of this Republic and you will see the passionate labor enthusiasm of people who with their deeds are responding to the resolution of the Congress, are making their modest contributions to the successful accomplishment of the tasks of the Seven-Year Plan.

Under circumstances of general enthusiasm and unforeseen growth of the activity of the working class of the Kalmytskaya ASSR preparations are being made to observe a glorious and noteworthy date in the history of the Kalmyks -- the 350th anniversary of the voluntary entrance into the Russian nation.

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The Kalmyks are a people of Mongolian origin who have an old original culture. Under the name of "Oyrats" their forebears led a migratory form of life in the northern and northwestern portions of China, which were at that time called Dzhungariya (Dzhungariya or Zyungariya

comes from the Mongolian word "zyun-gar," which means when translated, "East Side").

In the middle of the 14th century, when the Mongolian dynasty, which also ruled China, was founded, dissension and discord began within the previously powerful Mongolian Empires, which led to the formation of a multitude of independent domains.

At this time, three strong Mongolian tribes — Tsoros, Khoshut and Torgut — formed an alliance, known by the name of the Oyrat Alliance, for the purpose of maintaining their independence. (Oyrat is a Mongolian word which when translated means "allied," "neighbor," "ally"). Then, the Tsoros tribe divided into two: zyun-gar and derbet, and the tribal alliance was given a new name, "Derben-Oyrat" (Derben is the Mongolian for four. "Derben-Oyrat" means quadruple alliance, that is, an an alliance of four tribes).

In 1437 the chief of the Oyrat Alliance, Togon', succeeded in bringing another Mongolian tribe into the Oyrat group, the Elyuts. However, the Elyuts were so numerous that "after they joined the Oyrats all the Kalmyks began to be called 'Chshungarian Elyuts'" (Iakinf, Historical Outline of the Oyrats or Kalmyks From the 15th Century to the Present Time. St. Petersburg, 1834).

For many centuries the freedom-loving Oyrats persistently fought for their independent national existence, for freedom. In the 1440's the Oyrats, led by their captain, Khan Esen', crushed the attacking forces of their age-old oppressors and after ridding themselves of the heavy foreign yoke, they formed their own independent migratory government.

During this period of development of the power of the Oyrats the great captain Esen', the son and successor of the chief of the Oyrat Alliance, Togon', came to the fore. Professor A. M. Pozdneyev writes: "Being under the control of the Chingizkhanids, the Oyrats were nothing until, in the middle of the 15th century, the enterprising and active Esen' appeared in their midst. He combined the Oyrat generations into a single alliance, and under his leadership the Oyrats extended their conquests to the Great Wall of China." (See Zhurnal Ministerstva Prosveshcheniya (Journal of the Ministry of Education), 1886, Part 224, Nos. 3-4).

The next one-and-a-half centuries — from the middle of the 15th to the end of the 16th century — were a time of development of the Oyrats. During this period the movement of the tribes began in different directions in search of new places for settlement and grazing of cattle.

One part of the Oyrats, namely, the Khoshuts, moved towards the South, and gradually reached Tyan'-Shan', and then they swept through these mountains, conquered all of Kukunor and extended their nomadic camps to the Highlands of Tibet. Another part moved to the East, crossed the Etsin, and spread out over all of Alashan'. Finally, the third part, the Torguts and Derbets, went to the Northwest, to the tremendous uninhabited spaces of Siberia and the Transurals.

"At that time the Oyrats," writes Professor A. M. Pozdneyev,

ruled over the entire area from the shores of the Caspian in the West to Alashan' in the East, and from the Urals in the North to the boundary of India in the South. This power made it possible for them subsequently to conquer also Eastern Turkestan, and at the end of the 17th century to extend their conquests to all of Mongolia...therefore, the time of Khara-Khula and Batur Khun-Taydzhi is mainly the period in which the Oyrats were in power. This power was acquired exclusively by the realization of their unity and the most complete solidarity between the tribes included in the alliance. Despite the tremendous areas which now separated the Oyrats they were constantly in the closest familial and political relations, and none of them thought of separating from his alliance, any more than Kho-Urlyuk thought of doing so when he migrated to the boundary of Russia" (Zhurnal Ministerstva Prosveshcheniya, 1886, Part 224, Nos. 3-4).

The historic facts, however, indicate that the Kalmyk tribes and clans, in spite of the plans of the leaders of the Oyrat Alliance, decided to link their fate forever with the Russian Nation and with the great Russian people. Their becoming a part of Russia was entirely voluntary.

At the end of the 16th and the beginning of the 17th centuries large groups of Oyrats separated from the main mass of the people (hence, their name "Kalmyk" which means "one who has separated") and went to the steppe areas of Siberia and the Transurals, to the border of Russia. The first groups of Kalmyks appeared on the banks of the Irtysh and other Siberian rivers at the end of the 15th century. Moving gradually towards the West, in the 1630's they approached the Volga.

This long migration from one continent to another -- from Asia to Europe -- was completed in 1608-1609 by an outstanding event in the life of the Kalmyk people, its voluntary entrance into Russia. In the year 1608 Tsar Vasiliy Shuyskiy received the Kalmyk ambassadors, who asked that the Kalmyks become Russian subjects.

The entrance of the Kalmyk people into great and powerful Rus' was the only correct decision under the conditions which had been created historically and was of tremendous progressive significance.

By voluntarily entering the Russian Nation, the Kalmyks, by the same token, acquired a real, true friend, their own reliable defender and protector in the Russian people. From that time on the safety of the Kalmyk people was assured; the danger of enslavement disappeared; favorable opportunities were created for the economic and cultural communication with the great Russian people and with the other peoples of Russia; a road was opened toward a new, better life. The fate of the Kalmyk people was fundamentally changed. The Kalmyk and Russian peoples united so as together to seek the road to happiness, to true brotherhood and equality.

"Russia is actually playing a progressive part with respect to the East...it is playing a civilizing part for the Black and Caspian Seas and for Central Asia...", Engels wrote to Marx in 1851. (K. Marx and F. Engels. Works, Vol. XXI, Page 211).

Emphasizing the beneficial progressive significance of this out-

standing historical event -- the voluntary entrance of the Kalmyks into the Russian Nation -- we should not forget the colonizing reactionary policy, against the people's interests, which was pursued by the tsarist government with respect to minorities, including the Kalmyks. This was a policy of merciless oppression of "foreigners", in which tsarism bitterly put down any attempts at expression of national originality. It was not for nothing that shortly after they became part of the Russian Nation the Kalmyk people created the following apt saying: "The marsh hawk tore itself loose from the dragon's maw but fell into the sharp claws of the two-headed eagle."

After coming under the sharp claws of the colonizers, a considerable part of the Kalmyks in 1771 under the leadership of Khan Ubasha even decided to leave Russia and return to distant Dzhungariya. In the periodical literature much has been written about the return of the Kalmyks to China. The great Russian poet A. S. Pushkin also wrote about this event: "Between the Volga and the Yaik, over the vast steppes of Astrakhan' and Saratov the peaceful Kalmyks, who had left China under the patronage of the white Tsar, migrated. Since that time they had served Russia truly, safeguarding its southern boundaries. Russian inspectors, taking advantage of their simpleness and their removal from the center of government, began to oppress them. The complaints of this good and peaceful people did not reach the heads of the government; becoming impatient they decided to quit Russia and secretly bargained with the Chinese government. It was easy for them, without arousing suspicion, to migrate to the bank of the Yaik River. Suddenly, 30,000 covered carts, they crossed to the other side and extended over the Kirghizian steppe to the border of their previous homeland" (A. S. Pushkin. Collection of Works in a Single Volume. Moscow, 1949, Page 873).

The tsarist government, despite its colonizing character, showed a progressively greater interest in maintaining good-neighbor relations with the Kalmyks, which was brought about by political necessity (safeguarding of borders in the South of the country against restless border tribes). The tsarist government definitely counted on the Kalmyks as a quite considerable power capable of carrying out the tasks entrusted to it. It had a high regard for the military qualities of the Kalmyks. For the Kalmyks had long been glorified as excellent horsemen, as strong, brave warriors who had unusual physical endurance. "In their horsemanship the Kalmyks were better than all other Asiatic peoples and were fierce and dangerous enemies" (N. G. Prozritelev. The Military Past of Our Kalmyks (For the Hundred Years Between 1812 and 1912). Stavropol', 1912, Page 32). This is why "...from the very beginning of their existence in Russia the Kalmyks were actually a border army. The Russian government, taking into consideration all the advantages of this location of the Kalmyks, very cleverly used their military services..." (N. G. Prozritelev. The Military Past of Our Kalmyks (For the Hundred Years Between 1812 and 1912). Stavropol', 1912, Page 22).

The patronage of this great power not only did away with civil wars and attacks from without among the Kalmyk people but also predeter-

mined their entire subsequent fate. This is how the Kalmyks began to come up to the high level of administrative and spiritual culture of the great Russian people.

The friendship between the Kalmyk and the Russian peoples was hardened in the fight against a common foe of tsarism, in the flame of the people's uprisings led by Stepan Razin and Yemel'yan Pugachev. It was cemented in battles and campaigns undertaken together for the defense of the Russian land against foreign invaders. Together with Russian soldiers the Kalmyks defended the inviolability of the boundaries of their new country, Russia, under the leadership of Peter The First, Suvorov and Kutuzov.

Up to the present day there is a saying common among the Kalmyks: "They met once and became acquaintances; they met twice and became friends". Friends are made only when they open their hearts to each other, live in frankness, with attitudes of sincerity toward each other. Many persons who have had opportunities to come into contact with them have written about the sincerity and goodness of the Kalmyks. The attractive and beneficent features of the Russian character are well known. However, while the friendship of these peoples was cemented by blood shed together in defense of their common Fatherland, this true, indestructible friendship was in time converted into a brotherhood of the two peoples.

The Kalmyk cavalry participated with Russian soldiers in many campaigns for the defense of the Russian land. History -- a great chronicle -- has preserved the very important documents about the participation of 30,000 Kalmyk horsemen under the leadership of Peter The First in the defeat of the Swedish King Charles XII during the battle of Poltava (1709). During the Seven Years' War between Russia and Prussia three Kalmyk cavalry regiments were among the first to enter Berlin. This feat of the Kalmyk cavalry has been [illegible] in songs:

> [Here follows a poem about how the Kalmyk soldier served his Fatherland under the banner of his "older brother" (Russia); the poem tells further of how the Kalmyks under their brave and glorious leader Suvorov, the terror of enemy hordes, attacked at full speed].

Three cavalry regiments covered themselves with glory in the war of 1812 of the Russian people against the Napoleonic hordes. At that time the troops of the First Kalmyk Regiment distinguished themselves particularly. The commander of this regiment was awarded a gold saber with the inscription -- "For bravery, for zealous service and distinction in battles against French troops during the siege of the fortress of Modlin in 1813".

Together with the victorious Russian Army Kalmyk troops entered Paris in 1814. Particularly distinguished in the capture of Paris the Kalmyk Borokhinov was awarded two silver medals.

For brave service to Russia the Kalmyks received "the highest favor" also from Emperor Paul The First. He granted the Kalmyk People

all those territories from Tsaritsyn along the Rivers Volga, Sarpa, Sal, Manych, and Kuma and extending along the sea and other places in which their forebears had their nomadic camps, with the exception of those which have already been granted by a specific case" (N. G. Prozritelev. The Military Past of Our Kalmyks (For the Hundred Years Between 1812 and 1912). Stavropol', 1912, Page 37).

The Kalmyk people, however, that is the masses rather than the soldiers who were given awards, led a painful existence. They were under the dual yoke of tsarist colonizers and "their feudal aristocracy — Noyons and Zaysangs." Tsarism based itself on these latter as well as on their true services in its colonizing policy. Lawlessness and slavery, ignorance and lack of culture — this is what was given to the industrious Kalmyk people under tsarism. "The entire past of your people is a continuous chain of suffering"; this is how the great leader of the working class V. I. Lenin characterized the bitter past of the Kalmyk people in his famous address to "Kalmyk brothers". (The newspaper Izvestiya /News/, dated 24 July 1919).

Exploited by Russian landowners, by local feudal lords (Noyons and Zaysangs) and by the clergy, the Kalmyk working people welcomed the October Socialist Revolution enthusiastically, and along with other peoples of the country stood up for the defense of its great conquests. In the terrible days of 1919 the great Lenin appealed to the Kalmyk people. The words of the ingenious revolutionary leader, V. I. Lenin, inspired the Kalmyk workers at large to glorious deeds in the fight for the regime of the Soviets.

The October Socialist Revolution, the CP, and the brotherly assistance of the Russian people gave new life to the Kalmyk people, creating the necessary conditions for complete development of its economy and its distinctive national culture.

The Kalmyk people began to build a new life confidently, joyously, considering themselves full-fledged masters of their own fate, and happy creators of a socialistic way of life.

During the years of the Soviet regime there has been a radical change in Kalmykiya. During a short period of time it has made a historic jump from a backward patriarchal-feudal order to a developing socialist republic.

The Kalmytskaya Autonomous Republic has cast its lot in with the friendship and great family of the Peoples of the Soviet Union, where there is not and cannot be any place for national disunity or enmity. This Republic has become richer and better every year. However, the hitlerite horde invaded the Soviet Union and began to destroy and devastate everything which had been created during the years of the Soviet Regime. Again, the Kalmyk people along with all sons of this multinational country rose to the defense of their beloved Socialist Fatherland against the Fascist invaders. The Kalmyks showed themselves to be staunch patriots, true defenders of the Fatherland. They did quite a few heroic deeds. The words of the oaths taken by bogatyrs /heroes of folklore/ from the heroic popular epic "Dzhangar" became an exhortation to combat for the Kalmyks during the days of the Second World War:

"We shall commit our lives to the points of our spears.
Our fervor we shall dedicate to our country.
We shall bare our breasts and we shall give our hearts,
And for our people we shall shed our blood to the end.
But never will a Kalmyk retreat
From an enemy after seeing his immense army.
Never will his tongue lie,
Never will a Kalmyk be a coward..."

More than two years ago, on the decision of the Leninist Central Committee of the CP the national autonomy of the Kalmyk people was restored; all the necessary conditions were created for the rapid recreation and for the development of the economy and culture of Kalmykiya. Thanks to the Leninist national policy, continuous assistance and concern by the CP and Soviet Government the workers of the Republic have made considerable progress. The total number of sheep, the main resource of the Republic, has been increased by 900,000 head and has reached 2,300,000 in the past two-and-a-half years. In the same time the number of cattle has increased from 93,000 to 136,400. In the past year the hard workers of the fields of the Republic have produced a rich harvest, have given and sold the country 11,600,000 poods [one pood = 36 pounds] of grain instead of 4,000,000 poods provided for by the plan. The Republic of Kalmykiya has considerably overfulfilled the plans for the first half-year of 1959 in the sale of meat, wool, milk, eggs to the government, occupying one of the leading places in the Russian Federation.

A national song and dance ensemble, a dramatic theatre, a scientific research institute of language, literature and history, an institute for the advanced training of teachers, hundreds of schools, clubs and other cultural-educational institutions have been created and are operating.

Every year the assignations for the needs of public education and cultural-educational institutions are being increased: clubs, libraries, culture palaces. The cadres of intelligentsia, who have come from the people and are associated with the people and give all their efforts and knowledge to the people are growing. This is one of the most important results of the cultural development of Soviet Kalmykiya. The greatest achievement of socialism is the new spiritual countenance of the people of Kalmykiya.

During the years of the Soviet Regime an entire group of Kalmykiyan writers and poets has developed whose works are published not only in their native language but also in Russian translations. This is a brilliant, original, talented literature developing freely and in a full-blooded manner, which skillfully combines the best traditions of the popular oral creativeness as well as the traditions of its written general Mongolian literature, which has its roots in distant antiquity, in the culture of China, Tibet, and India, with the teaching of classic and Soviet literature. The founder of the literature of socialistic

realism, Maxim Gorky, that ingenious Russian writer, has been a true and constant friend of the Kalmyk writers, their advisor and mentor. In the last few years five books of a literary almanach, Light in the Steppe (Tevegin Gerl) have been published in which the works of more than 30 authors are included. These almanachs and other collections and books of Kalmyk writers represent their unique creative report for this glorious anniversary.

In the friendly and powerful family of peoples of the Soviet Union the Kalmytskaya ASSR, the workers of which are building a communist society in a self-sacrificing manner along with all the peoples of the Soviet Union, is growing and strengthening, carrying out the magnificent plans for the historic Twenty-First Congress of the CPSU.

Ts. K. Korsunkiyev

Public Health of Kalmykiya During the Years of the Soviet Regime

Prior to the October Socialist Revolution the Kalmyks were one of the most backward and oppressed peoples of tsarist Russia. Not only landowners and capitalists but also the Kalmyk clergy -- priests -- interfered with the cultural growth of the Kalmyks. Poverty and severe exploitation, religious stupefaction and the lack of medical aid was leading to the slow and inevitable extinction of the Kalmyk people. Among the Kalmyk population frequently epidemics of natural smallpox, cholera, plague raged, which took thousands of human lives. The child mortality rate was particularly high. The Kalmyk clergy, knowing the backwardness of the people, its superstition and customs, used every case of human disease for purposes of its own enrichment. The priests "treated" the patient with quack and charlatan remedies, and when the patient died, they said to the relatives: "The spirit of the dead person has gone too far, and therefore it cannot be returned"

An infectious disease, once having arisen in one family, spread rapidly to other families and throughout the villages. Epidemics gave rise to panic; entire families went away wherever the eye could see, leaving the patients at the mercy of fate. Antiepidemic and prophylactic measures were not taken. The result of this was a reduction of the Kalmyk population by 17,864 persons in 1910 by comparison with 1897.

Prior to 1911 there was a not a single physician in the Kalmyk steppes. Only one physician was assigned to Kalmykiya, the Inspector of the Astrakhan' Governor, who remained in the City of Astrakhan' without making any visits. Only in 1911, 1912 did the tsarist government open five hospitals in the Kalmyk steppes in what are now the villages of Yashkul', Liman, Privolzh'ye, Malyye Derbety, and in the City of Elista and 13 feldsher stations. In these 18 medical institutions a total of four physicians and 13 feldshers /physicians' assistants/ worked, among whom was the first Kalmyk, a midwife, T. I. Sagayeva, still in good health. This number of medical workers could not give timely assistance to the population scattered over the large steppe territory.

In 1916, in the center of the Kalmyk Steppe in Ikitsokhorskiy Ulus /an ulus is a semi-nomadic group related by kinship/ an epidemic of natural smallpox occurred. In 1918-1919, when Kalmykiya was occupied by the White Army and robbers of the "green band" an epidemic of typhus broke out. An epizootic of anthrax which occurred at this time destroyed a tremendous number of cattle, the only source of survival of the nomads.

The majority of women delivered at home through the aid of sorceress-midwives, and pathological deliveries, as a rule, caused the deaths of the parturient women. Stillbirth, prematurity of the fetus, and inflammatory diseases during pregnancy with all possible complications up the point of puerperal sepsis were common phenomena.

After the October Socialist Revolution the life of the Kalmyk people began to improve rapidly. In July and October 1919 the great

founder of the Soviet government V. I. Lenin signed two special decrees "Restoration of the Kalmyk Cattle Husbandry" and "Improvement of the Agricultural Life of the Kalmyk People", which played a tremendous part in improving the material situation of the Kalmyk workers. The government assigned the necessary funds for the expansion of medical aid to the population. During the period of destruction and starvation caused by the Civil War, emergency measures were taken for increasing the medical system. Even in 1920, a decree was adopted concerning the formation of the Kalmytskaya Autonomous Oblast, signed by Chairman of the VTsIK [All Union Central Executive Committee], M. I. Kalinin, and the Chairman of the Council of People's Commissars RSFSR, V. I. Lenin. The day of creation of Kalmyk autonomy was the date of birth of the Soviet Public Health System in Kalmykiya.

Here, the public health organizers were the physicians Dushan, Tovetikov, Lukin, Solarov, Tanin, Kolesnikov, Popov, Yerwiliny, Meshcheryakov, Molchanov, Konoplev, Timoshkayeva, Bakayeva, Mukhlayev and a number of others.

The Party and Government gave considerable attention to health-improvement measures in the Kalmyk steppes. Every year, the number of medical institutions and medical workers increased. In 1930, in the Kalmytskaya Autonomous Oblast there were 15 hospitals, 12 outpatient departments, 4 dispensaries, a trachoma dispensary, 20 stations for the control of trachoma, 45 feldsher stations, 10 sanitary-epidemiological institutions, and 1 sanatorium operating. In the therapeutic-prophylactic institutions there were 250 physicians, feldshers, midwives and nurses.

At the beginning of 1934 a 120-bed hospital was opened in Elista.

Therapeutic and sanitary-prophylactic institutions began to make efforts to control tuberculosis, malaria, trachoma, dermatovenereal and other diseases which had previously flourished in Kalmykiya.

In the control of social diseases great assistance was given by expeditions created on the decision of the Soviet Government and sent to Kalmykiya. In 1925, the expedition of Professor Berlin worked in Kalmykiya; in 1928 an expedition worked under the direction of Doctor Zhelyabovskiy on the control of tuberculosis; in 1930-34, a special expedition operated in the village of Yashkul' for the control of dermatovenereal diseases. The physicians Osetrov, Krasnoshchekov, Lipatov, Merkasov and Lidzhiyev worked in the latter expedition.

In 1937-38 an expedition under the direction of Doctor Urynpin did successful work on the control of trachoma.

Through the decree of the TsIK [All Union Central Executive Committee] and the SNK [Council of People's Commissars] USSR dated 25 December 1933, "The Organs of the State Sanitation Inspection" a State Sanitation Inspection was organized in the epidemic-control department of the Oblzdrav [oblast health department]. Beginning with that time better planned methodical epidemic-control measures began to be taken in Kalmykiya.

Thus, while prior to 1933 a sanitary-epidemiological group consisting of one physician and one physician's assistant worked in the

system of the Kalmyk Oblzdravotdel [oblast health department], after this decree by the TsIK and SNK SSSR a sanitary-epidemiological service was created in the Kalmytskaya Oblast which included the physicians Mukhlayev, Kartushev, Korsunkiyev, Lukin, Konoplev, Shapko, Meshcheryakov, Tsvetkov and others.

It should be noted that at the time the majority of physicians took an active part in sanitary-epidemiological work. Through the common efforts of epidemiologists and physicians great work was done on the control of malaria. As a result, the incidence of malaria decreased sharply. Thus, while in 1934 4,565 persons sick with malaria were recorded in the Oblast, in 1935 there were 6,605; in 1940 3,000 persons.

By the end of the 1930's eight malaria-control stations worked in the oblast (including one oblast station), and there were 45 tularemia-control detachments. A great part in the tularemia-control measures was taken by the physicians F. K. Voy, Ye. K. Kharitonova, A. G. Meshcheryakov, A. M. Ganchev, M. I. Kalinin, and others.

During these years plague epizootics which had hitherto been widespread in Kalmykiya were eliminated. The elimination of them was accomplished by the personnel of the plague-control organization of Kalmykiya, which began its activity in 1927.

The change of Kalmyks to a sedentary mode of life contributed to a reduction in the mass morbidity from different infectious diseases. After leaving his nomadic tent, the Kalmyk left his uncultured state and many diseases, and became an active builder of a new life, socialism.

In 1940, in the Kalmyk Republic there were 29 hospitals with 665 beds, 13 gynecological and pediatric consultation offices, 16 outpatient departments operated by physicians, 5 dispensaries for the control of social diseases, 14 sanitary-epidemiological institutions, 56 feldsher-midwife stations and 2 sanatoria operating.

Assignations for public health were increased every year. While in 1924 public health organs spent 404,300 rubles, in 1935 this number increased to 15,600,000 rubles.

The smooth-running medical service to the population of Kalmykiya was interrupted by the Second World War. On the temporarily occupied territory of Kalmykiya, during the period from August 1942 to the beginning of 1943, the majority of medical institutions was destroyed. The population of these regions remained without any medical aid. Epidemics of typhoid and typhus fever and other diseases broke out. From the first day of liberation of Kalmykiya by Soviet troops measures were taken in the Republic for the most rapid restoration of the system of medical institutions, for the elimination of epidemics and the rendering of medical aid to the population.

In a comparatively short time eight rayon hospitals were opened. The Elista City Hospital with a polyclinic, outpatient departments operated by physicians and the work of the State Sanitation Inspection and sanitary-epidemiological institutions were renewed. The entire population participated in the difficult but beneficent work on the restoration of the system of medical institutions.

A major factor in the turning point, bringing about a tremendous

development of all branches of the national economy of Kalmykiya, including the field of public health, was the historic resolution of the CC CPSU and the ukase of the Presidium of the Supreme Soviet USSR concerning the formation of the Kalmytskaya Autonomous Oblast, which in 1958 was converted into the Kalmytskaya ASSR.

In the last three years the Soviet Government has allotted more funds for the public health of Kalmykiya. While in 1957 6,000,000 rubles were allotted, in 1958 this number was 22,656,000 rubles; in the current year, 1959, 30,166,000 rubles.

While in 1957 42 hospitals with 820 beds, 40 nurseries with 800 beds, 146 feldsher-midwife stations, 11 sanitary-epidemiological stations and 15 other medical institutions were operating in the Oblast, in July 1959 there were 51 hospitals with 1100 beds, 45 nurseries with 1,000 beds, 3 specialized hospitals with 100 beds, 8 outpatient departments, 12 sanitary-epidemiological stations with laboratories and about 10 other medical institutions operating. In the City of Elista a republic children's hospital with 75 beds was opened; the bed system was enlarged in the republic hospital and tuberculosis dispensary; in many rayon hospitals the children's nurseries and kindergartens were enlarged.

Great prospects are being opened before public health of the Kalmykiya ASSR in the forthcoming seven-year period. In this time a tuberculosis hospital with 75 beds, an infectious disease hospital with 50 beds, a city hospital with 100 beds, a lying-in home with 40 beds, interkolkhoz and rayon hospitals will be opened. Measures will be worked out for the reduction of the incidence of cases of tuberculosis, brucellosis, cancer, cardiovascular diseases, on the protection of mother and child. A combination of operations will also be developed directed at an increase in sanitation culture in inhabited places, in domestic life and in industry, directed toward the development of physical culture and athletics. By the end of the seven-year period about 450 physicians and 2,000 medium-level medical workers will be working in the Republic.

The youth is working in the glorious army of medical workers alongside the distinguished physicians who have given many years to the work of public health. Russian physicians and native physicians who have been able to become specialists only because of the Soviet Regime, are fighting for human life.

The Twenty-First Congress of the CPSU has confronted the Soviet people with the respectable task of building communism in the Soviet Union. The medical workers of Kalmykiya, who are standing on guard for the health of Soviet people, will be in the ranks of fighters for communism.

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The Current Status of the Plague Focus in the Northwest Caspian and Problems of Its Further Study

As is well known, the plague focus of the Northwest Caspian, within the limits of which cultures of the plague microbe have been isolated from rodents and their ectoparasites, amounts to about 20 million hectares. It includes the southern rayons of Stalingradskaya Oblast, the right-bank rayons of Astrakhan'skaya Oblast, the eastern rayons of Rostovskaya Oblast, Kalmytskaya ASSR, the northern rayons of Stavropol'skiy Kray, part of the Checheno-Ingushskaya Autonomous Republic and the plain regions of Dagestan.

In this article we will deal chiefly with the territory of the Kalmytskaya ASSR, Astrakhan'skaya, Rostovskaya and Stalingradskaya oblasts, which in a methodological respect are serviced by the Rostov Plague-Control Institute. We shall mention the remaining portion of the focus in the Northwest Caspian only as necessary, considering the impossibility of separating it from the entire focus as a whole.

The first epizootics in the focus among the rodents began to be recorded in 1913. Since that time, for 25 years, until 1939 they were noted almost every year, although the degree of activity of the focus in its different parts varied considerably in different years.

In the 1920's and beginning of the 1930's, apparently as the result of expansion of the ploughing of virgin territory and increase in the census of inhabited places around Stalingrad, the northern boundary of the focus dipped approximately 40-50 kilometers to the south, whereas in the western and southwestern directions the focus successively and quite actively expanded, as the result of a displacement of the boundary of the area of distribution of the sousliks in this direction.

By 1932, that is, in nine years, the boundary of the enzootic territory had moved to the west by more than 120 kilometers in various places, and to the southwest, by 200-250 kilometers.

From 1928 through 1932 the epizootic among sousliks extended in the same direction in various places by 100 or more kilometers, whereby this "movement" of the plague pathogen proceeded as though on a solid front, excluding any doubt of the fact that we were dealing with a relay method of transmission of the plague microbe.

By 1933-1934 the total area of the enzootic territory of the focus amounted to more than 14,500,000 hectares. Successful control of the territory of the focus in the Northwest Caspian was possible because a relatively dense system of plague-control institutions (stations, departments, and epidemiological detachments) had provided for methodical chains of investigations with the aim of searching for the bodies of dead rodents as well as investigations of many hundreds of thousands of rodents and their ectoparasites in the plague-control laboratories.

Beginning with 1933, at the decision of the government, extermination measures of tremendous scale were begun against sousliks as the main sources of the plague pathogen; these in principle were solid clean-ups of territories, whereby certain areas were treated five-six times or more. This led to a subsidence of the bulk of the focus. The last cultures of plague microbe in the period before the war were isolated in Stalingradskaya Oblast in 1934; in Stavropol'skiy Kray in 1936; in Rostovskaya Oblast in 1938; in Kalmytskaya ASSR in 1938.

After a prolonged interruption, in 1946, cultures of the plague microbe were again isolated from sousliks and their fleas in Chernyye Zemli in the environs of Naryn-Khuduk. In subsequent years infected rodents and their fleas began to be recorded to the south, north and east of Naryn-Khuduk, whereby not only sousliks were involved in the epizootics but so also were sand rats, house mice and jerboas.

Apparently plague events in the Checheno-Ingushskaya ASSR and the plain region of Dagestan, where cultures of the plague pathogen were isolated for the first time in 1950 and the last culture was isolated in 1956, were in direct genetic connection with epizootics in Chernyye Zemli.

The possibility of penetration of the plague pathogen to the south of the Kuma River (into the Nogaysk Steppe) specifically from Chernyye Zemli could be substantiated by the following considerations. The Nogaysk Steppe borders directly on Chernyye Zemli, and the practically dried-out Kuma River at the present time cannot serve as a serious obstacle either to rodents, which are active throughout the entire year, or to sousliks in the summertime, without mentioning other wild mammals. In addition, consideration should be given to the fact that the ecological conditions for the rooting of plague, at least for a comparatively short time, have arisen here, in all probability recently, because in 1927 the bulk of the Nogaysk Steppe was free of sousliks (P. Sviridenko). Subsequently, the boundaries of the area of distribution of sousliks were gradually expanded, as the result of the active utilization of the steppes for the grazing of cattle and the regression of the Caspian Sea.

Of more than a little importance in the establishment of this part of the focus was apparently the fact that tremendous numbers of cattle have passed back and forth over the Nogaysk Steppes in the past [illegible] years for the purpose of spending the winter in the region of Chernyye Zemli.

The relatively rapid suppression of plague in the southeastern portion of the focus in the Northwest Caspian in the post-war period was possible, once again as the result of extermination measures taken here against sousliks and sand rats*. To the north of the Kuma River cultures of the plague microbe have not been isolated for five years; to the south (the plain region of Dagestan), for three years.

Naturally, this short period is clearly inadequate for speaking about the absence of the plague microbe on the territory of the focus at the present time. We cannot help but take into consideration the fact, for example, that in the environs of Naryn-Khuduk a recurrence of plague was observed in 1946 after an eight-year interruption.

* The term "sand rats" includes great sand rats and [illegible]

It is also necessary to make a search for the plague microbe in nature in the most careful manner with the application of all possible methods of bacteriological investigation of rodents and their ectoparasites. However, it would be a great error to permit the standard approach to the epizootiological evaluation of different parts of the focus. Based on the accumulated experience in work conducted by a large number of investigators and on the history of the focus we should, first of all, distinguish the areas in which chiefly the existence of smoldering foci of plague infection is possible and the areas in which the rooting of the pathogen for a long time is possible in the event of penetration, that is, areas where there are objective conditions for a plague enzootic.

We have already pointed out that in Stalingradskaya Oblast plague cultures have not been isolated for 25 years; in Stavropol'skiy Kray, 23 years; in Rostovskaya Oblast, 21 years. It would be an error to believe that here there are still residual foci of smoldering epizootics. We can speak only of the penetration of the plague microbe here from those portions of the focus where it has possibly been preserved in nature.

The same may be said with respect to the considerable territory of Kalmytskaya ASSR and Astrakhanskaya Oblast. In Stepnovskiy and Zapadniy Rayons of Kalmytskaya ASSR epizootics have not been recorded for more than 27 years; in Yergeni, for more than 26 years; in the environs of many inhabited places located along the right bank of the Volga (Chernyy Yar, Staritsa, Vetlyanka and others), 27 years; in the environs of Yenotayevsk, 21 years; of Adyk, 22 years, and others.

We can hardly doubt the fact that on the greater portion of the focus of the Northwest Caspian there is no plague microbe. Preservation of smoldering plague foci to the present day is possible in the eastern portion of Chernyye Zemli, in Primor'ye and in the Nogaysk Steppes. In these areas the maximum attention should be concentrated.

Aside from many years of work on the extermination of sousliks and, later, of sand rats, for a long time another, very important process has been occurring -- the progressive reclaiming of virgin and waste-land steppe for farm land.

In six years (1944-1950) the area of cultivated territory in five eastern rayons of Rostovskaya Oblast has increased by almost two times. While in 1944 the total area of cultivated territory amounted to 338,500 hectares, in 1950 it had increased to 648,400 hectares. Before the period of collectivization of agriculture in the Sal'sk and adjacent steppes a total of less than ten percent of the territory was plowed, whereas at the present time in Zimovnikovskiy Rayon, about 60 percent; in Dubovskiy Rayon, 45 percent; in Remontnenskiy Rayon, about 40 percent; in Zavetinskiy Rayon, 30 percent. In Stalingradskaya Oblast and in Krasnoarmeyskiy Rayon the total area of plowed territory amounts to more than 40 percent of the territory; in Nizhne-Chirskiy Rayon, more than 70 percent; in Voroshilovskiy Rayon, about 50 percent; in Kotel'nikovskiy and Kalachevskiy Rayon, about 60 percent; in Gorodishchenskiy Rayon, 60 percent. An even greater percentage of ploughing of virgin territory

occurs in Stavropol'skiy Kray.

As the result of the increasing intensification of agriculture the steppe landscape is becoming progressively more varied. Cultures of cereal crops and fodder grasses, irrigation and watering canals, oak-groves and forest-steppes, melon fields and orchards, gardens, vineyards, ponds, and others over a considerable portion of the territory have divided the settlements of sousliks into a multitude of small foci, which, even when there is a high census of the animals in them, certainly cannot provide for the rooting of the plague pathogen for a long time.

There is no doubt of the fact that mass extermination of sousliks for a long time and active agricultural activity of man has led to complete elimination of the most important causes of the natural focalization of plague in the tremendous areas of the Northwest Caspian Region.

At the present time, the boundaries within limits of which the rooting of the plague pathogen is possible, have been considerably narrowed and cannot go beyond the limits of the broad massifs of virgin steppes which have still been little reclaimed by man in an agricultural respect. In this group are the central and southern portion of Yergeni, including the eastern portion of Zavetinskiy Rayon, Chernyye Zemli, the rayons of the virgin steppes to the south and southwest of Chernyy Yar and Yenotayevsk, Primor'ye, the Nogaysk Steppes, and certain regions of the plain portion of Dagestan. Beyond the limits of this territory methodical search for the plague microbe has lost its significance.

For the purpose of giving a basis to the problems of studying the focus in the Northwest Caspian retrospective consideration of the characteristics of the course of the epizootic progress in various natural-historical regions is of great importance, because on the basis of it the methods of epizootological investigation of the territory should be determined.

The history of plague events as well as the ecological characteristics of rodents and their ectoparasites are evidence to the effect that acute and diffuse epizootics which spread relatively rapidly and which provided for the plague enzootic when there were extensive territories with a nigh souslik census present were characteristic of the bulk of the focus (Yergeni, Stavropol'skiye and Sal'sk Steppes banks of the Volga).

Once again, it should be noted that in part of this territory which has been little or not at all reclaimed by agriculture (the southern and eastern portions of Yergeni, the banks of the Volga, the Karpinsk and Yergeni Steppes and adjacent areas) the census of sousliks and their fleas has already long been restored to the degree which obtained during the period in which the active epizootics occurred. Therefore in these places the main factors for plague enzootic and conditions for acute and diffuse epizootics are present; only the plague microbe is absent, if this latter penetrates into these territories the possibility of occurrence of a "conflagration" of epizootics which can include large areas, is not ruled out. In Chernyye Zemli and in the Nogaysk Steppe the natural conditions and ecological characteristics of sousliks and their fleas are such as to permit the supposition of prolonged existence

of smoldering foci of the infectious disease in nature. It is sufficient to mention that in the period before the war the last epizootic in Chernyye Zemli was recorded in the environs of Naryn-Khuduk and the first epizootic in the post-war period was also noted there (1946). Primor'ye, including the il'men-delta region, occupies a kind of intermediate position in this respect. The variety of rodents and ectoparasites, their high degree of mobility provide for the possibility of occurrence of diffuse and active epizootics, and at the same time the existence of biotopes similar to the biotopes of Chernyye Zemli assures the possibility, at least in the western portion of the rayon, of the relatively prolonged existence of smoldering foci of plague.

These are the main theoretical premises which should be taken into consideration in the further study of the residual infectivity of the focus.

The problem of plague-control institutions of the Northwest Caspian lies in giving a definitive answer to the following question in the next four-five years: do smoldering foci of the infectious disease still exist in these places in nature? However, we are not sure whether with the existing methods and scale of work we can successfully solve this problem with which we are confronted. Existing methods and scales of operation provide for the detection of relatively acute epizootics, where bodies of dead rodents can be encountered on the surface of the ground and where the percentage of infected fleas is quite high. However, local smoldering foci of infection can readily be overlooked. A simple arithmetical calculation shows how low is the probability of detecting single infected rodents and their ectoparasites. Usually, the area which is under the supervision of each epidemiological detachment amounts to about 500,000 hectares. If we assume that during the spring-summer season the epidemiological detachment investigates 2,000 rodents and 10,000 ectoparasites where there is a density of 15 animals per hectare and a total number of ectoparasites of 1,000 per hectare, it turns out that the laboratory investigates one rodent out of almost 4,000 and one flea out of 50,000 living on the territory of the detachment.

Naturally, during the next few years in those places where the preservation of smoldering plague foci is still possible it is still essential to increase, by at least several times, the range of investigation of rodents and ectoparasites per unit area. This will be possible only if all the plague-control departments concentrate their efforts in the southeastern portion of the focus.

At the present time, on that portion of the territory of the Northwest Caspian, which in a methodological respect is subordinate to the Rostov Institute, there are eight plague-control institutions, including the epidemiological group of the Stalingrad Affiliate of the Rostov Institute and the Elista Plague-Control Station. The Stalingrad Epidemiological Group, the Tundutov, Zavetinsk, Yenotayevsk Departments, and the Elista Plague-Control Station investigate territories for which an acute course of the epizootic process has been characteristic in the past. In addition, a considerable part of this territory (Stalingradskaya Oblast, Dubovskiy Rayon, the western portion of Zavetinskiy and

Remontnenskiy rayons of Rostovskaya Oblast, the Zapadnyy and Yashaltinskiy rayons of Kalmytskaya ASSR) can no longer be considered enzootic areas by virtue of changed natural conditions. On the remaining territory serviced by these institutions, where there are conditions for the rooting of the plague microbe, in the event of its being imported from without, as has already been noted, no epizootics have been recorded for more than 20 years.

Naturally, in the future the relatively uniform study of the focus which has been undertaken up to the present time will be absolutely inexpedient. Beginning with 1960 a considerable reorganization of the work is essential, based on the considerations stated above.

The general trend of the work should consist of the gradual concentration of efforts in the southeastern portion of the focus, in the area of recent epizootics at the expense of a corresponding reduction of the scale of operation in that portion where there are no conditions for the rooting of the plague pathogen or where epizootics have not been recorded for many years straight and cannot be detected by epidemiological reconnaissance on an ordinary scale. All the departments mentioned above should, even in 1960, to a considerable degree go beyond the limits of the territory serviced in 1959 and participate in the investigation of Chernyye Zemli and Primor'ye, either by means of sending out epidemiological detachments or by means of the organization of investigation brigades with the aim of reinforcing the epidemiological detachments, which already have a suitable materiel basis.

The Stalingrad Epidemiological Group in the future should undertake the study of rodents and ectoparasites only if information about the death of rodents is received.

The Tundutov Plague-Control Department should study the southern portion of the territory; the Zavetinsk Department, the eastern portion; the Elista Station, the eastern portion of Yergeni and the adjacent plain; the Yenotayevsk Department, the southeastern and southern; the Volga Department, the western and southern portion of the territory which they service. On the territory of the Tundutov and Zavetinsk Departments and the Elista Station (within the limits of the Yergeni Heights) an investigation can be undertaken only during the period of dispersal and settlement of young sousliks, when, as plague events have indicated in the past, epizootics have developed among them for the most part. The entire remaining territory is being investigated from the time of awakening of sousliks from hibernation until their mass hibernation. In places of combined settlements of sousliks and sand rats the investigation is conducted throughout the year.

Methods of epizootological reconnaissance should also be differentiated. In those places where the occurrence of acute epizootics is possible (Tundutov and Zavetinsk Departments and the Elista Station) the main methods should be a search for the bodies of dead rodents and the investigation of fleas collected from the rodent holes. The main attention, particularly in drought years, should be given to such biotopes as the bottoms of ravines, the fringes of cultivated areas, the banks of estuaries and others, where sousliks concentrate in large

numbers. Therefore, in these regions the plague-control institutions are conducting work similar to that of zooparasitological detachments or groups prior to the dispersal and settlement of the young sousliks which have the aim of studying the rodent census, their distribution over the territory, and in some cases also that of taking the census of ectoparasites, chiefly migratory fleas. Where necessary, these detachments or groups can collect material for bacteriological investigation.

After the dispersal and settlement of the young in these places work is being conducted similar to that of extensive epidemiological reconnaissance detachments, the problem of which is the detection of acute epizootics. The principal method is collection and study of migratory fleas (species identification of them is not obligatory) as well as of the bodies of rodents. On the remaining territory, where by virtue of natural conditions the prolonged existence of smoldering plague foci is possible (Chernyye Zemli, Primor'ye, the Nogaysk Steppe) a study of living rodents is also necessary. In other words, on this territory epidemiological detachments of the examination-investigation type should be operative. Their problem is simultaneous work on extensive epidemiological reconnaissance and detailed study of the enzootic conditions, including a search for smoldering foci of plague epizootics.

The main attention should be given to places in which there are herds of cattle and strips over which cattle are driven. Each plague-control department and epidemiological detachment should, very carefully, make up a general plan of operation beforehand and establish tentative places for the collection of field materiel for bacteriological investigation and for chain inspections. Thereby, it is essential to avoid uniform coverage of the territory by inspection. The study of the rodent and ectoparasite census according to the data of previous years and epizootological evaluation of the territory with consideration of the history of plague events in the region are made the basis of the plan. The greatest attention should be given to places with a high rodent census, places of recent epizootics, junctions of landscapes, and others.

Above, it has been pointed out that the general tactics of work of the plague-control organizations of the Northwest Caspian should consist of the gradual concentration of efforts on the epizootological inspection of the southeastern portion of the focus, in the region of recent epizootics.

As the first step in this work it is advisable to organize six large epidemiological detachments located at Yashkul', Adyk, Khalkhut, Basy, Naryn-Khuduk and Artezian on the territory subordinate to the Rostov Plague-Control Institute as early as 1960. In each epidemiological detachment (chiefly in Artezian and Naryn-Khuduk) there should be no less than three-four search brigades, not counting brigades for the study of the rodent census, so that the number of investigated rodents and ectoparasites can be increased by two-three times as against the usual number in the plan.

In accordance with this, there should be an increase in the laboratory personnel of epidemiological detachments. The capacities of the epidemiological detachments should be increased partly from the

Tundutovo and Zavetinsk Departments and the Elista Plague-Control Station. In these departments and at the station it is sufficient to organize one inspection brigade, which before the period of dispersal and settlement of young sousliks will make observations of the rodent census and during the period of dispersal and settlement will switch over to epizootological inspection of the territory.

The total tentative scale of operation of the plague-control organizations on the right bank during the first year of study of focus can be represented in the following form.

A. № п/п	B. Противочумные учреждения	C. Число исследованных грызунов	D. Цепные обследования (га)	E. Число исследованных эктопаразитов
1	Элистинская лаборатория	—	1500	12000
2	Заветинское ПЧО	—	1000	12000
3	Тундутовское ПЧО	—	1000	12000
4	Черноземельское ПЧО	3000	1500	40000
5	Енотаевское ПЧО	1000	1500	20000
6	Приволжское ПЧО	2000	1500	20000
7	Яндыковское ПЧО	3000	1500	30000
8	Халхутинский Э.О	3000	1500	30000
9	Яшкульский Э.О.	2000	1500	30000
10	Адыкский Э. О.	2000	1500	30000
11	Н-Худукский Э.О	4000	1500	40000
12	Басинский Э. О.	3000	1500	30000
13	Артезианский Э.О.	4000	1500	40000

A. No.; B. Plague-Control Institutions; C. No. of Rodents Investigated; D. Chain Inspections (hectares); E. No. of Ectoparasites Investigated. 1. Elista Laboratory; 2. Zavetinsk Plague-Control Departments; 3. Tundutovo Plague-Control Departments; 4. Chernyye Zemli Plague-Control Departments; 5. Yenotayevsk Plague-Control Departments; 6. Volga Plague-Control Departments; 7. Yandyki Plague-Control Departments; 8. Khalkhuta Epidemiological Detachment; 9. Yashkul' Epidemiological Detachment. 10. Adyk Epidemiological Detachments; 11. Naryn-Khuduk Epidemiological Detachment; 12. Basy Epidemiological Detachment; 13. Artezian Epidemiological Detachment.

For the purpose of assuring a larger volume of work in 1961 and subsequent years it will be necessary starting with this year to begin a search for and preparation of bases of operation for additional epidemiological detachments in the southeastern portion of the focus which will begin to operate in 1961. The number of these epidemiological detachments which may be organized through further reduction in inspection operations in the more northerly and westerly regions should be gradually brought up to three-four in addition to those existing in 1960.

Another means of intensifying operations is not ruled out either; this lies in the gradual, from year to year, increase in the capacity of

various epidemiological detachments.

As far as extermination operations against sousliks are concerned, in the small volume in which they were conducted in recent years they can no longer check the process of recovery of the souslik census. In addition, almost all epizootic places have been treated three-four-five times. Essentially the area located to the west of Naryn-Khuduk (the winter camp of the "Krasnyy Partisan" kolkhoz, Dar-Tsubu), has been treated only once. In the next few years here it will be advisable to conduct operations for the improvement of the baiting method of control of sousliks and simultaneous destruction of rodents and their ectoparasites. In subsequent years extermination operations against sousliks should be planned only in the capacity of an epidemiological reserve over a scale of 50,000-70,000 hectares for each station. (We are speaking here about the northern part of Prikum'ye. As far as the Nogaysk Steppe is concerned, there, possibly, extermination operations are also necessary according to the solid clean-up principle).

Observations of the census of mouse-like rodents and sand rats in the next few years should be left at the present scale.

An increased census of small mouse-like rodents particularly should serve as a signal for concentrating attention on them and for switching laboratory operations to mass investigation of them.

There are no longer any indications for conducting field and village deratization and insect elimination for plague-control purposes on the greater part of the focus of the Northwest Caspian Region. In the future these measures should be planned chiefly only as an epidemiological reserve as well as by way of rendering practical assistance to sanitary-epidemiological stations.

In connection with the reduction and, in the future, the complete cessation of extermination operations against rodents on the right bank of the Volga a considerable number of specialists will become available. These cadres should be utilized for reinforcing the epizootological inspection of the focus as well as for operations on the elimination of the Volga-Ural Focus of Plague, which was provided for by the resolution of the Saratov Conference of Plague-Control Workers of the USSR in November 1958.

A. K. Shishkin

Plague Epizootics on the Territory of the Kalmyk Steppes

The Kalmyk steppes along the Caspian Sea between the Volga and the Kuma, including the Yergeni Heights, have long been unhealthy with respect to plague. It comes from authentic sources that an epizootic of plague among wild rodents was first found here in 1913. From that time until the Second World War cultures of the plague pathogen were isolated repeatedly in many places of the territory being described (see Table 1).

Measures connected with the elimination of the natural plague focus in the Northwest Caspian affected the Kalmyk steppes to a lesser degree than Rostovskaya and Stalingradskaya oblasts or Stavropol'skiy Kray because of the tactical plan of the souslik-control work. Thus, territories endemic for plague in the rayons of Rostovskaya and Stalingradskaya oblasts from 1934 through 1953 were subjected to repeated souslik extermination operations and were considerably reclaimed by agriculture. Plague epizootics among the rodents here have not been recorded for more than 20 years. The situation is different on the territory of Kalmytskaya ASSR and on the right bank of Astrakhanskaya Oblast where the extermination of rodents has been conducted mainly along the fringes (the delta and the Volga region) of the focus, whereas the central portion (Chernyye Zemli) remained untreated until 1946. The activity with which these territories were reclaimed by men was also low, which has in the past afforded the basis for assuming the possibility of preservation of plague epizootics on this territory. The correctness of our prediction was entirely confirmed somewhat later. In May 1946 the physician V. M. Proshchenko isolated the first plague microculture from sousliks caught in the region of Naryn-Khuduk settlement by a biological test. Subsequently, in a period of a month another 13 cultures were isolated in the same places; of these 10 were from living sousliks, and three were from souslik fleas.

On inspection of the adjacent territories no epizootics were found. It should be noted that the census of sousliks and jirds in 1946 was low in the epizootic region (see Table 2).

In 1947 two epizootic regions were found. The first was in the region of Naryn-Khuduk settlement, that is, on the territory where an epizootic had occurred in 1946; the other was in the region of the sixth siding of the Astrakhan' Kizlyar railroad (55 kilometers from Naryn-Khuduk settlement).

In the same year ten cultures of the plague microbe were isolated; of these, three were from living sousliks and

Table 1.

Plague Epizootics on the Territory of the Kalmyk Steppes.

№ №	Название населенного пункта, в районе которого установлена эпизоотия чумы	Дата эпизоотии	От кого выделены культуры возбудителя чумы
1	2	3	4
1	х. Киселевка Ростовской области	1913	От сусликов
2	х. Котов Ростовской области	1913	От сусликов
3	с. Заветное Ростовской области	1913	От сусликов
4	х. Кичкино Ростовской области	1913	От сусликов
5	х. Андреев Ростовской области	1913	От сусликов
6	с. Торговое Ростовской области	1913	От сусликов
7	х. Нестеров Ростовской области	1913	От сусликов
8	с. Заветное Ростовской области	1914	От сусликов
9	х. Киселевка Ростовской области	1914	От сусликов
10	х. Котов Ростовской области	1915	От сусликов
11	с. Заветное Ростовской области	1915	От сусликов
12	с. Заветное Ростовской области	1916	От сусликов
13	с. Федосеевка Ростовской области	1923	От сусликов
14	с. Яндыки (Шара Булук)*	1923–1924	От мышей (гребенщиковой песчанки)
15	с. Приютное	1924	От сусликов
16	х. Ангучинский хурул	1924	От сусликов
17	х. Баксин-Цеке	1924	От сусликов
18	х. Чимбя	1924	От сусликов
19	х. Дальча	1924	От сусликов
20	х. Мушаров	1924	От сусликов
21	х. Бурата	1924	От сусликов
22	с. Малые Дербеты	1924	От сусликов
23	с. Тундутово	1925	От сусликов
24	х. Оленичево	1925	От сусликов
25	х. Дьячково	1925	От сусликов
26	с. Яста	1926	От сусликов
27	х. Гурум	1925	От сусликов
28	с. Яндыки	1926	От сусликов
29	Хатон Дальча	1926	От сусликов
30	п. Улан Хеечи	1926	От сусликов
31	с. Ветлянка	1925	От сусликов

*The names of the inhabited places are given according to the map of Kalmytskaya ASSR, 1940.

[It will be noted that there are four columns, each of which is numbered from left to right near the top and there are numbers from one to 72 along the left-hand margin of the Table. The headings above the horizontal numbers mean the following: 1. No; 2. Name of inhabited place in the area of which —

the plague epizootic was found; 3. Date of epizootic; 4. From what the plague pathogen cultures were isolated. Going down in column four it will be noted that with the exception of the words opposite No. 14 and 67 all the other sources are the same, namely, "From sousliks"; opposite No. 14 we have "From mice," (crested jird [Meriones tamariscinus]; opposite line 67 we have "From Mice". The remaining designations, namely, those in column two will be given at the end of the Table.]

1	2	3	4
32	х. Харауси	1925	От сусликов
33	х. Шарабулук	1925	От сусликов
34	с. Базарное	1925	От сусликов
35	х. Яманский	1925	От сусликов
36	с. Тундутово	1926	От сусликов
37	Хатон Чурюм	1926	От сусликов
38	г. Элиста	1927	От сусликов
39	с. Вознесенское	1928	От сусликов
40	г. Элиста	1928	От сусликов
41	с. Кегульта	1928	От сусликов
42	Аршан-Балка	1928	От сусликов
43	с. Троицкое	1928	От сусликов
44	х. Гашун-Балка	1928	От сусликов
45	с. Яшкуль	1928	От сусликов
46	с. Приютное	1929	От сусликов
47	с. Малые Дербеты	1929	От сусликов
48	с. Тундутово	1929	От сусликов
49	х. Прашиб	1929	От сусликов
50	х. Чертково	1929	От сусликов
51	Капуково	1929	От сусликов
52	х. Браты	1929	От сусликов
53	г. Элиста	1929	От сусликов
54	с. Кегульта	1929	От сусликов
55	х. Ульдугин	1929	От сусликов
56	х. Аршани	1929	От сусликов
57	с. Карантинное	1929	От сусликов
58	х. Базарин	1930	От сусликов
59	Ильинко	1930	От сусликов
60	с. Приютное	1931	От сусликов
61	с. Яшалта	1931	От сусликов
62	х. Красная Михень	1931	От сусликов
63	х. Первый Чернозовский	1931	От сусликов
64	с. Бургуста	1931	От сусликов
65	х. Красный партизан	1931	От сусликов
66	х. Бурчуны	1931	От сусликов
67	с. Башанта	1932 - 1933	От мышей
68	х. Улан-Туг	1936	От сусликов
69	х. Улан-Хеечи	1936	От сусликов
70	х. Улан-Хол	1936	От сусликов
71	с. Яндыки	1936	От сусликов
72	Нарын-Худук	1936	От сусликов

1. Kiselevka Hamlet in Rostovskaya Oblast; 2. Kotov Hamlet in Rostovskaya Oblast; 3. Zavetnoye Village in Rostovskaya Oblast; 4. Kichkino Hamlet in Rostovskaya Oblast; 5. Andreyev Hamlet in Rostovskaya Oblast; 6. Torgovoye Village in Rostovskaya Oblast; 7. Nesterov Hamlet in Rostovskaya Oblast; 8. Zavetnoye Village in Rostovskaya Oblast; 9. Kiselevka Hamlet in Rostovskaya Oblast; 10. Kotov Hamlet in Rostovskaya Oblast; 11. Zavetnoye Village in Rostovskaya Oblast; 12. Zavetnoye Village in Rostovskaya Oblast; 13. Fedoseyevka Village in Rostovskaya Oblast; 14. Yandyki Village (Shara Buluk); 15. Priyutnoye Village; 16. Anguchinskiy Khurul Hamlet; 17. Baksin-Tseke Hamlet; 18. Chimbya Hamlet; 19. Dal'cha Hamlet; 20. Musharov Hamlet; 21. Burata Hamlet; 22. Malyye Derbety Village; 23. Tundutovo Village; 24. Oleniohevo Hamlet; 25. D'yachkovo Hamlet; 26. Yasta Village; 27. Gurum Hamlet; 28. Yandyki Village; 29. Khaton Dal'cha; 30. Ulan Kheyechi; 31. Vetlyanka Village; 32. Kharausun Hamlet; 33. Sharabuluk Hamlet; 34. Bazarnoye Village; 35. Yamanskiy Hamlet; 36. Tundutovo Village; 37. Khaton Churyum; 38. The City of Elista; 39. Voznesenskoye Village; 40. The City of Elista; 41. The Village of Kegul'ta; 42. Arshan-Balka; 43. Troitskoye Village; 44. Gashun-Balka Hamlet; 45. Yashkul' Village; 46. Priyutnoye Village; 47. Malyye Derbety Village; 48. Tundutovo Village; 49. Prishib Hamlet; 50. Chertkovo Hamlet; 51. Kanukovo; 52. Braty Hamlet; 53. City of Elista; 54. The Village of Kegul'ta; 55. Ul'dugin Hamlet; 56. Arshani Hamlet; 57. Karantinoye Village; 58. Bazarii Hamlet; 59. Il'ino; 60. Priyutnoye Village; 61. Yashalta Village; 62. Krasnaya Mikhen' Hamlet; 63. Pervyy Chernosovskiy Hamlet; 64. Burgusta Village; 65. Krasnyy Partizan Hamlet; 66. Burchuny Hamlet; 67. Bashanta Village; 68. Ulan-Tug Hamlet; 69. Ulan-Kheyechi Hamlet; 70. Ulan-Khol Hamlet; 71. Yandyki Village; 72. Naryn-Khuduk.

six were from souslik fleas caught in the region of Naryn-Khuduk settlement, and one was from a living souslik caught near the Sixth Siding. In 1947 the epizootic had a sluggish course on small areas with a low souslik census.

In 1948, a plague epizootic was recorded in 14 districts among rodents, whereby in the epizootic sand rats, house mice and jerboas were involved in addition to sousliks. The epizootic occurred chiefly in the delta region of Limanskiy Rayon. It was also recorded in the region of Khalkhuta settlement located 60-80 kilometers from the epizootic points of Limanskiy Rayon and 100-120 kilometers from Naryn-Khuduk settlement. In 1948 55 plague microbe cultures were isolated (see Table 3).

Table 2.

Density of Souslik Holes and Souslik Census in 1946

Наименование места обследования (1)	Плотность нор на 1 га (2)	Средняя численность сусликов на 1 га (3)
(4) Нарын-Худук	80	18
(5) пос. Семеновский	17	1
(6) пос. Бульчин	22	0.6
(7) пос. Зельма	27	2.4
(8) Разъезд № 5	23	2.8
Разъезд № 6	38	5
Разъезд № 7	41	4.2
Разъезд № 8	79	2.4
(9) ст. Зензели	27	2.4
(10) Промысловка	55	5.3
(11) Пески Тингута	160	24

1. Name of Place Inspected; 2. Density of Holes per Hectare; 3. Average Souslik Census per Hectare; 4. Naryn-Khuduk; 5. Semenovskiy Settlement; 6. Bul'chin Settlement; 7. Zel'ma Settlement; 8. Siding No. 5; 9. Zenzeli Station; 10. Promyslovka Village; 11. Peski Tinguta.

Despite the considerable number of epizootic points there were no diffuse epizootics in 1943; they were of a focal nature.

In 1949 in the area of the village of Yandyki a plague culture was isolated from a house mouse. In 1951, in the area of Venderevo village one plague culture was isolated from six crested jirds. The places at which epizootics were found in 1946-1954 are shown in Fig. 1.

In 1954, a plague culture was isolated from jerboas caught in the area of the village of Kurchenko. It should be noted that the plague microbe culture obtained in this year was at first not typical and only subsequently acquired the characteristic features of the plague microbe. The long time needed for identification of the culture delayed timely more profound study of the epizootic process on this territory.

Therefore, in a period of nine years 81 plague pathogen cultures were isolated; of these 36 or 44.4 percent were from living rodents (29 from sousliks and seven from other rodents); 20 cultures were from dead rodents, or 24.7 percent; 13 cultures or 16.0 percent were from fleas taken from rodent holes (chiefly from souslik holes); a total of only three cultures were found on fleas taken from nests, ...

Table 3

Isolation of Plague Cultures

№ п/п	Вид грызунов и эктопаразитов, от которых выделена культура чумы	Дата добычи грызунов и эктопаразитов	Место добычи грызунов и эктопаразитов	Дата выделения культур	Кем выделена культура
1	2	3	4	5	6
		1946 год			
1	Суслики (1 шт. — живой)	18 V	Нарын-Худук 12 км на северо-восток	22 V	Врачом Прощенко
				23 V	Врачом Прощенко
2	Блохи (группа)	16 V	Н.-Худук 2 км на сев.-восток	23 V	Врачом Прощенко
3	Блохи (группа)	16 V	Н.-Худук 25 км на запад	23 V	Врачом Прощенко
4	Блохи (группа)	17 V	Н.-Худук 15 км на запад	23 V	Врачом Прощенко
5	Суслики (группа — живые)		Окрестности Нарын-Худука	23 V	Врачом Прощенко
6	Суслики (1 шт. — живой)	25 V	Н.-Худук 14 км на север	28 V	Врачом Прощенко
7	Суслики (1 шт. — живой)	25 V	Н.-Худук 14 км на север	28 V	Врачом Прощенко
8	Суслики (1 шт. — живой)	28 V	Н.-Худук 3 км на север	1 VI	Врачом Прощенко
9	Суслики (1 шт. — живой)		Н.-Худук 2 км на запад	16 V	Врачом Прощенко
10	Суслики (группа — живые)	12 VI	Худук Цуба 5 км на запад	16 V	Врачом Прощенко
11	Суслики (группа — живые)	12 VI	Худук Цуба 2 км на запад	16 VI	Врачом Прощенко
12	Суслики (1 шт. живой)	14 VI	Худук Цуба 3 км на запад	16 VI	Врачом Прощенко
13	Суслики (группа — живые)	14 VI	Худук Цуба 3 км на запад	19 VI	Врачом Прощенко
14	Блохи (группа)		Окрестности Худука Цуба	20 VI	Врачом Прощенко
		1947 год			
1	Суслики (группа — живые)	8 V	6 разъезд 12 км от Ягдык	17 V	Врачом Ивашковой
2	(132 шт.)	14 V	Нарын-Худук 1 км на запад	19 V	Врачом Алешиной
3	Суслики (группа — живые)	20 V	Нарын-Худук 3 км на запад	24 V	Врачами Алешиной и Кононовой
4	(81 шт.)	21 V	Нарын-Худук 3 км на запад	24 V	Врачом Алешиной

[It will be noted that this entire Table is divided into six columns horizontally; the headings of those columns are the following: 1. No.; 2. Species of Rodent and Ectoparasites from which the Plague Culture was Isolated; 3. Date of Catching Rodents and Ectoparasites; 4. Place Rodents and Ectoparasites were Caught; 5. Date of Isolation of Culture; 6. Who Isolated Culture. The description will be continued at the end of the Table.]

[Table 3 continued]

5	(группа)	21.V	Парын-Худук 3 км на запад	25.V	Врачом Коноковичем
6	Суслики (группа живые)	21.V	Парын-Худук 3 км на запад	27.V	Врачами Алешиной и Коноковичем
7	(группа живые, 6 шт.)	19.VI	Парын-Худук 1 км на запад	22.VI	Врачом Коноковичем
8	(группа—живые, 8 шт.).	20.VI	Парын-Худук 1 км на запад	24.VI	Врачом Алешиной
9	(группа—живые, 1 шт.).	5.XII	Ямдыки 3 км. на восток	10.XII	Врачом Коноковичем

1948 год

1	Греб. песчанки (1 шт.—живая)	26XII.47	Вендерово 8 км на юг	1.1	Врачом Столяченовой
2	Домовые мыши (1 шт. живая)	28.XII.47	Бударино, жилой дом	1.1	Врачом Ивановым
3	Греб. песчанки (1 шт.—павшая)		Вендерово 1 км на юг	8.1	Врачом Столяченовой
4	(25 шт.).	4.1	Вендерово 8 км на сев.-запад	8.1	Врачом Столяченовой
5	(1 шт.).	6.1	Бударино, жилой дом	10.1	Врачом Столяченовой
6	Греб. песчанки (1 шт.—павшая)	?	Машарова 1 км на юг	23.1	Врачом Столяченовой
7	Греб. песчанки (1 шт.—павшая)	?	Машарово 0,5 км на север	23.1	Врачом Столяченовой
8	Полуд. песчанки (1 шт.—павшая)	9.II	Далься 15 км на северо-запад	10.II	Врачом Хохловой
9	Полуд. песчанки (1 шт.—павшая)	?	Парын-Худук 3 км на север	19.II	Врачом Коноковичем
10	Суслики (1 шт.—живой)	24.IV	К-з «Кр. Партизан» 3 км на юг	4.IV	Врачом Ивановым
11	Суслики (1 шт.—живой).	27.III	К-з «Кр. партизан» 2,5 км на юг	7.IV	Врачом Ивановым
12	Мышь-песчанка (1 шт. живой).	12.IV	Вендерово 3 км на юго-восток	19.IV	Врачом Столяченовой
13	Суслики (группа живые)	13.IV	Бударино 3 км на запад	19.IV	Врачом Столяченовой
14	(группа)	16—17.IV	П. Худук 3 км на юго-восток	19.IV	Врачом Коноковичем
15	(24 шт.)	17.IV	Вендерово 3 км на юго-восток	19.IV	Врачом Столяченовой
16	(группа живые)	15.IV	Бударино 5,5 км на запад	21.IV	Врачом Столяченовой
17	(группа живые).	19.IV	Вендерово 2 км на юго-запад	21.IV	Врачом Столяченовой
18	(группа)	21.IV	Зеленое 2 км северо-запад	26.IV	Врачом Столяченовой

[Table 3 continued]

1	2	3	4	5	6
19	(3 шт.)	?	Вендерово 2 км на юго-восток	26.IV	Врачом Столченковой
20	Суслики (1 шт. – павший)	22.IV	Куйкуин 2 км на север	27.IV	Врачом Шатиловой
21	Суслики (1 шт. – живой)	21.IV	Мал. Караванное 100 м на север	27.IV	Врачом Шатиловой
22	Полуд. песчанки (1 шт — павшая)	26.IV	Нарын-Худук 3 км на север	28.IV	Врачом Кононович
23	Суслики (группа – живые)	17.IV	Вендерово 2 км на юго-запад	29.IV	Врачом Столченковой
24	Суслики (группа – живые)	18.IV	Зеленое 2 км на север	29.IV	Врачом Столченковой
25	Полуд. песчанки (1 шт. – павшая)	28.IV	Нарын-Худук 1,5 км на север	29.IV	Врачом Кононович
26	(13 шт.)	?	Вендерово 1 км на юго-восток	29.IV	Врачом Столченковой
27	Суслики (1 шт. – живой)	26.IV	Мал. Караванное 300 м на север	3.IV	Врачом Шатиловой
28	Суслики (группа – живые)	19.IV	Маларово 2 км на юго-восток	4.IV	Врачом Столченковой
29	Суслики (группа – живые)	28.IV	6-й разъезд 1 км на северо-запад	5.IV	Врачом Столченковой
30	(16 шт.)	5.IV	Нарын-Худук 2 км на восток	8.IV	Врачом Кононович
31	Суслики (группа – живые)	29.IV	Мал. Караванное 300 м на север	12.IV	Врачом Шатиловой
32	Суслики (группа – живые)	29.IV	Мал. Караванное 30 м на север	12.IV	Врачом Шатиловой
33	Суслики (группа – живые)	11—13.V	Халтута 5 км на северо-запад	21.V	Врачом Прощенко
34	Суслики (1 шт. – малолетн.)	20.V	Канькуин 200 м от села	22.V	Врачом Шатиловой
35	Суслики (группа – живые)	16.V	К-з «Кр. Партизан» 2 км на север	23.V	Врачом Кононович

[Table 3 continued]

36	(группа)	22.V	Н.-Худук 2,5 км на юго-восток	26.V	Врачом Кононович
37	(группа)	24.V	К-з «Кр. Партизан», 2,5 км на северо-запад	26.V	Врачом Кононович
38	Суслики (1 шт.- павшая)	23.V	Куньхуи 3 км на северо-запад	1.VI	Врачом Шатиловой
39	Суслики (1 шт.- павший)	1.VI	Халхута 5 км на северо-восток	2.VI	Врачом Прощенко
40	(группа)	1.VI	Халхута 4 км на северо-запад	2.VI	Врачом Прощенко
41	(7 шт.)	2.VI	Халхута 5 км на северо-запад	5.VI	Врачом Прощенко
42	(107 шт.)	8.VI	К-з «Красный партизан» 3 км на юг	14.VI	Врачом Кононович
43	(96 шт.)	9.VI	Нарын-Худук 7 км на запад	14.VI	Врачом Кононович
44	(25 шт.)	9.IV	Веселерово 0,5 км на юг	15.VI	Врачом Столяровой.
45	Гребен. песчанки (1 шт.—павшая)	2.X	Грахота 1 км на северо-запад	8.X	Врачом Ивановой
46	Гребен. песчанки (1 шт.—павшая)	8.X	Образцовое 4 км на запад	15.X	Врачом Ивановой
47	Домовые мыши (1 шт.—павшая)	16.XI	Ядыки ур. Кукшин 4 км на север (скирды)	21.XI	Врачом Сокрутовой
48	Домовые мыши (1 шт.—павшая)	16.XI	Ядыки ур. Кукшин 4 км на север (стан)	21.XI	Врачом Сокрутовой
49	Домовые мыши (1 шт.—павшая)	16.XI	Ядыки ур. Кукшин 4 км на север (близ стога)	21.XI	Врачами Сокрутовой и Мелашенко

[Table 3 continued]

1	2	3	4	5	6
50	Домовые мыши (1 шт.- павшая)	18.XI	Яндыки ур. Кукшин 4 км на север (степь)	22.XI	Врачом Меланенко
51	Домовые мыши (1 шт.- павшая)	18.XI	Яндыки ур. Кукшин 4 км на север (степь)	22.XI	Врачом Сокрутовой
52	Домовые мыши (1 шт.- павшая)	22.XI	Яндыки ур. Кукшин 4 км на север (степь).	26.XI	Врачом Зининой
53	Домовые мыши (1 шт.—павшая)	25.XI	Яндыки ур. Кукшин 4 км на север (степь)	30.XI	Врачом Зининой
54	(15 шт.).	4.XII	Яндыки 5 км на северо-запад	11.XII	Врачом Зининой
55	Домовые мыши (1 шт.—павшая)	16.XII	Яндыки 5 км на север (степь)	22.XII	Врачом Сокрутовой
			1949 год		
1	Домовые мыши (1 шт.—павшая)	?	Яндыки 4 км на север	январь	
			1951 год		
1	Гребен. песчаный (группа—живые)	?	Вендерово	7 V	Врачом Калединой
			1954 год		
1	Евраячики (10 шт.—живые)	14--15.IV	с. Курченко 13 км на восток	25.IV	Врачами Фадеевой и Шмутер

[Table 3 is keyed here as follows: It will be noted that in reading downward, for each year, beginning with 1946, there is a vertical numeration which begins anew for each year. The description will be given by years according to these numbers and also in accordance with the numbering of the horizontal columns. For convenience the following abbreviations are used in this Table: sous.=souslik; c.j.=crested jird, Meriones tamariscinus ; m.j. [Meriones meridianus]; h.m.=house mouse; jer.=jerboa; N. Kh.=Naryn-Khuduk.]

1946

Column 2, reading down: 1. sous. (one--living); 2. fleas (group); 3. fleas (group); 4. fleas (group); 5. sous. (group--living); 6. sous. (one--living); 7. sous. (one--living); 8. sous. (one--living); 9. sous. (one--living); 10. sous. (group--living); 11. sous. (group--living); 12. sous. (one--living); 13. (group--living); 14. fleas (group). Column 3: [It will be noted that the months are designated by Roman numerals]; Column 4: 1. N. Kh., 12 kilometers to the NE; 2. N. Kh., 2 kilometers to the NE; 3. N. Kh., 25 kilometers to the W; 4. N. Kh., 15 kilometers to the W; 5. environs of N. Kh.; 6. N. Kh., 14 kilometers to the N; 7. N. Kh., 14 kilometers to the N; 8. N. Kh., 3 kilometers to the N; 9. N. Kh., 2 kilometers to the W; 10. Khuduk Tsuba, 5 kilometers to the W; 11. Khuduk Tsuba, 2 kilometers to the W; 12. Khuduk Tsuba, 3 kilometers to the W; 13. Khuduk Tsuba, 3 kilometers to the W; 14. environs of Khuduk Tsuba. Column 6: 1. The physician Proshchenko; 2-14. The physician Proshchenko.

1947

Column 2: 1. sous. (group-living); 2. same (132 individuals); 3. sous. (group--living); 4. (81 individuals); 5. (group); 6. sous. (group--living); 7. same (group--living, six); 8. (group--living, eight); 9. (group--living, one). Column 4: 1. Siding No 6, 12 kilometers from Yandyki; 2. N. Kh., 1 kilometer to the W; 3. N. Kh., 3 kilometers to the W; 4. N. Kh., 3 kilometers to the W; 5. N. Kh., 3 kilometers to the W; 6. N. Kh., 3 kilometers to the W; 7. N. Kh., one kilometer to the W; 8. N. Kh., one kilometer to the W; 9. Yandyki, 3 kilometers to the E. Column 6: 1. The physician Ivashkova; 2. The physician Aleshina; 3. The physicians Aleshina and Konovich; 4. The physician Aleshina; 5. The physicians Aleshina and Konovich; 6. The physicians Aleshina and Konovich; 7. The

physician Konovich; 8. The physician Aleshina; 9. The physician Konovich.

1948

Column 2: 1. c.j. (one--living); 2. h.m. (one--living); 3. c.j. (one--dead); 4. same (25); 5. same (one); 6. c.j. (one--dead); 7. same; 8. m.j. (one--dead); 9. m.j. (one--dead); 10. sous. (one--living); 11. sous. (one--living); 12. jer. (one--living); 13. sous. (group--living); 14. (group); 15. same (24); 16. sous. (group--living); 17. jer. (one--living); 18. same (three) 19. same (three); 20. sous. (one--dead); 21. sous. (one--living); 22. m.j. (one--dead); 23. sous. (group--living); 24. sous. (group--living); 25. m.j. (one--dead); 26. same (13); 27. sous. (one--living); 28. sous. (group--living); 29. sous. (group--living); 30. sous. (16); 31. sous. (group--living); 32. sous. (group--living); 33. sous. (group--living); 34. sous. (one--inactive); 35. sous. (group--living); 36. same (group); 37. same (group); 38. sous. (one--dead); 39. same; 40. same (group); 41. same (seven); 42. same (107); 43. same (96); 44. same (25); 45. c.j. (one--dead); 46. c.j. (one--dead); 47. h.m. (one--dead); 48. same; 49. same; 50. same; 51, 52, 53. h.m. (one--dead); 54. same (15); 55. h.m. (one--dead). Column 4. 1. Venderevo, 8 kilometers to the S; 2. Budarino, house; 3. Venderevo, one kilometer to the S; 4. Venderevo, 8 kilometers to the NW; 5. Budarino, house; 6. Nasharovo, one kilometer to the S; 7. Nasharovo, 0.5 kilometers to the N; 8. Dal'cha, 1.5 kilometer to the NW; 9. N. Kh., 3 kilometers to the N; 10. Krasnyy Partizan kolkhoz, 3 kilometers to the S; 11. same, 2.5 kilometers to the S; 12. Venderevo, three kilometers to the SE; 13. Budarino, four kilometers to the W; 14. N. Kh., three kilometers to the SE; 15. Venderevo, three kilometers to the SE; 16. Budarino, 5.5 kilometers to the W; 17. Venderevo, two kilometers to the SW; 18. Zel'ma, two kilometers to the SW; 19. Venderevo, two kilometers to the SE; 20. Kun'kuni, two kilometers to the N; 21. Mal. Karavannoye, 100 meters to the N; 22. N. Kh., three kilometers to the N; 23. Venderevo, two kilometers to the SW; 24. Zenzeli, two kilometers to the N; 25. N. Kh., 1.5 kilometers to the N; 26. Venderevo, one kilometer to the SE; 27. Mal. Karavannoye, 300 meters to the N; 28. Nasharovo, two kilometers to the SE; 29. Sixth Siding, one kilometer to the NW; 30. N. Kh., two kilometers to the E; 31. Mal. Karavannoye, 300 meters to the N; 32. same, 30 meters to the N; 33. Khalkduta, five kilometers to the NW; 34. Kun'kuni, 200 meters from the village; 35. Krasnyy Partizan kolkhoz, two kilometers to the N; 36. N. Kh., 2.5 kilometers

to the SE; 37. Krasnyy Partizan kolkhoz, 2.5 kilometers to the NW; 38. Kun'kuni, 3 kilometers to the NW; 39. Khalkhuta, 5 kilometers to the NE; 40. same, 4 kilometers to the NW; 41. same, 5 kilometers to the NW; 42. Krasnyy Partizan kolkhoz, 3 kilometers to the S; 43. N. Kh., 7 kilometers to the W; 44. Venderevo, 0.5 kilometer to the S; 45. Grakhota, 1 kilometer to the NW; 46. Obraztsovoye, 4 kilometers to the W; 47. Yandyki, 4 kilometers to the N of the Kukshin natural boundary (rick); 48. same, (camp); 49. same, (near a haystack); 50. same, (steppe); 51. same; 52. same; 53. same; 54. Yandyki, 5 kilometers to the NW; 55. same, five kilometers to the N (steppe). Column 6: 1. The physician Stolchenova; 2. The physician Ivanov; 3. The physician Stolchenova; 4. same; 5. same; 6. same; 7. same; 8. The physician Khokhlova; 9. The physician Kononovich; 10. The physician Ivanov; 11. The physician Ivanov; 12. The physician Stolchenova; 13. same; 14. The physician Kononovich; 15. The physician Stolchenova; 16, 17, 18, 19. same; 20. The physician Shatilova; 21. same; 22. The physician Kononovich; 23, 24. The physician Stolchenova; 25. The physician Kononovich; 26. The physician Stolchenova; 27. The physician Shatilova; 28. The physician Stolchenova; 29. same; 30. The physician Kononovich; 31, 32. The physician Shatilova; 33. The physician Proshchenko; 34. The physician Shatilova; 35. The physician Kononovich; 36. same, 37. same; 38. The physician Shatilova; 39, 40, 41. The physician Proshchenko; 42, 43. The physician Kononovich; 44. The physician Stolchenova; 45. The physician Ivashova; 46. same; 47, 48. The physician Sokrutova; 49. The physicians Sokrutova and Melashchenko; 50. The physician Melashchenko; 51. The physician Sokrutova; 52, 53, 54. The physician Zinina; 55. The physician Sokrutova.

1949

Column 2: 1. h.m. (one--dead). Column 4: 1. Yandyki, 4 kilometers to the N. Column 5: January.

1951

1. c.j. (group--living). Column 4: 1. Venderevo. Column 6: By the physician Kalodina.

Column 2: 1. jer. (ten--living). Column 4: 1. Village of Kurchenko, 13 kilometers to the E. Column 6: 1. By the physicians Fadeyeva and Shmuter.

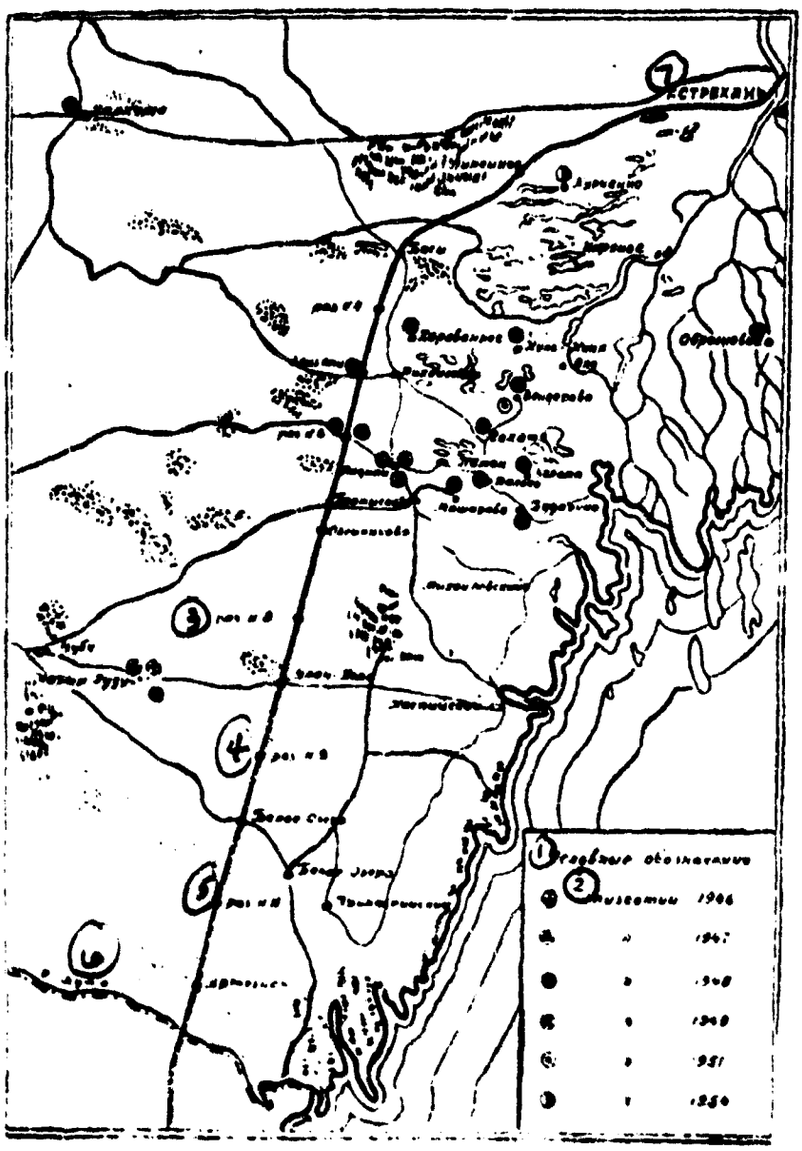

Fig 1. Places at which epizootics were found in 1946-1954. 1. Key; 2. Epizootics; 3, 4, 5. Sidings; 6. Kuma River; 7. Astrakhan'.

amounting to 3.7 percent. From fleas taken from rodents nine cultures or 11.2 percent were obtained, that is, 33.3 percent of the cultures were obtained from sousliks and 66.7 percent, from fleas.

The fleas from which the plague culture was isolated are divided in the following way in accordance with their species composition: C. tesquorum, 11, or 44.0 percent; N. setosa, eight, or 32.0 percent; Opht. volgensis, three, or 12.0 percent; C. mokrzeckyi, two, or 8.0 percent; C. laeviceps, one, or 4.0 percent.

It should be noted that 72 percent of the cultures were isolated during the spring-summer and only 28 percent, in the autumn and winter.

We should not overlook, at least in general outlines, the determination of plague epizootics on adjacent territories Groznenskaya Oblast and Dagestanskaya ASSR.

Thus, according to the materials of V. N. Ter-Vartanov, in 1950, 70-80 kilometers to the SW of the settlement of Karyn-Khuduk, a plague epizootic was found in sousliks and 37 cultures of plague microbe were isolated. In 1951, in approximately the same places of Kizlyarskiy Rayon a new epizootic was found, and 11 cultures were isolated. In the same year, 80-100 kilometers from the sites of epizootics of previous years, 112 plague cultures were isolated on the territory of Dagestanskaya ASSR.

In 1952, epizootics occurred on the territory of the Chechen-Ingush and Dagestan Republics, during which a large number of plague cultures were also isolated from several species of rodents and ectoparasites.

It is hard to determine the routes by which plague came into these places. Some claim that it was imported from the region of Karyn-Khuduk by a relay method; others believe that plague was imported by domestic animals during the driving of cattle; still others assume the possibility of existence of independent foci of plague there previously. Here, it is important to note that the territory of the Nogaysk Steppes is a part of the general natural focus of plague in the NW Caspian region.

As follows from the data presented in the Table, on the territory of the Kalmytskaya ASSR and the right-bank area of Astrakhanskaya Oblast plague has not been recorded for a total of only five years. This period, surely, is too small for claiming that the danger of plague has been eliminated here. Therefore, in the future extensive work needs to be done on the study of the status of plague infection in the focus with the use of the latest diagnostic methods of investigation. This is a very important division of the work, because the government has expended considerable effort and materiel for the elimination of the plague epizootic. There is no doubt of the fact that in the near future, in connecti-

ion with the reclaiming of territory for farming (watering, tree-planting, plowing of the earth, the production of gas, the increase in the sizes of inhabited places and others) plague will be eliminated forever on this territory also.

M. I. Levi, B. G. Val'kov, A. I. Shtel'man, Yu. V. Kanatov

Experimental Plague in Different Populations of Meridional Jirds

In the focus in the Northwest Caspian the main reservoir of the plague microbe is the dwarf souslik [Citellus pygmaeus], which forms uninterrupted settlements with a stable census on this territory. The eastern regions of the focus are inhabited by jirds--meridional and crested [Meriones meridianus and Meriones tamariscinus]; however, these animals do not form continuous settlements here. The bulk of plague microbe cultures in the focus in the Northwest Caspian was isolated from sousliks and their fleas. Only isolated cultures were obtained from jirds, whereby the finding of infected jirds always coincided with diffuse epizootics in dwarf sousliks during the spring-summer, that is, during the period of active existence of these hibernating animals.

In the Volga-Ural natural focus of plague the main reservoir, as has been shown in the work of N. P. Mironov (1934), is the meridional jird, which forms continuous settlements with a stable census and together with its fleas, Xenopsylla conformis and Ceratophyllus laeviceps, maintains the plague enzootic. The great mass of cultures in the Volga-Ural focus has been isolated from meridional and crested jirds as well as from the fleas mentioned above.

In the focus in the Northwest Caspian the meridional jirds do not play the part of the main reservoir for the following reasons: a) the mosaic nature of the settlements; b) the rarity of interspecies and intraspecies contacts; c) the absence of actively migrating Xenopsylla conformis fleas on this area which are responsible for the characteristics of plague epizootics in some other foci; d) at the openings of the jird holes fleas are almost never present, whereas these insects are common at the entrances to the holes of the Volga-Ural focus jirds (N. N. Bakeyev, 1956; N. N. Bakeyev and coauthors, 1956; V. S. Petrov and M. F. Shmuter, 1958; N. P. Mironov, 1957; N. P. Mironov and coauthors, 1957; M. I. Kryuchkov and coauthors, 1957; B. N. Pastukhov, 1958; Yu. M. Rall', 1958; A. N. Pavlov and coauthors, 1957). Yu. M. Rall' and V. N. Fedorov, V. S. Petrov and M. F. Shmuter expressed themselves on behalf of the existence of a single main reservoir for each separate focus of plague. The opponents of the view presented, although few (I. N. Mazontov, N. I. Kalabukhov) insist on the multiple-host nature of the natural plague foci, particularly of the natural focus in the Northwest Caspian.

Therefore, the meridional jird which inhabits the sandy semideserts of the area between the Volga-Ural rivers

plays the part of the main reservoir; in the steppes of the Northwest Caspian region this species does not play any significant part in maintaining the plague enzootic. M. M. Tikhomirova (1934), V. N. Lobanov and V. N. Fedorov (1939), V. M. Tumanskiy (1958), A. I. Shtel'man and A. A. Rozhkov (1955), M. F. Shmuter and coauthors (1957), and L. S. Malafeyeva (1957) have shown that the meridional jird belongs to the group of comparatively resistant species, because the majority of animals survived after infection with such large doses as 10,000,000-1,000,000,000 microbes of plague culture of a virulent strain. Simultaneously, pronounced differences in individual sensitivity were noted: whereas various animals died of the administration of 1,000 microbe bodies, part of the jirds survived after infection with 1,000,000,000 microbes.

The work of Ye. S. Biryukova (1957) stands apart; in her experiments only two out of 195 meridional jirds infected with doses less than 100 microbes survived. Ye. S. Biryukova found that the meridional jirds were no different from crested jirds in their infectious sensitivity; the latter are considered to be highly sensitive species by all investigators. This contradiction between the results of Ye. S. Biryukova's experiments and those of the other authors has not been given a satisfactory explanation. However, it is well known that Ye. S. Biryukova worked with meridional jirds from the right bank of the Volga, while all other investigators tested jirds from the left bank of the river.

Yu. M. Rall' and V. N. Fedorov believe that "... inherent in every virus is a definite immunobiological structure which has been elaborated in the course of history." It seems incredible that various populations of the same species can react differently to an infectious principle. Gloster and White (quoted by V. A. Barykin (1957)) infected rats from different places in India with plague, whereby the rodents of the State of Madras, which is free of plague showed 97 percent mortality, while rodents of the old plague focus in the State of Kanpore showed a total of 13 percent mortality. However, it is not certain that the authors worked with rats which had suffered from plague in nature. I. S. Tinker and Ye. N. Aleshina (1955) found that dwarf sousliks of the steppe region are five-eight times more susceptible to plague than sousliks taken from a different place. The lack of simultaneity of experiments performed by the authors and some other errors reduced the value of this work somewhat. N. I. Kalabukhov, N. A. Mokriyevich and S. A. Petrosyan (1959) found the differences in the ecologico-physiological characteristics of different populations of certain species of jirds, whereby those characteristics were investigated which, in the authors' opinion, may have a bearing on the susceptibility of rodents to plague.

In October-November 1958 N. I. Kalabukhov and A. I. Shtel'man performed an orientative experiment of simultaneous infection of a small number of right-bank and left-bank meridional jirds with plague bacteria (strain 297) in the laboratory of the Astrakhan' Plague-Control Station. The infection was carried out only with large doses--from a few score to several hundreds of millions of microbes. Of the 54 left-bank jirds 22 survived; at the same time, all 18 right-bank jirds infected with the same doses died with signs of acute plague.

In the present work we set before ourselves the aim of studying the infectious sensitivity of meridional jirds of the right and left banks of the Volga to plague under identical conditions. The work was conducted in parallel at the laboratories of the Astrakhan' and the Elista Plague-Control stations. The adult animals of both populations of approximately the same weight (32-44 grams) and the same sex ratios were infected simultaneously subcutaneously with the same strains and the same dilutions of plague culture, and after the infection they were kept under the same conditions. The jirds were caught in December 1958; the experiments were performed in January-March 1959: experiments 1, 3, 5, 7 and 8--at the laboratory of the Astrakhan' Plague-Control Station; experiments 2, 4 and 6--at the laboratory of the Elista Plague Control Station. In the meridional jirds of the right and left banks of the Volga in experiments 1 and 2 a study was made of bacteriemia. The places at which the rodents were caught are noted in Fig 1, which shows the distribution of meridional jirds on the right and left banks of the Volga.

The jirds were infected with strain 297 which had been isolated from a jerboa in 1954 in the Northwest Caspian focus; with strain 403, isolated from red-tailed jirds [Meriones erythrourus] in 1958 in a focus in the eastern Transcaucasus; and strain 1042, isolated from a great sand rat in the Central Asiatic Plain focus in 1955 (Table 1).

After a preliminary plating-out on nutrient agar six-seven animals from the right bank and the same number of animals from the left bank were infected subcutaneously with each dose--from 10^{-1} to 10^{9} microbial bodies. Calculation of the LD_{50} was made by the Reed and Muench method, while the standard deviations from the figures obtained were calculated according to the Pizzi formula (Shwerdt and Merrill).

While in the experiments performed by the Astrakhan' Station the difference in the LD_{50} for both populations amounted to a figure of approximately 20,000-30,000, according to the data of the Elista Station, the same figure was somewhat less than 67,000. The difference in the average life-spans of the jirds which died was considerable. Whereas the meridional jirds from the right bank died with a picture of acute plague, the left-bank animals, in the great-

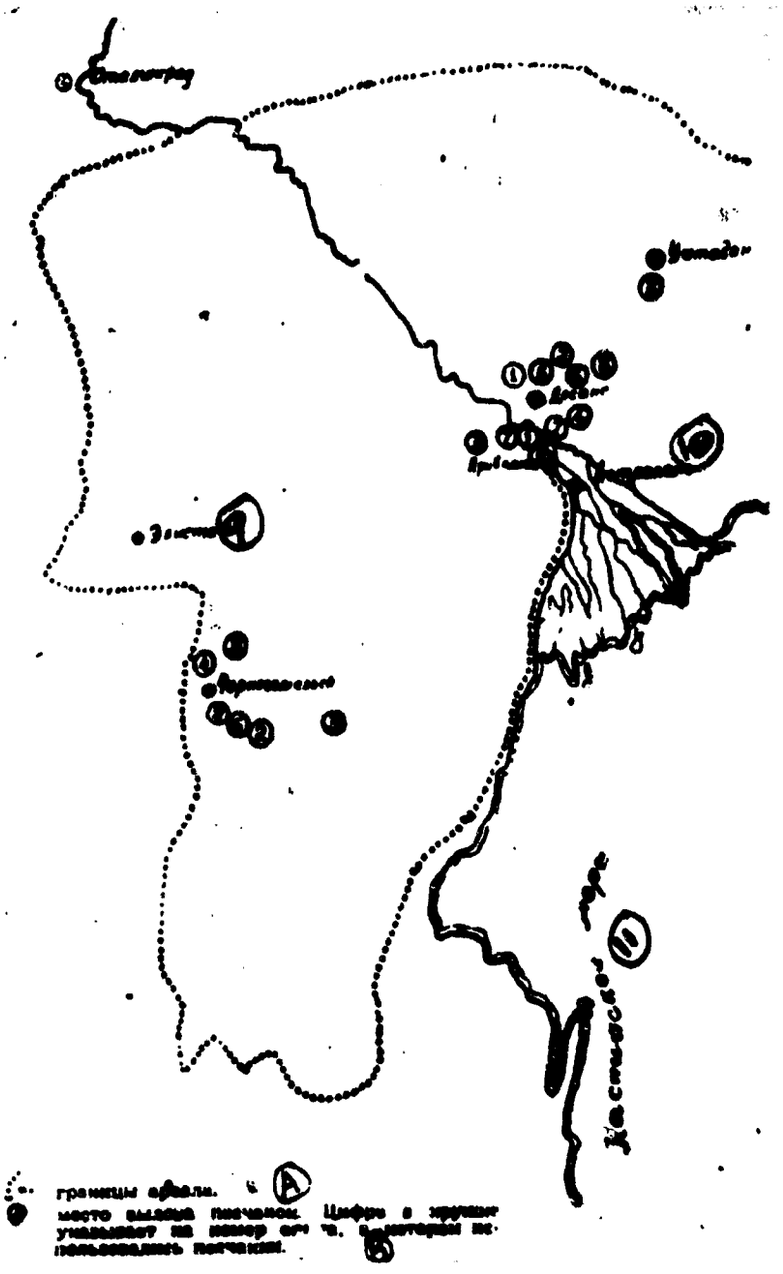

Fig. 1. Area of Distribution of Meridional Jird in the Region of the Lower Course of the Volga. A. Boundaries of area of distribution; B. Place at which jirds were caught. The figure in the circle indicates the number of the experiment in which the jirds were used; [that is, the figures from 1 through 8 on the map show this; the figures in circles which have been added by the translator, namely, 9, 10 and 11, are appropriately described here]; 9. Elista; 10. Astrakhan'; 11. Caspian Sea.

Table 1

Comparative Sensitivities of Meridional Jirds of the Right and Left Banks of the Volga to Subcutaneous Infection with Plague Bacteria.

(1) № опыта	(2) Штамм бактерий чумы	(3) Доза для заражения в м. т.	(4) Полученные песчанки						(11) Белые мыши			(12) Морские свинки		
			(5) правого берега			(6) левого берега								
			падо (7) всего	средняя продолжительность жизни (сутки) (9)	логарифм ЛД и антилогарифм в м. т. (10)	падо (7) всего	средняя продолжительность жизни (9)	логарифм ЛД и антилогарифм в м. т. (10)	падо (7) всего	средняя продолжительность жизни (9)	логарифм ЛД и антилогарифм (10)	падо (7) всего	средняя продолжительность жизни (9)	логарифм ЛД и антилогарифм в м. т. (10)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		10^{-1}	0/6	-		0/6	—		—			—	—	
		10^{0}	0/6	—		0/6	—		—	—		—	—	
		10^{1}	0/6	—		0/6	—		—	—		3/4	8	
		10^{2}	1/6	5		0/6	—		—	—		3/3	5	
		10^{3}	3/6	13		0/6	—		—	—		4/4	5.3	
1	297	10^{4}	4/5	8	3,0000 = 1000	1/6	8	7,0942 = 1950000	—	—		4/4	5.3	0,6667 = 5
		10^{5}	6/6	5.3		0/6	—		—	—		—	—	
		10^{6}	6/6	2.2		0/6	—		—	—		—	—	
		10^{7}	6/6	2		2/6	6.5		—	—		—	—	
		10^{8}	6/6	2		3/6	6.3		—	—		—	—	
		10^{9}	—	—		5/6	6		—	—		—	—	

1. No of Experiments; 2. Strain of Plague Bacteria; 3. Dose for the Infection in Microbe Bodies; 4. Meridional Jirds; 5. Right Bank; 6. From the Left Bank; 7. Died; 8. Total; 9. Average Length of Life (Days); 10. LD50 Logarithm; Antilogarithm in Microbe Bodies; 11. White Mice; 12. Guinea Pigs.

/Table 1 continued/

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	403	10^{-1}	1/4	4	0,8462 = 7	0/6	—	5.6739 = 472000	0/5	—	0.8779 = 8	0/4	—	0 = 1
		10^{0}	1/7	4		0/7	—		0/5	—		2/4	12	
		10^{1}	3/7	5.7		0/5	—		4/5	11,2		4/4	7,5	
		10^{2}	7/7	3,7		1/6	8		4/5	7,3		4/4	11,3	
		10^{3}	7/7	3,4		2/7	3,5		4/5	5,8		4/4	7,8	
		10^{4}	5/6	2,8		3/7	7,4		5/5	5,4		4/4	5	
		10^{5}	7/7	2,7		2/7	10,5		5/5	3		4/4	5,5	
		10^{6}	7/7	2,3		2/7	3		5/5	4,2		4/4	6,8	
		10^{7}	7/7	2		4/7	3,3		5/5	2,6		4/4	5	
		10^{8}	7/7	2		7/7	3,1		5/5	2,6		4/4	6,3	
		10^{1}	1/4	8	2,1666 = 147	—	—	6.5238 = 3340000	0/4	—	1,3 = 32	2/4	6,5	1 = 10
		10^{2}	1/4	5		—	—		4/4	4,3		4/4	7,3	
		10^{3}	4/4	4,8		0/4	—		4/4	3,8		4/4	7,8	
		10^{4}	4/4	4		0/4	—		4/4	2,8		4/4	6,3	
		10^{5}	1/4	2,5		1/4	6		4/4	3,5		—	—	
		10^{6}	4/4	2,3		0/4	—		4/4	3		—	—	
		10^{7}	—	—		3/4	3,3		—	—		—	—	
		10^{8}	—	—		4/4	4		—	—		—	—	
3	1042	10^{1}	0/4	—	1,8333 = 68									
		10^{2}	3/4	4										
		10^{3}	4/4	4,8										
		10^{4}	3/4	3										
		10^{5}	4/4	2,8										
		10^{6}	4,4	2										
		10^{1}	2/4	13	1,2325 = 17									
		10^{2}	3/4	9,3										
		10^{3}	4/4	4,3										
		10^{4}	4/4	3,5										
		10^{5}	4/4	2,5										
		10^{6}	4/4	2										

majority of cases, showed distinct pathological changes (enlargement of the spleen, liver, lymph nodes, areas of necrosis and others).

Table 2

Significance of the Differences in the Infectious Sensitivities of Right-Bank and Left-Bank Meridional Jirds to Plague (in Decimal Logarithms)

(1) № опыта	(2) Полуденные песчанки правого берега (3)		(4) левого берега		Разница в LD_{50} (7)	Сумма стандартных отклонений (8)
	LD_{50} (5)	стандартные отклонения (6)	LD_{50} (5)	стандартные отклонения (6)		
1	3,0000	±0,3847	7,6442	±0,3550	4,6442	0,8397
2	0,8462	±0,3715	5,6739	±0,3621	4,8277	0,9336
3	2,1660	±0,4062	6,5238	±0,3962	4,3572	0,8024

1. No of Experiments; 2. Meridional Jirds; 3. From the Right Bank; 4. From the Left Bank; 5. LD_{50}; 6. Standard Deviations; 7. Difference in the LD_{50}; 8. Sum of Standard Deviations.

In all three experiments the difference in the LD_{50} for the meridional jirds from the right and left banks was almost the same, whereby it was many times greater than the sum of the standard deviations (that is, it was statistically significant). The standard deviations (CO) were calculated from the Pizzi formula--logarithm $CO=\pm\sqrt{\frac{0.79nR}{n}}$, where 0.79 is a constant factor; n is the logarithm of the ratio of each successive dose to the previous one; R is the difference between the logarithms of the LD_{75} and the LD_{25}; n is the number of animals used for each dose.

The meridional jirds of the right bank belong to the subspecies Meriones meridianus nogaiorum Kept., while the meridional jirds of the Dosang region belong to the subspecies Meriones meridianus Pall., whereas the jirds of the central sandy area near Ushtagan belong to the subspecies Meriones meridianus uschtaganicus Rall. (Vinogradov and Promov). In our experiments, as is seen from the schema, representatives of these subspecies were used. On the right bank of the Volga the meridional jirds were caught in three places; on the left bank, in two.

We also compared the infectious sensitivity of crested jirds from the right bank, belonging to the subspecies

Meriones tamariscinus ciscaucasicus Sat. with crested jirds from the left bank, which belong to the subspecies Meriones tamariscinus tamariscinus Pall.; however, no definite differences were detected (Table 3).

Differences in the absolute figures for LD_{50} obtained by the Astrakhan' and Elista stations are explained by the different qualities of plague bacteria strains used in this work. Strains 403 and 297 possess approximately the same virulence for guinea pigs and white mice and different degrees of virulence for jirds (Table 4), whereby those differences proved to be statistically significant. The quantitative differences in the virulence of different strains for animals can be expressed as the difference between the logarithms of LD^1_{50} and LD^2_{50}. The difference between these figures can be considered statistically significant if the difference between the LD_{50} logarithms exceeds the sum of the standard deviations from these values. In other words, the index of differences in virulence is equal to $(\lg LD^1_{50} - \lg LD^2_{50}) - (\lg CC \text{ for } LD^1_{50} + \lg CO \text{ for } LD^2_{50})$. (If the value of $\lg LD_{50}$ is less than $\lg LD^2_{50}$ their places are changed).

In their virulence for white mice and guinea pigs strains 297 and 403 showed no essential differences. For meridional and crested jirds strain 403 proved to be no less than 10-35 times more virulent than strain 297. Such facts have not been previously described for the plague pathogen, whereas for tularemia bacteria, for example, it is known that strains equally virulent for white mice and guinea pigs showed different degrees of activity on white rats.

For all species of animals tested the differences in virulence between the strains 297 and 1,042, 1,042 and 403 were unitypical: for example, strain 1,042 was 2.2 times more virulent than strain 297 for meridional jirds from the left bank and 1.9 times more virulent for white mice. Therefore, the differences were of a quantitative rather than a qualitative nature.

We are inclined to explain the facts found from a historical standpoint. The existence of plague foci in the Caspian region, in the opinion of Yu. M. Rall' (1956), has been for tens of millions of years. It may be supposed that the population of meridional jirds from the right bank of the Volga has maintained the sensitivity to plague characteristic of the species, because there the main reservoir of the plague microbe consists of the dwarf sousliks, while the participation of meridional jirds in epizootics is a rare exception.

Table 3

Comparative Sensitivities of Crested Jirds from the Right and Left Banks of the Volga to Subcutaneous Infection with Plague Bacteria.

(1) Штамм бактерий чумы	(2) Доза для заражения м. т.	(3) Тамарисковые песчанки						(10) Белые мыши			(11) Морские свинки		
		(4) правого берега			(5) левого берега								
		(6) пало			(6) пало			(6) пало			(6) пало		
		(7) всего	(8) средняя продолжительность жизни в сутках	(9) логарифм LD_{50} и антилогарифм м. т.	(7) всего	(8) средняя продолжительность жизни в сутках	(9) логарифм LD_{50} и антилогарифм м. т.	(7) всего	(8) средняя продолжительность жизни в сутках	(9) логарифм LD_{50} и антилогарифм м. т.	(7) всего	(8) средняя продолжительность жизни в сутках	(9) логарифм LD_{50} и антилогарифм м. т.
403	10¹	5/5	4.6	<10	2/2	1/5	<10	1/4	8	<10	—	—	+
	10²	1/4	4.3		3/3	5		4/4	7		—	—	
297	10⁻¹	0/4	—		0/4	—		0/1	—		—	—	
	10⁰	0/4	—	$\frac{2,8334}{10}$ =680	0/4	—	$\frac{2,6667}{10}$ =500	0/2	—	$\frac{0,5}{10}$ =3	—	—	<10
	10¹	0/4	—		0/4	—		2/2	9		4/4	7,2	
	10²	0/4	—		0/3	—		2/2	6		4/4	7,2	
	10³	3/4	10		3/4	5		2/2	4		4/4	6,7	
	10⁴	3/4	11,3		4/4	6,8		2/2	4		4/4		

1. Strain of Plague Bacteria; 2. Dose for Infection, Microbes; 3. Crested Jirds; 4. From the Right Bank; 5. From the Left Bank; 6. Died; 7. Total; 8. Average Length of Life in Days; 9. Logarithm of LD_{50} and Antilogarithm in Microbes; 10. White Mice; 11. Guinea Pigs.

[Legend to Table 4, pp 50-51.]
1. Species of Animal; 2. Guinea Pigs; 3. White Mice; 4. Meridional Jirds; 5. From the Right Bank; 6. From the Left Bank; 7. Crested Jirds; 8. lg LD_{50}; 9. lg of Standard Deviations; 10. Difference in Logarithms of LD_{50}; 11. Sum of Standard Deviations; 12. Index of Difference in Virulence; 13. The Virulence Was Determined Twice; 14. Antilogarithm of the Index; 15. Strains Being Compared.

At the same time, the population of meridional jirds from the left bank of the Volga has acquired a new property in the form of resistance to plague under the influence of continuously occurring epizootics. The effect of epizootics on the genetic structure of populations of meridional jirds from the left bank, in our opinion, can have two explanations. According to the first, the epizootics acted like a factor in natural selection--those individuals which possessed a somewhat greater physiological resistance to the disease survived, whereas other individuals died. In connection with the continuity of action of this factor over generations of the animals an accumulation of properties occurred which contributed to the survival of the jirds during epizootics. According to the second explanation, frequent contact between the meridional jirds of the left bank of the Volga and the plague microbe led to the formation of a considerable segment of individuals which had recovered from the sickness, as the result of which resistance to plague became a trait which was transmitted by heredity.

Because in historical times on the left bank of the Volga apparently various individuals, and perhaps entire populations, existed which, for various reasons, were not involved in the plague epizootic, the parent pairs (males and females) in a certain percentage of cases were of different qualities with respect to the level of resistance, as the result of which the subsequent generations also showed pronounced individual deviations with respect to the resistance level. It is thereby possible to explain the condition of the left-bank population at the present time where, among meridional jirds various individuals are encountered which die from the administration of relatively low doses of the plague microbe. The resistance of meridional jirds of the left bank of the Volga in our experiments cannot be explained by the fact that they have recovered from plague, because in the Volga-Ural focus, because of the influence of many years of rodent-extermination operations, plague microbe cultures have not been isolated either from rodents or ectoparasites since 1952 after the most intense investigation; in the Josang area they have not been isolated since 1943. The average lengths of life of these animals in nature amount

Table 4. Comparative Virulences
Bacteria for Certain

Вид животного (1)	Морские свинки (2)				Белые мыши (3)				Пойманные (4) грызуны правого берега			
Сравниваемые штаммы (15)	lg M_{50} (9)	lg стандартное отклонение (9)	разность логарифмов под M_{50} (10)	сумма стандартных отклонений (10)	показатель разницы в вирулентности (11)	lg M_{50} (6)	lg стандартное отклонение (5)	разность логарифмов под M_{50} (16)	сумма стандартных отклонений (17)	показатель разницы в вирулентности (18)	lg M_{50} (8)	lg стандартное отклонение (8)	разность логарифмов под M_{50} (10)	сумма стандартных отклонений (14)	показатель разницы в вирулентности (12)
257	0,6667 0,5	±0,3633 ±0,3343	0,5	0,1333	-0,1496 -0,2203	0,5	±0,3545	0	0,6286	-0,1044 -0,6286	5	±0,3343	2,1938	0,7662	1,5996
403	0	±0,14150	0,6667	0,8083		0,2772 0,5	±0,4585 ±0,3343	0,3772	0,1736		0,8962	±0,3715			26
287	0,6667 0,5	±0,3633 ±0,3343	0,5	0,7529	-0,0750 -0,2295	0,5	±0,3343	1	0,6286	0,2714	3	±0,3343			
1042	1	±0,1950	0,3333	0,1083		1,5	±0,3343			1,9	2,1666	±0,4502	0,4335	0,1909	0,0424
1042	1	±0,4950	1	0,11		1,5	±0,3343	1	0,6286	-0,1506 0,3714	2,1666	±0,4502	1,5208	0,1178	0,5021
403	0	±0,4950	1	0,58	1,3	0,2772 0,5	±0,4585 ±0,3343	0,3772	0,1736	2,7	0,8962	±0,3715			15

The legend for Table 4 is on page 40.

of Different Strains of Plague

Species of Rodents.

Песчанки левого берега					Тамарисковые песчанки правого берега					Песчанки левого берега				
lg $ЛД_{50}$	lg стандартных отклонений	разность логарифмов $ЛД_{50}$	сумма стандартных отклонений	показатель различия в вирулентности	lg $ЛД_{50}$	lg стандартных отклонений	разность логарифмов $ЛД_{50}$	сумма стандартных отклонений	показатель различия в вирулентности	lg $ЛД_{50}$	lg стандартных отклонений	разность логарифмов $ЛД_{50}$	сумма стандартных отклонений	показатель различия в вирулентности
7.6945	±0.4550	2.0205	1.0171	1.0055	2.8594	±0.4785	2.8537	0.7928	1.6406	2.6661	±0.5663	2.1067	0.6736	1.4891
5.6439	±0.5621			10	0.5	±0.5145			55	0.5	±0.3863			31
7.6092	±0.4550	1.4104	0.8512	0.1592										
6.5458	±0.3962			1.4										
6.5258	±0.3962	0.0494	0.9584	-0.1084										
6.6138	±0.5621													

* Вирулентность определялась дважды (13)

** Оптитографом показателя (14)

to three-four months [7]. If we consider the inheritance of acquired resistance to plague possible it may be supposed that this trait possesses specificity. For checking this, experiments were performed on the comparison of infectious sensitivity and susceptibility of meridional jirds from the right and left banks of the Volga to tularemia and brucellosis (Tables 5 and 6).

The data presented are evidence to the effect that right-bank and left-bank meridional jirds are the same with regard to infectious sensitivity and susceptibility to tularemia and brucellosis. Prior to our experiments Ye. I. Novikova and T. N. Rusina (1955) found that meridional jirds die of tularemia after infection with such small doses as one microbe (the authors used jirds from the left bank). I. F. Taran (1959) found that meridional and crested jirds (from the right bank) are highly susceptible to the pathogen of brucellosis. In the experiments of M. M. Tikhomirova (1934) meridional jirds from the left bank of the Volga died after infection with small doses of the pseudotuberculosis pathogen. Therefore, it must be recognized that the resistance of meridional jirds to plague is not accompanied by increased resistance to any of the infectious diseases mentioned above.

We adhere to the viewpoint that both explanations presented are of actual significance. In those remote periods when the focus was established in the area between the Volga and Ural Rivers the meridional jirds were highly sensitive to plague. In some, although rare, cases the animals survived after infection with the plague microbe. The survival of various individuals could have been conditioned by the penetration of a relatively low dose of the infectious agent into the animal organism or by increased resistance from some kind of physiological characteristics. The epizootics acted as factors of natural selection and over generations led to an intensification of the physiological characteristics contributing to survival of the animals. This fact simultaneously led to an increase in the number of jirds which had recovered from plague and had developed resistance. Resistance to plague gradually began to be transmitted by heredity. Therefore, while initially the survival of various animals was assured by the penetration of a low dose of the infectious agent into the animal organism or by physiological characteristics, subsequently this factor received reenforcement in the form of inherited resistance, to which we ascribe decisive importance in explaining the present resistance of the population of left-bank meridional jirds to plague.

B. K. Fenyuk, M. Baltazard, L. S. Malafeyeva and some other authors believe that in foci of plague in which an important part is played by non-hibernating species of

Table 5

Comparative Sensitivity of Meridional Jirds from the Right and Left Banks of the Volga to Subcutaneous Infection with Tularemia Bacteria.

№ опыта (1)	Штамм бактерий туляремии (2)	Доза для заражения в м. т. (3)	Полученные песчанки (4) правого берега (5) пало (7) всего (8)	средняя продолжительность жизни в сутках (9)	логарифм LD_{50} и антилогарифм (10)	левого берега (6) пало (7) всего (8)	средняя продолжительность жизни в сутках (9)	логарифм LD_{50} и антилогарифм (10)	Белые мыши (11) пало (7) всего (8)	средняя продолжительность жизни в сутках (9)	логарифм LD_{50} и антилогарифм (10)	Морские свинки (12) пало (7) всего (8)	средняя продолжительность жизни в сутках (9)	логарифм LD_{50} и антилогарифм (10)
6	713	10^{-1}	3/4	9	(13)	3/4	7.7	(13)	0/1	—		—	—	(13)
		10^{0}	3/3	6.7		4/4	7.5		4/4	7.5		3/3	12.7	
		10^{1}	4/4	6.3		4/4	6.3		4/4	6.5		3/3	9.7	
		10^{2}	4/4	5.3		4/4	5.8		4/4	5.8		3/3	9	
		10^{3}	4/4	5		4/4	4.8		4/4	5.3		—	—	
7	1303	10^{-1}	0/6	—		5/6	10.6		2/4	8.5		—	—	
		10^{0}	6/6	7.5		6/6	10.7		4/4	6.2		—	—	
		10^{1}	6/6	7.8		6/6	7.3		4/4	6.2		—	—	
		10^{2}	6/6	6.8		6/6	5.5		4/4	5.2		—	—	
		10^{3}	6/6	5.7		6/6	5		4/4	5		—	—	

1. No. of Experiments; 2. Strain of Tularemia Bacteria; 3. Dose for Infection in Microbe Bodies; 4. Meridional Jirds; 5. From the Right Bank; 6. From the Left Bank; 7. Died; 8. Total; 9. Average Length of Life in Days; 10. Logarithm of LD_{50} and Antilogarithm; 11. White Mice; 12. Guinea Pigs; 13. Microbe Bodies.

Table 6

Comparative Sensitivity of Meridional Jirds from the Right and Left Banks of the Volga to Subcutaneous Infection with Brucellosis Bacteria

(1) № опыта	(2) Штамм бруцелл овечьего типа	Доза (3) заражения в м. т.		(6) Полуденные песчанки				(12) Белые мыши	
				(7) правого берега		(8) левого берега			
		(4) по оптическому	(5) результаты высева (средние)	(9) генерализация*) всего (10)	(11) средний титр сыворотки в реакции Райта 1 :	(9) генерализация всего (10)	(11) средний титр сыворотки в реакции Райта 1 :	(9) генерализация всего (10)	(11) средний титр сыворотки в реакции Райта 1 :
8	43	10^0	0	0/6	0	0/6	0	0/5	0
		10^1	1.5	1/6	67	1/6	13	0/4	0
		10^2	10,5	1/6	43	0/6	17	0/5	0
		10^3	—	1/6	72	0/6	17	0/6	0

*) Генерализация изучалась у зверьков, забитых на 13–21 день после заражения.

1. No. of Experiments; 2. Strain of B. melitensis; 3. Dose for Infection in Microbe Bodies; 4. According to the Optical Standard; 5. Results of Plating (Average); 6. Meridional Jirds; 7. From the Right Bank; 8. From the Left Bank; 9. Dissemination of Infection (Dissemination was Studied in Animals Killed on the 13th-21st Day After Infection); 10. Total; 11. Average Serum Titer by Wright Method; 12. White Mice.

rodents, the main reservoirs of plague are the resistant species (jirds, rats). This viewpoint has been developed in a particularly persistent and detailed manner by Baltazard, in whose formulation, it seems to us, the problem has been posed backwards: "...jirds and other rodents are the main reservoirs of plague because they possess a high degree of resistance." Logically continuing this viewpoint, Baltazard, despite the evidence, reaches a denial of the existence of independent natural foci of plague in which the main reservoirs of infection are sousliks. Baltazard's views have been supported at the meeting of the Committee of Experts on Plague 15-20 September, 1958 (Report of the Committee).

The role of resistant species (or more accurately, populations of these species) in maintaining the plague epizootics is beyond doubt; however, resistance is not of a primary character but rather is derived as the result of the prolonged dwelling of these rodents in plague foci in the presence of the appropriate physiological qualities in animals contributing to the formation of resistance. In the study of bacteriemia in crested and meridional jirds from the right bank (the latter can to a certain degree be compared with the original population of meridional jirds on the left bank of the Volga), Ye. S. Biryukova showed a notable difference. Whereas in the crested jirds bacteriemia led to a dissemination of the process and death of the animals, in the meridional jirds, in a number of cases, (42 animals out of 151), a recurrence of the bacteriemia was noted with one or two negative phases. The plague bacteria were present in the blood of meridional jirds much longer than in the blood of crested jirds. These data of Ye. S. Biryukova concerning the greater resistance of meridional jirds are evidence to the effect that right bank meridional jirds possess certain physiological characteristics distinguishing them from crested jirds in the nature of the bacteriemia. It may be supposed that specifically these characteristics, aside from others, contributed to the formation of a certain degree of resistance to plague in meridional jirds from the left bank of the Volga at the early stages of establishment of the natural plague focus in the area between the Volga and Ural rivers.

In resistant species of jirds experimental infection with low doses does apparently "not" intended kill them, but in the great majority of cases leads to a dissemination of the infectious process with an intense accumulation of bacteria in the internal organs. In other words, susceptibility of the main reservoirs, particularly meridional jirds of the left bank of the Volga, to plague is far greater than the susceptibility of resistant species of rodents which do not play the part of the main reservoirs. The materials

presented can testify to the fact that the experimental method can be a valuable aid for solving such important problems as the occurrence of resistance in the main reservoirs of infectious disease in the natural plague foci.

In connection with the finding of a difference in the infectious sensitivity to plague between the two populations of meridional jirds we decided to study the pathogenetic reasons for this difference. Because the outcome of the infection with the plague microbe is determined by toxemia, it would be justifiable to suppose that left-bank meridional jirds are more resistant to the plague toxin than right-bank jirds. This principle was checked in experiments on adult meridional jirds of approximately the same weight. The animals were given intraperitoneal injections of different doses of the plague toxin--fraction II (prepared by the method of Baker and others) of plague bacterial strain No 64--in a volume of 0.5 cc. Observation of the animals was made for 72 hours. In the laboratory of the Astrakhan' Plague-Control Station experiments Nos 1 and 2 were performed; in the laboratory of the Elista Plague-Control Station, experiments 3 and 4 were performed (Table 7).

Meridional jirds from the left bank proved to be approximately twice as resistant to the plague toxin as right-bank jirds. These differences apparently reflect the resistance of left-bank animals to plague but cannot explain the tremendous difference in infectious sensitivity between the two populations of meridional jirds.

Females (jirds and white mice) proved to be two-three times more resistant to the toxin than males. By comparison with meridional jirds white mice proved to be much more sensitive to plague toxin, which has been pointed out previously by A. G. Kratinov.

The explanation of the differences as different accumulations of bacteria in the bodies of infected jirds proved to be better substantiated. Below, proof is presented of the fact that the degree and rate of accumulation of microbes in the blood of right-bank jirds were considerably greater than in the blood of left-bank animals; however, the differences detected depended also on the strain of plague bacteria used for infection.

The different qualities of the strains 297 and 403, mentioned previously, were expressed in a unique manner in the study of bacteriemia in right-bank and left-bank meridional jirds (Table 8). In the jirds bacteriemia was studied for ten days after infection. Blood was taken for culture every six hours from animals infected with strain 297; from animals infected with strain 403, every eight hours. Bacteriemia was studied from a quantitative aspect. All the blood cultures were made with the same loop, which contained

Table 7

Sensitivity of Meridional Jirds of the Right and Left Banks of the Volga to Intraperitoneal Injection of the Plague Toxin

(1) Номера опытов	1			2			3			4		
(2) Дозы токсина в мг	(3) полуденные песчанки		(7) белые мыши	(3) полуденные песчанки		(7) белые мыши	(3) полуденные песчанки		(7) белые мыши	(3) полуденные песчанки		(7) белые мыши
	(4) правого берега (6)	(5) левого берега (6)		(4) правого берега (6)	(5) левого берега (6)		(4) правого берега (6)	(5) левого берега (6)		(4) правого берега (6)	(5) левого берега (6)	
0.008	—	—	—	—	—	—	—	—	—	0/4	0/4	0/4
0.015	—	—	—	—	—	—	3/4	0/4	1/4	0/4	0/4	1/4
0.031	1/2	0/2	0/2	0/2	0/2	0/2	1/4	2/4	1/4	0/4	0/4	2/4
0.062	1/2	0/2	2/2	0/2	0/2	0/2	4/4	1/4	4/4	0/4	1/4	4/4
0.125	1/2	2/2	2/2	1/2	1/2	1/2	2/4	4/4	1/4	3/4	3/4	4/4
0.25	2/2	2/2	2/2	2/2	1/2	2/2	4/4	3/4	4/4	4/4	2/4	4/4
0.5	2/2	2/2	2/2	2/2	0/2	2/2	4/4	4/4	—	4/4	3/4	4/4
1.0	2/2	2/2	2/2	1/2	1/2	2/2	—	4/4	—	—	—	—
(8) $ЛД_{50}$ в мг токсина	0,063	0,089	0.045	0.177	0.5	0.126	0.031	0.063	—	0.106	0.15	0.026

1. Nos of Experiments; 2. Dose of Toxin in mg; 3. Meridional Jirds; 4. Of the Right; 5. Of the Left; 6. Bank; 7. White Mice; 8. LD_{50} in mg of the Toxin.

In the numerator the number of animals which died is shown; in the denominator, the number used in the experiment. In experiments 1 and 2 only males were tested; in experiments 3 and 4, two males and two females were used for each dose of toxin. The LD50 was calculated by the Kerber formula--$\lg ED_{50} = \lg D_N - \delta(\sum Li - 0.5)$; here ED_{50} is the dose of toxin which, in this case, causes the death of 50 percent of the animals; D_N is the maximum dose; δ is the logarithm of the ratio of each successive dose to the previous one; Li is the ratio between the number of animals which died from the injection of the given dose to the total number of animals injected with this dose; $\sum Li$ is the sum of the values of Li found for all doses tested.

approximately one cubic millimeter of blood. The volume of blood taken up by the loop was determined by two methods: 1) by direct measurement with a micropipet and 2) by means of comparing the number of red blood cells per cubic millimeter of blood of the rodent with the number of red blood cells in a loop of a portion of blood which had first been put into one cc of physiological saline solution. Determinations of the volume of the loop by both methods coincided in their average values.

Blood culture was made on nutrient agar, (all the cultures were made on a single series of agar, on which individual microbes were grown out). The results of the cultures were determined by a count of colonies grown out from each portion of blood.

In 52 out of 53 right-bank meridional jirds bacteriemia, once established, increased and the animal died. In the blood of these animals the number of microbes was so great that it could not be counted. In two cases, in right-bank jirds which survived after infection with strain 403, bacteriemia was noted.

In left-bank jirds infected with different strains of plague bacteria the survival rate was considerable, whereby bacteriemia was found both in individuals which died and in those which survived. In the blood of left-bank jirds the number of microbes ra.ely reached the figures found in right-bank jirds; the beginning of bacteriemia was at somewhat later periods; detection of bacteria in the blood was not constant. Bacteriemia was recorde with particular frequency in surviving jirds which had been injected with bacteria of strain 403 (in 21 out of 27). Among 45 left-bank surviving jirds infected with strain 297 bacteriemia was detected in only three. In three cases, in left-bank jirds which died, no microbes were isolated from the blood. It should also be noted that after infection of left-bank jirds with strain 297 bacteriemia occurred from the injection of no less than 10^7 microbes; in jirds from the left bank bacteriemia was noted after the injection of minimum doses of bacteria of strain 403. Fig. 2 demonstrates the most typical curves of bacteriemia in the various jirds.

Considerable differences in the infectious sensitivity to plague bacteria in the presence of a relatively minor difference in the sensitivity to the plague toxin can be explained by the abundance of bacteria in the blood of the right-bank meridional jirds and the moderate bacteriemia in those from the left bank. Therefore, the total quantity of toxic substances in the blood of right-bank jirds was many times greater than in the blood of those from the left bank.

Determination of the intensity of bacteriemia made it possible to gain an impression of the possibilities of infecting fleas on experimentally infected jirds, because it is

Bacteriemia Curves in Some Meridional Jirds

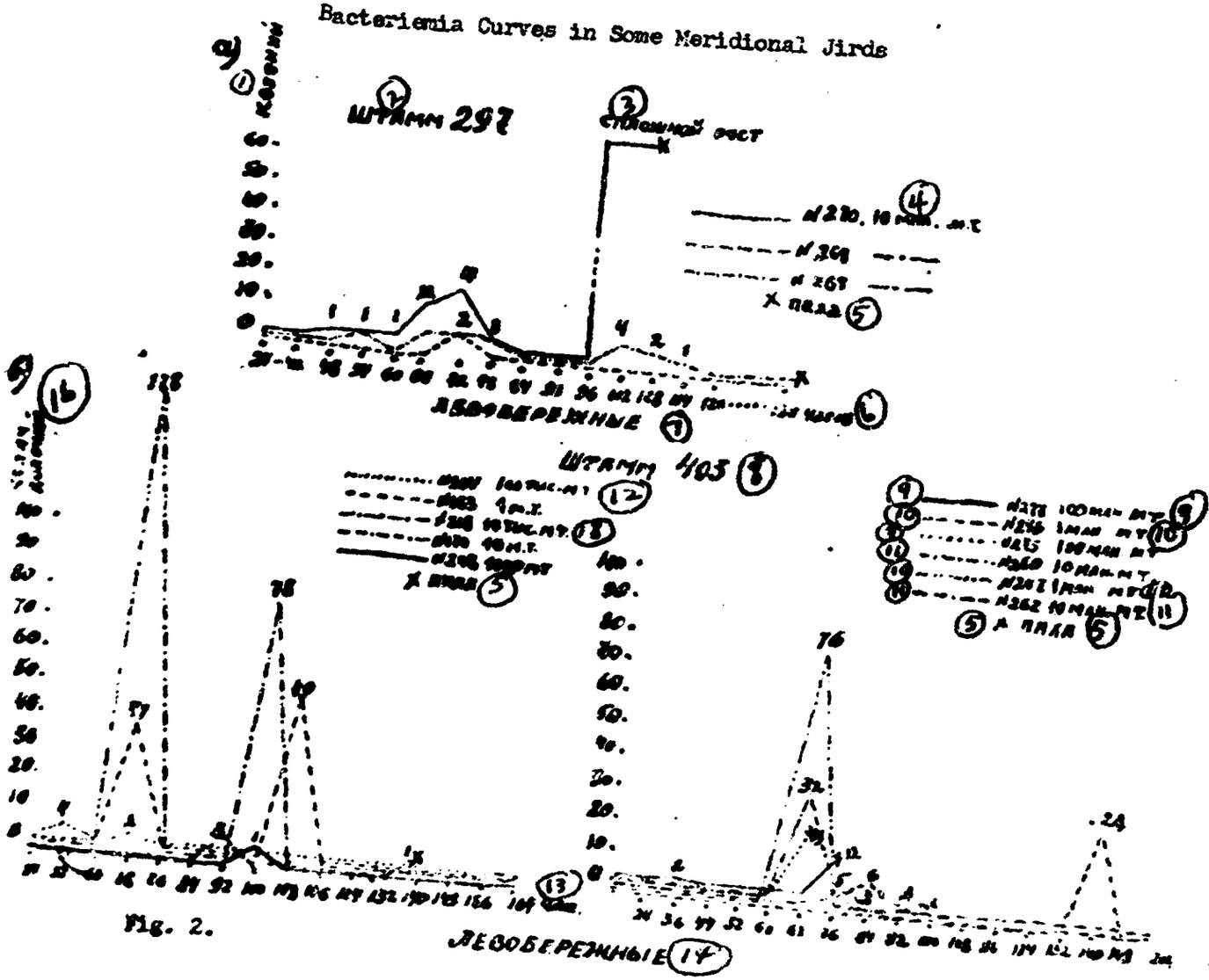

Fig. 2.

(Fig. 2 continued)

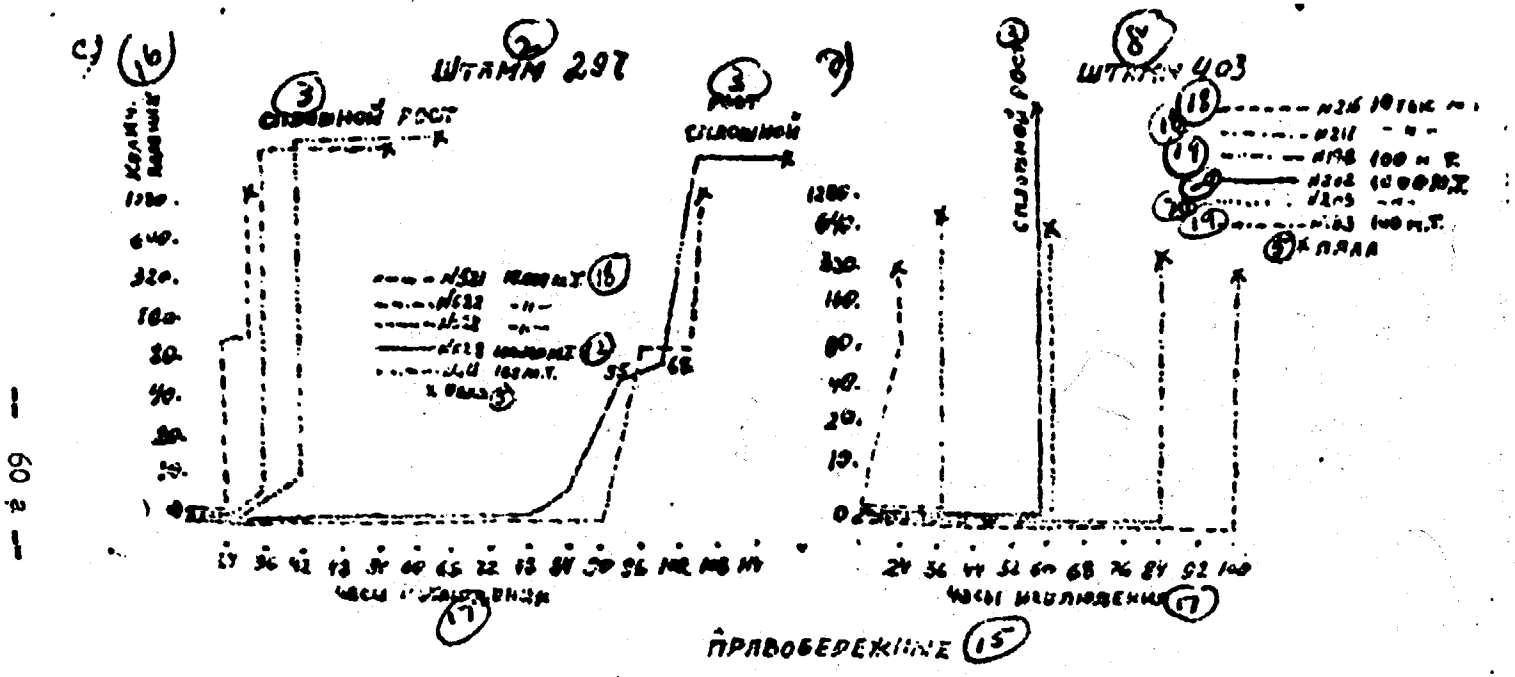

Fig. 2

1. No of colonies; 2. strain 297; 3. solid growth; 4. 10,000,000 microbes (the letter "D" followed by a number means the number of the jird used). 5. died; 6. hours; 7. left-bank; 8. strain 403; 9. 100,000,000 microbes; 10. 1,000,000 microbes; 11. 10,000,000 microbes; 12; 100,000 microbes; 13. hours; 14. left-bank; 15. right-bank; 16. No of colonies; 17. hours of observation; 18. 10,000 microbes; 19. 100 microbes; 20; 1000 microbes.

known that in feeding fleas drink approximately 0.2 - 0.3 cc of the rodent's blood (L. V. Bryukhanova, V. A. Sardar, and M. I. Levi, 1957). The different behaviors of bacteria of different strains in the bodies of meridional jirds, expressed in quantitative differences in the study of bacteriemia, throw light on certain unsuccessful attempts at experimental infection of fleas on infected jirds. It is quite evident that for the purpose of transferring the plague microbe by means of fleas experimentally consideration should be given to the characteristics of bacteriemia associated with the use of one strain or another.

Table 8

Bacteriemia in Meridional Jirds

① Штамм бактерий чумы	② Доза для заражения в м.т.	③ Полуденные песчанки					
		④ правого берега			⑤ левого берега		
		⑥ кол-во исслед. песчанок	⑦ бактериемия у		⑥ кол-во исслед. песчанок	⑦ бактериемия у	
			выживших ⑧	павших ⑨		выживших ⑧	павших ⑨
297	10^{1}	6	0/6	6	6	0/6	0
	10^{2}	6	0/5	1/1	6	0/6	0
	10^{3}	6	0/4	2/2	6	0/6	0
	10^{4}	6	0/2	4/4	6	0/5	0/1
	10^{5}	6	0	6/6	6	0/6	0
	10^{6}	6	0	6/6	6	0/6	0
	10^{7}	6	0	6/6	6	1/4	2/2
	10^{8}	—	—	—	5	1/4	1/1
	10^{9}	—	—	—	6	1/2	3/4
403	10^{-1}	4	1/3	1/1	3	2/2	0
	10^{0}	3	0/3	0	5	2/5	0
	10^{1}	3	1/2	1/1	3	3/3	0
	10^{2}	4	0	3/4	3	0/2	1/1
	10^{3}	4	0	4/4	5	3/3	2/2
	10^{4}	5	0	5/5	6	3/3	3/3
	10^{5}	3	0	3/3	4	3/3	1/1
	10^{6}	2	0	2/2	3	3/3	0
	10^{7}	2	0	2/2	3	2/2	2/3
	10^{8}	5	0	5/5	3	0	3/3

1. Strain of Plague Bacteria; 2. Infection Dose, in microbe bodies; 3. Meridional Jirds; 4. of the Right Bank; 5. of the Left Bank; 6. Number of Jirds Studied; 7. Bacteriemia in: ; 8. Survived; 9. Died.

The blood serum of certain jirds was investigated one-and-a-half months after infection by the passive hemagglutination reaction for the presence of antibodies to the capsular substance of the plague microbe (fraction 1A of strain 133). Five right-bank meridional jirds infected with strain 297 were investigated, but in no case were antibodies found. At the same time, among 17 left-bank animals antibodies were found in three (average titer, 1:25). In right-bank (six animals, average titer, 1:57) and left-bank (15 animals, average titer, 1:1431) meridional jirds infected with strain 403 antibodies were found in, respectively, five and 12 cases. These materials are in agreement with data concerning the different qualities of strains and results of the study of bacteriemia. The impression is created that left-bank meridional jirds respond to the injection of plague microbe by a more pronounced immunological reaction than right-bank animals.

Conclusions

1. Simultaneous testing of infectious sensitivity of meridional jirds of the right and left banks of the Volga to plague showed that right-bank animals are approximately 50,000 times more sensitive than left-bank animals, which are the main reservoirs of plague in the Volga-Ural focus. The average length of life of the animals which died and the pathological changes were also significantly different. These differences in infectious sensitivity went far beyond the limits of possible error.

2. The intensity of bacteriemia and, in connection with this, the total quantity of toxic substances in the bodies of right-bank meridional jirds, were considerably greater than in those from the left bank. This fact, by and large, explains the differences in infectious sensitivity between the two populations of meridional jirds. Immunological reactions and pronounced pathological changes in the internal organs are evidence of an active process of elimination of plague bacteria from the bodies of left-bank meridional jirds. The lower sensitivity of left-bank jirds to the plague toxin than that of the right-bank animals is not the main reason for differences between these populations with regard to the infectious sensitivity to the plague pathogen.

3. Crested jirds from the right and left banks of the Volga, which are secondary reservoirs of plague, did not show any essential differences in infectious sensitivity to this infectious disease.

4. Right-bank and left-bank meridional jirds were equally sensitive and susceptible to the tularemia microbe and the brucellosis pathogen.

5. In a number of plague foci where an important

part is played by species of rodents which do not go into hibernation the main reservoirs, on the whole, can be considered resistant species; however, this resistance apparently is the result of many centuries of constant involvement of these animals in epizootics.

6. Plague bacteria strains 297 and 403, approximately of equal virulence for white mice and guinea pigs, showed different degrees of virulence for meridional and crested jirds, which can attest to qualitative differences between these strains. For the purpose of reproducing bacteriemia in left-bank meridional jirds the injection of no less than 10^7 microbes of strain 297 but only a few bacteria of strain 403 was required.

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Experimental Plague in Different Dwarf Souslik Populations

The fact that plague outbreaks occur specifically in the extensive areas of Southeast USSR has long attracted the attention of outstanding microbiologists and epidemiologists. In 1912, I. A. Deminskiy, at the cost of his own life, ascertained the fact that dwarf sousliks are infected with plague under natural conditions. In subsequent years the role of this rodent in the preservation of the plague microbe has been confirmed by numerous investigators.

Simultaneously, the ecological trend in the study of the activity of the dwarf souslik was developed to a great extent. The life of this animal is characterized by a regular alternation of different periods throughout the year. The awakening period (spring and summer) is replaced by the hibernation period. This active period lasts about five months--after awakening from hibernation in March mating begins; then comes gravidity, feeding the young, and the dispersal and settlement of the young sousliks. During this dispersal and settlement of the young the old males begin to hibernate; after them the old females, having accumulated fat, also go into hibernation. The young sousliks go into hibernation last.

The manifestations of plague in sousliks are directly related to the periodic nature of activity of the animals. The largest number of bodies and the greatest infection of sousliks with plague are found in the summer, during the period of mass dispersal and settlement of the young animals. Precisely at this time the greatest activity of the animals, greatest contact of them with one another and with fleas, is noted. The intensity of the plague epizootic decreases as hibernation time draws near, but all attempts to find infected sousliks during the period of hibernation proper have met with failure. Incidentally, after awakening from hibernation no less than 30-40 days elapse before the first infected animals are found.

The most important problem of plague epizootology is the mechanism of preservation of the microbe in the interepizootic period. Some investigators believed that the microbe is preserved in the bodies of infected animals (chronic forms); others have insisted on the leading role of fleas as reservoirs of the infection during the hibernation period of the sousliks. V. S. Grikurov caught 450 sousliks in Remontnyy region in 1933 immediately after awakening from hibernation (14 March) in a section where an active epizootic had been noted the previous year; from one of these animals (which died 17 April) he isolated a culture of plague bacteria. I. S. Tinker and P. N. Stupnitskiy, after investigating 141 fleas, found plague bacteria in one insect on 27 February, that is, shortly before the sousliks awaken from hibernation.

Along with observations of epizootics among sousliks an abundance of data has now been accumulated on the results of experimental infection of the animals.

S. M. Nikanorov, A. A. Churilina, N. A. Gayskiy in 1924-1925 studied the susceptibility and infectious sensitivity of dwarf sousliks to plague experimentally. These authors succeeded in showing that susceptibility and infectious sensitivity of the animals undergo considerable variations associated with the ecological characteristics of the sousliks at different periods of life.

S. M. Nikanorov tested the seasonal susceptibility and sensitivity of sousliks to plague in four experiments using 120 animals, beginning with the middle of June, at intervals of two weeks. The largest number of surviving sousliks was noted as the hibernation period was approached. The great majority of sousliks infected subcutaneously (a total of 198 animals) died in the first two-seven days. In rare cases lingering chronic forms were noted. In sousliks which died after a month, S. M. Nikanorov succeeded, only in rare cases, in isolating plague bacteria from the internal organs by bacteriological or biological methods. V. M. Tumanskiy did not succeed in isolating plague bacteria from the internal organs in those cases where the sousliks died after the 14th day.

A. A. Churilina isolated the plague microbe from sousliks after five months when the animals had been infected during the hibernation period. If the infected animals awakened, the plague infection had a course in them which was the same as in the waking sousliks, but if the animals continued to be in a state of hibernation the infection assumed a chronic character.

From July 1924 through June 1925 N. A. Gayskiy tested the susceptibility of the dwarf sousliks to plague every month, utilizing 242 animals. N. A. Gayskiy concluded that the maximum susceptibility and sensitivity of sousliks to plague is observed in June-July, and then it decreases as the period of hibernation is approached; after awakening from hibernation it gradually increases in April and May, reaching a maximum during a period of dispersal and settlement of the young individuals. The infection of sousliks during the hibernation period was frequently accompanied by preservation of the plague bacillus at the injection site and in the neighboring lymph nodes. After such sousliks awake from hibernation a dissemination of the infectious process can occur with entrance of the bacteria into the blood, which creates possibilities for infection of fleas and expansion of the epizootic territory. Most frequently, bacteriemia in the infected sousliks was noted in June-July, whereas in the other seasons bacteria were found inconstantly in the blood. The frequency of the local forms of plague infection in sousliks increased as the hibernation season was approached.

S. M. Nikanorov, A. A. Churilina and N. A. Gayskiy believed that the plague bacillus can spend the winter in the bodies of sousliks, in which these authors from time to time noted chronic lingering forms of the infection experimentally. It should be noted that these authors did not deny the possibility of bacterial wintering in the bodies of infected fleas.

In 1932, I. S. Tinker and N. I. Kalabukhov, using a limited number of sousliks (40 animals), infected adult males and females as well

as young sousliks. The young sousliks were most sensitive; after them came the old females; the old males showed the greatest resistance; they survived in a number of cases after the injection of several tens of millions of microbes of a virulent strain.

I. S. Tinker and Ye. N. Aleshina in 1955 again confirmed the fact that the greatest infectious sensitivity to plague is shown by young sousliks during the period of dispersal and settlement, while tance is shown by old males just before going into hibernation. In rut the males were more sensitive than the females. The authors noted that the metabolic rate and the degree of infectious sensitivity coincided: the more oxygen the animals consumed the more sensitive they were to plague.

Therefore, various authors have come to approximately the same conclusions concerning the seasonal changes in susceptibility and sensitivity of dwarf sousliks. Incidentally, it should be added that some authors indicate the need for taking into consideration both the changes in susceptibility and variations in the virulence of the microbe itself. I. S. Tinker emphasizes the fact that in the summertime when diffuse epizootics are observed in sousliks the microbe is found in the most virulent form. As hibernation is approached, as well as immediately after awakening, the virulence of the microbe decreases. N. A. Gayskiy noted that in some experimentally infected sousliks, beginning with August, it is impossible to isolate a plague bacterial culture by a direct inoculation on nutrient media; the microbe is found only by means of infection of guinea pigs. In various cases, N. A. Gayskiy succeeded in isolating the plague pathogen by the bacteriological method, but after subculturing the colonies the bacteria died. N. A. Gayskiy believed that the plague microbe spends the winter in the bodies of the hibernating sousliks, thereby undergoing certain changes — a reduction in virulence for laboratory animals and the ability to grow on ordinary nutrient media. The author believed that in the body of the hibernating souslik the plague bacillus is changed into an invisible form.

The main area of distribution of the dwarf souslik is located in steppe, semidesert and desert regions on the plains of Southeast Europe, the northern parts of Central Asia and the northern Crimea (N. K. Vereshchagin). In far from all places in which the dwarf souslik lives does the animal play an essential part in plague epizootology; however, in the region of the lower course of the Don, Volga, Ural and Emba Rivers it is regularly involved in epizootics. In the area between the Volga and Don Rivers, in the eastern Precaucasus the dwarf souslik is the main and apparently the only principal reservoir of the plague microbe. However, even on these territories not all the areas are epizootologically equivalent. N. P. Mironov and others, on the basis of a study of the rules and regulations of the plague enzootic in a focus in the Northwest Caspian region carried out an epizootological zoning of the various regions of the focus. N. P. Mironov pointed out that from the viewpoint of the plague enzootic most important is the region of Yergeni. Of lesser importance, for example, are the regions of Chernyye Zemli and the southern regions of Stalingradskaya Oblast. Such con-

clusions were based on observations of plague epizootics on various territories in the past as well as on the study of the ecological and physiological characteristics of sousliks and their fleas.

The role played by susceptibility and infectious sensitivity of the souslik itself in the different epizootological significances of the various regions remained unclear. I. S. Tinker and Ye. N. Aleshina studied the physiological condition of individuals and the infectious sensitivity to plague in different populations of dwarf sousliks. By comparing the infectious sensitivity of sousliks caught in the sandy region (as we learned from the authors, this was the region of Chernyye Zemli) and sousliks caught in the loamy region (the region of Yergeni) the authors found that the LD_{50} for the former is five-eight times higher than for the latter. In these experiments 288 sousliks were used (72 males and 72 females from each region).

In the present work the same aim was posed as in the work of I. S. Tinker and Ye. N. Aleshina -- a comparison of the infectious sensitivities of sousliks from various places. In contrast to our predecessors we performed experiments in only one period, the period of rut. Along with infectious sensitivity bacteriemia was studied in the sousliks.

The dwarf sousliks were caught during the period from 28 March to 5 April 1959. In this year the mass awakening of sousliks from hibernation was noted at the end of March, and mass gravidity was noted in the first ten-day period of April. Among the females caught there were only several gravid ones. The animals were infected subcutaneously with different doses of the plague microbe (from 10^{-1} to 10^{-5} microbes); white mice and guinea pigs were infected with the doses at the same time. The same number of males and females were used for each infective dose. The weights of the sousliks ranged from 70 to 140 grams, but in the great majority of cases it was equal to 90-100 grams.

In the laboratory of the Elista Plague-Control Station the sousliks caught in the regions of Zavetnoye, Chernozemel'skiy and Dosang were infected on 10 April with strain 403 (which had been isolated from red-tailed jirds in AzSSR in the summer of 1958). In the laboratory of the Astrakhan' Plague-Control Station the sousliks caught in the region of Yenotayevsk and Dosang were infected on 17 April with strain 297 (which had been isolated from a jerboa in a focus in the Northwest Caspian region in 1954).

The sousliks which died were subjected to a bacteriological study. Cultures on nutrient agar were taken from the site of infection, the regional lymph nodes, the blood, liver, spleen and lungs. All the cultures were made on nutrient agar of the same series, on which even single microbes had been grown out. Thus, in culturing five, 50 and 500 microbes of strain 297 an average (of three plates) of 3.6, 20.3 and 244.3 colonies grew out per plate.

The surviving animals infected with strain 297 were killed in the laboratory of the Astrakhan' Plague-Control Station on the 39th-42nd day after infection and were studied by the bacteriological method, whereas in the laboratory of the Elista Plague-Control Station the

surviving animals were left for subsequent study of the blood serum of the animals in the passive hemagglutination reaction at various periods of time.

The results of comparative study of the infectious sensitivities of sousliks from various places are shown in Table I.

There was a large number of animals which died in which plague bacteria were not found. The sousliks which died before the 11th day after the infection, the cultures from the organs of which remained sterile have been put in the appropriate column of the Table. The animals which died after the tenth day and from which it was impossible to isolate the plague bacteria were put in the surviving group. In experiment 1 six out of the 114 surviving animals were of this type; in experiment 2, 15 out of 55. At the same time, in the earlier periods (up to the 11th day) no cultures were isolated in 26 animals which died in experiment 1; in experiment 2, in a total of 10. From the data presented below concerning bacteriemia it becomes clear that the duration of finding bacteria in the blood of sousliks infected with strain 297 is considerably greater than the duration of bacteriemia in sousliks infected with strain 403. This comparison suggests the idea that death of at least part of the animals in which no culture was isolated, both in the early and late periods, was brought about by plague infection; however, the absence of bacteriological confirmation caused us to exclude those animals which died before the 11th day after infection from the data for calculation of the LD_{50} and the standard error. The LD_{50} was calculated by the method of Reed and Muench; the standard error, from the Pizzi formula. The animals which died without isolation of a plague bacteria culture in the later periods were categorised in the group of surviving sousliks. It may be supposed that sterility of the cultures on agar was explained by the presence of some substance in the souslik tissues which suppressed the growth of plague bacteria. Below, direct proof of the fact that despite the absence of growth in cultures from internal organs and from the blood of part of the sousliks which died plague bacteria in a number of cases were found intra vitam in the peripheral blood of such animals, whereby not uncommonly the blood was profusely seeded, at times several hours before the animal died. In some cases it was possible to show that in the bodies of sousliks in which no plague bacteria were found on dissection, the pathogen multiplied actively during the life of the animal and entered the blood. Some practical workers, like the authors of the present work, have noted that in a number of cases, on attempts to isolate phage from the internal organs of sousliks, when smears are taken on agar on which plague bacteria colonies have grown out, the latter undergo a vitreous degeneration and die when subcultured on agar. However, this idea needs checking and careful study.

The fact is striking that death of the animals without isolation of a culture occurred more often after infection with smaller doses: from doses of 10^{-1} to 10^{1}, 21 sousliks died; from doses of 10^{2}-10^{5}, 15 animals died.

Above mention was made of the data of I. S. Tinker and others on

Table 1

Infectious Sensitivity of Different Dwarf Souslik Populations to Subcutaneous Infection with Plague Bacteria

№ опыта	Штамм	Место выловки сусликов	Доза для заражения в м. т.	Живых-сусликов: павших без выделения культуры	Живых-сусликов: павших с выделением культуры	Выжили	Мертвых-сусл.: павших без выделения культуры	Мертвых-сусл.: павших с выделением культуры	Выжили	Средн. продолж. жизни павших	LD50 в м. т.	Без. свинок: пали	Без. свинок: выжили	LD50 в м. т.	Морс. свинк.: пали	Морс. свинк.: выжили	LD50 в м. т.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Черноземельский		10	—	—	6	1	—	5	—		—	4		—	4	
			5	—	—	4	1	1	4	5,0		—	4		—	4	
			2	1	—	4	1	1	4	5,0		1	3		2	2	
			1	—	—	1	1	4	—	5,2	46	4	—	36	3	1	17
			0,5	—	—	2	1	3	—	4,2		3	1		4	—	
			0,2	—	3	—	—	3	—	5,6		4	—		4	—	
			0,1	—	3	2	—	4	—	4,7		4	—		4	—	
1	485	Джунгарский	10	—	—	6	—	—	6	—							
			5	—	—	5	—	—	6	—							
			2	1	—	3	1	—	4	7,5							
			1	—	1	3	—	1	5	7,9	616						
			0,5	—	2	4	—	3	2	6,0							
			0,2	—	3	2	—	2	3	6,8							
			0,1	—	3	2	—	4	2	5,3							

Nos. 1-18 are intrinsic in the Table.
1. No of exp't; 2. strain; 3. place sousliks caught; 4. infecting dose in microbes; 5. without isolation of culture; 6. with culture isolated; 7. survived; 8, 9, 10. [same as 5,6,7.] 11. average lifespan of animals which died; 12. LD_{50} in microbes; 13. died; 14. survived; 15. LD_{50} in microbes; 16. died; 17. survived; 18. LD_{50} in microbes; 19. female sousliks; 20. male sousliks; 21. died; 22. white mice; 23. guinea pigs; 24. Chernozemel'skiy; 25. Zavetnoye; 26. Dosang; 27. Yemutayevsk.

[Table continued next page]

Table 1 (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			10^{-1}	—	—	6	—	—	3	—							
			10^{0}	—	—	6	1	—	5	—							
			10^{1}	1	—	5	—	2	4	8,0							
			10^{2}	1	4	1	—	5	1	6,1	60						
			10^{3}	1	4	1	2	3	1	5,5							
			10^{4}	—	1	2	1	4	1	4,9							
			10^{5}	—	7	—	—	3	—	4,6							
			10^{-1}			1	1	—	3	—		—	6		—	2	
			10^{0}	1	—	3	—	1	3	4,0		2	4		—	3	
			10^{1}	—		4	1	—	3	—		1	5		—	3	
			10^{2}	—	3	1	—	2	2	10,2	82	6	—	24	2	1	56
			10^{3}	—	4	—	—	4	—	6,6		5	1		3	—	
			10^{4}	1	3	—	—	4	—	5,0		5	1		3	—	
			10^{5}		3	1	—	3	1	5,8		6	—		3	—	
2	297		10^{-1}	—	—	4	2	—	2	—							
			10^{0}	—	—	4	1	1	2	10,0							
			10^{1}	2	1	1	1	—	3	9,0							
			10^{2}	—	1	3	—	3	1	7,0	1000						
			10^{3}	—	2	2	—	2	2	5,3							
			10^{4}	—	2	2	—	3	1	5,0							
			10^{5}	—	2	2	—	3	1	7,0							

sex differences in the infectious sensitivity to plague. In our experiments males during the period of rut were apparently somewhat more sensitive than females; however, this difference did not go beyond the limits of the standard error (Table II).

Table II

Sex Differences in the Infectious Sensitivities of Adult Sousliks (in Decimal Logarithms)

1 Number of experiments	2 Strains of plague bacteria	3 LD_{50}: 4 Females	5 Males	6 Difference in the LD_{50}	7 Standard error: 4	5	8 Sum of standard errors
1	403	2,2857	1,7333	0,5524	±0,5559	0,5263	1,0822
2	297	2,6333	2,1852	0,4481	±0,7314	0,6	1,3314

1. Number of experiments; 2. Strains of plague bacteria; 3. LD_{50}; 4. Females; 5. Males; 6. Difference in the LD_{50}; 7. Standard error; 8. Sum of standard errors.

In both experiments the sum of the standard errors was greater than the difference in the LD_{50}, which did not permit drawing any conclusion as to the significance of sex differences in our experiments. Possibly these differences actually exist; however, for convincing proof of this the number of animals used must be considered inadequate.

In comparing the data of Table I it may be concluded that in experiment 1 sousliks caught in the region of Zavetnoye were most resistant. The average life spans of the animals which died indicated this. These differences went beyond the limits of possible error. In experiment 2 a difference was also found in the infectious sensitivity of sousliks to plague which had been caught in the region of Yenotayevsk and the region of Dosang, but in this case the differences were only slightly greater than the sum of the standard errors (see Fig. 1 Table III).

The fact attracts attention that sousliks caught in the region of Dosang and infected with different strains of plague bacteria showed different infectious sensitivities with relatively the same virulence of both strains for laboratory animals. This difference may be explained by the fact that for experiments 1 and 2 the sousliks had been caught in different places, separated from one another by five-ten kilometers. Nor should differences in the strains be overlooked.

The increased resistance of sousliks from the region of Zavetnoye can be explained by the fact that the region of West Yergeni is considered most important in the plague enzootic in the Northwest Caspian focus. Other regions in this focus are of lesser importance. What has been stated can give evidence of the hereditary nature of resistance to plague in sousliks caught in the region of Zavetnoye; however, in this

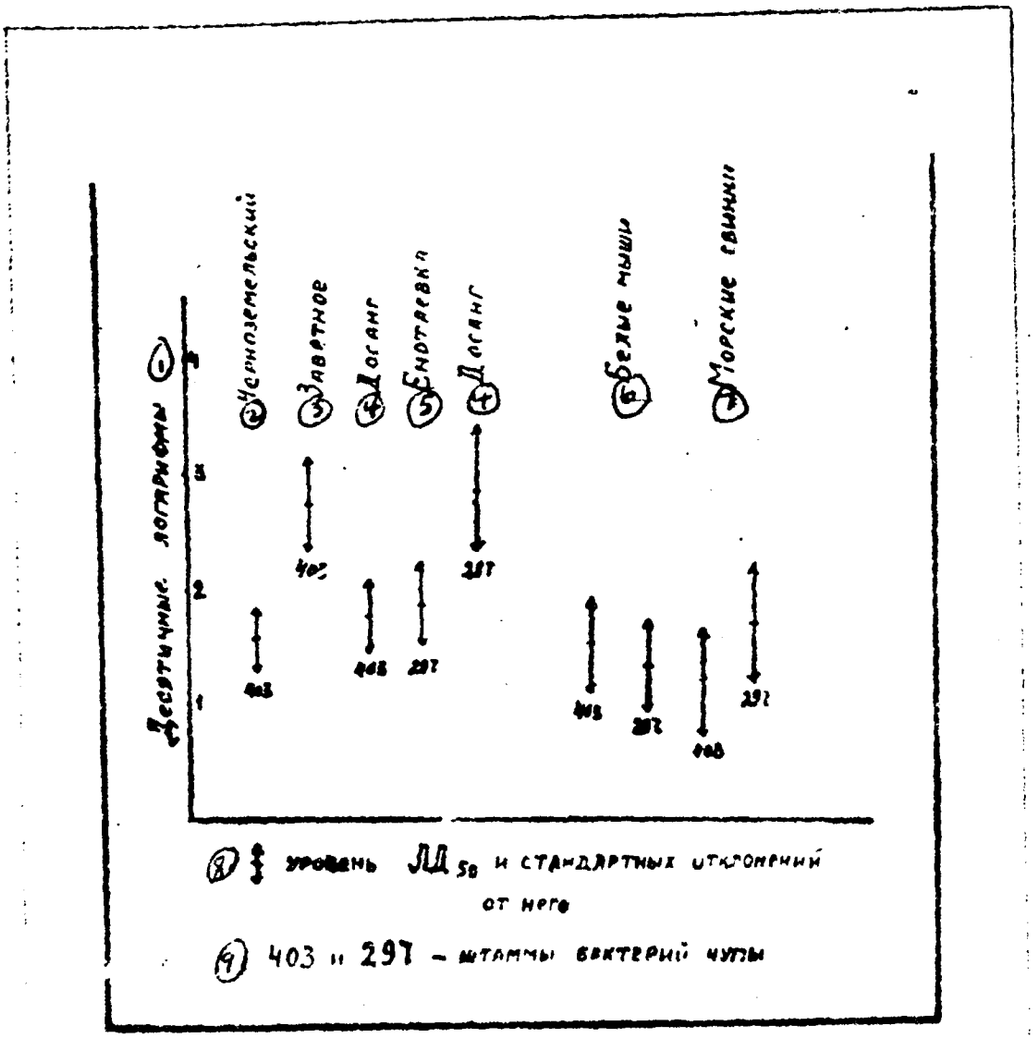


Fig. 1. Differences in the Infectious Sensitivity of Dwarf Souslik Population to Plague. 1. Decimal logarithms; 2. Chernozemel'skiy; 3. Zavetnoye; 4. Dosang; 5. Yenotayevsk; 6. White mice; 7. Guinea pigs; 8. LD_{50} and standard deviations from it; 9. 403 and 297 -- strains of plague bacteria.

Table III

The Significance of Differences in Infectious Sensitivity of Different Dwarf Souslik Populations to Plague (in Decimal Logarithms)

№ опыта и штамм (1)	Место вылова сусликов (2)	LD_{50} (3)	σ (4)	$(LD_{50}-M)^2 : (CO+CO^2)$
1	Черноземельский (5)	1,6531	±0,3087	0,4227
403	Заветное (6)	2,7895	±0,4050	
	Досанг (7)	1,7800	±0,3332	0,2713
2	Енотаевск (8)	1,9130	±0,3782	0,2018
297	Досанг (7)	3,0000	±0,5070	

1. Number of experiment and strain; 2. Place in which sousliks were caught; 3. LD50; 4. Standard error; 5. Chernozemel'skiy; 6. Zavetnoye; 7. Dosang; 8. Yenotayevsk.

case these interrelationships are not so clear as in the meridional jirds of the right and left banks of the Volga River, and this idea should not be considered substantiated in any way to date. It should not be forgotten that in sousliks a definite protective factor against epizootics is constituted by the summer and winter hibernation, whereas in left-bank meridional jirds a high degree of resistance to infection contributes to preservation of the species. It should be considered that these differences have exerted an essential influence upon the degree of resistance of the animals to plague. For this reason we are speaking here about the genetic conditioning of the increased resistance of sousliks from the region of Zavetnoye, while it has been a number of years now that in the Northwest Caspian focus no plague bacteria have been isolated from rodents or their ectoparasites because of active measures for suppression of the focus, despite extensive investigation.

In the region of Dosang sousliks in the past were involved in epizootics considerably more often than in the region of Yenotayevsk.

On the basis of the comparative study made the conclusion can be drawn that sousliks caught in various places possessed a somewhat differ-

ent infectious sensitivity during the period of rut; however, the reasons for these differences still await explanation.

The times of death of animals in which bacteria were found in the internal organs varied, but in all cases they were no more than a month. In sousliks infected with strain 403 the maximum period during which bacteria were found in the organs of the animal which died was 17 days; in sousliks infected with strain 297 they were found no later than the 20th day; in white mice, the 18th day; in guinea pigs, the 29th day.

Of 13 surviving sousliks caught in the region of Zenotayevsk and killed on the 39th-42nd day after infection with strain 297, a small number of bacteria were found in the lymph nodes of only one (five colonies in the culture). At the same time, of 18 surviving sousliks from the region of Dosang killed on the 40th-42nd day after infection with strain 297 plague bacteria were found in the internal organs (spleen, liver and lungs) of six (as a rule these were single colonies in the cultures, but in one case an abundant growth was obtained from the spleen and lungs).

In 12 surviving white mice and four guinea pigs infected with strain 297 and killed on the 43rd-45th day after infection it was impossible to isolate plague bacteria.

Pathological changes in sousliks of different sexes, from different places which had been injected with different strains of plague bacteria were approximately the same -- mucoid edema, hemorrhages, abscesses or necrosis at the site of injection, enlargement of the lymph nodes, change in the size and color of the spleen and liver, and hyperemia of the lungs. Not uncommonly, necrotic areas were found in the liver and spleen. It should be pointed out that in a number of cases when the souslik died and cultures from the internal organs remained sterile, a marked cachexia of the body and pathological changes in some organs were found at the time of dissection.

During the first eight days after infection 140 sousliks -- 28 animals from each place -- were studied for bacterial content in the peripheral blood. Two males and two females were used for each infective dose for the purpose of studying bacteriemia. In the laboratory of the Kilista Plague-Control Station blood from the infected animals was investigated every six hours; in the laboratory of the Astrakhan' Plague-Control Station the studies were also made at six hour periods, but at night one examination was omitted. The blood of sousliks was taken from an incision in the tail by a bacteriological loop, the size of which was measured by two methods. By the first method a measured quantity of whole blood was poured into the depression of a depression slide; then all the blood was transferred to agar with the loop; the volume of the loop was equal to the volume of blood in the depression divided by the number of times blood was taken by the loop. In the second method a comparison was made of the number of red blood cells per cubic millimeter of blood of a rodent with the number of red blood cells picked up by the loop. The second figure was divided by the first, and the quotient was the volume of the loop. The number of red blood cells picked up by the loop was counted in a chamber after preliminary

rinsing of the loop in one cc of physiological saline solution (the number of red blood cells in the entire volume of physiological saline solution is calculated). In the second method the volume of the bacteriological loop is equal to the number of red blood cells per cubic millimeter of physiological saline solution multiplied by 1,000 and divided by the number of red blood cells per cubic millimeter of blood of the rodent.

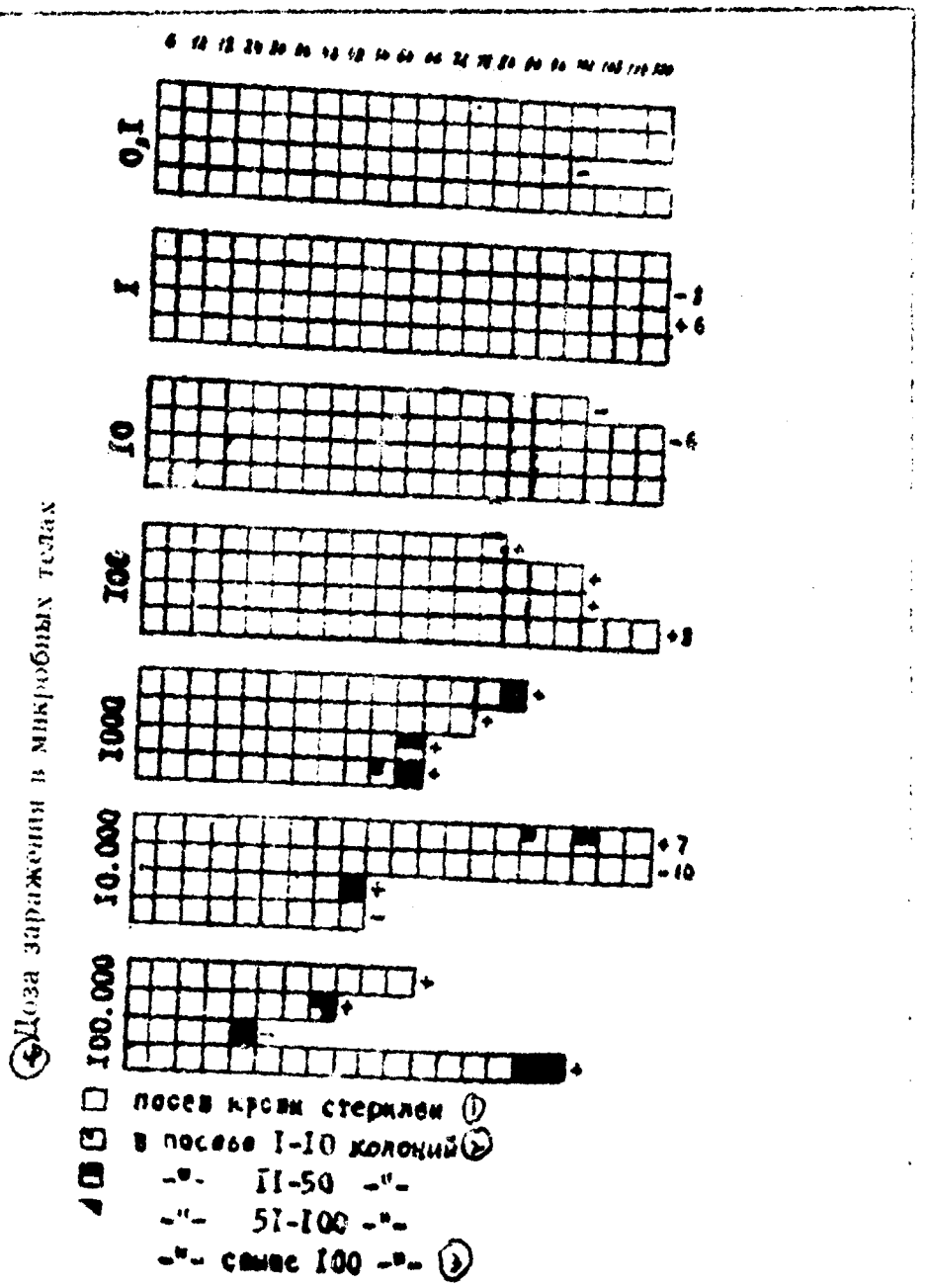
Both methods gave the same results, whereby the volume of the loop in the laboratory of the Kista Plague-Control Station amounted approximately to one cubic millimeter; in the laboratory of the Astrakhan' Plague-Control Station, to approximately three cubic millimeters. One loop of souslik blood was seeded on an agar plate, and the number of colonies which grew out was counted. Quantitative study of bacteriemia makes it possible to estimate the epizootological significance of the finding of bacteria in the blood, because it is known that fleas suck up approximately 0.2-0.3 cubic millimeter of rodent blood.

The results of study of bacteriemia in infected sousliks are shown on graphs presented below, where each horizontal row represents the results of determination of bacteria in the blood of one souslik. The first two rows of the infective dose are for males; the last two rows, females. For those animals which died the time of death and the result of bacteriological examination of the internal organs are indicated. The number of bacteria in the blood of sousliks at various periods is represented in Fig. 2, 3, 4, 5 and 6 by means of the shading of different areas.

In a number of cases the peripheral blood of the souslik was persistently sterile, despite the fact that the plague pathogen was found in the internal organs of the animal after its death. It should be considered that in these cases bacteriemia, even on the eve of death, was so brief or so slight that it could not be detected by means of the method adopted. On the other hand, cases were observed in which in the sousliks bacteria were found in the blood intra vitam, but after death of the animal the cultures from the internal organs remained sterile. The same result was sometimes observed in those sousliks in which several hours before death an intense bacteriemia was noted. Such facts still await explanation.

In the analysis of the data of bacteriemia differences between the plague bacteria strains were most prominent. In animals infected with strain 403 no bacteria was found more than five days after infection. In sousliks infected with strain 297 bacteriemia was studied for eight days; however this period should be considered inadequate, because it may be assumed, and not without reason, that the bacteria were present in the blood of the animals even later.

In all those cases where bacteria were found in the blood of sousliks infected with strain 403 the animals died, whereby, as a rule, death of the animals occurred immediately after the finding of bacteriemia. Bacteriemia of this kind is usually called preagonal. Bacteriemia usually occurred in those sousliks which had been infected with a dose of 1,000 microbes of strain 403 or more, whereby bacteria were



Key: + Plague Bacteria Found in the Blood or Organs of the Dead Souslik; - No Plague Bacteria Found in the Blood or Organs of the Dead Souslik; -8, day of death of the souslik /this may not necessarily be -8; it may be -10 or -6 as the case may be/.

Fig. 2. Bacteriemia in Sousliks, strain 403 (Chernozemel'skiy). 1. Blood culture sterile; 2. 1-10 colonies in culture; 3. More than 100 colonies in culture; 4. Dose of infection in microbes.

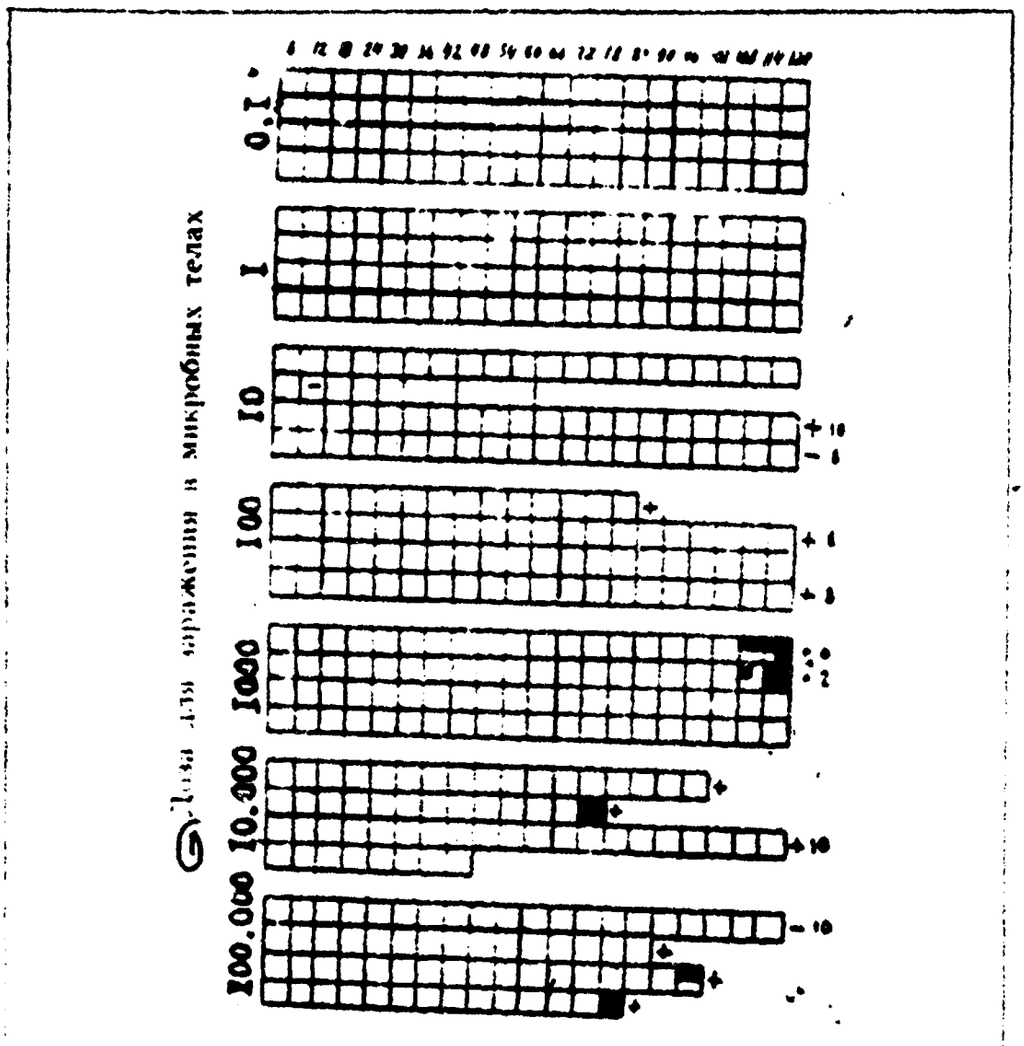


Fig. 3. Bacteriemia in sousliks (Zavetnoye). Strain 403. 1. Dose used for infection in microbes.

found in the blood of far from all animals infected with large doses.

A different picture was observed in sousliks infected with strain 297. In some animals bacteriemia was noted during the first few days after infection; frequently, bacteria were found on the fourth-sixth day as well as prior to the death of the animals. Intense bacteriemia was recorded usually several days before death. Not uncommonly, sousliks in which at times intense bacteriemia was recorded survived, which was not observed in the case of animals infected with strain 403. Of five surviving sousliks infected with strain 297 and killed on the 24th

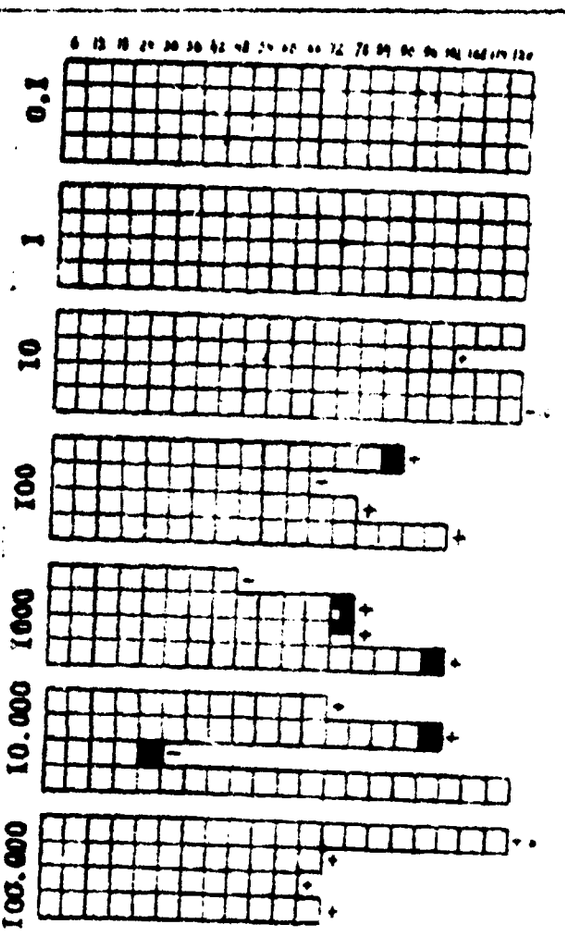


Fig. 4. Bacteriemia in sousliks (Dosang), Strain 403.

day with negative results of bacteriological examination of the internal organs, plague bacilli had been found in the blood in three of the animals during life. Of 12 surviving sousliks killed on the 39th-42nd day after infection a few bacteria were found in only two cases in the cultures from the internal organs, whereas, during life of the animals bacteria had been found in the blood of ten sousliks. On the basis of the data presented it may be supposed that the souslik organism actively eliminates plague bacteria when the animals are infected with strain 297. In the sousliks bacteriemia frequently occurred after the injection of such small doses as 0.1, 1 and 10 microbes. Bacteria were found in the blood of the great majority of infected sousliks examined.

A cursory glance at the graphs presented is sufficient to convince one of the definite differences in the nature of bacteriemia in

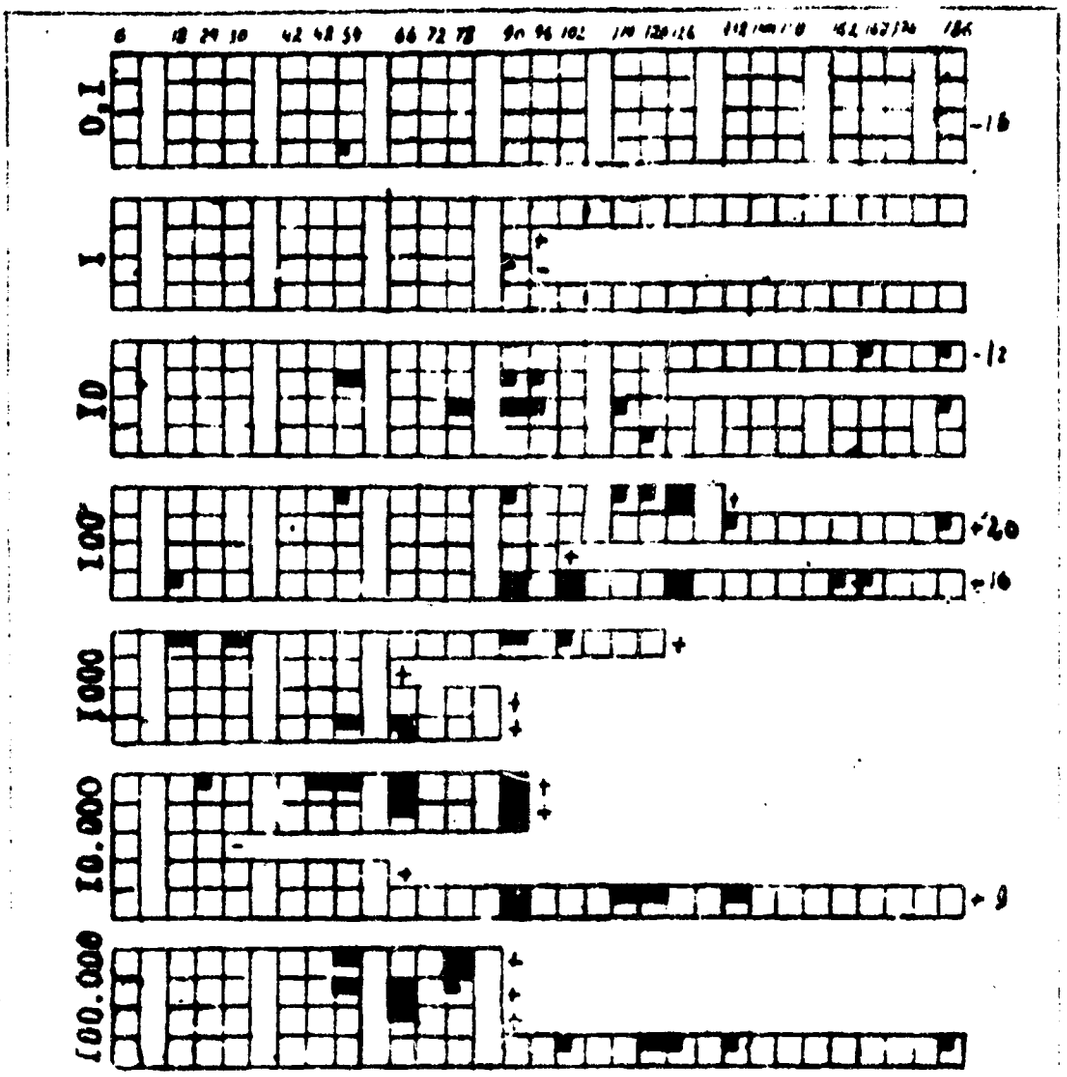


Fig. 5. Bacteriemia in sousliks (Zenotayevsk), Strain 297.

the sousliks infected with different strains of plague bacteria. A comparative study of infectious sensitivity was made with the same strains in different populations of the meridional jird (this work is being published in the present collection), whereby, qualitative differences were demonstrated in the strains, which was evidenced by different virulences of them for meridional and crested jirds with approximately the same virulence for white mice and guinea pigs. However, even in the work with jirds even greater differences were demonstrated between the strains with respect to bacteriemia. While strain 403 caused bacteriemia in meridional jirds from the left bank after the injection of

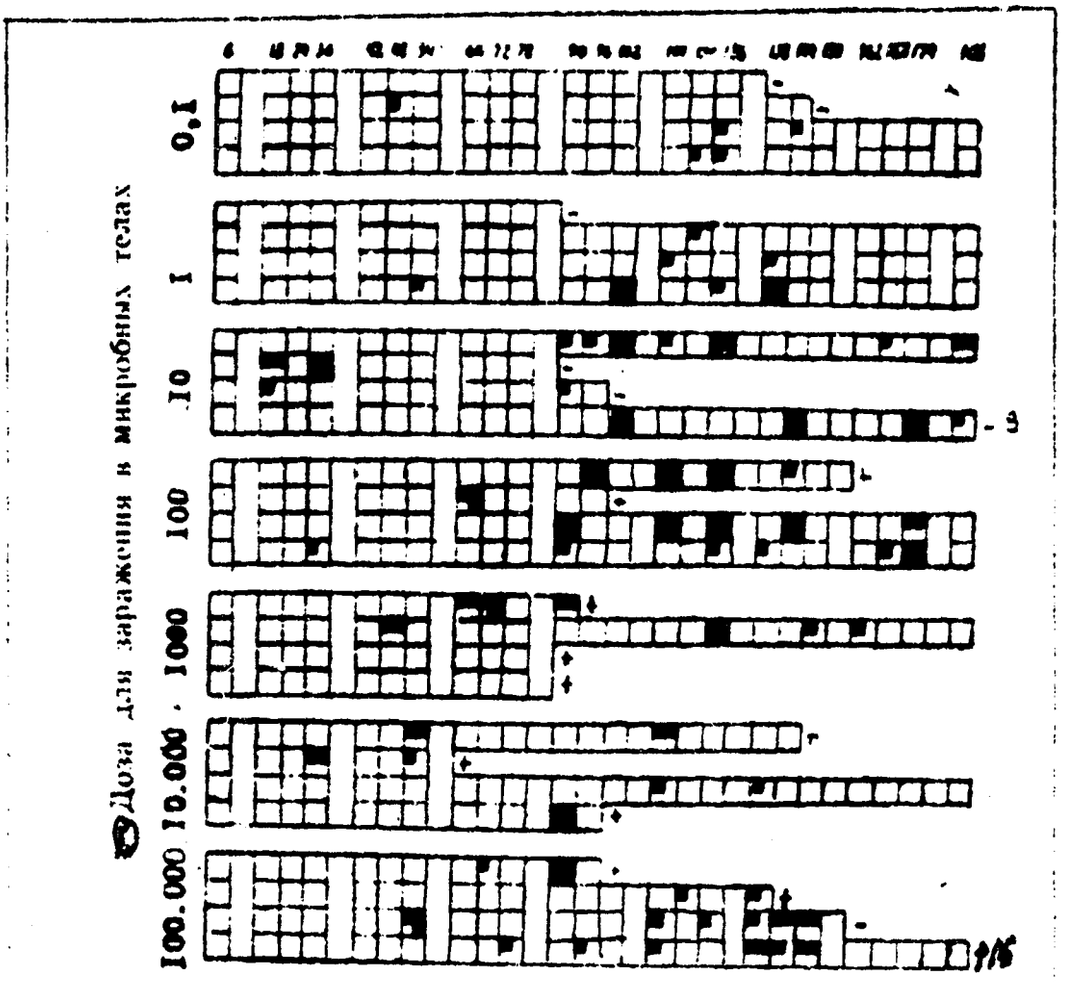


Fig. 6. Bacteriemia in sousliks (Dosang). Strain 297. 1. Dose used for infection in microbes.

such small doses as 0.1, 1 and 10 microbes, strain 297 under similar conditions caused bacteriemia only after the injection of such doses as 10 million microbes or more. In the present work, where the strains were the same in their virulence for white mice, guinea pigs and sousliks, clear-cut differences were demonstrated in the nature of bacteriemia. Apparently, this trait is of essential importance for the determination of differences in plague bacteria strains.

On the basis of the picture of bacteriemia in sousliks it is impossible to find any definite differences in different dwarf souslik populations. It may be noted only that among sousliks infected with strain 297 bacteriemia was more often encountered in animals caught in the Dosang region (in 24 cases) than in animals caught near Yenotayevsk

(18 cases).

Conclusions

1. During the period of rut differences are found in the infectious sensitivities of males and females to plague; however, this difference could have been chance, because it did not exceed the standard error.

2. Sousliks caught in different places (Zavetnoye, Chernozemel'skiy, Dosang, Yenotayevsk) possessed different degrees of infectious sensitivity to plague; however, the reasons for these differences await their explanation.

3. Quantitative study of bacteriemia in infected sousliks showed an essential difference in the nature of this process between animals infected with different strains, which is evidence of qualitative differences in the latter.

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B. G. Val'kov, Yu. V. Kanatov, Ye. R. Val'kova

Sensitivity of Young Sousliks Taken From Different Geographic Places to the Plague Microbe and Toxin

Among wild rodents which are the reservoirs and sources of plague infection a great part is played by the dwarf souslik, the most numerous species in the Northwest Caspian.

In the recent past (between 1913 and 1935) diffuse epizootics of plague were recorded almost yearly on a considerable part of this territory among these rodents, which here were the main sources of the plague pathogen (N. P. Mironov, I. S. Tinker, P. I. Shiranovich, A. K. Shishkin, 1957; N. P. Mironov, 1957).

In the works of S. M. Nikanorov, N. A. Gayskiy (1926), I. S. Tinker and N. I. Kalabukhov (1934), and I. S. Tinker (1940) and others problems of susceptibility and infectious sensitivity of the dwarf souslik to plague are quite well discussed in accordance with age, physiological condition, season, and other environmental conditions influencing the activity of this rodent. It has been established that adult sousliks are less susceptible and sensitive to plague at the time of going into hibernation and particularly during the period of hibernation in the winter and are more susceptible in the summer, in May-June (N. A. Gayskiy, 1926). The susceptibility of sousliks is also distinguished by sexual features. The males prove to be more resistant (I. S. Tinker and N. I. Kalabukhov, 1934). The young sousliks, particularly during the period of dispersal and settlement, possess the greatest susceptibility and sensitivity.

N. I. Kalabukhov and coauthors (1959) believes that the main factor influencing susceptibility of the rodents is their physiological condition.

Meyer (quoted by Pollitzer, 1954) in his works confirmed the fact of the greater susceptibility of young sousliks. At the same time, despite the data of I. S. Tinker and N. I. Kalabukhov, in his works he established the fact that adult males are more susceptible to plague than adult females. According to the results of study of susceptibility to plague in 450 sousliks the author concludes that various factors, particularly the duration and nature of the course of plague epizootics on the given territory in the past, exert an influence upon its degree.

I. S. Tinker and Ye. N. Aleshina (1955) studied the susceptibility of sousliks from different landscape-geographic regions. Thereby, they established the fact that sousliks taken from loamy soil are more susceptible to plague than sousliks which live on sandy soils. They explain this phenomenon by different physiological conditions of the

rodents taken from different places. The authors established a relationship between the susceptibility of sousliks to plague and the gas exchange level [metabolic rate]

The effect of the physiological condition of rodents on the degree of their susceptibility to the plague pathogen, described by the authors quoted above, is beyond doubt. At the same time, the problem of the effect of the epizootological past of the territory on which the souslik populations are remains unclear. Natural selection, under conditions of prolonged contact with the plague pathogen and active epizootics, could have reinforced, by heredity, the tendencies toward reduction of susceptibility.

The aim of the present work was a determination of the plague susceptibility of young sousliks caught on the Yergeni Heights, where for a number of years (between 1913 and 1935) diffuse plague epizootics had been recorded among the dwarf sousliks, and on territory where epizootics had been recorded less often (1925, 1936 -- Chernyy Zemli in the region of the Chernozemel'skiy Sovkhoz; 1938-1940, 1942, 1946-1947 -- on the left bank of the Volga in the region of Dosang station).

In an experiment performed in June 1959 32 sousliks from each place, a total of 96, were used. Part of the rodents, which died of extraneous causes, was excluded from the experiment. The infection was given with a virulent strain 403, isolated from the red-tailed jird in Azerbaydzhan in 1958, subcutaneously with doses of 1, 10, 100, 1000 microbes. The LD_{50} was calculated by the Kerber method. The results of the experiment are shown in Table 1.

For the purpose of comparing sensitivity of young and old sousliks to plague we are presenting the experimental results with the old sousliks, which were infected in April 1959.

The young sousliks used in the experiment died of plague with subsequent isolation of the culture, as a rule, on the fourth-ninth day, and only four sousliks out of 35 died after the tenth day. Dissection of the rodents showed that in the majority of sousliks, both old and young, no apparent changes were found in the organs, with the exception of a marked congestion of the lungs, and sometimes even several necrotic nodules. Only in which rodents which died in the later periods were pathological changes observed in other organs also: the spleen and the liver.

All this is evidence of the fact that the majority of sousliks died of acute plague. No difference in the pathological picture between old and young sousliks was noted.

In our experiments both males and females were infected equally with plague; it was impossible to find any difference in sensitivity depending on sex.

Table 1

Sensitivity of Young Sousliks of Different Populations to Subcutaneous Infection with the Plague Pathogen

Место вылова сусликов (1)		Доза заражения в микробных телах (2)	Пало (3)	Выжило (4)	LD_{50} в микробных телах (5)
Заветное (6) суслики		1	0	6	57
		10	1	3	
		100	4	2	
		1000	5	1	
Черноземельский суслики (7)		1	0	7	46
		10	2	2	
		100	5	2	
		1000	5	3	
Досанг (8) суслики		1	0	8	42
		10	2	2	
		100	5	2	
		1000	6	2	
Контроль (9)	Белые мыши (10)	1	0	4	31
		10	1	3	
		100	3	1	
		1000	4	0	
	Морские свинки (11)	1	0	4	17
		10	2	2	
		100	3	1	
		1000	4	0	

1. place at which sousliks were caught; 2. dose of infection in microbes; 3. died; 4. survived; 5. LD_{50} in microbes; 6. Zavetnoye sousliks; 7. Chernozemel'skiy sousliks; 8. Dosang sousliks; 9. control; 10. white mice; 11. guinea pigs.

As is seen from Table 1, the LD_{50} in young sousliks taken from the territory of Zavetnoye village was equal to 57 microbes; from Chernozemel'skiy Sovkhoz, 46; from Dosang station, 42 microbes.

These data attest to the fact that the young sousliks taken from the territories described are the same in their sensitivities to the plague microbe.

Comparing data obtained in experiments with young and old sousliks (Tables 1 and 2), we see that sousliks which live on the territory of Chernozemel'skiy Sovkhoz and Dosang station possessed

Table 2

Sensitivity of Old Sousliks of Different Populations to Subcutaneous Infection with the Plague Pathogen

Место вылова сусликов (1)	Доза заражения в микробных (2) телах	Пало (3)	Выжило (4)	LD_{50} (5) в микробных телах
Заветное (6) сусликн	0,1	0	12	
	1	1	11	
	10	5	7	
	100	8	4	616
	1000	6	6	
	10000	9	3	
	100000	8	4	
Черноземельский сусликн (7)	0,1	1	11	
	1	4	8	
	10	4	8	
	100	10	2	45
	1000	10	2	
	10000	12	0	
	100000	8	2	
Досанг (8) сусликн	0,1	0	9	
	1	1	11	
	10	3	9	
	100	10	2	60
	1000	10	2	
	10000	9	3	
	100000	10	0	
Контроль (9) Белые мыши (10)	0,1	0	4	
	1	0	4	
	10	1	3	
	100	4	0	36
	1000	3	1	
	10000	4	0	
	100000	4	0	
Морские свинки (11)	0,1	0	4	
	1	0	4	
	10	2	2	
	100	3	1	
	1000	4	0	17
	10000	4	0	
	100000	4	0	

1-11. same as in Table 1.

the same sensitivity to the plague microbe (Dosang station: LD_{50} for old sousliks -- 60 microbes; for young sousliks, 42 microbes. At the Chernozemel'skiy Sovkhoz: the LD_{50} for old sousliks, 45 microbes; for young sousliks, 46). The old sousliks, caught in the region of Zavetnoye village, possessed greater resistance to the plague microbe than the young rodents (for the old sousliks the LD_{50} was 616 microbes; for the young ones, 57).

Analyzing the data obtained from the viewpoint of the epizootic past of the territory on which the sousliks used in the experiment had been caught, we should note the fact of an increased resistance to plague infection among old sousliks caught in the previous enzootic focus of plague -- the village of Zavetnoye (according to the data of M. I. Levi, B. G. Val'kov, G. B. Minkov and Ye. I. Novikova) and the absence of such a difference in the young sousliks.

Based on the experiments of M. I. Levi, B. G. Val'kov, A. I. Shtel'man and Yu. V. Kanatov, who noted different sensitivities of meridional jirds from the right and left banks of the Volga not only to the plague pathogen but also to the plague microtoxin, we attempted to clarify the sensitivities of young sousliks to plague toxin, particularly since in the literature available to us we have encountered no such work, with the exception of the work of A. G. Kratinov (1957), who showed different degrees of sensitivity of meridional jirds, house mice and other rodents to the plague toxin.

We used the protein toxin fraction obtained from a virulent strain of B. pestis 133 by means of mechanical destruction of killed and acetone-dried microbes with subsequent extraction with weak saline solutions and precipitated with ammonium salts. The protein fraction used in the experiment possessed a pronounced toxicity for white mice. The results of this experiment are shown in Table 3.

In all, 60 sousliks were used in the experiment; of these four were from the territory of Zavetnoye village; 36, from Chernozemel'skiy Sovkhoz; 20, from Dosang station. In connection with the small number of animals caught on the territory of Zavetnoye village it was not possible for us to compare their sensitivity to the toxin with that of sousliks caught in other places. However, we made such a comparison between the sousliks of the right (Chernozemel'skiy Sovkhoz) and left (Dosang station) banks of the Volga. As is seen from the Table, no essential difference was noted in the sensitivity of these rodents to the plague toxin.

In this experiment a relatively low sensitivity of young sousliks to the plague toxin was demonstrated. This is confirmed by the comparative data of sensitivity of sousliks and white mice to the toxin (see Table 3).

Table 3

Sensitivity of Young Sousliks to Plague Toxin

1 Доза токсина в мг	2 Суслики									6 Белые мыши		
	3 Дозанг			4 Черноземельский			5 Заветное					
	количество животных	павших	средняя продолжительность жизни в часах	количество животных	павших	средняя продолжительность жизни в часах	количество животных	павших	средняя продолжительность жизни в часах	количество животных	павших	средняя продолжительность жизни в часах
0,0625	4	0		4	0					4	3	15
0,125	4	0		4	0					4	4	12
0,25	4	0		4	0					4	4	6
0,5	4	4	17	4	0		2	0		4	4	6
1	1	2	8	4	1	16	2	0				
2				4	1	20						
3				4	3	19						
4				4	0							
5				4	1	18						

1. dose of toxin in mg; 2. sousliks; 3. Dosang; 4. Chernozemel'skiy; 5. Zavetnoye; 6. white mice; 7. number of animals; 8. died; 9. average survival time of animals in hours.

Thus, while white mice weighing 20 grams died in 100 per cent of the cases (CLD) from the minimum dose of toxin, equal to 0.1 to 5 mg, young sousliks weighing 48 grams survived in 100 per cent of the cases, even with a dose of 5 milligrams.

Conclusions

1. Young sousliks taken from places which had different epizootic pasts (the village of Zavetnoye, Chernozemel'skiy and Dosang station) showed no essential difference in their infectious sensitivity to the plague microbe.

2. Old and young sousliks caught in the regions of Dosang station and Chernozemel'skiy Sovkhoz did not show any essential difference in infectious sensitivity to plague. Old sousliks taken from the region of the village of Zavetnoye were ten times more resistant than the young animals.

3. Differences in sensitivity to plague infection were not found between young females and males.

4. Young sousliks were more resistant to the plague toxin than white mice.

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Lingering Forms of Plague in Laboratory Animals

Report IV. Dissemination of chronic forms of plague with reduction of resistance of the macroorganism.

(Report I. Trudy Rostovskogo-na-Donu Gos. Nauchn.-Issled. Protivochumnogo In-ta (Works of the Rostov-na-Donu State Scientific Research Plague Control Institute), Vol. XV, No. 1, 1959. Reports II and III in the sixteenth volume of the same works. 1959)

Chronic plague in rodents has been the subject of discussion of many investigators (Simond, 1898; Kolle and Martini, 1902; Gottschlich, 1903; Hata, 1904; D. K. Zabolotnyy, 1906; S. M. Shchastnyy, 1910, 1912; the English Commission for Study of Plague in India, 1906-1912; S. V. Suvorov, 1926; Williams, 1926 and many others). However, opinions about its epizootological significance have diverged even since the time of the first works, which substantiated the participation of rodents in the rooting of plague in nature.

Thus, Simond and Gottschlich, Kolle and Martini believed that chronic plague in rats may be responsible for the preservation of this infectious disease in the interepizootic periods and give rise to new acute epizootics. The English Commission, on the basis of extensive observations, supplemented by histological studies of Ledingham (1907), concluded that chronic plague is of no significance for the rooting of this infectious disease in nature and represents a stage in successful recovery from the acute form of the disease. The Commission therefore considered it better to call the chronic form of plague "resolving plague", by the same token emphasizing the impossibility of its subsequent exacerbation. The works of the English Commission exerted a great influence on many investigators, and for several decades the viewpoint that dissemination of chronic forms of plague was impossible predominated. This principle was shaken by the works of Dujardin-Beaumetz and Mosny (1912), A. A. Churilina (1915), N. A. Gayskiy (1926, 1944), Wu Lien-teh (1928), V. S. Grikurov (1934) with respect to the part played by hibernating rodents in the transmission of the plague pathogen from one epizootic season to the next. As far as non-hibernating rodents are concerned, not so long ago, in 1944, analyzing extensive factual material on plague epidemiology accumulated over half a century V. N. Fedorov wrote that there is no reason for considering chronic plague of non-hibernating rodents a means of

perpetuating this infectious disease in nature.

In recent years, however, irrefutable facts have been obtained concerning the dissemination of chronic forms of plague, both in rodents going into hibernation and in non-hibernating rodents, and many authors have expressed the opinion that chronic forms play a part in the maintenance of the plague enzootic (O. M. Petrunina, 1950; V. M. Tumanskiy, N. M. Sokolova, and N. K. Fedutina, 1951; N. A. Pletneva, 1957; L. S. Malafeyeva, 1957; T. I. Anisimova, 1959 and others). Thereby, it is believed that the cause of exacerbation of chronic forms of plague may be a reduction in the protective forces of the body when the rodents come under unfavorable existential conditions. Nevertheless, we have not succeeded in finding a single work in the literature which gives direct proof of the fact that unfavorable influences upon the body of the rodent which has the chronic form of plague would lead to dissemination of the infectious process.

In connection with this, we made an attempt to learn experimentally to what degree unfavorable factors can affect the course and outcome of chronic forms of plague. In the literature there is mention of the fact that such attempts have not given positive results (M. G. Akhundov, 1940; V. N. Fedorov, 1944).

For the purpose of reducing the resistance of the body we used cortisone as well as starvation. The choice of methods was not by chance. It is well known that cortisone in large doses is a powerful factor reducing the resistance of animals to various infectious diseases. It has been determined that the administration of cortisone to white mice markedly increases their sensitivity to the plague pathogen (Payne, Larson, Walker, Foster and Meyer, 1955; S. L. Blyakher, 1958; D. T. Shiryayev, G. A. Lalazarov, I. M. Vorona, L. K. Melashchenko, 1958). It should be noted that in immunized mice no such effect was observed (Payne, Larson, Walker, Foster, and Meyer, 1955). Hayashida, 1957, reports a considerable reduction of resistance to the plague microbe in white rats which were injected with adrenocorticotropic hormone. At the same time, there are observations in existence which attest to the fact that a state of malnutrition increases the sensitivity of animals to plague (E. I. Klets, V. P. Khrustselevskiy, R. S. Kolesnik, Z. S. Kudinova, N. V. Ol'kova, L. A. Smirnova, 1957).

Experimental Data

For the purpose of clarifying the possibility of dissemination of chronic forms of plague after the effect of unfavorable conditions

upon the macroorganism we performed experiments on white rats and white mice. In the experiments adult white rats weighing 180-250 grams and white mice weighing 18-25 grams were used. Cortisone from the French Roussel Company was used. Infection of the animals was carried out by subcutaneous injection in the area of the left thigh of 0.5 cc of a microbe suspension prepared in physiological saline solution from a one-day agar culture of the plague pathogen grown at 28°. The animals which died and were killed were subjected to dissection and bacteriological study. The latter was accomplished by means of inoculation of material from the infection site, regional lymph nodes, liver, spleen, lung and blood into agar plates. Microscopic study of the pathology of the experimental animals was carried out in the pathology laboratory of the Institute by Z. D. Khakhina; the results of these studies have been used in the present report.

In preliminary experiments the activity of the cortisone was checked. The activity of the preparation for white mice was determined by means of infecting them with a vaccine strain of B. pestis, strain 1, after a preliminary single intramuscular injection of different doses of cortisone into the animals four hours before infection. After infection of the mice with a dose of 200,000,000 microbes of B. pestis 1 part of the "cortisone-treated" animals died of disseminated plague, whereas all the mice which had not been injected with the preparation survived. Based on this experiment, for the purpose of provocation of chronic forms of plague in white mice we considered the best dose of cortisone to be eight milligrams, because higher doses proved toxic.

In the literature we have been unable to find any studies which throw light on the effect of cortisone on the plague infectious process in white rats. In connection with this we tested the activity of cortisone in infection of white rats with a virulent strain of B. pestis, 773. Cortisone was injected once into the muscles of the right thigh four hours before infection. Observation of the animals was made for a month. The results of the experiment are presented in Table 1.

The death of the animals from plague occurred on the sixth and seventh days after infection. Growth of the plague microbe on agar plates in cultures of the organs and blood of the animals which died in the majority of cases was abundant. As is seen from Table 1, injection of cortisone considerably increased the infectious sensitivity of white rats to plague. Based on this experiment, the dose of 30 milligrams was adopted as the optimum for the provocation of chronic forms of plague in white rats.

After making sure of the fact that cortisone reduces the resistance of white mice and white rats to the plague pathogen and after

Table 1

The Effect of Cortisone on the Course of Plague in White Rats Infected with B. pestis 773

(1) № групп животных	(2) Количество животных в группе	(3) Доза заражения (в микробных телах)	(4) Доза кортизона (в мг)	(5) Пало		(8) Выжило
				(6) от генерализованной чумы	(7) с отрицательным результатом бактериологического посева	
1	4	1000	25	1	1	2
2	4	1000	50	2	—	2
3	4	1000	100	3	—	1
4	4	—	50	—	1	3
5	4	—	100	—	2	2
6	4	1000	—	—	—	4

1. number of groups of animals; 2. number of animals in the group; 3. dose of infection (in microbes); 4. dose of cortisone (in mg); 5. died; 6. from disseminated plague; 7. with a negative result of bacteriological examination; 8. survived.

determining the optimum doses of the preparations we proceeded with the performance of the main experiments. Twenty-four white mice were infected with 1, 10, 100 and 1,000 microbes of B. pestis 773. Six animals were used for each dose. In Table 2 the results of the experiment are presented on the 29th day after infection.

All the surviving mice looked completely healthy, ate well and were active. On the 29th day after infection eight white mice which had survived 10 and 100 microbes were injected intramuscularly into the right thigh with eight milligrams of cortisone. The other six mice were not given cortisone in the belief that animals with chronic forms of plague can occur only among those surviving larger infective doses (see report I). In the group of those which received the cortisone injection four white mice died; the others were killed on the ninth and 10th days after injection of the preparation. All the white mice, with the exception of one, No 1-31, were hardly noteworthy. Three of them died of causes which had no bearing on the plague infection.

Table 2

Results of Infection of White Mice With Different Doses of B. pestis 773

(1) № групп животных	(2) Количество животных в группе	(3) Зараждающая доза (в микробных телах)	(4) Погибло от чумы	(5) Продолжительность жизни павших животных (в сутках)	(6) Выжило
1	6	1	0	—	6
2	6	10	1	9	5
3	6	100	3	5, 5, 15	3
4	6	1000	6	5, 5, 6, 8, 8, 23	0

1. number of groups of animals; 2. number of animals in the group; 3. infective dose (in microbes); 4. died of plague; 5. length of life of animals which died (in days); 6. survived.

Among animals infected with 1 microbe and killed on the 38th day after infection no chronic forms of plague were found.

White mouse No 1631, which had survived after infection with 100 microbes of B. pestis 773 and which on the 29th day had received eight milligrams of cortisone, died on the 37th day after infection. At autopsy the following pathological changes were found in it: the subcutaneous tissue was markedly congested, particularly in the inguinal and axillary regions, markedly edematous on the left side of the body, and moderately edematous on the right. Edema of the subcutaneous tissue reached its greatest degree of expression in the left inguinal region and at the site of infection. At the infection site necrosis of the muscles of the thigh of a creamy-greenish color was found; in the central portion of the necrosis the muscles had liquefied; along the periphery, they were diffusely impregnated with a purulent exudate; the adjacent subcutaneous tissue was increased in volume, markedly edematous, and hemorrhagic. The left inguinal and left iliac lymph nodes were markedly enlarged. The right inguinal lymph node was moderately enlarged. The liver was of a clay color. The spleen was considerably enlarged, of dark cherry color. On bacteriological examination an abundant growth of a typical plague microbe culture was found in cultures taken from

the organs and the blood.

On histological examination of white mouse No 1631, at the infection site a focus of complete muscle necrosis was found, purulent inflammation of the surrounding tissues; among the cells of the exudate plague bacilli were encountered; the muscle fibers, separated by the exudate, had become necrotic. In the regional lymph nodes hyperplasia of the reticular cells and a diffuse plasma cell infiltration wereobserved. In the spleen a very marked congestion of the pulp was noted with impoverishment in cellular elements; the follicles were large and rimmed by a narrow region of necrosis in which small accumulations of plague bacilli were encountered. The liver was congested; the parenchymal cells showed marked degenerative changes. In many intralobular capillaries accumulations of plague bacilli were found which had penetrated into the surrounding tissue also. In the lungs congestion was noted, and there were small foci of acute inflammation; in the capillaries of the septa and between the cells there was a large number of plague bacilli.

The data presented attest to the fact that in white mouse No 1631, which died on the 37th day after infection, a disseminated plague infectious process had been established with the presence of agonal septicemia.

With the aim of provocation of chronic forms of plague in white rats two experiments were performed. In the first, 41 white rats which had survived after infection with different doses of B. pestis 773 were given a single intramuscular injection of 50 milligrams of cortisone. From the time of the infection to the time of injection of cortisone 49 days elapsed for 19 animals and 38 days for 22. Thirty control white rats were infected with 1,000 microbes of B. pestis 773; of these, 20 animals received 50 milligrams of cortisone intramuscularly four hours before infection.

All the experimental animals remained alive and were killed 17-20 days after cortisone injection. Nine of them had chronic forms of plague which were characterized by the presence of encapsulated abscesses filled with necrotic contents in the tissues. In cultures of the abscess contents the growth of plague microbe cultures was abundant. In two white rats, in which the abscesses were localized at the infection site, the regional inguinal lymph nodes were considerably enlarged, and in cultures of the latter on agar plates growth of the plague pathogen was observed in the form of single colonies.

On histologic study no changes were found in the rats which would permit suspecting an exacerbation of chronic forms of plague.

The fact that plague microbe was isolated from lymph nodes regional to the site of the encapsulated abscesses provides the basis for the belief that encapsulation is a relative barrier to the plague microbes, and the latter can penetrate beyond their limits from foci of lesions.

Therefore, in this experiment cortisone provocation did not lead to an exacerbation of chronic forms of plague.

In the control experiment cortisone considerably reduced the resistance of white rats to plague: by the 15th day after infection 17 of the 20 animals which had been given the preparation died of disseminated plague, whereas out of 10 rats which had not been given the preparation only four died.

In the second experiment 37 white rats which had survived after infection with different doses of B. pestis 773 were subjected to the unfavorable factors. These rats were injected subcutaneously twice with 50 milligrams of cortisone each with an interval of 13 days between the injections. From the time of infection to the time of the first injection of the preparation 31 days elapsed for 17 animals; 34 days, for 18; 109 days, for two. Five days before the first injection of cortisone all the white rats were transferred to a limited diet, on which they were kept until the end of the experiment. Prior to this day milk, brown bread and oats had been included in the diet of the rats. Milk and bread were eliminated from the diets; the quantity of oats was cut in half. Instead of milk the rats drank water. Observation of the animals was conducted for 23-28 days after the first cortisone injection. In this time seven white rats died; the rest were killed at the times indicated. In the majority of animals, both those which died and those which were killed, a considerable loss of weight was noted.

Of the group of animals which died five white rats showed no pathological changes suspicious of plague; no culture of plague microbe was obtained from them. The other two rats which died -- No 859 and No 867 -- deserve special attention.

White rat No 859 was infected with 100 microbes of B. pestis 773. Cortisone was injected into it once on the 34th day after infection. It died on the ninth day after injection of cortisone, on the 43rd day after infection. On pathological examination the following was found: the rat was moderately well nourished; the subcutaneous tissue was markedly congested. In the left inguinal region there was an encapsulated abscess measuring 0.7 x 0.5 x 0.4 centimeter filled with thick necrotic contents of a cream color. The surrounding tissues and the abscess capsule were hemorrhagic. In the liver areas of an intense red color alternated with areas of

a clayey hue. The spleen was small. The lungs were markedly changed. The left lung and the middle lobe of the right were enlarged, dense (of liver consistency); on section they were red and did not collapse. In the middle lobe of the right lung there were several small greyish-white necrotic nodules. The upper and lower lobes of the right lung were bright red in color, moderately edematous and aerated. On bacteriological examination in the cultures of all the organs and blood a typical culture of plague microbe grew out. Growth of the pathogen was particularly abundant in the cultures of the abscess contents and of the lungs; somewhat less copious in the blood culture.

Histopathological study showed the following results: the left inguinal lymph node was completely necrotic; in the necrotic tissue there were many plague bacilli; along the periphery the area of necrosis was surrounded by a zone of purulent inflammation. The capsule only partially localized the focus of the lesion, and where there was no capsule the purulent infiltrate penetrated far into the surrounding tissue (see photographs 1 and 2). The spleen was congested. In the liver there was granular degeneration of parenchymal cells; many Kupffer cells were enlarged, and in some nuclear degeneration was observed. In the left lung and in the middle lobe of the right there was a diffuse acute inflammatory process. In the exudate there were erythrocytes, leukocytes and serous fluid with a mass of plague bacilli (see photograph 3). In other parts of the lungs, against the background of marked congestion, there were multiple small pneumonic foci with serous and serous-leukocytic exudate in which there were many plague bacilli. In the kidneys there was a marked granular degeneration. The suprarenal glands were congested.

The data presented are evidence to the effect that in white rat No 859 a dissemination of the chronic form of plague had occurred. The plague pathogen had extended beyond the limits of the localized focus of the lesion in the regional lymph node and had caused an extensive acute pneumonia. Death of the animal occurred with signs of a quite intense bacteriemia.

The virulence of the subculture obtained from blood of white rat No 859 was tested in the few days after its isolation by means of the infection of white rats, guinea pigs and white mice, and it was shown to have remained at its high initial level for all three species of animals.

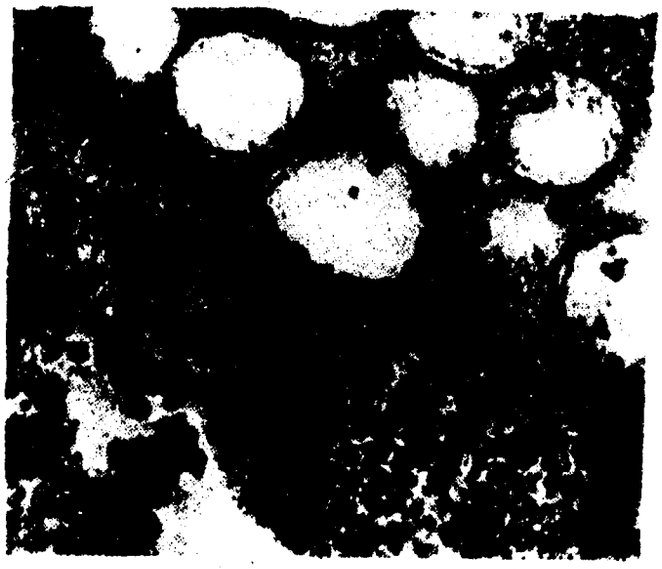
White rat No 867, infected with 1,000 microbes of B. pestis 773, was injected with cortisone twice, 34 and 47 days after infection. It died on the 52nd day after infection. At autopsy the

Photograph 1. White rat No 859. Section of abscess wall. In the center the capsule is seen; below, the purulent infiltrate.

animal showed loss of weight, pronounced hyperemia of the subcutaneous tissue, a large encapsulated cess at the infection site, moderate enlargement of the reg lymph nodes, atrophy of the spleen, and congestion of the lungs. In the culture of the abscess contents the growth of plague bacteria culture was abundant; in the culture of the regional inguinal lymph node single colonies of the plague pathogen grew out.

Histologic examination of white rat No 867 did not reveal any features which would attest to dissemination of the infectious process. The abscess capsule was thin over a considerable extent.

Therefore, even the fatal outcome did not produce dissemination of plague in white rat No 867: the plague microbes remained localized within the limits of the primary complex.



Photograph 2. White rat No 859. Section of abscess wall. No capsule; the purulent infiltrate penetrates uninterruptedly into the subcutaneous fatty tissue.

On examination of the surviving animals chronic forms of plague were found in four white rats. Thereby, encapsulated abscesses were found in two rats at the infection site; in one, in the retroperitoneal lymph node, and in the latter, No 953, at the infection site and in the spleen. Culture of the abscess contents in all cases gave an abundant growth of typical plague microbe colonies.

White rat No 953, killed on the 58th day after infection, is interesting. At autopsy no other changes were found in it except for a thin walled encapsulated abscess at the infection site and a large encapsulated abscess in the liver. However, on bacteriological examination plague microbe cultures grew out not only in cultures of the abscess contents but also in cultures of the spleen, lungs (moderate growth) and blood (single colonies).

Histological study of white rat No 953 did not reveal any changes in the organs which would confirm dissemination of the chronic form of plague.

Photograph 3. White rat No 859. Smear of lung. In the exudate is a mass of plague bacilli.

Discussion

In our previous investigations it was determined that the plague pathogen can be maintained for a long time in the bodies of white rats, guinea pigs and white mice with chronic forms of plague in these animals (Report I). The virulence of the pathogen thereby remained at the high initial level for these three species of animals, regardless of the species of the host in which the plague microbe had coexisted for a long time (Report II). In white rats which had suffered infection with the LD_{50} of plague bacteria, the strength of the immunity was determined 25-71 days after infection (Report III). Thereby, the white rats among which part of the animals had chronic forms of plague showed a relative resistance to a second infection with both small (10 CLD) and large (200 CLD) doses of plague microbes. In rats which died after a second infection, as a rule, there were poorly expressed pathological changes, and a complete absence of plague microbes was observed in the organs and tissues, or they had a very low content of the pathogen in them. However, in a small number of rats after a second infection an extensive secondary specific involvement of the lungs occurred. The fact was noteworthy that antemortem bacteriemia developed

only in these animals, whereby the saturation of blood with plague microbes was high. The fact that the rats died with signs of extensive plague pneumonia is evidence of the fact that various organs of the animals which had suffered from subcutaneous infection with plague can acquire a different degree of resistance to a repeated incorporation of plague bacteria. These data are in agreement with the results obtained by other authors. Thus, it is known that the lungs are immunized in plague poorly by comparison with the other organs and after a delay (Bazarov, 1899; N. Zhukov-Verezhnikov, 1940; M. P. Pokrovskaya and L. S. Kaganova, 1947). Jawets and Meyer (1944), after infection of immunized white mice and guinea pigs with doses of virulent plague bacteria which were not very large, observed an extensive plague bronchopneumonia in the remote periods in the animals which died in the absence of lesions in the other organs. These investigators regard this phenomenon as the result of incomplete or partial immunity. They also believe that the toxin liberated from death of plague bacteria in a partially immune organism reduces the resistance of the lung tissue to the incorporation of the plague pathogen in it and contributes to the occurrence of the pneumonia described above, whereas the liver and spleen remain intact in view of their resistance to the toxin and cellular activity.

According to the data of D. I. Shiryayev (1957), in house mice which survived after primary infection with the LD_{50} of a virulent strain of plague microbe resistance develops to a second infection. However, the "degree of immunity in house mice which have recovered from the plague is low, and on second infection with 10-25 doses of plague microbes a considerable number of the mice dies of the plague."

Therefore, in the chronic forms of plague interrelationships can be created between the pathogen and the host organism in some cases, evidently, in which the plague microbe preserves its high degree of virulence, and the body possesses a relative or incomplete immunity.

The protective role of the tissue barrier in the form of the abscess capsule is very relative. Such a barrier in the absence of an adequate immunity is perfectly surmountable by the plague microbe. Thus, in the experiments of O. N. Trubchaninova and L. N. Makarovskaya (1958), after early termination of treatment with inadequately effective doses of streptomycin in guinea pigs infected with plague, not uncommonly the plague bacteria broke through the capsules of the abscesses formed and an acute disseminated infection developed. The cases of isolation of plague microbe cultures from lymph nodes regional to the site at

which encapsulated abscesses were found presented above also confirm the possibility of the pathogen's penetration into the surrounding tissue from the abscess. Finally, the degree of expression of the abscess capsule is different; sometimes the capsule is so thin over a certain length that it is found only on histologic examination.

Therefore, there is reason for the belief that the premises exist on the basis of which chronic forms of plague can produce dissemination of the infectious process. It is entirely probable that the reason for the exacerbation in such cases is a reduction of the infectious sensitivity of the macroorganism.

The results of the experiments performed confirm this assumption. The reduction of the resistance of the animal organism led to an exacerbation of chronic forms of the plague in some of them and terminated fatally with signs of dissemination and antemortem bacteriemia.

Reduction of the resistance of white rats far from always led to an exacerbation of the chronic forms of plague in them. Of 15 of the rats which had maintained the plague pathogen in their bodies, dissemination with a fatal outcome occurred in only one. Exacerbation occurred in a white rat from the group of animals which were on a starvation diet and subjected to the influence of cortisone. Reduction of the protective forces of the animals of this group was so great that part of the white rats died of extraneous causes. Nevertheless, in one of the rats which died, No 867, plague microbes remained within the limits of the primary complex.

In the white mouse dissemination was characterized by a more or less uniform involvement of various organs and tissues in the infectious process, whereas in the white rat an extensive involvement of the lungs predominated with insignificant involvement of other organs in the process.

Conclusions

1. In our method of performing the experiments cortisone reduced the natural resistance of white rats and white mice to plague.

2. Reduction of the infectious resistance to these species of animals can lead to a dissemination of chronic forms of plague and to a fatal outcome with a high degree of saturation of the blood with the pathogen.

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The Problem of the Role of Ticks in the Epizootology and Natural Focalization of Plague in the Northwest Caspian Focus

Recently, in connection with the realization of large-scale measures in the Soviet Union for the sanitization and elimination of natural foci of plague there has been a definite increase in interest in clarification of the role of ticks as possible long-term reservoirs and vectors of the plague microbe in nature. To date, this problem remains unclear, despite the fact that the attention of many investigators has been directed to ticks as possible reservoirs and vectors of plague for a long time.

Thus, in 1911, I. I. Mechnikov, travelling through the Kalmyk steppes, directed attention to the marked degree of infestation of suslike with ticks and expressed the idea that ticks can play a part of vectors of plague infection among rodent populations.

M. M. Tikhomirova (1929), S. M. Nikanorov (1930), D. A. Golov and A. N. Knyazevskiy (1930) isolated plague microbe cultures from Rhipicephalus schulzei ticks collected from sousliks and from their holes. Subsequently, under natural conditions many species of ticks were found to be infected with plague (Ixodes crenulatus, Hyalomma asiaticum asiaticum, Haemaphysalis numidiana turanica, Rhipicephalus pumilio, Ornithodorus tartakovskyi) which have close biocoenotic relationships with rodents -- reservoirs of plague in nature (O. F. Afanas'yeva and M. A. Mikulin, 1957).

These findings stimulated investigators to take up the study of the role of ticks in the preservation and transmission of the plague pathogen under experimental conditions. As a result of their studies it has been determined that various specimens of ticks of the species Argas persicus can take up the plague microbe and preserve it in their bodies up to 110 days (D. T. Fadeyeva, 1932).

In the body of the adult tick Hyalomma scupense the plague microbe has been preserved for 11 days; in the larvae, up to seven days, in the nymphs, three days (A. K. Borzenkov and G. D. Donskov, 1938).

It has also been made clear that the larvae and nymphs of the tick Dermacentor marginatus can be infected with the plague microbe after feeding on a plague-infected guinea pig in a considerable percentage of cases and preserve it in their bodies up to 10 days (D. N. Zasukhin and M. M. Tikhomirova, 1936).

It should be noted that in the first stage of this work the selection of ticks for experimentation was not at all successful from the methodological viewpoint, because ticks were used in the experiment

which had no biocoenotic relations with rodents -- sources of plague in nature. Therefore, this work could not give the correct answer to the question of the significance of ticks in the natural focalization of plague.

In recent years reports have appeared about successful experiments of infecting R. schulzei ticks under experimental conditions and of new cases in which ticks were found infected with plague in places of epizootics among sousliks as well as facts of the prolonged preservation of the plague microbe in the bodies of R. schulzei ticks.

Thus, K. I. Kondrashkina (1957, 1959) writes that all the developmental stages of the tick R. schulzei are capable of taking up the plague microbe when feeding on an infected animal and can preserve the infection in the body during the course of metamorphosis. K. I. Kondrashkina succeeded in observing transmission from one phase to the next in 23 cases, and in two she observed the transmission of the plague pathogen to healthy rodents by ticks which had been transplanted to them for feeding up (the mechanism of infection was not studied). During a plague epizootic which occurred among sousliks in the northern part of the Volga-Ural natural plague focus K. I. Kondrashkina found a large number of infected R. schulzei ticks along with the infected rodents and fleas. Thereby, repeated isolation of plague microbe cultures from unfed adult ticks and nymphs caught in the susliks holes gave the author the basis for expressing the idea that transmission of the plague microbe from one stage to the next occurs under natural conditions also.

T. A. Burlachenko (1957) showed that in the tick Ornithodorus tartakovskyi the transmission of the plague microbe from one stage of the nymph to the next is possible, but in considerable material she convinced herself that ticks which have undergone metamorphosis and have been kept for a long time do not transmit the plague microbe to another animal and do not cause its death from plague.

Analyzing the materials accumulated, O. V. Afanas'yeva and M. A. Mikulin (1957) concluded that ixodial and argasid ticks cannot be of essential significance in the development of epizootics, that is, in the extensive spread of the plague pathogen among rodent populations. The authors reinforced this conclusion with the following arguments: the impossibility of transmission of the plague pathogen to a healthy animal by ixodial ticks which have undergone metamorphosis; the duration of the developmental cycle, and feeding (normally) only once in each stage of development. Foreign investigators have come to the same conclusion (Pollitzer, 1954).

Therefore, from the works presented above it follows that on the problem of evaluation of the epizootological significance of ticks so far there is no agreement. To be sure, possibly various species

of ticks are not equivalent in this respect.

For the work of the plague-control organization of the Caspian natural focus as a whole and the Northwest Caspian focus in particular only two species of ticks can be of the greatest interest: R. schulzei and Ix. l. laguri.

The tick R. schulzei in the foci indicated above is most abundant. Its abundance in certain seasons of the year can be judged from the materials of V. N. Fedorov, G. A. Kayzer and A. A. Flegontova (1936), who observed R. schulzei ticks in large numbers in the Biyruk sands on dwarf, red and yellow sousliks [Citellus pygmaeus, major, and fulvus, respectively]. According to the materials of Ye. N. Nel'zina, L. I. Slin'ko and others (1955), this parasite is encountered almost on the entire territory of the Caspian focus, with the exception of Stavropol'skiy Kray and certain eastern rayons of Rostovskaya Oblast.

Ixodes l. laguri is the species of tick which is second with regard to census; it is parasitic on rodents living on the territory of almost the entire focus of the Northwest Caspian, according to the data of the same authors (1955).

There are controversial opinions on the problem of the epizootological significance of the tick R. schulzei. M. M. Tikhomirova and M. S. Nikanorov (1930) expressed the idea that this parasite is of great importance as a possible reservoir and vector of plague. In their opinion, ticks, changing hosts, can readily move the boundaries of a region enzootic for plague outward. However, not everyone agrees with this opinion. Thus, V. N. Fedorov, I. I. Rogozin and B. K. Fenyuk (1955) write that not a single experimenter has succeeded in proving entirely convincingly that ixodial ticks can be active vectors of plague. O. V. Afanas'yeva and M. A. Mikulin (1957) write the same thing as was mentioned above.

In experimentation with ticks R. schulzei and Ix. l. laguri we have also failed to bring about the active transmission of the plague microbe by infected tick to a healthy animal. Incompletely fed ticks of this species, as a rule, do not attach themselves a second time to a guinea pig. Judging by the fact that other investigators did not succeed here either, we believe that we can agree entirely with the idea of K. I. Kondrashkina (1959) to the effect that in two of her experiments of infecting sousliks from infected ticks transmission did not occur from the bite but rather as the result of rubbing the contents of the internal organs of crushed infected ticks into the skin, that is, the infection was by chance.

Nevertheless, as is well known, only the capacity of a vector actively to transmit a pathogen from an infected to a healthy animal is of decisive importance for the development of epizootics and for maintaining enzootics of plague. For the purpose of elucidation of this im-

portant problem with respect to the ticks R. schulzei and Ix. i. laguri in the spring of 1951 at the Elista Plague-Control Station appropriate experiments were performed.

We began with the elucidation of the capacity of ticks of becoming infected on feeding on a plague-infected guinea pig.

With this aim in view 80 specimens of adult female Ix. i. laguri collected in the environs of Elista were placed on four plague-infected guinea pigs.

Of these only 33 ticks sucked until they were satiated. Part of the ticks fed to an incomplete degree, and the rest died.

Of the 33 ticks which had sucked until they were satiated eight (24.2 percent) were found to be infected with plague. On bacteriological examination of them a plague microbe culture was isolated from them. Therefore, this comparatively small experiment showed the quite considerable capacity of ticks of the species Ix. i. laguri for taking up the plague pathogen.

From this experiment it was possible to find out that the plague microbe is capable of surviving in the tick organism in an unchanged form, completely preserving its virulence for 65 days (this is not the maximum period).

Similar experiments were performed with the tick R. schulzei and its nymphs. R. schulzei ticks proved to be less susceptible to plague than Ix. i. laguri ticks. Thus, 236 adult ticks were attached to seven guinea pigs which had first been infected with plague. On bacteriological examination of 165 satiated ticks the plague microbe culture was isolated from only two (1.2 percent).

In another experiment, 283 nymphs of the same species of tick were attached to 10 guinea pigs infected with plague. Of 141 satiated nymphs a plague microbe culture was isolated from only one (0.7 percent) on the seventh day after it fed on the infected animal.

Ticks, incompletely fed, attached to healthy guinea pigs for completion of feeding, did not attach themselves a second time, as has been mentioned above.

Data obtained in these experiments are the same as the observations which we made previously in bacteriological study of ticks collected from areas in which an active plague epizootic was occurring in sousliks. Thus, in the spring-summer of 1948 at the epizootic points of Limanskiy Rayon of Astrakhanskaya Oblast 3,156 ticks were collected from sousliks and from their holes as well as from birds, jerboas and other rodents, of which 2,687 (85 percent) belonged to the species R. schulzei. All the ticks collected were subjected to careful bacteriological examination in the laboratory of the Yandyki Plague-Control Department with the use of individual cultures and performance of biological tests. Despite this, it was impossible to isolate a single

plague microbe culture from the ticks. At the same time, from the rodents collected on the same territory 32 cultures were isolated and 15 cultures were isolated from their fleas.

Therefore, the data which we obtained in the Northwest Caspian focus are evidence of the poor capacity of ticks generally and of R. schulzei in particular for picking up the plague pathogen under conditions of a naturally occurring epizootic among rodents.

This gives us the basis for confirming the opinion of O. V. Afanas'yeva and M. A. Mikulin (1957, 1957a), who justifiably believe that ixodial ticks cannot be of essential importance in the extensive and rapid spread of plague epizootics.

As is well known, there is no agreement either on another, no less important subject, namely, on the problem of the mechanism of preservation of the plague microbe in the interepizootic period, particularly in the case of hibernating rodents. To date, a discussion has been going on as to what brings the plague microbe through the interepizootic period: rodents or their ectoparasites (fleas, ticks).

I. S. Tinker (1940) believes that there is adequate proof of the fact that in a souslik focus the plague microbe can be maintained from one epizootic period to the next both in the body of the hibernating souslik and in the body of the souslik flea.

V. N. Fedorov (1944) asserts that in foci of the temperate zone only fleas provide the possibility of survival from one epizootic period to the next for the plague microbe.

V. N. Fedorov, I. I. Rogozin and B. K. Fenyuk (1955) believe that in the interepizootic seasons the plague pathogen is preserved in the bodies of rodents as well as in the bodies of fleas.

During a plague epizootic in sousliks in the steppes of the Volga-Ural focus (in the spring of 1950) K. I. Kondrashkina (1957, 1959) noted that the onset of this epizootic coincides with the mass appearance of ticks in nature. Thereby, in all developmental phases of the ticks infected individuals in an unfed state were found. This permitted the author to express the idea that the ticks and the nymphs infected with plague in 1949 had carried the plague microbe through the winter of 1949-1950 to the spring of 1950, and with the beginning of souslik activity transmitted the plague pathogen to them.

On the basis of this fact K. I. Kondrashkina expressed the idea that R. schulzei ticks, together with rodents and fleas, can become sources of new epizootics after the interepizootic period.

O. V. Afanas'yeva and M. A. Mikulin (1957) have also expressed themselves on behalf of the fact that ticks can be important elements in the mechanism of maintaining the natural localization of plague.

It seems to us that if ticks could regularly carry the plague infection from one epizootic season to the next and actively transmit the

pathogen to the recipient, measures for the elimination of plague foci would be inconceivable without the performance of special insect elimination operations directed at the elimination of ticks. Otherwise, these measures would inevitably be doomed to failure.

Ticks with their capacity for prolonged existence (even in an unfed state) in the event of infection with plague could preserve the plague microbe for a very long time in their bodies and contribute to a rooting of plague for an indefinitely long period of time. However, in practice this is not observed. To date, as is well known, in taking measures which have as their final aim the elimination of a plague focus all efforts are directed at extermination of rodents only; these are the main sources of the plague microbe and, as a rule, no operations are conducfed against their ectoparasites. Therefore, in places where work is being done for the extermination of rodents only rodents die, while their ectoparasites -- ticks and fleas -- survive, by and large, well. For example, facts of finding considerable numbers of fleas, including those infected with plague, in places where extermination operations have been conducted shortly after their completion are evidence of this. If the fleas and the ticks could preserve the infection for a long time after the deaths of their hosts, then, by remaining alive they would provide for the maintenance of plague epizootics in the places enzootic for plague from one season to the next, because a certain number of rodents always remains in them after the performance of extermination operations (as is well known, it has never been possible for anyone yet to destroy rodents as a species).

Experience in the elimination of a plague enzootic on tremendous territories shows that where extermination operations against rodents are carried out in good quality and on a large enough area, the epizootics, as a rule, are no longer repeated, despite the fact that the next year after the extermination operations on the territory on which they were conducted a certain number of rodents and a considerable number of ectoparasites can always be collected (I. V. Men'shova, 1957).

In the rayons of Stalingradskaya and Rostovskaya oblasts previously enzootic for plague as well as over a considerable territory of the Kalmyk Republic within the limits of the Yergeni Heights (the area of distribution of R. schulzei and Ix. 1. laguri) plague epizootics among sousliks stopped after the first effectively done extermination work and have not recurred for 25 years now. Thus, despite the most careful search for the plague microbe in these places it cannot be found. In these regions for a number of years a bacteriological examination has been made for plague in several millions of rodents and their ectoparasites (ticks and fleas) with negative results. Until 1935 here plague epizootics in sousliks recurred yearly in the vicinity of scores of in-

habited places. However, after the solid-coverage extermination operations of 1934 the epizootics stopped completely over a tremendous territory (more than 10,000,000 hectares) and are no longer being recorded, although the low souslik census was maintained on this territory only up to 1938-1939. During the Second World War work on the extermination of rodents was stopped everywhere, in connection with which the souslik census in the regions mentioned above increased in places and reached the level which had existed there prior to the onset of the solid-coverage work of rodent extermination (prior to 1934), but there were no plague epizootics among the sousliks (O. N. Bocharnikov and others, 1957).

In recent years an almost similar picture has been observed in the steppes of the Volga-Ural focus, where after the accomplishment of considerable work on souslik extermination, beginning with 1953, no plague epizootics have been recorded over a tremendous territory constituting the main area of distribution of the tick R. schulzei. Indeed, in this part of the Volga-Ural focus plague epizootics had occurred every year and in many places (K. S. Karpuzidi, 1957; K. S. Karpuzidi, 1959; K. S. Karpuzidi and others, 1959). It should be noted that here the fight has been waged only against rodents, the main sources of plague, and no special measures have been taken against ectoparasites.

It is perfectly clear that we would not have such a persistent state of epizootic welfare if the ticks had been long-term reservoirs and effective vectors of the plague microbe.

Therefore, the facts graphically repudiate the assertion that a plague enzootic can be given root for an indefinitely long time by ticks. Therefore, the absence of an effective method of destroying ticks in rodent holes to date should not leave us without weapons in the matter of fighting against enzootics, because in the final analysis this does not at all reflect on the antiepizootic effect of operations conducted against rodents with the aim of eliminating plague foci.

Therefore, on the basis of an analysis of material in the literature and our own observations we have come to the conclusion that under conditions of the Caspian natural focus and particularly in its northwest portion R. schulzei and Ix. 1. laguri ticks are not long-term reservoirs or active vectors of plague infection in nature and for this reason can have no essential influence upon the antiepizootic effect of extermination operations taken in this focus with the aim of eliminating it. Both these species can be infected by chance only against the background of active epizootics.

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M. I. Levi

Some Additions to the Characterization of the Main Plague Microbe Reservoirs

Through Academician Ye. N. Pavlovskiy's teaching about the natural focalization of arthropod-borne diseases the main rules and regulations of existence of natural plague foci were revealed. Only the existence of all components of the epizootic triad (rodent, flea and pathogen) and regular food relations between them make possible the existence of natural foci of plague infection. To be sure, each of the components of the triad is qualitatively unique and plays its own quite definite part in the formation and existence of natural foci, but I daresay the pathogen, without which existence of the foci is impossible, is of determinative significance.

An outstanding achievement in plague epizootology was the division of rodents into main and secondary reservoirs and the latter, in turn, into facultative and incidental. V. N. Fedorov, I. I. Rogozin and B. K. Fenyuk note that "the leading part of the main reservoirs is conditioned by the relatively high density and continuity of settlements over large territories, the characteristics of plague pathogenesis in them, as well as the mass nature of ectoparasites (fleas) on the rodents themselves as well as in their holes." Because there are several main reservoirs of the plague microbe on the earth, undoubtedly, features common to all of them should exist as well as features characteristic of only individual main reservoirs. The most common feature of the main reservoir is the possibility of preserving the plague microbe among its populations over long historical periods of time. In the epizootic process the plague pathogen is regularly transmitted by fleas from infected individuals (the main reservoir) to uninfected individuals of the same species. In the bodies of certain secondary reservoirs the pathogen develops and multiplies, in connection with which the infection of blood-sucking insects is possible, and these, in turn, can infect uninfected animals by sucking blood, including the main or secondary reservoirs; however, such a connection is not of a regular nature and in the great majority of cases ends in an epizootological blind alley for the pathogen.

Thus, the plague microbe sometimes comes into a population of house mice, and in the event of a considerable density of the populations of these rodents and an abundance of fleas among them the epizootic can exist among these animals for a certain time without new importations of the infectious disease; however, the microbe cannot

circulate for a long time in the house mouse population, which is evidenced by many years of experience of plague-control institutions.

Crested jirds have been found to be infected quite often in the Volga-Ural and Central Asiatic plain foci. With the same fleas common to different species of jirds there is no doubt of the fact that from time to time the microbe can be imported to populations of the main reservoir from crested jirds; however, this connection is not of a regular nature, and in the great majority of cases the crested jirds constitute an epizootic blind alley for the pathogen.

It should not be thought that in all cases the microbe enters the body of a flea from the body of the main reservoir and from there comes back to the body of the main reservoir. In a number of cases the organism of the main reservoir also becomes a blind alley for the microbe; however, this happens incomparably less often than among populations of secondary reservoirs. Here are several schemata of epizootic processes in plague:

Main reservoir -- flea -- main reservoir -- flea -- main reservoir -- flea, etc.

Main reservoir -- flea -- main reservoir -- blind alley.

Main reservoir -- flea -- secondary reservoir -- flea -- secondary reservoir -- blind alley.

Main reservoir -- flea -- secondary reservoir -- flea -- secondary reservoir -- flea -- main reservoir -- flea -- main reservoir -- flea, etc.

Therefore, in a number of characteristics the difference between the main and secondary reservoirs is only quantitative, but quantitative differences change into qualitative ones when we deal with preservation of the microbe in a rodent population. These quantitative differences create the possibility of preservation of the microbe in a population of the main reservoirs and the impossibility of prolonged maintenance of it in a population of secondary reservoirs.

In the great majority of foci practical difficulties have arisen and continue to arise in the determination of the main reservoir, because in localities where plague epizootics are manifested the pathogen is not found in a single species of animal but rather in several. In these cases knowledge of a number of characteristics of the main reservoirs assists in the determination: the comparatively frequent and constant finding of plague bacteria, a stable census for relatively long periods of time, continuity of settlements, an abundance of fleas in the holes and on the rodents themselves, extensive territories occupied by rodent settlements, and some other characteristics. At the present time, the main reservoirs have already been determined in the great majority of plague foci.

To a certain degree a comparison of the areas of distribution

of the animals in which the plague microbe has been found and the localities in which epizootics have been recorded can assist in the determination of the main reservoir. In a number of foci coincidence of the area of distribution of the pathogen and the area of distribution of the rodent which is the main reservoir have actually been noted. Thus, the entire territory occupied by the gray marmot [Marmota baibacina] has been considered endemic for plague. With the same degree of assurance the entire territory occupied by settlements of great sand rats [Rhombomys opimus] has been considered an endemic focus of plague. To a considerable degree, inadequately skillful detection of single infected animals in nature interferes with the elucidation of this correlation.

Recently, new facts have become known which indicate a discrepancy between the area of distribution of the pathogen and the area of distribution of the reservoir. Right-bank meridional jirds have for a long time now been carefully studied for infection with the plague microbe, and only from time to time has it been possible to isolate plague cultures from them during acute epizootics among sousliks. Right-bank meridional jirds, in contrast to jirds inhabiting the left bank of the Volga River, have been shown to be highly sensitive to the plague infection. What has been stated leaves no doubt of the fact that right-bank animals are not the main reservoirs in the focus of the Northwest Caspian. Therefore, only in the area between the Volga and Ural rivers is the meridional jird the main reservoir. Let us take another, similar example: the red-tailed jird in AzSSR is the main reservoir, whereas over extensive territories of Central Asia there is no basis for considering it the main reservoir. The reasons for such phenomena are complex and varied; we shall not touch on them in the present article; the very fact that there is a discrepancy between the boundaries of the plague focus and the area of distribution of the main reservoir deserves interest. Thus, the foci not uncommonly have their own boundaries, whereby the focus occupies only part of the area of distribution of one rodent or another playing the part of the main reservoir.

Yu. M. Rall' and V. N. Fedorov, V. S. Petrov and M. F. Shmutser have come to the conclusion that all the foci in nature are of a single-host type, that is, they have one rather than several main reservoirs. To this it should be added that each specific natural plague focus has its own main reservoir; however, this situation can be changed in the case of rodents with separated areas of distribution. By a single-host situation we mean a situation in which one species of rodent (the main reservoir) more than others and regularly maintains the development and multiplication of the plague pathogen in the given focus.

Persistent plague foci in nature exist only in those places where there are not only conditions for the existence of the species of rodent

known to be the main reservoir but also where conditions exist for the regular progress of the epizootic process, for the existence of generations of vector fleas and of the pathogen itself in infinite numbers, that is, the existence of all components of the epizootic triad.

The epizootic triad is not just a group of living organisms. These, so heterogeneous species of living beings (rodent, flea and pathogen) show a strict relationship and connection. First of all, let us speak about the pathogen itself. Its habitat is the body of the main reservoir. Many properties of the pathogen are created and are changed in the bodies of the main reservoirs, whereas the influence of secondary reservoirs either leaves no or almost no traces in the evolution of the microbes; in the great majority of cases those developmental branches of the microbe which are completed in the secondary reservoirs die, as far as the future is concerned, because they end in a blind alley. In the epizootic process a certain adaptation of the pathogen to the main host occurs, but because all the natural foci are single-host types, and each focus, incidentally, has its own main reservoir, it would be no exaggeration to consider that each plague focus is characterized by its own biological race or variety of pathogen. This has been nearly evidenced by data on bacteriemia in left-bank meridional jirds and dwarf sousliks infected with strains 297 and 403, of which the former was isolated in a souslik focus; the latter, in a jird focus. These data have been presented in other works of the present collection. It has been possible to observe a more or less constant bacteriemia after infection with relatively small doses only if the jirds have been infected with a strain isolated from a jird focus or sousliks infected with a strain isolated from a souslik focus. In other cases bacteriemia has occurred after the infection of rodents with relatively large doses and has been of an agonal nature. It seems to us that the degree of difference between biological varieties of the plague microbe depends specifically on: a) differences in the taxonomic positions of their main reservoirs and b) the duration of parasitism of the plague microbe in the body of a given main reservoir (the age of the focus). The adaptation of the pathogen to the main reservoir intensifies the part played by the latter in maintaining focalization.

Quite a bit of attention has been given to the study of plague microbe varieties. In 1928, Zabolotnyy wrote that "differentiation of various races has been inadequately worked out, and we have no data for differentiating different types of plague bacillus, similar to what exists in the case of diplococci, vibrios, bacilli of the typhoid group, gonococci, spirochetes and many other groups of microbes. The organotropism, cultural and serological differences between various strains should be elucidated by a series of new experiments."

The significance of isolation of varieties of the plague microbe has been well characterized by Tumanskiy: "Study of the varieties of

plague microbe is of great theoretical and practical importance. Careful study of this problem along with other data will make it possible to introduce greater clarity into the problem of studying the natural focalization of plague and accurately establishing the main reservoirs of the pathogen in those enzootic foci where epizootics are observed among several species of rodents as well as to distinguish between adjacent epizootic foci, establish the connection of the foci with one another and, finally, outline the correct means of eliminating natural foci of this infectious disease."

In 1951, Devignat isolated three varieties of plague microbe according to the relationship of the pathogen to glycerin and the production of nitrites. Tumanskiy gave a similar classification of varieties after distinguishing rat, marmot and souslik varieties.

Varieties of Plague Microbe (Tumanskiy, 1958)

(1) Разновидности	(2) Характеристика разновидностей		
	(3) ферментация глицерина	(4) нитрификация	(5) денитрификация
(6) Крысиная	—	(—) +	+
(7) Сурчиная	+	(+) —	+
(8) Сусликовая	+	—	—

1. Varieties; 2. Characteristics of varieties; 3. Fermentation of glycerin; 4. Nitrification; 5. Denitrification; 6. Rat; 7. Marmot; 8. Souslik.

Key: The results obtained with a small number of strains of the given variety are presented in parentheses.

It should be noted that these varieties were isolated on the basis of fermentative and biochemical features without adequate consideration of the influence of biological factors on the microorganism. Ye. N. Pavlovskiy ascribes tremendous importance to the influence of hosts on the properties of parasites. In application to the pathogen of tick-borne encephalitis he wrote the following: "The 'genealogy' of the virus strain is a matter of the past and it cannot be reproduced in retrospect but we must reckon with the possibility of an influence by the host organism on the virus strain found within it. Possibly, in the future, with future experiments in the laboratory it will be possible to determine how one species of host or another which has for a certain time been the habitat of a virus influences the virus strain qualitatively." A similar idea with respect to the plague microbe has been expressed by Tumanskiy: "The reason for the occurrence of varieties of the plague mi-

crobe should be sought in physiological characteristics of the bodies of different species of rodents, the main reservoirs of the plague pathogen in nature, rather than in geographic conditions or the history of plague pandemics."

On the basis of existing materials the suggestion can be made that among the strains of the souslik variety (according to Tumanskiy), to which group strains 297 and 403 should be referred, there are different races or varieties, the existence of which is associated with parasitism in the bodies of different main reservoirs, which in a taxonomic respect are different from one another. Strain 403 was isolated from red-tailed jirds; at the same time, judging by the bacteriemia in meridional jirds it behaves like a true jird strain. It may be supposed that the nature of bacteriemia after incorporation of the jird variant will be similar in the related species of jirds. The nature of bacteriemia depends not only on the species of animal but also on the degree of resistance to plague. In left-bank meridional jirds infected with strain 403 constant bacteriemia was noted in response to large infective doses, whereas in right-bank meridional jirds this type of bacteriemia was observed only after infection with small doses. Therefore, within this variety, which Tumanskiy referred to the souslik group, two subvarieties can be outlined -- jird and souslik.

The main reservoir is a concept which is not only biological but also historical. Under certain historical conditions the secondary reservoirs can enter the ranks of the main reservoirs. The greatest probability of transition from the secondary reservoir group to the main reservoir group, under otherwise equal conditions, is maintained by those species of animals, secondary reservoirs, which in a taxonomic respect are related to the main reservoirs.

In plague infection several mechanisms of infection are known (alimentary, contact, arthropod-borne and droplet); however, plague belongs to the group of arthropod-borne infectious diseases because this mechanism of transmission is characteristic of the course of the infectious disease among the main reservoirs. The mechanism of transmission is the connecting link which cements the entire triad. In connection with this, the arthropod-borne mechanism of transmission has made an impression on the properties of the main reservoir and of the pathogen. In the case of arthropod-borne infectious diseases the alternation of the microorganism's being in the bodies of warm-blooded animals and poikilothermic hosts is of the nature of epidemiological necessity. Without a flea the microbe cannot enter the body of a rodent (since in plague transovarial transmission of the pathogen is unknown among fleas), while without the rodent the microbe cannot enter the body of the flea. Thereby, even if certain changes in the properties of the plague pathogen occur in the organism of the rodent they can be lost

various existential aspects of plague infection in various natural foci. It should be emphasized that everything stated has a bearing on the biological species of living beings rather than on separate individuals of the main reservoir, vector or microbe. The relations studied bear the imprint of historical development, without consideration of which interpretation of characteristics of members of the epizootic triad in different natural foci of plague existing at the present time would be inconceivable.

Conclusions

1. The main reservoir is capable of maintaining the development and multiplication of the plague pathogen over an infinite number of generations under favorable conditions, in contrast to facultative secondary reservoirs.

2. The boundaries within which the plague epizootics are expressed in every specific focus may not coincide with the area of distribution of the main reservoir but may be only part of this area of distribution.

3. In nature, apparently, specialized varieties of the plague microbe exist -- souslik and jird.

4. The arthropod-borne mechanism of transmission cements the epizootic triad into a single whole and explains the characteristics of bacteriemia in various species of rodents. Members of the epizootic triad show deep-seated relationships and influences on one another, in connection with which the properties of the main reservoir cannot be analyzed apart from those of the other members of the epizootic triad in any specific natural plague focus.

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Jird Fleas (Aphaniptera) of the Northwest Caspian

Information about the flea fauna of the Northwest Caspian began to appear in the literature only in the 1920's (I. G. Ioff, 1925, 1926, 1928; Yu. N. Vagner, 1926; V. I. Kuzenkov, 1928, and others). At the first stages of the investigations the main attention was given to the study of fleas living in human houses, on domestic animals, and on a rodent which is very widespread here, the souslik.

Interest began to be taken in jird fleas only with the beginning of the 1930's, after M. M. Tikhomirova (1934) first gave an epizootological evaluation of the meridional jirds of the Volga-Ural plague focus. Since that time numerous studies have begun to be published on the ecology of small species of jirds and their ectoparasites (Yu. M. Rall', 1938, 1939, 1941; M. M. Tikhomirova and others, 1935; A. A. Flegontova, 1940; S. A. Kolpakova, 1944, 1950; A. F. Dudinkova, 1951; B. K. Tenyuk and M. P. Demyashev, 1936, and others), but for the most part they dealt with territories located on the left bank of the Volga.

In connection with the general combination of studies on plague natural focalization in recent years a study has been begun on jird fleas of the right bank of the Volga (P. I. Shiranovich, 1950) and in the Eastern Precaucasus (N. N. Bakeyev and others, 1956). A thorough study of the biology of the flea Xenopsylla conformis was made by N. F. Darskaya and others (1957) in the deserts of the Transcaucasus.

It should be noted that in the past, in the study of the ecology of fleas, attention was paid mainly to seasonal changes in the species composition and in the abundance of parasites. One of the essential defects of these studies was the fact that for the purpose of constructing curves of changes in the flea census frequently material was used which had been taken from different localities. However, the study of the seasonal dynamics of the species is essential for establishing the reasons for activation or subsidence of epizootics. For knowledge of the structure of the focus and its epizootological zoning no less important is the analysis of materials, not only from a seasonal but also from a territorial aspect. Based on these principles we set about treating material on jird fleas of the Northwest Caspian, the results of which have been presented in the present report.

In the collection of material, in addition to the authors, Ye. N. Polkovova, K. A. Ivanov, Kh. G. Shadiyeva, G. P. Derkach, Proshina, A. I. Artamonova and others participated, for which we should like to express our gratitude to them.

Collections of fleas from jirds (Meriones meridianus Pall. and Meriones tamariscinus Pall.) and from other species of rodents were carried out from 1947 through 1953 on the right-bank territory of the Caspian lowlands within the limits of Astrakhanskaya and south Stalingradskaya oblasts and Kalmykiya.

The landscape-ecological zoning of this territory was carried out by N. P. Mironov (1945). In the study of fleas of the Northwest Caspian we considered it possible to utilize materials from three arbitrarily distinguished regions for the purpose of comparison of material: 1. Chernyye Zemli; 2. the Il'men region (with the exception of the area along the sea and the Volga sands; 3. Yergeni and the adjacent dry lowland steppes, including the southern rayons of Stalingradskaya Oblast.

In all, 90,632 collections containing 30,694 fleas were processed. In this group 5,473 fleas were collected from 20,669 meridional jirds; 20,873, from 24,535 crested jirds; 2,810, from 45,012 holes; and 1538 fleas, from 416 nests (Table 1).

The collections were made according to the generally accepted method for parasitological work. In a considerable part of the work we had at our disposal the so-called general collections obtained as the result of the practical activity of plague-control institutions. Therefore, in treating the materials it was possible to utilize only the main indices of flea censuses -- first of all, the index of abundance ("O") and the index of total frequency of occurrence of objects containing fleas. Thereby, the index of "hole" fleas was determined from the calculation for 100 hole entrances investigated.

The investigations were conducted in the region of deserts and semideserts with the whole conglomeration of soils, vegetation, animal world and climate characteristic of them.

Essential components in the life of the plague focus of the Northwest Caspian are small species of jirds, settlements of which are located in the sands and brush copses. The ecology of these animals under local conditions has been studied by N. P. Mironov and A. A. Listsyn (1953), N. N. Bakeyev (1956), and A. N. Pavlov (1958).

On the territory of the Northwest Caspian 30 species of fleas have been recorded on jirds, in their holes and nests (Table 1); of these, 25 are from meridional jirds; 26, from crested jirds; 21, from jird holes; and 15 species of fleas from the nests. As seen from the materials presented in Table 2, the average yearly general index of abundance of fleas on meridional jirds over a period of many years has been equal to 0.32; on crested jirds, 0.95, or three times as great. This, apparently, is explained by the fact that meridional jirds, smaller animals which have short and thin fur, are incapable of maintaining a large number of ectoparasites on themselves.

Table 1

The Distribution of Jird Fleas in the Northwest Caspian Region (1947-1953)

№ по порядку	Места сбора / Виды блох	Полуденные песчанки: Черные земли, Кизлярский и Приморск. р-ны (19208)		Полуденные песчанки: Ергени (1461)		Гребенщиковые песчанки (24535)		Норы (45812)		Гнезда (416)		Всего блох
		абс.	%	абс.	%	абс.	%	абс.	%	абс.	%	
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Pulex irritans L.	1	0,02	—	—	—	—	20	0,71	4	0,27	26
2	Echidnophaga gallinacea Westw	—	—	—	—	2	0,01	22	6,78	—	—	24
3	Ctenocephalides canis Curt	—	—	—	—	—	—	1	0,0003	—	—	1
4	Xenopsylla conformis Wagn.	8	0,15	—	—	168	0,81	33	1,17	—	—	209
5	Coptopsylla bairamaliensis Wagn	71	1,32	—	—	32	0,16	5	0,17	7	0,46	115
6	Coptopsylla lamellifer Wagn.	—	—	—	—	10	0,05		—	—	—	10
7	Oropsylla ilovaiskii W. et I.	30	0,56	—	—	10	0,05	—	—	—		40
8	Ceratophyllus laeviceps Wagn.	4506	84,1	43	36,1	17140	83,56	2129	75,77	675	3,88	24793
9	Ceratophyllus tesquorum Wagn.	90	1,7	5	4,2	122	0,59	34	1,21	54	3,51	305
10	Ceratophyllus comosus Wagn	22	0,41	1	0,8	34	0,16	6	0,28	10	0,65	73
11	Ceratophyllus mokrzeckyi Wagn	56	1,04	23	19,3	157	0,75	54	1,92	6	0,39	296
12	Frontopsylla frontalis alatau I. a	—	—	—	—	1		—	—	—	—	1

1. Number in order; 2. Species of fleas; 3. Site of collection; 4. Meridional jirds; 5. Chernye Zemli, Kizlyar and Primorskiy regions (19,208); 6. Yergeni (1461); 7. Crested jirds (24,535); 8. Holes (45,812); 9. Nests (416); 10. Absolute number; 11. Total fleas.

[Table 1 continued on next page]

(Table 1 continued)

1	2	3	4	5	6	7	8	9	10	11	12	13
13	Frontopsylla semura W. et I.	6	0,11	—	—	29	0,14	19	0,68	—	—	54
14	Ophthalmopsylla volgensis W. et I.	13	0,24	9	7,6	141	0,67	32	1,2	33	2,14	228
15	Meropsylla hebes J. et R.	6	0,11	1	0,8	84	0,40	48	1,71	—	—	139
16	Meropsylla lenis J. et R.	1	0,02	—	—	—	—	—	—	—	—	1
17	Meropsylla tuschkan W. et I.	30	0,56	—	—	116	0,55	62	2,21	1	0,09	209
18	Amphipsylla rossica Wagn.	34	0,63	7	5,9	62	0,30	41	1,45	1	0,09	145
19	Leptopsylla taschenbergi Wagn.	—	—	—	—	69	0,33	—	—	—	—	69
20	Leptopsylla segnis Schonh.	—	—	1	0,8	23	0,11	—	—	—	—	24
21	Ctenophthalmus secundus Wagn.	24	0,45	15	12,6	82	0,39	5	0,17	136	8,84	262
22	Ctenophthalmus pulex W. et I.	—	—	5	4,2	3	0,01	—	—	—	—	8
23	Ctenophthalmus dolichus Roths.	—	—	—	—	26	0,12	6	0,16	—	—	32
24	Rhadinopsylla cedestis Roths.	67	1,25	—	—	1772	8,5	151	5,37	16	1,04	2006
25	Rhadinopsylla integra Roths.	126	2,35	—	—	245	1,17	1	0,0003	47	3,05	319
26	Rhadinopsylla ukranica Iofl.	13	0,24	—	—	7	0,03	3	0,001	11	0,71	34
27	Rhadinopsylla acuminata I. et T.	2	0,03	—	—	4	0,02	—	—	—	—	6
28	Neopsylla setosa Wagn.	90	1,7	9	7,6	118	0,57	48	1,71	483	31,40	748
29	Stenoponia ivanovi I. et T.	2	0,03	—	—	—	—	—	—	—	—	2
30	Stenoponia tiasovi I. et T.	156	2,91	—	—	116	0,55	90	3,20	54	3,51	416
1)	Mean data	5354	100	119	100	20873	100	2810		1538	100	30694
2)	Mean index	0,28		0,08		0,85		6,24		3,69		

12. Total fleas; 13. General index.

The number of collections is shown within parentheses.

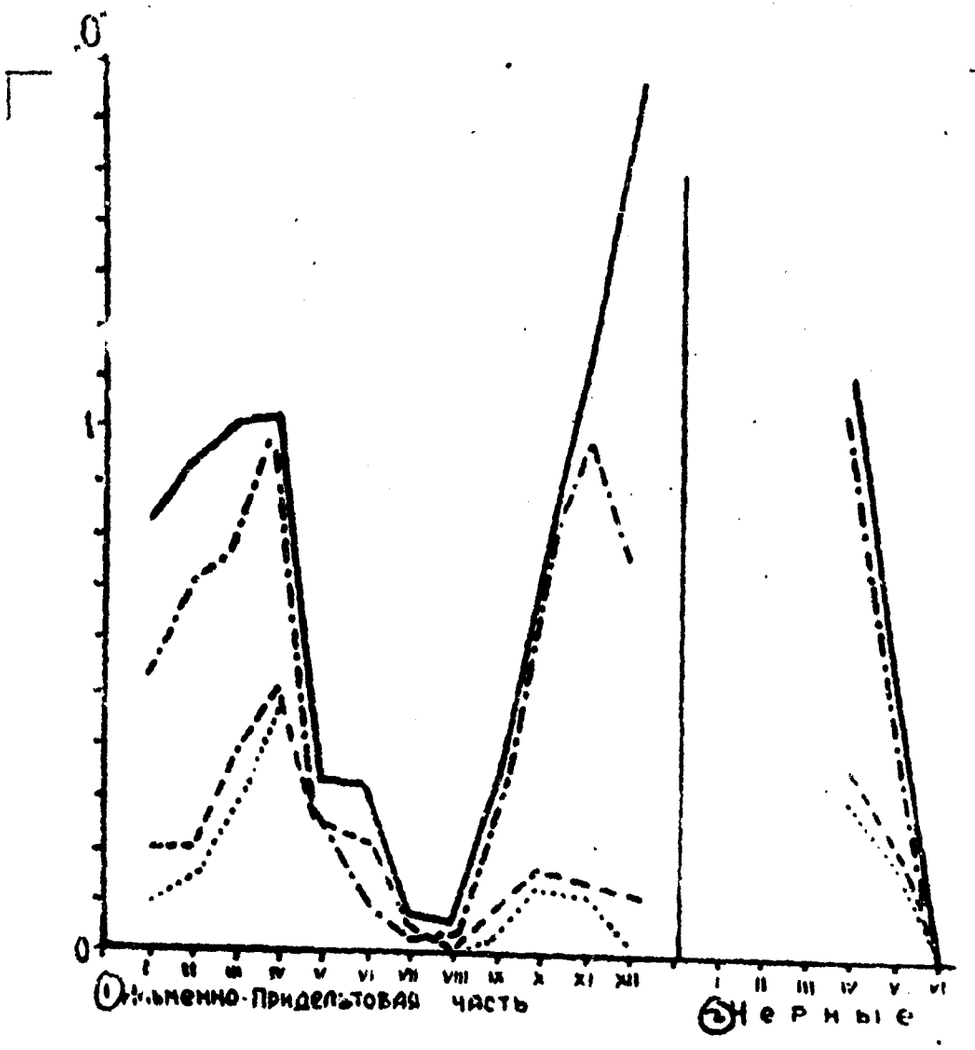
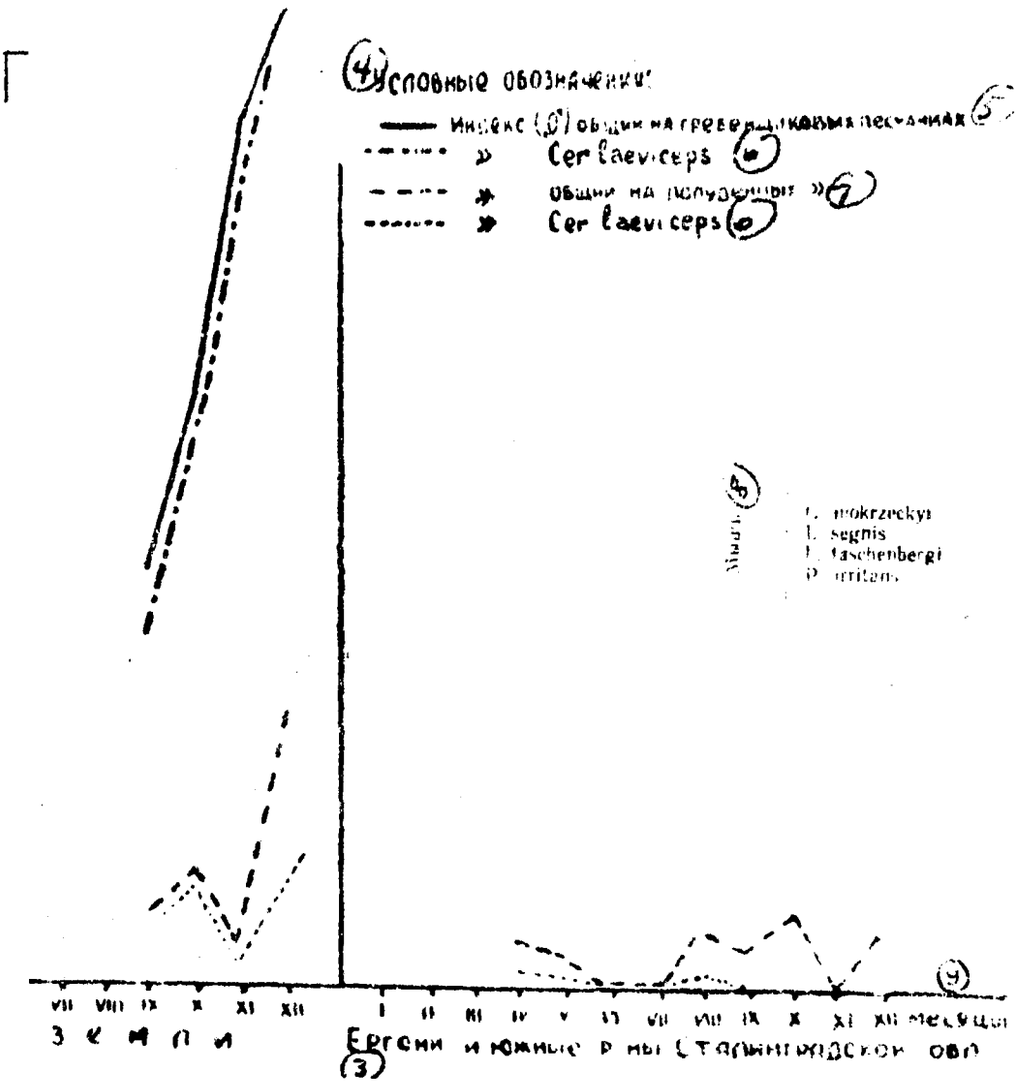


Fig 1. Indexes of Abundance of Fleas on Meridional and Crested Jirds
tion; 2. Chernyye Zemli; 3. Yergeni and southern rayons of Stalin-
6. C. laeviceps; 7. Common to meridional jirds; 8. Mice; 9. Months.

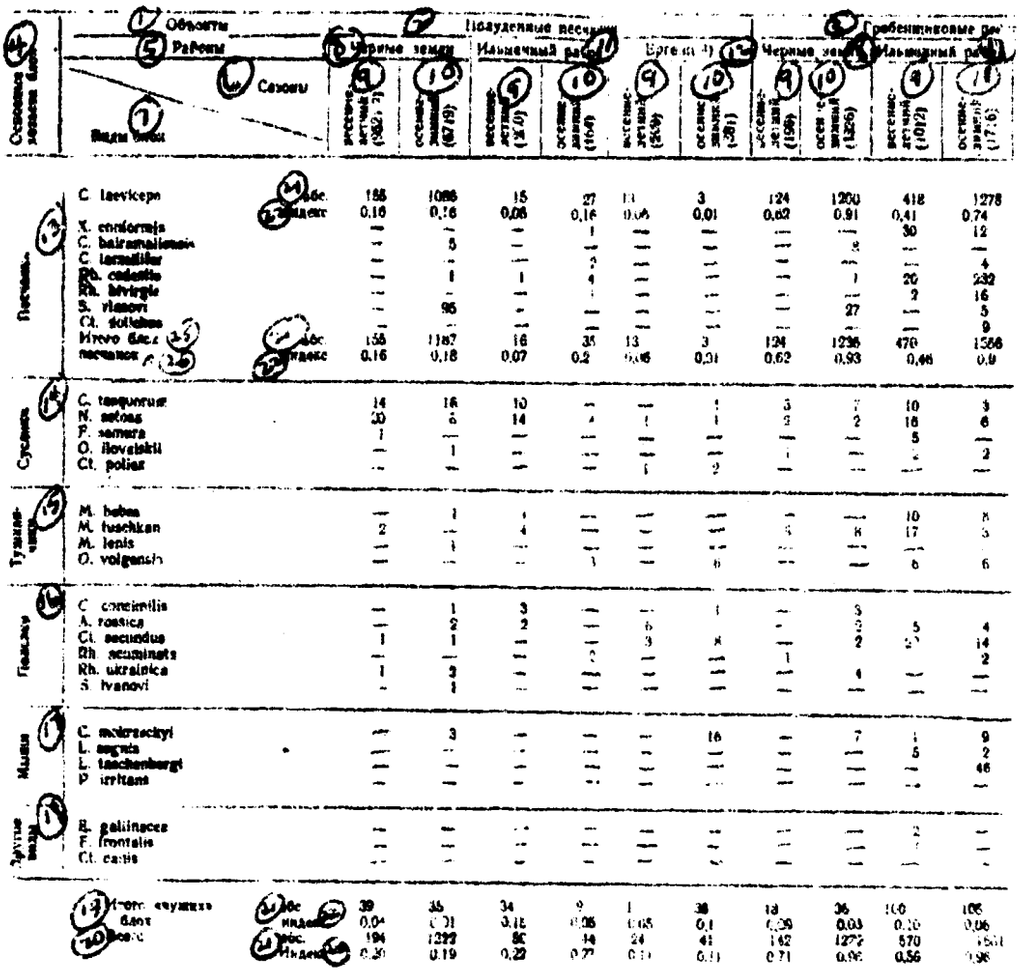


in Various Regions of the Northwest Caspian. 3. Ilmen-Delta peregradskaya Oblast; 4. Key; 5. Index of abundance on crested jirds;

Table 3

Landscape-Ecological Arrangement and Seasonal Changes in the Species
(1947-

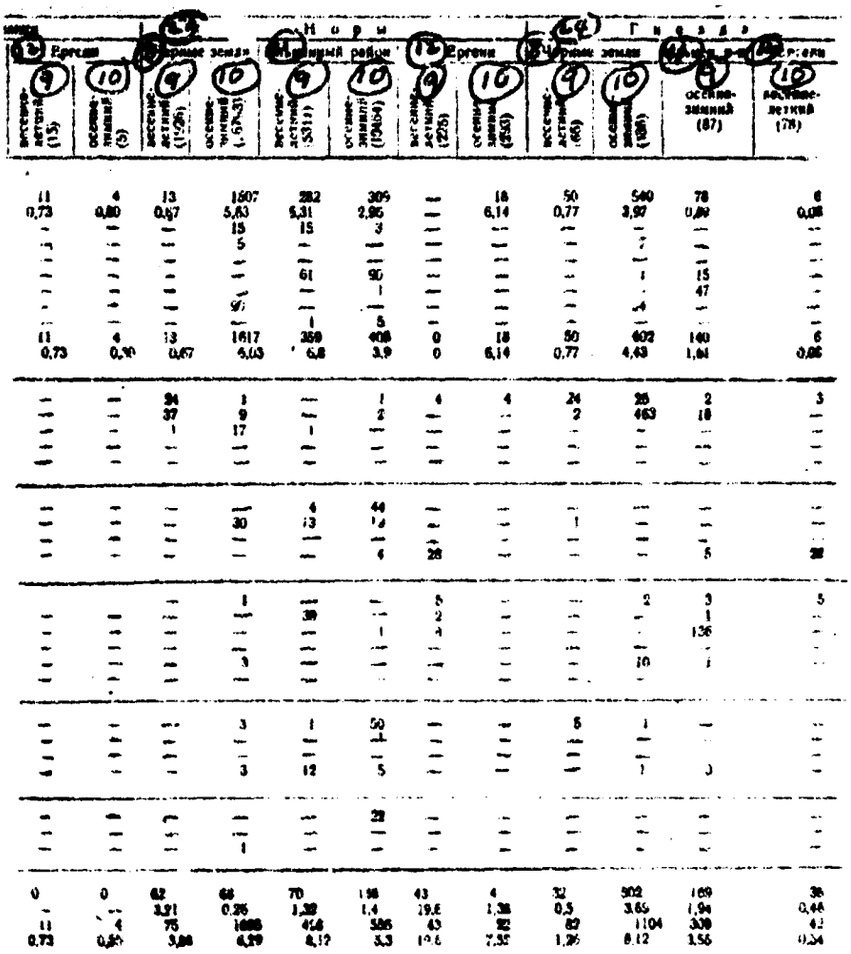
(In this Table only the authors' own collections have been



1. Object; 2. Meridional jirds; 3. Crested jirds; 4. Main flea hosts; 9. Spring-summer; 10. Autumn-winter; 11. Il'men region; 12. Yer- south of Stalingradskaya Oblast); 13. Jirds; 14. Sousliks; 15. Jerboas; fleas; 20. Grand total; 21. Absolute number; 22. Index; 23. Holes; different numbers under them according to the different headings/.

(Note: The number of objects (collections) investigated is shown within parentheses). 25. Total fleas; 26. Total jirds.

Composition and Flea Census of Jirds in the Northwest Caspian Region
1953)
included)



5. Regions; 6. Seasons; 7. Flea species; 8. Chernyye Zemli; geni (this landscape region also includes the lowland steppes of the 16. Voles; 17. Mice; 18. Other species; 19. Total "foreign" 24. Nests. (The numbers 9 and 10, referring to seasons, have

C. laeviceps, which amounts to more than 83 percent on the animals and in their nests and more than 75 percent of all the fleas collected in their holes, is predominant among both species of jirds. This species is encountered over the entire area of distribution of jirds and is parasitic throughout the year. An increase in its census is observed during the spring and autumn with a slight reduction in the wintertime and a considerable one in the summer.

Thus, the index of abundance of fleas on meridional jirds caught in Chernyye Zemli in April was equal to 0.3; in the Il'men region, 0.45; in the former region in December, 0.23; in the latter region in October, 0.14. On the crested jird this index in April was equal to 0.93 in Chernyye Zemli; 1.79 in December; in the Il'men region it was equal to 0.97 in April and 0.98 in November (Fig 1).

Other species of specific jird fleas are few. Thus, while X. conformis is one of the predominant parasites of jirds of the left bank of the Volga and is of great epizootological significance there (A. A. Flegontova, 1940, S. A. Kolpakova, 1944, and others), on the right bank this species is far from being encountered everywhere; the area of its distribution is limited to a narrow territory of the Il'men region and does not coincide with the distribution of the host. At the boundary of the area of distribution this species is definitely in a depressed state, considerably lagging in its census behind other jird parasites. X. conformis was found chiefly in the northeastern portion of Limanskiy Rayon in the environs of the villages of Yandyki, Sharluzung, Mikhaylovka, Liman, Venderevo, Udrush, Dzhivoga, Kukshin, Zel'ma, Gakhata, and Khuduk-Duga. On the meridional jird this species amounts to 0.14 percent of the total number of fleas collected from this rodent; on crested jirds, 0.81 percent; in the rodent holes, it amounts to 1.17 percent. In recent years a reduction has been noted in the census of this species, which may be seen from the materials of Table 2. Fleas of the genera Stenoponia and Coptopsylla are encountered on jirds only from September through December in small numbers (see Table 3).

The places in which these species of fleas were found were in the southeast corner of the Northwest Caspian region, including the central and southern regions of Chernyye Zemli: Artezian station, the ninth, 10th and 11th sidings, the villages of Andra-Ata, Gayduk, Khlebnyy, Naryn-Khuduk, Zapadnyy, Krasnyy, Kamyshannik, Prudovoy, the Sovkhoz imeni Kirov, the environs of the village of Yandyki. An analysis of the materials presented in Tables 1, 3 and 4 shows the great association between these species and the meridional jird, although the index of their abundance on the crested jird is somewhat greater than on the meridional jird.

Fleas of the genus Rhadinopsylla on the jirds, in their holes and nests amounted to 7.68 percent of the entire collection. They were

Table 2

Change in the X. Conformis Census by Years

Наименование ①	1947—1948			1949—1951		
	② число сборов	③ число блох	.O.	② число сборов	④ число блох	.O.
④ Песчанка полуденная	140	3	0,02	206	1	0,005
⑤ Песчанка гребенщиковая	584	76	0,13	1373	28	0,02
⑥ Полевка общественная	179	6	0,03	49	—	—
⑦ Норы грызунов	8559	160	1,87	58983	1	0,002

1. Name; 2. Number of collections; 3. Number of fleas; 4. Meridional jirds; 5. Crested jirds; 6. Social vole [Microtus socialis]; 7. Rodent holes.

recorded more often in the autumn-winter period in the Il'man region. In the autumn the index of abundance on meridional jirds in the case of R. cedestis and R. bivirgis was equal, respectively, to 0.02 and 0.007; on crested jirds; 0.02 and 0.002; in their nests, 0.17 and 0.54. In the hot part of the year these species were not recorded. In recent years the census of the latter species, just like the census of X. conformis, has been decreasing. Thus, R. bivirgis fleas constituted 22.4 percent of the total number of fleas collected in 20 jird nests in the winter of 1947-1948, but in the material from 476 nests obtained during the period from autumn 1948 through 1953 this species constituted a total of only 3.05 percent.

The other species of fleas found on jirds, in their holes and nests, are nonspecific for them, that is, they are "foreign" fleas, the usual hosts of which are souslike, jerboas, mice and voles.

The flea census changes appreciably in accordance with the landscape. Thus, on meridional jirds of the Il'men region the general index amounts to 0.3; on Chernyye Zemli, 0.27; for crested jirds, 0.79 and 1.06, respectively. As is seen from Table 5, for meridional jirds of Chernyye Zemli the index was somewhat less than that for jirds caught in the Il'men region. This reduction occurs mainly on account of a reduction in species specific for the jirds.

Table 4

Comparative Evaluation of Flea-Infestation of Jirds and the
of the Northwest

Наименование районов	Полуденная песчанка						Гребенщиковая песчанка					
	число песчанок	всего блох	в т. ч. „чужих" блох	„О" общ.	„О" „чужих" блох	% „чужих" блох	число песчанок	всего блох	в т. ч. „чужих" блох	„О" общ.	„О" „чужих" блох	% „чужих" блох
(15) Черные земли	14345	3964	207	0.27	0.01	5.2	3806	4063	96	1.06	0.03	2
(16) Ильменно-Придельтовый район	4368	1304	199	0.30	0.03	12	20155	15916	751	0.79	0.04	5
(17) Ергени и южные районы Сталинградской области	1461	119	76	0.08	0.05	64						

1. Name of region; 2. Meridional jirds; 3. Crested jirds; 4. Number of jirds; 5. Total fleas; 6. In this number the number of "foreign" fleas; 7. General index of abundance; 8. Index of abundance of "foreign" fleas; 9. Percent of "foreign" fleas; 10. Number of jirds; 11. Number of holes; 12. Number of nests; 13. Jird holes; 14. Jird nests; 15. Chernyye Zemli; 16. Il'men-delta region; 17. Yergeni and southern rayons of Stalingradskaya Oblast.

Circulation of Fleas in Different Landscape-Ecological Regions Caspian (1947-1953)

Норы песчанок						Гнезда песчанок					
число нор	всего блох	в т. ч. "чужих" блох	"О" общ.	"О" "чужих" блох	% "чужих" блох	число гнезд	всего блох	в т. ч. "чужих" блох	"О" общ.	"О" "чужих" блох	% "чужих" блох
28719	1760	126	6,12	0,43	7	201	1187	523	5,89	2,60	44
15775	980	217	6,21	1,36	22	94	309	168	3,28	1,78	54
518	70	52	13,51	10,04	74	121	42	36	0,35	0,29	85

On the crested jird of Chernyye Zemli in recent years a tendency has been observed toward a relative (compared with the Il'men region) increase in the flea census, which is apparently associated with increase in the census of the crested jird in this region, which in recent years has begun to predominate progressively over the meridional jird (N. P. Mironov and A. A. Lisitsyn, 1953). The specific C. laeviceps fleas adapted to this rodent and others are finding more favorable conditions for their existence in Chernyye Zemli in connection with this.

The lowest flea indices are noted in Yergeni and in the southern rayons of Stalingradskaya Oblast. Here is the boundary of the area of distribution of the meridional jird, where its census is low and its settlements are scattered. The general index of abundance of fleas in these regions is equal to 0.08; of the specific jird fleas only C. laeviceps in exceedingly small numbers. By and large, on Yergeni jirds souslik and mouse-like rodent fleas predominate (Table 1 and 3). An increased flea census on the jirds in all landscape-ecological regions has been noted in the early spring and in the autumn-winter periods (Figs 1 and 3). Such a nature of dynamics is determined chiefly by the modes of life of the jirds, which, as is well known, change according to seasons of the year. While in the spring-summer season active digging activity is noted in the jird behavior -- they build a multitude of temporary shallow holes and nests which are near the surface of the ground and are subject to the unfavorable influence of environmental conditions -- in the autumn and winter the jirds live in permanent deep holes where more favorable microclimatic conditions are created for flea multiplication.

During the spring the increase in the flea census on jirds occurs through an increase in C. laeviceps as well as an increase in "foreign" fleas, chiefly souslik. During the autumn the increase in the flea census on the animals occurs also because of an increase in C. laeviceps and, in addition, because of an increase in the autumn-winter species of fleas of jirds of the genera Stenoponia, Coptopsylla and Rhadinopsylla as well as the fleas of the mouse-like rodents.

Everywhere, common rules and regulations are noted -- during the cold season the main mass of fleas parasitic on jirds belongs to their specific species, while during the warm season the abundance of specific fleas decreases appreciably, and "foreign" fleas appear on jirds in large numbers.

The most active exchange of fleas between jirds and other rodents is observed in the Il'men region, which is distinguished by a variety of biotopes including considerable areas of sand. This territory is saturated with settlements of different species of rodents, among which jerboas and jirds predominate.

In this region, by comparison with Chernyye Zemli, there is

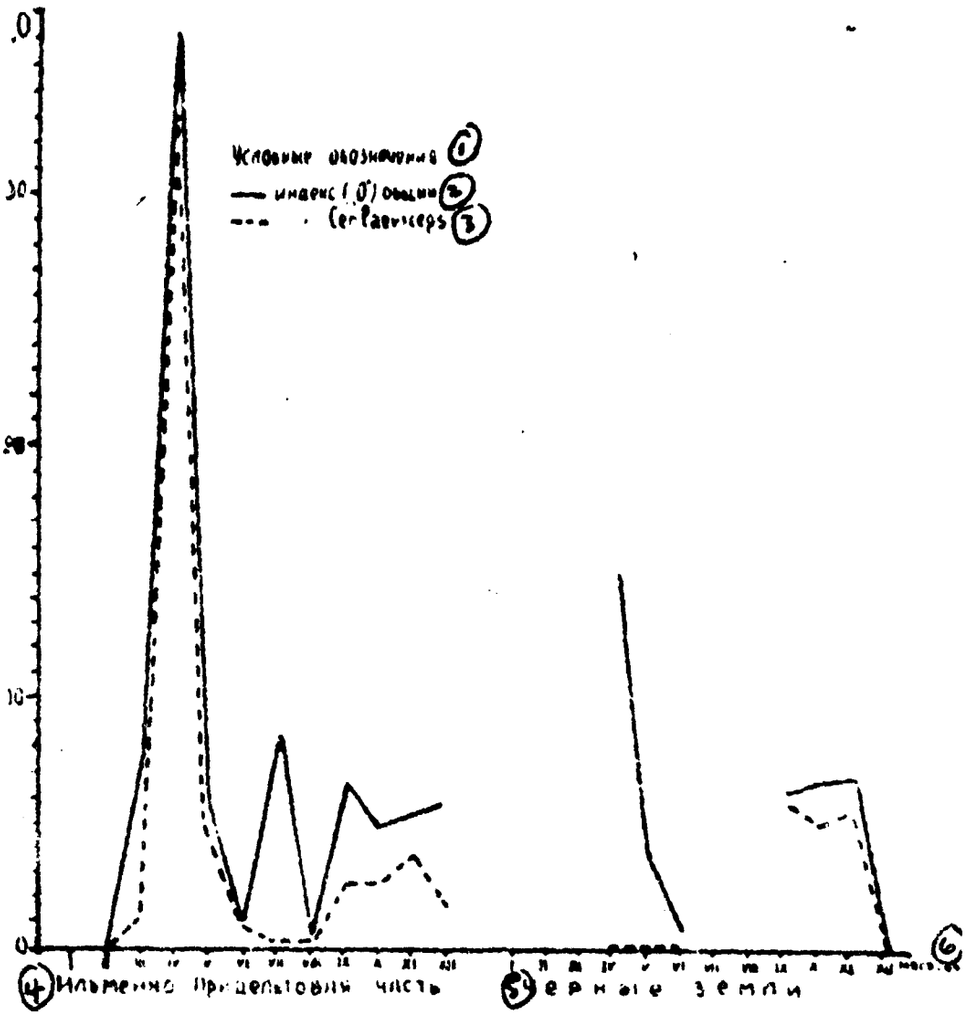


Fig 2. Indices of Abundance of Fleas in Jird Holes in Various Regions of the Northwest Caspian. 1. Key; 2. General index of abundance ("O"); 3. C. laeviceps index; 4. Il'men-delta area; 5. Chernyye Zemli; 6. Months.

not only a higher general index of abundance but also a higher index of "foreign" fleas on the meridional jirds. The latter is equal to 0.03, which amounts to 12 percent of the general index (Table 4). In Chernyye Zemli this index is equal to 0.01 and has a specific value of 5.2 percent. In Yergeni and in the southern regions of Stalingradskaya Oblast the percentage of "foreign" fleas reaches 64 and the index comes to 0.05 while there is a low general index of abundance (0.08) on the meridional jirds. On the crested jirds in the Il'men region the index of "foreign" fleas is equal to 0.04 while there are five percent of them in the general collection. In Chernyye Zemli these indices drop respectively to 0.03 and two percent.

In the jird holes and nests the highest percentage of "foreign" fleas was noted in Yergeni and in the adjacent steppes (74 percent in the holes; 85 percent in the nests). This figure is somewhat less in the Il'men region (22 percent in the holes and 54 percent in the nests). In Chernyye Zemli it drops to seven percent in the holes and 44 percent in the nests (Table 4).

The greatest species variety of fleas is observed in the Il'men region, where 25 species have been recorded; in Chernyye Zemli, 20 species; in Yergeni, 11. Parasitic contact between jirds and sousliks is characterized by the following figures. In the Il'men region of the total number of 25,380 fleas on sousliks jird parasites amounted to 0.21 percent; souslik fleas on jirds amounted to 1.7 percent.

In Chernyye Zemli these relationships were different. Here, the jird fleas (21 specimens) amounted to only 0.03 percent of the number of fleas (71,506 specimens) taken from sousliks and, conversely, souslik fleas (188 specimens) amounted to 2.2 percent of the number of fleas (8,017 specimens) taken from jirds.

Therefore, the exchange of fleas between these rodents, the most important sources of the plague microbe in the Northwest Caspian in all areas is characterized by a unilateral direction, from sousliks to jirds. Thus, in Chernyye Zemli souslik fleas were encountered on jirds 76 times more often than on sousliks, while in the Il'men region, where the souslik and souslik-flea censuses are low, they were still encountered eight times more often. These facts indicate probable routes of circulation of the pathogen in the focus, where the main source of the plague microbe is the souslik.

Returning to the evaluation of the jird flea census on the right bank of the Volga, let us analyze materials collected from the holes of these rodents (Tables 1 and 3). First of all, it should be noted that the flea infestation of the holes is extremely low and cannot be compared in any way with that on the left bank of the Volga.

Thus, according to the data of A. F. Didmkova (1951), the flea census in jird holes of the [illegible]

per 100 holes according to the seasons (with an average annual index of 490); according to our data, for the Northwest Caspian the flea census in the jird holes did not exceed 36 per 100 holes (with an average annual index of 6.24 over many years). The highest index of abundance of fleas in jird holes was recorded in the Il'men region in April (36.2). Subsequently (Fig 2) it decreased gradually, and by August reached its minimum figures ("O"=0.3). In the autumn a very slight increase in census occurred again ("O" went up to 6.7-4.9). A similar picture was observed in Chernyye Zemli, but the census figures here were even lower; they ranged from 0.1 to 15.2. In Yergeni and the adjacent areas the general index of fleas in jird holes during the spring-summer season amounted to 21.33; in the autumn, 7.51. The majority of fleas collected from the holes during the first period were "foreign", chiefly souslik fleas; in the autumn, C. laeviceps was caught in small numbers, as were also fleas of the mouse-like rodents. It should be noted that frequently fleas were found in holes which had no nests or which had empty nests. This suggests the idea that the passages of the rodent holes are filled with fleas mainly because of parasites lost by the animals rather than because of the flea migration.

Many investigators (I. G. Ioff, S. A. Kolpakova, 1944, 1950; A. F. Dudnikova, 1951, and others) directed attention to the exceedingly low flea census in the nests of inhabitants of the sands and particularly of the jirds, which was explained by their living conditions in the loose soil. This was also confirmed by our material.

The nests of the jirds were dug up in 1950-1951 in the region of the settlements of Naryn-Khuduk and Beloye Ozero as well as in the environs of the village of Yandyki and the village of Privolzhskiy. Very frequently thereby it was impossible to determine which jird was the host in a given nest, because in settlements in which the meridional and crested jirds lived together differentiation of them was made difficult. However, by and large, these were nests of meridional jirds.

In the spring and summer fresh brood nests were obtained in large numbers; these were usually located a little below the surface (20-50 centimeters) and had little nest material. In general, they were temporary -- they were built for the time of breeding the progeny and then were left by the animals, covered over with sand and destroyed. The index of abundance of fleas in these nests in April was close to zero; in May-July an increase of it was observed to 1.55-1.35 (Fig 3); thereby, at this time there were from 27.5 percent to 51.9 percent nests containing fleas. In these nests C. laeviceps predominated; in addition, souslik fleas were encountered in small numbers in them.

Observation of the condition of the generative organs of C. laeviceps showed that during the spring the percentage of females with eggs is high (it reaches 88.8 percent). Thereby, a low census of this species

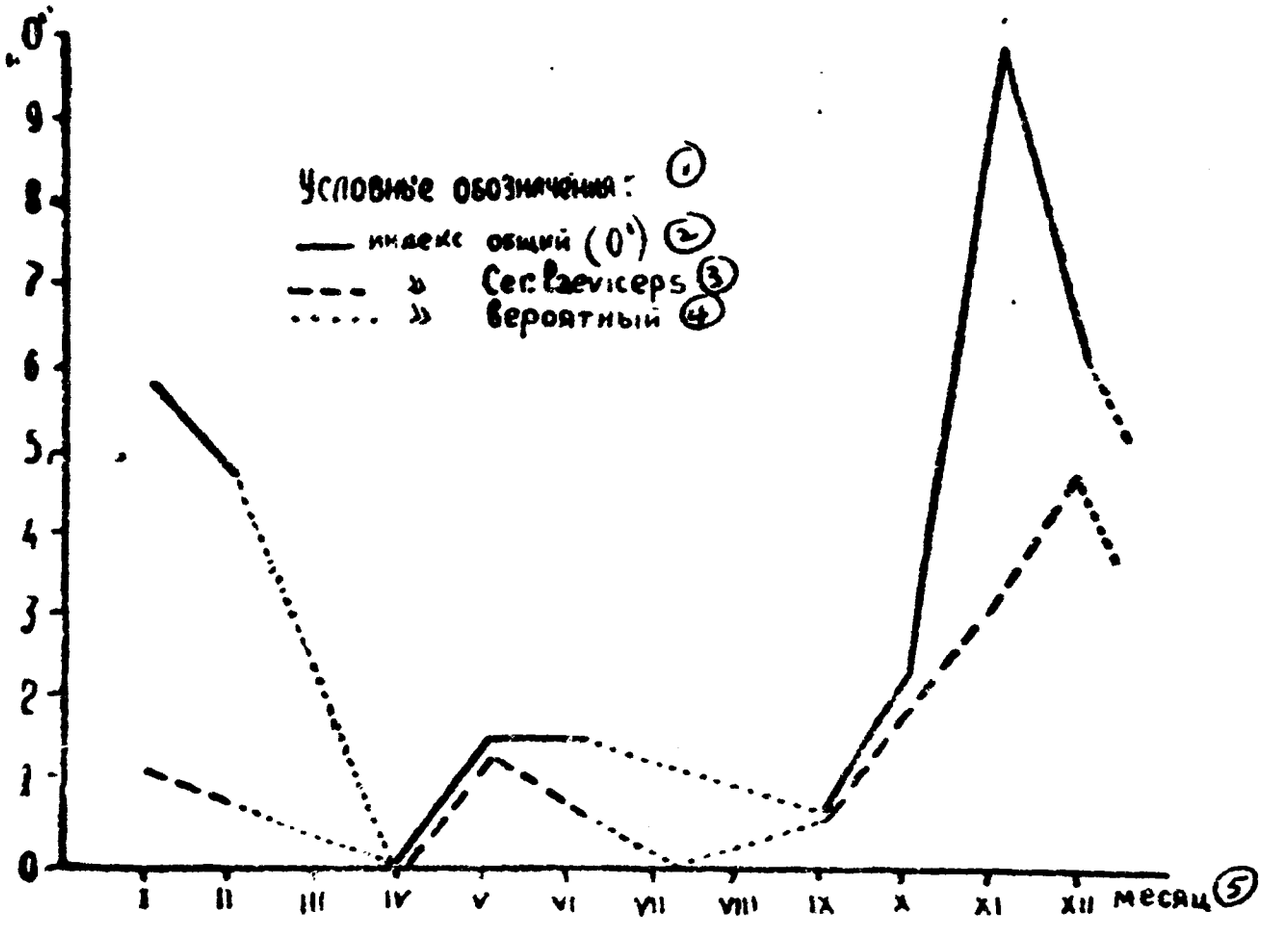


Fig 3. Indices of Abundance of Fleas in Jird Nests in the Northwest Caspian. 1. Key; 2. General index of abundance ("O"); 3. C. laeviceps index; 4. Probable index; 5. Month.

is noted. This phenomenon is explained by the fact that the freshly prepared brood nests initially are free of fleas and only later are the parasites, which then begin to multiply actively, brought into them by the animals. In April, in these nests the flea larvae are usually absent. Only at the end of May-beginning of June is the presence of a very large number of larvae, hatched from eggs laid at the beginning of spring, noted. In the summer, beginning with June, a reduction

occurs in the flea census in the nests. In the latter an absence of larvae is also noted. This is apparently associated with a rise in the temperature and a reduction in the humidity of the air, which have an unfavorable influence on activity and development of C. laeviceps. In addition, the animals, dispersing and settling, leave their nests, as a result of which the existential conditions are impoverished in them even more for the fleas and larvae. From October through February a considerable increase in the flea census was observed in the permanent jird nests. Thus, the number of nests infected with fleas rises again to 77.7 percent, and the index of abundance of fleas in them reaches 10.

The conditions of the autumn-winter season and the ecological characteristics of jirds are responsible for the change in the nest fauna of fleas not only in a quantitative but also in a qualitative respect. Thus, while from April through June six species of fleas were counted in the nests of meridional jirds, by autumn this number had increased to 14. At this time typical autumn-winter species of fleas appeared in the nests: S. vlasovi, C. bairamaliensis, P. cedestis and P. bivirgis.

Table 5

Percentage of C. Laeviceps in Jird Nests According to Data for Many Years(1948-1951)

① Месяцы	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Средний за год ②
	17.8				9?9	42.6	—		87.5	99.2	28.9	78.8	45.4

1. Month; 2. Average per year.

From the autumn diggings winter nests were obtained which were located usually at great depths -- about 100 centimeters down, on the average; the greatest depth was 420 centimeters.

In the deepest nests usually S. vlasovi and C. bairamaliensis were found; in the more superficial ones, C. laeviceps. The favorable conditions of flea habitation in the winter nests are indicated by the presence of a large number of larvae. These nests are maintained for a long time; the animals rarely leave them, which makes it possible for the fleas, under favorable temperature and humidity conditions, to find a source of nutrition constantly, the host of the hole.

The great constancy of the temperature conditions in the rodent holes has been pointed out by Yu. M. Rall' (1932, 1939) and others. Our observations of the hole microclimate have shown that at a depth of 90-100 centimeters the air temperature in the nest reaches 12°,

whereas the temperature over the surface of the soil ranged from -2 to 10°. The result of all this is active multiplication of fleas. Thus, in October-December from 32.4 to 80.6 percent of C. laeviceps females were "gravid"; of C. bairamaliensis females, up to 81.8 percent.

Despite the fact that the species composition and census of fleas change according to seasons within broad limits, C. laeviceps remains the predominant species in the nests and on the animals in all seasons of the year (Table 5).

The relative reduction in the C. laeviceps census in November should be ascribed to the fact that in that month one souslik nest was found, utilized by a jird, from which a large number of souslik fleas, N. setosa, was collected.

The index of abundance of C. laeviceps in the jird nests (Fig 3) is higher in the autumn-winter season (November -- 3.27; December -- 4.85; January -- 1.05) and lowest in the summer (June -- 0.76). The number of flea-inhabitated nests also increases from spring to autumn (Table 6).

Table 6

Percentage of Jird Nests Infested with Fleas

Месяцы	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	В среднем
	10	—	—	9	51.9	27.5	—	—	27.7	32.5	34.9	37.9	32.9

1, 2. [Same as for Table 5]

As has been stated above, the rate of multiplication is high in the spring and particularly in the autumn. This permits us to believe that the optimum conditions for many species of jird fleas exist during the cold season. Apparently, the ecological characteristics of jirds, their concentration in distinctive "survival areas" -- winter nests -- which creates a great population density and closer contact between the animals, assuring increased possibilities of contact between fleas and their feeder-hosts, are of more than a little importance. In the summer, the increased need for blood-sucking on the part of fleas (as the result of considerable loss of moisture) cannot be satisfied fully because of the scattering of their hosts.

The structure of the jird holes and the composition of their fauna are evidence to the effect that at the boundary between the sandy areas and the plakor steppe [a plakor consists of elevated plain areas, the soil and vegetation of which best express the zonal features of the

landscape of a given area, an active circulation of the fauna occurs between sousliks and jirds not only during the spring-summer but also after the sousliks go into hibernation, when this circulation is realized by means of hole contact. P. I. Shiranovich and N. P. Mironov (1956) and other investigators have pointed to phenomena of this kind. Through direct observations it was determined that jirds adapted souslik holes for their own dwellings and, conversely, sousliks used jird nests. Usually, in such nests we encountered either a mixed flea fauna or else simply fleas of the previous host.

Thus, in the summer of 1951 in a sandy area we dug up a hole which in its external features was very similar to a jird hole, but in which a souslik was found. In the nest many souslik fleas were found among the jird parasites. In another nest, clearly that of a jird, dug up in the autumn only souslik fleas were found. In November 1950, four C. tesquorum, 12 N. setosa and four C. laeviceps fleas were collected from a nest in which a meridional jird was caught. In the stomachs of females of the first two species mentioned there was fresh blood which they could have sucked only from a jird.

This fact indicates the possibility of existence of souslik fleas under circumstances not characteristic for them and feeding on a non-specific host.

Conclusions

1. Thirty species of fleas were recorded on meridional and crested jirds, in their holes and nests in the Northwest Caspian. The main species was C. laeviceps, which on jirds, in their holes and nests constituted 80.8 percent of the total number of fleas collected from them.

2. In the Northwest Caspian region the flea census of the meridional jird was low. The index of abundance here rarely reached 0.5.

The spring rise in the census occurs chiefly because of the hatching of C. laeviceps as well as because of a changeover of souslik fleas to jirds.

The autumn-winter rise is accomplished by means of the second C. laeviceps generation, the hatching out of the autumn-winter species of the genera Stenoponia, Coptopsylla and Rhadinopsylla and infestation of mouse-like rodents with the jird fleas.

A similar seasonal course of the census is shown by fleas of crested jirds, but the abundance of fleas on them is considerably greater, particularly in the autumn. Marked seasonal changes in the flea census are observed in the first part of the jird holes. Only in the early spring (March-April) is a relatively high flea infestation of them noted. In the rest of the time practically no fleas can be found at the entrances

to the holes. This fact is of indubitable practical interest and it should be taken into consideration in the organization of the epizootological investigation.

3. X. conformis is a species which is predominant on jirds in the Volga-Ural sands; in the Northwest Caspian region it has an extremely low census. The area of distribution of this flea is limited to the Il'men landscape region and by far does not reach the boundaries of the area of distribution of the host. The species census is showing a tendency toward a decrease.

4. At the boundary of the area of distribution of jirds (Yergeni) a reduction of the census and a reduction in the species variety of jird fleas have been observed. Of the specific parasites only C. laeve [illegible] lives here.

5. The greatest and most varied interspecies contact between fleas occurs in the Il'men region. Here, jirds are in contact chiefly with jerboas and mice and to a lesser degree, with souslike. In Chernyye Zemli there is considerable contact between jirds and souslike, while in Yergeni, in addition, there is much contact between jirds and mice.

6. The factual material presented in the present work once again confirms the opinion, well known in the literature, that under conditions of the Northwest Caspian region there is a unilateral passage of fleas from souslike to jirds. On jirds the number of souslik fleas which are parasitic is 10 times greater than the number of jird fleas on souslike. This phenomenon is of great epizootological importance.

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P. I. Shiranovich, N. Ya. Mokrousov, Kh. G. Shadiyeva

Notes on the Ecology of Jerboa Fleas in the Northwest Caspian Region

Jerboas and their fleas are essential components of the biocoenoses of natural plague foci in regions of deserts, semideserts and dry steppes. Specifically, for the focus in the Northwest Caspian the scirtopod jerboa [Scirtopoda telum] and the dwarf jerboa [Allactaga elater] are indicated among the natural reservoirs of the pathogen (Yu. M. Rall', 1958). The natural carriage of B. pestis has also been determined in the jerboa parasites -- in the flea Ophthalmopsylla volgensis and in certain species of the genus Mesopsylla. For the first time in the Southeast USSR epizootics among jerboas were recorded in 1913. In the Northwest Caspian (in the environs of Venderovo) the plague microbe was isolated from scirtopod jerboas during the spring-summer and autumn of 1948. In 1954, after three years of epizootological quiet, the plague pathogen was again isolated from a scirtopod jerboa caught in the regions of Kurchenko (Privolzhskiy Rayon). This was the last culture obtained from rodents on the right bank of the Volga, and at the same time the plague events in the focus which we are studying were concluded with this "epizootic".

In connection with what has been presented the interest in the study of jerboas and their ectoparasites, the basis for which was laid by investigators working in 1913 under the direction of D. K. Zabolotnyy, becomes understandable. We find the main ecological information about jerboa fleas in the works of I. G. Ioff (1929a, 1929b, and others), in which with exhaustive completeness their specificity, landscape relations and division into ecological groups are shown: fleas of fur and fleas of the nest. Some information about these ectoparasites is presented in the work of P. I. Shiranovich (1950). A special study on the ecology of fleas of the hairy-footed jerboa [Dipus sagitta] was published in 1951 by A. A. Sinichkina and A. F. Dudnikova. Various bits of geographic and ecological information on this group of parasites can be encountered in many works on the Aphaniptera of the USSR. However, some important aspects of the ecology of jerboa fleas remain inadequately studied; in particular the seasonal dynamics and territorial distribution of their census, etc. have been incompletely clarified. Of indubitable interest are the facts obtained in the plague focus during the period of its quiescence. Taking this into consideration, we attempted to generalize on the material existing at our disposal on jerboa fleas in the Northwest Caspian region.

A study was made in the southeast portion of the focus according to the method generally accepted in parasitological practice (P.I.-

Shiranovich, 1949). In addition to the authors K. P. Zheldakova, G. P. Derkach, A. I. Artamonova and others participated in collecting the material. P. I. Shiranovich supervised the work generally. The studies were made in two periods -- from 1946 through 1953 (period I) and from 1953 through 1955 (period II).

During the first period the so-called general collections were used, which were obtained through the performance of everyday inspection work on the territory of Chernyye Zemli, the Il'men landscape region and adjacent areas. During the second period the collections were made by N. Ya. Mokrousov and Kh. G. Shadiyeva according to a special program in the environs of the settlements of Venderovo and Kurchenko (Il'men region).

In both periods of work 3,673 jerboas were examined, 5,707 specimens of other rodents, and 11 nests were analyzed. In all, 9,999 flea specimens were collected, including 4,175 jerboa fleas.

In all, on the jerboas of the Northwest Caspian 13 species of fleas were recorded: 1. Xenopsylla conformis Wagn.; 2. Oropsylla ilovaiskii W. et I.; 3. Ceratophyllus laeviceps Wagn.; 4. Ceratophyllus tesquorum Wagn.; 5. Frontopsylla semura W. et I.; 6. Ophthalmopsylla volgensis W. et I.; 7. Mesopsylla hebes J. et R.; 8. Mesopsylla tuschkan W. et I.; 9. Mesopsylla lenis J. et R.; 10. Ctenophthalmus secundus Rhoths; 11. Rhadinopsylla cedestis Rhoths; 12. Rhadinopsylla bivirgis Rhoths; 13. Neopsylla setosa Wagn.

In addition, in the jerboa holes two other species were found: 14. Frontopsylla frontalis alatau Fed.; 15. Amphipsylla rossica Wagn.

General information about the species composition and census of jerboa fleas is shown in Table 1. The materials presented in this Table in general confirm the ecological conclusions drawn by I. G. Ioff in 1929. Of the specific jerboa fleas on the scirtopod jerboa and tarbagan [Marmota sibirica] M. tuschkan predominates. (Recently, (I. G. Ioff and Ye. P. Bandar', 1956) this species has been reduced to a category of a subspecies of Mesopsylla eucta. We adhere to the previous taxonomic treatment of this form (Sh.)). In this animal, in addition, frequently two other species of jerboa steppe fleas are encountered -- M. hebes and O. volgensis. On the earth hare [otherwise known as alactaga; Allactaga jaculus], as might have have been expected, the main parasite was M. hebes (67.9 percent). On the dwarf jerboa a considerable number of nest fleas, O. volgensis were caught, which in the material of the nests constituted more than 90 percent of the total collection. The jerboas are provided with "foreign" fleas chiefly by souslik and jird. The tarbagan has a particularly large number (more than 50 percent) of nonspecific parasites: among them jird fleas predominate. Many souslik fleas (about 20 percent) have been removed from scirtopod jerboas, the earth hare and dwarf jerboa

Table 1

Species Composition of Jerboa Fleas
1946-1952

(1) № п/п	(2) Виды блох	(3) Группировки блох	(4) Емурачик 1458 сборов (9)			(5) Тарбаганчик 218 сборов (9)		
			(10) число блох	%	(11) индекс обилия	(10) число блох	%	(11) индекс обилия
1.	Mesopsylla hebes	(12) Блохи тушканчиков	146	21,1	0,10	21	14,8	0,10
2.	» tuschkan		222	32,1	0,15	31	21,8	0,14
3.	» lenis		1	0,1	0,0007	—	—	—
4.	Oph. volgensis		137	19,8	0,09	15	10,5	0,07
	Итого (16)		506	73,1	0,34	67	47,1	0,3
5.	C. laeviceps	(13) Блохи песчанок	21	3,5	0,02	31	21,8	0,14
6.	Rh. cedestis		—	—	—	17	12,0	0,08
7.	Rh. bivirgis		—	—	—	1	0,7	0,004
8.	N. setosa	(14) Блохи сусликов	85	5,2	0,02	13	9,2	0,06
9.	C. tesquorum		92	13,2	0,06	12	8,5	0,06
10	Fr. semura		5	0,8	0,003	—	—	—
11	Or. kovalskii	(15) Блохи полевок	29	4,2	0,02	—	—	—
12	Ct. secundus		—	—	—	1	0,7	0,004
(17)	Итого случайных видов		185	26,9	0,13	75	52,9	0,34
(A)	Всего блох		691	100	0,4	142	100	0,6
(19)	Число видов блох		9			9		

1. Number; 2. Species of fleas; 3. Groupings of fleas; 4. Seirtopod jerboa; 5. Tarbagan; 6. Earth hare; 7. Dwarf jerboa; 8. Nests; 9. Collections, 10. Number of fleas; 11. Index of abundance; 12. Jerboa fleas; 13. Jird fleas; 14. Souslik fleas, 15. Vole fleas; 16. Total, 17. Total "foreign" species; 18. Total number of fleas. 19. Number of flea species.

in the Northwest Caspian according to Collections

(6) Большой тушканчик			(7) Малый тушканчик			(8) Гнезда		
281 сбор (9)			150 сборов (9)			11 сборов (9)		
(10) число особей	%	индекс обилия (11)	(10) число сборов	%	индекс обилия (4)	(10) число сборов	%	индекс обилия (11)
282	67,2	1,0	18	9,8	0,12	—	—	—
42	10,1	0,15	18	9,8	0,12	2	1,6	0,18
—	—	—	10	5,5	0,06	—	—	—
24	5,8	0,08	125	67,9	0,83	108	90,1	9,81
348	83,8	1,23	171	93,0	1,14	110	91,7	10,0
2	0,5	0,004	3	2,7	0,03	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
42	10,1	0,15	—	—	—	2	1,6	0,1
17	4,2	0,06	6	3,3	0,04	—	—	—
—	—	—	2	1,0	0,01	7	5,9	0,6
6	1,4	0,02	—	—	—	—	—	—
—						1	0,8	0,09
67	16,2	0,24	13	7,0	0,08	10	8,3	0,9
415	100	1,47	184	100	1,22	120	100	10,9
7			7			5		

have considerably fewer "foreign" fleas. The impression is created that the first two species of rodents are more often in contact with other rodents -- neighbors in the areas in which they live -- than the latter.

K. A. Ivanov and G. P. Derkach (1951) also point to the close contact relations between the small jerboas in the Il'men region. In explaining this phenomenon it should be taken in consideration that, aside from the ecological characteristics of these animals (their great mobility) the areas which they inhabit are distinctive. They have been caught chiefly in the Il'men region, which is distinguished by a variety of habitats, including considerable areas of sands. This territory has saturated settlements of different species of rodents, among which the scirtopod jerboa predominates (N. I. Kalabukhov and others, 1955; N. Ya. Mokrousov, 1955), which creates particularly favorable conditions for the exchange of ectoparasites between the different hosts.

From the works of I. G. Ioff (1929) the high degree of specificity of jerboa fleas is known. These data have been confirmed by materials from the Northwest Caspian region. Thus, among 58,677 fleas collected in 1949-1953 from 33,604 dwarf sousliks, there were only 65 jerboa fleas (21 M. hebes; 21 M. tuschkan; 23 O. volgensis), or a total of about 0.1 percent of the collection. A higher percentage of these insects occurred in collections from the meridional (0.52 percent) and crested (1.75 percent) jirds. The great frequency with which parasites migrated from jerboas to other rodents -- inhabitants of the sands -- reflects the general rules and regulations which have been noted in the literature (I. G. Ioff, 1929).

During the second period of our observations a somewhat different relationship of species was obtained (Table 2). During this period a small number of "foreign" fleas was collected from the jerboas. Thus, on the scirtopod jerboa this category of parasite amounted to about two percent instead of 26.9 percent, as according to the collections of the first period; on the earth hare these numbers were, respectively, 7.3 percent and 16.2 percent. On the dwarf jerboa, aside from the parasites common to it, only one jird flea was found, and on the tarbagan no "foreign" fleas were found at all. Such changes in the species composition of ectoparasites made in a relatively short period of time could not occur simply under the influence of natural evolution of the focus. It is most probable that this marked change in the composition of the flea fauna, which indicates an appreciable reduction in the contacts between rodents, an actual interruption of these connections, occurred as the result of measures taken in the focus for rodent extermination, directed chiefly at suppressing the main sources of infectious disease -- sousliks and jirds.

As is well known (I. Z. Klimchenko, 1957), extermination of

Table 2

The Census and Distribution of Fleas Among Rodents in the Il'men Region of the Northwest Caspian (1953-1955)

Экологическая группировка	Виды блох / Виды грызунов	Емурчинок	Большой тушканчик	Малый тушканчик	Тарабаганчик	Гребенщиковая песчанка	Полуденная песчанка	Малый суслик	Полевая мышь	Серый хомячок
Блохи тушканчиковых	M. tuschkan	46,4	7,9	41,6	80,0	0,12	5,0	0,08	—	22,6
	M. bebes	4,1	84,8	29,2	20,0	2,53	0,4	—	3,4	3,2
	O. volgensis	47,7	—	25,0	—	0,24	6,4	0,17	—	12,9
Блохи сусликовых	N. setosa	0,7	2,1	—	—	0,04	—	56,96	—	—
	C. tesquorum	0,17	—	—	—	0,04	2,7	37,79	—	—
	F. semura	0,1	2,1	—	—	—	—	4,82	—	—
	O. ilovaiskii	—	1,0	—	—	—	—	0,06	—	—
Блохи полевых грызунов	C. laeviceps	0,7	2,1	4,2	—	87,8	71,5	0,05	—	9,7
	X. conformis	0,13	—	—	—	7,99	11,6	0,04	—	—
	Другие виды	—	—	—	—	3,1	5,4	—	96,6	51,6
	Осмотрено зверьков	1485	46	18	17	2572	442	1060	29	38
	Собрано с них блох	2308	276	24	15	4141	259	2363	30	31
	Индекс обилия	1,55	6,0	1,33	0,88	1,61	0,59	2,23	1,03	0,82

1. Ecological grouping; 2. Species of flea; 3. Species of rodent; 4. Scirtopod jerboa; 5. Earth hare; 6. Dwarf jerboa; 7. Tarbagan; 8. Crested jird; 9. Meridional jird; 10. Dwarf souslik; 11. Field mouse; 12. Gray hamster; 13. In percentages of the total number; 14. Jerboa fleas; 15. Souslik fleas; 16. Jird fleas; 17. Other species; 18. Animals examined; 19. Fleas collected from them; 20. Index of abundance.

jirds and sousliks in the Il'men region was begun in 1950-1951 and was conducted particularly extensively in 1952 and 1954. If we take into consideration the fact that the main collections of the first period were made before 1950, that is, before the beginning of mass measures for rodent extermination, and the collections of the second period were made after them, the reasons for the phenomenon described become clear, the meaning of which in the final analysis consists of an interruption of epizootological connections between different groups of rodents.

The data presented in Table 2 once again confirm the opinion of the close connection between fleas of the genera Mesopsylla and Ophthalmopsylla and their true hosts, jerboas. Cases of migration of jerboa fleas to other rodents are generally quite rare. These parasites are particularly few on sousliks. There are also few souslik fleas on jerboas. An increased number (up to five percent) of M. tuschkan fleas has been noted on the meridional jird; of M. hebes, on the field mouse. An exception to the general rule -- the comparatively low census of jerboa fleas on other rodents -- is their presence in very high numbers in the fur of gray hamsters [Cricetulus migratorius]. The interpretation of this fact will be a matter for the future.

The material on the flea census is quite variegated (Tables 3 and 4). Thus, on the scirtopod jerboas during the first period of observation there were an average of 0.4 flea; in the second period, 1.55 each (variations for each individual month ranged from 0.4 to 3.95). Such a sharp rise in the census can be explained by the fact that in the second case the collections were made in areas with an increased rodent density, that is, in habitats favorable for activity not only of the hosts but also of the ectoparasites.

The highest and most stable census of fleas is characteristic of the earth hares. Thus, in an area in the environs of the Village of Venderovo (Table 2) the general index of abundance on them was equal to 6.0; on an area in the environs of Kurchenko (Table 4) it ranged from 13.2 (May) to 22.5 (October) with a definite tendency toward a rise in the autumn. An increased flea census was noted in the holes of this rodent also.

Some seasonal changes in the census of fleas can be noted from the material of collections from scirtopod jerboas (Tables 3 and 4). In the dynamics of the M. tuschkan species two census rises are noted: a late-spring rise in May and a summer-autumn rise in August-October (1955 collections, see Table 4). A high census in early spring (March-April) and late autumn (up to 1.65 in October 1955) is characteristic of the seasonal course of O. volgensis. Apparently, O. volgensis comes out of its cocoon stage in increased numbers in the autumn, and possibly the hatching continues even later. It must be ...

Table 3

Flea Census of the Scirtopod Jerboas of the Il'men Region (Environs of the Village of Venderovo)

Виды блох	1951			1952						1953				
	июнь	сентябрь	октябрь	март	апрель	май	июнь	август	октябрь	апрель	май	июнь	июль	октябрь
N. [illegible]	0,15	0,25	0,17	0,074	0,31	0,83	0,2	0,45	0,09	0,26	0,44	0,15	0,58	0,5
J. [illegible]gerasi	0,08	0,1	0,9	3,44	2,08	0,65	0,28	0,89	0,016	1,6	0,2	0,18	0,24	0,5
[illegible]	—	0,01	—	0,14	0,26	—	0,05	0,03	0,13	0,015	0,03	—	0,035	—
[illegible]	0,015	—	—	0,03	—	—	—	—	—	—	0,04	—	0,005	—
N. [illegible]	0,01	—	—	—	—	—	—	—	—	0,003	0,1	—	0,003	—
C. [illegible]	—	0,01	0,13	—	—	—	—	—	—	—	—	—	—	—
[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	0,001	—
[illegible]	352	201	110	51	77	78	172	107	339	324	119	44	565	2
[illegible]	0,27	0,89	1,2	3,82	2,75	1,48	0,53	0,57	0,21	1,88	0,81	0,34	0,86	1,0

1. [illegible]; 2. Year; 3. Month; 4. July; 5. September; 6. October; 7. March; 8. April; 9. [illegible]; 10. [illegible]; 11. August; 12. June; 13. Index of abundance; 14. Number of animals; 15. [illegible].

Table 4

The Census of Jerboa Fleas in the Il'men Region (Environs of the Village of Kurchenko, 1955)

Виды грызунов (1)	(2) Емурачник			(3) Большой тушканчик			(4) Малый тушканчик	(5) Тарбаганчик	(6) Норы емурачника			(7) Норы большого тушканч.
(8) Период обследования	III	V	X	III	V	X	III, X	III, V, X	III	V	X	V X
(9) Всего грызунов	263	251	47	51	18	2	28	84	974	1821	314	296
(10) Из них с блохами	111	89	10	41	16	2	8	40	217	202	22	35
(11) Индексы обилия: C. volgensis	0.5	0.39	1.65	0.23	—	—	0.18	0.89	0.24	0.18	0.025	0.07
M. hebes	0,008	0.02	3.06	13.1	13.06	22.5	0,1	0.46	0.45	0.04	0.04	1.36
M. tuschkan	0.48	0.44	1.65	0.02	0.11	—	1.32	1.25	0.26	0.11	0.13	0.09
(12) Другие виды	0,024	0,004		0.08	—	—	—	0,02	0.006	0,001	0,009	—
(13) Общий индекс	1.05	0.65	3.36	13.61	13.17	22.5	1.6	2.32	0.956	0.331	0.2	1.62

1. Rodent species; 2. Scirtopod jerboa; 3. Earth hare; 4. Dwarf jerboa; 5. Tarbagan; 6. Scirtopod jerboa holes; 7. Earth hare holes; 8. Periods of investigation; 9. Total rodents; 10. Of these, the number with fleas; 11. Indices of abundance; 12. Other species (C. laeviceps, R. cedestis, N. setosa, F. semura, A. rossica, F. frontalis, X. conformis; the last four species were collected from holes); 13. General index.

supposed that this parasite is capable of multiplying in the winter nests of jerboas. This is indirectly indicated by the high census of the species during the period of awakening of the scirtopod jerboas from hibernation.

Therefore, O. volgensis is a winter species, and M. tuschkan (a fur flea) is chiefly a parasite of the summer season.

The material presented is not in agreement with data obtained by K. A. Ivanov and G. P. Derkach (1955). They observed the highest flea census in scirtopod jerboas (an index of 3.5) during the period of their mass awakening from hibernation (March). Subsequently, during the period of activity of the animals, the parasitic index gradually dropped, and by the time the hosts went into hibernation it reached 0.3. Unfortunately, the authors operated with the so-called general indices, which do not permit judging the actual population dynamics of the specific species. Diametrically opposite data were obtained by A. A. Sinichkina and A. F. Dudnikova (1951), who write the following: "... the tendency toward an increase of the specific frequency of occurrence of the specific jerboa flea O. kasakiensis from April to October is in accordance with the autumn hatching of this species from cocoons."

From these comparisons it may be judged that many aspects of the biology of jerboa fleas remain unknown as yet. Observations are still too few for final conclusions. Investigations should be continued.

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Census Dynamics of Sousliks on Treated Areas in the Natural Plague Focus of the Northwest Caspian Region

Soviet investigators have proved the possibility of suppressing and eliminating relatively independent natural plague foci by means of conducting extensive solid-coverage extermination operations against the main reservoirs of this infectious disease -- sousliks, marmots and jirds (B. M. Ayzin and coauthors, 1957; N. P. Mironov, 1957; I. Z. Klimchenko, 1957; P. Ye. Nayden, 1957; V. N. Fedorov and coauthors, 1955; B. K. Fenyuk, 1948-1957).

As the result of analysis of tremendous field material collected during the course of realization of measures for the extermination of sousliks and the holding of a special discussion the need for repetition in suppression and elimination of the plague enzootic was substantiated (N. P. Mironov, 1957; B. K. Fenyuk, 1957, and others).

Along with the doing of work on the elimination of sousliks on an extensive territory, observations were organized in some areas of it on the census dynamics of the animals after taking control measures (I. Z. Klimchenko and coauthors, 1955, G. A. Kondrashkin and coauthors, 1957; A. A. Lisitsyn, 1957; M. G. Yakovlev, 1950, and others), which makes it possible most correctly to evaluate the treated areas in an epizootological respect as well as plan the time and volume of repeated treatment more efficiently. However, data published on this problem are so far inadequate, which has accounted for the making of further observations on the census dynamics of sousliks on the treated areas. In parallel, observations have been made on territories which have not been subjected to treatment. It should be noted that preliminary data on the current topic (from 1949 through 1953) have been published (I. Z. Klimchenko and others, 1955). Here, the summarizing material, characterizing the census dynamics of sousliks through 1957 inclusive, is being presented.

Material and Method

For the purpose of determining the time and nature of recovery of the souslik census on treated areas, in 1948 we organized special observations on an area of 50,000 hectares, located in the region of the settlement of Naryn-Khuduk of Kalmytskaya ASSR. This area was treated twice (in 1949 and 1950) for rodents, using fused cyanides. With the aim of counting the census of sousliks over the entire area 50 one-hectare areas were plotted out, on which in the autumn of each

year (from 1948 through 1957) all the holes were counted and dug up, and in the spring of the next year (after the mass awakening of the animals from hibernation) the number of vertical passages which appeared in them were counted; we took this number to be the number of sousliks which had passed the winter here.

In parallel with this work, according to the same method, observations were made on the census dynamics of this species on an untreated area. In this case the census of the animals was taken from 1949 through 1956 inclusive, on one-hectare areas laid out on the territory of the Volga steppe landscape-ecological region of the Northwest Caspian. In addition, the sousliks were examined for their reproductive status as follows: 38,072 in Chernozemel'skiy Rayon (from 1949 through 1958), and 63,042 in the Volga steppe (from 1949 through 1954). This material makes it possible to substantiate more completely the census dynamics of the animals in various years and on various natural areas.

Results of the Observations and Discussion of Them

The census dynamics of sousliks on a twice-treated area of 50,000 hectares is characterized by the following figures (Table 1).

Table 1

April Data on Souslik Census in the Region of Naryn-Khuduk Settlement from 1949 through 1958

(1) Показатели	(2) Средняя численность сусликов на 1 га в абсолютных и относительных показателях									
	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
(3) Число учетных площадок на 1 га	50	50	40	50	50	20*	50	50	50	50
(4) Средняя численность сусликов на 1 га	30.0	14.1	2.7	4.4	5.5	6.0	6.3	9.0	10.3	12.1
(5) В % к 1949 г.	100	47.0	9.0	11.8	18.4	20.0	21.0	30.3	34.3	40.3

1. Indices; 2. Average souslik census per hectare in absolute and relative figures; 3. No. of areas counted per hectare; 4. Average souslik census per hectare; 5. In % of 1949. In 1954 the souslik census was not determined in special areas but rather according to selective data of the Naryn-Khuduk Antiepidemic Detachment.

From data presented in Table 1 it is seen that from 1950 through 1958 inclusive the souslik census increased steadily and reached 40.3 percent of the pre-treatmend 1949 census and 85.8 percent of the 1950 census. The annual increase of animals in this original group, that is, from one spring to the next, varied from five percent to 64.4 percent. However, it should be taken into consideration that the data presented are the results of data for 50 areas counted. In connection with this it is not without interest to analyze the corresponding figures for each area, which were constant from 1955 through 1958 (Table 2).

While the summarizing data for Table 1 show that from 1950 through 1958 the souslik census increased to different degrees but steadily, in the separate counting areas (Table 2) the corresponding figures either increased precipitously (areas No 5, 13, 36, 46) or decreased sharply (areas 11, 12, 19, 24, 41); at times, they remained more or less stable (areas No 20, 21, 26, 27, 31, 48). This nature of the souslik census dynamics is brought about not only by multiplication and death of them but also by a regrouping of the animal populations. From Table 2 which has been presented in addition, it is seen that the most marked increase in the number of individuals is noted on areas with low settlement densities (areas No 1, 5, 6, 7, 13, 17, 22, 36, 44, 47), which is evidence of the presence of migrational activity of the animals.

Our material is in complete agreement with the statements made by N. P. Naumov (1957), who believes that by means of migrations of the animals a redistribution of the population is accomplished in accordance with constantly changing existential conditions. Thereby a higher rate of multiplication of sousliks on the treated areas (where their census was markedly reduced after control measures) is explained by the presence of the proper ecological conditions for the activity of the animals.

We consider it necessary to emphasize that the general rules and regulations of steady increase in the souslik census from 1950 through 1958 inclusive are not revealed by the separate counting areas but rather by the sum of a certain number of them, which in this case should be no less than 25. We have drawn this conclusion on the basis of an appropriate mathematical treatment of the data of Table 2. With this aim in view we have determined the average figures for the souslik census for 10, 15, 20 and 25 areas. In the first case, from 41 series (the average souslik census for 1955-1956-1957-1958) deviations from the rules and regulations indicated above were obtained in 43.9 percent of the cases; in the second and third cases these deviations were 30-27.8 percent and 31-19.4 percent, respectively; only in the last case did all 24 series show a steady increase in the souslik census from 1955 through 1958 inclusive. However, the minimum number of counting

Table 2

Souslik Census Dynamics for Fifty Constant Counting Areas

№ учетных площадок	Численность сусликов по годам				№ учетных площадок	Численность сусликов по годам			
	1955	1956	1957	1958		1955	1956	1957	1958
1	2	12	16	23	10	14	5	4	8
2	10	4	13	11	11	15	11	8	22
3	5	12	8	16	12	24	6	7	15
4	4	10	11	10	13	0	2	4	13
5	0	11	12	18	14	3	7	31	6
6	3	13	10	8	15	2	1	6	5
7	3	12	14	13	16	5	5	15	7
8	3	9	7	12	17	4	30	14	20
9	4	8	18	12	18	10	4	16	40
19	5	4	2	11	35	5	9	6	10
20	9	8	5	7	36	1	7	12	13
21	6	10	9	9	37	4	8	14	9
22	5	24	18	13	38	11	7	7	10
23	7	8	5	8	39	4	10	15	13
24	13	6	4	15	40	4	6	15	7
25	8	6	14	4	41	13	6	5	10
26	7	6	6	9	42	7	8	10	16
27	6	7	9	6	43	1	28	15	9
28	2	6	6	9	44	1	9	12	9
29	9	14	9	13	45	4	5	10	11
30	8	9	8	13	46	3	9	14	15
31	6	7	7	5	47	2	9	11	8
32	5	5	5	8	48	9	7	9	6
33	7	9	11	15	49	20	8	21	8
34	3	2	5	14	50	15	21	13	11

1. No of counting areas; 2. Souslik census by years.

areas (25) can be reduced or increased in accordance with the nature of the settlement of the animals, which is brought about by the period of their activity and the landscape-ecological differences of the area investigated. On the territory of the Volga steppe landscape-ecological region, where no control measures were taken against sousliks, their census dynamics are shown in the following form (Table 3).

Table 3

April Data on Souslik Census in the Volga Steppe Region from 1949 through 1955

Показатели (1)	Средняя численность сусликов на 1 га в абсолютных и относительных показателях (2)							
	1949	1950	1951	1952	1953	1954	1955	1956
Число учетных площадок на 1 га (3)	300	207	200	205	197	200	100	97
Среднее число сусликов на 1 га (4)	10,8	8,8	8,2	9,4	14,2	20,8	19,0	16,0
В % к 1949 г. (5)	100	81,5	76,5	105,6	131,5	192,6	176,0	148,9

1. Indices; 2. Average souslik census per hectare in absolute and relative figures; 3. No. of counting areas per hectare; 4. Average number of sousliks per hectare; 5. In percent of 1949 figure.

From the data presented in Table 3 it is seen that from 1949 through 1951 inclusive the rodent census decreased appreciably and then began to increase, after reaching its maximum in 1954, after which it again declined.

These data confirm the wave-form nature of the souslik census dynamics, to which I. M. Mamontov drew attention (1944). Under other landscape-ecological conditions or at a different time the nature of development of the population can have its own specific features, which is determined by the intensity of multiplication and the mortality of the animals. These two opposite phenomena, in turn, are determined by the specific ecological conditions, the population structure, and the physiological conditions of various individuals (S. N. Varshavskiy, 1938; A. A. Lavrovskiy and Ya. F. Shatas, 1948, and others). Nevertheless, the souslik census dynamics on the treated areas is qualitatively different from that of the untreated areas. While in the former case the census of the animals, as has been mentioned above, increased, on the untreated territories it at times increased and at times decreased; at times it remained relatively stable. From Table 3 it is seen that the range of the souslik census over many years reaches only 154 percent (1951 and 1954); in the same year this figure did not exceed 46 percent (1953-1954). The data presented depict the souslik census dynamics in nature with undoubted accuracy, because we have shown the statistical reliability of the corresponding material on a much smaller number of

counting areas in Chernozemel'skiy Rayon.

Let us now proceed with an analysis of the material on the multiplication of sousliks in these two areas. However, before proceeding with the presentation and analysis of these data we should make the reservation that they are inadequately comparable, because in Chernozemel'skiy Rayon the animals were caught and investigated not only from treated areas but also from the extensive environs of this territory including untreated areas. Nevertheless, we believe that material of this kind is of definite interest for the elucidation of the general rules and regulations of reproduction of the souslik pack.

The intensity of their multiplication in various years and under various landscape conditions can be characterized by the following figures (Table 4).

From the figures in Table 4 it is seen that in various years gravid females are encountered for 30-60 days in Chernozemel'skiy Rayon and 20-55 days in Privolzhskiy Rayon. This period is conditioned, chiefly, by the course of the spring and the nature of awakening of the sousliks from hibernation. Every year from 45 percent to 95 percent of all the mature females participate in multiplication. On the average, each of them has from 5.2 to 7.0 embryos (variations from one to 15). If we assume that the gravid females deliver and breed their offspring successfully, the original spring census may be increased by two-three or even four times. However, in nature we do not observe this because of the continuous mortality process of the animals caused by various factors, both in embryonic and post-embryonic stages of their development. The intensity of souslik multiplication is determined, as has been pointed out above, by specific ecological conditions, population structure and the physiological condition of various individuals

Having at our disposal many years of data on the souslik census in certain regions (and on constant counting areas for certain years) and data on their rates of multiplication, we can also determine the degree of the yearly mortality of the animals (S). We determined this figure according to the following formula: $S=\frac{C \cdot a \cdot M_1}{100}+M_1-M_2$, where "C" is the percentage of females participating in multiplication in the total number of animals (males and females); "a" is the average number of embryos per gravid female; "M_1" is the average number of sousliks per hectare in the spring of the previous year; and "M_2" is the average number of sousliks per hectare in the spring of the current year.

Let us take the corresponding figures for Chernozemel'skiy Rayon and let us determine the mortality rate of the animals from 1951 through 1952. $\frac{37.5 \cdot 5.3 \cdot 2.7}{100}+2.7-4.4=3.7$ or 45.7 percent of the

Table 4

The Main Figures Characterizing the Intensity of Souslik Multiplication

(1) Годы	(2) Исследовано половозрослых самок [экз.]	(3) Период встречи беременных самок [дни]	(4) Процент участвовавших в размножении самок	(5) Среднее число эмбрионов на 1 беременную самку	(6) Вероятный приплод сусликов в % к исходному их числу
	(7) Черноземельский район				
1949	1474	40	77	7.0	270
1950	1035	45	66	6.2	205
1951	1270	30	75	5.3	199
1952	943	60	95	5.6	266
1953	1422	40	86	6.0	258
1954	1098	30	66	6.3	208
1955	335	30	75	7.0	262
1956	548	40	78	6.2	242
1957	1137	45	90	6.2	279
1958	346	60	80	6.7	268
	(8) Приволжский степной район				
1949	4980	55	78	6.0	234
1950	5031	35	87	6.5	283
1951	3199	25	85	6.3	268
1952	3150	30	70	6.5	228
1953	3146	35	45	5.2	117
1954	309	20	85	5.4	230

1. Years; 2. Mature females investigated (specimens); 3. Period for which gravid females were encountered (days); 4. Percentage of females participating in multiplication; 5. Average number of embryos per gravid female; 6. Probable number of souslik offspring in percent of original number; 7. Chernozemel'skiy Rayon; 8. Privolzhskiy Steppe Rayon.

Notes: 1. The data presented in Table 4 have been checked, and differ only to a certain degree from the corresponding figures in the text of the present work; 2. In the determination of the figure for the probable number of souslik offspring we assumed that their population consists 50 percent of females and 50 percent of males.

total pack, that is, of the original census (2.7) with the expected offspring (5.4). These calculations are presented for all the years of our observations in Table 5.

Table 5

Index of Souslik Census Dynamics for Chernozemel'skiy and Privolzhskiy Steppe Rayons

Годы (1)	% самок, участвовавших в размнож. к общему числу зверьков (C) (2)	Среднее число эмбрионов на 1 беременную самку (a) (3)	Среднее число сусликов на 1 га (M_1 - M_2) (4)	Ожидаем. приплод сусликов на 1 га $\frac{C \cdot a \cdot M_1}{100}$ (5)	Годовая смертность сусликов (6)	
					абсолют. число зверьков на 1 га (7)	в % к общ. числу (8)
			(9) Черноземельский район			
1949	58,5	7,0	30,0	80,8	96,7	87,3
1950	33,0	6,2	14,1	28,9	40,3	93,7
1951	37,5	5,3	2,7	5,4	3,7	45,7
1952	47,5	5,6	4 4	11,7	10,6	68,6
1953	43,0	6,0	5,5	14,2	13,7	69,5
1954	33,0	6,8	6,0	12,5	12,2	66,0
1955	37,5	7,0	6 3	15,5	12,8	58,7
1956	39,0	6,2	9,6	21,8	20 5	66,6
1957	45,0	6,2	10,3	25,7	25,0	69,0
1958	10,0	6,7	12,1	32,4	?	?
			(10) Приволжский район			
1949	39,0	6,0	10,8	25,2	27,2	75,5
1950	43,5	6,5	8,8	24,9	25,5	75,7
1951	42,5	6,3	8,2	22,0	18,8	62,2
1952	35,0	6,5	11,4	25,9	23,1	61,9
1953	22,5	5,9	14,2	16,6	10,0	32,5
1954	42,5	5,4	20,8	47,7	49,5	72,3

1. Years; 2. Percent of females participating in multiplication in total number of animals (C); 3. Average number of embryos per gravid females (a); 4. Average number of sousliks per hectare (M_1-M_2); 5 Expected number of souslik offspring per hectare $\frac{C \cdot a \cdot M_1}{100}$; 6. Annual mortality of sousliks; 7. Absolute number of animals per hectare; 8. In percent of their total pack; 9. Chernozemel'skiy Rayon; 10. Privolzhskiy Rayon.

A count of the souslik census was made only in the spring; therefore, their rate of multiplication in a given year exerts an appropriate influence upon the figure for the animal census only in the next year. From the data presented in Table 5 it is seen that for Chernozemel'skiy Rayon the highest mortality rate of sousliks (which is entirely natural) occurred in 1949 and 1950 (87.3 and 93.7), that is, during the years in which extermination operations were conducted against them. In the next year, 1951, this figure dropped sharply (45.7 percent), which was responsible for the greatest jump upward in the

souslik census (64.3 percent). Then the mortality rate of the souslik increased again and remained almost at the same level from 1952 through 1958 inclusive. For the Privolzhskiy Steppe Rayon the highest mortality of the animals was observed in 1949 and 1950. From 1951 through 1953 inclusive this figure dropped steadily, and in 1954 it again increased sharply.

The material presented permits us to conclude that in the souslik census dynamics the mortality rate rather than the multiplication rate is of determinative significance. For example, for the Privolzhskiy Steppe Rayon the increased mortality of sousliks in 1949 and 1950 brought about reduction in their census from 10.8 to 8.2 individuals per hectare. Then, from 1951 through 1953 inclusive the mortality of the animals was reduced to a considerable degree, which led to an increase in their census from 8.2 to 20.8 individuals per hectare. In 1954 this figure again rose to 72.3 percent; at the same time, the souslik census in 1955 dropped to 19 per hectare. Analyzing the material for the multiplication rate of the population along this line, we do not observe such rules and regulations. Therefore, the census dynamics of the souslik are regulated by the multiplication and mortality rates; the mortality rate factor is of determinative significance along this line.

Conclusions

1. A count of the souslik census according to the spring holes assures obtaining reliable data. This count should be begun immediately after the mass awakening of sousliks from hibernation and should be concluded no later than after 15-20 days.

2. For the purpose of obtaining statistically reliable data on the souslik census a count of them should be made on no less than 25 one-hectare areas in each landscape-ecological region.

3. On treated areas, where the souslik census has been reduced by 90 percent or more and the residual settlement density is equal to single units, the recovery of their census to the level existing prior to treatment occurs in no less than 10-12 years.

4. On the treated areas the souslik census increases from year to year; on untreated areas it increases at times and at times decreases; at times, it remains more or less stable.

a) In Chernozemel'skiy Rayon the annual increase in the souslik census on a treated area of 50,000 hectares ranged from five percent to 64.3 percent. The average percentage of gravid females on this and on the adjacent territories varied from 66 percent to 95 percent according to years, with an average number of 5.3-7.0 embryos per female.

b. In the Primorskiy Stepps Rayon, where control measures have not been taken against the souslik, their census now dropped, now increased, from 1949 through 1956 inclusive, ranging, on the average, from 8.2 to 20.8 individuals per hectare. The percentage of gravid females here ranged from 45 to 77 percent by years, with an average number of embryos per female of 5.2-6.5.

5. The annual mortality rate caused by unfavorable weather and food conditions as well as by epizootic and activity of carnivores, ranged from 32 to 76 percent. This factor is determinative in the census dynamics of the animals.

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Findings of Remains of the Great Sand Rat in the Northwest Caspian Region

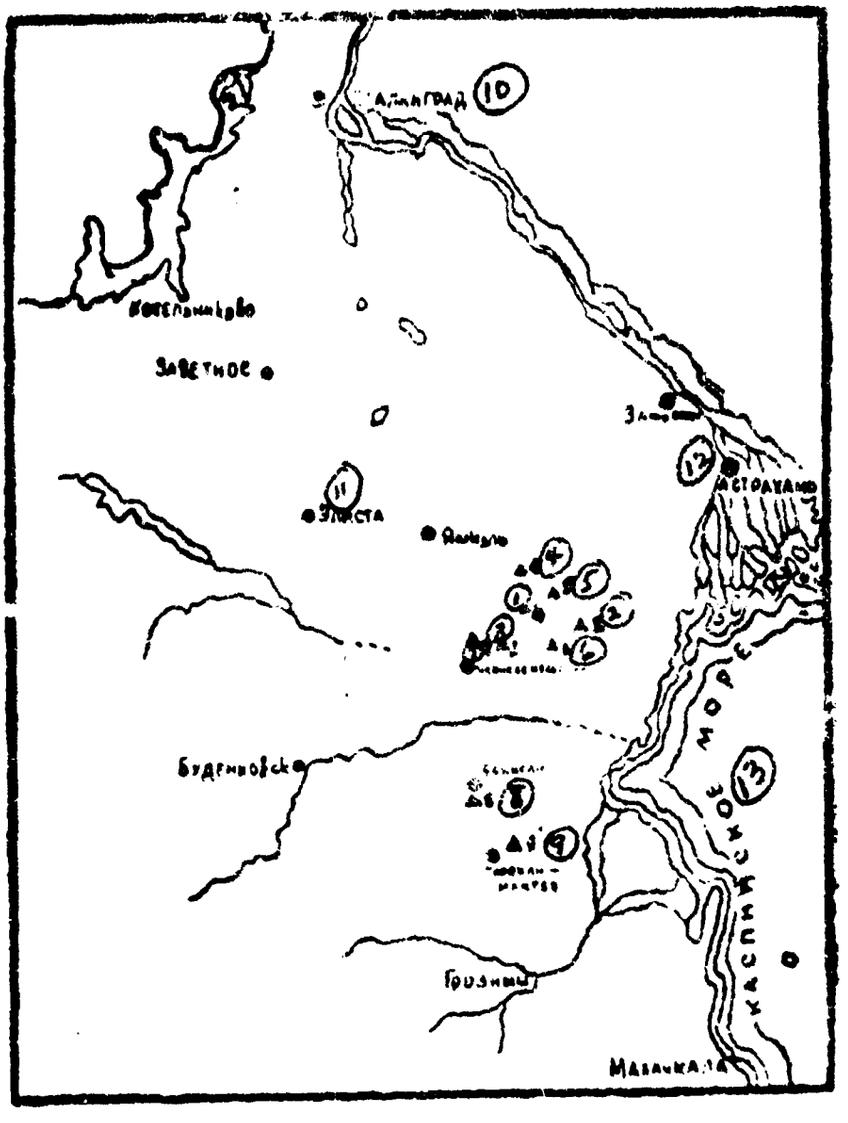
Within the limits of the USSR the great sand rat (Rhombomys opimus Licht.) is distributed in Southern Kazakhstan and over the entire plain area of Central Asia (B. S. Vinogradov and I. M. Gromov, 1952). According to the data of A. V. Afanas'yev, V. S. Bazhanov and others, 1953), the current area of distribution of the great sand rat in Kazakhstan begins in the region of the mouth of the Emba River. The latest studies (I. Z. Klimchenko, N. P. Mironov and others, 1959) show that animals of this species have been moving to a considerable extent to the West, where their colonies come flush against the city of Gur'yev. The northern boundary of the area of distribution within the limits of Gur'yevskaya Oblast pass approximately along the line of Yamankhalinka-Makat. The eastern boundary passes along the Makat-Kul'sary railroad line.

The area of distribution of the great sand rat in the past was considerably more extensive, which is evidenced by the findings of remains excavated in the lower Urals (N. K. Vereshchagin and I. M. Gromov, 1952) and on the right bank of the Volga River in the environs of Zam'yana Village in Astrakhanskaya Oblast (S. N. Obolenskiy, 1927).

In doing work in counting the rodent census over a number of years, in 1955-1956, we found the teeth of great sand rats in Kalmyk and Checheno-Ingush republics.

In Kalmykiya bony remains of these animals were collected on the following sandy areas of Chernozemel'skiy Rayon: Antasyuk (1), Tsuba (2), Chuluta (3), Tavkatsa (4), Shil' (5), west of the settlement of Komsomol'skiy (6), 18 kilometers to the north of Chernozemel'skiy Sovkhoz (7). In Karanogayskiy Rayon of Checheno-Ingushskaya ASSR teeth of the great sand rat were found in drifts of the Bazhigano-Terekli sands, located in the area between the Terek and Kuma rivers in two places: 12 kilometers to the south of Bazhigan (8) and 10 kilometers to the northeast of Terekli-Mekteb (9) (see the Figure) (the species classification of the teeth collected was confirmed by S. K. Dal' and Yu. M. Rall').

The bone relics were found on isolated areas of the sands from 20 to 200 hectares in area. In the majority of cases these were drifting sands which only along the fringes were grown over with giant ryegrass and other plants. Thereby, the teeth of the animals were found



Places at Which Teeth of the Great Sand Rat Were Found. Key [the figures from 1 to 9 designating the sites at which the teeth were found were not clear on the original reproduction and they were put in in ink by the translator; the numbers 10 to 13 are simply orientative, giving a general idea of the location of the area]. 1. Antasyuk; 2. Tsubu; 3. Chuluta; 4. Tavkatsa; 5. Shil'; 6. West of the settlement of Komsomol'skiy; 7. 18 kilometers to the north of the Chernozemel'skiy Sovkhoz; 8. 12 kilometers to the south of Bazhigan; 9. 10 kilometers to the north of Terekli-Mekteb Village; 10. Stalingrad; 11. Elista; 12. Astrakhan'; 13. Caspian Sea.

in the troughs of sand-drifts, the bases of which were made up of dense brownish-pale-yellow loess-like loam and sandstone. In all, 186 teeth were collected belonging to no less than 50 specimens of this species of rodent (Table 1). The following number of teeth were collected according to the separate sandy areas (Table 1).

Table 1

Sites of Collection and the Number of Great Sand Rat Teeth Found

(1) Места сбора	(2) Собрано зубов					
	(3) резцов		(6) коренных зубов			
	(4) правых	(5) левых	нижних	(7) верхних	(8) нижних	(9) неопределенных
(12) Калмыцкая АССР*						
1. Пески Антасюк	3	2	2	1		
2. Пески Цубу	11	5	15	6	1	
3. » Чулута	1	1	3			
4. » Тавкацца	7	6	14	4		
5. » Шиль	2	3	2			
6. » 5 км зап. пос. Комсомольский	15	16	25			
7. Пески 18 км северное совх. Черноземельский	3	1		1	1	
(13) Чечено-Ингушская АССР*						
8. Пески 12 км южнее Бажигана	1					
9. Пески 10 км сев.-вост. Терекли-Мектеб	8	2	1	3	1	2

1. Sites of collection; 2. Teeth collected; 3. Upper incisors; 4. Right; 5. Left; 6. Lower incisors; 7. Molar teeth; 8. First; 9. Upper; 10. Lower; (part of the first molar teeth, the enamel rods of which were destroyed, could not be divided into upper and lower); 11. Second; 12. Kalmytskaya ASSR; 13. Checheno-Ingushskaya ASSR. [The legend which is numbered in type within the Table is as follows]. 1. Antasyuk sands; 2. Tsubu sands; 3. Chuluta sands; 4. Tavkatsa sands; 5. Shil' sands; 6. Sands five kilometers to the west of the settlement of Komsomol'skiy; 7. Sands 18 kilometers to the north of Chernozemel'skiy Sovkhoz; 8. Sands 12 kilometers to the south of Bazhigan; 9. Sands 10 kilometers to the northeast of Terekli-Mekteb.

In contrast to the teeth of crested jirds (Meriones tamariscinus Pall.), the teeth of great sand rats collected are more massive; the upper incisors have two longitudinal parallel fissures along the anterior wall of enamel; the anterior wall of enamel of the lower incisors is flat with a chisel-like cutting edge. The molar teeth are distinguished by the absence of roots. In comparing the teeth collected with the teeth of the present-day great sand rats from the Northern Aral Sea area no appreciable differences could be found.

It is difficult to judge the ages of our findings. The usual method of determining geological age of bones, proposed by I. G. Pidoplichko (1948) by the percentage of organic matter preserved in the bone is not applicable here because, in the opinion of N. K. Vereshchagin and I. M. Gromov (1952), "fossilization" of the enamel and dentin occurs in a different way from that of the bone marrow. It may be supposed only that the hosts of the teeth which we collected lived in the Northwest Caspian in the Mangyshlak regression, when the Caspian Sea was a lake bounded on the north shore by the Makhach-Kala-Groznyy line (N. P. Mironov, 1957). In connection with this, it was possible for the Central Asiatic fauna to penetrate to the West and, specifically, for the great sand rats to come from the territory of what is now Mangyshlak into the Northwest Caspian region. These rodents died, as was described by N. P. Mironov (1957) apparently as the result of the last, so-called Nikol'sk transgression, which occurred 5,000-6,000 years ago, when the shore of the Sea was constituted by the Yergeni Heights.

In the works of P. G. Yazan (1952, 1955) it is mentioned that the formation of sands in the Northwest Caspian region refers to the eighth-ninth century B.C. These areas were created from ancient deposits of the Kuma and Kura rivers (Pre-Caucasus) as well as of the Caspian Sea. At the present time these are mainly stationary sands overgrown with rootstock-grass vegetation. The total area on which the sand massifs are scattered is equal to approximately 1,100,000 hectares. The drifting areas of sand are encountered rarely and are small. Mammals are represented by steppe forms here (Citellus pygmaeus Pall., Allactaga jaculus Pall., Microtus arvalis Pall. [dwarf souslik, alactaga, common vole] and others), as well as by desert forms (Meriones meridianus Pall., Dipus sagitta Pall. [meridional jird, hairy-footed jerboa] and others). According to the data of S. K. Dal' (1954), in the first phase of settlement of the sands of the Northwest Caspian region the desert species were predominant, and these were then gradually displaced by steppe species, which led to the numerical primacy of the latter.

Relics of the great sand rats found indicate the fact that this species was also included here among the desert fauna.

Therefore, tying in the Zam'yana finding of relics of the rodents

mentioned with our own material, it may be supposed that in the past great sand rats lived in the territory of the Northwest Caspian as far as the Yergeni Heights. This considerably expands the existing information on the history of the area of distribution of the great sand rats and also gives us new data for studying the natural foci of arthropod-borne diseases, the existence of which is associated with these rodents in nature.

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S. I. Kaplanina and A. S. Filimonova

Medium for the Differential Diagnosis of Pasteurella pseudotuberculosis and the Geographic Varieties of Pasteurella Pestis

The differential bacteriological diagnosis between plague and pseudotuberculosis microbes, which have very many similar biological traits, requires a large number of different media and a long time for making the examinations.

Therefore, it is important in practice to work out the problems associated with study of metabolic reactions in these two microbial species to media of complex composition which make it possible to determine simultaneously several of the basic features of these microorganisms and, by the same token, to reduce the time of the examination.

Devignat and Boivin (1953) worked out the recipe for a medium which makes it possible to differentiate all three geographic varieties of the plague microbe and the pathogen of rodent pseudotuberculosis by the fermentation of glycerin, rhamnose and the reduction of nitrates to nitrites. We modified the preparation of this medium somewhat. The composition of the medium which we used was the following: Hottinger's agar at a pH=7.2, 100 cc; rhamnose, 1 gram; pure glycerin 0.2 gram; potassium nitrate 0.2 gram; 2 percent alcoholic solution of bromthymol blue, 2 cc, with the addition of four percent NaOH until the medium turns green. The medium was sterilized at 100° (fractionally) and was poured out into test tubes in 6-cc units so that part of the agar remained unslanted (a half-column). The cultures were grown at 28°; a s ulture was made of a two-day culture by means of a five-m ameter loop. One loop of culture was put into the column; the other was streaked over the surface of the agar. We used both bouillon and agar cultures. The agar cultures were more convenient to inoculate, because it is easier to obtain growth over the entire surface of the streak. The results of the experiments were read on the second, third, fifth and fourteenth days. (See Table 1).

For four days tests are made for reduction of nitrates by the addition of four-five drops of Griess' reagent. In all, two strains of Pasteurella pestis v. orientalis, 13 strains of Pasteurella pestis v. mediovalis, nine strains of Pasteurella pestis v. antiqua and 16 strains of Pasteurella pseudotuberculosis were tested. The strains of the oriental variety of plague microbe, which do not decompose glycerin or rhamnose, produced a gradual alkalinization of this medium, which is noted as early as after 24 hours and which increases as the cultures stand in the incubator. Alkalinization was expressed in a bluing of the agar (the unseeded control medium was

Table 1.

Results of Cultures on Differential Diagnostic Medium

	(1) Обозначение штаммов	(2) Изменения среды: через 1 сутки (3)	через 2 суток (4)	через 4 суток (5)	через 2 недели (6)	Реакция восстановления нитратов (7)
(8)	BV OTTEN	(13) Быстро начинающееся посинение среды в верхней части пробирки. Основание пробирки зеленое	(14) Посинение пробирки усиливается. Дно зеленое	(15) Почти вся пробирка становится синей. Дно чуть зеленоватое	(16) Окраска среды всей пробирки синяя	+
(9)	(12) AM0 469, 95, 96, 114, 116, 118, 150, 151, 154, 234, 235, 295, 236	(17) Наклон агара в пробирке зеленый, иногда синий. Пожелтение в нижней части (прямом столбике агара)	(18) Наклон агара в пробирке становится более синим. Основание пробирки желтое	(19) Посиневший агар занимает большую часть пробирки. Дно желтое	(20) Окраска среды всей пробирки синяя.	
(10)	M2 487, 1я, 555, 741, 764, 772, 775, 707, 768	(21) Наклон агара в пробирке зеленоватый. В нижней части (прямом столбике) интенсивное пожелтение	(22) Интенсивное ощелачивание среды агар в пробирке становится синим. Придонная часть желтоватая	(23) Среда в пробирках желтая	(24) Окраска всей пробирки синяя	+
(11)	5, 203, 204, 205, 480, 491, 494, 496, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929	(25) Среда быстро окисляется и почти весь агар пробирки желтеет. Иногда остаются небольшие участки зеленоватого цвета	(26) Резкое окисление среды. Пробирки желтые	(27) Интенсивное ощелачивание среды. На дне небольшой участок желтого оттенка	(28) Среда в пробирках желтая	+

[Key on next page]

1. Names of the Strains; 2. Changes in the Medium; 3. After One Day; 4. After Two Days; 5. After Four Days; 6. After Two Weeks; 7. Nitrate Reduction Reaction; 8. Eastern Variety of Plague Microbe; 9. Middle-Ages Variety of Plague Microbe; 10. Ancient Variety of Plague Microbe; 11. Rodent Pseudotuberculosis Microbe; 12. Ab; 13. A Bluing of the Medium Rapidly Begins in the Upper Part of the Test-Tube. The Base of the Test-Tube is Green; 14. Bluing of the Test-Tube Increases. The Base is Green; 15. Almost the Entire Test-Tube Becomes Blue. The Bottom is Slightly Greenish; 16. The Color of the Medium in the Entire Test-Tube is Blue; 17. The Agar Slant in the Test-Tube is Green, Sometimes Blue. Yellowing in the Lower Portion (The Straight Agar Column); 18. The Agar Slant in the Test-Tube is Becoming Bluer. The Base of the Test-Tube is Yellow; 19. The Agar Turning Blue Occupies the Bulk of the Test-Tube. The Base is Yellow; 20. The Color of the Medium in the Entire Test-Tube is Blue; 21. The Agar Slant in the Test-Tube is Greenish. In the Lower Part (Straight Column) there is an Intense Yellowing; 22. An Intense Alkalinization of the Medium--the Agar in the Test-Tube is Becoming Blue. The Part Near the Bottom is Yellowish; 23. The Medium in the Test-Tube is Yellow; 24. The Color of the Entire Test-Tube is Blue; 25. The Medium Is Rapidly Oxidized, and Almost the Entire Agar in the Test-Tube Is Turning Yellow. Sometimes Small Areas of a Greenish Color Remain; 26. Marked Acidification of the Medium. The Test Tubes Are Yellow; 27. Intense Alkalinization of the Medium. On the Bottom There Is a Small Area of Yellow Hue; 28. The Medium in the Test-Tubes Is Yellow.

green), which began at the top in a slanted layer of agar and in four days spread throughout the test-tube. Subsequently, the medium remained intensely blue. The strains of the Middle-Ages variety of plague microbe, which oxidize glycerin, produced a yellowing of the medium in the depth of the agar because of this (in the lower portion of the test-tube), and then a gradual alkalization of the medium in the upper part of the test-tube. The medium in the test-tube became blue after four days' of growth of the culture.

The strains of the ancient variety, which also break down glycerin, produced approximately the same changes in the medium as the strains of the Middle-Ages variety.

Cultures of Pasteurella pestis 13 and 545 produced a more intense yellowing of the medium, which then (by the third-fourth day) was replaced by an intense blue color. Pasteurella pseudotuberculosis produced an intense yellowing of almost the entire medium as early as after 24 hours because of the oxidation of glycerin and rhamnose. In the test-tubes the medium subsequently remained intensely yellow.

Depending on the quantity of material introduced, complete yellowing of the medium occurred after one to four days. The observations show that alkalinization of the medium is not produced by the pseudotuberculosis strains no matter how long the test-tubes with the cultures stood in the incubator. The same medium makes it possible to check the nitrate reduction reaction in the cultures investigated because of the presence of niter salts in it. On the third-fourth day the Griess reagent was introduced into the test-tube, whereby in the strains of the oriental variety a markedly positive reaction of nitrate reduction was obtained (a bright red color); in strains of the Middle-Ages variety the reaction was negative; in strains of the ancient variety the reaction of nitrate reduction was positive. Pseudotuberculosis strains produced a slowly occurring nitrate reduction reaction. In certain cases, where the plague strains broke down rhamnose the yellowing of the medium was persistent. Therefore, for definitive differentiation studies accepted for the identification of these cultures should be made in addition.

Conclusions

A complex medium containing rhamnose, glycerin and KNO_3 makes it possible tentatively to differentiate the three geographic varieties of plague microbe and the pseudotuberculosis pathogen in four days. The final diagnosis of these microbes is made by means of additional studies.

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G. G. Gurleva

Simplified Method of Adsorption of Group Agglutinins by Antiplague Serum

As is well known, only a relative specificity is characteristic of the agglutination test. Antisera obtained by means of bacteria of one species frequently agglutinate bacteria of other species also. Such a characteristic feature of diagnostic sera depends on the presence of group antibodies.

Plague antisera do not constitute an exception in this respect. The inadequate specificity of the agglutination test in plague is associated with the presence of group antibodies for a whole series of microorganisms in the serum (Ye. I. Korobkova, B. Yu. Favorisova and P. N. Kraynova, 1935; L. A. Timofeyeva, R. R. Zhivolyapina and G. V. Yakubovskaya, 1954; L. A. Timofeyeva, 1957.

For the purpose of eliminating the group reactions the method of agglutinin adsorption is used known by the name of the "Castellani test". Technically, this reaction is complicated; for the purpose of performing it no less than 22 hours and special equipment are necessary.

V. S. Kiktenko, I. Kh. Ashurova and V. D. Kucherenko (1955) showed in working with the colon-typhoid group that for the purpose of extracting group agglutinins from the serum a 10-minute contact of it with antigen is necessary, which is then filtered off through an asbestos filter in a syringe. The authors recommended this simplified method of group agglutinin adsorption for work under field conditions.

Keeping in mind the simplicity and availability of this method, we decided to study the possibility of using it for the adsorption of group antibodies in antiplague serum. Experiments performed for this purpose constitute the subject of the present report.

The experiments were performed with antiplague serum series 310 of the Saratov "Mikrob" Institute. The agglutinating properties and titers were determined on the following cultures: P. pestis 1, 17, 145, 150, 151, 154; P. pseudotuberculosis rod. Pfeifferi 5, 203, 496, 498, 923, 928, 994, 1022, 1023, 1025, 1026; B. dysenteriae shigella Boydi 663, 664, 674; B. dysenteriae Flexneri 3.0; B. proteus vulgaris 687, 688 (See Table 1).

All the strains mentioned, with the exception of P. pseudotuberculosis 1022 possessed typical morphological, staining, cultural and biochemical characteristics. P. pseudotuberculosis 1022 showed a whole series of properties characteristic of the plague microbe along with those typical of the pseudotuberculosis microbe (it did not cause the breakdown

Table 1

The Agglutination Reaction of Cultures With Normal Antiplague Serum Series 810.

① Наименование культуры \ ② Разведение сыворотки	1 : 20	1 : 40	1 : 80	1 : 160	1 : 320	1 : 640	③ КС	④ КА
P. pestis I	++++	++++	++++	++++	++++	++++	—	—
P. pestis 17	++++	++++	++++	++++	++++	++++	—	—
P. pestis 145	++++	++++	++++	++++	++++	++++	—	—
P. pestis 150	++++	++++	++++	++++	++++	++++	—	—
P. pestis 151	++++	++++	++++	++++	++++	++++	—	—
P. pestis 154	++++	++++	++++	++++	++++	++++	—	—
P. pestis 5	++++	++++	++++	++++	++++	++++	—	—
P. pestis 203	++++	++++	++++	++++	++++	++++	—	—
P. pestis 496	++++	++++	++++	++++	++++	++++	—	—
P. pestis 488	++++	++++	++++	++++	++++	++++	—	—
P. pestis 982	++++	++++	++++	++++	++++	—	—	—
P. pestis 928	++++	++++	++++	++++	++++	++++	—	—
P. pestis 984	++++	++++	++++	++++	—	—	—	—
P. pestis 1022	++++	++++	++++	++++	++	—	—	—
P. pestis 1023	++++	++++	++++	++++	++++	—	—	—
P. pestis 1025	++++	++++	++++	++++	++++	++++	—	—
P. pestis 1026	++++	++++	++++	++++	++++	++++	—	—
B dysenteriae shigella Boydi 674	++++	++++	++++	++++	++++	++++	—	—
B. dysenteriae shigella Boydi 663	++++	+	—	—	—	—	—	—
B. dysenteriae shigella Boydi 664	++++	++++	++++	++++	++++	++++	—	—
B. dysenteriae Flexner's 680	++++	++++	—	—	—	—	—	—
B. proteus vulgaris 688	++++	—	—	—	—	—	—	—
B proteus vulgaris 687	++++	++++	++++	—	—	—	—	—

1. Name of Culture; 2. Serum Dilution; 3. and 4. Agglutination-Test Controls.

of rhamnose, urea, and did not reduce methylene blue.)

In the experiments cultures were used which had been grown for 24 hours on Hottinger's agar, pH 7.2 at 28°.

The adsorption of serum was carried out with one of the typical pseudotuberculosis strains (P. pseudotuberculosis 496). For this purpose 2.5 cc of a thick suspension of living culture of P. pseudotuberculosis 496, which had been washed with physiological saline solution from the surface of slant agar in six-seven test-tubes, was added to 0.5 cc of serum. The mixture of serum and microbes was shaken for ten minutes for the purpose of more complete agglutinin absorption. After this, two cc of physiological saline solution was added to the serum and filtered through an asbestos filter divided into halves and placed at the bottom of a syringe. As the result, serum was obtained which was diluted 1:10. The agglutination test was performed by the usual method.

The results of the agglutination test with serum adsorbed by the pseudotuberculosis strain 496 are shown in Table 2. From the Table it is seen that the serum did not agglutinate ten out of 11 pseudotuberculosis strains used in the experiment following adsorption. An exception was constituted by strain 1022, which continued to be agglutinated without change in a titer up to 1:320, just as before adsorption. B. dysenteriae shigella Boydi 664 and 674 continued to be agglutinated, showing a reduction in the intensity of agglutination in the final dilutions. The serum titer for B. dysenteriae Flexneri 680 was reduced by one dilution. B. dysenteriae shigella Boydi 663, B. proteus vulgaris 687 and 688 which had been adsorbed by serum were not agglutinated. After adsorption the serum titers for the plague strains changed but not to the same degree. Thus, P. pestis I, 150 and 154 were agglutinated almost without change, showing a reduction in intensity of agglutination in the 1:640 dilutions by 2+. In the case of P. pestis 17 and 145 the titers decreased by two dilutions; for strain 151, by three dilutions. P. pseudotuberculosis 1022, which continued to be agglutinated after adsorption, is one of the atypical strains isolated in Leningrad (N. M. Somova and K. A. Sergeyeva, 1957). The authors found an unusual variation in P. pseudotuberculosis in the direction of plague microbe. The data which we obtained once again confirmed the close antigenic relationship between this culture and P. pestis.

Antiplague serum adsorbed by P. pseudotuberculosis 1022 in subsequent experiments did not show agglutination with any of the plague strains which we tested.

Conclusion

From the experiments performed it is seen that the

Table 2

The Agglutination Test of Cultures with Antiplague Serum Adsorbed by the Pseudotuberculosis 496 Strain

① Из чистой культуры	② Разведения сыворотки	1:20	1:40	1:80	1:160	1:320	1:640	③ КС	④ КА
P. pestis I		++++	++++	++++	++++	++++	++	—	—
P. pestis 17		++++	++++	++	++	—	—	—	—
P. pestis 146		++++	++++	++++	++++	—	—	—	—
P. pestis 150		++++	++++	++++	++++	++	—	—	—
P. pestis 151		++++	++++	+	—	—	—	—	—
P. pestis 154		++++	++++	++++	++++	++++	+	—	—
P. pseudotuberculosis 5		—	—	—	—	—	—	—	—
P. pseudotuberculosis 288		—	—	—	—	—	—	—	—
P. pseudotuberculosis 496		—	—	—	—	—	—	—	—
P. pseudotuberculosis 498		—	—	—	—	—	—	—	—
P. pseudotuberculosis 923		—	—	—	—	—	—	—	—
P. pseudotuberculosis 928		—	—	—	—	—	—	—	—
P. pseudotuberculosis 994		—	—	—	—	—	—	—	—
P. pseudotuberculosis 1022		++++	++++	++++	++++	++++	—	—	—
P. pseudotuberculosis 1023		—	—	—	—	—	—	—	—
P. pseudotuberculosis 1025		—	—	—	—	—	—	—	—
P. pseudotuberculosis 1026		—	—	—	—	—	—	—	—
B. dysenteriae shigella Boydi 674		++++	++++	++++	++++	++++	++	—	—
B. dysenteriae shigella Boydi 663		—	—	—	—	—	—	—	—
B. dysenteriae shigella Boydi 664		++++	++++	++++	++++	+	+	—	—
B. dysenteriae Flexner's 680		++++	—	—	—	—	—	—	—
B. proteus vulgaris 686		—	—	—	—	—	—	—	—
B. proteus vulgaris 687		—	—	—	—	—	—	—	—

1-4. [Same as for Table 1]

simplified method of adsorbing group antibodies proposed by V. S. Kiktenko and coauthors may be applied in plague-control practice for the differential diagnosis between P. pestis and P. pseudotuberculosis. By means of P. pseudotuberculosis we succeeded in adsorbing the group antibodies for all the typical pseudo-tuberculosis strains completely from the serum. Thereby, antibodies were also adsorbed against B. proteus vulgaris and partially against dysentery strains which were tested. The diagnosis of atypical pseudotuberculosis strains requires a combination of studies.

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P. I. Shiranovich and P. F. Treshchilin

The Method of Studying Fleas in the Epizootological Investigation of Sandy Regions

The first observations which showed the possibility of easy detection of a plague epizootic through a study of fleas were made in 1928 by I. G. Ioff and M. P. Pokrovskaya (1929) in the Sal'sk Steppes. In America similar work has been begun by the laboratory in San Francisco in 1936, and subsequently bacteriological study of fleas caught in rodent holes acquired predominant importance there in investigation of plague foci (F. Evans and Others, 1943).

Extensive study of "hole" fleas in the foci of plague of the Soviet Union became possible in 1947 when P. I. Shiranovich and A. S. Fomicheva (1949) worked out and applied, in an epizootological investigation, the so-called strip method of collecting ectoparasites from rodent holes. Using this method for the study of one of the areas of Chernyye Zemli in the spring-summer seasons of 1947-1948, it was possible to isolate eleven cultures of the plague pathogen from the total number of 19 cultures obtained from dwarf souslik fleas during this period.

At the present time, bacteriological study of fleas is being utilized extensively for the study of epizootics in various regions of the USSR and is one of the basic methods of epidemiological reconnaissance.

Therefore, it is no accident that many specialists have worked and are continuing to work for decades on improvement of methods of treating fleas prior to bacteriological examination. However, it should be noted that to date the method continues to be relatively laborious.

The latter circumstance is associated with the need for careful sterilization of the superficial integument of the insects investigated. Actually, a bacteriological investigator can always expect the danger of contamination, the source of which is usually considered the chitinous integument of the parasite. Of lesser importance, apparently, is contamination from the air.

The usual method of treating the integument of insects by washing them three times in physiological saline solution or boiled water, in which the investigator has to transfer the fleas from one test-tube to another with a platinum loop repeatedly, is quite painstaking, and in the case of a mass investigation of material takes up considerable time. This method has been described in many instructions and methods guides (P. I. Shiranovich, 1947, and others) and has been included in some textbooks on plague (V. A. Yumatiy, 1953). The method of sterilizing insects in 96 percent alcohol

which was described in 1924 by Ye. N. Pavlovskiy is now widely used for the study of ticks (P. L. Burlachenko, 1951) and is used in experimental work with fleas (I. M. Yagubyants, 1958). However, as our observations have shown, this method does not simplify the procedure very much, because after keeping the insects in alcohol a careful rinsing of them is needed for the purpose of removing the traces of alcohol.

For the purpose of clarifying the problem of the significance of "pre-inoculation" treatment of fleas on the purity of the cultures, we studied them after a preliminary washing by the usual method and with alcohol; in addition, part of the cultures were taken from fleas which had not been subjected to sterilization. (The investigation was made in the sandy region of Chernyye Zemli during the spring-summer season of 1952 at the Maryn-Khuduk epidemiological detachment (Kalmytskaya ASSR)). In washing, for the purpose of transferring the fleas from one bath to the other, use was made of a loop, or else they were washed in a stream of fluid, placing the parasites on a small strainer made of mill silk.

Living fleas collected from rodent holes were investigated without treatment. Collections of these fleas were preserved and brought to the laboratory in sterile test-tubes containing sand. The fleas were picked out of the sand with an entomological forceps and put into another, clean test-tube (a manipulation necessary in any method of treating fleas), and were transferred from it to a mortar, in which they were ground up for preparation of a suspension. Further study was made according to the usual method (culture on agar plates and others). Living fleas were investigated in parallel after sterilization of them.

In all, 31,396 fleas were investigated, and 657 cultures were made from them, an average of 47 fleas per plate. About one-fourth of all the cultures (155) was made from fleas which had not been washed. The other cultures were from suspensions prepared by ordinary methods.

The dirtiest cultures were obtained from the investigation of dead fleas. The cultures obtained from fleas which were prepared for examination without washing were no more contaminated than the cultures prepared by other methods.

This, it would appear at first glance, paradoxical conclusion finds its explanation in the simple fact that, in the summer, under desert conditions and under the influence of increased sunshine, the surface layers of sand remain uninhabited by microorganisms (D. I. Ansuldkin, 1930; verbal communication by I. S. Tinker) or else are poorly inhabited by them. Illustrating the latter statement, we should like to refer at least to the study made by P. F. Samsonov and others (1929) in Central Kara-Kumy in April, on the day after a rain. In samples of sand taken from different parts

of a sandhill they found bacteria, fungi and actinomycetes in comparatively small numbers, about 100,000 individuals per gram of sand. For the purpose of obtaining more convincing proof, in 1956 we proposed a method which we had worked out for treating fleas for application in one of the epidemiological detachments of an expedition for the study of a plague focus in Mangyshlak. The experiment gave an encouraging result, which was the reason for the extensive application of this method in research work of epidemiological detachments of Guryevskaya Oblast. Recently, our conclusions have been confirmed in the practice of investigation work done in a plague focus of Azerbaydzhan (O. S. Bulakh, 1958).

The observations presented permit us to draw, first of all, the practical conclusion that it is possible in sandy regions and under conditions of a hot tropical climate to make a bacteriological examination of fleas without preliminary washing of them, which considerably simplifies the method and, secondly, permit us once again to emphasize the need for differential study of living and dead fleas, to which I. G. Ioff and M. P. Pokrovskaya drew attention in the past (1929).

The problem next in turn should be the checking of the method of preparing fleas for bacteriological examination being proposed in other (besides the summer) seasons and under conditions of different geographic aspects, and also experimentally to work out the problem of sources of contamination of the material being investigated under circumstances of laboratories of the field types in application to various environmental conditions.

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Z. A. Yurgina, I. M. Sokolova, G. P. Nikitina

The Possibilities of Prolonged Preservation of the Plague Microbe on Media Made of an Enzyme Hydrolysate of Casein

It has been determined by previous investigations (Z. A. Yurgina. Study of Casein Media with the Aim of Diagnosis of the Plague Microbe. Trudy Instituta "Mikrob" [Works of the "Mikrob" Institute] No IV, 1959) that nutrient media made with the use of an enzyme hydrolysate of casein proved to be of high quality for growing out the plague microbe, by virtue of which they were recommended for application for purposes of diagnosis of the plague pathogen (Z.A. Yurgina, 1959).

Subsequently, it seemed interesting to find out whether the morphological, biochemical and biological properties of the plague microbe are changed when it is grown and kept for a long time on the media which we proposed made of an enzyme hydrolysate of casein.

Two strains of plague microbe were used in the experiment: the virulent 708 strain and the avirulent EV strain.

A preliminary check of these strains showed that in their properties (morphology, biochemical activity, relationship to specific bacteriophage and others) they showed no deviations from the typical plague microbe strains.

The plague microbe strains used in the experiment (708 and EV) were cultivated in test-tubes containing the casein medium being tested as well as Hottinger's agar, which constituted a control in our experiments. After a two-day incubation of the cultures at 28° all the test-tubes were divided into two groups: one of them was kept in a refrigerator (four degrees); the other, at room temperature (20-25°).

After standing under these conditions for ten months without subculture the contents of each test-tube were plated out onto solid and liquid nutrient media.

Thereby, it was determined that the viability of both strains of plague microbe had been preserved completely. They produced entirely satisfactory growth on liquid and solid nutrient media without change in morphological properties. The bouillon remained clear, with a clumpy sediment at the bottom which broke up readily on shaking.

Colonies of the plague microbe on casein agar were pigmented and granular. On control Hottinger's agar the peripheral area of the plague microbe colonies was more striking than on casein agar, which was also noted with the original plague microbe strains.

The morphology of the cellular elements was also the same as that of the original cultures. In smears from the agar gram-negative bacilli which were polymorphic in size

and staining were observed. In smears from the bouillon bipolarly stained bacilli were found arranged in bunches and chains.

The biochemical activity of plague microbe strains kept on casein agar and Hottinger's agar did not change for carbohydrates or alcohols by comparison with the original strains; they broke down glucose, maltose, lactose, mannitol and did not ferment sucrose or rhamnose. The virulent strain of plague microbe, 708, broke down glycerin, while the EV strain of plague microbe did not ferment it (the observations were made for 47 days).

Based on the fact that in practical work extensive use is made of a test with plague bacteriophage as one of the methods of differentiation of cultures suspected of plague, we considered it necessary to find out the influence of prolonged standing of the plague strain in casein medium on its sensitivity to bacteriophage. With this aim in view, we utilized cultures of the plague microbe which had been plated out of the medium being tested and determined the fact that the relation of plague microbe to bacteriophage had not undergone any changes. Both strains were readily lysed by plague bacteriophage, after ten months of being kept on casein agar, as well as the original strains.

The length of time for which the plague strains were kept on casein medium did not affect the agglutinable properties of these cultures. After ten months of being kept this way these strains gave a positive test with specific agglutinating serum in the same titers as the original strains (1:160).

The preservation of the virulent properties of the plague microbe when kept on casein agar was checked in the following way. Microbe suspensions of plague microbe cultures (strain 708) kept on casein agar and Hottinger's agar under different temperature conditions were injected subcutaneously into guinea pigs in quantities of 10, 100, 1000 and 10,000 microbes.

The results of the experiment presented in Table 1 show that the plague microbe (strain 708) kept on casein medium for ten months did not lose any virulence. All 16 infected guinea pigs died with a striking pathological picture of plague. Of 16 guinea pigs infected with a plague microbe culture which had been kept on Hottinger's agar two survived the minimum infective dose (10 microbes). A certain prolongation of the lifespans of the animals infected with a plague microbe culture which had been kept on Hottinger's agar was noted by comparison with cultures of P. pestis which had been kept on casein agar. In addition, in these experiments an increase in the lifespans of laboratory animals was noted when they were infected with cultures kept at room temperature, regardless of whether they had been kept on casein agar or Hottinger's agar. Apparently,

Table 1

Virulence of Plague Microbe Cultures Kept for Ten Months on Casein Agar and Hottinger's Agar Under Different Temperature Conditions

(1) Агар	(2) Условия хранения	(3) Доза заражения в микробных телах	(4) Количество морских свинок	(5) Пало	(6) Выжило	(7) Средняя продолжит. жизни
(8) Казеиновый	холод (10)	10	2	2	—	7,7
»	»	100	2	2	—	
»	»	1000	2	2	—	
»	»	10000	2	2	—	
(9) Хоттингера	»	10	2	0	2	8,3
»	»	100	2	2	—	
»	»	1000	2	2	—	
»	»	10000	2	2	—	
(8) Казеиновый	комната (11)	10	2	2	—	10,0
»	»	100	2	2	—	
»	»	1000	2	2	—	
»	»	10000	2	2	—	
(9) Хоттингера	»	10	2	2	—	12,2
»	»	100	2	2	—	
»	»	1000	2	2	—	
»	»	10000	2	2	—	

1. Agar; 2. Conditions Under Which Kept; 3. Dose of Infection in Microbes; 4. No of Guinea Pigs; 5. Died; 6. Survived; 7. Average Duration of Life; 8. Casein; 9. Hottinger's; 10. Refrigerator; 11. Room.

under these conditions some reduction in virulence must be explained by the conditions under which the cultures were kept.

We performed the next experiment with the aim of determining the immunogenic properties of plague microbe cultures kept for a long time on casein agar.

Various groups of guinea pigs were vaccinated with a plague microbe culture (EV) taken separately from casein agar and Hottinger's agar after ten months of being kept under different temperature conditions. The immunization was conducted according to the same plan; the culture was injected subcutaneously in doses of 1,000, 1,000,000 and 1,000,000,000 living microbes. Twenty days after immunization all the experimental guinea pigs, together with the controls (not immunized) were infected subcutaneously with highly virulent strains of the plague microbe. The results of the experiment are shown in

Table 2.

Table 2

Immunogenic Properties of Plague Microbe Grown Out and Kept for Ten Months on Casein Agar and Hottinger's Agar Under Different Temperature Conditions.

(1) Агар	(2) Условия хранения	(3) Доза иммунизации [в м. т.]	(4) Количество морских свинок в опыте	(5) Пало	(6) Выжило	(7) Средняя продолжительность жизни	(8) % выживших
(9) Казеиновый	холод (10)	1 тыс (14)	10	10	—	6,2	0
»	»	1 млн. (15)	10	1	9	7,0	90
»	»	1 млрд (16)	10	1	9	6,0	90
(12) Хоттингера	»	1 тыс.	9	9	—	6,0	0
»	»	1 млн.	10	6	4	9,8	40
»	»	1 млрд.	10	3	7	14,0	70
(9) Казеиновый	комн. (11)	1 тыс.	9	9	0	6,2	0
»	»	1 млн.	10	10	0	10,8	0
»	»	1 млрд.	9	7	2	9,5	22,2
(12) Хоттингера	»	1 тыс. (14)	10	10	0	6,0	0
»	»	1 млн. (15)	10	8	2	8,5	20,0
»	»	1 млрд (16)	10	7	3	12,7	30,0
(13) Хоттингера (контроль)		—	10	10	0	5,0	0

1. Agar; 2. Conditions Under Which Kept; 3. Dose of Immunization (in Microbes); 4. No of Guinea Pigs in Experiment; 5. Died; 6. Survived; 7. Average Lifespan; 8. Survival Rate; 9. Casein; 10, 11. [Same as Table 1]; 12. Hottinger s; 13. Hottinger's (Control); 14. 1,000; 15. 1,000,000; 16. 1,000,000,000.

Analyzing the data obtained, it may be noted that the immunogenic properties of the plague microbe are somewhat better preserved when it is kept on casein agar under refrigerated conditions than on Hottinger's agar under the same conditions. The preservation of the plague microbe culture (vaccine strain EV) for ten months at room temperature on either Casein agar or Hottinger's agar leads, as was to be expected, to a marked reduction in immunogenic properties.

Conclusions

1. When the plague microbe is kept for ten months under refrigerator conditions on agar made of an enzyme hydrolysate of casein no changes are noted in its basic biological properties.

2. Prolonged standing of the plague microbe at room temperature on either casein agar or Hottinger's agar leads to a certain reduction in virulence and a considerable reduction in immunogenicity.

3. Casein agar, along with other nutrient media, may be recommended for the prolonged keeping of plague microbe cultures.

S. L. Borod'ko and L. G. Samsonovich

Compatibility of Living Plague, Tularemia, Brucellosis and Anthrax Vaccines in Experiments on Guinea Pigs

The creation of a combination of vaccines with the aim of protecting man simultaneously against several infectious diseases with a single inoculation is one of the tasks involved in solving the problem of control of contagious diseases. In recent years, progressively greater attention in Soviet public health is being given to living vaccines; combinations of vaccines made of living and killed or only living microbes have become subjects of study.

The work of V. G. Akimenko (1949) showed the possibility of using tularemia vaccine in combination with smallpox vaccine and the NIISI polyvaccine for the first time. [Scientific Research and Testing Institute vaccine consisting of the antigens of typhoid fever, paratyphoid A and B, Shiga and Flexner dysentery, cholera vibrio, as well as tetanus toxoid.]

Ye. I. Korobkova (1950-1951) made a study of a combination of vaccines made of living plague vaccine and killed NIISI triple vaccine [typhoid and paratyphoid A and B.] Ye. I. Korobkova and coauthors (1953) experimentally showed the rationale for simultaneous immunological prophylaxis of plague and cholera with an associated cholera-plague vaccine.

In the works of workers of different institutes the compatability and harmlessness of a combination of two or three living vaccines were proved.

It is well known that the combination of brucellosis and tularemia vaccines is harmless by subcutaneous, percutaneous or intradermal immunization and produces the same immunobiological reorganization in the body as does each of the monovaccines (V. G. Pilipenko and A. M. Polyakova, 1955; V. G. Pilipenko, A. M. Polyakova and T. A. Shchekina 1956; Ye. A. Gubina, 1957; B. R. Uzbekova, M. F. Shmutor and others, 1958).

An experimental study was made of combinations of three vaccines. Simultaneous immunization against plague, brucellosis and tularemia in the works of Z. P. Klets, R. S. Kolesnik, Ye. P. Potapova and others (1958); V. G. Pilipenko, M. A. Miroshnichenko, T. A. Shchekina and others (1958) produces a quite strong immunity to the respective infectious diseases in guinea pigs.

The addition of anthrax antigen to the combination of vaccines causes an inhibition of the plague, tularemia and brucellosis antigens, in the opinion of some authors (N. D. Anina-Radchenko, N. F. Gratskavets, Ya. Ye. Pushkarenko, 1956; V. G. Pilipenko, M. A. Miroshnichenko, T. A. Shchekina

and others, 1953); in the opinion of other authors, the anthrax antigen, as a weaker stimulus of physiological mechanisms in the vaccine process, is inhibited by the other antigens included in the combination (N. K. Vereninova, Ye. P. Smirnova, [illegible] Kalacheva and others, 1953).

Based on this, the authors suggested that vaccination against anthrax be performed ten days before inoculation of the triple vaccine rather than simultaneously with plague, brucellosis and tularemia vaccines.

Taking all these factors into consideration, in the middle of our experiment, which was performed with the aim of studying the immunobiological changes in experimental animals inoculated simultaneously against plague, tularemia, brucellosis and anthrax, we decided that at the time of re-vaccination, aside from everything else, we would once again direct attention to the interaction of the anthrax antigen and the others.

The method of operation consisted of the vaccination of guinea pigs with a combination of four living vaccines--plague, tularemia, brucellosis and anthrax and a combination of three living vaccines--plague, tularemia and brucellosis.

For the vaccination a 3,000,000,000-suspension of a two-day culture of plague vaccine 1-17, a 3,000,000,000-suspension of a two-day culture of brucellosis vaccine (strain 19) and a 1,000,000,000-suspension of a one-day culture of tularemia vaccine were prepared. The three vaccines were mixed in equal volumes and, in this way, 1,000,000,000 microbes of the plague and brucellosis antigen and 330,000 microbes of the tularemia antigen were obtained per cc. One cc of the triple vaccine was injected into guinea pigs subcutaneously in the right inguinal region. In an experiment with four vaccines one drop of the undiluted "STI" [Sanitary Technical Institute anthrax vaccine, living non-virulent] vaccine, series 114 of the Tbilisi IVS [Institute of Vaccines and Sera] was applied to a previously prepared area of skin and rubbed in carefully.

Each experiment was accompanied by two controls: the first was on guinea pigs vaccinated with the respective mono-vaccines; the second, on non-immunized guinea pigs.

For two weeks the temperatures were taken in guinea pigs which had been immunized with the associated tetravaccine (40 guinea pigs) against plague, tularemia, brucellosis and anthrax as well as of those which had been vaccinated with the triple vaccine against plague, tularemia and brucellosis (50), and the respective monovaccines (10 each).

In the guinea pigs which had been immunized by the four vaccines we did not observe any marked temperature reaction to the inoculation; only in several guinea pigs did the temperature rise to 40° or higher on the second-third day after vaccination and remained there for two-three days.

In the others the temperature rise ranged from 0.2 to 0.5° above the original level for three-five days. In the majority of guinea pigs immunized with the associated vaccine against plague, brucellosis and tularemia, on the second-third day after inoculation a temperature rise was observed by 1.0-1.2° or higher; thereby, it reached 40° and 41°. On the fifth-sixth day the temperature dropped to the original figures.

In guinea pigs inoculated with monovaccines against plague, tularemia and brucellosis we observed the same temperature reaction to the inoculation.

Thereby, in guinea pigs vaccinated with the brucellosis monovaccine it appeared on the third-fourth day after vaccination. There was no appreciable temperature reaction in guinea pigs immunized with the anthrax vaccine. Analyzing the temperature curves, we concluded that they are approximately the same in all groups inoculated with the exception of those inoculated with STI anthrax vaccine alone by the percutaneous method. Therefore, the general reaction of the animal organism, which was expressed in the form of a temperature reaction, makes it possible to use associated vaccines against four or against three infectious diseases with the aim of prophylactic inoculation.

The local reactions in 15 out of 40 guinea pigs immunized against plague, tularemia, brucellosis and anthrax appeared on the second day after inoculation; after eight days they occurred in all guinea pigs and remained for a month in the majority.

The manifestation of local reactions consisted of an enlargement of the regional lymph nodes, which gradually reached the size of a large bean. In part of the guinea pigs, on the 10th-12th day, suppuration of the inflamed lymph nodes occurred. By the end of a month the reactions had subsided. At the site of application of the anthrax vaccine in these guinea pigs we observed a slight and very transitory hyperemia along the courses of the scratches; in only 13 animals did edema appear (1.5x2.0 centimeters), which gradually became denser and was resorbed by the end of a month.

In 40 out of 50 guinea pigs immunized against plague, tularemia and brucellosis an enlargement of the regional (right inguinal) lymph nodes was recorded on the fourth day after vaccination, the sizes of which in the majority of cases reached that of a large bean after two weeks. At the injection site of the vaccine in part of the guinea pigs by this time abscesses had formed. By the end of a month the reactions had gradually subsided; the abscesses were resorbed (they were incised and drained in only six guinea pigs).

It should be noted that the abscesses at the site of subcutaneous injection of guinea pigs vaccinated with four

or with three vaccines appeared approximately in the same interrelationships in both groups of animals inoculated, and the number of them reached 16-18 percent.

In two guinea pigs which had been immunized with the associated triple vaccine, there were no local reactions to the inoculation.

In the group of guinea pigs immunized with plague monovaccine 1-17 in part of the animals on the fourth day after inoculation an enlargement of the regional lymph nodes was recorded; by the tenth-12th day the regional lymph nodes were enlarged in nine out of ten guinea pigs; thereby, they were thickened, and their sizes were that of a pea; by the beginning of the third week, in the majority of guinea pigs the local reaction had disappeared, and only in two did it last for three weeks. In one guinea pig there was no local reaction to the inoculation.

In a group of guinea pigs immunized with tularemia monovaccine, by the end of the first week local reactions in the form of enlargement of lymph nodes to the size of a large bean were observed in all ten guinea pigs. In one guinea pig, at the injection site of the vaccine, by the end of the second week an abscess had formed which by the end of the third week had almost been resorbed. In the majority of guinea pigs the local reaction subsided by the beginning of the third week after injection of the monovaccine.

The local reaction in the form of a slight enlargement of regional lymph nodes appeared on the 10th-12th day in all guinea pigs immunized with the anthrax STI monovaccine. By the 20th day after inoculation the regional lymph nodes were no longer palpated. At the site of application of anthrax vaccine we observed a very transitory hyperemia along the courses of the scratches; edema of the subcutaneous tissue appeared in only two guinea pigs on the fourth day after inoculation, and by the tenth day it had already been resorbed.

In guinea pigs immunized subcutaneously with brucellosis monovaccine local reactions appeared in the majority by the end of the first week. In the animals the right inguinal lymph nodes the size of a pea were palpated; by the end of the second week some of the glands had become denser, and in one guinea pig they had suppurated, forming an abscess. By the end of the third week the reactions had gradually subsided, and after a month it was impossible to detect them.

Therefore, the local reactions manifested themselves less intensely in guinea pigs immunized with anthrax monovaccine, somewhat more vigorously in guinea pigs immunized subcutaneously with plague, brucellosis, and tularemia monovaccines, and most vigorously in those inoculated

with associated triple and tetravaccines. Therefore, the combination of vacoines against plague, tularemia, brucellosis and anthrax as well as the combination against plague, tularemia and brucellosis produces more side effects after suboutaneous injection with the same interrelationship of microbes as was indicated above, apparently because of the simultaneous injection of a large number of microbes and the reaction of the animal organism corresponding to this.

Thirty to 33 days after vaccination a study was made of the immunobiological reorganization of guinea pigs by means of the determination of the antibody level and the presence of allergic reactions. True, these reactions permitted us to detect the immunobiological reorganization only with respect to tularemia and brucellosis.

For the purpose of performing the Wright serological test the Huddleson series 120 diagnosticum of the Odessa NIIVS Scientific Research Institute of Vaccines and Seral was used as an antigen, for the purpose of detecting agglutinins to tularemia we used a 1,000,000,000-suspension of a one-day culture of B. tularense 713 as an antigen.

The results of the serological tests are shown in Table 1.

As is seen from the Table, the agglutination titers in the agglutination test with tularemia diagnosticum in animals immunized with combinations of vaccines range from 1:10 to 1:320; the agglutination titers were within the same limits in animals immunized with tularemia monovaccine alone. However, the average agglutination titer in those inoculated with tularemia vaccine was somewhat higher than in those inoculated with the triple and tetravaccines. In the Wright test, the serum titers range from 1:20 to 1:320. The average agglutination titers in those inoculated with brucellosis monovaccine are higher than in those inoculated with the tetra- and triple vaccines. In all cases the agglutination titers with tularemia diagnosticum were somewhat higher than the agglutination titers obtained in the Wright test. All these data are evidence to the effect that tularemia vaccine is apparently one of the antigens producing the greatest side effects in the vaccine combination.

The allergic tests were checked with brucellin series No 80 and tularin series No 7 of the Odessa NIIVS by means of the performance of intradermal tests.

They were expressed to the same degree in those inoculated with tetra- and triple vaccines as well as with the corresponding monovaccines. However, in all cases the inflammatory reaction to tularin was more pronounced than the reaction to brucellin, which also apparently occurs because of the greater side-effect production of the tularemia vaccine.

The results of immunological tests obtained in our

Table 1

Results of Serological Tests

(1) Виды вакцин	(2) Число животных	(3) Число положительных реакций Райта						(4) Число отрицательных реакц.	(5) Число положительных реакций с туляремийным диагностикумом						(6) Число отрицательных реакций
		1:10	1:20	1:40	1:80	1:160	1:320		1:10	1:20	1:40	1:80	1:160	1:320	
(6) Комплексная — смесь чумной, туляремийной, бруцеллезной и сибиреязвенной	40	—	6	5	16	5	6	2	2	3	5	16	4	9	1
(7) Комплексная — смесь чумной, туляремийной и бруцеллезной	50	—	1	10	12	17	8	2	—	4	7	7	12	18	2
(8) Моновакцина — туляремийная	10								1	—	1	2	1	5	—
(9) Моновакцина — бруцеллезная	10	—	—	—	4	4	2	—	—	—	—	—	—	—	—

1. Types of Vaccines; 2. No of Animals; 3. No of Positive Wright Tests; 4. No of Negative Tests; 5. No of Positive Tests with the Tularemia Diagnosticum; 6. Combined--Mixture of Plague, Tularemia, Brucellosis and Anthrax; 7. Combined--Mixture of Plague, Tularemia and Brucellosis; 8. Monovaccine--Tularemia; 9. Monovaccine--Brucellosis.

experiments of vaccination of guinea pigs with a combination of plague, tularemia, brucellosis and anthrax vaccines, as well as with a combination of plague, tularemia and brucellosis vaccines confirm the data of Pilipenko and others to the effect that this combination of antigens, particularly in the combination of three vaccines, produces the same immunobiological reorganization of the animals as the corresponding monovaccines.

In the opinion of the majority of investigators, the index of immunity which has developed in vaccinated animals is the resistance of the vaccinated animal to the infection with a virulent culture of the respective pathogen.

This simultaneously characterizes the strength of immunity. With this aim in view, 30-35 days after vaccination we infected vaccinated guinea pigs with plague (200 CLD), tularemia (1,000 CLD), brucellosis (2 infective units) and Tsenkovskiy's vaccine II (10 CLD) [anthrax vaccine used in veterinary practice] pathogens. For this purpose we used cultures of B. pestis 403--one CLD--100 microbes; of B. tularense 713--one CLD--ten microbes; of B. melitensis 548, one infective unit--5 microbes; of Tsenkovskiy's vaccine II--one CLD--28,000 germinal spores of anthrax. (In our experiment the animals were infected with a dose which was somewhat greater than two infective units, because the control subculture of brucellas on agar plates gave an average growth of 17 colonies from five microbes; of 30 colonies from 10 microbes; of 307 colonies from 100 microbes.)

Observation of infected animals lasted 30-33 days, after which the surviving animals were killed, and cultures were made from their organs on nutrient media. For the purpose of detecting the growth of plague and anthrax microbes use was made of ordinary meat infusion agar containing sodium sulfite; for the purpose of detecting growth of B. tularense use was made of solid yolk medium; for detecting dissemination of brucellosis infection use was made of "D agar. In the latter case, the guinea pig organs were seeded on agar "B" slants which contain liver agar to which thionin has been added, and on liver bouillon. By the method of Zdrodovskiy the medium containing thionin made it possible to differentiate the growth of B. melitensis immediately from the growth of the vaccine strain. All the cultures were kept at optimal temperatures.

The results of the comprehensive vaccination with the mixture of four vaccines are shown in Table 2.

As is seen from the Table, all the control guinea pigs died of infection with plague, tularemia and anthrax. Thereby, they died of plague on the sixth-seventh and 12th days; of tularemia, the seventh-eighth day; of the spores of Tsenkovskiy anthrax vaccine, on the second day. All the guinea pigs infected with a virulent culture of Brucella melitensis showed a disseminated infectious process.

Table 2

Results of Comprehensive Vaccination with Mixture of Four Vaccines

(1) Виды вакцины	(2) Способ вакцинации	(3) Результаты заражения возбудителями (4) Чума	(5) Туляремия	(6) Бруцеллез	(7) Сибирская язва	(8) Примечание
(9) Комплексная — смесь чумной, туляремийной и бруцеллезной	(15) подкожно и накожно	6/0	6/3*	6/0	6/3	*) Из них 2 пали от посторонних причин (18)
(10) Моновакцина чумная	(16) подкожно	6/0				
(11) » туляремийная	»		6/1			
(12) » бруцеллезная	(16) подкожно			7/1		
(13) » сибиреязвенная	(17) накожно				6/3	
(14) Контроль — неиммунизированные животные		6/6	6/6	6/6	6/6	

Key: The Numerator Represents the No of Animals Used in the Experiment; the Denominator, the No of Animals Which Died or (After Infection with the Brucellosis Culture) Had Signs of the Dissemination of the Infectious Disease. 1. Types of vaccine; 2. Method of vaccination; 3. Results of infection with the following pathogens: 4. Plague; 5. Tularemia; 6. Brucellosis; 7. Anthrax; 8. Note; 9. Comprehensive--mixture of plague, tularemia, brucellosis and anthrax; 10. Plague monovaccine; 11. Tularemia monovaccine; 12. Brucellosis monovaccine; 13. Anthrax monovaccine; 14. Control--non-immunized animals; 15. Subcutaneously and percutaneously; 16. Same; 17. Percutaneously; 18. Of these, two died of extraneous causes.

As the result of comprehensive vaccination a high degree of resistance of the guinea pigs was observed when they were infected with plague or tularemia pathogens, and the absence of dissemination of brucellosis was noted. Of three guinea pigs which died on the 18th-20th day which had been infected with tularemia none showed a growth of B. tularense; thereby, two guinea pigs showed growth of a diplococcus culture, and their deaths were caused by this infection.

Approximatoly the same survival rate was observed in

the group of animals immunized with plague, tularemia and brucellosis monovaccines.

In one case of death of a guinea pig from tularemia which had been vaccinated against this infectious disease, death occurred on the 13th day after infection. A culture of B. tularense was isolated.

In our experiment we did not observe any inhibition of the anthrax antigen used in the combination by the other three antigens, which had been observed in their experiments by N. S. Vereninova, Ye. I. Smirnova, N. F. Kalacheva, and others (1958); no inhibition of the other three by the anthrax antigen was observed either; this had been observed in the works of V. G. Pilipenko, M. A. Miroshnichenko, T. A. Shchekina, and others (1958).

As is seen from Table 2, among animals immunized with anthrax vaccine alone and among those immunized with a combination of four vaccines the same number of guinea pigs (50 percent) infected with the germinal spores of anthrax proved to be unprotected against this infectious disease. Our data do not permit us to draw the conclusion that immunity of adequate strength developed to what was apparently a weak antigen of the anthrax vaccine when it was used as a monovaccine or in combination with other vaccines. It is possible that here the fact that we applied one rather than two drops of vaccines to the skin of guinea pigs, as previous investigators had done, had an influence, but even after immunization with a smaller dose of a weak anthrax antigen we did not observe inhibition of it by the other three antigens.

The results of vaccination with a combination of three vaccines are shown in Table 3.

As is seen from Table 3, in the experiment of vaccination of experimental animals with combinations of three vaccines results were obtained which indicated the development of a quite strong immunity to plague, tularemia and brucellosis. In animals immunized with the respective monovaccines immunity of approximately the same degree of strength developed.

Therefore, the data which we obtained in the experiment of immunization of animals simultaneously with a combination of three vaccines confirm the conclusions of a number of authors to the effect that this combination possesses adequate strength and is capable of producing the same immunological reorganization in the body as the respective monovaccines.

In none of the works of authors which we have mentioned above are more vigorous side-effects noted, which are created apparently by the actual combination of three or four vaccines, by comparison with the side-effects of the monovaccine after subcutaneous injection. Thus, as the result of inoculation with

Table 3

Results of Vaccination with a Combination of Three Vaccines

(1) Виды вакцин	(2) Способ вакцинации	(3) Результаты заражений возбудителями		
		(4) чумы	(5) туляремии	(6) бруцеллеза
(7) Комплексная — смесь чумной, туляремийной, бруцеллезной	(12) подкожно	6/2	6/1	7/2
(8) Моновакцина чумная	»	6/0	—	—
(9) » туляремийная	»	—	6/1	—
(10) » бруцеллезная	»	—	—	7/1
(11) Контроль — неиммунизированные морские свинки	»	6/6	6/6	6/6

1. Types of Vaccine; 2, 3, 4, 5, 6. [Same as for Table 2]. 7. Comprehensive--mixture of plague, tularemia, and brucellosis; 8. Plague monovaccine; 9. Tularemia monovaccine; 10. Brucellosis monovaccine; 11. Control--non-immunized guinea pigs; 12. Subcutaneously.

associated vaccines a marked local reaction appeared in the animals in the form of a considerable enlargement of regional lymph nodes, densification of them, and, which is particularly important, the formation of a considerable number of abscesses at the injection site of the vaccine (up to 18%). All this indicates that the problem of the possibility of utilization of associated vaccines with the aim of prophylaxis must be solved by using the percutaneous method of vaccination because of their considerable local reactivity after subcutaneous injection.

Conclusions

1. After comprehensive vaccination with four types of vaccines (plague, tularemia, brucellosis and anthrax) as well as with three types of vaccines (plague, tularemia and brucellosis) an immunity of adequate strength developed in

the guinea pigs simultaneously against plague (200 CLD), tularemia (1,000 CLD) and brucellosis (two infective units) which was almost the same as immunity developing after immunization with the respective monovaccines.

2. Anthrax antigen in the dose in which it was applied to the skin proved to be a weak stimulus of the mechanisms of the vaccine process both when used in combination as well as in the case of vaccination of guinea pigs with the STI anthrax monovaccine alone.

3. The combination of three or of four vaccines is harmless for the animal organism, but at the site of subcutaneous injection it produces a vigorous local reaction which in a considerable percentage (up to 18 percent) of cases is accompanied by the occurrence of abscesses.

4. Future solution of the problem of the possibility of using associated vaccines should be attained in experiments with percutaneous application of them.

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S. L. Borod'ko, V. G. Pilipenko, A. M. Polyakova, B. G. Val'kov

Immunological Changes in Persons Inoculated Percutaneously Against Plague, Brucellosis and Tularemia

With the aim of prophylaxis of various diseases, along with considerable sanitation education work among the population, extensive use is being made of inoculations with killed and living vaccines. The variety of inoculations which need to be given to the same person for the purpose of preventing various infectious diseases not uncommonly gives rise to difficulty among medical workers for a whole series of reasons. This has stimulated investigators to seek out comprehensive vaccines, one inoculation of which will protect man simultaneously against several infectious diseases. At first, this problem was successfully solved with respect to associated vaccines made of killed microbes, toxoids and complete antigens. As the result, in medical practice use is already being made of vaccination with comprehensive vaccines made of killed microbes and toxoids for the purpose of prophylaxis of certain intestinal, wound and children's infections.

A number of investigators has taken up the study of associated vaccines made of living and killed or of living microbes only. These authors proved the absence of competition between microbes with compatible growth of them on nutrient media and when injected into experimental animals. Thereby, associated vaccines gave rise to the development of immunity of the same strength with respect to each infection as the corresponding monovaccines did (V. G. Akimenko, 1949; Ye. I. Korobkova and co-workers, 1957; S. L. Borod'ko, 1950; V. G. Pilipenko and A. M. Polyakova, 1955; V. G. Pilipenko, A. M. Polyakova, T. A. Shchekina, 1956; Ye. A. Gubina, 1957; N. K. Vereninova, Ye. I. Smirnova, K. F. Kalacheva and others, 1958).

The results which we obtained in experiments of comprehensive vaccination of guinea pigs with three types of vaccines (plague, tularemia, brucellosis) as well as the experimental data of V. G. Pilipenko, M. A. Miroshnichenko, T. A. Shchekina and others (1958), N. K. Vereninova, N. F. Kalacheva, Ye. I. Smirnova and others (1958) showed that in the experimental animals, both after subcutaneous and percutaneous immunization, immunity of adequate strength develops against plague (200 CLD), tularemia (1,000 CLD) and brucellosis (two infective units), which is not much different from the immunity developing after immunization with the respective monovaccines. In addition, simultaneous immunization of animals with such associated vaccine was harmless for them and did not produce much reaction, particularly in experiments of percutaneous vaccination.

All this enabled us to vaccinate a small group of volunteers with associated vaccines simultaneously against plague, tularemia and brucellosis by the percutaneous method.

For this purpose men and women from 18 to 24 years of age who showed a negative reaction for brucellosis and tularemia by serological and allergic tests and who had not (in their histories) received inoculations against these infectious diseases or against plague, who had no subjective complaints and were clinically healthy were selected. In all persons, three days before vaccination, the temperature was taken, and the inoculations were given to those in whom the temperature was normal this entire time.

Inoculations with monovaccines were given simultaneously to persons who showed negative reactions, by allergic and serological tests during the preliminary examination, to both infectious diseases or to the one against which they were vaccinated.

For the vaccination the plague vaccine 1-17 series No 11 of the Saratov "Mikrob" Institute, tularemia vaccine series No 456 of the IEM imeni Gamaleya [Institute of Epidemiology and Microbiology imeni Gamaleya] and the brucellosis vaccine series No 291-2 of the IEM imeni Gamaleya were used.

Tularemia vaccine was diluted with physiological saline solution in the quantity indicated on the label for percutaneous application. Then, diluted tularemia vaccine was introduced into the ampule for plague vaccine in place of the quantity of physiological saline solution indicated for percutaneous application, and the brucellosis vaccine was diluted with a mixture of tularemia and plague vaccines, adding them in a quantity such that the percutaneous dose of brucellosis vaccine in the combination amounted to 3,000,000,000 microbes. For percutaneous application of this series of brucellosis vaccine it was necessary to dilute it in a smaller quantity of fluid than was needed for the other vaccines; therefore, with the aim of obtaining a comprehensive vaccine we diluted one in the other in the sequence described above. In this case, in each ampule as many percutaneous doses of associated vaccine were obtained as there should have been for the brucellosis vaccine of the same series alone.

For the purpose of inoculation with monovaccines the same doses which had been used in the combination were utilized.

The method of the inoculation was the following: after preliminary treatment of the skin with alcohol three drops of vaccine were applied to the middle third of the forearm in three places at a distance of three-four centimeters from one another; using a vaccination quill four vertical and four horizontal scratches were made through them, each one centimeter in length. The drops were carefully rubbed in with the back side of the vaccination quill.

In determining compatibility of the vaccines we took the following into consideration: 1. The temperature reaction of the bodies of the inoculees to injection of the vaccine. 2. The phenomena at the injection site of the vaccines and the general reactions of the inoculees. 3. Allergic reactions and agglutination tests of the blood sera of those vaccinated with the respective antigens.

With the aim of taking into consideration the local and general reactions of the body we made observations of those vaccinated for two weeks after inoculation.

Thirty persons were inoculated with the associated vaccine against plague, tularemia and brucellosis: 11 women and 19 men; in 26 of them a local reaction to the inoculation was observed; in four (men) there was no local reaction.

The onset of the local reaction was noted in 96 percent of the inoculees 24 hours after vaccination and was characterized by the appearance of redness and a small infiltrate along the courses of the scratches. Gradually, the sizes of the infiltrates increased; the boundaries of them reached the limits of the squares plotted or went beyond the limits of them, and then their sizes were 1.5 centimeters x 1.5 centimeters or 1.2x1.5 centimeters. On the fifth-seventh day after vaccination, in 16 persons from two to six-eight vesicles were formed along the courses of the scratches. On the 11th-13th day the sites of inoculations were covered with scabs, which on the 18th-21st day fell off in the majority of cases, and in three persons remained up to a month. Only in two inoculees were the regional lymph nodes slightly enlarged and painful. In 10 persons, after the formation of the infiltrate, beginning with the seventh-ninth day the local reaction gradually subsided, and disappeared by the end of the second week.

Therefore, local reactions of the majority of those inoculated with associated vaccine proceeded in a manner similar to a moderate local reaction, that is, with the formation of hyperemia, an infiltrate and vesicles; in two persons it had a course of a severe local reaction with the addition of lymphadenitis; in 10 persons the local reaction had a course which was that of a weak local reaction, that is, with the presence of moderate infiltrates and hyperemia. In all cases of infiltrate formation they were more or less painful.

In the group of those vaccinated with monovaccine against tularemia there were four women and eight men. In them the local reaction appeared 24 hours after vaccination, and subsequent development of it proceeded in the same way as in those vaccinated with associated vaccine.

In men and women the local reaction was manifested to the same degree: in six persons it had the course of a moderate reaction; in two, of a severe reaction; in four, of a weak reaction.

Four women and six men were inoculated with the monovaccine against plague. In two women and two men no local reaction was observed. Of six persons vaccinated a weak reaction was found in five; in one there was a moderate local reaction.

In the group of persons vaccinated against brucellosis alone there were seven men. The local reaction in them appeared on the third-fifth day after vaccination and had a course of a weak type of reaction, with hyperemia and a slight infiltrate along the courses of the scratches which disappeared after two-three days.

According to their intensity we arbitrarily divided the general reactions into three categories: 1. weak reaction; 2. moderate reaction; 3. severe reaction.

We considered the reactivity weak, when the temperature rose to no more than 37.5° after the inoculation, when the general condition was satisfactory and when there was no interference with the ability to work. We put persons in whom severe headaches, dizziness, vomiting were noted and in whom there was interference with the ability to work in the category of the severe reactions.

Table 1

Side Effects of Associated Vaccine

(1) Виды вакцин	(2) Всего вакцинировано	(3) Число случаев без реакции	(4) Число случаев с реакцией		
			(5) слабой	(6) средней	(7) сильной
(8) Ассоциированная вакцина против чумы, туляремии и бруцеллеза	30	26(33%)	2	2	—
(9) Туляремийная вакцина	12	7(60%)	3	2	—
(10) Противочумная вакцина	10	8(80%)	—	1	1
(11) Бруцеллезная вакцина	7	6(90%)	—	1	—

1. Types of vaccine; 2. Total persons vaccinated; 3. Number of cases without reaction; 4. Number of cases with reactions; 5. Weak; 6. Moderate; 7. Severe; 8. Associated vaccine against plague, tularemia and brucellosis; 9. Tularemia vaccine; 10. Plague vaccine; 11. Brucellosis vaccin. .

From the Table it is seen that in the majority of persons inoculated with either the associated vaccine or monovaccine no general reactions were observed. We observed most of the weak and moderate general reactions in persons inoculated with tularemia vaccine (with respect to the number of those inoculated). There were considerably fewer general reactions in persons inoculated with the bruceliosis vaccine only. A severe general reaction, which lasted two days (fourth and fifth days after vaccination) occurred in only one person inoculated with plague vaccine and was accompanied by a temperature elevation, severe headache and vomiting.

Therefore, the local reactions in all groups of inoculees were expressed more markedly than the general reactions. At the same time, the manifestations of both local and general reactions in those inoculated with associated vaccine against plague, tularemia and brucellosis were no more severe than in persons inoculated with the respective monovaccines only.

The immunological changes in the inoculees were checked a month after vaccination by serological and allergic tests. These tests made it possible for us to detect the allergic reorganization and the appearance of antibodies only with respect to tularemia and brucellosis antigens.

For the purpose of performing the allergic test use was made of tularin, series No 8 of the Odessa IEM [Institute of Epidemiology and Microbiology] and brucellin, series No 60 of the Odessa IEM. The results of the allergic tests are shown in Table 2.

As is seen from the Table, immunization of people with the associated vaccine produces the same allergic reorganization in them with respect to tularemia and brucellosis as does immunization with the respective monovaccines. This is evidenced by the percentage of positive Burnet tests and tests with tularin, which are even somewhat higher in the group of those inoculated with associated vaccine. Here, it should be noted that the reaction to the tularin test in all cases was more marked than to the test with brucellin.

For the purpose of performing serological tests use was made of the Huddieson antigen (for the purpose of performing the Wright test), series 61 of the Odessa IEM and the tularemia diagnosticum series 43 of the Odessa IEM. The results of serological observations are shown in Table 3.

As is seen from the Table, as early as a month after vaccination in those inoculated with associated vaccine and monovaccines approximately the same number of positive serological tests is found.

Two negative Wright tests and one negative test with tularemia diagnosticum in the group of those inoculated with associated vaccine in the given case do not indicate competition of the antigens within the combination of vaccines but rather apparently are the result of individual

Table 2

Results of Allergic Tests

(1) Вакцина, которой производилась иммунизация	(2) Всего привито-вировано	(3) Число положительных реакций Бюрне	(4) Число положительных реакций с туляремином	(5) Колич. лиц с непроверен. аллергическ. реакц.
(6) Ассоциированная вакцина против чумы, туляремии и бруцеллеза	30	27(90%)	29(100%)	1
(7) Туляремийная вакцина	12	—	10(90%)	1
(8) Бруцеллезная вакцина	7	6(85%)	—	—

1. Vaccine with which immunization was conducted; 2. Total persons vaccinated; 3. No. of positive Burnet tests; 4. No. of positive tests with tularin; 5. No. of persons with unchecked allergic tests; 6. Associated vaccine against plague, tularemia and brucellosis; 7. Tularemia vaccine; 8. Brucellosis vaccine.

Table 3

Results of Serologic Tests

	(1) Число обследованных привитых	(2) Число положит. реакций (3) Райта	(4) с туляремийным диагностикумом
(5) Ассоциированная вакцина против чумы, туляремии, бруцеллеза	28	26	27
(6) Туляремийная вакцина	12	—	12
(7) Бруцеллезная вакцина	7	7	—

1. No. of inoculees investigated; 2. No. of positive tests; 3. Wright; 4. With tularemia diagnosticum; 5. Associated vaccine against plague, tularemia and brucellosis; 6. Tularemia vaccine; 7. Brucellosis vaccine.

serological reactivity of the body to injection of the antigens. In these persons positive allergic reactions were present at the same time. In a person who showed a negative reaction to the serologic test for tularemia, T., the allergic tests showed the following: with tularin, an area of one centimeter x two centimeter; with brucellin, one centimeter x one centimeter; in those who reacted negatively in the Wright serologic test, M. and K., the allergic tests showed the following: with brucellin, 3x4 centimeters and doubtful; with tularin, 1.5x2 centimeters and 1x2 centimeter.

The agglutination titers obtained in the Wright test and with tularemia diagnosticum are shown in Table 4.

Table 4

Agglutination Titers in Those Inoculated with Different Vaccines

(1) Вакцина, которой производилась иммунизация	(2) Реакция Райта						(3) Реакция с туляремийным диагностикумом					
	1:10	1:20	1:40	1:80	1:160	1:320	1:10	1:20	1:40	1:80	1:160	1:320
(4) Ассоциированная вакцина против чумы, туляремии и бруцеллеза	1	7	9 (1:70)*	3	5	1	—	4	2	11 (1:120)	6	4
(5) Туляремийная вакцина							—	2	3	2 (1:90)	5	—
(6) Бруцеллезная вакцина	1	— (1:20)	4	2								

1. Vaccine with which immunisation was performed; 2. Wright test; 3. Test with tularemia diagnosticum; 4. Associated vaccine against plague, tularemia and brucellosis; 5. Tularemia vaccine; 6. Brucellosis vaccine. Note: The average agglutination titer is indicated in parentheses.

As is seen from the Table, the agglutination titers for the Wright test in those inoculated with associated vaccine ranged from 1:10 to 1:320. The highest number of tests showed an agglutination titer of 1:40 to 1:160. The average reaction titer was 1:70.

In those vaccinated against brucellosis alone the agglutination titers range from 1:10 to 1:80. The highest number of reactions here

occurred with a titer of 1:40. The average agglutination titer in this group of inoculees was 1:50.

The agglutination titers with tularemia diagnosticum in the group of those inoculated with associated vaccine ranged from 1:20 to 1:320. The largest number of sera showed titers of 1:80-1:160. The average agglutination titer in this test was 1:120.

In the group of those vaccinated with tularemia monovaccine alone the agglutination titers of the sera ranged from 1:20 to 1:160; thereby, most of the sera had titers of 1:40 and 1:160. The average agglutination titer was equal to 1:90. Therefore, both the average and the actual agglutination titers in the Wright and tularemia diagnosticum tests once again constitute evidence of the absence of competition between antigens within the combination of living vaccines against plague, tularemia and brucellosis.

Comparing the results of local and general reactions of the body to inoculations, the allergic and serological data, we have concluded that the greatest activity and, therefore, the greatest side-effect production is shown by tularemia and plague vaccines; they apparently are responsible for the activity of the associated vaccine also.

Without being able to determine the development of immunity against plague by allergic and serologic tests in those inoculated with the associated vaccine and the plague monovaccine, we believe that in those inoculated in both groups immunity of sufficient strength occurs with respect to the plague antigen also, particularly since in the given combination the plague vaccine is one of the active antigens, more active than the brucellosis antigen, with respect to which, as has been stated above, immunity of adequate strength develops. The activity of the plague antigen, used in combination with tularemia and brucellosis antigens, has been confirmed by experimental work of V. G. Pilipenko, A. M. Polyakova, T. A. Shchekina (1956), N. K. Vereninova, Ye. I. Smirnova and N. F. Kalacheva (1958).

Specifically, the number of vaccinated guinea pigs surviving after infection with a virulent plague culture is direct proof of the fact that in the associated vaccine against plague, tularemia and brucellosis each antigen is quite active and accounts for the development of immunity of adequate protective strength with respect to the respective infections.

Conclusions

1. The use of associated vaccine against plague, tularemia and brucellosis percutaneously in our observations was not associated with severe reactive manifestations by the vaccinated organism.

2. Local postvaccinal phenomena were expressed in those

inoculated with both associated and monovaccines more markedly than the general postvaccinal phenomena. Both local and general reactions were the same, with respect to the degree of expression, in those inoculated with associated vaccine and with monovaccines.

3. The results of allergic and serologic studies of persons vaccinated with brucellosis and tularemia antigens constitute evidence of an immunological reorganization of the body which is expressed equally and occurs simultaneously in those inoculated with associated vaccine and with the respective monovaccines.

4. The combination of doses of tularemia and plague vaccines and 3,000,000,000 microbes of brucellosis vaccine, which are usual for percutaneous vaccination, is harmless and at the same time fully active and capable of evoking protective reactions with respect to the corresponding infectious diseases.

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V. P. Strachkova and S. L. Borod'ko

The Harmlessness of the Vaccine Strain of Brucella Abortus 104-"M" and Serological Reorganization Occurring from Subcutaneous and Percutaneous Application of It

Inoculations against brucellosis with living vaccine made of the Brucella abortus 19 (BA) strain have been included in the general practice of brucellosis control.

Epidemiological observations have confirmed the efficacy of this vaccine. However, by virtue of the immunity characteristics in brucellosis infection, the vaccine needs an increase in immunological effectiveness, because the immunity created by it is of a low degree of strength and is brief.

Continuing a search for a Soviet vaccine strain which would possess greater immunological efficacy, Kh. S. Kotlyarova in the Institute imeni Gamaleya selected and studied a new vaccine strain, Brucella abortus "M". Experimental observations have shown that this strain satisfies all the requirements made on vaccine strains with respect to harmlessness, immunogenicity and stability of properties. The vaccine was tested for prophylactic vaccination of people. A dose of 100,000,000 microbes by subcutaneous immunization proved to be innocuous for people.

According to the data of Kh. S. Kotlyarova, A. M. Polyakova, V. F. Biryukova (1957), vaccination with doses of 40,000,000 to 100,000,000 microbes by subcutaneous injection reduced the brucellosis morbidity in the foci by an average of 4.7 times among people.

By a decree of the Serum-Vaccine Committee in March 1958 it was decided to make a further study in 1958-1959 of the immunogenicity and side-effect production of living dry brucellosis vaccine made of strain 104-"M" in the foci of sheep brucellosis with an increase in the vaccinating doses.

In the present work the aim was posed also of further study of the Brucella abortus 104-"M" strain after percutaneous and subcutaneous application of it, whereby percutaneous vaccination with the "M" strain was used for the first time.

We proceeded along the line of increasing the dosage of the vaccine. For the purpose of inoculation with a vaccine made of the "M" strain we selected persons who were at the time of observation not associated with animals (students in courses for truck drivers, tractor drivers and students in construction school No 2), which made it possible subsequently to conclude that the preparation was harmless, because the slightest clinical manifestations of brucellosis in such persons after the inoculation could be attributed to side-effect production of the

vaccine strain. The selection of persons was made according to serological and allergic tests, subjective and objective data, as well as according to hematological indices.

For the inoculation by the subcutaneous method the vaccine strain of Brucella abortus "M" series 19 was used; for percutaneous inoculation, vaccine series 7, prepared at the Stavropol' Scientific Research Plague-Control Institute. Sixty-three persons of a group of those reacting negatively to brucellosis and clinically healthy were inoculated by the percutaneous method.

The vaccine was applied to the upper third of the arm (after preliminary treatment of the skin with alcohol) in a quantity of two drops at a distance of three-four centimeters from each other. Four scratches one centimeter in length were made through the drops (two longitudinal and two transverse). The vaccine was rubbed into the scratches with the flat side of a vaccination quill. One human dose for percutaneous inoculation, equal to 3,000,000,000 microbes, was contained in two drops of the vaccine.

A record of the local and general reactions in the persons vaccinated was made for 10 days.

Of 63 persons inoculated by the percutaneous method only two persons failed to show a local reaction to the inoculation; in 61 persons the local reaction was expressed in hyperemia along the courses of the scratches and in the occurrence of a small infiltrate which did not go beyond the limits of the scratches.

The reaction lasted three-four days and then disappeared. There was no general reaction in those inoculated by the percutaneous method.

With the aim of studying side-effect production of the vaccine strain "M" for persons who reacted positively for brucellosis five human volunteers were immunized percutaneously. In these persons there were pronounced local reactions; however, no general reactions or any clinical phenomena were recorded.

Therefore, the vaccine made of the Brucella abortus 104-"M" strain did not produce any severe local reactions and did not produce any general reactions after percutaneous immunization with 3,000,000,000 microbes.

A month after vaccination 49 persons were again examined clinically, hematologically, and, in addition, blood was taken from them for the performance of serologic tests. Clinical examination showed no abnormalities. All inoculees were healthy and made no complaints.

Hematologic investigation in some cases showed a slight leukocytosis; in others, a slight leukopenia. No appreciable change in the differential count could be noted. The erythrocyte sedimentation rate did not exceed 16 millimeters per hour. Therefore, everything stated is evidence of the innocuousness of the strain tested for people.

Immunological changes in this group of persons were checked by means of the Wright serologic test. The results of the test and its maximum titers are shown in Table 1.

Table 1

Results of Serologic Examination of Persons Vaccinated with Brucella Abortus 104-"M" by the Percutaneous Method

Количество обследованных прививших (1)	Количество отрицательных реакций (2)	(3) Количество положительных реакций Райта в титре						
		1:10	1:20	1:40	1:80	1:160	1:320	1:640
49	2	2	3	13	13	4	6	1

1. No. of inoculees examined; 2. No. of negative tests; 3. No. of positive Wright tests in titers of:

As is seen from the Table, in the majority of persons inoculated by the percutaneous method the agglutination titers ranged from 1:40 to 1:320. Only in two persons was the Wright test negative. Therefore, as early as a month after the inoculation with the "M" vaccine strain antibodies appeared in the human body which attested to the occurrence of an immunological reorganization of the organism.

Sixteen persons were inoculated subcutaneously with a vaccine made of the 104-"M" strain simultaneously. One cc was injected, in which there were 200,000,000 microbes of this series, which constituted a single human dose.

In this group of inoculees we also took into consideration the local and general reactions for 15 days after inoculation, and a month after vaccination a clinical examination, study of the blood picture and of the immunological reorganization were made. The same thing was repeated after three months. In all those inoculated by the subcutaneous method both local and general reactions were noted.

The local reaction in the majority of the inoculees appeared as early as on the second day in the form of hyperemia and an infiltrate at the injection site of the vaccine. For two-three days the infiltrate enlarged (up to six-seven centimeters), became thickened, and then gradually resorbed; by the sixth-eighth day the local reaction had disappeared. Only in three out of 16 cases did the local reaction have a

severe course, with enlargement of regional lymph nodes to the size of a plum and the formation of abscesses at the inoculation site of the vaccine in two persons. In one, the abscess was incised and drained; in the other, it resorbed, leaving a densified area after it in the subcutaneous tissue. We arbitrarily divided the general reactions of those inoculated by the subcutaneous method into three categories with respect to course: a weak reaction -- here, a slight malaise was noted in the inoculees; the temperature was normal; moderate reaction -- here the temperature reached 37.5°; there was no loss of the ability to work; a stormy reaction -- the inoculees noted headaches, the temperature was 37.8° or higher; there was severe malaise with loss of the ability to work.

Data concerning the degree to which the general reactions were expressed are shown in Table 2.

Table 2

Degree of Expression of General Reactions to Subcutaneous Injection of Brucella Abortus 104-"M"

Число обследованных привитых (1)	(2) Количество общих реакций		
	(3) слабых	средних (4)	(5) бурных
16	8	3	5

1. No. of inoculees examined; 2. No. of general reactions; 3. Weak; 4. Moderate; 5. Stormy.

As is seen from the Table, the majority of inoculees showed weak and moderate general reactions; thereby, the duration of fever in them was no more than two days. In five persons the general reaction had a stormy course; fever lasted three-four days in them. It should be noted that two out of five persons in this group had had contact with a source of brucellosis infection in the past, and apparently were in a state of sensitization to it and for this reason showed a stormy reaction to the inoculation. A month after inoculation and again after three months the group of persons inoculated subcutaneously was again given a clinical checkup. We did not succeed in finding any manifestations of brucellosis, and the inoculees presented no complaints.

The innocuousness of the "M" vaccine strain for people after subcutaneous injection in our observations was also confirmed by the absence of any appreciable abnormalities in the blood. A slight leukocytosis was noted with a relative lymphocytosis. In only two inoculees did the leukocyte count reach 12,000-14,000. However, no marked change in the differential count was observed in them.

The erythrocyte sedimentation rate, as in the majority of persons inoculated percutaneously, was normal. In three persons the sedimentation rate was 20-22-25 millimeters in an hour. Acceleration of the sedimentation rate in some and leukocytosis in others were apparently the result of an influenzal infection and seasonal anginas which they had suffered after the vaccination.

Immunological changes in this group of inoculees were studied twice: one month and three months after vaccination by means of the Wright and Huddleson tests. The agglutination titers obtained in the Wright test performed a month after inoculation are shown in Table 3. As is seen from the Table, one person had a negative Wright test; in the others it was positive.

Table 3

Results of Serologic Examination Made a Month After Vaccination in Persons Vaccinated with Brucella Abortus 104-"M" by the Subcutaneous Method

(1) Количество обследованных	(2) Количество отрицательных реакций	(3) Количество положительных реакций Райта в титрах:					
		1:10	1:20	1:40	1:80	1:160	1:320
11	1	—	—	2	5	3	—

1. No. of inoculees examined; 2. No. of negative tests; 3. No. of positive Wright tests with the following titers:

Thereby, the agglutination titers, by and large, ranged from 1:40 to 1:80. Therefore, a month after vaccination in the majority of inoculees an immunobiological reorganization occurred. Three months after vaccination the agglutination test was performed in 14 persons. The results obtained are shown in Table 4.

Table 4

Results of Serologic Examination of Persons Vaccinated with Brucella Abortus 104-"M"

1	2	3	4								
		Число положительных реакций Райта в титрах:									
		1:10	1:20	1:40	1:80	1:160	1:320	1:640	1:1280		
14	3	1	2	2	1	3	1	—	1	14	

1. No. of inoculees examined; 2. No. of negative Wright tests; 3. No. of positive Wright tests in titers: 4. No. of positive Huddleson tests.

As is seen from the Table, in three inoculees the Wright test was negative: after a month in one of them it was not checked; in another, the results of the examination were the same after one month and after three months; in a third, a reduction in the agglutination titer occurred from 1:160 to negative. In the other inoculees who were checked the agglutination titers showed a tendency in the direction of a slight increase rather than a reduction.

The Huddleson test in all persons vaccinated with the "M" strain was positive. Therefore, the immunological reactions are also evidence to the effect that brucellosis strain 104-"M" not only proved to be innocuous for the human body after subcutaneous injection of 200,000,000 microbes but also possessed a high degree of immunological effectiveness. The latter was maintained for three months (the observation period).

Conclusions

1. A vaccine made of the "M" strain of Brucella abortus is innocuous for people when used percutaneously in a quantity of 3,000,000,000 microbes and subcutaneously in a quantity of 200,000,000 microbes.

2. In those vaccinated by the percutaneous method local reactions had mild and moderate courses, and there was no general reaction. In those vaccinated by the subcutaneous method the general and local reactions had a more stormy course.

3. No considerable regular abnormalities were found in the blood of either group of vaccinated persons.

4. These doses of the "M" strain of Brucella abortus vaccine, both after subcutaneous and percutaneous inoculation, bring about an immunological reorganization of the organisms of people which is detectable a month after vaccination and is maintained for three months in the group of persons inoculated by the subcuraneous method (the observation period).

5. The vaccine made of the "M" strain of Brucella abortus should find application for vaccination in medical practice because of its immunological properties.

S. L. Borod'ko

Experimental Brucellosis in Social and Meadow Voles

Study of the susceptibility of wild rodents to brucellosis is of great epidemiological and epizootological significance. In the literature there is information about susceptibility to brucellosis under natural and experimental conditions in wild brown rats [Rattus norvegicus] (I. A. Karkadinovskaya, 1936, 1937; S. S. Borisov, A. I. Gluzman and N. Yu. Kolesnik, 1937; N. G. Kucherova, 1957), hamsters, souslike (I. F. Taran, 1937; M. M. Rementsova, 1956; I. F. Taran and others, 1957), meridional and crested birds (I. F. Taran, 1957).

Of definite interest is the study of susceptibility to brucellosis in social and meadow voles [Microtus socialis and Microtus arvalis, respectively], which not uncommonly inhabit the grazing land of short-horned and long-horned cattle.

In the literature available to us there are scattered works on the study of infection and carriage of the brucellosis pathogen by voles under natural conditions. M. M. Rementsova (1956) isolated a culture of brucellas from one meadow vole. Studies of voles made by I. F. Taran, S. K. Dal' and others (1957) gave negative results. We did not find any data in the literature on the susceptibility of social or meadow voles to brucellosis infection of the sheep and goat type under experimental conditions. Nevertheless, the study of this problem is important not only from epidemiological and epizootological viewpoints but is also of significance for clarifying the possibility of utilization of voles as laboratory animals along with white mice.

The aim of the present work was an elucidation of the degree of susceptibility of voles to brucellosis, the duration of carriage and the possibility of their excretion of brucellas into the environment.

Simultaneously, we studied brucellosis infection of voles under natural conditions.

The social and meadow voles were caught in places where farms on which the situation was unfavorable with regard to brucellosis in small- and long-horned cattle were located.

Part of the rodents was studied for carriage of brucellosis; another part was left for study of susceptibility of voles to brucellosis of B. melitensis type experimentally.

In experiments on the study of brucellosis infection under appropriate conditions an investigation was made of 97 social and 68 meadow voles; thereby, the method of investigation was the following: an emulsion made of lymph nodes, liver, and spleen of no more than

10 investigated rodents was injected subcutaneously into white mice in a quantity of 0.5 cc. In all, eight biological tests were performed using social voles and five biological tests using meadow voles.

Twenty-one days after infection we killed the biological test animals and seeded their organs on nutrient media (liver agar to which 0.5 percent sodium sulfite and liver bouillon had been added). The cultures were kept in an incubator for a month at 37° and were examined every three-four days. We did not succeed in isolating a single culture of brucellas from the biological test animals infected with the organs of either the social or meadow voles. However, the comparatively small number of animals studied does not give us the right to claim that there are no voles infected with this infectious disease in the foci of brucellosis.

Along with an investigation of brucellosis in social and meadow voles caught under natural conditions we performed a number of experiments on artificial infection of them with cultures of B. melitensis. For the infection the standard B. melitensis 548 strain was used the minimum infective dose of which is equal to five microbes for white mice.

In experiments on subcutaneous infection 40 social and 40 meadow voles were used. They had been quarantined 21-30 days before infection. During this time, in 16 social and 12 meadow voles an investigation was made of the blood by the Wright agglutination test with a dilution of 1:2, which gave a negative result.

In addition, a serologic examination of the blood was made by the Wright test with negative results in 27 social and 21 meadow voles brought in from the same places but which had not been included in the experiment of artificial infection because of the fact that they died after blood was taken from the heart. These voles were studied by the biological method. Thereby, it was impossible to isolate a brucellosis culture from them. All this gives us the basis for the belief that the rodents used in the experiment were free of brucellosis.

Social and meadow voles were infected in groups of 10 specimens each with an emulsion made of a two-day agar culture of B. melitensis 548 containing, respectively, five, 10, 100 and 1,000 microbes by the bacterial optical standard. Cultures of five and 10 microbes on plates containing liver agar gave a moderate growth, equal to 10 and 26 colonies respectively. Simultaneously, white mice were infected with the same doses. Observation of the infected animals was made for 21 days. During this time no signs of disease were noted in the rodents. Nineteen days after infection the allergic intradermal Burnet test was performed, which was read for two days. In all cases this reaction proved negative.

Twenty-one days after infection we took blood from the hearts

of the animals, after which the rodents were sacrificed and dissected. Pieces of lymph nodes, liver, spleen as well as blood and urine were inoculated on nutrient media; the cultures were kept in an incubator at 37° for 20 days, being examined every two-three days.

The results of bacteriological examination of the social voles are shown in Table 1.

From Table 1 it is seen that in all 10 social voles a disseminated infection occurred even after infection with five microbes; thereby, the highest number of brucellosis cultures were plated out from the regional lymph nodes (inguinal, paraaortic), liver and spleen; fewer cultures were obtained from the submaxillary and cervical lymph nodes, blood and urine.

The fact that brucellas were excreted in the urine by one vole infected with five microbes, by four voles infected with 10 microbes, by two and one vole infected, respectively, with 100 and 1,000 microbes is important. This is evidence to the effect that in the case of dissemination of the infectious process in social voles brucellas can be excreted into the environment in the urine.

On dissection of the social voles pathological changes were noted in only five out of 40 infected with different doses; these occurred in the form of enlargement of inguinal, paraaortic and cervical nodes. No visible changes were found in the other organs.

A similar experiment was performed on white mice. In all mice infected subcutaneously with doses from five to 1,000 microbes a disseminated brucellosis infection was demonstrated, whereby two white mice infected with five and 10 microbes excreted brucellas in the urine. On autopsy of 12 white mice infected with different doses, pathological changes were found only in individual lymph nodes.

As has already been pointed out, the blood of social voles and white mice was studied in the Wright agglutination test. The results of these studies are shown in Table 2.

From this Table it is seen that of 38 voles investigated (blood was not taken from two voles) the Wright test was positive in 35 animals. The reaction titers ranged from 1:20 to 1:640. In all white mice the Wright test was negative.

Therefore, the experiment of subcutaneous infection of social voles showed that they are highly susceptible to brucellosis infection of the B. melitensis type and are more sensitive to it than are white mice.

The results of experimental infection of meadow voles are shown in Table 3.

From Table 3 it is seen that all 40 meadow voles in the experiment of subcutaneous infection with B. melitensis 548 were found to be infected. Even a dose of five microbes caused a disseminated

Table 1

Results of Bacteriological Examination of Social Voles Infected Subcutaneously with the Sheep and Goat Type of Brucellosis

(1) Вид животного	(2) Количество животных	(3) Зараженная доза в микробах	(4) Выделены бруцеллезные культуры из: (5) паховых лимфатич. узлов	(6) подчелюстн. лимф. узлов	(7) шейных лимфатич. узлов	(8) парааортал. лимфатич. узлов	(9) печени	(10) селезенки	(11) крови	(12) мочи	(13) Число животн. с: (14) генерализованной инфекцией	(15) региональной инфекцией
(16) Общественные полевки	10	5	10	1	4	10	8	9	1	1	10	0
»	10	10	10	2	3	10	8	10	3	4	10	0
»	10	100	7	2	2	9	7	9	0	2	9	1
»	10	1000	8	1	4	7	4	8	0	1	10	0
(17) Контрольные белые мыши	3	5	2	0	0	2	2	2	0	1	3	0
»	3	10	3	1	0	2	2	2	0	0	3	0
»	3	100	3	1	2	3	1	3	0	0	3	0
»	3	1000	2	0	0	2	1	3	0	0	3	0

1. Species of animal; 2. No. of animals; 3. Infective dose in microbes; 4. Brucellosis cultures isolated from: 5. Inguinal lymph nodes; 6. Submaxillary lymph nodes; 7. Cervical lymph nodes; 8. Paraaortic lymph nodes; 9. Liver; 10; Spleen; 11. Blood; 12. Urine; 13. No. of animals with: 14. Disseminated infection; 15. Regional infection; 16. Social voles; 17. Control white mice.

Table 2

Results of Serological Examination of Social Voles Infected Subcutaneously with the Sheep and Goat Type of Brucellosis

Вид животного (1)	Количество животных (2)	Зараженная доза в микробных телах (3)	Количество положительных реакций в развед. сыворотки (4)							Количество отрицательных реакций (5)	Количество неисследованных животных (6)
			1:10	1:20	1:40	1:80	1:160	1:320	1:640		
(7) Общественные полевки	10	5	—	1	1	3	1	1	1	1	—
» »	10	10	—	—	1	3	3	1	—	1	—
» »	10	100	—	—	5	2	1	1	1	—	—
» »	10	1000	—	1	—	4	1	1	1	—	2
(8) Контрольные белые мыши	3	5	(9) отрицательная								
»	3	10	«			«					
»	3	100	«			«					
»	3	1000	«			«					

1. Species of animal; 2. No. of animals; 3. Infective dose in microbes; 4. No. of positive tests for serum dilutions of: 5. No. of negative tests; 6. No. of animals not examined; 7. Social voles; 8. Control white mice; 9. Negative.

Table 3

Results of Bacteriological Examination of Meadow Voles Infected Subcutaneously with the Sheep and Goat Type of Brucellosis

(1) Вид животных	(2) Количество животных	(3) Зараженных доз в микроб. телах	(4) Выделены бруцеллезные культуры из: (5) подчелюстных лимф. узлов	(6) паховых лимф. узлов	(7) подмышечных лимф. узлов	(8) заднепеченочных лимф. узлов	(9) печени	(10) селезенки	(11) крови	(12) мочи	(13) Число животных с: (14) генерализованной инфекцией	(15) регионарной инфекцией
(16) Обыкновенные полевки	10	5	10	1	1	7	7	8	3	2	10	0
»	10	10	9	1	3	3	10	10	5	0	10	0
»	10	100	7	2	2	8	9	8	1	1	9	1
»	10	1000	6	6	3	8	6	10	1	2	10	0
(17) Контрольные белые мыши	3	5	2	0	0	2	0	1	1	0	2	1
»	3	10	2	0	0	3	0	2	0	0	3	0
»	3	100	3	0	0	2	3	3	1	0	3	0
»	3	1000	3	2	1	3	3	3	0	0	3	0

1, 2, 3. [Same as previous Table]. 4. Brucella cultures isolated from: 5.-15. [Same as Table 1]. 16. Meadow voles; 17. Control white mice.

Table 4

Results of Serological Examination of Meadow Voles Infected Subcutaneously with the Sheep and Goat Type of Brucellosis

Виды животных (1)	Количество животных (2)	Заражающая доза в микробных телах (3)	Количество положительных реакций в разведении сыворотки (4)							Количество отрицательных реакций (5)	Количество неисследованных животных (6)
			1:10	1:20	1:40	1:80	1:160	1:320	1:640		
(7) Обыкновенные полевки	10	5	—	2	—	2	1	—	—	4	1
»	10	10	—	1	1	2	1	—	—	3	2
»	10	100	—	1	2	2	1	—	—	2	2
»	10	1000	—	1	3	1	1	—	—	3	1
(8) Контрольные белые мыши	3	5	(9) Отрицательная								
»	3	10	»		»		»				
»	3	100	»		»		»				
»	3	1000	»		»		»				

1, 2, 3. [Same as previous Table] 4. No. of positive tests in the following serum dilutions; 5. No. of negative reactions; 6. No. of animals not examined; 7. Meadow voles; 8. Control white mice; 9. Negative.

process in them. It should be noted that from two meadow voles infected with five microbes, one infected with 100 microbes and two infected with 10,000 microbes cultures of brucellas were obtained from the inoculations of urine, which is evidence of the ability of these rodents also to excrete the brucellosis pathogens into the environment during the period of dissemination of the process.

On dissection of the animals an enlargement and hyperemia of the regional lymph nodes were noted in only eight meadow voles infected with different doses, and in one vole infected with 1,000 microbes punctate hemorrhages were noted in the liver. In the other voles no visible pathological changes were found; however, brucella cultures were isolated from the organs of these voles, just as in the case of examination of the social voles.

Simultaneously with meadow voles 12 white mice were infected with the same doses. In 11 mice a disseminated infectious process was demonstrated; in one mouse only a regional infection was noted.

On autopsy, in nine out of 12 mice pathological changes were found in the form of enlargement of lymph nodes; in addition, in six of them there was a slight enlargement of the spleen. In the other mice no visible pathological changes were found in the organs.

The blood of meadow voles and white mice was studied in the Wright test. The results of these examinations are shown in Table 4.

From Table 4 it is seen that in 12 out of 40 meadow voles a negative Wright test was obtained; in 22, a positive test, whereby the reaction titer was no greater than 1:160. In six rodents blood was not examined. All white mice gave a negative agglutination test by the Wright method.

Therefore, the experiment of subcutaneous infection of meadow voles with a virulent strain of B. melitensis indicates that these rodents are susceptible to brucellosis of the sheep and goat type.

We speak of the greater sensitivity of social and meadow voles than white mice on the basis of the fact that the seeding of their organs with brucellas was greater than that of the organs of control mice.

The susceptibility and sensitivity of meadow and social voles were approximately the same. However, in their serological activity these two species of animals were different. Thus, the Wright test was negative in 36 percent of the meadow voles and in only eight percent of the social voles.

In addition, the Wright test titers in the meadow voles were somewhat lower (up to 1:160) than in the social voles (up to 1:640). On the whole, the results obtained indicate that both meadow and social voles can be utilized as laboratory animals together with white mice.

After obtaining positive results in experiments of subcutaneous infection of social and meadow voles with a virulent culture of B. mel-

litensis we decided to find out the duration of preservation of the pathogen of this infectious disease in the bodies of these animals. For this purpose 15 social voles were infected with 10 times the disseminating dose of B. melitensis, that is, with 50 microbes. Five, 30, 45 and 66 days after infection we sacrificed the social voles in groups of three and made cultures on the liver agar media. In addition, three voles which died on the 32nd, 34th and 35th days after infection were utilized.

The results of these studies are shown in Table 5.

As is seen from Table 5, the cultures of brucellas were isolated from social voles sacrificed or which died from the 30th to the 66th day after infection. Thereby, in three voles killed after 30 days and those which died on the 32nd, 34th and 35th days after infection and in two voles killed on the 45th day a disseminated brucellosis was demonstrated.

In one social vole 45 days after infection and in one social vole 66 days after infection brucellas were isolated from the regional lymph nodes only; in two other social voles studied after 66 days no brucella cultures were isolated. It should be noted that in one social vole studied 30 days after infection brucellas were isolated not only from the lymph nodes and parenchymatous organs but also from the urine.

From this Table it is seen that the Wright test, which became positive 30 days after infection in two social voles, was positive in all voles investigated 45 days after infection and in two out of three voles studied 66 days after infection.

Thereby, the agglutination titers of the Wright test gradually decreased from 1:80 to 1:10. Therefore, the social voles infected with B. melitensis can preserve the pathogen for a long time, up to 66 days (the observation period).

The susceptibility of social and meadow voles to brucellosis of the B. melitensis type, the ability of these rodents to carry the pathogen in their bodies for more than two months and, which is particularly important, excrete it into the environment in the urine suggests the idea that these rodents might under certain conditions be carriers and reservoirs and sources of brucellosis under natural conditions.

The susceptibility of social and meadow voles to subcutaneous infection and their ability of excreting brucellas into the environment in the urine set before us the problem of studying experimentally the ability of these rodents to be infected with brucellosis after administration of the pathogen by mouth, thereby making experimental infection with brucellosis more like possible infection under natural conditions.

Oral infection with brucellosis was conducted in experiments on rodents by I. A. Karkadinovskaya, N. G. Kucherova, I. F. Taran and others.

Table 5

Duration of Preservation of the Infectious Process in Social Voles Infected Subcutaneously with the Sheep and Goat Type of Brucellosis

(1) № животного	(2) Заражающая доза	(3) Срок исследования с момента заражения в днях	(4) Выделение бруцеллезн. культуры из: (5) паховых л. у.	(6) подчелюстных л. у.	(7) поясничных л. у.	(8) парааортальных л. у.	(9) печени	(10) селезенки	(11) крови	(12) мочи	(13) Реакция Райта (14) разведения сывороток 1:10	1:20	1:40	1:80	1:160	1:320	1:640
219	50	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
220	»	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
221	»	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
222	»	30	+	+	—	—	—	—	—	—	++++	++++	++++	++			
223	»	30	+	—	—	+	—	+	—	—	—	—	—	—	—	—	—
224	»	30	+	—	+	+	+	+	—	+	++++	+++	++++	++	—	—	—
225	»	32*	+	+	—	—	—	+	—	—	0	0	0	0	0	0	0
226	»	34*	—	+	—	+	+	+	+	—	0	0	0	0	0	0	0
227	»	35*	+	—	—	—	+	+	—	—	0	0	0	0	0	0	0
228	»	45	+	—	—	+	—	+	—	—	++++	++++	—	—	—	—	—
229	»	45	+	—	+	+	—	—	—	—	++++	++	—	—	—	—	—
230	»	45	+	—	—	—	—	—	—	—	++	—	—	—	—	—	—
231	»	66	+	—	—	+	—	—	—	—	++	—	—	—	—	—	—
232	»	66	—	—	—	+	—	—	—	—	+++	—	—	—	—	—	—
233	»	66	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Key: X -- dead body [despite this, there is no "X" given in the Table; possibly this refers to the * after three of the numbers in column 3]; + -- culture isolated; - no culture isolated; 0 -- blood not examined.

1. number of the animal
2. infective dose
3. period of examination from moment of infection, in days

4-12. [same as Table 1]
13. Wright's reaction
14. serum dilutions

I. A. Karkadinovskaya (1937), infecting wild brown rats with the cow and swine strains of brucella, concluded that the oral method gives poorer results than the subcutaneous method. At the same time, she proved the fact that healthy rats, eating infected ones, are thereby infected with brucellosis.

N. G. Kucherova (1957) showed that rats are easily infected with brucellosis of the B. melitensis type when fed products infected with the corresponding microbes.

Meridional jirds are also susceptible to oral infection; 100 microbes of B. melitensis 548 produced a disseminated brucellous process in these animals (I. F. Taran, 1957).

In our experiments use was made of social and meadow voles after they had been in quarantine three weeks and after a preliminary partial examination by the Wright test. Serologically, 10 social and nine meadow voles were studied; they all showed a negative Wright agglutination test with dilution of 1:2.

For the purpose of infecting the animals we used an emulsion made of a two-day agar culture of B. melitensis 548, from which dilutions were prepared containing 1,000,000,000, 100,000,000, 10 000,000, 10,000 and 100 microbes according to the bacterial optical standard. Control inoculations of 10, 100 and 1,000 microbes on plates containing liver agar gave a moderate growth, equal, respectively, to 30, 282 and 2,375 colonies.

The infective dose was present in 0.1 cc of emulsion and was administered orally by means of a micropipet with a rubber bulb to social, meadow voles and white mice. We observed the infected animals for 21 days. None of them showed signs of disease; many of them gained weight in this time. Twenty-one days after reading the Burnet allergic test, which in all experimental animals proved to be negative, and after taking blood for the purpose of examination by the Wright agglutination test, the social and meadow voles and white mice were sacrificed, and lymph nodes, liver, spleen as well as blood and urine were studied by the methods described above.

The social voles were infected orally in groups of 10 specimens each with 1,000,000, 1,000, 100 and 10 microbes of the brucellosis pathogen of the sheep and goat type.

The results of the experiment are shown in Table 6.

From the Table it is seen that 100 microbes of B. melitensis 548 caused infection in one out of 10 social voles: thereby, the pathogen was isolated from the cervical lymph nodes, which indicates developing regional infection. Disseminated brucellosis with isolation of the pathogen was observed in social voles only after the injection of a considerable number of microbes (1,000 and 1,000,000).

On dissection of several social voles pathological changes were

Table 6

Results of Bacteriological and Serological Examinations of Social Voles Infected Orally with the Sheep and Goat Type of Brucellosis

Вид животного (1)	Количество животных (2)	Заражающая доза в м. т. (3)	Выделены бруцеллезные культуры из: (5)								Число животных с (15)			
			паховых л. у. (6)	шейных л. у. (7)	подчелюстных л. у. (8)	заглоточных л. у. (9)	печени (10)	селезенки (11)	крови (12)	мочи (13)	генерализованной инфекцией (14)	регионарной инфекцией (15)	положительной реакцией Райта (16)	незараженных (17)
(18) Общественные полевки	10	10	0	0	0	0	0	0	0	0	0	0	0	10
»	10	100	0	1	0	0	0	0	0	0	0	1	0	9
»	10	1000	0	2	2	0	0	2	0	0	2	0	0	8
»	10	1 млн (20)	2	7	7	5	5	7	2	1	7	1	5	2
(19) Контрольные белые мыши	3	10	0	0	0	0	0	0	0	0	0	0	0	3
»	3	100	0	0	0	0	0	0	0	0	0	0	0	3
»	3	1000	0	0	0	0	0	0	0	0	0	0	0	3
»	3	1 млн (20)	0	1	0	0	0	2	0	0	2	1	0	—

1-4. [Same as Table 1]. 5. No. of animals with: 6. Inguinal lymph nodes; 7. Cervical lymph nodes; 8. Submaxillary lymph nodes; 9. Paraaortic lymph nodes; 10. Liver; 11. Spleen; 12. Blood; 13. Urine; 14. Disseminated infection; 15. Regional infection; 16. Positive Wright test; 17. Non-infected; 18. Social voles; 19. Control white mice; 20. Million.

found in the form of a slight enlargment of cervical, submaxillary and sometimes paraaortic lymph nodes; no visible pathological changes were found in the internal organs.

On serologic examination of the blood we obtained positive Wright tests in five social voles infected with 1,000,000 microbes; thereby, in three voles the reaction titers were 1:80; in one vole, 1:160; in one vole, 1:320. All the other voles in this experiment gave negative Wright tests.

Simultaneously with the social voles white mice were infected orally with the same doses in the experiment, using groups of three per dose.

As is seen from Table 6, the dose of 1,000,000 microbes caused the development of regional brucellosis in one white mouse (the brucellas were isolated only from cultures of the cervical node); in two white mice, the development of a disseminated brucellcus process In them the pathogen was isolated from the spleen in addition to the cervical lymph nodes. Mice which were given oral administrations of 1,000, 100 and 10 microbes were not infected with brucellosis. At autopsy, pathological changes were found in only two out of 12 mice in the form of enlargement of cervical and paraaortic lymph nodes. The Wright test was negative in all white mice.

Comparing the results obtained in the experiment of oral infection with the brucellosis pathogen with results obtained in the experiment of subcutaneous infection we concluded that social voles, like white mice, are infected with brucellosis, but a dose which is 100 times greater than that for subcutaneous infection is needed for the development of the disseminated process after oral infection.

Meadow voles in groups of six were infected with 10,000,000, 1,000,000, 1,000, 100 and 10 microbes of the B. melitensis pathogen. The results of the experiment are presented in Table 7.

From the Table it is seen that five out of six meadow voles which received 10,000,000 microbes of B. melitensis 548 orally were infected, and the infectious process was disseminated in them. With reduction of the infective dose there was a reduction in the number of meadow voles with a disseminated infection and an increase in the number with a regional infection. Thus, of six voles infected with 1,000,000 microbes brucella cultures were plated out of three from the submaxilliary lymph nodes only. The voles which had received 1,000, 100 and 10 microbes orally were not infected with brucellosis.

At autopsy visible pathological changes were found in two voles, which had been infected respectively with 10 and 1,000,000 microbes, in the form of a slight enlargement of the submaxillary and cervical lymph nodes. It should be noted that in our experiments of infection of both social and meadow voles visible pathological changes in the

Table 7

Results of Bacteriological and Serological Examinations of Meadow Voles Infected Orally with the Sheep and Goat Type of Brucellosis

(1) Вид животных	(2) Количество животных	(3) Зараженная доза в м. т.	(4) Выделены бруцеллезные культуры из:								(15) Число животных с			
			(5) паховых л. у.	(6) шейных л. у.	(7) подчелюст. л. у.	(8) паравертебральных л. у.	(9) печени	(10) селезенки	(11) крови	(12) мочи	(13) генерализованной инфекцией	(14) регионарной инфекцией	(15) положительной реакцией Райта	(17) незаразившихся
(18) Обыкновенные полевки	6	10	0	0	0	0	0	0	0	0	0	0	0	6
»	6	100	0	0	0	0	0	0	0	0	0	0	0	6
»	6	1000	0	0	0	0	0	0	0	0	0	0	0	6
»	6	1 млн. (20)	0	3	5	0	2	3	0	0	3	3	4	0
»	6	10 млн. (20)	0	3	2	1	2	4	0	0	5	—	3	1
(19) Контрольные белые мыши	3	10	0	0	0	0	0	0	0	0	0	0	0	3
»	3	100	0	0	0	0	0	0	0	0	0	0	0	3
»	3	1000	0	0	0	0	0	0	0	0	1	0	0	2
»	3	1 млн. (20)	1	3	3	2	2	3	0	0	3	0	0	0
»	3	10 млн. (20)	0	3	2	1	1	3	1	0	3	0	0	0

1-15. Same as in Table 1; 16. Positive Wright test; 17. Non-infected; 18. Meadow voles; 19. Control white mice; 20. Million(s).

lymph nodes and parenchymatous organs were rarely encountered. We were not always able to isolate the pathogen from the abnormal organs. Conversely, we frequently came across the situation where brucellas were isolated from organs which had no visible pathological changes. The largest number of successful platings of brucella cultures in experiments of oral infection were obtained from regional lymph nodes (submaxillary and cervical) and from the spleen.

Serologic examination gave the following results: in two meadow voles infected with 10,000,000 microbes the Wright agglutination test was positive in a dilution of 1:20; in one vole of the same group, in a dilution of 1:80. In the group of voles infected with 1,000,000 microbes two gave a reaction in a dilution of 1:20 and two, in a dilution of 1:40. In all the other voles the Wright test was negative. Here, it should be noted that the titers of the positive Wright test in the meadow voles were two dilutions lower than the titers of the similar test in the social voles.

White mice infected in groups of three simultaneously with the meadow voles and with the same doses and by the same method were infected with brucellosis after administration of 1,000, 1,000,000 and 10 microbes. Thereby, in all mice which received 1,000,000 and 10,000,000 microbes and in one mouse which received 1,000 microbes a disseminated infectious process occurred; all the other mice were not infected with brucellosis.

The Wright test was also negative in this case in all white mice. Therefore, the meadow voles, like the social voles, can be infected orally with brucellosis.

The results which we obtained in the experiment of oral infection of voles confirm other authors' data to the effect that infection of wild animals orally with brucellosis is possible, but a large dose of the pathogen is necessary for it. In this case, in both species of rodents a disseminated process develops which in the social voles is sometimes associated with the excretion of the pathogen into the environment in the urine. Small doses of the brucellosis pathogen of the B. melitensis type either cause the development of regional infections or are entirely inadequate for infection of the animals when administered orally.

Because brucellosis infection of animals usually occurs by mouth under natural conditions, those in which small doses of the microbe cause a disseminated process associated with the excretion of this pathogen into the environment are primarily infected and represent a danger to the others.

Those animals in which brucellosis infection and the development of the disseminated process occur only when large quantities of the pathogen enter the mouth can be infected and can play a part in the

maintenance of the natural brucellosis focus only under certain conditions, that is, in those cases where contact of such an animal occurs with large doses of the pathogen. Among the latter animals are the social and meadow voles.

Conclusions

1. On investigation of 97 social and 68 meadow voles by the biological method and 43 social and 38 meadow voles by the serological method no animals were found infected with brucellosis.

2. Social and meadow voles are highly susceptible to brucellosis infection with B. melitensis after subcutaneous infection under experimental conditions; thereby, they are not only reservoirs of the pathogen (two months, the observation period) but also excrete it into the environment in the urine for 21-30 days.

3. Oral infection of social and meadow voles with brucellas of the B. melitensis type occurs only when they are given a large quantity of the pathogen. Small doses of the pathogen, when given orally, bring about the development only of a regional infection or are entirely inadequate for producing brucellosis infection.

4. Social and meadow voles can be utilized as laboratory animals along with white mice.

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Observations on the Maintenance of Tularemia Infection in a Natural Microfocus

In the study of a natural tularemia focus in the northern part of the Volga-Akhtubinsk Valley N. G. Olsuf'yev, V. V. Kucheruk, N. N. Makarov, V. P. Borodin, V. G. Petrov, and Ye. I. Selyanin (1955) determined the existence of multiple-host tularemia microfoci in the valley. Further study of the this focus (N. S. Yamolova, B. G. Val'kov, Z. I. Murav'yeva, P. A. Kartushin, V. A. Mikhayleva, 1956) confirmed the existence of such tularemia microfoci in it.

On the basis of the observations presented and a number of other observations the conclusion may be reached that tularemia microfoci exist in which the infection is maintained during the interepizootic periods.

In the past, in the Pallasovskiy Rayon of Stalingradskaya Oblast and Dzhanybekskiy Rayon of Zapadno-Kazakhstanskaya Oblast, tularemia epizootics in rodents have been recorded repeatedly (mouse-like rodents and sousliks), as have also cases among people. Mouse-like rodents were the sources of the infectious disease. In 1955, an epizootic among mouse-like rodents was observed in Kaztalovskiy, Furmanovskiy, Dzhanybekskiy, Chapayevskiy rayons of Zapadno-Kazakhstanskaya Oblast and Altayskiy and Novouzenskiy rayons of Saratovskaya Oblast. In 1955, an epizootic was again recorded in Dzhangalinskiy, Chapayevskiy, Furmanovskiy and Taypakskiy rayons. Cultures of B. tularense were isolated from the steppe lemming [Lagurus lagurus], dwarf souslik, water vole [Arvicola terrestris], house mouse, wood mouse, crested and meridional jirds, the mole vole [Ellobius talpinus] and the house cat as well as from ticks of the genera Dermacentor, Rhipicephalus and Hyalomma (P. M. Kucherov, L. T. Sykov, V. A. Merlin, N. K. Kunitsa and M. N. Demyashov, 1957).

The territory occupied by Pallasovskiy and Dzhanybekskiy rayons is part of the so-called combination steppe, characterized by microterrain which represents a frequent alternation of elevated and depressed elements. In the depressions herbaceous-motley grass associations predominate; on the elevations -- wormwood associations are predominant. About seven percent of the territory is taken up by cultivation; about 25 percent of the area, by hay land, and the entire remaining territory is used for cattle grazing.

Almost all the grazing land is inhabited by dwarf sousliks, with a census which varies, by and large, from six to 20 sousliks per hectare.

In 1954-1955 the settlements of the social vole and the s t e p p e lemming were distinguished by a high population density here (average-40-60; maximum-248 individuals per hectare). As the result of the severe winter of 1955-1956 these species of rodents died out almost completely.

House mice were distributed over the entire territory; however, in the main types of areas (grazing lands, hay land, cultivated land) their censuses did not exceed two percent of the trap catch. An increased census of house mice was recorded on bur'yanniki [territory covered with wild, bushy weeds] (seven percent), in the orchards and plantations (eight percent), along the shores of the Torgun and Malyy Uzen' steppe rivulets. Here, settlements of wood mice, meadow and water voles and of the common hamster [Cricetus cricetus] are encountered. In 1957, there was a considerable increase of the census of water voles and of the common hamster along the shores of those rivulets by comparison with 1955 and 1956 (along the shores of the Torgun and Malyy Uzen' rivulets in the spring of 1957 39 water voles and 262 common hamsters were caught in traps).

Almost everywhere along the sloping shores of the Torgun and Malyy Uzen' steppe rivulets ixodial ticks of the species Dermacentor marginatus and, considerably less often, of the species Rhipicephalus rossicus are encountered.

In making a detailed inspection of Pallasovskiy and Dzhanybekskiy Rayons, we based ourselves on the fact that the entire territory occupied by these rayons is unsuitable for rooting of the tularemia infection, and we assumed the existence of local tularemia microfoci. The most probable places for the formation of such microfoci could be areas related to the small steppe rivulets existing here and inhabited by certain species of rodents and ticks. In 1956, our attention was attracted by a small area on the shore of the Malyy Uzen' rivulet, which was different from the rest of the territory. This area was located on the territory of Dzhanybekskiy Rayon of Zapadno-Kazakhstanskaya Oblast. Here, the river valley widens to 500 meters, and during the spring flood it is partially inundated with water. The most elevated portion of this area has been dammed up and cut through by irrigation channels (before 1953 there was a plantation here). The vegetation on the area in which we are interested is quite heterogeneous. Along the shores of the rivulet there are dense bushy thickets of willow and sedge; on the unflooded areas blackthorn, honeysuckle, buckthorn, wild rose predominate; on the leas formed Chilean wormwood and

The presence of dam embankments and trenches densely overgrown with heterogeneous vegetation in the area under analysis has created conditions for the existence of rodents.

The census of house and wood mice here range from 1.3 percent to 34.3 percent of animals trapped.

In the examination made in the autumn of 1956 on areas of 3.5 hectares a count was made of 15 common hamster holes. The holes were surrounded by traps and in two days six hamsters were caught; in addition, two hamsters were found dead. A different picture was observed in the spring of 1957. On the same area as in the former case 70 holes were counted, and in two days 17 hamsters were caught and poured over with water.

In 1955-1956 on the area under our observation only tracks of water voles were noted. During this period, 300 traps were set and a total of only one water vole was caught. During the spring-summer season of 1957 on the same area 200 traps were set, and 16 water voles were caught. Here, Eversmann's hamster [possibly the Siberian polecat is intended here, the scientific name of which is Mustela eversmanni], the meadow vole, the birch mouse [Sicista subtilis], the white-toothed shrew [Suncus etrusca], long-eared hedgehog [Erinaceus auritus] and weasel are also encountered.

In this area D. marginatus ticks were found to be very abundant also; about 3000 of these ticks were collected per flag. At the same time, in the spring of 1957, 302 specimens of D. marginatus ticks were collected from 19 common hamsters (five imagoes, 300 nymphs, and 97 larvae), as well as 50 specimens of R. rossicus ticks, (six imagoes and 44 nymphs), six specimens of R. schulzei ticks (imagoes) and three specimens of Ixodes (nymphs). The tick census on each of the hamsters was different and ranged from one to 90 individuals (average, 24). All the material obtained from investigation was subjected to examination. A study was made of 471 rodents for tularemia; of these 149 were house mice; 242, wood mice; 13, water voles; 35, common hamsters; and 13 were other rodents. Of the Ixodial ticks of the species D. marginatus collected on a flag from cattle and from common hamsters a study was made of 3,227 specimens with the performance of 58 biological tests.

In May of 1956, as the result of bacteriological examination of 1,411 D. marginatus ticks with the performance of 30 biological tests, four cultures of B. tularense were isolated, and in October of the same year two cultures were isolated from two dead common hamsters. Two biological tests on white mice and guinea pigs were performed using each dead common hamster. The white mice and guinea pigs died seven days after infection, showing a pathological picture characteristic of tularemia on dissection. In 1957, an investigation was made of 1,216 D. marginatus ticks; 30 biological tests were performed and five cultures of B. tularense isolated; the ticks were collected on a flag in the same area. One culture of B. tularense was isolated from nymphs of D.

marginatus ticks which had been collected from common hamsters. All the cultures of B. tularense isolated were typical in their cultural and antigenic properties and possessed a high degree of virulence.

As is seen from the Table, white mice (with the exception of one) died of doses of ten and one microbes, and part of them died of a dose of 0.1 microbe; in those cases where white rats were infected they died from doses of 1,000,000,000 and 100,000,000 microbes and part of them died of doses of ten and one million microbes.

Results of a Check of the Virulence of B. tularense Isolated from Common Hamsters and D. Marginatus Ticks

(1) № штаммов	(2) От кого выделена культура	(3) Белые мыши (4) Доза 10 м. к. (5)	1 м. к.	0.1 м. к.	(6) Белые крысы (4) Доза 1 млрд. (7)	100 млн. (8)	10 млн. (9)	1 млн. (10)
854	Обыкновен. хомяка (9)	+++ 6 6 6	+++ 6 6 5	+++ 6 6 7	не ставился (12)			
1029	Обыкновен. хомяка (9)	+++ 5 5 6	+++ 6 6 6	+++ 6 7 8	не ставился (12)			
38	Клещей (10)	+++ 6 6 6	++— 7 8	+—+ 6 5	++| 3 3 2	+++ 4 4 5	+++ 5 5 4	+++ 3 4 4
43	Клещей	+++ 6 6 6	+++ 7 7 7	+++ 7 6	+++ 5 5 3	+—+ 5 4	+++ 10 3 2	—++ 5 5
490	Клещей (10)	+++ 6 6 6	+++ 7 7 7	—++ 7 10	+++ 3 2 3	+++ 3 6 3	—+— 4	+— 3
44	Клещей	+++ 7 6 6	+++ 5 6 6	—++ 4 5	+++ 4 5 5	++— 5 6 ·	+++ 4 5 5	++— 5 6
891	Нимф (11)	+++ 6 7 6	+++ 6 7 7	—+ 6	+++ 2 2 4	+++ 4 3 3	++— 5 4	++— 9 9

Note: The + sign means that the animal died; the - sign means that the animal survived; the figure means the day on which the animal died. The cultures were checked for a month after they were isolated. 1. No of strains; 2. From what the culture was isolated; 3. White mice; 4. Dose; 5. Microbes [literally, microbe cells]; 6. White rats; 7. Billion; 8. Million (s); 9. Common hamster; 10. Ticks; 11. Nymphs; 12. Not done.

Conclusions

1. In the steppe region of Zayadno-Kamka-tanskaya Oblast various small areas related to the steppe rivulets

stand out in relief. On these areas, which are richer (than the rest of the steppe) in vegetation, many species of rodents are concentrated (the water vole, common hamster, house mouse, wood mouse, and meadow vole), as are also ixodial ticks which play an important part in maintaining the tularemia infection.

2. In these areas there are microfoci of tularemia which maintain the infectious disease in the interepizootic periods, which has been confirmed by the isolation of B. tularense cultures from such a microfocus, which we found in the spring and autumn of 1956 and in the spring of 1957, in the absence of diffuse tularemia epizootics on the territory of entire Dzhanybekskiy Rayon during this period.

3. The high census of ixodial ticks of the species D. marginatus in the microfocus and the considerable percentage of them infected permit us to speak of the fact that ticks play the main part in maintaining the tularemia infection from one interepizootic period to the next.

4. The isolation of two B. tularense cultures from two dead common hamsters indicates that the common hamster plays an important part in maintaining tularemia in the microfocus.

5. The cultures of the tularemia pathogen isolated from nymphs of D. marginatus ticks parasitic on the common hamster are evidence to the effect that the infectious disease can be transmitted by these ticks to this animal.

6. Wood and house mice living in this area can readily be involved in an epizootic, since they are rodents highly sensitive to tularemia (the first group, according to the Olsuf'yev and Dunayeva classification).

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Fever in Some Regions of the Kalmyk Autonomous Republic

Beginning with 1951 an active study has been made of fever on the territory of the Soviet Union. As is well known, fever was found for the first time in the Soviet Union in the Central Asiatic Republics and in the Crimea (. . Kalagin and N. K. Kekchoyeva, 1954).

Subsequently, in a short period of time a number of reports followed about detection of this infectious disease in almost all oblasts of the European portion of the USSR. In certain localities of the country (the Central Asiatic Republics, West Siberia) natural foci of this infectious disease were found (S. N. Kulagin, 1956).

At the present time, more and more new regions of distribution of fever are being found: Stavropol'skiy Kray (. . Kaytsev and Ye. V. Pokrovskaya, 1956), the Urals (. . Larganskiy, . . Kaplinskiy, P. Zygovskiy and N. P. Berdnikov; 1957; B. . Vaysfel'd, L. E. Gol'dberg, O. I. Ishchenko, 1957); Dagestan (. . Fedorova and others, 1957); Chitinskaya Oblast (Soktimirov and others, 1957); the Buryat-Mongolian Republic (R. I. Rubkova and others, 1957); the Far East (. . Legokonidova and I. P. Grigor'yan, 1956; I. . Nikhinson, I. B. Kambar, . . Savchenko, 1956); Yaroslavskaya Oblast (S. . Kulagin and coworkers, 1958); BSSR (L. . Koso'utskiy and . . Timofeyeva, 1958); Moscow (S. . Kalugin and R. I. Rubkova, 1957). Therefore, the opinion of the first investigators, who believed that fever is found almost everywhere, has been confirmed.

Sick cattle is the source of the infectious disease both for other cattle and for people, as the majority of investigators has pointed out. Thereby, while previously it was b lieved that the disease occurred asymptomatica y in anim recently works have appeared repudiating this idea. Sterility in cattle, abortions, signs of pneumonia of undetermined etiology can be ascribed to fever.

The Kalmyk Autonomous Republic is a large animal husbandry center, chiefly for short-horned cattle. In connection with this, the main mass of the population is occupied in animal husbandry. In addition, on the territory of Kalmykiya a cattle-driving husbandry is also found, including those places in which fever is found among agricultural animals.

The presence of a considerable percentage of barren ewes, abortions and cases of pneumonia of undetermined etiology as well as disease among people in which the diagnosis has been undetermined or in which a diagnosis of "brucellosis" is given which is not confirmed by the laboratory has con-

stituted the basis for beginning a study of Q fever in Kalmykiya.

For this purpose, collection and study of sera of cattle and people were made by means of the complement-fixation test using antigen from R. burneti prepared in the rickettsial disease department of the IEM AMN SSSR im. Gamaleyi [Institute of Epidemiology and Microbiology of the Academy of Medical Sciences USSR imeni Gamaleyi].

Two sheep-raising farms were studied; here, according to the veterinary service data, the highest number of abortions in the Republic had been recorded among sheep, as well as the highest number of sterile ewes and cases of pneumonia of undetermined etiology. Both farms were located in the East of the Republic; the cattle in them were on local land utilization. The routes of cattle drives from other rayons and oblasts passed through these farms.

In all, 71 sera from sheep were investigated; of these, ten sera showed a positive complement fixation test with the Q fever antigen in titers of 1:4-1:8. We were unable everywhere to determine the clinical picture of the cases of Q fever in sheep and its sequelae, because of the absence of numbering of the cattle and the absence of a record of the individual morbidity. We obtained such information only for two flocks in this farm, where a study was made of the blood serum of nine sheep which had aborted; the study was made for Q fever and for brucellosis. Of this number of sheep, seven were found to be sick with brucellosis (the Wright agglutination test was positive in a titer of 1:400) and two had Q fever (the complement fixation test was positive in a titer of 1:4).

In the Gashunskiy Sovkhoz an investigation was made of 50 sheep from a single composite flock: of these nine were sterile; four had had pneumonia; two had had mastitis of undetermined etiology. Of the nine sheep investigated which were sterile a positive complement fixation test was found in two in titers of 1:8 and 1:16; of four animals which had suffered from pneumonia, a positive complement fixation test was found in one sheep in a titer of 1:8. In the sheep with mastitis the test was negative.

After we recorded the existence of Q fever among sheep attention was directed to the morbidity among people who had undetermined clinical diagnoses, chiefly those who had been in contact with animals.

By means of questioning the population on farm No 4 of the Kirovskiy Sovkhoz ten persons were found who had in the past suffered from a disease similar to Q fever in its clinical signs. Of the ten persons examined, a positive complement fixation test was found in two. In one case, where the patient had suffered from the disease nine months before, the titer was 1:128; in another where only 15 days had passed

after the disease, the reaction titer was 1:16.

In the city of Elista an investigation was made of ten persons who at various times had suffered from a sickness suspected of being Q fever as well as of all the workers in Zagotsherst' Meat Combine (41 persons). The result of the examination of 51 sera failed to confirm the presence of Q fever.

In Chernozemel'skiy Rayon, in the settlement of Komsomol'skiy, four persons were investigated who had had a disease similar to Q fever; among these a positive complement fixation test was obtained in two housewives: in one, in a titer of 1:16 (she had been sick three months before); in another, in a titer of 1:64 (she had been sick four months before). Both patients made personal use of goats, from which their infection possibly occurred. We did not examine the goats.

The clinical picture in all cases was expressed in the same way. The disease began acutely, without prodromal phenomena. The patients complained of fever (temperature of 38.5-40°), headache, rheumatic type pains over the entire body, pains in the gastrocnemius and lumbar muscles. The duration of the febrile period was, on the average, from six to ten days. Then the patients gradually recovered.

After detecting Q fever morbidity among animals and among people we made a study of ticks collected from cattle in these farms and from other places as well as from holes and from rodents which were on the grazing land of these animals. S. M. Kulagin (1956) reports that the rickettsial disease was found in 52 species of ixodial, argasid, and gamasid ticks and thrombiculid mites.

Among Soviet fauna there are many representatives of these species, among which spontaneous infection with Q fever has been determined (Z. N. Zhmayeva, A. A. Pchelkina, F. K. Mishchenko, 1955; P. F. Zdrodovskiy, 1955; V. A. Lysukhina, N. L. Nozharovskaya, 1955, and a number of others).

We made a study of ticks by means of infecting guinea pigs with an emulsion made of 30-50 specimens. After a month, blood was taken from the guinea pigs for the purpose of performing the complement fixation test with the Burnet antigen.

In this way, a total of 1,318 ticks were investigated. These ticks belonged to the species: Hyalomma plumbeum, 1203; Rhipicephalus schulzei, 335; and Ixodes laguri laguri, 230.

The complement fixation test of Q fever antigen with sera obtained from guinea pigs infected by the ticks showed a negative result. We could not establish spontaneous infection of these species of ticks with Q fever; however, this gives us no basis for denying its existence in Kalmykiya.

Therefore, our brief material on the study of animals, ticks and people for infection with Q fever constitute evidence to the effect that among the animals of Kalmykiya

Q fever is widespread; this may be the cause of pneumonia, sterility and abortions among cattle.

Q fever has also been detected among people, chiefly among those engaged in animal husbandry. Frequently, in such cases a clinical diagnosis of brucellosis is made, which is not confirmed by laboratory examinations. Less often, in such patients the disease proceeds without an established diagnosis. In them, a fever, malaise, pains in the muscles and loss of the ability to work are recorded.

All this is evidence of the fact that in Kalmykiya a more detailed study of the epidemiological characteristics of Q fever must be made.

Conclusions

1. As the result of an examination made by means of the complement fixation test using antigen from R. burneti in three regions of Kalmykiya cases of Q fever were established among people and animals.

2. Among the sheep investigated which had suffered from pneumonia, which had aborted and which were sterile, Q fever was demonstrated.

3. On investigation of 24 cases of disease of undetermined etiology in people Q fever was found in four.

4. The investigation of 1,093 specimens of ixodial ticks for Q fever gave a negative result in our experiments. [the figure given in the text for the number of ticks was 1818 above].

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