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PEST RODENTS (RODENTIA: CRICETIDAE, MURIDAE, SCIURIDAE) ON FODDER CROPS IN SOUTH-EAST OF KAZAKHSTAN

Abstract. A total of 8 species of pest rodents from the family of Murids (Muridae), Hamsters (Cricetidae) and Squirrels (Sciuridae), among them the subfamily Gerbils (Gerbillinae) –Lybian jird *Meriones lybicus* Lichtenstein, 1823, Tamarisk jird *Meriones tamariscinus* (Pallas, 1773), great gerbil *Rhombomys opimus* (Lichtenstein, 1823), Mice subfamily (Murinae) - house mouse *Mus musculus* Linnaeus, 1758 and brown rat *Rattus norvegicus* (Berkenhout, 1769), subfamily of voles (Microtinae) - Zaisan, or the eastern mole vole *Ellobius tancrei* Blasius, 1884, and the common vole *Microtus arvalis* (Pallas, 1778), a subfamily of ground squirrels (Xerinae), the yellow ground squirrel *Spermophilus fulvus* Lichtenstein, 1832. Of these, 2 species of and 2 species of murids are optional or complete synanthropes, i.e., capable of harming not only on crops but also in residential, household and storage premises. *R. norvegicus*, *M musculus*, *M. arvalis*, *E. tancrei* have a growing tendency. Same species is most widely distributed in the fields of damaged crops - fixed in Kerbulak on sowing of breadbasket and corn, in Bayserke - on sowing of alfalfa, soya, wheat, barley and corn. The distribution of rodents in the fields of forage crops depends on their ecology. Gerbils have been recorded only on grassland crops. *E. tancrei* is noted on all crops, but abundant only on those without irrigation. *R. norvegicus* needs permanent sources of drinking water and therefore gravitates towards wet habitats, is most abundant in these fields. *M. musculus* and *M. arvalis* are ecologically plastic and common in all cultures. According to the literature, there may be other rodents in the study area that have not yet been identified by us - at least 8 from the families already mentioned above and species from the families of Dipodidae and Gliridae.

Key words: rodents, Rodentia, Cricetidae, Muridae, Sciuridae, fodder crops, "Baiserke Agro" LLP, south-east Kazakhstan, Economic malware threshold (EMT).

Introduction. The rodents (Rodentia) are the largest group of mammals. At present, 2277 rodent species are described. The distinctive feature of the rodent group is the presence of diastema and one pair of large incisors in the upper and lower jaws. They are common everywhere, except for some islands, as well as Antarctica. Body sizes are usually small, ranging from 5 cm in mice to 130 in capybara. On average, they do not exceed 50 cm. The tail may be considerably longer than the body (in mice and jerboas) or may not be present (in guinea pigs). Body and limb shapes may vary quite a lot depending on lifestyle. Jumping forms can have strongly developed hind limbs. In digging, the body gets a rolled shape and well developed claws on the front limbs. There are also planning rodents with lateral skin fold (flying squirrels). Rodents that feed on crops are serious pests, destroying both growing plants and already harvested crops. Of these, mouse-like rodents and ground squirels are the most important in Kazakhstan. Mouse-like rodents are a collective name for small rodents of mouse and hamster families, multi-causative pests that can damage a variety of agricultural and other crops. They are distinguished by their gluttony (the daily mass of food consumed by mouse-like rodents can reach 300% of body weight) and very high fertility (some species are able to give birth regularly throughout the year). They are active all year round: in cold weather during the day, in hot weather at night and at twilight. They cause significant damage to the national economy, especially agriculture: they damage all agricultural crops (especially

perennial grasses and cereals) during the vegetation period; in winter they eat winter sprouts, eat roots and bark of trees and make large stocks of tree seeds; they eat fodder crops in fields, pastures and hayfields; they spoil food and containers in residential and storage buildings and may cause damage to buildings themselves. They can often be hosts of infectious and invasive agents of human and animal diseases. Ground squirrels are multi-causing pests that can damage a wide variety of crops and other crops. They cause the greatest damage to grains, eating both green crops and grains in the ear. Around ground squirrel's dens as a result of such feeding bold spots are formed, with a large population of bred places are combined with each other and crops can be destroyed entirely. The ground squirrels also do no less harm to corn, they dig out germinating seeds, thus significantly thinning the crops. On sprouted plants, they eat up the first gentle leaves and the remaining hemp either die or develop very little. In addition to eating green mass, damage is also caused by digging dens, when a large amount of land is thrown to the surface, thus making it difficult to harvest. On pastures 20-30 individuals per 1 ha can destroy more than half of the forage stock. Newly sown forest belts also suffer from them. Ground squirrels dig out and eat seeds of different tree species on them. In 1 season 1 ground squirrel can eat 4 kg of grain. With 10 individuals per 1 ha, 40 kg of grain will be lost from each. In addition, ground squirrels are hosts of many dangerous zoonotic infections (plague, tularaemia, encephalitis, etc.). Infection occurs through fleas or in direct contact with sick individuals. For these reasons, rodents and methods of control on crops are given considerable attention in world practice [11-20]. In "Bayserke Agro" LLP various fodder crops are grown, the authors constantly conducted and carry out phytosanitary monitoring of crops for pest infestation [10]. Although the main damage to crops is caused by diseases and pests, the damage caused by rodents is also very significant. It significantly exceeds the losses caused by nematodes, molluscs and mites, although less than those caused by insects (9). Therefore, the authors decided to identify rodent species composition in forage crops. Besides, nowadays in Kazakhstan there is a lack of specialists on pest rodents harmful to crops, especially after the untimely death of A.Zh. Agibayev, associate professor of Kazakh Agrarian University, who devoted much time to this topic. This is due to the relevance of this work.

Materials and methods. The material was collected in Talgar and Kerbulak districts of Almaty region by the authors of the publication in 2018-2020 at the implementation of phytosanitary monitoring of fodder crops and other works within the framework of the project IIC RK BR 06249249 "Development of a comprehensive system to improve the productivity and pedigree quality of farm animals, by the example of LLP" Baiserke Agro "on the sub-project 2" Improvement of technology of cultivation and harvesting of fodder crops.

Standard methods were used to collect the material. Rodents were caught by Gero's snap traps and traps №0 and №1, indirect presence of rodents was determined by visual accounting of their burrows. Identification of rodent species and specification of bioecology and economic significance was carried out with the help of bulletins and determinants from the list of literature [1-8]. In the rodent characteristics listed below, crops in the Talgar area are designated as 'Baiserke' and in Kerbulak area as 'Kerbulak'.

Research results. As a result of the research, the following rodent species were observed in the area of fodder crops in the south-east of Kazakhstan.

Family Muridae - Murids

Lybian jird - *Meriones lybicus* Lichtenstein, 1823. Distribution: densely soiled plain and lowland deserts and semi-deserts of Northern Xinjiang, Southern Kazakhstan, Middle and Near Asia, Transcaucasia, Southern Asia Minor, Levant, Western Arabia; Africa north of the Sahel zone. Optional synanthropic species. Grain eater, sometimes pest of grain crops, granaries. Host of highly dangerous infections and helminthoses. Kerbulak, on breadcrumbs crops. Numbers average, did not exceed EMT in 2018-2019.

Figure 1 – Lybian jird

Tamarisk jird – *Meriones tamariscinus* (Pallas, 1773). Distribution: Primarily along river valleys in deserts from Pre-Caucasus through Kazakhstan to southwestern Mongolia and to southern Tajikistan. Optional synanthropic species. Grain eater, sometimes pest of grain crops, granaries. Host of especially dangerous infections and helminthoses. Kerbulak, on breadcrumbs crops. Single number, did not exceed EMT in 2018-2019.

Figure 2 – Tamarisk jird

Great gerbil – *Rhombomys opimus* (Lichtenstein, 1823). Distribution: Lesser deserts of Iranian Highland, Kazakhstan, Central and Central Asia. Feeds on green shoots of plants, harm is insignificant. Carrier of especially dangerous infections and helminthoses. Kerbulak, sporadic colonies near or on breadcrumbs t crops were observed. Single number, did not exceed EMT in 2018-2019.

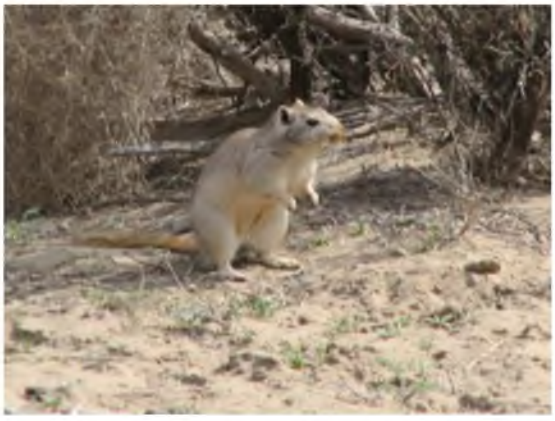

Figure 3 – Great gerbil

House mouse – *Mus musculus* Linnaeus, 1758. Distribution: Worldwide in human settlements. Sinanthropic species. Grain eater, sometimes a pest of grain crops, granaries. Host of especially dangerous infections and helminthoses. Kerbulak, on breadbasket crops. Baiserke, on crops of alfalfa, soybean, barley, wheat and corn. The number is high, but did not exceed EMT in 2018-2019, and in 2020 it tends to grow.

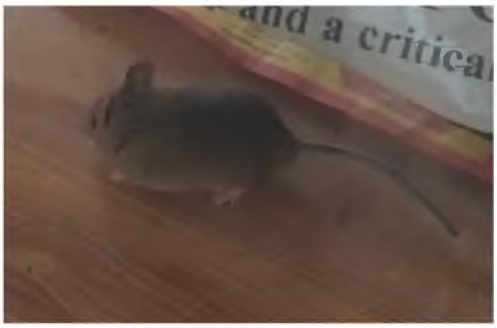

Figure 4 - House mouse

Brown rat – *Rattus norvegicus* (Berkenhout, 1769). Distribution: Originally - Transbaikalia, Priamurye, Primorye, Northeast China; lightly in or near human settlements. Sinanthropic species. Grain eater, sometimes pest of grain crops, granaries. Host of highly dangerous infections and helminthoses. Kerbulak, on cereal crops and corn. Baiserke, on crops of alfalfa, soya, barley, wheat and corn. The number is high, but did not exceed EMT in 2018-2019, in 2020 it tends to grow.

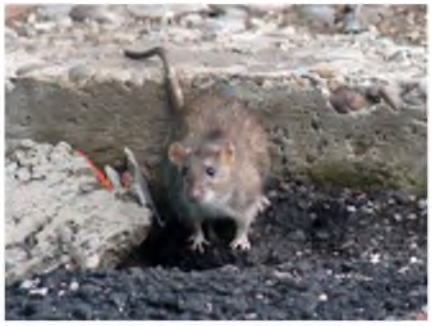

Figure 5 – Brown rat

Family Cricetidae – Hamsters

Zaisan, or Oriental mole vole – *Ellobius tancrei* Blasius, 1884. Distribution: Deserts and semi-deserts of plains and foothills, mountain and alpine steppes and meadows to the east from the Amudarya River to the Alakol basin and Prizaisanya, Tien Shan and Pamir-Alay Mountains up to 4000 m above sea level; isolated in Tuva; northern border is not clarified. Mongolia, North-Western China. Feeds on underground parts of plants, harm is insignificant. Host of highly dangerous infections and helminthoses. Kerbulak, on breadcrumbs and corn crops. Bayserke, on crops of alfalfa, soybeans, wheat, barley and corn. The number is high, but did not exceed EMT in 2018-2019, in 2020 it tends to grow.

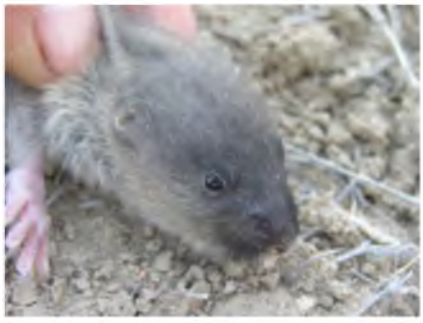

Figure 6 – Zaisan mole vole

The common vole is *Microtus arvalis* (Pallas, 1778). Distribution: South of forest, forest-steppe and steppe zones of Europe, south of Western Siberia, east to Altai, Xinjiang, Northwest Mongolia. Feeds on green shoots of plants, harm is insignificant. Host of especially dangerous infections and helminthoses. Bayserke, on crops of alfalfa, soybaen, wheat, barley. The number is high, but did not exceed EMT in 2018-2019, in 2020 it tends to grow.

Figure 7 – Common vole.

Family Sciuridae - Squirrels.

Yellow ground squirrel - *Spermophilus fulvus* Lichtenstein, 1832. Distribution: Kazakhstan, Central Asia Plain, North-Eastern Iran, North-Western Afghanistan, western Xinjiang. At high numbers it can damage crops. Host of highly dangerous infections and helminthoses. Kerbulak, on crops. Baiserke, on soybeans. Numbers are single, did not exceed EMT in 2018-2019, no upward trend was noted in 2020.

Figure 8 – Yellow ground squirrel

Discussion of research results. In total, we observed 5 species of pest rodents from the family of Murids (Muridae), 2 species from the Hamsters family (Cricetidae) and 1 species from the family of Squirrels (Sciuridae) on fodder crops in the south-east of Kazakhstan. Of these, 4 murids are optional or complete synanthropists, i.e. they are capable of harming not only on crops, but also in living, household and storage areas. Species such as the brown rat *Rattus norvegicus* (Berkenhout, 1769), house mouse *Mus musculus* Linnaeus, 1758, common vole *Microtus arvalis* (Pallas, 1778) and Zaisan or Oriental mole vole *Ellobius tancrei* Blasius, 1884 have a tendency to increase in numbers. These same species are most widely distributed in the fields of damaged crops (table 1).

Table 1 – Species composition and distribution of rodents on forage crops in the south-east of Kazakhstan (Talgar and Kerbulak districts, "Baiserke Agro" LLP) in 2018-2020

Rodent species	Culture					
	Alfalfa	Soyben	Barley	Wheat	Corn	Breadcrumbs
Lybian jird *Meriones lybicus* Lichtenstein, 1823						++
Tamarisk jord *Meriones tamariscinus* (Pallas, 1773)						+
Great gerbil *Rhombomys opimus* (Lichtenstein, 1823)						+
Zaysan, or Oriental mole vole *Ellobius tancrei* Blasius, 1884	++	+	++	++	+	++
Common vole *Microtus arvalis* (Pallas, 1778)	++	++	++	++	++	++
House mouse *Mus musculus* Linnaeus, 1758	++	++	++	++	++	+
Brown rat *Rattus norvegicus* (Berkenhout, 1769)	+	++	+	+	++	+
Yellow ground squirrel *Spermophilus fulvus* Lichtenstein, 1832		+				+
Symbols: + - single findings; ++ - common species.						

As can be seen from the table, the distribution of rodents in fields of forage crops depends on their ecology. Xerophilous species such as gerbils are recorded only on the grassland crops. Oriental mole vole, which due to underground lifestyle does not like overwetting, is noted on all crops, but high numbers are observed only on those crops that do not have irrigation. In fields of water-intensive crops with abundant irrigation, such as soybeans and corn, it is found only in single numbers. The gray rat, which, in contrast, needs permanent sources of drinking water and therefore gravitates towards wet habitats, is most abundant in these fields. The common vole and house mouse, which are common in all cultures, are quite ecologically plastic.

At high numbers, these rodent species can not only cause direct economic damage to plants, but also cause disease in humans and domestic animals, because they are hosts of their pathogens. For this reason, their numbers should be constantly monitored and protective measures should be taken if necessary. According to the literature, other rodents may also be present in the study area that we have not yet noted - at least 8 representatives of the families already mentioned and species from the families of Dipodidae and Gliridae.

Conclusion. Of the 8 species of pest rodents identified on fodder crops in the south-east of Kazakhstan, 4 species of murids are optional or complete synanthropists, which can harm not only crops, but also in residential, household and storage facilities. The increase in numbers is observed in the brown rat *R. norvegicus,* house mouse *M. musculus,* common vole *M. arvalis* and oriental mole vole *E. tancrei*. They are also the most widespread in the fields of damaged cultures. Thus, when conducting surveys and predicting an outbreak of mass reproduction of pest rodents, attention should be paid first to these species.

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ОҢТҮСТІК-ШЫҒЫСЫНДАҒЫ ҚАЗАҚСТАННЫҢ ЖЕМДІК ДАҚЫЛДАР ЕГІСІНДЕГІ ЗИЯНДЫ КЕМІРГІШТЕР (RODENTIA: CRICETIDAE, MURIDAE, SCIURIDAE)

Аннотация. Қазақстанның оңтүстік-шығысындағы жем – шөп дақылдарының егістігінде барлығы қамыт тұқымынан (Cricetidae) шыққан зиянды кеміргіштердің 5 түрі: қызылқұйрық құмтышқан Meriones lybicus Lichtenstein, 1823, жыңғыл құмтышқаны *Meriones tamariscinus* (Pallas, 1773), үлкен құмтышқан *Rhomomys opimus* (Lichtenstein, 1823), зайсан, немесе шығыс соқыр *Ellobius tancrei Blasius*, 1884, кәдімгі тоқалтіс *Microtus arvalis* (Pallas, 1778) (Cricetidae); 2 түрінің бірі-отағасы Мышиные (Muridae) – үй тышқан *Mus musculus Linnaeus*, 1758 және сұр егеуқұйрық *Rattus norvegicus* (Berkenhout, 1769), және 1 түрі тектес Беличьих (Sciuridae) – сары саршұнақ *Spermophilus fulvus Lichtenstein*, 1832. Олардың 2 түрі қамыт (қызыл-сүйекті және тарақ құмы) және 2 түрі тышқан (сұр егеуқұйрық және үй тышқаны) факультативтік немесе толық синантроптар болып табылады, ягни егісте гана емес, тұргын, шаруашылық және қойма үй-жайларында зиян келтіруі мүмкін. Санының өсу үрдісі сұр егеуқұйрық *R. norvegicus*, үй тінтуір *M. musculus* сияқты түрлері бар, кәдімгі дала *M arvalis* және зайсан, немесе шығыс соқыр *E. tancrei*. Бұл түрлер зақымданган дақылдардың алқаптары бойынша кең таралған – кербұлақта еркекшөп пен жүгері егістіктерінде, Байсерке – жоңышқа, майбуршақ, бидай, арпа және жүгері егістіктерінде тіркелген. Кеміргіштердің азықтық дақылдар алқаптары бойынша таралуы олардың экологиясына байланысты. Құм сияқты ксерофильді түрлер тек еркекшөп егістіктерінде гана белгіленген. Жер асты өмір салтына байланысты шамадан тыс жақсара алмайтын шығыс соқыр, барлық дақылдарда атап көрсетілген, бірақ жогары саны суарылмайтын олардың ішінде гана байқалады. Майбуршақ және жүгері сияқты мол суарылатын дәнді дақылдардың егістіктерінде ол тек қана бірлі-жарым мөлшерде табылган. Керісінше, ауыз судың тұрақты көздеріне мұқтаж сұр егеуқұйрық, осыган орай ылғалды жерлерге көшіп кетеді, осы алқаптарда көп. Кәдімгі тоқалтіс және үй тышқан, барлық дақылдарда қарапайым экологиялық пластикалық. Жаппай көбею өршуі кезінде осы зиянды кеміргіштер өсімдіктерге тікелей экономикалық зиян келтіріп қана қоймай, адамдар мен үй жануарларының ауруларын тудыруы мүмкін, себебі олардың қоздырғыштарын таратушылар болып табылады. Осыган орай олардың санына тұрақты мониторинг жүргізу және қажет болган жағдайда-қоргау іс-шараларын жүргізу қажет. Осылайша, зиянды кеміргіштердің жаппай көбеюін зерттеу және болжау кезінде бірінші кезекте аталган түрлерге назар аудару керек. Әдеби мәліметтер бойынша, қоршалган аумақта басқа да кеміргіштер, әзірге біз белгілемеген – жогарыда көрсетілген тұқымдастардың кем дегенде 8 өкілі және ұша тұқымдастарынан (Dipodidae) және ұйқы тұқымдастарынан (Gliridae) тұратын түрлер болуы мүмкін.

Түйін сөздер: кеміргіштер, Rodentia, Cricetidae, Muridae, Sciuridae, жемшөп дақылдары, "Байсерке Агро" ЖШС, Оңтүстік-Шығыс Қазақстан.

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ВРЕДНЫЕ ГРЫЗУНЫ (RODENTIA: CRICETIDAE, MURIDAE, SCIURIDAE) НА ПОСЕВАХ КОРМОВЫХ КУЛЬТУР НА ЮГО-ВОСТОКЕ КАЗАХСТАНА

Аннотация. Всего на посевах кормовых культур на юго-востоке Казахстана нами было отмечено 8 видов вредных грызунов из семейства Мышиных (Muridae), Хомяковых (Cricetidae) и Беличьих (Sciuridae), среди них: подсемейство Песчанковые (Gerbillinae) – краснохвостая песчанка *Meriones lybicus* Lichtenstein, 1823, гребенщиковая песчанка *Meriones tamariscinus* (Pallas, 1773), большая песчанка *Rhombomys opimus* (Lichtenstein, 1823), подсемейство Мышиные (Murinae) – домовая мышь *Mus musculus* Linnaeus, 1758 и серая крыса *Rattus norvegicus* (Berkenhout, 1769), подсемейство полевок (Microtinae) – зайсанская, или восточная слепушонка *Ellobius tancrei* Blasius, 1884, и обыкновенная полевка *Microtus arvalis* (Pallas, 1778), подсемейство земляные белки (Xerinae) – желтый суслик *Spermophilus fulvus* Lichtenstein, 1832. Из них 2 вида песчанковых (краснохвостая и гребенщиковая песчанки) и 2 вида мышиных (серая крыса и домовая мышь) являются факультативными или полными синантропами, т.е. способными вредить не только на посевах, но в жилых, хозяйственных и складских помещениях. Тенденцию к росту численности имеют такие виды, как серая крыса *R. norvegicus*, домовая мышь *M. musculus*, обыкновенная полевка *M arvalis* и зайсанская, или восточная слепушонка *E. tancrei*. Эти же виды имеют наиболее широкое распространение по полям повреждаемых культур и зафиксированы в Кербулаке на посевах житняка и кукурузы, в Байсерке – на посевах люцерны, сои, пшеницы, ячменя и кукурузы. Распределение грызунов по полям кормовых культур зависит от их экологии. Такие ксерофильные виды, как песчанки отмечены только на посевах житняка. Восточная слепушонка, которая в силу подземного образа жизни не любит переувлажнения, отмечена на всех культурах, но высокая численность наблюдается только на тех из них, на которых отсутствует полив. На полях влагоемких культур с обильным поливом, таких как соя и кукуруза, она найдена только в единичных количествах. Серая крыса, которая, напротив, нуждается в постоянных источниках питьевой воды, и в силу этого тяготеет к влажным местообитаниям, наиболее многочисленна на этих полях. Достаточно экологически пластичны обыкновенная полевка и домовая мышь, обычные на всех культурах. При вспышке массового размножения данные вредные грызуны способны нанести не только непосредственный экономический ущерб растениям, но и вызвать заболевания людей и домашних животных, поскольку являются переносчиками их возбудителей. В силу этого следует вести постоянный мониторинг их численности и в случае возникновения необходимости – проводить защитные мероприятия. Таким образом, при проведении обследований и прогнозировании вспышки массового размножения вредных грызунов следует в первую очередь обращать внимание на указанные виды. По литературным данным, на обследуемой территории могут присутствовать и другие грызуны, пока не отмеченные нами – по меньшей мере 8 представителей из уже указанных выше семейств и виды из семейств тушканчиков (Dipodidae) и соневых (Gliridae).

Ключевые слова: грызуны, Rodentia, Cricetidae, Muridae, Sciuridae, кормовые культуры, ТОО «Байсерке Агро», юго-восточный Казахстан, экономический порог вредоносности (ЭПВ).

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REFERENCES

[1] Gromov I.M., Erbaeva M.A. (1995) Mammal fauna of Russia and adjacent territories. Hares and rodents. St. Petersburg: ZIN RAS (in Russ.).

[2] Karaseva E.V., Telitsyna A.Yu., Zhigalsky O.A. (2008) Methods of studying rodents in the field. M.: Publishing House of LCI (in Russ.).

[3] Nurmuratov T.N. (1998) Insects and rodents that live on desert pastures of southeastern Kazakhstan. Almaty: Ұonzhyҙ (in Russ.).

[4] Pavlinov I.Ya. (2006) Systematics of modern mammals. 2nd Edition. M.: Publishing House Moskau University. (in Russ.).

[5] Pavlinov I.Ya., Lisovsky A.A. (ed.). (2012) Mammals of Russia: a systematic and geographical reference. M.: KMK scientific publications (in Russ.).

[6] Panteleev P.A. (2010) Rodentology. M.: Partnership of scientific publications of KMK (in Russ.).

[7] Sludsky A.A., Bekenov A.B., Borisenko V.A., Grachev Yu.A. et al. (1977) Mammals of Kazakhstan. In 4 volumes. T. 1. Part 2. Alma-Ata: Science of the Kazakh SSR (in Russ.).

[8] Sludsky A.A., Borisenko V.A., Kapitonov V.I., Makhmutov S. et al. (1978) Mammals of Kazakhstan. In 4 volumes. T. 1. Part 3. Alma-Ata: Science of the Kazakh SSR. (in Russ.).

[9] Govorushko S.M. (2014) Mammals and birds - agricultural pests: a global situation. Agricultural biology, 6: 15-25. DOI: 10.15389/agrobiology.2014.6.15rus (in Russ.).

[10] Temreshev I.I., Makezhanov A.M., Tursynkulov A.M., Yeszhanov A.B. (2019) On species composition of Insecta Coleoptera of feed crop fields in the Kerbulak branch of Bayserke-Agro LLP. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of Agricultural Sciences, 5 (53): 113-125. DOI: 10.32014/2019.2224-526X.69 (in Eng.).

[11] Pimentel D., Wilson C., McCullum C., Huang R., Dwen P., Flack J., Tran Q., Saltman T., Cliff B. (1997) Economic and environmental benefits of biodiversity. Bio Science, 47 (11): 747-755. DOI: 10.2307/1313097 (in Eng.).

[12] Youder J. (2002) Estimation of wildlife-inflicted property damage and abatement based on compensation program claims data. Land Econ., 78 (1): 45-59. DOI: 10.2307/3146922 (in Eng.).

[13] Loth Mulungu, Ladslaus Mnyone, Bernard M. Mchukya (2020) Trap Barrier System (TBS) as a New Tool for Rodent Pest Management in Irrigated Rice in Africa. In book: Pests Control and Acarology. DOI: 10.5772/intechopen.81828 (in Eng.).

[14] Nils Chr Stenseth, Herwig Leirs, Anders Skonhoft, Stephen A Davis, Roger P Pech, Harry P Andreassen, Grant R Singleton, Mauricio Lima, Robert S Machang'u, Rhodes H Makundi, Zhibin Zhang, Peter R Brown, Dazhao Shi, Xinrong Wan (2003) Mice, rats, and people: the bio-economics of agricultural rodent pests. Frontiers in Ecology and the Environment. DOI: 10.2307/3868189. (in Eng.).

[15] Sara Fratini, Chiara Natali, Stefania Zanet, Alessio Iannucci (2020) Assessment of rodenticide resistance, eradication units, and pathogen prevalence in black rat populations from a Mediterranean biodiversity hotspot (Pontine Archipelago). Biological Invasions, DOI: 10.1007/s10530-019-02189-1 (in Eng.).

[16] Alex Mayamba, Bram Vanden Broecke, Herwig Leirs, Brian Eriphaz Isabirye (2019) Fitness of the pestiferous small rodent *Mastomys natalensis* in an agroecosystem in Mayuge district, Lake Victoria Crescent, Uganda. Mammalia, 84 (4). DOI: 10.1515/mammalia-2019-0101 (in Eng.).

[17] Loth Mulungu (2017) Control of rodent pests in maize cultivation: the case of Africa. Chapter (PDF Available). In book: Achieving sustainable cultivation of maize. 2: 317-33710. DOI: 19103/AS.2016.0002.18 (in Eng.).

[18] Brown Peter, Douangboupha B., Nyo Me Htwe, Jens Jacob (2017) Control of rodent pests in rice cultivation. Chapter (PDF Available). In book: Achieving sustainable cultivation of rice. 2: 343-376. DOI: 10.19103/AS.2016.0003.24 (in Eng.).

[19] Nyo Me Htwe, Grant R Singleton, David E. Johnson. (2019) Interactions between rodents and weeds in a lowland rice agro- ecosystem: the need for an integrated approach to management. Integrative Zoology, 14 (4). DOI: 10.1111/1749-4877.12395 (in Eng.).

[20] Clare Jones, Renee Lorica, James Michael Villegas, Angelee Fame Ramal. (2016) The stadium effect: rodent damage patterns in rice fields explored using giving-up densities. Integrative Zoology, 12 (6). DOI: 10.1111/1749-4877.12251 (in Eng.).