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MONITORING OF BROWN RATS ON THE TERRITORY OF MEGALOPOLIS

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Abstract In 2013-2016 annually questionings of the Moscow and Kostroma (Russian Federation) populations was carried out in July and October for detecting brown rats' habitats. The suitability of this method for reconnaissance evaluation of their spatial distribution, taking into account the nature of favorable conditions, and for quality evaluation of the works on the management of brown rats' number is shown. The dependence of rats' detection frequency on respondents' number is found. Selective data of urban residents' interviews is confirmed by the results of observations conducted by professionals.

Key words Brown rat, the incidence of rat, rodent control in the city, questioning the city's population

INTRODUCTION

The presence of Brown rats in metropolitan areas and in small regional centers is an indicator of municipal sanitary troubles. Detection of rats in the streets of the city is the result of the poor work of public services, the rate of inefficiency control measures against rats in urban buildings and in open areas, which finally reduces the life of the townspeople. Assessment of the relative density of the Brown rat *(Rattus norvegicus* Berk., etc., rats) and evaluation of rodent in the metropolis Moscow, is not an easy task. But even in the cities of regional subordination, this task is impossible in the absence of informative, at the same time, inexpensive methods. One of such methods is the questionings of population to detect the rat in the city, which is the aim of the present study.

For this study, the following tasks were set: 1) confirmation via surveys residents priori hypothesis about the presence of rats in the areas of the city; 2) the dependence of the detection rats (rats/km^2) on the share of respondents (people / km2); 3) types of frequency distribution of the detection rats index. Places of Brown rats detection on the map, in the hands of an experienced and competent pest controller, is a powerful tool that allows choosing the right tactics and strategy of the pest control and preventive work, to check the results of their activities by assessment of independent

MATERIALS AND METHODS

Our studies have begun in 2013 and are still going on. The places of rats' detection in the cities we get with the help of questioning of the townspeople during the 2013-2016. Randomly selected respondents were asked to answer the following questions: 1. Have you ever seen rats in your home and / or in the surrounding area: since the spring (in the survey in June); since the autumn this year (in the survey in October) till the present time? (If no, pass to question 3, if so, to question 2). Question 2. Please let us know the street and house number, where you have seen rats. Question 3. Can you name the other

addresses, where you have seen rats? Each survey involved residents of several urban areas. Obtained based on sociological survey addresses of rats' detection we mark on a special map. Microsoft software package was used for statistical processing and illustration of a sociological survey data, IBM SPSS Statistics 22.

To confirm a priori hypothesis about the presence of rats in the districts of the city we used Bayes' theorem, based on surveys of residents.

Virtual maps with marks of rats meetings in Moscow and Kostroma, data analysis, as well as information about the resistance of rats to anticoagulants are published freely accessible on the Internet at www.ratcompany.ru site. For translation from Russian, you can use the program Imtranslator - application to Firefox or other available means.

RESULTS AND DISCUSSION

In total for 4 years 4604 people, living in the cities of Moscow and Kostroma, took part in the study. Interviews conducted twice a year in the period of the greatest rat activity. To conduct interviews often economically did not seem appropriate. Regardless of the time of year, the municipal district and the year of survey in Kostroma 13-16% respondents met the rats in the study period. For the megacity, this rate was 26-32%. Placement the addresses of detected rats at inspection of the buildings and the territory of Kostroma, according to cumulative data for 2014-2016, in general corresponds to each other, although the point of rats' meeting are located disorderly.

A comparison of the spatial and temporal dynamics of Brown rats in open areas and buildings in Kostroma in 2014-2016 was carried out. Figure 1 shows that revealed seasonal patterns correspond to the generally accepted idea of the seasonal dynamics.

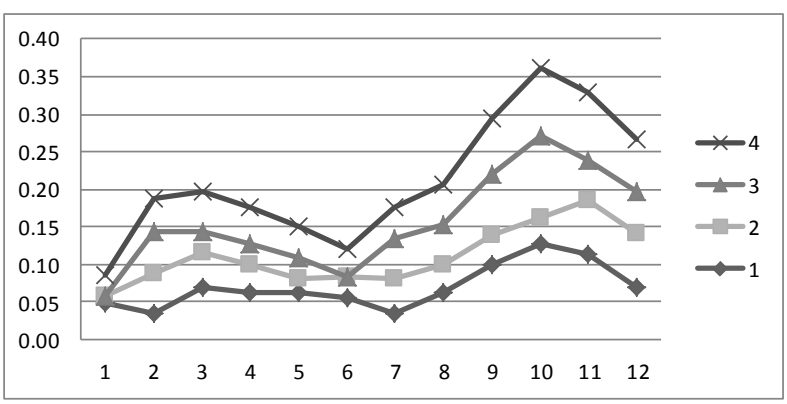

Figure 1. Rats' detection density in Kostroma based on average data for 2014-2015 monitoring in buildings. Ordinate axis- density of the rats 'detection places, abscissa axis- the number of survey month. 1 – Central district, 2 - Fabrichny district, 3- Zavolzhsky district, 3- summary municipal data

Figure 2 shows that the index distribution of the places of rats' detection in the monitored cities tends to lognormal distribution. The asymmetry of investigated variational series <3, that is not essential. Its presence is due to the influence of various accidental circumstances. Deviations from the normal distribution of excesses as not significant. According to the Student t-test with a probability of 0.954 can be argued that the average value of the sample at a larger volume will not go beyond the found interval.

In accordance with the studies conducted in Kostroma compliance of the index of dynamics of the density of places of the rats' detection according to surveys in open areas, with the dynamics of the density of places of the rats' detection in the buildings of the city, to the greatest extent, observed in if the survey was conducted with the stated density distribution of respondents from 1,84 people/km^2. Under respondent density of 0.63 people/km^2 these regularities do not appear. Stated above gives us the

grounds to make an adjustment to the method of using the population' questionings as an indicator of Brown rats location in the city, setting the limit of the number of respondents to be not lower than 1.84 persons/km^2 (Bogacheva, 2016).

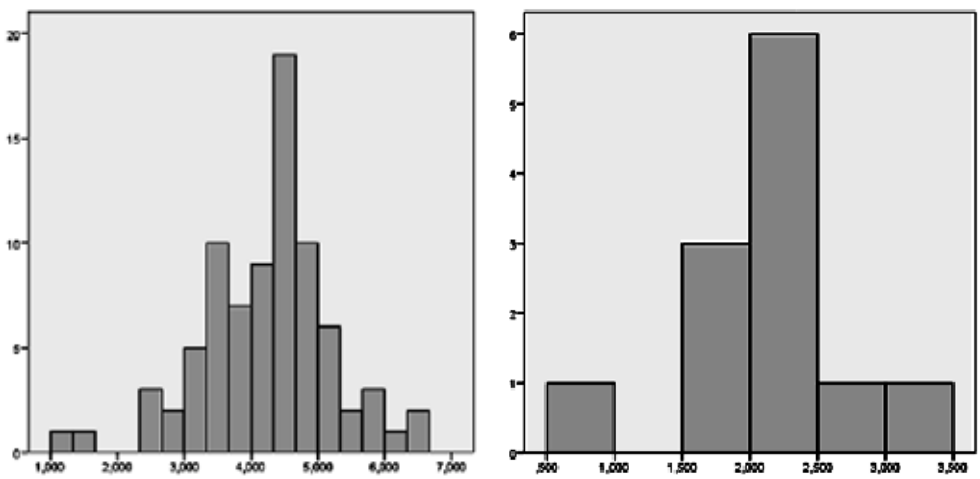

Figure 2. Logarithmic distribution the places of rats' locations in Moscow (left) (rats/km^2) and Kostroma (right) according to generalized interviews data 2013-2016 (Moscow) and 2014-2016 (Kostroma). Ordinate axis - the relative frequency of rats' location index, abscissa axis – logarithm of values of rats' location index (rats/km^2).

In Moscow, the density of respondents is conventionally divided into 6 groups, density of places the rats' detection were also divided into 6 groups. Figure 3 shows that the limit of 1.84 persons/km^2 is included in the group 3. The third group of respondents was selected for further studies to test the hypothesis of a necessary minimum of respondent number for conducting questionings.

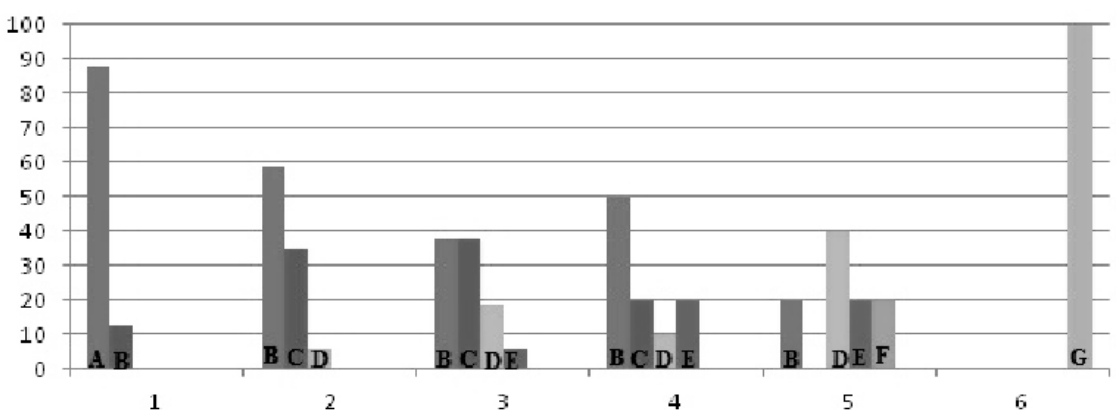

Figure 3. The density of rats' detection Moscow.On the abscissa axis - the group of respondents by density. Group 1: 0,1-2,74 people/km^2, Group 2: 2,75-5,48 people/km^2, Group 3: 5,49-8,22 people/km^2, 4 group: 8,23-10,96 people/km^2, group 5: 10,97-13,70 people/km^2, 6 group: more than 13.70 people/km^2. On the ordinate axis - the share of rats' groups of with different densities. Group 1 (0-0,84 rats/km^2) - Column A, group 2 (0,85- 1,68 rats/km^2) - Column B, Group 3 (1,69 - 2.52 rats/km^2) - the C column, group 4 (2.52 - 3.36 rats/km^2) - the D column, group 5 (3,36-4,2 rats/km^2) - the E column, group 6 (more than 4.3 rats/km^2) - column G.

The observed pattern of detection rats in Moscow and Kostroma is, in many respects, a reflection of the conditions that created for rats by people. Favorable conditions stimulate the active reproduction of the resident population of rats and attracts immigrants from neighboring areas (Rylnikov and Tuchkova, 2013). Results of the survey of city residents are used to verify a priori hypotheses about the degree of influence of indicators of favorable conditions for the rats in the different municipal districts. on their numbers. The probability of meeting the rats by citizens in open areas of the city - P (B) = 0.3 - survey data. Let a priori probability characterizing the presence of rats, P (A) = Y, where Y will take the values depending on the conditions favorable to the presence of rats. It should be noted that we have developed the method of evaluation of favorable conditions for rats, for a single object (Rylnikov, 2013). Obviously, it will require its rework according to the conditions of the municipal districts. The probability of rats meeting by citizens in the places with known food sources (e.g., areas for waste collection and food waste), P (B/A) = β. When β = 0,1, Y = 0,7, then, according to Bayes' theorem, the posterior probability, proof of actual data is: P(A/B)=(P(A)×P(B/A))/P(B)=(0.7×0,1)/0,3=0,23. When β=0,01, Y=0,7, P(A/B)=0,023. The probability of confirmation of the rats' presence will decrease with a reduction the probability of rats' detection around garbage dumps. When β = 0,01, Y = 0,95, P (A/B) = 0.032. That is, the probability of confirmed rats presence will grow with complex conditions favorable to the life of rats. When β = 0,2, Y = 0,95, P (A/B) = 0.63. This means that the probability of confirmed rats presence will increase with the probability of their meeting in the places of garbage dumps.

Let's estimate maximum number of rats in Moscow, based on the amount of food waste - the main source of the rats' feeding, which, undoubtedly, is a limiting factor. 186 grams of organic waste accounted per person per day of which some part, assumed 50%, is food (Sapozhnikova, 2017). Tainted food rats do not eat, but its share may not be large, assumed 10%, that is 84 grams of benign (in terms of the rat) waste. One adult rat can eat 15 grams of dry food and 30 grams - wet, i.e. 45 grams per day. Food waste from one person can feed about 2 rats per day. At the same time, the number of Moscow's population in 2014 was 12,111,000 people (Goroda Rossii, 2017). The maximum of rat numbers in Moscow, taking into account only the amount of food waste is 12111 00 x 2 = 24222 000 animals. The rats usually feed in the available sources of food raw materials, food, fodder, especially in places of domestic, agricultural and service animals. Compassionate old women feed up stray cats and pigeons around the apartment houses, a lot of food waste is around the street food stalls, markets, etc. One cannot ignore the possibility of feeding the rats by small animal food: invertebrates, amphibians, reptiles, clutches birds, small mammals, as well as the vegetative parts of cultivated and wild plants, their fruits and seeds. The actual number of rats would fall to spring and would increase to autumn due to breeding. In addition, the number of rats is under pressure of natural mortality factor in the autumn-winter period and forced mortality as a result of rodent pest control (Rylnikov, 2010). Presumably, all additional food sources, taken together, can provide increasing the number of rats in 1.5-2.0 times, that is 3-4 rats per person. The calculated maximum number does not reflect the real number of rats in the city, which, in fact, can be several times below the maximum possible number.

The sanitary and epidemiological welfare of the population - is a state of public health and the human environment in which there is no harmful impact of environmental factors on human and there are favorable conditions for its functioning. Favorable conditions of human life - is a state of the environment in which there is no harmful effect of its factors on human (harmless conditions) and there is potential for the recovery of disturbed functions of the human organism. The absence of rodents and their metabolic products is an integral part of measures aimed at achieving these goals. General and selective evaluation of detection of rodents by such application methods, as tracking devices, traps Gero, arc traps are highly expensive in terms of both financial and manpower, even in a small town, not to mention such metropolis like Moscow. The evaluations of the presence / absence of rodents by town's people should be recognized not less important than the estimates made by experts, because the rats is

sanitary conditions indicator. According V.V.Kucheruk the use of the visual (score) assessment of the number of rodents can be recommended for a questionnaire (Kucheruk, 2006). Experts can use the survey materials for the primary determination of rats activity areas in the city, and following monitoring by objective control methods: tracking devices, Gero traps and arc traps. Efficiency of measures against rodents consists of stages, each of which contributes to the resulting value.

The factors that determine the number of rodents on controlled objects include: the natural course of the rodent population dynamics depending on reproduction, mortality, immigration and emigration; the capacitance of rodent habitats, which depends on the purpose of the object (objects of increased risk: food objects, houses, children, medical - prophylactic objects, etc.), the sanitary condition, skill of pest control operator (disinfectant), which depends on the theoretical knowledge and practical skills for the qualitative conduct pest control on objects.

The tasks and solutions:

1. Correction of a priori hypotheses about the probability of the presence of rats in the municipal districts with favorable conditions for their dwelling can be carried out using a model based on Bayes' formula, in which, to confirm the data of the survey population can be used;

2. The index of rats' detection (rats/km^2) is proportional to the number of respondents (people/km^2);

3. Hypothesis of logistical dependence of the rats' detection index on the number of respondents (people/km^2) can find evidence under higher respondents density; however, we will face the problem assess the economic feasibility of such increasing;

4. The frequency of the detection rats generally corresponds to a logo-normal distribution;

5. The data of interviewing may be used as a reconnaissance estimation of rats' abundance in the city, including quality evaluation of conducted disinfestation.

6. If there is information on the number and distribution of brown rats in the city is possible to predict the risk of rats' appearance anywhere in the city and rural settlements.

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