

Population of the *Columba livia* in Yoshkar-Ola and execution of the ecological project "Watch out, ornithosis!"

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Abstract. In the manuscript, the authors described the results of the evaluation of the *Columba livia* population in Yoshkar-Ola (Russia). In the period from 2018 to 2022, the population density of pigeons in the city center increased by 15% and amounted to about 1,000 individuals per km². The increase in the number of *C. livia* is not safe for humans. *C. livia* are most active during the day at permanent locations where they are fed by people. Of the five color morphs, dark-gray prevails. Pigeons belonging to the dark-gray morph are the most adapted to life in urban conditions. As part of the first phase of the project "Watch out, ornithosis!" from the Presidential Grants Foundation of the Russian Federation we conducted a survey of the citizens. As a result of the survey, we identified risk groups of the people due to ignorance about the features of the disease ornithosis. Older people feed pigeons more often and do not know about the diseases that birds carry. Schoolchildren also do not know about ornithosis. The next stage of the project will be the dissemination of preventive information about ornithosis and other diseases carried by pigeons, preventive measures.

1 Introduction

Currently, the population of synanthropic bird species in cities is increasing every year, which draws the attention of scientists to the study of the processes of formation of stability of synanthropic bird species, such as the *Columba livia* (Gmelin, 1789) [1-3]. Adaptations and long-term existence of a population in changing environmental conditions are determined by the polymorphism of the species. The nature of polymorphism allows researchers to assess the state of the population and the degree of compliance of environmental conditions with the ecological requirements of the species. A change in the polymorphic structure can be used for bioindication purposes [4]. The adaptive capacity of the *C. livia* population is manifested in forage harvesting - food waste. *C. livia* can be a vector of infectious human diseases. Increase of *C. livia* in cities may lead to the threat of epidemics [5, 6]. Our research has revealed the dominant species of birds, individuals of which are constantly in the recreation areas of Yoshkar-Ola and near human habitation – this is *C. livia*. There is not enough information about the population of *C. livia* on the territory of Yoshkar-Ola, as well as people's awareness of the biological danger from *C. livia*.

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The purpose of this work is to analyze the state of the *C. livia* population in the central part of the city of Yoshkar Ola and to present the first results of the project "Watch out, ornithosis!" from the Presidential Grants Foundation of the Russian Federation.

2 Materials and methods

We conducted research in Yoshkar-Ola (Mari El Republic, Russia). We studied the seasonal dynamics of *C. livia* abundance during 2018-2019 and 2021-2022. The birds were counted by the route method, on a transect with a fixed width [7, 8]. We counted the birds in the recreation area, in the city center. The central part of the city is classified as a zone of moderate environmental pollution with an average road load, since there are no large industrial enterprises here [9, 10]. The length of the route traversed during the accounting was 4.5 km (Figure 1). During one season of the year, at least 3 bird counts were carried out. The total length of the route was 130.5 km. The registration was carried out constantly at the same time – from 10.00 to 12.00. We counted all the pigeons, including those sitting on the ground and buildings, as well as flying.

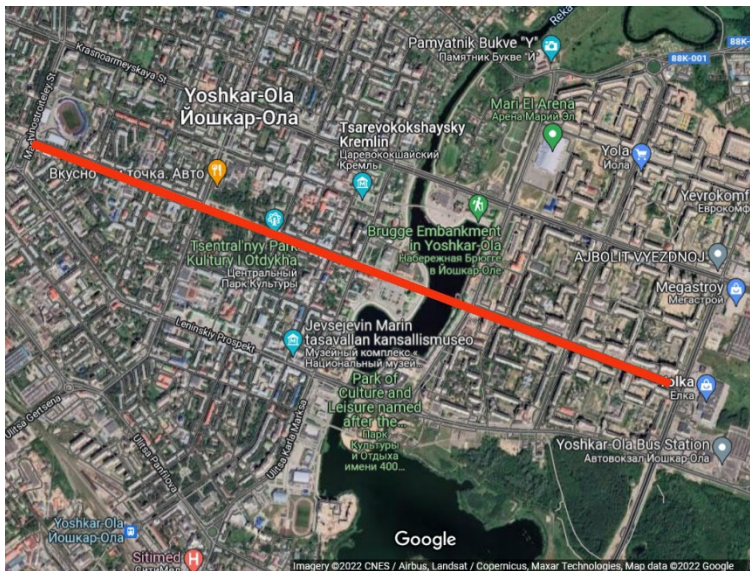


Fig. 1. Place of research (coordinates from 56°38'24.8"N 47°52'19.0"E to 56°37'43.1"N 47°55'38.2"E) [11].

When studying the diurnal dynamics of *C. livia*, we used the method of accounting for the number of birds in the anthropogenic landscape [12]. 5 sites were selected in different parts of the city – permanent locations for feeding birds by the population and places for installing garbage containers. The distribution pattern of *C. livia* micropopulations in the city was studied. To determine the color of pigeons, the classification of A.S. Ksencz was used [13].

As part of the "Watch out, ornithosis!" project, performers and volunteers in February – May 2022 conducted a survey of the people demonstrating their level of knowledge about ornithosis and other diseases carried by urban birds. 1,138 residents and guests of Yoshkar-Ola and the village of Medvedevo took part in the offline and online survey. The questionnaire included 10 questions. The online questionnaire was created on the Google forms platform, which we distributed via social networks and messengers.

For the statistical analysis we used the χ^2 criterion, ANOVA, Scheffe's test [14].

3 Results and discussion

We found that the population density of *C. livia* in the city center increased by 15% over the years of the study and averaged 846 birds per 1 km² in 2018, and 976 birds in 2022 ($\chi^2=33.379$, $v=3$, $P<0.01$). Such a high number of *C. livia* can be explained by the absence of predators, the presence of shelters for hatching offspring (attics of buildings, roof vents), the availability of food in dumpsters. In addition, there are permanent locations on the central city boulevards and in the courtyards of houses, where people feed pigeons for many years. Birds wait food from human even in the summer (Figure 2).



Fig. 2. *Columba livia* on boulevard in Yoshkar Ola.

As a result of the study of the daily dynamics, it was revealed that the number of pigeons at the selected sites is relatively the same at the same time of day both in summer and in winter ($P>0.05$). Urban pigeons are most active during the day: the maximum number of pigeons at all sites was observed in the time interval from 12 a.m. to 13 p.m. ($\chi^2=32.5$, $P<0.01$). This is probably due to the high illumination and the need of birds for food. Pigeons are less active in the morning and evening hours. On the territory of some sites, garbage was being removed with the help of heavy machinery, which, with its appearance and noise, scared the birds away, and they did not return to their usual places for a long time after that. The daily dynamics of fluctuations in the number of pigeons of different sexes at different sites is approximately the same, no statistically significant difference was found ($P < 0.05$).

In the city of Yoshkar-Ola, the main color morphs of *C. livia* are represented: dark-gray – 78.9%, blue - 12%, black color – 6.8%, brown-gray - 0.9% and brown – 1.4%. The study revealed the highest number of pigeons of the dark-gray morph (Figure 2). Studies conducted by a number of scientists have shown that individuals of the dark-gray morph are more viable in urbanized landscapes. A prerequisite for the preservation of urban pigeon populations is the presence of individuals of a bluish morph – the initial type of coloration in the gene pool of the population [15].

The increase size of *C. livia* population in the recreational part of the city is unsafe for humans. It is known that *C. livia* are carriers of about 90 pathogens of various diseases, of which about 10 are zoonoses – diseases transmitted to humans, among which ornithosis is the most dangerous. The causative agent of psittacosis is the intracellular parasitic bacterium

Chlamydophila psittaci (Lillie, 1930). There are symptoms of the disease such as general intoxication of the body, fever, damage to the lungs and nervous system, liver and spleen enlargement, the occurrence of thromboses. Full recovery occurs 2-3 months after starting treatment. Diagnosis of ornithosis is difficult, since the symptoms of the disease are similar to other respiratory infections [6, 16, 17].

Our project "Watch out, ornithosis!" was supported by a grant from the President of the Russian Federation for the development of civil society. The goal of the project is the prevention of human diseases transmitted by urban birds, by increasing the medical, biological and environmental literacy of residents and visitors of our city. There are some results of the first phase of the project.

To the question, "Is it necessary to feed urban birds?" the majority of female respondents answered in the affirmative (72%), only 46% of men responded in the same way ($\chi^2 = 73.54$, $\nu = 1$, $p < 0.001$). Schoolchildren consider it necessary to feed urban birds (77%), unemployed citizens less often answered this question positively (42%) ($\chi^2 = 27.12$, $\nu = 4$, $P < 0.001$). Question No. 5 suggested that we choose the birds that people feed. The choice of respondents was distributed in descending order of answers: *Passer*, *Parus* and *Pyrrhula*; *Columba*; Corvidae; Anatinae. Pigeons are fed by about 30% of respondents in descending order: elderly people, schoolchildren, students, working citizens and the unemployed; also more often women than men.

Question No. 7 "What role do pigeons play in human life?" with multiple choice revealed the following opinion of respondents in descending order of votes: pollute urban facilities with droppings, spread human diseases, contribute to improving the emotional background. Some people falsely think that pigeons destroy insect pests, others believe that these birds do not play any role. However, we were primarily interested in the awareness of the people regarding the spread of human diseases by pigeons. Distribution of results on this issue in descending order of knowledge about ornithosis: students, working citizens, schoolchildren, unemployed citizens and pensioners. Most residents see that the number of pigeons in our city is increasing (55.5%). Only schoolchildren think equally (45%) that the number of *C. livia* either increases or does not change ($\chi^2 = 55.52$, $\nu = 8$, $P < 0.01$). Citizens think that pigeons should forage themselves, but they need to be fed only in winter (43.8%). Men believe that people should not feed pigeons (56%) ($\chi^2 = 62.13$, $\nu = 2$, $P < 0.001$). A similar opinion is shared by residents of the districts of the Republic of Mari El – 46% ($\chi^2 = 16.31$, $\nu = 4$, $P < 0.01$) and the working population – 49% ($\chi^2 = 147.63$, $\nu = 8$, $P < 0.01$).

Despite the differences in the answers, the majority of respondents (73.5%) firmly replied that they would like to know more information about the danger to humans of ornithosis and other diseases carried by pigeons (question 10). Moreover, women are more interested in this – 79% than men – 64% ($\chi^2 = 30.73$, $\nu = 2$, $P < 0.01$). Motivation in obtaining information about ornithosis can be distributed in descending order: students, working citizens, schoolchildren, pensioners and the unemployed ($\chi^2 = 112.03$, $\nu = 8$, $P < 0.01$).

4 Conclusions

Over the years of the research, the population density of the *C. livia* population in the central part of the city of Yoshkar-Ola increased by 15% and amounted to 976 birds per 1 km² in 2022. *Columba livia* activity is statistically significantly higher during the daytime at all the studied sites in Yoshkar-Ola. The basis of the urban population consists of pigeons of dark-gray color. The predominance of dark-gray morphs individuals may be a consequence of adaptation to the anthropogenic environment. The increase in the population of pigeons in the recreational part of the city is unsafe for humans. It is necessary to carry out preventive measures that will limit the feeding of pigeons by people, and will allow the birds to return to eating natural food – plant seeds.

As a result of the survey, we identified risk groups of the population due to ignorance about the features of the disease ornithosis. Older people feed pigeons more often and do not know about the diseases that birds carry. Schoolchildren also do not know about ornithosis. The next stage of the project will be the dissemination of preventive information about ornithosis and other diseases carried by pigeons, preventive measures. We hope that people will be more conscious about their health and the health of the environment.

The research was carried out within Presidential Grants Foundation, grant no. № 22-1-001004 «*Watch out, ornithosis! (Ostorozhno, ornitoz!)*». Mari State University Strategic Academic Leadership Program (PRIORITY-2030) funded this research. We thank the students of the Mari State University, Maria Ilyina and Darya Glushkova for their part in collecting the material: pigeon population size study.

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