

UDC: 591.521: 599.742.43

## Features of the fox and badger burrows' distribution in forests of national parks of the Kharkiv region N.O.Brusentsova

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The aim of the research was to investigate the distribution of fox and badger burrows in pine and oak forests in national parks of the Kharkiv region. It has been established that the density of burrows in oak forests is higher than in pine forests due to the greater number of badger setts. Both in foxes and badgers, the burrows with 1–4 entrances dominate. The largest badger settlements (10 entrances) are located in the pine forests. With the help of the Clark-Evans coefficient (R), it has been determined that badger setts are characterized by group distribution. It is due to the biology of the species (the creation of several shelters in a family area); however, in the pine forest of the Gomilshanski Lisy NNP, the distribution of setts used by the badger is random. In the studied areas, the burrowing activity of badgers varies according to the nature of forage biotopes and anthropogenic factors. The random distribution of the shelters used by the fox is determined by the influence of environmental factors, none of which is decisive. In the oak forest of the Gomilshanski Lisy NNP and in the pine forest of the Slobozhanskyi NNP, fox burrows are clustered. Factors that determine such distribution need additional research.

**Key words:** *Vulpes vulpes, Meles meles, national park, burrow, sett, pine forest, oak forest.*

## Особливості розподілу нір лисиці та борсука в лісах національних парків Харківщини Н.О.Брусенцова

Метою роботи було дослідити розташування нір лисиці та борсука у нагірних дібровах та соснових лісах національних парків Харківщини. Встановлено, що загальна щільність нір у дібровах вища за таку у сосновому лісі за рахунок більшої кількості борсучих сховищ. Як у лисиць, так і у борсуків переважають нори з 1–4 вхідними отворами. Найбільші борсучі поселення (10 вхідних отворів) розташовані у соснових лісах. За допомогою коефіцієнта Кларка-Еванса (R) визначено, що для борсучих нір характерним є груповий розподіл. Він обумовлений особливостями біології виду (влаштування на сімейних територіях кількох сховищ), але на ділянці соснового лісу НПП «Гомільшанські ліси» нори, які використовуються борсуком, розміщені випадково. На досліджуваних ділянках активність спорудження нір борсучими змінюється у залежності від характеру кормових біотопів та антропогенних чинників. У нагірній діброві НПП «Гомільшанські ліси» та сосновому лісі НПП «Слобожанський» розташування нір лисиць має характер кластерів. Чинники, що визначають такий розподіл, потребують додаткових досліджень.

**Ключові слова:** *Vulpes vulpes, Meles meles, національний парк, нора, сосновий ліс, діброва.*

## Особенности распределения нор лисицы и барсука в лесах национальных парков Харьковщины Н.А.Брусенцова

Целью работы было исследовать расположение нор лисицы и барсука в нагорных дубравах и сосновых лесах национальных парков Харьковщины. Установлено, что плотность нор в нагорных дубравах выше, чем в сосновых лесах, за счёт большего количества барсучих убежищ. Как у лисиц, так и у барсуков преобладают норы с 1-4 входами. Самые большие барсучьи поселения (10 входов) расположены в сосновых лесах. С помощью коэффициента Кларка-Эванса (R) определено, что для барсучьих нор характерным является групповое распределение. Оно обусловлено биологией вида (создание на семейных территориях нескольких убежищ), но на участке соснового леса НПП «Гомольшанские леса» норы, которые используются барсуком, размещены случайно. На исследуемых участках активная норная деятельность барсуков изменяется в зависимости от характера кормовых биотопов и антропогенных факторов. Случайное распределение убежищ, которые используются лисицей, определяются влиянием факторов окружающей среды, среди которых ни один не имеет решающего значения. В нагорной дубраве НПП «Гомольшанские леса» и сосновом лесу НПП «Слобожанский» норы лисиц кластеризованы. Факторы, которые определяют такое распределение, требуют дополнительных исследований.

**Ключевые слова:** *Vulpes vulpes, Meles meles, национальный парк, нора, сосновый лес, дубрава.*

### Introduction

Species such as the red fox (*Vulpes vulpes* L., 1758) and the European badger (*Meles meles* L., 1758) are important components of forest natural systems. These carnivores may have very similar ecological niche in a wide range of habitats competing for food or storage places. However, there are cases of their simultaneous residence in burrows. Active fox and badger burrowing activity affects the state of the soil, vegetation, as well as creates shelters for other species (Kowalczyk et al., 2008; Kurek et al., 2014; Reichman, Smith, 1990). The study of the fox and badger's burrowing biology is extremely important to determine the biogeocenotic relationships between these animals and to develop strategies of managing their populations.

Research on these carnivores' underground shelters in national parks of the Kharkov region have been conducted since the first years the parks were established. The main objectives were to determine and compare the aspects of burrowing activity of badgers and foxes in pine forests and upland oak forests, to estimate the features of spatial distribution of the burrows of these two species in different forest types. In the present work, we summarize the materials on the location of the fox and badger burrows in the forests of two national parks in the Kharkiv region.

### Material and methods

The Slobozhanskyi National Nature Park (Krasnokutsk district, Kharkiv region) has an area in total of 5244 hectares and includes an upland oak forest on the right bank of the Merla River (left tributary of the Vorskla River) with an area of 1588 hectares. There is also a pine forest on the river's left bank covering an area of 3507 hectares, as well as other specific sites with an area in total of 149 hectares. The Gomilshanski Lisy National Nature Park (Zmiyv district, Kharkiv region) has an area in total of 14314.8 hectares. Researches of fox and badger burrows have been conducted on sites of the upland oak forest with an area of 1800 hectares and in a pine forest covering 1110 hectares.

In our previous studies (Brusentsova, 2011, 2015) we obtained data on the number and location of the carnivore's burrows, while the present investigation presents the results of supplementary observations. The spatial distribution of the burrows was analyzed by the nearest neighbor distance (NND) using the Clark-Evans coefficient (R) (Clark, Evans, 1954; Kharitonov, 2005). Visualization of the burrows' local densities for the study area was carried out using QGIS software package.

### Results and discussion

In the upland oak and pine forests of the national parks, 53 underground shelters have been revealed in the Slobozhanskyi NNP, and 108 in the Gomilshanski Lisy NNP. The distribution of the carnivores' burrows by the biotopes and the features of use are given in table 1.

Table 1.

#### Burrows in the forests of the national parks in the Kharkiv region

Burrows	Number of burrows		Percentage of burrows		Density of burrows per 1000 ha	
	oak forest	pine forest	oak forest	pine forest	oak forest	pine forest
Gomilshanski Lisy NNP						
<i>Vulpes vulpes</i>	29	7	36.71	24.14	16.11	6.31
<i>Meles meles</i>	30	11	37.97	37.93	16.67	9.91
Unused	24	11	30.38	37.93	13.34	9.91
All	79*	29	100	100	43.88	26.13
Slobozhanskyi NNP						
<i>Vulpes vulpes</i>	4	7	14.81	26.92	2.52	2.00
<i>Meles meles</i>	18	1	66.67	3.85	11.34	0.29
Unused	4	14	14.81	53.85	2.52	3.99
All	27**	26***	100	100	17.00	7.41

\* 4 burrows used by badgers and foxes together, \*\* for 1 burrow the species it is used by is not determined, \*\*\* for 3 burrows the species they are used by is not determined; also one burrow is used by dogs.

The density of fox and badger's underground shelters is higher in the Gomilshanski Lisy NNP. The density of burrows in the oak forests in the national parks is higher than in the pine forests due to the higher number of badger setts. Such pattern was also revealed in the same forest types near Yaremivka village, Lzyum district, Kharkiv region (Brusentsova, 2012). The upland oak forest is more favorable habitat for badgers providing more space for building of setts and more sources of food. The low density of underground shelters in the pine forest of the Slobozhanskyi NNP appears to be related to the insufficient study of the territory.

The badger does not use burrows of other species, although there are data that it can settle in bobak (*Marmota bobak*) colonies (Polishchuk, Reut, 2005). The fox, where it is possible, prefers using burrows of other animals (Brusentsova, 2012; Kowalczyk et al., 2008). Unlike the Slobozhanskyi NNP, in the upland oak forest of the Gomilshanski Lisy NNP foxes actively dig the burrows themselves. Therefore, in case of the badger, it makes sense to calculate the share of the number of burrows dug by the badger (n=55), but not of the number of all burrows (n=79). In that case, for the upland oak forest of the Gomilshanski Lisy NNP the share of used badger setts is 54.55%. For the pine forests the share of used setts is the following: Gomilshanski Lisy NNP (20 badger setts) – 55%; Slobozhanskyi NNP (3 badger setts) – 33.33%.

Most of the fox burrows in the study area (60–70 %) have only one entrance, while 30–40 % of the burrows have 2–4 entrances. In the upland oak forests foxes occupy mostly badger setts for breeding and use 1 to 3 entrances. Badger setts by the number of entrances have the following distribution: 30–40 % with 1 entrance, 30–40 % with 2–3 entrances, and 20–40 % with 5–10 entrances. The largest badger settlements with 10 entrances are located in the pine forests of the national parks.

When studying the fox and badger' burrowing biology it is important to consider not only the number of burrows and their density, but also the distribution of the shelters in the space. The nearest neighbor analysis has showed that the burrows in sites of the Gomilshanski Lisy NNP and in the Slobozhanskyi NNP are distributed by groups (table 2).

**Table 2.**

**Features of spatial distribution of fox and badger burrows in the forests of the national parks in the Kharkiv region**

Territory	Burrows	Indicators				
		mean of NND, m	min NND, m	max NND, m	R	c*
oak forest						
Gomilshanski Lisy NNP	All	125.72±14.68	13.83	712.10	0.53	8.05
	<i>M. meles</i>	196.21±42.74	13.83	1004.97	0.51	5.17
	<i>V. vulpes</i>	203.58±41.67	15.95	761.74	0.52	4.98
Slobozhanskyi NNP	All	246.22±62.79	15.90	1266.22	0.64	3.56
	<i>M. meles</i>	205.39±62.22	15.90	963.79	0.44	4.57
	<i>V. vulpes</i>	748.11±413.70	34.62	1555.22	0.75**	0.95
pine forest						
Gomilshanski Lisy NNP	All	167.57±21.82	17.59	508.72	0.54	4.72
	<i>M. meles</i>	371.43±144.40	17.59	1202.11	0.74**	1.65
	<i>V. vulpes</i>	662.67±108.36	310.31	1121.97	1.05**	0.27
Slobozhanskyi NNP	All	310.65±63.63	32.90	1178.98	0.53	4.54
	<i>V. vulpes</i>	322.94±131.26	34.57	736.18	0.29	3.60

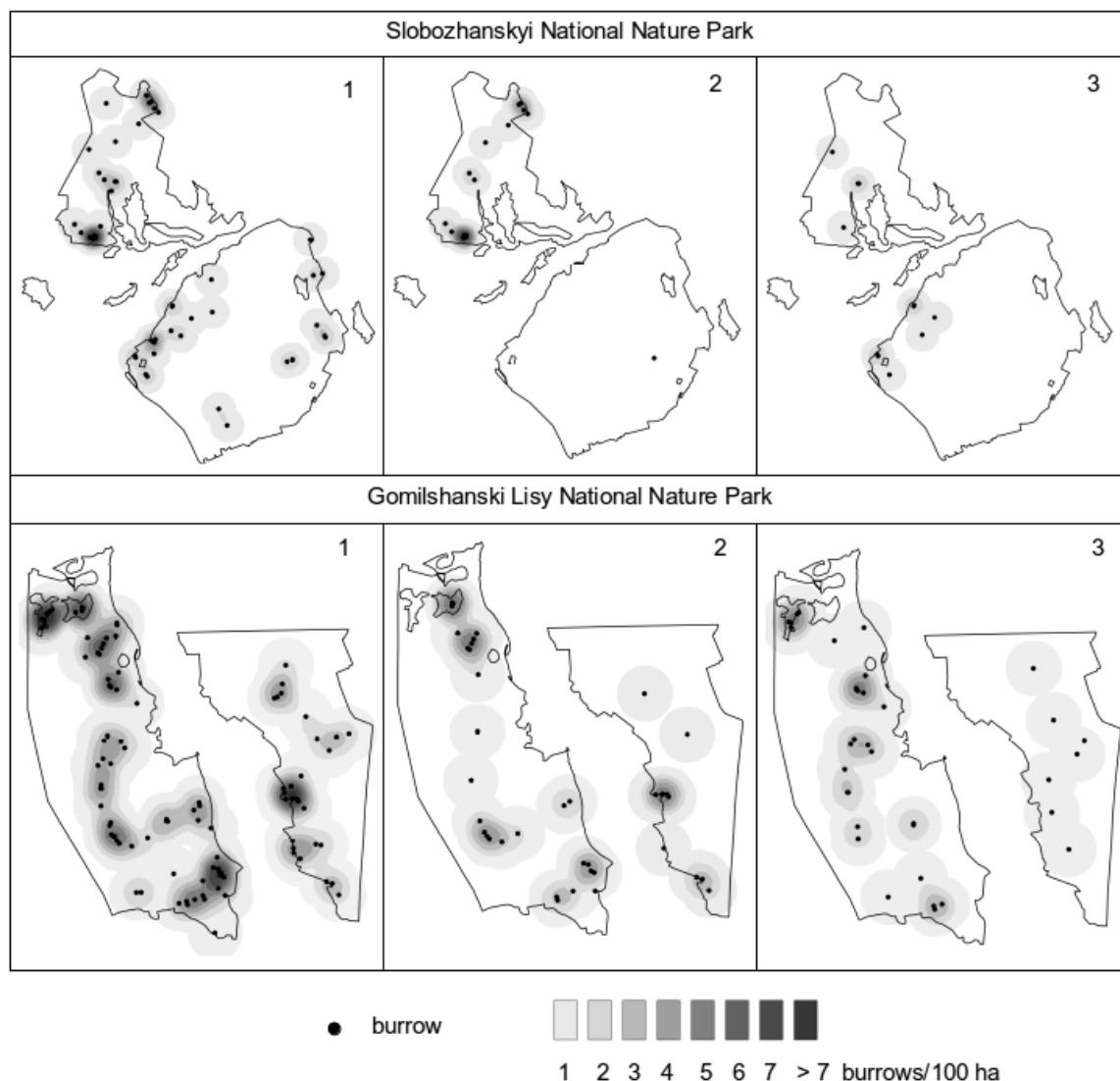
\* the standard variate of the normal curve; \*\* R is not reliable, the distribution is random.

The aggregate distribution of burrows is due to the badger's behavior, particularly because of creation of several shelters in each family area (Brusentsova, 2011; Wilson et al., 1997). Although, in the pine forest of the Gomilshanski Lisy NNP, the distribution of used badger setts is random, which is evidenced by the value of the Clark-Evans (R) coefficient. To clarify the reasons of such use of burrows additional research is needed.

Burrows used by foxes are distributed randomly, because their location depends on different environmental factors, such as forest conditions, food objects, distance to water, human activity, etc. (Brusentsova, 2012; Goldyn et al., 2003; Holmala, Kauhala, 2009; Polishchuk, Reut, 2005; Kurek et al., 2014). The influence of these factors is differently distributed in the space, but none of them is determinative (Odum, 1986). In the upland oak forest of the Gomilshanski Lisy NNP, fox burrows have group distribution,

although this issue needs additional research. Such burrowing behavior may suggest the idea that foxes live in clans in this territory (Gołdyn et al., 2003). In the pine forest of the Slobozhanskyi NNP, the group distribution of fox burrows may be connected to the features of the relief, soil moisture over most of the pine terraces, edge effect, etc.

The local density of underground shelters in the forests of the national parks in the Kharkiv region is shown on figure 1.



**Fig. 1. Local densities of burrows in the forests of the Slobozhanskyi NNP and the Gomilshanski Lisy NNP: 1 – all burrows; 2 – burrows used by the badger; 3 – burrows used by the fox**

Visualization of local densities reflects the activity centers of the animals within the studied areas. In the Slobozhanskyi NNP, badgers actively build setts and use them in the northern and southern parts of the upland oak forest. In these areas, the oak forest is bordered by an apple garden and a field, which can serve as additional feeding habitats (Holmala, Kauhala, 2009). The increased possibility of disturbance by humans can force the animals to build and use more shelters within these family territories than in the deep of the forest. The features of setts used by badgers in the upland oak forest of the Gomilshanski Lisy NNP are largely determined by the proximity and characteristics of the nearest settlements (Brusentsova,

Ukrainskiy, 2014). In the pine forest of this national park, most of the badger setts are located within the first terrace above the floodplain, that is also observed in the pine forest near Yaremivka village, Izyum district, Kharkiv region (Brusentsova, 2012). Meanwhile, in the Slobzhanskyi NNP the main sett of badgers is located in the deep of the pine forest. Perhaps it is due to the presence of forest wetlands and lakes on the second terrace in the study area and clear parts of mixed forest.

### Conclusion

Fox and badger burrows in the forests of the Gomilshanski Lisy NNP and Slobzhanskyi NNP are distributed by groups. The density of burrows in oak forests is higher than in pine forests due to the greater number of badger setts. The group distribution is characteristic for badger setts because of the biology of this species. In the site of the pine forest of the Gomilshanski Lisy NNP, the distribution of setts used by badgers is random. Random distribution of burrows used by foxes in the pine forest of the Gomilshanski Lisy NNP and in the upland oak forest of the Slobzhanskyi NNP is due to the lack of determinative environmental factors. In the upland oak forest of the Gomilshanski Lisy NNP and in the pine forest of the Slobzhanskyi NNP burrows used by foxes have aggregate distribution.

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Представлено: І.В.Загороднюк / Presented by: I.V.Zagorodnyuk

Рецензент: Т.А.Атемасова / Reviewer: T.A.Atemasova

Подано до редакції / Received: 8.02.2017