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Species composition of bird assemblages on waste landfills in Kharkov Region

Yana Yuriivna Dementieieva*, Angela Borysivna Chaplygina & Roman Ivanovych Kratenko

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Abstract The article lists the bird species of solid waste landfills for the period 2019–2022 in the Kharkiv region of Ukraine. A total of 73 species in 56 genera, 27 families and 11 orders were registered at the seven largest landfills in the region. We performed faunal and ecological analyses to determine the structure of the landfills' avifauna by status, relative abundance, distribution by landfill zones, and protection status. We found solid waste landfills to play an important role for birds of various ecological groups, as 53% of species use the territory as a nesting place or permanent habitat. In addition, a significant proportion of registered birds are protected by various regulatory and legal acts of Ukraine and the world, pointing out the importance of landfills for endangered birds. We calculated the Menhinick and Shannon indices to estimate the species richness and abundance, which did not show high species diversity. Therefore, we also calculated the Pielow index to quantify the evenness of the grouping structure. In addition, the Berger-Parker index showed the importance of the dominant species, which negates the uniformity and thus, the stability of the groups. The general characteristics of the formation of the avifauna were revealed by the qualitative and quantitative (Jaccard and Sørenson indices) comparisons of bird habitats in the Kharkiv region and the Autonomous Republic of Crimea. As a result, we drew conclusions about the similar factors of the formation and grouping structure of the specific avifauna, as well as the environmental conditions creating the differences.

Keywords: avifauna, solid waste landfills, transformed urban landscapes, region biodiversity

Összefoglalás Tanulmányunk Ukrajna Harkov régiójában szilárdhulladék-lerakók területén 2019–2022 között megfigyelt madárfajokat mutatja be. A vidék hét legnagyobb hulladéklerakóján 11 rendbe, 27 családba, 56 nemzetségbe tartozó 73 fajt figyeltünk meg. Fauna- és ökológiai elemzésekkel meghatároztuk a hulladéklerakók madárvilágának szerkezetét állapot, fajlagos tömegesség, hulladéklerakó-övezet általi megoszlás és védettségi állapot szerint. Megállapítottuk, hogy a szilárdhulladék-lerakók fontos szerepet töltenek be a különböző ökológiai csoportokba tartozó madarak számára, mivel a fajok 53%-a fészkelőhelyként vagy állandó élőhelyként használja azokat. A megfigyelt madárfajok jelentős részét Ukrajna és a világ különböző szabályozási és jogi dokumentumai védik. Így feltételezhetjük, hogy a hulladéklerakók a veszélyeztetett madarak számára fontos élőhelyek. A fajgazdagság és tömegesség becslésére a Menhinick és Shannon mutatókat használtuk, amelyek nem jeleztek nagy diverzitást. A Pielow indexszel is kiszámítottuk a közösség szerkezetének egyenletességét. A Berger-Parker index egyértelművé tette a domináns fajok jelentőségét, ezáltal tagadva a csoportok egységességét, így állandóságát. A madárfauna általános jellemzőit a Harkiv régió és a Krími Autonóm Köztársaság madár élőhelyeinek minőségi és mennyiségi (Jaccard és Sørenson indexek) összehasonlítása tárta fel. Következtetéseket vontunk le az adott madárfauna kialakulásának és csoportosulási szerkezetének hasonló tényezőire, valamint a különbségeket létrehozó környezeti feltételekre nézve.

Kulcsszavak: madárvilág, szilárdhulladék-lerakók, átalakult városi tájak, vidék élővilágának sokszínűsége

H. S. Skovoroda Kharkiv Pedagogical University, Valentynivska Street, Kharkiv 61168, Ukraine
** corresponding author, e-mail: dementeeva.y@gmail.com*

Introduction

Solid household waste landfills are highly transformed landscapes that create conditions for the formation of a high diversity and high-density avifauna (Dementieieva *et al.* 2021, Dementieieva 2021a). The main factors in the formation of large groups of birds are an unlimited food resource and a large space for resting, nesting, roosting and wintering.

Species diversity is usually formed from large flocks of polyphagous and saprophagous birds, such as Gulls (Belant *et al.* 1993, Meissner & Betleja 2007, Caron-Beaudoin *et al.* 2013, Bárbara *et al.* 2017, O'Hanlon *et al.* 2017), Corvids (Vuorisaloa *et al.* 2003, Marasinghe *et al.* 2018, Noreen & Sultan 2021, Soualah *et al.* 2021), White Storks (Rumbold *et al.* 2009, Arizaga *et al.* 2018, Jagiello *et al.* 2018, Marasinghe *et al.* 2018, Bialas *et al.* 2020, Bialas *et al.* 2021, Dementieieva 2021b, Rao *et al.* 2021), Sparrows, Starlings and Pigeons (Soualah *et al.* 2021), Herons (Burger & Gochfeld 1983, Abigail *et al*. 2013). Landfills are large, relatively human-free territories, rich in insects and seeds of ruderal plants, which attract many native birds (Kostin 2020). The large number of different birds attracts birds of prey to these territories as well (Turrin *et al.* 2015, Carlin 2019), which may eventually change feeding habits and use human food waste or livestock waste.

A large body of information have already been published about birds nesting at landfills around the world: America (Belant *et al.* 1993, Belant 1997, Rumbold *et al.* 2009), Canada (Chen *et al.* 2013), Oman (Mcgrady & Alfazari 2013), Poland (Zduniak *et al.* 2021), Western Europe and Africa (Vuorisaloa *et al.* 2003, Pellissier *et al.* 2012, Jagiello *et al.* 2018, Bialas *et al.* 2020, Bialas *et al.* 2021) and even the Arctic (Saalfeld *et al.* 2013). Bird nutrition and its health consequences have been described in many studies. Thus, a significant role is played by the birds of landfills in the spread of resistance to antimicrobial drugs in the population of nearby towns and villages (Blanco & Bautista 2020, Martín-Maldonado *et al.* 2020, Ruiz-Ripa *et al.* 2020, Anand *et al.* 2021, Jarma *et al.* 2021).

Landfills play a significant role in exposing birds to pollution because they accumulate a wide variety of persistent chemical compounds and their residues (Chen *et al.* 2013). Some pollutants accumulate in the yolk of bird eggs (Tongue 2020). Studies of heavy metal pollution have shown that the levels of metals in the body of White Stork chicks can be influenced by the parents' use of landfills as feeding sites (de la Casa-Resino *et al.* 2014). Birds are also contaminated with microplastics, which can be transferred through trophic chains up to higher-order consumers (Belant *et al.* 1993). There are also higher level of endoparasite infections (Parejo *et al.* 2015), mutilation and injuries in birds (Michalicha & Pitucha 2019) staying at landfills. In general, the listed factors indicate both the significant negative impact of landfills on the ecology of many species of birds, as well as the significant role of landfills in the modern life of many species. On average, the avifauna of landfill sites is represented by more than 50 species of birds. All this indicates the relevance of careful monitoring studies on the species composition of birds of landfills as an indicator, because sharp changes in behavior or numbers will give impetus to the search for the cause. This, in turn, will most likely consist of certain negative environmental aspects: climate change, acid rain, abnormal pressure indicators, pollution with hazardous waste, etc. Birds are among the best indicators because they are easy to observe, and they give quick responses to environmental changes.

Materials and Methods

We studied the avifauna of solid waste landfills in the Kharkiv region between 2019 and 2022. Seven landfills of the region were identified as test sites: Dergachy and Rohan landfills of the city of Kharkiv, as well as Kupyansk, Lozova, Nova Vodolaga, Merefa, and Zmiiv landfills (Dementieieva 2022) *(Figure 1)*. The Dergachy landfill (0.8917 km^2) *(Figure 2b)* is located 15 km north of the city of Kharkiv and 500 meters from the village of Novi Dergachy, in the valley of the Lopan River. The Rogan landfill (0.3662 km^2) *(Figure 2a)* is located on the southern border of the city of Kharkiv in the valley of Studenok River. The Kupyansk landfill (0.1003 km^2) *(Figure 2d)* is situated 4 km southwest of Kupyansk, in the

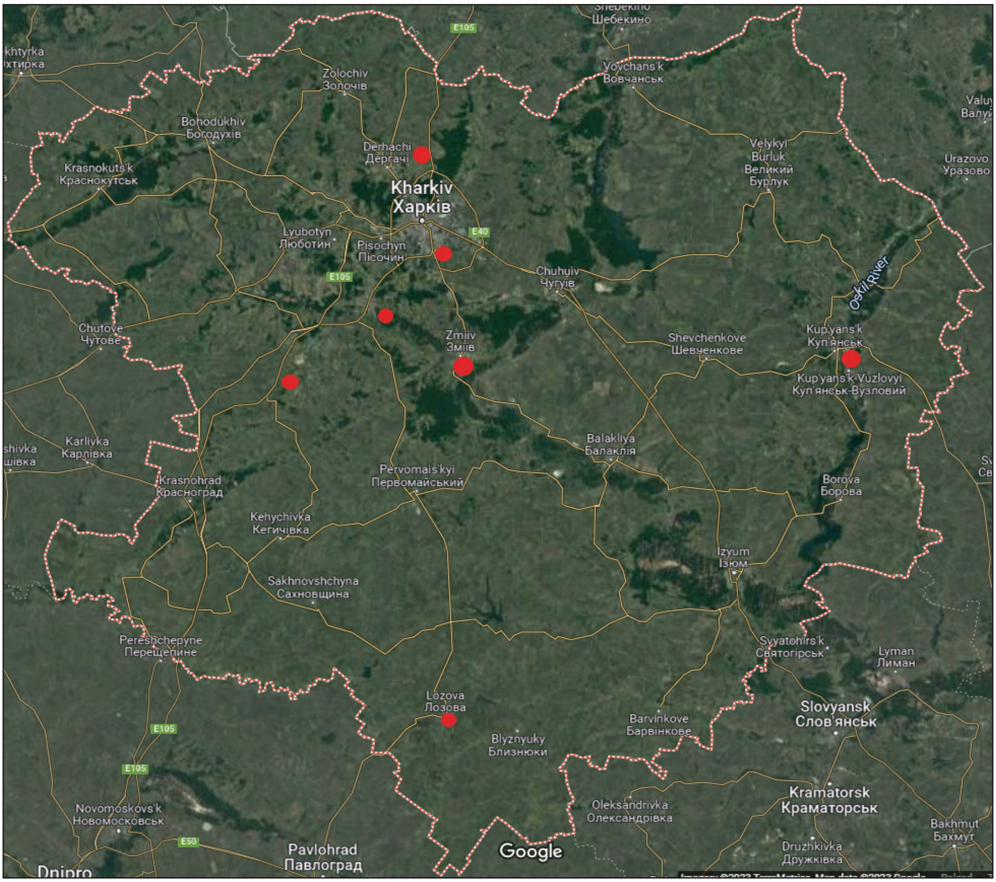

Figure 1. Investigated landfills of Kharkiv region, Ukraine (www.ua-maps.com)
1. ábra Vizsgált hulladéklerakók Ukrajna Harkov régiójában

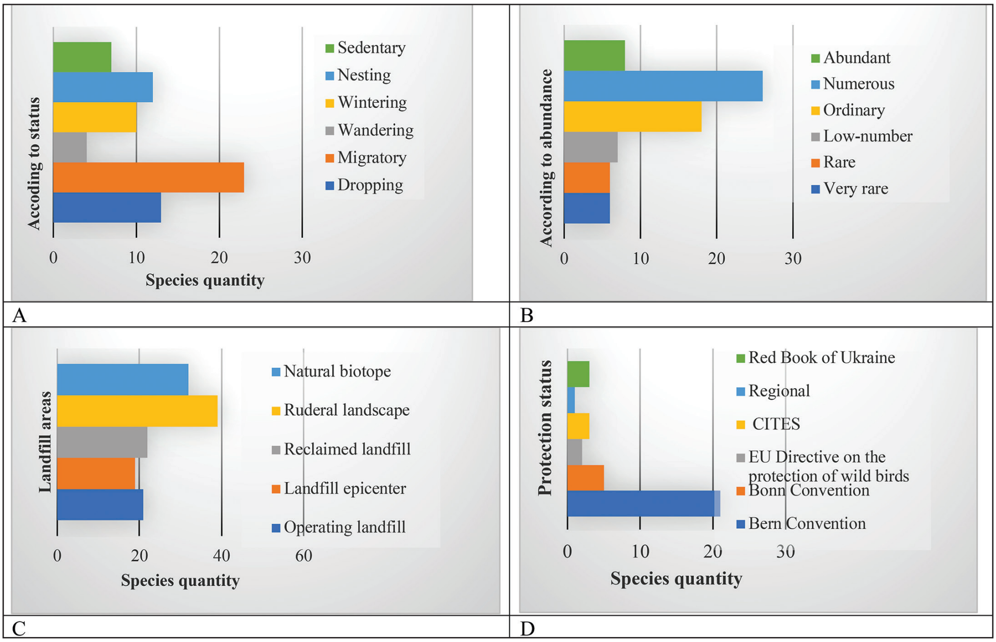

Figure 2. Analysis of landfills in Kharkiv region A: Distribution of species diversity according to status, B: Distribution of species diversity according to abundance degree, C. Distribution by landfill areas, D: Species distribution by protection status

2. ábra Hulladéklerakók elemzése a Harkov-régióban A: A faji sokféleség megoszlása állapot szerint, B: A faji sokféleség megoszlása a tömegesség foka szerint, C: Megoszlás hulladéklerakó-területek szerint, D: Fajmegoszlás védettségi állapot szerint

valley of the Oskil River. The Lozova landfill (0.0614 km^2) *(Figure 2c)* is located 1 km south of the city of Lozova, in the valley of the Gnyla River. The landfill borders the territory of the water treatment facilities of the city of Lozova, which clearly affects the formation of the species composition of birds. Zmiiv landfill (0.0299 km^2) *(Figure 2e)* lies 4 km from the city of Zmiivskyi, in a branch of Siverskyi Donets River (the largest river of the Kharkiv region). The Merefa landfill (0.0322 km^2) *(Figure 2g)* is located in the village of Yakivlivka, in the valley of Rzhavchyk River. The Nova Vodolaga landfill (0.0683 km^2) *(Figure 2f)* is found within 500 meters of the Nova Vodolaga town periphery (Dementieieva 2022).

The area of landfills can be divided into different functional zones, which are unevenly occupied by birds (Marasinghe *et al.* 2018). The epicenter of the landfill is the dumping point of "fresh waste", which changes according to the logistics and landfill filling plan. Operating landfill is the territory that includes the epicenter and receives waste at the current stage of operation. Reclaimed landfills are the territories that underwent reclamation and no longer accept waste. Ruderal zones are the areas along the perimeter of the landfill, which have a linear elongated shape, strongly transformed soils and ruderal vegetation. Natural biotope zones are usually small areas not subjected to human intervention. These areas are used differently by birds, and, accordingly, their density and types of diversity have differences.

Quantitative indicators of the presented species also differ. The main dominants and absolutely typical for landfills are crows (Corvidae) and gulls (Laridae), as well as the following species: Common Starling *(Sturnus vulgaris)*, Feral Pigeon *(Columba livia)*, Eurasian Tree Sparrow *(Passer montanus)* and House Sparrow *(Passer domesticus)*. Among birds of other species, significant fluctuations in numbers are not observed.

Landfills serve as nesting, wintering, and roosting areas, and also serve as stopover sites of migration corridors (Arizaga *et al.* 2018). So, we categorize the bird species as follows:

Sedentary species stay in the studied area throughout the year.

Nestling species nest in the studied territory and leave the area after the end of the reproductive period.

Wintering species occur only during winters.

Wandering species do not nest in the study area, but regularly appear in the summer.

Migratory species do not nest nearby, but use the area as stopover sites during seasonal migration.

Vagrants occasionally appear in the study area only during the migration period (Potish 2009).

We determined the relative abundance by Belyk (2000): very rare species (1–5 sightings during all years of research); rare species (6–10 sightings); low-number species (regular, but not annual sightings); ordinary (regular annual observations); numerous (1–10 sightings per day); abundant (more than 10 sightings per day).

To quantify the study intensity of landfill avifauna in the Kharkiv region, we used the Chao1 index, which shows the prospect of new discoveries of species diversity in the perspective of further research $chao1 = S\,obs + \frac{f_1^2}{2f_2^2}$, and Turings index $S_T = \frac{S_{obs}^2}{S_{obs} - f_1}$. Both indexes take into account the variables of singletons (one-time encounters of species representatives) and doubletons (two-time encounters).

Species diversity and abundance were characterized by the Menhinick index $D_{Mn} = \frac{S}{\sqrt{N}}$, where S is the number of species in the study area, N is the number of encounters. The higher is the ratio of the average share of one species per one sample, the greater is the species diversity of the studied territory. We also applied the Shannon index $\mathrm{H} = -\Sigma p_i \log 2\, p_i$, where p_i is the relative abundance of species (the dependence of representatives of a species on the total number of individuals of all species). The latter, according to the same principle, quantifies the diversity in accordance with the principle of maximum diversity, when all individuals of a group belong to different species, or zero, when all individuals belong to the same species.

The evenness of the grouping structure has been analyzed by using the Pielow index $E_H = \frac{H}{H_{max}}$, where H_{max} – the maximum value of Shannon index.

To determine the significance of the species, we use the Berger-Parker index $D_{BP} = \frac{n_{max}}{N}$, where n_{max} is the number of individuals of the most abundant species.

For convenience, the values are presented as 1/d. The index values are always in the range from zero to one, where zero indicates no dominance and one means absolute dominance.

We determined the difference of the territories by dominant species value indices; diversity, abundance and evenness of bird groups, which were displayed in the dendrogram. The graph was made by STATISTICA program thanks to the cluster analysis of hierarchical classification according to Berger-Parker, Menhinik, Shannon and Pielow index calculations.

Jacquard and Sørensen indices were used to compare the studied territories with each other, as well as to analytically determine the difference between the object of study in the Kharkiv region and the data of the Crimean peninsula. $C_j = \frac{c}{a+b-c}$, $C_s = \frac{2C}{a+b}$,where "a" is the number of species in the first biota, "b" the number of species in the second biota, "c" the number of species common to both biota.

Results

As of 2022, the known species richness of birds at landfills of the Kharkiv region is 73 species, 56 genera, 27 families, 11 orders. The species richness of the landfills consists of 61 and 56 species at the Dergachy and Rohan landfills of Kharkiv city, 52 and 51 species at the Lozova and Kupyansk landfills, and 50, 43, 39 at the Zmiiv, Merefa, and Nova Vodolaga landfills, respectively. It is worth noting that there is a bias in the study due to the uneven observation at different landfills of Kharkiv region. Technically, we built the study with an emphasis on Kharkiv landfills as the most representative test objects.

Our records covered 73% of the total (unknown) species richness, as assessed by the Chao1 species richness estimate. Results close to 75% are considered sufficient studies of the object and indicate a reliability of the compiled list. In addition, we calculated the Turing index, the value of which reached 74%, which confirms the reliability of our results.

A significant share of the species registered at the landfills are nesting – 33% and sedentary – 20%; 17% and 14% are migratory and wandering, respectively; 10% – occasional are vagrants on the area of landfills, and 6% – species that exclusively winter on the territory of landfills *(Figure 2a)*.

By relative abundance: the numerous (up to 10 occurrences) and ordinary species account for 37 and 25%, respectively, of the entire bird fauna of landfills, while the abundant (>10 occurrences) have a share of 11%. The rare, the very rare, and the low-number species constitute 27% of the species richness *(Figure 2b)*.

The species diversity of landfills is unevenly distributed. The density of birds in the zones of the landfills differed significantly *(Figure 2c)*. The greatest diversity of species is noticeable along the perimeter of landfills in ruderal landscapes and natural areas – 30 and 24%, respectively. At the operating landfill, including the epicenter, 30% of species are recorded. The least diverse are usually the territories of reclaimed areas of landfills. Here the following species are important for nesting in small numbers: Gray Partridge *(Perdix perdix)*, Greenfinch *(Carduelis chloris)*, Common Linnet *(Acanthis cannabina)*, Sedge Warbler *(Acrocephalus schoenobaenus)*, Marsh Warbler *(A. palustris)*, Common Whitethroat *(Sylvia communis)*, Barred Wabler *(Curruca nisoria)*, Western Yellow Wagtail *(Motacilla flava)*, Bluethroat *(Luscinia svecica)*, and also predators: Rough-legged Buzzard *(Buteo lagopus)*, Northern Goshawk *(Accipiter gentilis)*, and Eurasian Sparrowhawk *(A. nisus)*.

Among the birds belonging to landfills, 22 species are protected by several conventions *(Figure 2d)*. The most widespread are species protected by the Bern Convention, many of which are also protected by other regulatory documents. Species listed in the Red Book of

Figure 3. A flock of Black Kite *(Milvus migrans)*. Rogan landfill, Kharkiv, Ukraine 17.06.2020
3. ábra Barna kánya csapat *(Milvus migrans)*. Rogan hulladéklerakó, Harkov, Ukrajna 2020.06.17.

Ukraine and the IUCN are registered at the landfills: Hen Harrier *(Circus cyaneus)*, Stock Dove *(Columba oenas)* and Black Kite *(Milvus migrans)*. The latter formed significant groups in the research area *(Figure 3)*.

Seven species are categorized as dominants, forming groups of 200 or more individuals – Rook *(Corvus frugilegus)*, Jackdaw *(Corvus monedula)*, Common Starling, Caspian Gull *(Larus cachinnans)*, Black-headed Gull *(Chroicocephalus ridibundus),* Feral Pigeon, Eurasian Tree Sparrow. We calculated the Berger-Parker index divided by one for these species, which shows the significance of each species. The index was 3.86 for the Rook, 5.15 – for the Jackdaw, 5.72 – for the Common Starling, 7.72 – for the Caspian Gull, 17.16 – for the Black-headed Gull, 38.61 – for the Feral Pigeon, and 30.89 – for the Eurasian Tree

Figure 4. White Stork *(Ciconia ciconia)*, Rogan landfill, Kharkiv, Ukraine 18.07.2021
4. ábra Fehér gólya (Ciconia ciconia), Rogan hulladéklerakó, Harkov, Ukrajna 2021.07.18.

Sparrow. Subdominants birds that form groups of 20 to 150 individuals included – Raven *(Corvus corax)*, Magpie *(Pica pica)*, Hooded Crow *(Corvus cornix)*, Great Tit *(Parus major)*, Goldfinch *(Carduelis carduelis)*, Eurasian Collared Dove *(Streptopelia decaocto)* and White Stork *(Ciconia ciconia)*. The latter species is currently of much interest among researchers, as landfills in Western Europe have greatly increased their population size. We have recorded groups of up to 40 individuals on the Kharkiv landfills (Dementieieva 2021b) *(Figure 4)*.

An increase in the significance index of the most numerous species means a decrease in diversity and an increase in the degree of dominance of one species. In this case, the importance of the Rook and Jackdaw as dominants, respectively, is clearly visible.

The Common Redstart *(Phoenicurus phoenicurus)*, House Sparrow, Crested Lark *(Galerida cristata)*, White Wagtail *(Motacilla alba)*, Western Yellow Wagtail *(Motacilla flava)*, etc. occur less frequently than the dominant or subdominant species. They mainly visit sandy areas, artificial water bodies, and adjacent agricultural areas.

Calculations of indices of species abundance by Menhinick and Shannon for the landfill areas of Kharkiv region showed results of 0.83 and 2.26, respectively. Thus, the Menhinick abundance index is higher, the greater the species abundance of the studied territory. An increase in the number of individuals with an unchanged number of species leads to a decrease in the value of Shannon's diversity index, which usually varies from 1.5 to 3.5, so our results show a rather high diversity of avifauna of landfills in the region. Its evenness according to the Pielow index equals 0.53. This shows the structure of the bird assemblage at the region's landfills to be uneven, because the quantitative characteristics of the species diversity should strive to reach the maximum possible value.

According to the calculations of the Berger-Parker, Menhinik, Shannon and Pielow indices, we determined the difference of the territories by the indicators of the value of the dominant species, diversity, abundance and evenness of bird groups *(Figure 5)*.

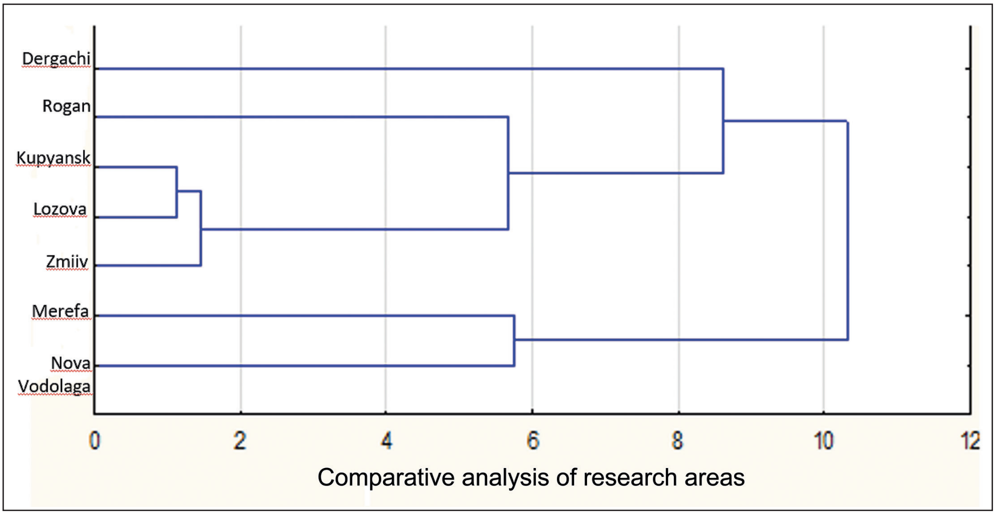

Figure 5. Cluster analysis of landfill differences by Jaccard and Sørenson similarity indices
5. ábra A hulladéklerakók közötti különbségek elemzése Jaccard és Sørenson hasonlósági mutatók felhasználásával

Based on the obtained results, we concluded that the small landfills of Kupyansk and Lozova are most similar to each other. This can be explained by similar biotope conditions, and proximity to sewage treatment plants. The conditions make it possible for avifauna to be more evenly distributed, which means to avoid strong dominance of individual species. Similar conditions for the formation of birds' community, very close to natural condition, are in Zmiiv, because there is a large forest massif nearby. The forest creates conditions for various species of birds and eliminates the problem of the concentration number of animals near an artificial fodder resource. The Rohan landfill is the last in the list of territories similar by species diversity and abundance, because despite the aggregation of birds it showed very low indices of dominant species value. These indicators are lower than in Dergachi, which, in turn, affects the evenness index of Pielow grouping. Special attention should be paid to Merefa and Novaya Vodolaga landfills, because their indicators differ significantly both among themselves and with other territories. The Merefa landfill occupies a relatively small area and is limited by the species composition. Due to this, the role of dendrogram variables in relation to uniform distribution, as well as the value of dominants, is growing. Moreover, Nova Vodolaga is defined as a fairly uniform structure, but here as well as the Merefa landfill, the specifics of places are very similar. Both places are limited territories that close to and rises above settlements.

Since indices of species diversity strongly depend on the number of representatives, they were also determined separately by Jaccard and Sørenson similarity indices to compare all the species composition landfills in the Kharkiv region.

The Dergachy and Rohan landfills, which serve the regional center of the city of Kharkiv, are the most similar. The similarity is (0.79) of common species for the two sites, which is explained by the proximity of the territories and the large area. The lowest similarity index was shown by the sections of the Nova Vodolaga and Zmiiv landfills (0.5). Although the distance is the same as between the Dergachy and Rohan ones, the lack of similarity must be explained by the fact that the Zmiiv landfill has a much shorter period of formation. Besides, it possesses the largest protective zone with woody vegetation, and lies in the proximity of a large forest of the Gomilshan Forests National Park, which also attracts a variety of birds. The Zmiyiv landfill generally does not have high similarity indices with all landfills. This indicates the lowest degree of transformation of this biotope. The solid waste landfills of the cities of Lozova and Kupyansk have a significant similarity (0.69), despite their distance. This can be explained by the proximity of both landfills to biological treatment facilities for standing water and filtration fields. Such biotopes form seminatural habitat complexes, specific and similar in species composition.

Discussion

The largest number of species we recorded within the Dergachy and Rohan landfills – 61 and 56 species, respectively. This is primarily due to the size of these landfills, which serve the metropolis, the largest city of the Kharkiv region, and have the most diverse morphological composition of waste.

Analyzing the obtained data, it is possible to conclude the significant role of landfills for birds of different ecological groups, which differ in the status of their habitat in the territory and its use. Thus, more than half (53%) of the species use the area as a nesting or permanent residence. This points out at the exceptional role of landfill areas for birds.

The territory is very densely populated, in addition, dominant species play a very important role. They are numerous – up to 10 or more encounters per excursion, which makes a total of 48% of all birds. Seven species of birds are dominant in number, which in different seasons of the year form large gatherings, up to 2,000 individuals of the Rook, up to 1,500 thousand starlings and jackdaws, up to 1,000 martins and up to 3 hundreds pigeons and sparrows. The Rook is defined as an absolute dominant, as is the Corvidae in particular and in general, which is also confirmed by other ornithological studies of landfills in continental zones.

The avifauna of landfills has specific formation factors, which are primarily related to factors of anthropogenic influence – pollution and changes in environmental conditions, a significant increase in the number and availability of food resources and their proximity to populated areas, etc. (Dementieieva 2022). This all leads to the concentration of bird species in these areas. Of course, the species composition is influenced by natural factors such as proximity to water bodies and climatic conditions, which shape the conditions for the regional biota. However, the avifauna of landfills is always less rich than the species composition of the surrounding habitats and is characterized by a low degree of evenness. The dominance of individual species in the avifauna of landfills is emphasized in all studies of landfill fauna that were considered, as stated in Materials.

The number of birds at a landfill depends on the weather conditions and the season of the year. Thus, birds of the Corvidae are en masse at the landfill in the winter, while in the summer, birds of the Gull and Stork families, in particular, the White Stork, reach large numbers.

A related study of the avifauna of landfills in Ukraine was conducted in the Crimean peninsula at the end of the last century (Kostin 1996). Sixty-one species of birds were registered at four investigated sites. Of these, 30 species share the same as those observed at the Kharkiv landfills, which gives a value of 0.27 when calculating the Jaccard index. This indicates a significant difference in the species composition of birds of landfills in different regions of Ukraine, which is easily explained by differences in the physical-geographical and anthropogenic factors. However, the dominant species and the structure of the zonal placement of birds at landfills determined in the work of S. Yu. Kostin show the features in the formation of landfill avifauna that are also characteristic of many other landfills on the continent and around the world. The author points out at birds of the Gull family, e.g. the Caspian Gull*)*, as the dominant birds. Similar data are noted in the coastal zones of other countries (Meissner & Betleja 2007, Rumbold *et al.* 2009, Abigail 2013, Caron-Beaudoin *et al.* 2013, Chen 2013, Bárbara *et al.* 2017, O'Hanlon *et al.* 2017, Martín-Maldonado *et al.* 2020, Rao *et al.* 2021, Soualah *et al.* 2021, etc.). Since the Kharkiv region is located at a significant distance from the seacoast, gulls are inferior to other types of birds in dominant positions here. Thus, birds of Corvidae, which are subdominant for landfills of the Crimean Peninsula, are, on the contrary, absolute dominants at landfills in the Kharkiv region, as well as non-coastal zones in other countries (Vuorisaloa *et al.* 2003, Marasinghe *et al.* 2018, Noreen & Sultan 2021, Soualah *et al.* 2021, etc.). Common Starlings and pigeons are among the dominant species of the continental zones, including the Kharkiv region (Soualah *et al.* 2021). Across several European and American landfills near the seashores, storks, herons and egrets are often noted (Burger *et al.* 1993, Rumbold *et al.* 2009, Abigail *et al.* 2013, Jagiello *et al.* 2018, Marasinghe *et al.* 2018, Bialas *et al.* 2020, Rabaça *et al.* 2020, Bialas *et al.* 2021, Rao *et al.* 2021). These are also recorded in Kharkiv region. The White Stork was concentrated in groups of up to 40 individuals for the past few years, and the Gray Heron are registered exclusively as transient during migration.

The zonal distribution of birds relative to the territory of landfills is also similar between Kharkiv region and Crimean Peninsula. Thus, a group of dominant birds is concentrated in the epicenter of the landfill, or the active area of waste discharge, as defined by Kostin (Kostin 2020). It is interesting, that birds of Corvidae, e.g. the Rook, the Jackdaw, the Raven, and the Hooded Crow in both regions show the same feeding behavior. They search for food in the epicenter of the landfill and fly around its perimeter to eat and rest. The Common Starling and pigeons, which are found in large groups in the epicenter of landfill, have the same behavior and preference in both regions' landfills. Small sparrow-like and other small species, including nesting species, e.g. the Magpie, the Gray Partridge, etc. are mostly registered outside the perimeter of the landfill, regardless of where the foraging process takes place: either in ruderal zones, stands of trees or waste masses.

Large number of Ravens and Gulls in both regions use landfill sites for wintering, which emphasizes the role of landfills during unfavorable periods.

Conclusions

Our investigations of landfill avifauna of in the Kharkiv region allow us to state that, despite the significant technogenic influence, these territories play a special role in supporting the bird population, and are a place of concentration of not only widespread, but also rare species. In general, the presence of bird species was found on the territory of the landfills, where there are rare and endangered species listed in the Red Book of Ukraine *(Circus cyaneus, Columba oenas, Milvus migrans)*. Solid household waste landfills, which are large in acreage, are characterized by a high degree of dominance of certain species, which negatively affect interspecies relations among representatives of the avifauna. Dominance as opposed to species diversity makes the ecosystem more vulnerable and incapable of self-recovery.

Waste landfills are an urgent environmental problem that requires changes in environmental management, work with the population and industry regarding waste formftion, as well as a careful and delicate solution to the problem of waste isolation, taking into account the needs of the animal world formed at landfills.

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