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POPULATION SIZE AND NESTING PECULIARITIES OF THE BLACK-HEADED GULL *CHROICOCEPHALUS RIDIBUNDUS* (LINNAEUS, 1766) ON THE TERRITORY OF WATER TREATMENT FACILITIES

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Background. Today, the black-headed gull inhabits man-made areas of wastewater treatment facilities (WTF) to comensate for the the reduction of natural aquatic and wetland habitats. Over the last decade, a nearly tenfold increase in its population has been recorded, despite a low reproduction rate. This fact indicates the lack of stability in the bird population, necessitating thorough research.

Materials and Methods. The analysis of the population size and biological characteristics of black-headed gulls involved censuses and observations at the WTF of the city of Kharkiv using conventional methods during the spring-summer periods of 2020–2021 and 2023.

Results. The population of the black-headed gull reached its peak in the third decade of May 2020 (2637 individuals) and 2023 (2124 individuals), as well as in the second decade of May 2021 (3949 individuals). The maximum nesting density was observed on sludge sites (SS) of wastewater treatment facilities that are most similar to natural habitats, where dried mud alternates with water patches and vegetation at the bottom and around the perimeter (Type V): 236.7±26.7 pairs/ha in 2020 and 242.9±28.5 pairs/ha in 2021. The majority of nests were found in the first decade of May 2021 and the third decade of May 2020.

The black-headed gull forms mixed-species, occasionally monospecific subcolonies. Nesting in association with it were: *Sterna hirundo*, *Anas platyrhynchos*, *Spatula clypeata*, *Vanellus vanellus*, *Charadrius dubius*, *Himantopus himantopus*, *Fulica atra*, *Gallinula chloropus*, and *Aythya ferina*.

The size of the complete black-headed gull clutch was 3.1±0.4 eggs (n = 190). The egg dimensions were 50.9±2.1 × 36.2±1.1, with a mass of 34.6±2.8 g. Regarding shell coloration, five types of background colors were identified. Mass egg laying occurred from the third decade of April to the first decade of May, constituting 40.3 % (n = 993) in 2020 and 62.3 % (n = 1757) in 2021. The egg-laying period extended from April to July, with the latest non-incubated clutches recorded in the first decade of July (3.07.2020). The first chicks were found in nests in the first decade of May, while mass hatching occurred in the second half of May. The latest registration dates of the birds on nesting territories were in the second decade of July for 2020 and 2023, and the first decade of August for 2022. The nesting season duration varied from 125 to 140 days in different years. Autumn migration commenced with summer relocations and concluded from late October to early November.

The reproductive success – the percentage of nestlings that fledged and successfully achieved flight – constituted 29.2 % (n = 2404 of laid eggs) in 2020, and 15.5 % (n = 6138) in 2021. The majority of offspring perished due to changes in water levels (prolonged rainfall or industrial wastewater discharge), predation, disturbance factors, etc.

Conclusion. The colonial nesting of the black-headed gull creates favorable conditions for the habitation and reproduction of various bird species, including rare ones, which is essential for their conservation.

Keywords: wastewater treatment facilities, black-headed gull, population size, nesting biology, aviafauna

INTRODUCTION

The population of the black-headed gull *Chroicocephalus ridibundus* (Linnaeus, 1766) in Europe has long been considered to be steadily increasing (BirdLife International, 2004). In recent years, the numbers of these birds vary in different countries. In Central Europe, particularly in the Czech Republic, the population is decreasing due to a decline in nesting pairs in large colonies and the disappearance of small settlements (Poprach *et al.*, 2016). In Ukraine, significant fluctuations in the population of black-headed gulls are observed, with large colonies disappearing in certain years, and smaller settlements remaining unstable. (Grishchenko *et al.*, 2013; Fedun *et al.*, 2015; Banik, 2016). In Western European countries, the population is increasing in the areas where birds can feed on anthropogenic food sources such as food wastes in landfills and farms, etc. (BirdLife International, 2016; Feng & Liang, 2020; Indykiewicz *et al.*, 2023). In lieu of natural wetland habitats, which are particularly prone to degradation due to agricultural intensification and climate changes (Čížková *et al.*, 2013; Reid *et al.*, 2019), birds opt for artificial water bodies and solid waste disposal (SWD) sites, which provide them with favorable conditions for habitation and nesting (Ferns & Mudge, 2000; Andersen *et al.*, 2003; Sebastián-González & Green Andy, 2015). Thus, artificial water bodies for the treatment of domestic wastewater and the reservoirs of food processing plants, particularly those associated with sugar and starch factories, remain optimal for the black-headed gull nesting (Fedun *et al.*, 2015; Martín-Vélez, *et al.*, 2021; Mamedova, 2023).

Philopatry, which is characteristic of black-headed gulls, implies their steadfastness to nesting locations (Piro & Schmitz Ornés, 2021). Therefore, uncontrolled fluctuations in populations of black-headed gulls in urban ecosystems may raise concerns about the contamination of natural water bodies with fecal matter, various impurities, including bacteria or ecto- and endoparasites that birds may carry from SWD sites or sewage channels (Indykiewicz *et al.*, 2021; Dementieieva *et al.*, 2022; Hamdoune *et al.*, 2023). All of this can pollute natural water bodies and pose a threat to the health of humans and agricultural animals. On the other hand, the black-headed gull is inclined to feed in agroecosystems, where the use of pesticides can lead to the demise of the birds (Pesotskaya *et al.*, 2020; Yarys *et al.*, 2021; Poluda, 2023).

Despite the widespread occurrence of the black-headed gull in various habitats, the bird is protected under the Bern Convention. In 2023, the Ukrainian Society for the Protection of Birds announced the black-headed gull as the symbol of the year. To date, there is a lack of accurate data on the nesting biology of the black-headed gull in both natural and anthropogenic landscapes of Ukraine. The aim of this research was to determine the population size and nesting characteristics of the black-headed gull at the wastewater treatment facilities in the city of Kharkiv in order to understand the population dynamics trends of these birds, particularly in large urban areas.

MATERIAL AND METHODS

Material collection on the nesting of the black-headed gull was conducted in 2020-2021, sporadically in 2023, on the territory of wastewater treatment facilities of the city of Kharkiv (49.91510773859936, 36.27499964637481). In particular, we surveyed sludge sites (hereafter referred to as SS) and Novyi Lyman Lake (a former sand mining quarry) adjacent to them and enclosing the water treatment complex. The protected status of the area limits the impact of disturbance factors, contributing to a relatively high and stable bird population both during the nesting periods and migrations.

The total SS area of 123 hectares is divided into two sections: the first one (hereafter A) comprises 39 SS, and the second (B) has 38 SS. Considering different combinations of water and dry land fractions, as well as the presence of vegetation, we classified the SS into five types:

I – the proportion of water area up to 100 %; episodic patches of vegetation along the perimeter (3A, 12A);

II – the proportion of water area up to 80 % with islands of dried mud (20 %); sporadic patches of vegetation along the perimeter of SS and on islands of dried mud (5A, 30A);

III – sludge areas with the share of water up to 50–60 %; vegetation projective cover of 50–60 % in the form of a wide strip of the common reed and various grasses along the perimeter and the bottom (1A, 4A, 39A);

IV – overgrown SS with the proportion of water area up to 10–15 %; vegetation projective cover up to 70 % (6A, 10A, 12B, 16A, 20A, 25A, 26A, 38A);

V – partially dried SS (up to 90 %) sporadically covered with vegetation at the bottom, resembling natural salt marshes (1B, 2A, 7A, 8A, 9A, 11A, 13A, 18B, 19B, 21A, 31A, 32A, 35A, 36A).

Some of the SS on the studied territory were completely overgrown with common reed; these habitats were not inhabited by black-headed gulls (Mamedova *et al.*, 2023).

The census of black-headed gulls was conducted through systematic visual observations from the day of the birds' arrival at the nesting sites to the end of breeding. Weekly counts of the number of birds, nests, and chicks were made on each SS. Nesting density was recalculated per one hectare, utilizing the total area of each SS on Google Maps. The timing of arrivals, onset of nest construction, egg-laying, reproductive success, and other nesting biology features of the birds were determined. Each separate SS inhabited by black-headed gulls was regarded as a functionally isolated subcolony.

Binoculars with a 20×40 magnification, and a Canon 80D digital camera equipped with a Canon EF 100–400 mm f/4.5-5.6L IS USM lens, were utilized for data registration. Large bird aggregations were photographed and counted based on captured images. Authorship of the photographs presented in the article is credited to Y. P. Mamedova.

For egg measurements, a micrometer with an accuracy of 0.1 mm was employed. The volume of the eggs was calculated using the formula $V = 0.51 \times L \times B^2$, where V represents the volume (cm^3), L is the length (cm), and B is the width (cm) of the egg. The egg shape index was determined by the ratio of the width to the length, expressed as a percentage: $Sph = 100 \times D/L$, where Sph is the roundness index, D is the width, and L is the length. The weight of the eggs was measured in freshly laid clutches with an accuracy of 0.1 g. All calculations were performed using the Excel package. The taxonomy and bird species names are presented according to G. V. Fesenko (2022). Rare bird species are listed according to the Red Data Book of Ukraine (Akimov, 2009).

RESULTS

Phenology, size, and dynamics of the breeding population. In Kharkiv region, the black-headed gull is found in most wetland areas with suitable nesting or feeding sites. Colonies of black-headed gulls have been present on the WTF of Kharkiv city for over 25 years, however they have not been thoroughly studied before.

The arrival of the first migrant black-headed gulls in this area in spring was recorded on the following dates: March 11, 2020; March 20, 2021; March 9, 2023. During the spring period, when temperatures dropped below the freezing point, the birds fed on the aerators of the water treatment facilities and on SWD sites. The majority of black-headed gulls arrived at their nesting territories in the latter half of April, with over 2000 individuals registered on April 23, 2021.

The maximum population of black-headed gulls in 2020 was recorded in the third decade of May (2637 individuals), which decreased throughout the season. In 2021, several peaks in the numbers of birds were observed: in the third decade of April (3778 individuals) and in the second decade of May (3949 individuals). In 2023, the highest number of birds was registered in the third decade of May (2124 individuals) (**Fig. 1*A***).

Some individuals and pairs of black-headed gulls continuously moved throughout the entire territory of the WTF, hence the population varied across different SS during the breeding season. In 2020, the birds were recorded on twenty-five SS. The highest number of individuals was registered on the following SS: 16A (249 individuals), 1A, 13A, 30A, 31A (180–190 individuals); 2A, 6A, 12A, 32A, 39A (90–130 individuals); 3A, 9A, 18B, 19B, 38A (50–80 individuals); 5A, 11A, 12B, 20A, 26A (25-45 individuals). Less than 20 individuals were recorded on 4A, 10A, 35A, and 36A sites. In 2021, the black-headed gull was found on twenty-four sludge sites. The majority of individuals were recorded on the following SS: 16A (414 individuals); 2A, 20A, 21A (over 300 individuals); 1B, 3A, 8A, 11A, 12A, 31A, 39A (over 100 individuals); 1A, 5A, 6A, 19B, 25A, 35A, 38A (over 50 individuals); 4A, 7A, 9A, 10A, 26A, 30A (less than 20 individuals). We were not able to establish a correlation pattern between bird population and the level of desiccation of the sludge areas. The highest bird density was recorded on the SS of type IV – 62.2±14.3 individuals/ha (2020), 106.8±15.8 individuals/ha (2021) and type V – 68.3±19.1 individuals/ha (2020), 109.8±23.4 individuals/ha (2021) (**Fig. 1*B***). Most birds settled on attractive SS immediately upon returning from migration and began breeding.

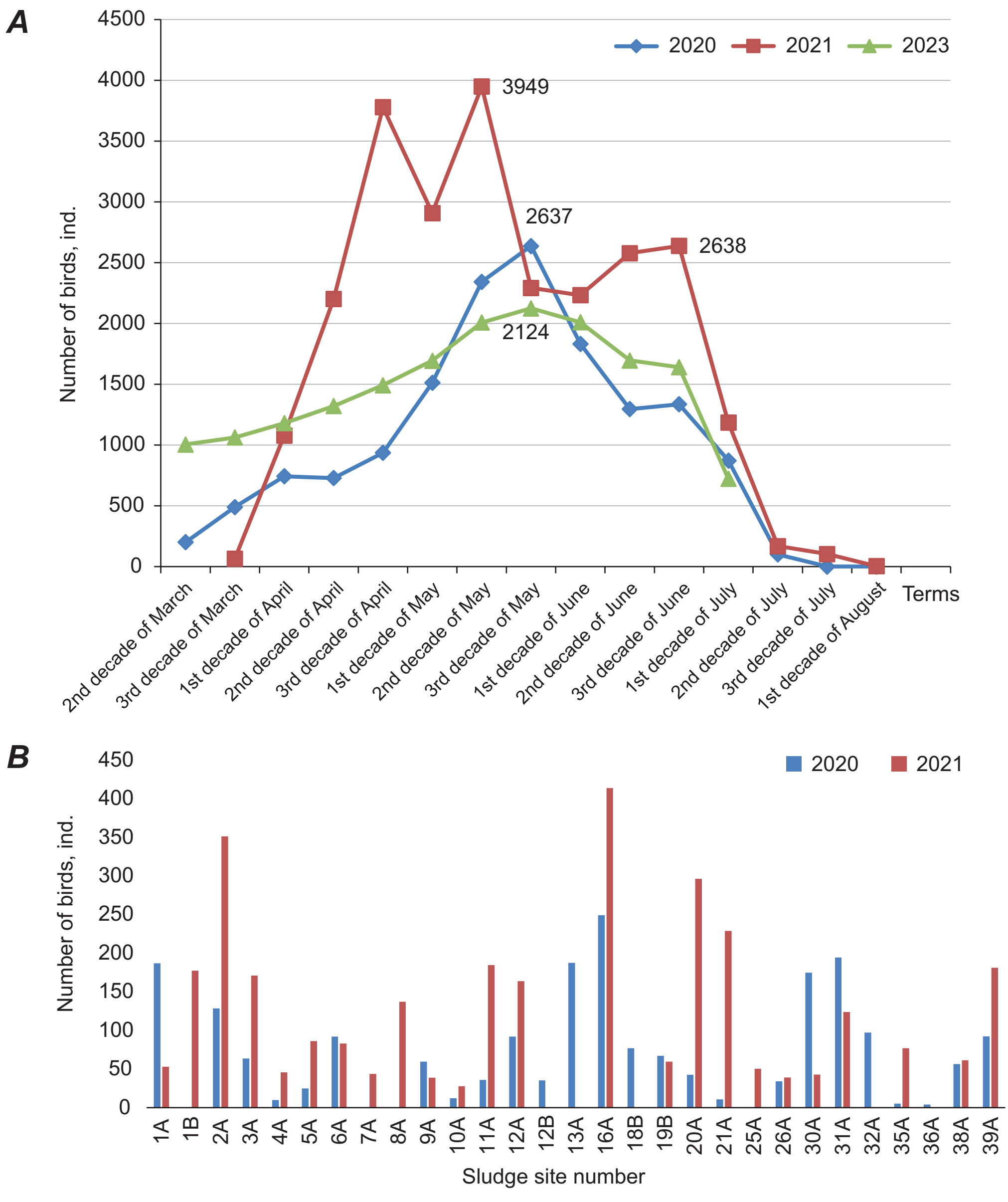

Fig. 1. Population dynamics of the black-headed gull during the nesting periods of 2020–2021 and 2023 (***A***); population size of the black-headed gull on different SS in 2020-2021 (***B***)

Throughout the entire season, on less suitable habitats for breeding, often alongside nesting pairs, clusters of resting (non-breeding) individuals were recorded. Their total number reached up to 500 individuals each year.

Nest construction and nesting sites. In 2020, nesting sites of the the black-headed gull were recorded on 13 SS, in 2021 – on 18 SS, and in 2023 – on 10 SS. Throughout all years of study, black-headed gulls inhabited four SS: 2A, 11A, 16A, 39A (**Fig. 2*A***). The

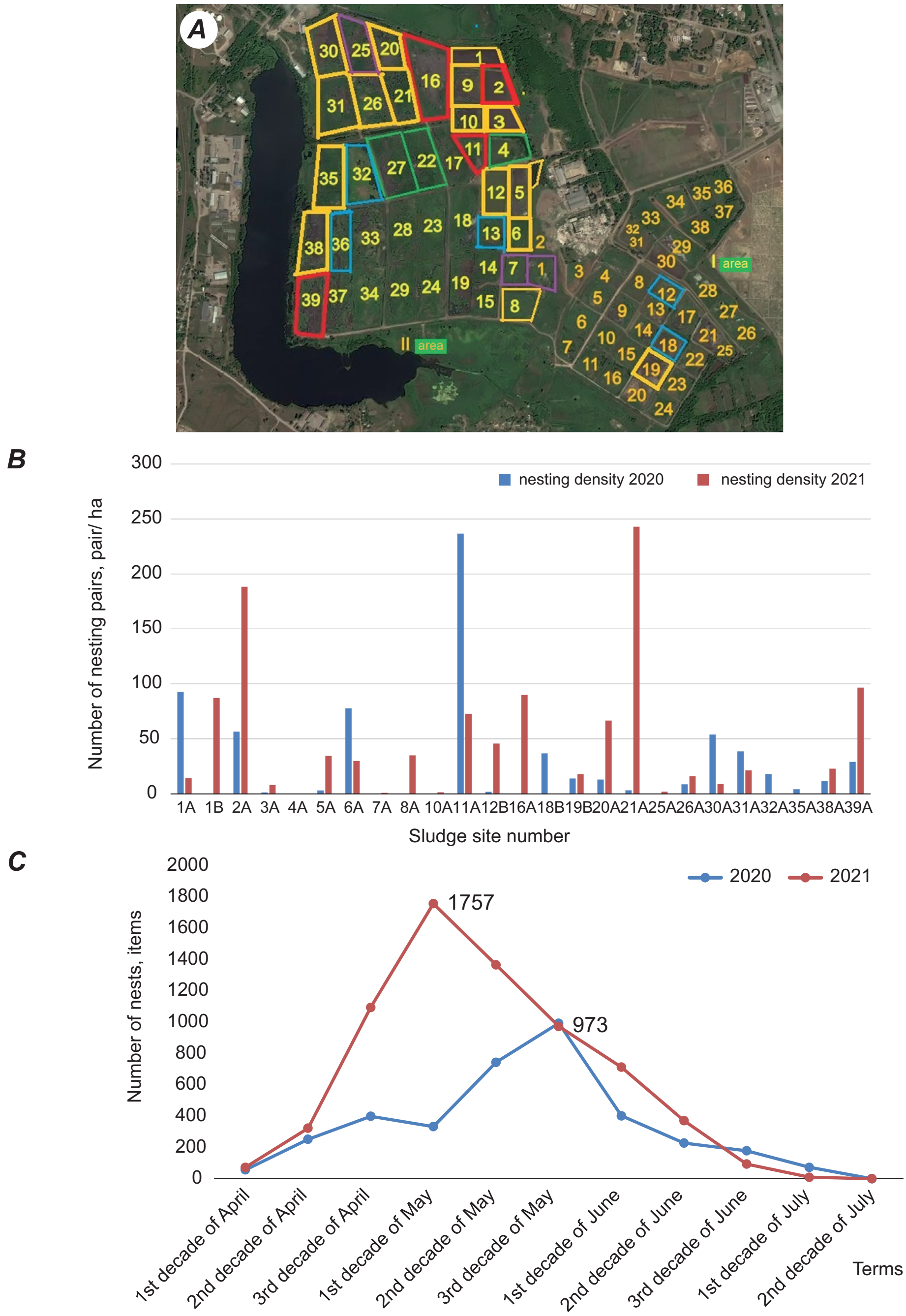

Fig. 2. Nesting of the black-headed gull on the territory of WTF: schematic layout of nesting subcolonies of black-headed gulls in 2020–2021 and 2023 on the sludge sites of the WTF (***A***); nesting density of black-headed gulls in 2020–2021 on different SS (***B***) and overall during the breeding season (***C***)

Note: Nesting of birds on sludge sites: during three seasons of 2020–2021 and 2023 marked in red; during two seasons of 2020–2021 – in orange; only during one season: 2020 – in blue; 2021 – in lilac; 2023 – in green most popular were SS resembling natural habitats with areas of dried mud interspersed with water patches and vegetation along the bottom and the perimeter (Types III and V). In 2020, the highest nesting density of birds was found on such types of SS: Type III (1A) – 92.9±15.2 pairs/ha and Type V (11A) – 236.7±26.7 pairs/ha; in 2021 – Type III (39A) – 96.7±12.2 pairs/ha and Type V (2A and 21A) – 188.3±13.6 and 242.9±28.5 pairs/ha, respectively (**Fig. 2*B***). The nesting density of black-headed gulls during the breeding season averaged 39.1±9.2 pairs/ha in 2020 and 52.6±12.8 pairs/ha in 2021. The maximum number of nests was recorded in the third decade of May 2020 and in the first decade of May 2021 (**Fig. 2*C***).

Birds readily colonized small gaps in dried sludge on the sites. They brought dry vegetation to construct nests and used it for building platforms that elevated the hatching tray above the ground. The higher the nest, the greater the chances for the offspring to avoid being flooded during rains or industrial water discharges. Sometimes, birds built solid islands from last year's grass (**Fig. 3*A*,*B***). On these plots, nests were almost touching each other. The total area of such islands on the WTF was insignificant, thus only a small part of the black-headed gulls' population nested in this way.

Fig. 3. Nesting of the black-headed gull on sludge islands: a mixed (joint) subcolony of the black-headed gull and the common tern *Sterna hirundo* (Linnaeus, 1758), 2021 (***A***); the black-headed gull and the common tern incubate clutches on their nests (***B***) monospecific settlement of the black-headed gull on little islands, 2020 (***C***)

The diversity of habitat conditions on sludge sites can vary throughout seasons and years, depending on the industrial facility operation. Specifically, in 2020, the combination of dry areas with shallow waters and vegetation on SS 1A provided camouflage for nests and chicks, hence the nesting density was 92.9±15.2 pairs/ha. With water loss in the following year, the SS was densely overgrown with grasses, transforming into a less attractive habitat for black-headed gulls in 2021 (14.3 pairs/ha). In contrast, sludge sites 21A and 39A were completely filled with water in 2020, while in 2021, they dried-out, so black-headed gulls nested there massively.

Overall, the nesting period of the black-headed gull on wastewater treatment facilities ranged from 125 to 140 days in different years. During this time, some birds repeatedly lost their nests with eggs and even chicks. In particular, in 2020, one of the subcolonies of the black-headed gull chose SS 6A with tall dry vegetation for nesting, as the industrial facility did not operate for some time. This SS was located near an unauthorized waste disposal site, which was replenished almost daily with food waste, attracting various bird species (**Fig. 4*A***). Considering the sufficient food supply and the high level of nest protection among the plant stems, the nesting density in this area was 77.8 pairs/ha. Thus, in the third decade of May 2020, there were approximately 193 black-headed gulls and 70 nests (**Fig. 4*B***). However, after the discharge of water by the facility to the adjacent SS (5A) in the first decade of June, the water level rose in SS 6A as well, causing the flooding of most nests. Consequently, the bird population decreased to 72 individuals and 12 nests (**Fig. 4*C***). The remains of gulls' eggs and chicks became food for starlings, which moved in flocks across the sludge areas. Eventually, the breeding success of black-headed gulls in this subcolony was catastrophically low – 5.2 %. In 2021, the nesting density of birds decreased by half (30.0 pairs/ha).

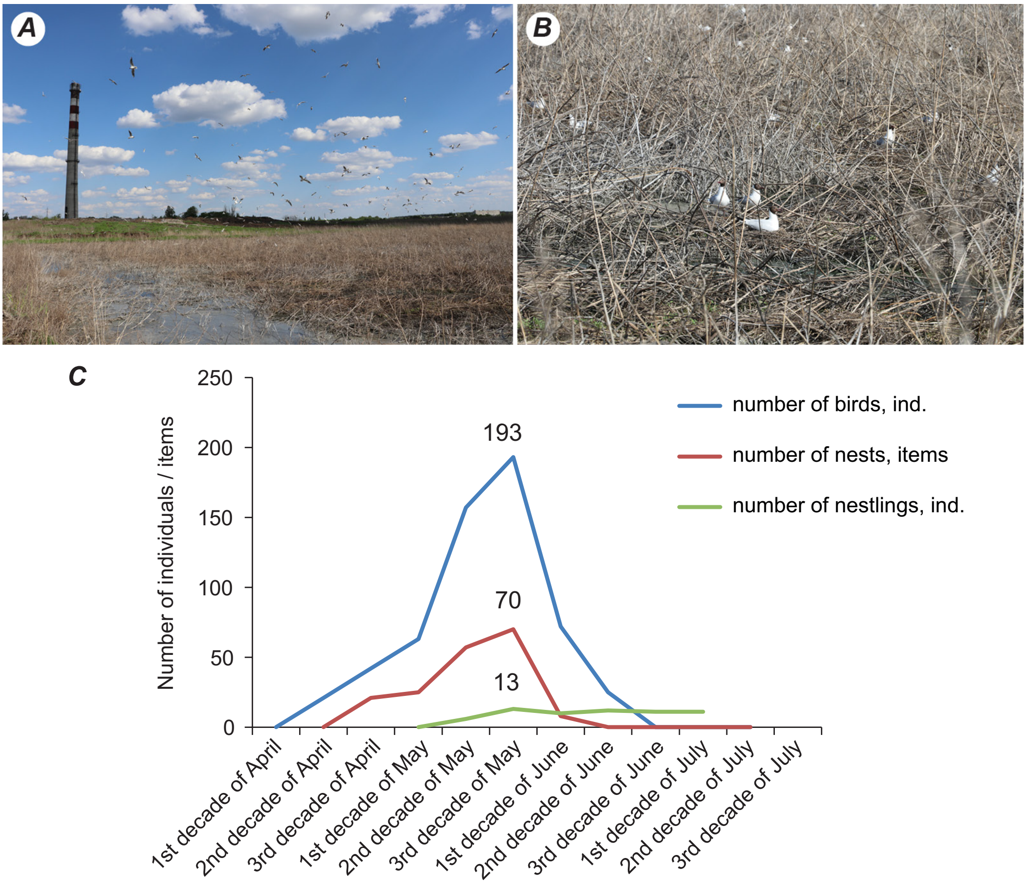

Fig. 4. Nesting of black-headed gulls among last year's plants: an overall view of the subcolony arrangement (***A***); a close-up of the subcolony (***B***); dynamics of some nesting parameters on sludge site 6A in 2020 (***C***)

Each year of the study period, the black-headed gull inhabited (45–50 nests) a small island on Novyi Lyman Lake, where other waterfowl bred, including the mallard *Anas platyrhynchos* (Linnaeus, 1758) and the Eurasian coot (*Fulica atra* Linnaeus, 1758). Black-headed gulls also nested along the inner perimeter of the lake, on bends of reed and cattatil, on submerged tree stumps, car tires, and a fishing pier (**Fig. 5*A***).

Within the territory of urban WTF, the black-headed gull usually forms mixed-species, sometimes monospecific subcolonies. In 2020, alongside the black-headed gulls nested the following species: the common tern *Sterna hirundo* (Linnaeus, 1758) – SS 16A; the mallard – SS 5A, 12A; on the island of Novyi Lyman Lake: the northern shoveler *Spatula clypeata* (Linnaeus, 1758) – SS 5A, 12A, 16A; the northern lapwing *Vanellus*

vanellus (Linnaeus, 1758) – SS 3A, 16A, 18A, 19A, 38A, 39A; the little ringed plover *Charadrius dubius* (Scopoli, 1786) – SS 1A, 2A, 16A, 38A, 39A, 1, 8A, 19A; the black-winged stilt *Himantopus himantopus* (Linnaeus, 1758) – SS 1A, 2A, 12A, 13A, 18A; the Eurasian coot – SS 1A, 3A, 5A, 12A, 5A.

Fig. 5. Types of the black-headed gull nest placement: on a tree stump (***A***); on a fishing pier (***B***)

In 2021, the settlements of the black-headed gull, the common tern, black-winged stilt, the Eurasian coot, and the Common moorhen *Gallinula chloropus* (Linnaeus, 1758) ware observed due to an increase in the number of breeding pairs of birds and their redistribution within the territory of the sludge sites. With regard to the above, the following species nested alongside the black-headed gull: the common tern – SS 4A and 11A; the mallard – SS 20A, 21A; the northern lapwing – SS 1A, 7A, 8A, 10A, 11A, 30A, 31A, 35A; the little ringed plover – SS 4B, 30B, and 31B; the black-winged stilt – SS 3B, 11B, 13B, 31B, 38B, the common pochard *Aythya ferina* (Linnaeus, 1758) on Novyi Lyman Lake.

Throughout the entire observation period, individual nests of the black-headed gull were registered outside the subcolonies, including one at SS 10A and two nests located on Lake Novyi Lyman on a tree stupm submerged in water (**Fig. 6**). All of these nests were destroyed during clutch incubation. In 2020, the birds attempted to nest on a „floating island.” Due to strong winds, five nests placed on a fallen tree were all destroyed at an early stage of construction. Admittedly, all attempts of birds' individual nesting on the WTF conclude with the destruction of the nests.

For nest construction, black-headed gulls primarily utilized dry stems of various herbaceous plants (reed, bulrush, sedge, etc.). The nest cup was typically lined with thinner and softer material. Some nests were found to contain anthropogenic materials among the construction components, such as fragments of copper and iron (rusty) wire, rubber pieces, plastic tubes, polyethylene, and the like.

Fig. 6. Individual nests of the black-headed gull on the wastewater treatment facilities in 2020–2021

The nest sizes varied depending on their location, weather conditions, as well as the diversity, availability, and nature of the building materials. Nests with greater height of 20-50 cm above the surface of the mud were better protected from flooding in case of rain or industrial water discharge. Some nests at Novyi Lyman Lake reached heights of up to 80 cm above the water surface.

Characteristics of clutches. The average size of a complete clutch of the black-headed gull is 3.1±0.4 eggs (1–4) n = 190. The morphometric characteristics of black-headed gulls' eggs (n = 77) are as follows: 50.9±2.1 (45.1–56.3) × 36.2±1.1 (33.2–39.1) mm, with a mass of 34.6±2.8 (28.3–42.8) g, a volume of 34.0±2.3 (25.6–43.9) cm^3, and a shape index of 71.1±2,9 (69.5–73.6) %.

In the coloration of the eggshell, five types of background colors were identified: dark olive (11.7 %; n = 77), greenish-gray (32.5 %), dirty green (14.3 %), bluish-green (9.1 %), and green (32.5 %). The main shades of eggshell coloration are green, olive, and brown. The coloration of the eggs exhibits inter-clutch and intra-clutch variability.

Terms of the reproductive period. Mass egg laying occurs from the third decade of April to the first decade of May: 40.3 % (n = 993) in 2020 and 62.3 % (n = 1757) in 2021. The duration of the egg-laying period extends from April to July (the last unincubated clutches were found in the first decade of July: 03.07.2020). Chicks from late clutches do not survive. The first chicks in black-headed gulls' nests hatch in the first decade of May (09.05.2020; 09.05.2021; 06.05.2023). During this period, the birds emit quite loud sounds, attack researchers, and prevent them from entering the territory of the sludge sites. Mass hatching of chicks occured in the second half of May (in 2020, 2021). Chicks in one nest hatched within 1–2 days (**Fig. 7*A***), remained in the nests for approximately 3–5 days, after which hid in the vegetation near the nest. They started moving around SS on the 8th-10th day, and in the case of danger, gathered in groups, forming flocks, which included young birds of various ages. Even the feathered chicks hide in vegetation in small goups of 1–3 individuals in case of danger. At the age of 40–45 days, young gulls are already able to fly, with the earliest flights observed from the end of the first decade of June (**Fig. 7*B***).

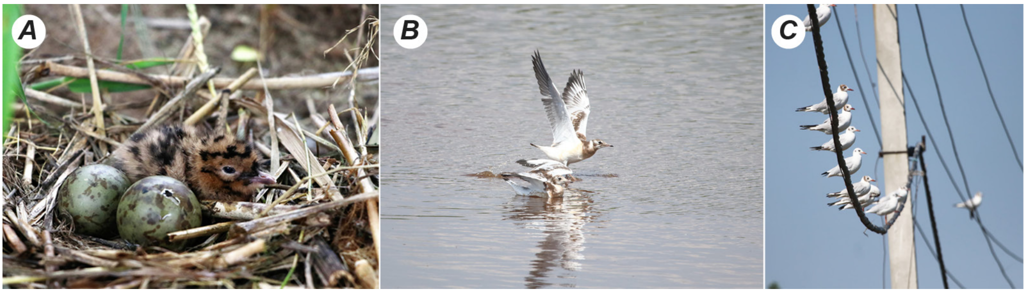

Fig. 7. Fledgling development: a 1–2-day-old downy chick (***A***), the young black-headed gulls at the age of 40–45 days (***B***), young black-headed gulls before the departure from the nesting site (C)

Each year, on the sludge sites of the WTF, the peak of hatching of black-headed gulls' nestlings coincides with the beginning of egg laying period of the common tern, which occurrs in the second decade of May. The latest registration dates of the black-headed gull on the WTF were in the second decade of July 2020 and the first decade of August 2022 and 2023. The bird's autumn migration commenced with summer relocations and concluded from late October to early November.

Reproductive success and causes of offspring mortality. The reproductive success of black-headed gulls on the WTF is relatively low: out of 2404 eggs laid in 2020, only 702 chicks (29.2 %) fledged; in 2021, the proportion was 15.5 % (n = 6138). Sludge sites of types I and IV were found to be the most favourable habitats for nesting: 100.0 % (n = 42) and 59.4 % (n = 553) in 2020; and 41.1 % (n = 198) and 36.0 % (n = 2034) in 2021, respectively.

The most popular type of SS – type V – was characterized by low reproductive success: out of 3243 eggs laid, only 14.1 % of chicks fledged in 2021, and 22.7 % (n = 1419) in 2020. Sludge sites of type III exhibited the lowest reproductive success: 22.4 % (n = 390) in 2020 and 1.0 % (n = 663) in 2021. The majority of offspring perished due to changes in water levels (prolonged rains or industrial water discharges), or disturbances within the subcolony, during which eggs can be displaced from the nest, or chicks may drown in the diluted filtrate of the WTF.

Among predators, the greatest impact on the survival of the black-headed gull is exerted by the hooded crow *Corvus cornix* (Linnaeus, 1758), which nests in small numbers on tall trees at the periphery of the sludge sites, the red fox *Vulpes vulpes* (Linnaeus, 1758), which resides nearby, and stray dogs. Crow species and occasionally the Caspian gull *Larus cachinnans* (Pallas, 1811) occasionally disturbed nests in small settlements. Birds of prey such as the western marsh harrier *Circus aeruginosus* (Linnaeus, 1758), the common buzzard *Buteo buteo* (Linnaeus, 1758), the Eurasian goshawk *Accipiter gentilis* (Linnaeus, 1758), the Eurasian sparrowhawk *Accipiter nisus* (Linnaeus, 1758), and the booted eagle *Hieraaetus pennatus* (Gmelin, JF, 1788), hunted adult birds and nestlings. In addition, cannibalism is occasionally observed among the black-headed gulls.

Determining the cause of clutch or nestling mortality is often challenging. For instance, in June 2021, 17 dead bodies of fledged nestlings were found without any specific injuries. Overall, the living conditions for birds on the WTF are hazardous, especially for juvenile nestlings. Throughout the study period, nearly all individually placed nests of black-headed gulls were found destroyed by predators, whereas the majority of clutches in colonies tend to be better protected. Thus, the reproductive success of the black-headed gull varies significantly across different SS. It depends on weather conditions, the availability of vegetation cover for nestlings, the density of nesting colonies, predator activity, disturbance factors, etc.

DISCUSSION

During the lifetime of M. M. Somov (1897), the black-headed gull was considered to be a rarely breeding migrating bird that migrated twice in the territory of Kharkiv region. The spring migration started in March and lasted until late April. The autumn migration perion extended from mid-August to late October. The increase in the number of birds nesting and the expansion of black-headed gulls' settlements in Kharkiv region can be explained by the growing "marine" tendencies in the region due to the construction of reservoirs in the second half of the 20th century. In the 1970s and 1980s, the birds' nesting sites were recorded in the Pryorillya area (Banik, 2016). In 1994–1996, a colony numbering 325–400 pairs of black-headed gulls inhabited the territory of the Horila Dolyna (The Burnt Valley) Tract. The birds fed on the water bodies of the Lyman lake system (Banik & Vergeles, 2003). At that time, in Ukraine colonies of black-headed gulls, which numbered 368–1124 nests, were described in the Desna floodplain (Afanasyev *et al.*, 1992).

The transformation of a significant portion of natural lakes and marshes into reservoirs for technical purposes (cooling ponds, ash ponds, fish ponds, sugar factory ponds, etc.), extensive drainage of the majority small river floodplains, and the construction of the Dnipro-Donbas canal have led to significant changes in the hydrological regime of the region in the late 20th and early 21st centuries. This has had a dramatic effect on the redistribution of waterbird populations (Chaplygina *et al.*, 2023). For example, the number of birds in the black-headed gull colony in the Horila Dolyna Tract decreased by half in 2002 (Banik & Vergeles, 2003). Presumably, during this period, birds began to inhabit various man-made territories in Kharkiv region, as was the case in other countries (Andersen *et al*., 2003; Indykiewicz *et al*., 2021).

Currently, the largest colony of black-headed gulls in Kharkiv region nests within the territory of the city's WTF. In 2010–2012, this nesting population numbered 350–400 individuals (Nadtochiy & Osadchuk, 2013). Thus, over the past decade, the black-headed gull population has increased almost tenfold.

Along with the black-headed gull, mixed-species settlements include: the black-winged stilt (Red Data Book of Ukraine; Bk2; Bo2), the common tern (Bk2; Bo2), the little ringed plover (Bk2; Bo2; X), the northern shoveler (Bk3; Bo1,2; X), the northern lapwing (Bk3; Bo2), the Eurasian coot (Bk3; Bo2), and the common moorhen (Bk3). The fact that most of these species are under protection of European and Ukrainian nature conservation acts underscores the significant role of man-made water bodies in the preservation and restoration of rare species populations (Mamedova, 2021; Mamedova & Chaplygina, 2021; 2022).

The prerequisite for the settlement of black-headed gulls in the WTF on the outskirts of the city of Kharkiv is the abundant food base provided by solid waste disposal sites. Specifically, the Rohansky SWD site is located 9 km east of the city's WTF, while the Derhachi SWD site is situated 30 km to the north. Black-headed gulls arrive at these sites early in the spring, where they feed on domestic food wastes (Dementieieva *et al.*, 2023). Some individuals find food at the SWD sites during the breeding season. Flocks that numbered hundreds of black-headed gulls were recorded at the SWD sites during the post-breeding period, in August and September.

During the winter period, black-headed gulls were not found on the territory of WTF, while small groups of the birds occasionally appeared at the SWD sites for brief periods. Usually, the black-headed gull migrates southward within the country, where it forms winter aggregations. A few birds (75 individuals) were recorded on the Dnipro River near Kaniv on December 25, 2011 (Grishchenko *et al*., 2013). Since the second half of the 20th century, the majority of black-headed gulls, have wintered in Poland (Tomiałojć & Stawarczyk, 2003). Large aggregations of birds have been reported on water bodies, settling ponds, and landfills, particularly on the outskirts of large cities, near rivers (the Oder, Vistula, and Warta), as well as along the coast, primarily in Żuławy, Gdańsk, and to a lesser extent in Szczecin Pomerania (Bukaciński & Bukacińska, 2015). In 2021, the wintering population of black-headed gulls on the Warsaw reservoir was estimated at 42.441 individuals (Sidelnik & Rapczyński, 2022).

CONCLUSION

The population of the black-headed gull at the wastewater treatment facilities exhibits a tendency to increase: from 400 individuals (2010–2012) to 2637 (2020) and 3949 (2021). The decrease in population to 2124 individuals in 2023 can be attributed to the military activities in the region – repeated explosions scare the birds away.

The first spring migrants of the black-headed gull were recorded in the second decade of March (11.03.2020, 20.03.2021, 9.03.2023). The maximum number of nests was registered in the third decade of May 2020 and in the first decade of May 2021.

During the breeding season, the nesting density of black-headed gulls averaged 39.1±9.2 pairs/ha in 2020 and 52.6±12.8 pairs/ha in 2021. The most popular habitats among the birds were the sludge sites of the WTF that are most similar to natural habitats – dried mud interspersed with water patches and vegetation at the bottom and around the perimeter (Types III and V). In 2020, the highest nesting density of black-headed gulls was found in such SS types: Type III (1A) – 92.9±15.2 pairs/ha and Type V (11A) – 236.7±26.7 pairs/ha; in 2021 – Type III (39A) – 96.7±12.2 pairs/ha and Type V (2A and 21A) – 188.3±13.6 and 242.9±28.5 pairs/ha, respectively.

The size of the complete clutch of the black-headed gull averages 3.1±0.4 eggs (1–4) n = 190. The morphometric parameters of the eggs are 50.9±2.1 × 36.2±1.1 mm, with a mass of 34.6±2.8 g. Mass egg laying occurs from the third decade of April to the first decade of May: 40.3 % (n = 993) in 2020 and 62.3 % (n = 1757) in 2021. The duration of the egg-laying period extends from April to July. Chicks from late clutches do not survive. The first nestlings appear in the first decade of May, while mass hatching occurs in the second half of May. The latest registered dates of hatching were in the second decade of July in 2020 and the first decade of August in 2022 and 2023. The breeding period of the black-headed gull at the WTF lasted from 125 to 140 days in different years.

The relatively low reproductive success of the black-headed gull at the WTF, 29.2 % (n = 2404) in 2020 and 15.5 % (n = 6138) in 2021, indicates the population's instability. Sludge sites of types I and IV were found to be the most favourable nesting sites in terms of reproductive success.

Thus, multi-species settlements of black-headed gulls and other rare bird species have formed on the wastewater treatment facilities within the city, including the common tern, the mallard, the northern shoveler, the northern lapwing, the little ringed plover, the black-winged stilt, the Eurasian coot, and the common moorhen. The significant aggregation of black-headed gulls attracts predatory bird species that prey on adult birds and their chicks. Overall, the ornithocomplexes of the WTF serve as unique habitats for birds throughout the year, due to favourable man-made conditions.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as apotential conflict of interest.

Animal studies: The experiment was conducted in compliance with bioethics, in accordance with the provisions of the Convention on the Protection of Vertebrate Animals Used for Experimental and Other European Scientific Purposes (Strasbourg, 1986), and does not violate the conventions on wildlife protection in Europe (Berne Convention), the Law of Ukraine "On Fauna" (March 3, 1993), the Law of Ukraine "On Environmental Protection" (June 26, 1991)

AUTHOR CONTRIBUTIONS

Conceptualization, [Y.M; A.Ch.] methodology, [Y.M; A.Ch.]; validation, [Y.M.; A.Ch.]; formal analysis [Y.M.; A.Ch.]; investigation, [Y.M; A.Ch.] resources, [Y.M.; A.Ch.]; data curation, [Y.M.; A.Ch.]; writing – original draft preparation, [Y.M.]; writing – review and editing, [Y.M.; A.Ch.]; visualization, [Y.M]; supervision, [A.Ch.]; project administration, [Y.M.; A.Ch.]; funding acquisition, [Y.M.; A.Ch.].

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ЧИСЕЛЬНІСТЬ І ОСОБЛИВОСТІ ГНІЗДУВАННЯ МАРТИНА ЗВИЧАЙНОГО *CHROICOCEPHALUS RIDIBUNDUS* (LINNAEUS, 1766) НА ВОДООЧИСНИХ СПОРУДАХ

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Вступ. Зменшення природних водно-болотних угідь мартин звичайний компенсує за допомогою техногенних ділянок водоочисних споруд. На таких ділянках протягом останнього десятиріччя зареєстровано збільшення його чисельності майже в 10 разів, за низької успішності розмноження. Усе це свідчить про відсутність стабільності популяції птахів, що потребує ретельних досліджень.

Матеріали та методи. Аналіз чисельності й особливостей біології мартинів передбачали обліки та спостереження на водоочисних спорудах за загальноприйнятими методами у весняно-літні періоди 2020–2021 та 2023 рр.

Результати. Популяція мартина звичайного досягала максимуму у ІІІ декаді травня 2020 р. (2637 ос.) та 2023 р. (2124 ос.), а також у ІІ декаді травня 2021 р. (3949 ос.). Максимальної щільності гніздування досягли на мулових майданчиках (ММ), найбільш подібних до природних біотопів, де підсушений мул пере-

межовувався з ділянками води та рослинності по днищу і по периметру (V тип): 236,7±26,7 (11А) пар/га у 2020 р., а також 242,9±28,5 пар/га у 2021 р. Більшість гнізд виявлено у I декаді травня 2021 р. та у III декаді травня 2020 р.

Мартин звичайний утворює полівидові, інколи моновидові субколонії. Спільно з ним гніздилися: *Sterna hirundo*, *Anas platyrhynchos*, *Spatula clypeata*, *Vanellus vanellus*, *Charadrius dubius*, *Himantopus himantopus*, *Fulica atra*, *Gallinula chloropus*, *Aythya ferina*.

Величина повної кладки – 3,1±0,4 яйця (n = 190). Розмір яєць: 50,9±2,1 x 36,2±1,1, маса 34,6±2,8 г. У забарвленні шкаралупи виявлено 5 типів кольорів основного фону. Масове відкладання яєць: III декада квітня – I декада травня: 40,3 % (n = 993) у 2020 р. та 62,3 % (n = 1757) у 2021 р. Тривалість періоду відкладання яєць: протягом квітня – липня (останні ненасиджені кладки у I декаді липня: 3.07.2020). Перші пташенята у гніздах у I декаді травня. Масове вилуплення пташенят у II половині травня. Найпізніші дати реєстрації на гніздовій території – II декада липня 2020, 2023 рр. та I декада серпня 2022 р. У різні роки гніздовий період становив 125–140 діб. Осінній проліт починається літніми кочівлями і закінчується в кінці жовтня – на початку листопада.

Успішність розмноження: 29,2 % пташенят, які стали на крило (n=2404 відкладених яєць) у 2020 р. та 15,5 % (n = 6138) у 2021 р. Більшість нащадків загинуло від зміни рівня води (затяжні дощі або технологічні скидання води підприємством), діяльності хижаків, фактора занепокоєння тощо.

Висновки. Колоніальне поселення мартина звичайного створює сприятливі умови для перебування та розмноження різних видів птахів, зокрема рідкісних, що є важливим для їхнього збереження.

Ключові слова: водоочисні споруди, мартин звичайний, чисельність, гніздова біологія, орнітофауна

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