

The formation of sclerophilic ornithocomplexes in the quarries in the South of Ukraine and their conservation prospects

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ABSTRACT

The ornithocomplexes of the quarries include both domain-specific breeding burrowing birds, or sclerophylls, as well as species from the surrounding biotopes. In the quarries 4 species from the group of primary minnows (*Merops apiaster*, *Coracias garrulus*, *Alcedo atthis*, *Riparia riparia*) were registered, and 15 species of secondary burrowing birds (*Tadorna tadorna*, *T. ferruginea*, *Upupa epops*, *Falco tinnunculus*, *F. naumanni*, *Athene noctua*, *Sturnus vulgaris*, *Pastor roseus*, *Passer montanus*, *P. domesticus*, *Corvus monedula*, *Motacilla alba*, *Oenanthe oenanthe*, *O. pleschanka*), as well as 25 related species of dendrophils, camphophiles. *Riparia riparia* colonies in quarries count up to 500-1500 pairs, *Merops apiaster* – up to 100-250 pairs, *Coracias garrulus* – up to 7-15 pairs. The core of the ornithocomplexes is the *Riparia riparia* and *Merops apiaster*. The process of formation of ornithocomplexes of quarries runs as follows: the new quarries in the initial years of their formation are first settled down by *Riparia riparia*, in 2-4 years there arrive *Merops apiaster*, then *Coracias garrulus*. In 5-10 years, with the coming of grassy and shrub-tree vegetation in large quarries appear 20-25 species of the related ornithocomplexes, represented by the steppe birds (*Alauda arvensis*, *Anthus campestris*), ruderal (*Calerida cristata*), shrub-tree (*Phasianus colchicus*, *Perdix perdix*, *Columba palumbus*, *Streptopelia turtur*, *Otus scops*, *Cuculus canorus*, *Corvus cornix*, *Pica pica*, *Turdus merula*, *T. philomelos*, *Lanius collurio*, *L. minor*, *Sylvia communis*, *S. nisoria*, *Luscinia luscinia*) meadow complex (*Motacilla flava*, *M. feldegg*, *Saxicola rubetra*, *S. torquata*, *Coturnix coturnix*). Mixed or multi-species colonies of *Riparia riparia* and *Merops apiaster* comprise about 60%. Mixed colonies with associated species (secondary burrowers) comprise up to 10-15 species. Large species of birds occupy for breeding the habitats of crevices and cavities in natural cliffs and quarries. Annual changes in the species composition of bird nesting in quarries increases 2-3 times, the quantitative composition gains 10-30 times, which is related to the climatic, weather, and forage conditions of seasons and human activity. The decrease in the number of species-determinants (primary burrowers) leads to the breach of consortia, accompanied by a sharp decrease in quantity or disappearance of consortment species (secondary burrowers).

Key words: Birds, Conservation, Ecological groups, Management, Ornithocomplexes, Quarries, Species diversity.

Introduction

Due to economic activity over the past 150-200 years, the natural landscapes in the south of Ukraine have been significantly transformed. They have been replaced by anthropogenic landscapes with a depleted composition bird species. The main relief forms of the Black Sea lowland are coastal steep slopes – effectual coastal cliffs created by the activity of the sea, landslides of ravines and cloughs. Given that, from west to east their decrease can be noted and reduction in the density of the ravine-clough network is observed. The territory of the region has been developed for agrilandscapes; it is used to obtain minerals, including building materials (sand, clay, shell rock, marl, etc.). The number of quarries where building material deposits are exhausted is increasing year on year (Pershin, 1978; Andryushchenko *et al.*, 2005). Natural cliffs and quarries are inhabited by a unique ecological group of sclerophiles, or burrowing birds, originally nesting in natural cliffs (6% of the regional ornifauna), forming the specific ornithocomplex. The sclerophiles are a specialized ecological group of birds that combines species nesting in earthen burrows, caverns, on rock shelters (Afanasova and Khokhlov, 1986; Malovichko and Konstantinov, 2000; Bauer, 1952; Collias, 1964; Demong and Emlen, 1975; Glutz von Blotzheim and Bauer, 1980; Sieber, 1980; Del Hoyo *et al.*, 2005). Nesting ornitocomplexes of quarries, as well as natural cliffs along the waterfronts, include both primary and secondary burrowers. Their core consists of birds of the first group (*Merops apiaster*, *Coracias garrulus*, *Alcedo atthis*, *Riparia riparia*, where the first two species act as edificators). The birds of this ecological group are characterized by communal and colonial types of nesting (Malovichko and Konstantinov, 2000; Bauer, 1952; Collias, 1964; Glutz von Blotzheim and Bauer, 1980; Goray *et al.*, 1992; Brown 1978). The group of secondary burrowers includes 15 species (*Tadorna tadorna*, *T. ferruginea*, *Upupa epops*, *Falco tinnunculus*, *F. naumanni*, *Athene noctua*, *Sturnus vulgaris*, *Pastor roseus*, *Passer montanus*, *P. domesticus*, *Corvus monedula*, *Motacilla alba*, *Oenanthe oenanthe*, *O. pleschanka*, *Phoenicurus ochruros*). This makes up about 5% of the regional avifauna. Besides, among sclerophiles the following groups are distinguished: obligatory and optional, active and passive burrowers. The obligatory, or real burrowers cannot go without their burrows, so

the absence thereof leads to a reduction or complete disappearance of the population. A severe intra- and interspecific competition often arises for the burrows' possession. The optional burrowers nest both in burrows and outside them; therefore, the absence of burrows does not limit the size of their populations (Malovichko and Konstantinov, 2000; Goray *et al.*, 1992; Brown, 1978; Busel, 2014). The independent digging of the burrows is the major adaptation to the settlement in them, therefore, the species capable of this belong to a separate group – that of the active burrowers.

For them, the man-made cliffs in quarries have become an important substitute for the natural ones, since coastal and waterfront zones are intensively built up and used for recreation. Among sclerophiles there are rare endangered species and economically important species. In recent years, burrowing birds have experienced a lot of pressure from humans, which leads to a decrease in their number. The ornithological fauna of the south of Ukraine includes over 330 species of birds, of which 45-60 species nest in quarries of various type and area, including the quantity from the group of sclerophiles, namely 25-30 species (Chernichko, 1998; Koshelev and Matruhan, 2010; Koshelev *et al.*, 2018). The diversity of avifauna is determined by the human activity, the diversity of biotopes and their mosaic and depends on these factors. The original avifauna type is preserved only in nature reserves and inarable lands, but it also underwent transformations due to the disappearance of many indigenous species and the introduction of the new species (Andryushchenko *et al.*, 2005; Koshelev and Matruhan, 2010; Koshelev and Yakovleva, 2019; Koshelev *et al.*, 2007; 2010; 2018; Orlov, 1959).

Materials and Methods

The study of birds inhabiting the quarries and natural cliffs was carried out in the southern regions of Ukraine (Zaporizhia, Kherson, Nikolaev, Odessa oblasts and the Republic of Crimea) in 1990-2019 throughout 29 field seasons. Over 140 quarries of various types, areas and degrees of economic use, as well as over 500 km of cliffs of the coastline of the Azov Sea, Molochnyi and Utlyuk estuaries, the Dniester, the Dnieper, and the Molochnaya rivers, were examined. In 1992-2004 special attention was paid to the survey of the shores of the Kakhovskoye reservoir and its islands. In 2007-2016 in the

Kherson oblast, in the floodplain of the lower Dnieper in areas with steep coastal slopes, 12 test sites were founded to study the species composition and number of birds. In the south of Zaporizhia region in 2001-2019 two control sites were founded and examined annually: in the old quarry near the village of Rodionovka Akimovsky rayon and in the group of operational and non-operational quarries in the outskirts of the village of Terpenie of Melitopol rayon. The generally accepted methods of ornithological research were used (Goray *et al.*, 1992; Bogolyubov, 1996; Gudina, 1999). In all quarries, the continuous counts of nesting birds were carried out, as well as route counts in other seasons of the year, the mapping of colonies and nesting sites, the photographing of colonies of the burrowing birds, the nesting biology was studied, bird ringing was carried out in a small volume (300 specimens). The economic use of inoperative quarries and the degree of anthropic factors impact on birds were also studied (Afanasova *et al.*, 1989).

By the term "quarries" in the present study we mean a set of excavations in the Earth's crust, that is formed by open-cast mining of minerals, including the working zone of mining, in which overburden operations were carried out or are being carried out, that is, quarries are huge wells dug in the Earth's surface. The platform of the lower ledge is referred to as the bottom or the pit-floor of the quarry.

The natural cliffs along water bodies are divided into the following classes: sea, estuary, river, ponds; according to the nature of the soil they are distinguished into clay, sand, shell, and granite ones. The division of quarries is carried out according to the types of minerals mined: sand, clay, shell, granite, marl, chalk, granite, quartzite, marble, zeolite, basalt, perlite, copper, diamond, coal, etc. According to the type of output quarries are subdivided into block, and esioic, etc. According to the method of utilization quarries are subdivided into the operating ones and the developed non-operating ones, as well as the flooded ones (Pershin, 1978). The cliffs' height in the quarries varies between 1 to 30 m and more, the length of each cliff varies in the range of 3 m to 1000 m and more; the area is from several dozens to dozens of thousands of square meters. The cliffs' slope angle, the nature and extent of overgrowing by vegetation of the slopes and peaks, of the quarry bottom, the nature of the adjacent landscapes, including the proximity of open water (fresh or salty) and the degree of economic activity also

vary significantly. It should be pointed out that limestone mining is currently not performed in the studied region, only the abandoned quarries of this type were examined.

Results and Discussion

The location of the nests of one and different species of birds of the sclerophilic complex is primarily associated with the size and area of the clift, the nature of the soil and its preference for different species, as well as the size of the inlet of the hole. For instance, *Riparia riparia* choose sandy soil layers, *Merops apiaster* favour clay layers.

The nests in burrows in mixed multi-species colonies are arranged vertically in several ordered rows, the distance between adjacent burrows in a row is from 5 to 50 cm or more, the distance between rows is 15-50 cm. Colonies of *Riparia riparia* number from 10-30 to 500-1200 pairs. Colonies of *Merops apiaster* have a disordered structure both vertically and horizontally, with up to 10-120 pairs. Colonies of *Coracias gracilus* consist more often from 5-12, less commonly up to 20 burrows. Mixed or multi-species colonies of *Riparia riparia*, *Merops apiaster* comprise 60% of the total number of colonies. Mixed colonies with the share of related species account for up to 10-15 species of birds.

The large bird species (*Corvus corax*, *C. monedula*, *Tadorna tadorna*, *T. ferruginea*) occupy for nesting natural niches and caverns in cliffs, old burrows of *Vulpes vulpes* or expanded burrows of small birds. The nesting ornithocomplexes have been monitored for many years in quarries near the village of Rodionovka and the village of Terpenie of the *Melitopol rayon of Zaporizhia oblast*. Over the course of 20 years, the dynamics in the species composition of nesting birds have been recorded; the changes in the species composition by 2-3 times have been registered and in the quantitative composition by 10-30 times, which is associated with climatic, weather, and forage conditions of the seasons and human activities (Table 1). The violation of consortive connections affects to a lesser extent; for instance, the downsizing in species determinants (primary burrowing) automatically results in a dramatic downsizing or disappearance of consortment species (secondary burrowing species).

The ornithocomplexes of the limestone cliffs of Crimea are distinguished by their peculiarity. On the ledges, in the crevices, niches and caverns of the

Table 1. The number of nesting birds in quarries at control sites in 1992-2018

Species	The number of breeding pairs/ 10 hectares in quarries of various types				
	Sand quarries		Clay quarries		Limestone quarries
	Operational	Non-operational	Operational	Non-operational	Non-operational
<i>Tadorna ferruginea</i>	3.5–7.0	≥ 0.5	3.5–4.0	3.5–7.0	3.5–7.0
<i>Tadorna tadorna</i>	2.0–4.5	≥0.5	1.5–2.0	2.0–4.5	2.0–4.5
<i>Falco tinnunculus</i>	0.5–1.0	≥0.5	≥0.5	0.5–1.0	0.5–1.0
<i>Athene noctua</i>	1.5–3.0	1.5–3.0	2.0–3.0	1.5–3.0	1.5–3.0
<i>Coracias garrulus</i>	1.5–2.0	≥0.5	≥0.5	1.5–2.0	1.5–2.0
<i>Alcedo atthis</i>	1.0–1.5	≥0.5	2.0–2.5	1.0–1.5	1.0–1.5
<i>Merops apiaster</i>	1.0–1.5	≥0.5	2.0–3.0	1.0–1.5	1.0–1.5
<i>Upupa epops</i>	3.5–7.0	≥0.5	3.5–4.0	3.5–7.0	3.5–7.0
<i>Riparia riparia</i>	2.0–4.5	≥0.5	1.5–2.0	2.0–4.5	2.0–4.5
<i>Delichon urbica</i> **	0.5–1.0	≥0.5	≥0.5	0.5–1.0	0.5–1.0
<i>Sturnus vulgaris</i>	1.0–7.5	2.5–3.0	2.5–3.5	1.0–7.5	1.0–7.5
<i>Oenanthe oenanthe</i>	10.0–16.0	7.5–14.0	7.5–8.5	10.0–16.0	10.0–16.0
<i>Oenanthe pleschanca</i>	≥ 0.5	≥0.5	0.5–2.5	≥0.5	≥0.5
<i>Phoenicurus ochruros</i>	3.5–7.0	≥0.5	3.5–4.0	3.5–7.0	3.5–7.0
<i>Passer montanus</i>	2.0–4.5	≥0.5	1.5–2.0	2.0–4.5	2.0–4.5
<i>Passer domesticus</i> ***	0	0.5	1.0–1.5	2.5–3.0	0.5
Total	≥ 0.5	≥0.5	2.0–2.5	≥0.5	≥0.5

Note: * - there are currently no operational limestone quarries in the research region; ** - only according to the literature data; *** - only near the settlements

cliffs nest the following species: *Phalacrocorax aristotelis*, *Falco peregrines*, *Coilumba livia*, *Delichon urbica*, *Hirundo rustica*, *Apus apua*, *A. melba*, *Sturnus vulgaris*, *Pastor roseus*. The upper tier is traditionally occupied by *Apus apus*.

The ratio of the burrowing species in control sites in the lower Dnieper varies significantly in different types of quarries (Fig. 1). The dominant species were *Riparia riparia*, *Sturnus vulgaris*, *Meropa apiaster*. Less common on nesting *Falco tinnunculus*, *Athene noctua*, *Otnanthe pleschanka*. *Tadorna tadorna*, *T. ferruginea*, which soft sandy soil is not suitable for

nesting, are not found in sand quarries, since nesting chambers are at risk of flooding due to the hygroscopicity of the sand. So, in the delta part of the river after long rains in the spring of 2016, the Southern Bug had been flooded with almost all burrows occupied by *Coracias gracilus*, *Anhene noctua*, they were later abandoned.

The clay cliffs, in contrast to the sand ones, have less hygroscopicity and thus are more resistant to unfavourable weather conditions. The nesting bird colonies under such conditions are longer-term and are characterized by a more diverse species composition. The long-term nesting holes contribute to their settlement in subsequent years and nesting of bird species from the group of secondary burrowers, which use ready-made holes, expanding the nesting chamber. In the sand quarries, such cases are rare, while in the clay quarries this is a fairly common phenomenon. Thus, in the examined quarries, the burrows of *Coracias gracilus* are more frequently occupied by *Falco ninnunculus* and *Anhene noctua*, while the burrows of *Merops apiaster* and *Riparia riparia* are occupied by *Oenanthe pleschanka*, *O. oenanthe*, *Passer montanus*, *Sturnus vulgaris*, less often by *Pastor roseus*. Given the abundance of empty burrows in old colonies in springtime, most

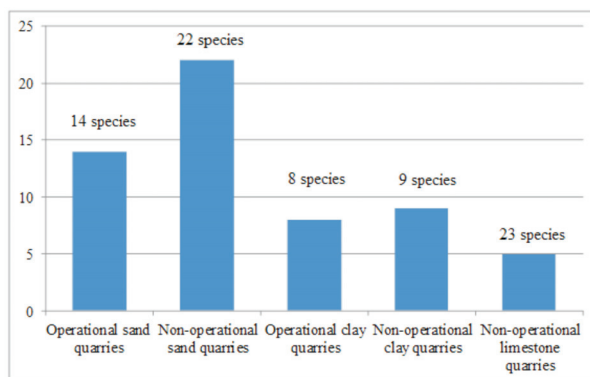


Fig. 1. The ratio of the species composition of nesting birds in various types of quarries.

species of primary burrowers try to occupy ready-made ones, while expanding the nesting chamber. Moreover, even when there are large hollows nearby in the tree-shrub thickets, *Coracias gracilus* and *Athene noctua* prefer to nest in the burrows, which was also brought to notice by other researchers (Busel, 2014; Orlov, 1959). The colonies of nesting birds in sandy and clay quarries with low slopes often suffer from predatory animals and humans. Thus, the overall of 172 colonies were examined, with a total number of more than 7,000 breeding pairs, were affected by humans and predators, in particular the nests located 1-3 m above the bottom of the quarry (Fig. 2).

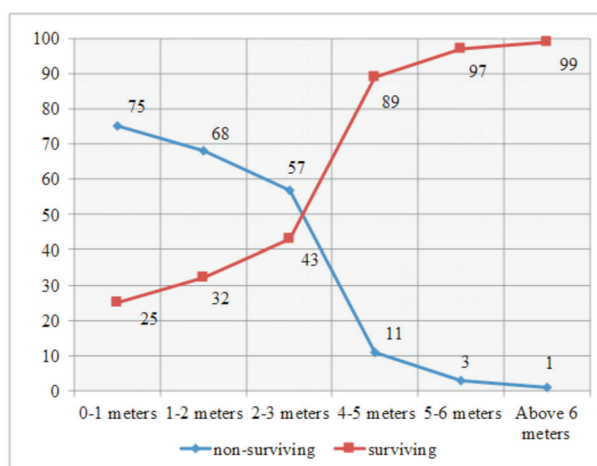


Fig. 2. The ratio of the non-surviving and surviving broods of the burrowing birds depending on the height of the nesting burrow on the quarry cliff, in %.

Nests in burrows located higher than 5-6 m are usually inaccessible and not affected by predators. We examined 443 destroyed burrows with the clutches or broods of birds. The most dangerous for colonial nesting of the burrowing birds are *Nyctereutes procyonoides* – 320 burrows (72.2%), *Vulpes vulpes* – 57 burrows (12.9%), *Martes foina* – 23 burrows (5.2%), *Mustela putorius* – 18 burrows (4.0%). Less commonly, burrows are destroyed by *Meles meles* – 9 burrows (2.0%), *Mustela erminea* 8 burrows (1.8%), *Canis lupus familiaris* – 3 burrows (0.7%). There are occasional cases of the clutches' destruction by snakes, in particular *Dolichophis caspius* – 2 burrows (0.5%), which uses burrows for a day's rest in the nesting and post-nesting periods. Excavated burrows in sand pits of *Felis silvestris catus* 3 (0.7%) are also very rare. The destructive

human activity (an excavation of sand and clay, a direct destruction of holes) as a rule causes the entire colony to perish.

The limestone quarries are characterized by a dense mineral composition, which makes it impossible for birds to independently build nesting holes. This dramatically affects both the species composition of nesting species and their population dynamics. Here the colonies are rare to be found, the birds usually nest in separate pairs, less often in group settlements on rock shelters, in natural voids or rock fractures. In the formation of the species composition, and in particular, determines the small number or absence of crayfish, an important factor is that all known quarries have not been operated for a long time (the youngest are at least 40-50 years old). Old abandoned quarries have a high percentage of moisture, which contributes to the rapid development of tree-shrub vegetation, and it makes it difficult for birds to approach nesting colonies (Busel, 2014). No cases of the nests' and clutches' destruction by predators were noted in limestone quarries, which are also explained by the good protective properties of the dense limestone.

The sequence and pace of quarries' colonization by birds of different ecological groups was studied using the example of a quarry system in the village of Terpenie and non-operational quarry near the village of Rodionovka (Tables 2, 3).

The birds populate new quarries, in particular for sand mining in a very short time. So, *Riparia riparia* establishes its colonies in the first year of the existence of sand and clay quarries, despite the ongoing mining of minerals. Other species, such as *Merops apiaster*, *Upupa epops*, *Falco tinnunculus*, *Athene noctua*, *Sturnus vulgaris*, *Passer domesticus*, *P. montanus*, *Corvus monedula*, *Motacilla alba*, *Oenanthe oenanthe*, *O. pleschanka*, appear in quarries only in 3-5 years. In large open quarries, among grassy and shrub-tree vegetation, up to 20-25 species nest from related ornithocomplexes from both the group of secondary burrowers and birds of the campophilic (steppe) ornithocomplex (*Perdix perdix*, *Alauda arvensis*), and ruderal complex (*Calerida cristata*, *Anthus campestris*), shrub-tree complex (*Phasianus colchicus*, *Columba palumbus*, *Streptopelia turtur*, *Otus scops*, *Asia otus*, *Cuculus canorus*, *Corvus cornix*, *Pica pica*, *Turdus merula*, *T. philomelos*, *Lanius collurio*, *L. minor*, *Sylvia communis*, *S. nisoria*, *Luscinia luscinia*), meadow complex (*Motacilla flava*, *M. feldegg*, *Saxicola rubetra*, *S. torquata*, *Coturnix coturnix*). In the

Table 2. The formation of ornithocomplexes in sand quarries near the village of Terpenie

Years/Stages of overgrowing by vegetation	Number of breeding species by ecological groups				Species in total
	Sclerophiles		Tree-shrub (dendrophils)	Meadow-steppe (campophiles)	
	Primary burrowers	Secondary burrowers			
1-5 years	1-2	2	-	1	4-5
6-10 years *	3-5	18	8	4	33-35
11-20 years *	1-2	22	16	4	43-44
More than 20 years*	1	12	23	4	40

Note: *- non-operational quarries

Table 3. The population of quarries by birds (on the example of a clay quarry near the village of Rodionovka, Akimovskiy region)

Years of study	Number of breeding species by ecological groups				Species in total
	Sclerophiles		Species in total	Meadow-steppe (campophiles)	
	Primary burrowers	Secondary burrowers			
1960-1975	3	10	4	2	19
1976-1985*	3	15	12	4	34
1986-1995*	3	20	16	4	43
1996-2005*	2	10	21	3	36
2006-2017*	1	6	23	2	32

Note: Non-operational quarry, takes place a minor spontaneous mining of minerals by local population

colonies of *Riparia riparia* and *Meropus apiaster* constantly hunts *Falco subbuteo*, less often hunt *Circus aeruginosus*, *Corvus corax*, *Buteo buteo*.

The burrowing birds cannot nest in open pit quarries. Such walls, for example, in the old non-operational Rodionovskiy quarry, account for 95% of the perimeter, so the birds have a shortage of convenient places. In subsequent years, the situation worsened, the number of birds dropped sharply. In recent years, there has been a sharp decrease in the number of burrowers due to dry seasons and the drying of neighboring water bodies, which has led to the deterioration in the food supply. The bird anxiety factor plays a special role: the nests are ruined and destroyed by teens, beekeepers are shooting down the birds, quarries are spontaneously utilized for dumping household and construction waste, the livestock is grazed in the quarries, and the anxiety factor increases. The garbage dumps in quarries are appealing as feeding sites for many birds, synanthropic species of rodents (a gray rat, a house mouse), stray and feral domestic dogs. With the appearance of bushes and trees in the old quarries, including with the participation of birds (12), the forest species begin inhabiting them. During the

wintertime, in open pits, up to 8-15 bird species are identified while feeding and having a night's rest in bushes and weeds.

The dynamics of the number of breeding species in quarries is given in tables 4 and 5.

The taxonomic structure of sclerophilic ornithocomplexes is as follows. Among the primary burrowers, *Coraciiformes* comprise 75%, *Passeriformes* make up 25%. *Passeriformes* comprise 58%, *Anseriformes*, *Falconiformes* and *Strigiformes* account for 12% each, *Upupiformes* 6% prevail among secondary normik species. It should be noted that species with extensive habitats prevail among burrowing birds, as well as a significant share of the southern species. Among the primary burrowers, the representatives of the European type of fauna dominated (75%), the share of the Mediterranean was 25%. Among the secondary burrowers, representatives of the Mediterranean and European fauna comprised 30%, transpalearctic 25%, Mongolian 10%, Siberian 5% of the total number of sclerophilic species. The trophomorphic structure of sclerophilic ornithocomplexes is also characterized by specificity. The zoophagous hunters predominate by the nature of their food (75%), the share of shrew

euriphages accounts for 25% of the species; other ecological groups (zoophages-shavers, phytophages, euriphages-gatherers, euriphages-inspectors) are not represented among the sclerophiles.

The seasonal aspects of the species composition of ornithocomplexes in old non-operational quarries, with thickets of shrubs, trees, sections of meadow and steppe vegetation, preserved steeply walls, are expressed extremely vividly. In the summertime, over 60 species of birds (up to 20% of the regional avifauna) are observed in quarries, which emphasizes the importance of these biotopes in maintaining biodiversity. In autumn, only 10-15 species are recorded here (including *Carduelis carduelis*, *Acanthis cannabin*, *Turdus pilaris*, *Parus major*, *P. caeroleus*, *Passer domesticus*, *P. montanus* arriving for feeding), 3 species are common in winter (*Corvus corax*, *Buteo lagopus*, *Turdus pilaris*). Most of the species (90%) are represented by migratory birds.

Overall, the ornithocomplexes of the quarries are depleted, but are still represented by specialized

nesting species, burrowers, which are an important component of the regional fauna, enhance the level of biodiversity, pertain uniqueness and originality to it. On the other hand, it is these species that emphasize and support the specifics of this type of biotope.

In places of sand and clay extraction, landslides of coastal swallow colonies are observed on an ongoing basis, which annually leads to nests perishing counted by thousands. There also occur ongoing processes of natural destruction and overgrowing of cliffs with vegetation, which negatively affect the number of nesting birds. Beekeepers are shooting *Merops apiaster*, as well as the destruction of their burrows. As the quarries are ageing, they lose their significance for burrowers. Until recently, the protection of the burrowing birds in the region under study has not been given sufficient attention. In order to maintain the optimal number and improve the protection of burrowing birds, in the future it is expedient to preserve and maintain in an operating condition the most significant and important quarries and cliffs for birds, guard and protect them, cre-

Table 4. The number of burrowing birds in quarries near the village of Terpenie (Melitopol rayon) in 2007-2018

Bird species	Number of pairs		Population Index (12-year average)
	Min (year)	Max (year)	
Primary burrowers			
<i>Ńoracias garrulus</i>	3 (2014)	11 (2013)	6
<i>Merops apiaster</i>	21 (2014)	185 (2011)	50
<i>Riparia riparia</i>	0 (2011)	1600 (2009)	600
Secondary burrowers			
<i>Falco tinnunculus</i>	0 (2007)	5 (2009)	3
<i>Athene noctua</i>	0 (2007)	5 (2012)	2
<i>Upupa epops</i>	0 (2007)	2 (2012)	0.8
<i>Sturnus vulgaris</i>	0 (2007)	13 (2018)	0.1
<i>Oenanthe oenanthe</i>	0 (2007)	3 (2014)	0.5
<i>Phoenicurus ochrorus</i>	0	2 (2012)	0.3
<i>Passer domesticus</i>	0 (2010)	20 (2008)	5
<i>Passer montanus</i>	0 (2010)	4 (2013)	0.5

Table 5. The dynamics of the species diversity of nesting birds in quarries near the village of Terpenie (Melitopol rayon) by stages

Ecological groups by nesting types	Species in total (2007-2018)	The number of pairs for specific years		
		2007	2012	2018
Burrowers	12	4	10	7
Tree	9	-	2	8
Bush	4	-	2	4
Ground	7	1	4	7
Total	32	5	18	26

ate nature reserves and national parks on their territory. The natural and man-made cliffs themselves have a unique, spectacular view, extremely high and broken relief and mosaic (the depth of some quarries exceeds 30-50 m) and deserve attention and conservation as unique elements of landscapes, as a habitat for rare and endangered species of plants and animals. In Western European countries, for the conservation of burrowing birds, the man-made burrows are constructed from plastic pipes and installed on the low coasts of water bodies where natural cliffs have been destroyed. In fact, the quarries can be appealing locations for ornithological tourism and birdwatching.

Conclusion

Thus, the population of nesting birds by quarry openings in river estuaries of the Ukrainian steppe has several features. For example, the sand excavations are populated very rapidly, but they are characterized by a relatively high risk for nesting birds. The nesting burrows usually collapse in the early years and are rarely reused by both the hosting varieties and other species. In the sand quarries, the nesting of 22 sclerophile bird species was noted, of which *Riparia riparia* and *Sturnus vulgaris* are the dominant ones. Nesting holes in clay workings, due to the physical properties of the rock, are more resistant to adverse weather conditions. The nesting bird colonies under such conditions are longer-term and have a greater species composition, and the long-term nesting burrowers, in turn, contribute to their settlement in subsequent years and re-nesting of the species that do not dig burrows themselves, but reuse the existing ones, usually expanding the nesting chamber. The nesting of 9 birds species was noted in clay workings, of which *Merops apiaster* are dominant. The limestone quarries are characterized by a dense mineral composition, which makes it impossible for birds to independently build nesting burrows; therefore, they usually nest in separate pairs, less often in group settlements on rock shelves, in natural crevices or outcrops. The nesting of 5 bird species was noted in the limestone workings, of which *Pastor roseus* is the dominant species. The scarcity of the species and quantitative composition of the cliff birds is largely due to the lack of ponds and, accordingly, birds of the wetland complex, and the small area of shrub-tree vegetation.

References

- Andryushchenko, Y.O., Koshelev, O.I. and Matsyura, O.V. 2005. Features of the geographical landscape Zaporizhzhya Azov. In: Anosova, I.P., Afanasieva, L.V., Krylova, M.V. and Prigaro, M.V. (Eds.), *Ethno-Social Life of the Peoples of Zaporizhzhya Azov in Geocultural Context: Monograph*. Regional State Administration, Zaporizhzhya; MDPU, Melitopol; Tavriya, Simferopol, pp. 32–44.
- Afanasova, L.V. and Khokhlov, A.N. 1986. Ornithocomplexes of coastal cliffs are protected objects of the Stavropol Territory. In: Abstracts of the scientific and practical conference: *Rare and endangered species of plants and animals, floristic and faunistic complexes of the North Caucasus that need protection*. (Stavropol, 14-19 Oct., 1986). SSU, Stavropol, pp. 83–85.
- Afanasova, L.V., Bichev, A.N. and Khokhlov, A.N. 1989. Factors affecting the number of birds on coastal cliffs. In: Abstracts: *Ornithological resources of the North Caucasus*. SSU, Stavropol, pp. 146–154.
- Bauer, K. 1952. Der Bienenfresser (*Merops apiaster* L.) in Osterreich. *Journal of Ornithology*. 93 : 290–293.
- Brown, J.L. 1978. Avian communal breeding systems. *Annual Review of Ecology, Evolution, and Systematics*, 9 : 123–155.
- Busel, V.A. 2014. An Unusual Case of Breeding of a Blue Roll and House Owl in a Landscape Transformation of the Left Bank of the Kakhovskoye Reservoir. In: Materials of the international conference: *Double Nesting Birds as Model Objects in Solving Population Ecology and Evolution* (Moscow, 22-27 Sept., 2014). M.V. Lomonosov MSU, Moscow, pp. 33–36.
- Bogolyubov, A.S. 1996. *Methods of Counting the Number of Birds: Route Counts*. Ecosystem, Moscow, 17 pp.
- Gudina, A.N. 1999. *Methods of registration nesting birds: Territorial mapping*. Wild Field, Zaporozhye, 241 pp.
- Collias, N.E. 1964. The evolution of nest and nest-building in birds. *American Zoologist*. 4 (2) : 175–190.
- Chernichko, R.M. 1998. Birds of the Cape Tarkhankut cliffs. *Proceedings of the Azov-Black Sea Ornithological Station*. 1 : 125–128.
- Demong, N.J. and Emlen, S.T. 1975. An optical scope for examining nest contents of tunnel-nesting birds. *Wilson Bull.* 87 : 550–551.
- Del Hoyo, J., Elliot, A. and Sargatal, J. 2005. *Handbook of the Birds of the World*. Vol. 10. Barcelona, Lynx Editions, 895 pp.
- Glutz von Blotzheim, U.N. and Bauer, K.M. 1980. *Handbuch der Vogel Mitteleuropas*. Vol. 9: Colum-biformes – Piciformes. Akademischer Verlag, Wiesbaden, 420 pp.
- Go-ray, L.F., Koshelev, A.I. and Chernichko, I.I. 1992. Golden bee-eater in the northwestern Black Sea region. *Modern Ornithology*. 3 : 161–171.

- Koshelev, V.A. and Matruhan, T.I. 2010. Zoo Career Complexes in the North Azov Region: structure, dynamics, balanced use and protection. In: Abstracts collection of the international scientific-practical conference: *Ecology: Scientists in Solving Problems of Science, Education and Practice* (Zhytomyr, 25-26 March, 2010). I. Franko ZhDU, Zhytomyr, pp. 98–99.
- Koshelev, V.A., Koshelev, A.I. and Afanasieva, K.V. 2018. Ornithocomplexes of Careers in the North Azov Region: Structure, Dynamics, Use in Ecological Tourism and Protection. In: Scientific works collection: *Ecology – Philosophy of Existence of Humanity*. Color Print LLC, Melitopol, pp. 45–49.
- Koshelev, A.I., Peresadko, L.V., Koshelev, V.A. and Nikolenko, A.N. 2007. Anthropogenic transformation of landscapes of the North Azov Sea, recessions and upsurges in the number of background vertebrate species and their impact on the structure of zoocenoses. In: Sytnyk, K.M. (Ed.), *Balanced Development of Ukraine – the Road to Health and Well-Being*. Center for Eco-Education and Information, Kyiv, pp. 122–125.
- Koshelev, A.I., Koshelev, V.A. and Nikolenko, A.N. 2010. *The Priazovye Reserve*. Lux, Melitopol, 156 pp.
- Koshelev, V.A. and Yakovleva, O.S. 2019. Birds participation in forested sandy quarries (south of Zaporizhzhya region). In: *Proceedings of the 38th ACCHORG International Scientific Conference: Topical issues of research and protection of birds*. UTOP, Kyiv, pp. 65–70.
- Malovichko, L.V. and Konstantinov, V.M. 2000. *Comparative Ecology of Birds of Nornik: Ecological Adaptations*. SSU, Stavropol-Moscow, 288 pp.
- Orlov, P.P. 1959. Changes in the avifauna of the lower Dnieper in the area of construction of the Kakhovka hydroelectric complex. *Proceedings of the Research Institute of Biology and the Faculty of Biology of KSU*. 28 : 101–114.
- Pershin, P.N. 1978. *Atlas of natural conditions and natural resources of the Ukrainian SSR [Maps]*. GUGK, Moscow, 315 pp.
- Sieber, O. 1980. Kausale und funktionale Aspekte der Verteilung von Uferschwalbenbruten (*Riparia riparia* L.). *Zeitschrift für Tierpsychologie*, 52 : 19–56.
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