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PRINCIPAL FACTORS DETERMINING THE ISLANDS SPATIAL DISTRIBUTION OF COLONIALLY BREEDING LARIDAE
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The analysis of the main factors, which specify the spreading of colonial Laridae to the islands of Azov and Black Sea region, is presented. The influence of the anthropogenic pressure and the interspecific interrelations on the island bird communities is considered. The basic directions of anthropogenic influence on island birds were determined. The analysis of mutual breeding of island birds was performed.

Key words: island, bird communities, anthropogenic pressure, interspecific interrelations, analysis.

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ФАКТОРИ, ЩО ОБУМОВЛЮЮТЬ РОЗПОДІЛ КОЛОНІАЛЬНИХ ПТАХІВ РОДИНИ LARIDAE НА ОСТРОВАХ
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Наведено комплексний аналіз факторів, що обумовлюють просторовий розподіл колоніальних навколоводних птахів на островах Азово-Чорноморського регіону. Розглянуто ступінь впливу різноманітних факторів на видове різноманіття птахів острівних систем. Доведено, що домінуючий вплив на колонії має антропогенний прес та система міжвидових зв'язків в угрупованнях гніздових птахів.

Ключові слова: острова, угруповання птахів, антропогенний вплив, міжвидові взаємозв'язки, аналіз.

The islands, being the parts of the region wetland community, are not only the places of the large bird concentration during the migrations and the areas with the maximum carrying capacity of breeding congregations, but the central landscape units supporting for the biodiversity. The islands themselves possess the high vulnerability and restricted possibilities of resilience. On the other hand, they are characterized as the excellent model plots for the monitoring and management, by virtue of their limited territory and high concentration of colonially nesting waterfowl.

In the considered region, the small marine continental islands and spits together with numerous alluvial islets of the bays, estuaries, and saline lakes have the maximum carrying capacity for the breeding bird communities. The number of birds breeding on the islands comprises more than 50 % from the total regional amount; moreover, the alluvial and continental islands provide breeding habitats for 15.7 % of all non-Passerines birds within the region (Siokhin & Chernichko, 1996). Several birds are listed in the European List of the Rare and Threatened Birds, among them Great Black-headed Gull *Larus ichthyaetus*, Mediterranean Gull *Larus melanocephalus*, Slender-billed Gull *Larus genei*, Gull-billed Tern *Gelochelidon nilotica*, Caspian Tern *Hydroprogne caspia*, Sandwich Tern *Thalasseus sandvicensis*, Common Tern *Sterna hirundo*, and Little Tern *Sterna albifrons*. The Great Black-headed Gull and Caspian Tern are listed also in the Red Data Book of Ukraine (Shcherbak, 1994).

Thus, for the successful island management and conservation it is necessary to establish the main factors, caused the dispersion and quantity of the breeding birds.

MATERIAL AND METHODS

The field material was collected during the breeding seasons of 1995-1999, conducting the regular observations in constant monitoring plots of the Sivash and Azov-Black Sea coast. About of 30 island and island groups with total area more than 700 ha were inspected. The annual counts of the colonially nesting birds were conducted by two methods (Mikityuk, 1997): the method of the absolute count of birds in the colonies (for the small colonies); the method of partial count: complete calculation of nests was performed only for the part of colony and then it was extrapolated to the entire territory (we used this in the large colonies).

The islands' areas were determined by own measurements. For the islands with annual fluctuations of areas and configurations, we took the data from the topographic maps of 1993, scale 1: 50000. The vegetation pattern was studied by transect method with registering of the specific composition, dominant associations, vegetation cover and plants' height. The interrelation between the specific diversity of bird communities and island parameters was estimated by the multivariate regression analysis (SYSTAT, 1989).

RESULTS AND DISCUSSION

Anthropogenic pressure

The number of island birds in the Azov-Black Sea region is subjected to the considerable oscillations, caused by various factors. Each breeding settlement has the specific set of factors and the mechanism of their actions. The distribution, structure and fluctuation of the breeding birds are caused by the anthropogenic impact, the habitat conditions on the islands, the interspecific and intraspecific interplays, the weather conditions, the action of terrestrial predators, and the cyclical fluctuations of the birds' number. We estimated that the anthropogenic factors have the strongest impact on the breeding island communities. The majority of the colonies are situated within the area of intensive economic utilization; moreover, even the protected territories are influenced by human disturbance. The general decline of the economic situation and decreasing of the living standards of the local people have negative effect on bird colonies. We determined the following directions of straight anthropogenic press:

- the periodic human presence on the islands during the nesting period decreases the breeding success in the colonies of Slender-billed gull, Great Black-headed Gull, Little Tern;

- the active human utilization of island reed associations completely reduces these breeding habitats of herons and egrets;

- in the places of the intensive fish catch the fishermen eliminate the colonies of the Cormorant *Phalacrocorax carbo*;

- the active nest robbing and eggs' collecting in the colonies of Yellow-legged Gull by the local people has drastic effect on the only Sivash colony of Caspian Tern and Great Black-headed Gull, breeding on these islands;

- the human disturbance within the breeding period provokes the predation of Yellow-legged Gull that in turn leads to the decrease in number of other species and their extinction from breeding sites;

- the spreading of the Cormorant to the new islands, after a destroying of its colonies by fishermen, causes the turnover of rare island species;

- the human disturbance leads to the increase of nestlings' mortality in the colonies from overheat;

To estimate the effect caused by the discussed factors on the number and distribution of the nesting birds, we analyzed the islands by two methods. We performed the regression analysis of the number of species and the island area. For the convenience of calculations and unification of the results, we expressed all the data in the logarithmic scale; we took the initial data for the areas of islands in the hectares. After analysis we divided all the islands

into two groups - with low and high degree of the anthropogenic pressure. According to island theory (McArthur, 1967), the values that characterize the most suitable habitats are situated above the regression line and correspond to the islands with the higher number of species per area unit (Fig. 1).
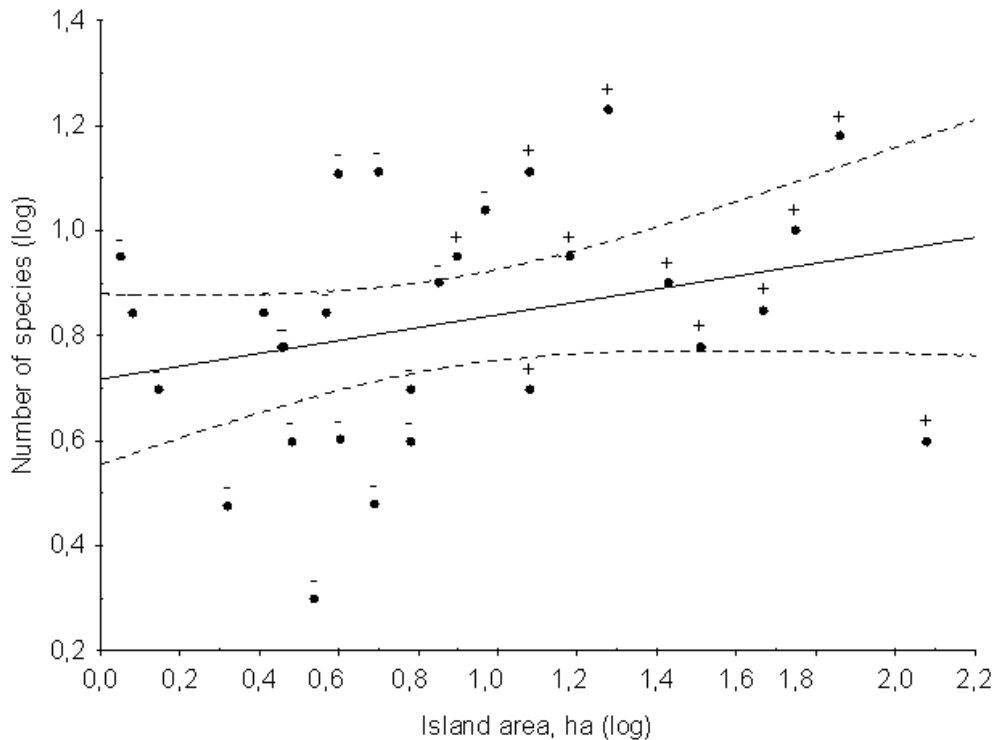

Fig. 1. The log species-area plot for all islands
(−) are the islands with high degree of anthropogenic impact, (+) are the islands with low degree of anthropogenic impact. Equation of the regression: the number of species = 0.71 + 0.13 * island area (R^2 = 71.60 %, r = 0.85).

The regression line shows the relatively identical scatter of values for the islands with the different degree of anthropogenic press, but the values of islands with the lower degree are arranged more higher above regression line (R^2 = 3.86; r < 0.05, One-Way ANOVA). The number of species per area unit is more for the islands with low level of the anthropogenic pressure, which indicates its importance in the distribution of bird species.
Characteristic of interspecific interrelations in the colonies of birds
For the purpose of the explanation of the pattern of bird distribution among the islands and island groups the analysis of their contingency by the "chi-square" (χ^2) criterion was performed (1).

$$\chi^2 = [(ad\text{-}bc) - 0.5F)]^2 * F / [(a + b)\,(a + c)\,(b + d)\,(c + d)] \qquad (1)$$

where: *a* − is the number of the islands, where both species breed
b - number of the islands, where species *a* is only breed
c - number of the islands, where species *b* is only breed

d - number of the islands, where nor *a* neither *b* species breed
F - number of the analyzed islands (n = 29)

This criterion illustrates the probability of the independent or conjugated distribution of two species within the community. The higher the value the greater the probabilities of these species to exist mutually; the low value of the criterion determines the negative contingency and characterizes the tendency of species to live separately (Table 1).

Table 1.

The coefficients of contingency for the Laridae breeding species.

Species	Largen	Larcac	Gelnil	Stehir	Thasan	Stealb
Larus melanocephalus	3.91	0.31	2.81	0.95	4.96	0.84
Larus genei	-	0.32	1.10	4.44	5.26	1.46
Larus cachinnans	0.32	-	0.07	0.01	0.001	0.19
Gelochelidon nilotica	1.10	0.07	-	0.13	0.69	1.46
Sterna hirundo	4.44	0.01	0.13	-	2.33	8.65
Thalasseus sandvicensis	5.26	0.001	0.69	2.33	-	4.25
Sterna albifrons	1.46	0.19	1.46	8.65	4.25	-

The abbreviated names of the birds in the columns correspond to the names in the lines with the same serial number. Values are statistically significant at p ≤0.05 (Wilcoxon significance test). The Great Black-headed Gull and Caspian Tern are not included to this table due to their mono-specific colonies and distribution pattern.

CONCLUSIONS

According to this the species are divided into three groups of bird pairs occurences - complete repulsion, independent distribution, complete contingency or the coincidence:

1) Yellow-legged Gull and all the species, except for the Slender-billed Gull and Mediterranean Gull; Mediterranean Gull and Common Tern; Mediterranean Gull and Little Tern; Sandwich Tern and Gull-billed Tern.

2) Slender-billed Gull and Gull-billed Tern; Slender-billed Gull and Little Tern; Common Tern and Sandwich Tern; Little Tern and Gull-billed Tern.

3) Slender-billed Gull and Common Tern; Little Tern and Common Tern; Sandwich Tern and Slender-billed Gull.

The species of the second and third group usually form mixed colonies and breed mutually on one island without essential effect on each other; the species of the first group are characterized by the most intensive interspecific interrelations, their mutual existence on one island is almost impossible.

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