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A comparison of the structure of 2 waterbird assemblages during postbreeding movements in the arid zone of Uzbekistan

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Abstract: Natural riverbeds in arid regions of Central Asia play an important role in waterbird migration. However, agricultural irrigation in the Aral Sea basin, in combination with climate change, is leading to wetland habitat loss. In this study, we consider the importance of the 2 largest river systems in this region during postbreeding movements and compare waterbird assemblages in relation to habitat parameters between the Amu-Darya and Syr-Darya rivers. In the second half of August 2011, we counted waterbirds along 125 and 106 km of the Amu-Darya and Syr-Darya rivers, respectively. Both rivers showed a high similarity of richness indices. Analysis of waterbird occurrence in sections of river habitat showed no differences in the numbers of individuals, but the numbers of species on the Syr-Darya sections were significantly higher than on the Amu-Darya sections. A negative regression relationship between the number of species and the riverbed width could be explained by the greater attractiveness of small, shallow reservoirs compared with the flowing river with wide riverbeds. However, both rivers should be regarded as important places in the Palearctic for migratory waterbirds, despite negative changes in the habitat quality of wetlands in the arid zone of this region.

Key words: Waterbird, migration, large rivers, arid zone

1. Introduction

River systems and marshes attract migratory birds and often become major migratory corridors for many bird species (Berthold, 2001; Tourenq et al., 2001). Natural riverbeds with sandy islands, sandbanks, and muddy banks are ideal habitats for migrating waterbirds (Bocheński et al., 2006). These habitat types play an important role for migrating birds, especially in arid zones of Central Asia. The Amu-Darya and Syr-Darya rivers, within the Aral Sea basin, encompass a broad spatial overlap between the East Asian, Central Asian, and Eurasian–African flyways (Iverson et al., 2011). However, the extensive wetland habitats in the Aral Sea basin are under threat as a result of agricultural irrigation, mainly for cotton production, which is leading to ecological impacts on an unparalleled scale (Kreuzberg-Mukhina, 2006a). Furthermore, the climate changes noted in Central Asia additionally aggravate the ecological problems in this region (Kreuzberg-Mukhina, 2006b). It is necessary to coordinate development activities with a comprehensive water policy that includes the use of water-saving technologies and conservation of water resources. When considering regional climate scenarios, the regional hydrological model has shown that the discharge from the Amu-Darya River is expected to decrease over time (Agal'tseva et al., 2011). Large-scale water withdrawals from the Amu-Darya and Syr-Darya rivers, and the expected climate warming, will have further negative consequences for wetland ecosystems and the migrating status of many bird species (Kreuzberg-Mukhina, 2006b). Therefore, it is important to monitor waterbird populations in the Aral Sea basin and to understand how water withdrawals and climate change may impact future migratory patterns (Kingsford, 2000).

Waterbirds represent different guilds and can be used as indicators of environmental change at a variety of spatial and temporal scales (Kushlan, 1993; Paillisson et al., 2002; Mistry et al., 2008; Everard and Noble, 2010). Assemblages of waterbirds are influenced by the hydrological and ecological conditions of catchments, especially in arid zones (Kingsford et al., 2004; Reid et al., 2013). The Aral Sea basin wetlands are considered very important due to their high diversity of inland waterbird species and attractive habitats (Kreuzberg-Mukhina, 2006a; Williamson et al., 2013). Recent studies have focused attention on

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ground and aerial surveys within these wintering areas (Kreuzberg-Mukhina, 2006b; Lanovenko, 2006). However, assessments of autumn water bird migration patterns through the Aral Sea basin are limited. Previous bird migration studies of Central Asia were carried out mostly in Kazakhstan and focused mainly on waders of the genus *Charadrii* (Gavrilov, et al., 1993; Schielzeth et al., 2010).

The main goal of this study was to describe the species composition and richness of waterbirds along the Amu-Darya and the Syr-Darya rivers during postbreeding migration. Apart from the wintering period, we predicted that both rivers could also play an important role for birds migrating in autumn, especially due to their location and the effects of climate warming, which could lead to the reduction of adequate wetland foraging habitats in the semidesert zone (Kreuzberg-Mukhina, 2006a; Newton, 2008). The next aim was to determine if the number of birds and the species diversity differed between the 2 study areas. The null hypothesis of our study was that both rivers are similar with respect to species composition and bird numbers because of having the same geographic location. However, we expected that some habitat conditions could differ between the rivers and thus affect the proportions of various trophic groups and species domination.

2. Materials and methods

Observations of autumn waterbird migration were conducted between 21 and 25 August 2011 in the lower part of the Amu-Darya (125 km length), between Miskin (41°23′N, 61°10′E) and Karata (42°05′N, 60°16′E) near Urganch (Figure 1). In this part of the river, the main riverbed width ranged from 400 to 1200 m and the course was in a northwestern direction. The Amu-Darya River crosses desert and semidesert climatic regions, and it forms a boundary between the Kara Kum and Kyzyl Kum deserts. At this point, the river loses much of its discharge to evaporation and water withdrawal for irrigation purposes (Agal'tseva et al., 2011). Furrow-irrigated upland cotton (*Gossypium hirsutum*), winter wheat (*Triticum aestivum*), and flood-irrigated rice (*Oryza sativa*) are the dominant crops along the riverbanks (Awan et al., 2011).

We sampled the Syr-Darya along a middle section of the river (length: 106 km), between Bekobod (40°13′N, 69°14′E) and Verkhenevolynskoye (40°41′N, 68°57′E). Data were collected between 27 and 31 August 2011. The river bed was relatively narrow (70–500 m) and the discharge was low, mainly due to the presence of a dam situated on the border of Uzbekistan and Tajikistan. Similar to the Amu-Darya, the Syr-Darya basin has a high degree of agricultural activity that relies heavily on irrigation.

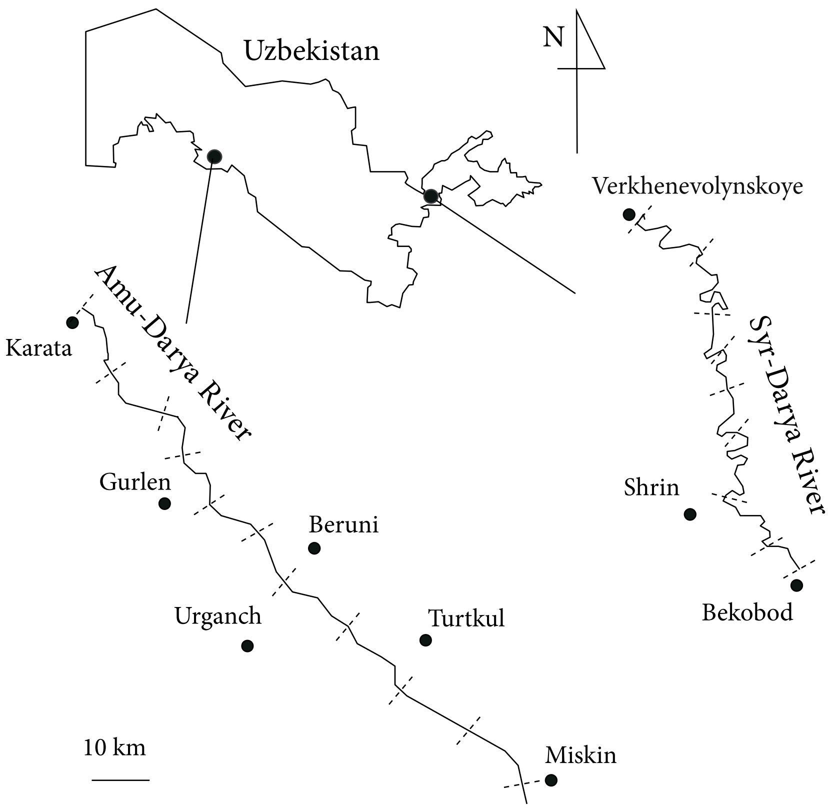

Figure 1. Map of study area. Habitat sections are marked by dotted lines.

The gap between the end of observations on the Amu-Darya and the start of bird counting on the Syr-Daria was only 2 days; the whole period coincided with the peak of autumn migration for most of the waders (Pronkevich, 1998; Schielzeth et al., 2010). We canoed in the main channel of each river and then paddled closer to groups of birds associated with the river and surrounding habitats. Use of kayaks allowed penetration of habitats (e.g., islands) that were not accessible by observations performed from the riverbank. Special attention was paid to shallows and sandbars, where birds were concentrated. For counting and identification of birds, we used 10 × 42 binoculars. Nonpasseriform water-associated species were noted, with a distinction made between flocks and single individuals. In order to avoid pseudoreplication (e.g., noting startled individuals twice), their movements were noted as precisely as possible.

The distance between the 2 study areas was about 700 km. Both study reaches of river were divided into sections based on natural differences in habitats, the width of the riverbed, and the number of sandy islands and irrigation canals. A total of 18 habitat sections (mean = 12.8 km, SD = 3.54 km) were distinguished: 10 sections on the Amu-Darya and 8 sections on the Syr-Darya. Because river sections were not exactly the same lengths, we corrected for this parameter before analysis. The 2 rivers did not differ in the lengths of sections (Wilcoxon test, Z = 0.44, P = 0.657, N = 18), and the lengths of sections were not correlated to either the numbers of species (Spearman rank correlation test, r_S = 0.11, P = 0.660, N = 18) or to the numbers of individuals (Spearman rank correlation test, r_S = 0.10, P = 0.692, N = 18).

Similar to the method of Saygılı et al. (2011), bird species were divided into trophic groups based on their food type: F – phytoplankton (filter feeders); P – plants; V – vertebrates (amphibians, fish, reptiles, birds, rodents); I – invertebrates (insects, mollusks, crustaceans, etc.); P/I – both plants and invertebrates; and I/V – both invertebrates and vertebrates. Species whose numbers exceeded a threshold of 5% of all individuals were treated as dominant. Species diversity was calculated using the Shannon diversity index:

$$H' = -\Sigma \text{ fr} \ln (\text{fr}),$$

where fr is the frequency of records of each species (Shannon and Weaver, 1963).

We compared the number of bird species on both rivers using chi-square tests; differences in density and flock size of particular species were tested with the Wilcoxon test. In the analysis of the relationship between species numbers and individual numbers, we applied Pearson's correlation after having checked that the distribution was normal; if this was not the case, the variables were log-transformed. Differences in species and bird numbers between sections of rivers were tested by Student's t-test. Regression models were used to find the influence of 3 habitat parameters, the width of the riverbed, the number of sandy islands, and the number of irrigation canals (independent variables), on the numbers of individuals and the numbers of species noted on the river sections (dependent variables). The diversity of trophic groups was compared using G-tests after x + 1 transformation. The Hutcheson test was used to compare Shannon diversity indices (Hutcheson, 1970). The calculations were performed using Statistica 10.0 (www.statsoft.com).

3. Results

On the Amu-Darya River, we sampled 2901 birds (232.1 ind./10 km) belonging to 44 species; on the Syr-Darya River, we sampled 5085 birds (479.7 ind./10 km) from 48 species (Table 1). From a total of 58 waterbird species

Table 1. Characteristics of bird species composition observed on the Amu-Darya and Syr-Darya rivers: N – numbers of individuals, DN – density (ind./10 km), D – domination, Mean – mean size of flock. Trophic groups: F – phytoplankton (filter feeders), P – plants, V – vertebrates (amphibians, fish, reptiles, birds, mammals), I – invertebrates (insects, mollusks, crustaceans, etc.), P/I – feed on both plants and invertebrates, I/V – feed on both invertebrates and vertebrates.

Species	Amu-Darya River				Syr-Darya River				Trophic group
	N	DN	D	Mean	N	DN	D	Mean	
Actitis hypoleucos	52	4.2	1.8	1.8	44	4.2	0.9	1.4	I
Alcedo atthis	1	0.1	<0.1	1.0	27	2.5	0.5	1.1	V
Anas acuta	-	-	-	-	12	1.1	0.2	12.0	P/I
Anas clypeata	-	-	-	-	1	0.1	<0.1	1.0	P/I
Anas crecca	128	10.2	4.4	32.0	511	48.2	10.0	34.1	P/I
Anas platyrhynchos	106	8.5	3.7	10.6	49	4.6	1.0	6.1	P/I
Anas querquedula	140	11.2	4.8	14.0	1069	100.8	21.0	44.5	P/I
Anser anser	9	0.7	0.3	9.0	-	-	-	-	P
Ardea alba	-	-	-	-	4	0.4	0.1	1.3	I/V
Ardea cinerea	126	10.1	4.3	2.5	101	9.5	2.0	2.7	I/V

Table 1. (Continued).

Ardea purpurea	8	0.6	0.3	1.1	34	3.2	0.7	1.1	I/V
Arenaria interpres	2	0.2	0.1	1.0	5	0.5	0.1	5.0	I
Aythya fuligula	3	0.2	0.1	3.0	45	4.2	0.9	6.4	P/I
Burhinus oedicnemus	-	-	-	-	26	2.5	0.5	6.5	I
Calidris alba	5	0.4	0.2	5.0	-	-	-	-	I
Calidris alpina	1	0.1	<0.1	1.0	-	-	-	-	I
Calidris ferruginea	3	0.2	0.1	1.5	2	0.2	<0.1	2.0	I
Calidris minuta	29	2.3	1.0	3.6	58	5.5	1.1	4.8	I
Calidris temminckii	12	1.0	0.4	2.4	25	2.4	0.5	1.5	I
Charadrius alexandrinus	18	1.4	0.6	2.3	-	-	-	-	I
Charadrius dubius	18	1.4	0.6	1.2	40	3.8	0.8	1.8	I
Charadrius hiaticula	3	0.2	0.1	1.0	-	-	-	-	I
Chlidonias hybrida	3	0.2	0.1	3.0	-	-	-	-	I/V
Chroicocephalus ridibundus	101	8.1	3.5	4.6	8	0.8	0.2	2.7	I/V
Ciconia ciconia	-	-	-	-	54	5.1	1.1	4.5	I/V
Ciconia nigra	-	-	-	-	1	0.1	0.1	1.0	I/V
Egretta garzetta	-	-	-	-	64	6	1.3	2.8	I/V
Gallinago gallinago	14	1.1	0.5	7.0	58	5.5	1.1	2.6	I
Gallinula chloropus	-	-	-	-	1	0.1	<0.1	1.0	P/I
Gelochelidon nilotica	271	21.7	9.3	15.9	38	3.6	0.7	2.5	I/V
Glareola pratincola					48	4.5	0.9	4.4	I
Haematopus ostralegus	25	2	0.9	5.0	-	-	-	-	I
Himantopus himantopus	1	0.1	<0.1	1.0	88	8.3	1.7	4.2	I
Hydroprogne caspia	49	3.9	1.7	2.1	58	5.5	1.1	7.3	I/V
Ichthyaetus ichthyaetus	-	-	-	-	1	0.1	<0.1	1.0	I/V
Larus cachinnans	461	36.9	15.9	8.7	143	13.5	2.8	7.2	I/V
Limosa lapponica	1	0.1	<0.1	1.0	-	-	-	-	I
Milvus migrans	8	0.6	0.3	2.0	111	10.5	2.2	5.8	V
Netta rufina	-	-	-	-	28	2.6	0.6	5.6	P/I
Numenius arquata	1	0.1	<0.1	1.0	24	2.3	0.5	4.0	I
Nycticorax nycticorax	27	2.2	0.9	2.7	69	6.5	1.4	5.8	I/V
Pandion haliaetus	1	0.1	<0.1	1.0	2	0.2	<0.1	1.0	V
Phalacrocorax carbo	53	4.2	1.8	7.6	2	0.2	<0.1	1.0	V
Phalacrocorax pygmeus	39	3.1	1.3	19.5	767	72.4	15.1	9.6	V
Philomachus pugnax	261	20.9	9.0	32.6	60	5.7	1.2	5.0	P/I
Plegadis falcinellus	618	49.4	21.3	88.3	-	-	-	-	I/V
Podiceps cristatus	-	-	-	-	1	0.1	<0.1	1.0	I/V
Stercorarius parasiticus	1	0.1	<0.1	1.0	-	-	-	-	I/V
Sterna hirundo	101	8.1	3.5	3.7	45	4.2	0.9	4.5	I/V
Sternula albifrons	82	6.6	2.8	5.1	5	0.5	0.1	2.5	I/V
Tringa glareola	12	1.0	0.4	4.0	131	12.4	2.6	3.9	I
Tringa nebularia	74	5.9	2.6	1.6	126	11.9	2.5	1.7	I
Tringa ochropus	14	1.1	0.5	1.4	54	5.1	1.1	1.6	I
Tringa stagnatilis	-	-	-	-	6	0.6	0.1	1.5	I
Tringa totanus	2	0.2	0.1	1.0	3	0.3	<0.1	1.0	I
Vanellus leucura	7	0.6	0.2	1.2	2	0.2	<0.1	1.0	I
Vanellus vanellus	-	-	-	-	1028	97	20.2	73.4	I
Xenus cinereus	10	0.8	0.3	1.4	8	0.8	0.2	1.1	I
Total	2901	232.1	100	-	5085	479.7	100	-	-

observed on both rivers, 10 unique species were observed on the Amu-Darya River and 14 unique species were observed on the Syr-Darya River. Most species (34) were common to both rivers and the differences in species diversity were not significant (test: chi-square with Yates correction = 0.01, P = 0.992, df = 1). The Shannon diversity index for the Amu-Darya River was H = 2.75 and did not differ from that for the Syr-Darya River (H = 2.65; Hutcheson test, t_{89} = 0.38; P = 0.707).

The most numerous species on the Amu-Darya River were the Glossy Ibis (*Plegadis falcinellus*), Caspian Gull (*Larus cachinans*), Gull-billed Tern (*Gelochelidon nilotica*), and Common Tern (*Sterna hirundo*). On the Syr-Darya River, Garganey (*Anas querquedula*), Lapwing (*Vanellus vanellus*), Pygmy Cormorant (*Phalacrocorax pygmeus*), and Teal (*Anas crecca*) were the dominant species (Table 1). There were no differences in bird densities between rivers (Wilcoxon test, Z = 1.93, P = 0.052, N = 55) or in the average flock sizes for particular species (Wilcoxon test, Z = 0.13, P = 0.986, N = 33).

In more detailed analysis, we found that the numbers of individuals within sections did not differ between rivers (Student's t-test, t = 1.56, df = 16, P = 0.137), but the numbers of species on the Syr-Darya sections were statistically higher when compared to those of the Amu-Darya (Student's t-test, t = 3.51, df = 16, P = 0.003, Table 2). The relationship between species numbers and numbers of individuals on particular river sections was stronger for the Syr-Darya (Pearson correlation, r = 0.97, P < 0.001, N = 8) than for the Amu-Darya (Pearson correlation, r = 0.76, P = 0.012, N = 10), but there was no significant difference between the slopes ($F_{1,14}$ = 4.43, P = 0.054, Figure 2). The regression model showed that the numbers of species were negatively related to the riverbed width (Table 3). The number of sandy islands and the number of irrigation canals did not influence species diversity. In addition, none of the habitat components affected the number of individuals ($F_{3,14}$ = 1.48, P = 0.263).

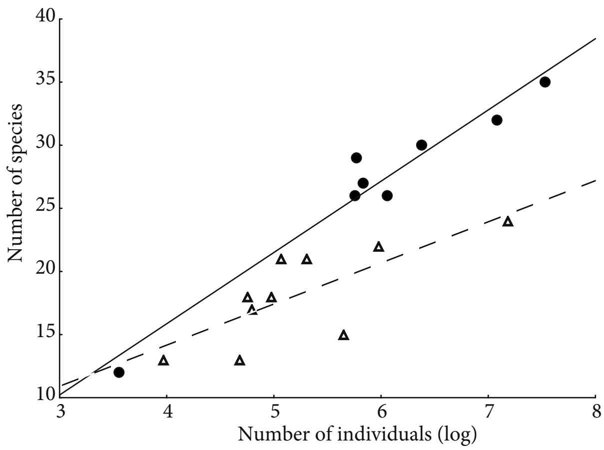

Figure 2. Relationship between species numbers and numbers of individuals on defined sections of the Amu-Darya (open triangle and dotted regression line; N = 10) and Syr-Darya (filled circle and solid regression line; N = 8) rivers.

The proportions of bird species from various trophic groups did not differ significantly (G test = 3.43, P = 0.448, df = 4) between rivers. For both rivers, the dominant bird species belonged to the invertebrate (I) and invertebrate and vertebrate (I/V) feeding groups. Bird species that feed on plants (P) were observed only on the Amu-Darya (Figure 3). The proportions of individuals in trophic groups differed significantly (G test = 66.24, P < 0.001, df = 4). On the Amu-Darya River, most birds (above 60%) were classified as both invertebrate and vertebrate (I/V) feeders. Birds feeding on invertebrates (I) and both plants and invertebrates (P/I) were more numerous on the Syr-Darya (Figure 3).

Table 2. Numbers of individuals and numbers of species on the Amu-Darya (N = 10) and the Syr-Darya (N = 8) river sections in defined sections of both rivers.

River	Number of individuals			Number of species		
	Mean	SD	Range	Mean	SD	Range
Amu-Darya	290.0	374.14	53–1317	18.2	3.79	13–24
Syr-Darya	635.6	598.97	35–1864	27.1	6.85	12–35

Table 3. Results of regression model describing the influence of habitat parameters on the numbers of species in analyzed sections.

Habitat parameters	Beta	SE	t	P
Width of the riverbed	–0.99	0.375	2.64	0.019
Number of sandy islands	0.40	0.332	1.21	0.244
Number of irrigation canals	0.06	0.254	0.25	0.805

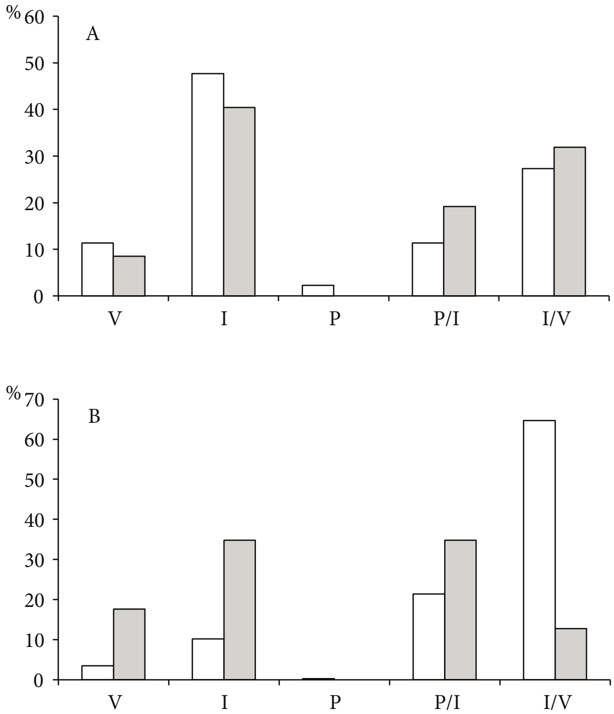

Figure 3. Proportions of species (A) and of individuals (B) within trophic groups of birds observed on the Amu-Darya (white bars) and the Syr-Darya (gray bars) rivers. V – vertebrates (amphibians, fish, reptiles, birds, rodents), I – invertebrates (insects, mollusks, crustaceans, etc.), P – plants, P/I – feed on both plants and invertebrates, and I/V – feed on both invertebrates and vertebrates.

4. Discussion

Climate warming in combination with the redistribution of water resources and the transformation of ecosystems leads to changes in the distributions of waterbirds in the arid zone of the Aral Sea basin (Kreuzberg-Mukhina, 2006a). Decreases in river flows and the loss of wetlands have negatively affected the numbers and the species composition. Habitat changes in the valleys of the Amu-Darya and the Syr-Darya rivers may affect waterbird migration, because 3 important Asian flyways overlap there. Our results showed that the Syr-Darya River had a higher total density of waterbirds compared to the Amu-Darya. This result confirmed the greater importance of the Syr-Darya River for nonbreeding assemblages of waterbirds (Lanovenko, 2006), despite its narrower riverbed and smaller area of potential feeding grounds. On the other hand, differences in the densities of particular species were not significant. Similarities of species richness and species composition could be explained by the relatively short distance between the 2 rivers and are in accordance with the hypothesis stated in Section 1. However, different dominant species were observed on each river. The Syr-Darya River seems to offer better conditions for Lapwing and Garganey than the Amu-Darya River. These 2 species, and other ducks, should be treated as migrants from breeding areas in southwestern Siberia, which is situated northeast of the Syr-Darya (Veen et al., 2005). In contrast, high numbers of Pygmy Cormorant on the Syr-Darya are primarily associated with local breeding populations. Loss of suitable habitats due to the rapid shrinkage of the Aral Sea has drastically reduced breeding populations in the Amu-Darya delta (Kreuzberg-Mukhina, 2008). Since the mid-1980s, colonization of new sites has occurred in southern Uzbekistan, primarily due to recently constructed irrigation reservoirs (Kreuzberg-Mukhina, 2008). Along the Amu-Darya, the Glossy Ibis, Caspian Gull, Gull-billed Tern, and Common Tern dominated the waterbird assemblage. Flocks of ibises and terns were observed mainly during evening flights to roost sites on islands. It appeared that some waterbirds were using foraging areas outside the river channel. This conjecture is supported by other studies showing that a small reservoir on the left bank of the Amu-Darya River valley was used as a breeding site and for spring stopovers by wader species (Shemazarov and Turaev, 1998). The use of artificial habitats (e.g., rice fields) by migrating birds is also common in other Palearctic regions (Czech and Parsons, 2002; Sanchez-Guzman et al., 2007; Toral and Figuerola, 2010), although habitat degradation in these places has a negative influence on bird populations (Onmuş and Sıkı, 2013).

Two patterns of species diversity and numbers of individuals were used for characterizations of the rivers: overall and more detailed, based on section division. Discrimination by section allowed more precise comparisons of bird occurrence, taking into account the habitat differences. We found statistical differences in species numbers in distinct sections between rivers, but not in numbers of individuals. Moreover, the Syr-Darya had a stronger, but not significant, relationship between species numbers and the numbers of individuals. This finding could be the result of different habitat conditions in the 2 rivers, related primarily to the lower water levels observed in the Syr-Darya as compared to the Amu-Darya. This caused the negative relationship found between the numbers of species and riverbed width. It could be explained by the fact that the flowing river within a wide riverbed is less attractive to birds than a system of small, shallow pools. Significant differences in the proportions of individuals from various trophic groups between both rivers confirmed the better foraging conditions for greater numbers of waterbird species on the Syr-Darya. In particular, numerous waders feeding on invertebrates and ducks feeding on both plants and invertebrates were noted there. In other studied wetlands, the abundance of ducks showed a direct correlation with water level changes due to human activities (Boertmann and Ricet, 2006; Redolfi De Zan et al., 2010). However, birds feeding on both invertebrates and vertebrates clearly dominated along the Amu-Darya. This phenomenon could be explained by water stress and the reduced size of wetlands in the Syr-Darya Valley due to dams and water diversions upstream, which may lead to concentration of the birds within the riverbed. Additionally, within the desert region of the Amu-Darya River basin, new water-storage reservoirs are being constructed, which offer greater habitat availability throughout the Amu-Darya River valley for waterbirds, thus reducing the concentration of birds within the river (Kreuzberg-Mukhina, 2008). Moreover, comparatively mild climatic conditions have caused some species to spend the winter on inland wetlands within Uzbekistan; despite the small size of the riverbed, more waterbirds were noted on the Syr-Darya (Lanovenko, 2006).

It should be taken into consideration that waterbird numbers during migration can vary, even from day to day (Pronkevich, 1998; Meissner et al., 2009; Schielzeth et al., 2010). However, autumn movements in the Palearctic are extended in time and are slower than the spring migration (Bregnballe et al., 1997, Green and Alerstam, 2000; Anthes et al., 2002). Our study was carried out during the peak of autumn migration for most of the waders, and the lack of differences in bird densities and the average flock size between rivers seem to confirm that time of observation had a marginal effect. Moreover, the method of counting, although based on observations conducted on river fragments over a few days, allowed for comparison of the bird assemblages noted in the present study with results from other large Palearctic rivers, including the Vistula (Poland), Volga (Russia) (Goławski and Kasprzykowski, 2004), Ili (Kazakhstan) (Dmoch and Goławski, 1999), Dniester (Ukraine) (Goławski and Szynkarczyk, 2000), and Huang-He and Selenga (China) (Goławski et al., in press). Species richness and bird density observed in the present study for the Syr-Darya River were relatively high compared to the rivers previously studied across the Eurasian region. Only the Vistula and Volga showed higher values of waterbird densities (Goławski and Kasprzykowski, 2004), and higher numbers of species were observed only on the Volga and Huang-He (Goławski and Kasprzykowski, 2004; Goławski et al., in press). Species composition and densities of waterbirds on the Amu-Darya reached similar levels in comparison to previous autumn stopover studies throughout Eurasia.

In conclusion, our study increases our understanding of bird utilization of a flyway junction during autumn migration within Eurasia. Both rivers should be classified as important migratory flyways and stopovers for waterbirds in the arid zone of Central Asia. Despite the close geographical proximity, differences in total density, species domination, species numbers in sections, and proportions of individuals from various trophic groups between both rivers were noted. Paradoxically, the Syr-Darya is more attractive for waterbirds than the Amu-Darya, due to low water levels and a system of small, shallow pools along the riverbed.

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