NAT. CROAT. | VOL. 15 | No 1–2 | 1–14 | ZAGREB | June 30, 2006

original scientific paper / izvorni znanstveni rad

BREEDING WATERBIRDS ON WASTEWATER POOLS OF FOUR SUGAR REFINERIES IN VOJVODINA

MARKO TUCAKOV[1] & SLOBODAN PUZOVIĆ[2]

[1]Marka Oreškovića 9, 25275 Bački Breg, Serbia and Montenegro (e-mail: mtucakov@eunet.yu)

[2]Institute for the Nature Conservation of Serbia, Radnička 20A, 21000 Novi Sad, Serbia and Montenegro (e-mail: puzovic@ptt.yu)

Tucakov, M. & Puzović, S.: Breeding waterbirds on wastewater pools of four sugar refineries in Vojvodina. Nat. Croat., Vol. 15, No 1–2, 1–14, 2006, Zagreb.

This paper presents the results of surveys of breeding waterbirds (species belonging to the families *Anatidae, Rallidae, Recurvirostridae, Charadriidae, Scolopacidae, Laridae* and *Sternidae*) on wastewater pool complexes of sugar refineries in Žabalj, Pećinci, Zrenjanin and Padinska Skela in Vojvodina (N Serbia) completed during the breeding season in 2001. The basic characteristics of the breeding niches are described, as well as similarities between the composition of breeding waterbird avifaunas of the study sites and wastewater pools of other sugar refineries in central Europe.

Key words: breeding waterbirds, wastewater pools, sugar refineries, breeding sites, Vojvodina, Serbia

Tucakov, M. & Puzović, S.: Vodene ptice koje gnijezde na bazenima za otpadne vode četiriju šećerana u Vojvodini. Nat. Croat., Vol. 15, No 1–2, 1–14, 2006, Zagreb.

Rad dodnosi rezultate istraživanja močvarnih gnjezdarica (vrste iz porodica *Anatidae, Rallidae, Recurvirostridae, Charadriidae, Scolopacidae, Laridae* i *Sternidae*) na bazenima za otpadne vode šećerana u mjestima Žabalj, Pećinci, Zrenjanin i Padinska Skela u Vojvodini (sjeverna Srbija), provedenih tijekom sezone gniježđenja 2001. opisuju se osnovne osobine gnijezdilišnih niša, kao i sličnosti između sastava avifaune močvarnih gnjezdarica navedenih lokaliteta i bazena s otpadnom vodom drugih šećerana središnje Europe.

Ključne riječi: močvarice gnjezdarice, bazeni za otpadne vode, šećerane, gnijezdilišta, Vojvodina, Srbija

INTRODUCTION

Large quantities of water are necessary for all phases of sugar production from sugar beet. Almost 99% of this water is expelled from the process as wastewater.

Sugar refineries use mechanical, thermal, chemical, physical and biological methods or combinations of these methods for eliminating pollution from wastewater. The starting phase of purification is the elimination of insoluble ingredients. Some waste components that cannot be eliminated by mechanical means enter an aerobic and an anaerobic biological phase. During the aerobic process biotransformation takes place. In the presence of oxygen, aerobic microorganisms partly mineralise biowaste, transforming a part of it into microbial biomass whilst producing heat energy. In order to ensure a medium for this process, factories have built pools for natural oxygenation of wastewater. These facilities can be considered artificial systems in which biological treatment can run much faster than in natural ones by the maintenance of suitable conditions (KUKIĆ, 1995).

In Vojvodina (northern province of Serbia) there are 12 sugar refineries: in Crvenka, Bač, Vrbas, Žabalj, Senta, Nova Crnja, Zrenjanin, Kovačica, Kovin, Padinska Skela, Pećinci and Sremska Mitrovica.

Birds are an important component of the fauna occurring in effluent pools. Using their adaptability, birds can exploit these secondary man-made wetlands. The damaged indigenous biodiversity of sites where the collecting pools were dug, as in all stagnant waters which serve for wastewater collection (STEVANOVIĆ & VASIĆ, 1995), grows unexpectedly (PUZOVIĆ, 1995). Furthermore, these habitats, like many other man-made wetlands (fishponds, wastewater pools of cattle farms, reservoirs) have became one of the most important strongholds for waterbirds in Serbia (PUZOVIĆ, 1998).

However, this phenomenon has received little attention from bird researchers in Serbia. The only survey of the breeding bird fauna in wastewater pools is of factories in Crvenka and Bač (TUCAKOV & ŽULJEVIĆ, 2002). Additional information about the observations of rarities or interesting breeders exist for the wastewater pools of Pećinci (PUZOVIĆ 1995; 1999; 2000), Zrenjanin (PELLE *et al*., 1977; DIMITRIJEVIĆ, 1977) and Kovačica factories (GERGELJ, 1995).

To get more information on the phenomenon of breeding of birds in these secondary wetlands, the aim of this work is to answer the following questions: a) which waterbird species and in what numbers breed in the wastewater pools of particular sugar refineries in Vojvodina; b) what are the basic characteristics of the breeding niches occupied by them, and c) are there any similarities between the composition of the breeding waterbird avifauna of the study sites and the wastewater pools of other sugar refineries in Europe?

METHODS

In this study, a non-taxonomic group of waterbirds is defined following the methodology of the Ramsar Convention and International Waterbird Censuses (IWC): species ecologically dependent upon wetlands (DELANY & SCOTT, 2002). Representatives of the following families are taken in consideration: *Anatidae*, *Rallidae*, *Recurvirostridae*, *Charadriidae*, *Scolopacidae*, *Laridae* and *Sternidae*.

Surveys of the waterbird fauna on 4 sugar refinery wastewater pool complexes in Vojvodina were completed during the breeding season in May and June 2001. Sites were surveyed from the embankments that separate pools, or by entering the pools and making direct inspections. Criteria for confirmed and potential breeding follow HAGEMEIJER & BLAIR (1997). In cases of confirmed breeding, the number of breeding pairs was determined on the basis of the number of active nests, number of territorial adults (trying to chase observers by demonstration of territoriality), or number of females with chicks. In the case of potential breeding, the number of breeding pairs was determined according to the number of adults or pairs by using previous experience (TUCAKOV & ŽULJEVIĆ, 2002). In order to define the features of the study areas, water depth, vegetation, and characteristics of breeding niches for particular species were measured and noted.

The wastewater pools at Pećinci were studied separately from these surveys. Intensive research was started in 1989 by the second author, while surveys of breeding pairs were done in given years during the period 1989 to 2003. Different numbers of field visits per year during the study of the Pećinci pools are the most important difference between the methods used for these surveys, which resulted in differing reliability of the data for study sites. In 2001, however, the number of breeding pairs of Northern Lapwing *Vanellus vanellus*, which is an early breeder, could not be determined during surveys which started as late as May.

DESCRIPTION OF THE STUDY SITES

Wastewater pools of the Ravni Srem sugar refinery in Pećinci

This sugar refinery is situated in eastern Srem. The first deposal of wastewaters into pools dug near the village of Sibač (ĆURČIĆ, 1978; UTM: DQ17) took place in 1978. Only one pool was full of water in 2001. A belt of ruderal vegetation occurred on the embankments between ponds, while 9 elongated mud islets were present in the lower pool. All of them were bare except the largest one (1.5 m wide, 104 m long and up to 1.5 high), which was covered by ruderal and partly emergent vegetation. On the bottom of the second pool a mosaic of shallow water, patches of bare soil and emergent vegetation (*Carex* sp., *Scirpus* sp.) were present during 2001. The remaining 2 pools were filled with water. All pools were square and bordered by 2 m high embankments. The site is not protected, but has been identified as a nationally important bird area (PUZOVIĆ & GRUBAČ, 1998).

Between 1988 and 2003 the location and number of pools at Pećinci changed. Three pools have disappeared after filling with soil and recultivation (transformation into arable land). However, during the study period five new pools were constructed successively, causing temporary movement of the whole habitat towards the west.

Effluent pools of the Zrenjanin sugar refinery in Zrenjanin

The system of wastewater pools of this factory is situated in the outskirts of Zrenjanin (UTM: DR52). During 2001 one pool was dry and covered by ruderal

vegetation. In the central part of the second pool a shallow pond existed, with a 20 m long, 5 m wide and about 1 m high islet, covered by low and sparse vegetation in its centre. The third pool was covered by a dense stand of *Xanthium italicum*, except in the southernmost part, where shallow water emerged on the surface. The largest water body occurred in the fourth pool. Other parts of that pool were, however, converted into a corn field. All pools were rectangular-shaped, connected with canals and bounded by 3 m high embankments.

Wastewater pools of The Dimitrije Tucović 1898 First Serbian Sugar Refinery at Padinska Skela

The wastewater pools of this factory are situated in south-eastern Banat, near Belgrade (UTM: DQ57). Since 1998 the water level in the pools has been maintained exclusively by precipitation, because the factory is not operating anymore. The bottom of the largest pool is lined with an artificial fabric layer, while embankments are strengthened by concrete. This pool contained clear shallow water with submergent vegetation in 2001. Other pools were overgrown with ruderal and emergent vegetation, while shallows and mudflats existed in 2 of them.

Wastewater pools of the Šajkaška sugar refinery at Žabalj

Wastewaters of this refinery drain into a natural depression situated on the edge of a former flood zone of the Tisa River between Žabalj and Čurug (UTM: DR33). About 80% of the depression is covered by ruderal vegetation with patches of dense emergent vegetation in the centre. 20% of the depression is under water, which is very shallow on the edges, but up to 1 m deep in the easternmost part. This wastewater pool is part of the Jegrička Important Bird Area (PUZOVIĆ & GRUBAČ, 2000).

Fig. 1. Location of the study sites in Vojvodina (N Serbia): 1 – Žabalj, 2 – Zrenjanin, 3 – Pećinci, 4 – Padinska Skela

Fig. 2. Characteristic position of Black-winged Stilt *Himantopus himantopus* nest in the wastewater pools of sugar refineries (Zrenjanin, photo: M. Tucakov)

RESULTS

Waterbirds found breeding in the studied sites are listed in Tab. 1. The number of breeding pairs is represented by minimal and maximal numbers for each species and locality.

The phases of construction and the method of wastewater storage have influenced the composition of the breeding bird community as well as the number of pairs of breeding waterbirds, especially of *Charadriiformes*. A good example is the construction of a new pool at Pećinci in 1996. After the pool was dug and surrounding embankments erected, shallow depressions and piles of soil remained on its floor. It was not used for the storage of wastewater in that year, and therefore was filled only by precipitation and ground water. However, in 1997 a small amount of wastewater was released in it for the first time, which created a shallow wa-

Tab. 1. Comparative overview of number of breeding pairs of waterbirds breeding in the study areas in 2001

Species	Pećinci	Žabalj	Zrenjanin	Padinska Skela
Podiceps nigricollis	0	2–3	0	0
Anas platyrhynchos	1–2	3–4	2–5	0–1
Aythya ferina	0	1–2	0–1	1–2
Aythya nyroca	1	3–5	0–1	0
Gallinula chloropus	1–2	1–2	2–3	0
Fulica atra	2	3–5	0	0
Himantopus himantopus	12–14	1–2	8	3
Recurvirostra avosetta	8	0	6	0
Charadrius dubius	1	0	0	0
Tringa totanus	1	0	0	0
Vanellus vanellus	1>	?	1>	0
Larus ridibundus	54	250–300	0	0
Sterna hirundo	9–11	0	1	0

ter body with six islets. That was the year of the first colonization of the locality by Black-headed Gulls (Tab. 1). The construction of the new pool, together with an adjacent one with identical habitat features, is responsible for the increase of the numbers of Common Tern pairs (Tab. 1).

DISCUSSION

Importance of wastewater pools of sugar refineries for breeding of waterbirds

All sugar refineries in Vojvodina except those in Zrenjanin and Crvenka were built during the 1970s and 1980s (Tab. 2). Pools for wastewater disposal were constructed together with industrial facilities and were used from the beginning for sugar production. Suitable conditions for breeding waterbirds (Tab. 2) probably existed as early as the first years of operation. Certainly, at the end of the 1980s all disposal facilities in use as breeding niches for waterbirds have stabilized.

Four basic habitat elements, created by the sugar beet processing technology and wastewater treatment have attracted the listed breeders: 1. eutrophic water, especially in the shallow 5–20 cm deep pools, 2. islets (bare or with sparse and short vegetation), 3. a mosaic of emergent and ruderal vegetation on the banks and islets and 4. the absence of comparable habitats in the surrounding agricultural lands. All shallow pools also contained the islets. Pools for wastewater disposal are divided according to the type of the wastewater which goes into particular pools. In pools in which water from the washing of sugar beet is stored, soil from the roots forms a

Tab. 2. Basic characteristics of the studied complexes of wastewater pools

Sugar refinery	Construction of pools	Number of pools in 2001	Total surface	Source
Pećinci	1976	4	50 ha	TURAJLIJA, pers. comm.
Zrenjanin	1980's	4	70 ha	GOMBAR, pers. comm.
Padinska Skela	1983	6	60 ha	DRONJAK, pers. comm.
Žabalj	1980	3	140 ha	KOVAČEVIĆ, pers. comm.

Tab. 3. Fluctuations of numbers of breeding pairs of waterbirds in wastewater pools of the Ravni Srem sugar refinery at Pećinci between 1988 and 2003

Species	1988	1989	1990	1995	1997	1998	2002	2003
Tachybaptus ruficollis	+	+	2–5	+	5–6	2–3	?	?
Anas platyrhynchos	+	5–10	3–7	<20	5–10	+	+	+
Anas querquedula	?	2–4	1–3	2–3	3–5	?	3–5	?
Aythya ferina	?	?	?	?	2–3	0	0	0
Aythya nyroca	2–3	?	0	?	2–3	?	0	0
Fulica atra	1	1–2	2–3	1–2	10–15	1–2	4–6	?
Galinula chloropus	?	1–2	1–3	?	2–4	?	?	?
Himantopus himantopus	2–3	2–3	1–2	1–2	7–9	4–5	4–7	6–7
Recurvirostra avosetta	1	2–3	0	8–10	6–8	8	7–10	3–5
Charadrius dubius	0	0–1	1–2	2	1–2	?	2–3	?
Vanellus vanellus	1–3	2–4	4–7	10–15	10–20	5–10	?	5–8
Larus ridibundus	0	0	0	0	20–30	20	0	15–17
Sterna hirundo	0	0	2	35–45	60–70	50–70	0	30–35
Chlidonias hybridus	0	0	0	0	10–15	0	0	0

Legend: + – breeding was confirmed, but number of breeding pairs undetermined; ? – breeding status could not be determined; < less than indicated number, but exact number was not determined; > more then indicated number, but exact number was not determined

sediment at the bottom. There are pools for the storage of mud sediments, and pools for biological consumption of oxygen in which waste is exposed to biotransformation. These pools receive water from the first two types of pools (DRONJAK, pers. comm.). Islets in all studied sites were created after a long process of sedimentation of soil, or they were left in some pools during construction as accidental accumulations of soil that were not removed (SLIJEPČEVIĆ, pers. comm.). The third habitat element prevailed at the Žabalj pools, where bare islets were missing. All three elements existed at Zrenjanin, Pećinci and Padinska Skela pools.

All breeding waterbirds found in the study sites except the Common Tern have been observed foraging in the pools themselves in shallow water. *Sterna hirundo*

was also observed foraging in surrounding freshwater: Galovica canal (Pećinci) and Begej River (Zrenjanin). Both water courses pass close to the wastewater pools. Although diet studies have not been performed in the wastewates and mud of the sugar refineries, larvae of *Chironomidae*, *Ceratopogonidae*, *Culicidae*, *Tipulidae* and *Oligochetae* have been found in other studies, especially starting from April (SCHMIDT, 1985; ZUNA-KRATKY, pers. comm.).

According to the number of active nests found in particular pools, and according to the use of feeding sites, the relative importance of the habitat features of wastewater pools of sugar refineries is assessed (Tab. 4).

At least one of all four habitat elements was of high importance for all species, while for all breeding waders eutrophic water and islets had high importance. The combination of both habitat elements and the existence of a vegetation-free contact zone between ground and water are habitat components that are absent on most natural wetlands in Vojvodina (own data). This is perhaps the main reason for the absence of breeding waders on them. In wastewater pools they exist thanks to regular fluctuations of water levels. In each complex there was at least one pool with a low water level into which water flows after sedimentation from pools which are full during the sugar beet processing season and immediately after it. Until March, the water covers almost all the small islets, but before the breeding season it evaporates or flows into other pools. The fast succession of plant communities and overgrowing of the islets is restricted by that means.

During the construction, utilization and recultivation of particular pools, the importance of different phases and water levels can be identified. The most important years were after the construction of new pools was finished. However immediately after the construction of pools, the importance for breeding waterbirds was much lower due to the absence of all habitat elements (Tab. 2). Also, during the construction of pools they are not suitable for breeding.

In the case of changes in the working process of a factory, pools which were suitable for breeding in one year became unsuitable in the subsequent year. There are two main reasons for this. Islets become flooded, or, if pools stay without water, dense and high ruderal vegetation invade them, for example in 2002 in pools at Zrenjanin and Pećinci. This might be an important reason for the fluctuation of breeding numbers of waders (Tab. 3, TUCAKOV & ŽULJEVIĆ, 2002).

Obviously, the creation of this and other wetlands by human activity has influenced the distribution and numbers of Black-winged Stilt and Avocet in Vojvodina. The number of breeding pairs of the Black-winged Stilt, after the first noted breeding in Vojvodina at Kanjiža in 1964 (ANTAL *et al.*, 1971), was low. An increase started in 1980's after the colonization of temporary ponds suitable for nesting in Banat (DIMITRIJEVIĆ, 1983). After the first unsuccessful breeding attempt in a natural wetland situated where the Zrenjanin wastewater pools were later constructed (DIMITRIJEVIĆ, 1977), it did not breed in that locality between 1965 and 1979 (DIMITRIJEVIĆ, 1984). After the mid 1980s, however, it started to colonize different man-made wetlands: fishponds (DEVIĆ, 1995, 1998), effluent disposal from cattle farms (BALOG, 1998; GERGELJ *et al.*, 2000; GERGELJ, 2002), wastewater disposal of alcohol and sugar

Tab. 4. Importance of particular habitat elements for breeding of waterbirds on wastewater pools of sugar refineries in Vojvodina

Species	Eutrophic shallow water	Islets	Vegetation
P. nigricollis	High	Low	High
T. ruficollis	High	Low	High
A. platyrhynchos	High	Medium	High
A. querquedula	High	Low	High
A. ferina	High	Medium	High
A. nyroca	High	Low	High
F. atra	High	Medium	High
G. chloropus	High	Low	High
H. himantopus	High	High	Low
R. avosetta	High	High	Low
C. dubius	High	High	Low
V. vanellus	High	High	Medium
L. ridibundus	Medium	High	Medium
S. hirundo	Low	High	Low
C. hybrida	Low	Low	High

Tab. 5. Breeding density of Black-winged Stilt *H. himantopus* on wastewater pools of sugar refineries in central Europe

Sugar refinery	Breeding density (bp/10ha)	Year	Source
Szolnok (H)	5,52	2002	DROZD, pers. com.
Acs (H)	1,5	2002	PENZES, pers. com.
Ormož (SLO)	1,6–1,78	2001	ŠTUMBERGER, pers. comm.
Hohenau (A)	0,15	2001	
Crvenka (SCG)	1,53–1,84	1999	TUCAKOV & ŽULJEVIĆ, 2002
Žabalj (SCG)	0,07–0,14	2001	this paper
Pećinci (SCG)	2,4–2,8	2001	this paper
Zrenjanin (SCG)	1,14	2001	this paper
Padinska Skela (SCG)	0,5	2001	this paper

industries (TUCAKOV & ŽULJEVIĆ, 2002) and wastewaters from tanneries (ŠĆIBAN, 2001). Currently 95% of pairs of this species in Vojvodina breed on man-made wetlands (TUCAKOV & ŽULJEVIĆ, 2002).

The avocet was, before colonization of secondary wetlands, strongly associated with natron lakes in the Tisa valley (DIMITRIJEVIĆ, 1983). From only 20 pairs in

Vojvodina during the 1970s (DIMITRIJEVIĆ, 1977), after the 1980 colonization of secondary wetlands (DEVIĆ, 1998), there were in the early 1990s many breeding sites on man-made wetlands with a total of 350 pairs breeding in Vojvodina (LUKAČ, 1996). A shallow or bare contact zone between ground and water is the factor which is qualitatively identical for wastewater pools of sugar refineries and natron lakes. Breeding of the Avocet indicates this habitat feature rather than saline water as claimed by DIMITRIJEVIĆ (1984).

Importance of wastewater pools of sugar refineries for Black-winged Stilt breeding

Himantopus himantopus is the only species nesting in all the studied wastewater pools of sugar refineries in northern Italy, (TINARELLI, 1988; 1989; 1991), Slovenia (ŠTUMBERGER & BRAČKO, 1996), Hungary (PENZES, in lit.; DROZD, in lit.; PELLINGER, in lit.), Austria (ZUNA-KRATKY, 2001), Croatia (CRNKOVIĆ *et al.*, 2002), and Serbia and Montenegro (PUZOVIĆ, 1995; TUCAKOV & ŽULJEVIĆ, 2002). It can therefore considered as a characteristic breeder in this habitat. In ecosystems which are urbanized and changed by intensive agriculture, wastewater pools of sugar refineries appear to be important secondary wetlands for the species which offer conditions suitable for nesting (CRAMP, 1998). However, breeding density varies among sites (Tab. 5.).

Although breeding density is not a decisive indicator of the habitat quality (NEWTON, 1998), in areas in which the Black-winged Stilt bred before the colonization of secondary wetlands (Hungary, Vojvodina), breeding density in the natural habitats was higher than in the areas colonized more recently.

Active management of wastewater pools of sugar refineries

Wastewater pools are insular habitats separated from the influence of natural water dynamics; their hydrographical features completely depend on human activity. That is why dependence of particular bird species on these habitats can result in negative consequences for the stability of their populations, which has also been confirmed for other man-made wetlands (FASOLA & RUIZ, 1996). It is possible to manage all three key habitat elements of wastewater pools of sugar refineries, in order to prevent their deterioration. Management has to be directed towards maintaining conditions for regular breeding of all key waterbird species (ZUNA-KRATKY, 2005).

Maintenance and management of water levels is possible by connecting the pools by a system of canals and sluices in order to gain a mosaic of surfaces with different water levels. These interventions are possible by bringing the water from neighbouring water bodies (ZUNA-KRATKY, pers. comm.). The maintenance of stable islets is possible by their artificial construction as solid rafts (DENAC, 2002) or temporary islands (PELLINGER & MOGYOROSI, 1994). The removal of vegetation in particular pools can also contribute to an increase in the number of pairs of species which use this habitat type (ŠTUMBERGR, in lit.). Having that in mind, there is an urgent need for the establishment of a system of proper utilization, management and mainte-

nance of wastewater pools of sugar refineries in Vojvodina. This could help to preserve rare and threatened bird species which have disappeared from surrounding cultivated lands.

Acknowledgements

Marko Tucakov carried out this research through the generosity of an award received in September 2000 from the Royal Norwegian Embassy in Belgrade. Many thanks to Roberto Tinarelli and Thomas Zuna-Kratky for sending the literature, Laslo Penzes and Attila Drozd for oral information, and to Robert MacCurrach who made grammatical corrections to the text. Many thanks also to Slobodanka Simić for useful suggestion and to the anonymous referees for improvement of the manuscript.

Received August 20, 2005

REFERENCES

ANTAL, L., J. FERNBACH, J. MIKUSKA, I. PELLE & L. SZLIVKA, 1971: Namenverzeichnis der Vogel der Autonomen Provinz Vojvodina. Larus **23**, 73–127.

BALOG, I., 1998: Ornitološki podaci iz okoline Temerina. Ciconia **7**: 100.

CRAMP, S., 1998: The complete birds of the Western Palaearctic on CD-ROM. Oxford University Press, Oxford.

CRNKOVIĆ, R., I. D. GRLICA, M. ŠETINA & D. BARAĆ, 2002: Breeding of the Black-winged Stilt *Himantopus himantopus* in Croatia. Larus **48**, 85–89.

ĆURČIĆ, S., 1978: Opština Pećinci – ekonomska monografija. Prirodno-matematički fakultet – Institut za geografiju, Novi Sad.

DELANY, S. & D. SCOTT, 2002: Waterbird Population Estimates – Third Edition. Wetlands International, Wageningen.

DENAC, D., 2002: Common Tern *Sterna hirundo* breeding population: development and nature conservation management results at the Ormož wastewater pools between 1992 and 2002 (NE Slovenia). Acrocephalus **23** (115), 163–168.

DEVIĆ, M., 1995: The ornithofauna of the fishpond »Uzdin«. Ciconia **5**, 32–44.

DIMITRIJEVIĆ, S., 1977a: *Charadriiformes* in the Province of Voivodina. Larus **29–30**, 5–32

DIMITRIJEVIĆ, S., 1977b: Potreba zaštite slatinskih terena na području Vojvodine. Priroda Vojvodine **3** (2), 53–54.

DIMITRIJEVIĆ, S., 1983a: Ponovno gnežđenje vlastelice crvenonoge *Himantopus hinamtopus* u Vojvodini. Larus **33–35**, 214–215.

DIMITRIJEVIĆ, S., 1983b: *Recurvirostra avosetta* in Vojvodina. Larus **33–35**, 161–172.

DIMITRIJEVIĆ, S., 1984: Ornithofauna of saline sites in the region of Banat. Proceedings of Natural Sciences of Matica Srpska **67**, 39–57.

FASOLA, M. & X. RUIZ, 1996: The value of rice fields as substitutes for natural wetlands for waterbirds in the Mediterranean region. Colonial Waterbirds **19**, Special Publication 1, 122–128.

GERGELJ, J., 1995: The nesting of the Mediterranean Gull (*Larus melanocephalus*) in the Vojvodina from 1986 to 1995. Ciconia **5**, 18–22

GERGELJ, J., L. TOT. & Z. FRANK: 2000: Ptice Potisja od Kanjiže do Novog Bečeja. Ciconia **9**, 121–158.

GERGELJ, J., 2002: White Stork and Heron colonies – public information campaign. Ciconia **11**, 26–34.

KUKUĆ, G., 1995: Voda i otpadne vode. In: SUŠIĆ, S., S. PETROV, G. KUKIĆ, V. SINOBAD, P. PERUNOVIĆ, B. KORONSOVAC & Đ. BAŠIĆ: Osnovi tehnologije šećera 2. Industrija šećera SR Jugoslavije & »Jugošećer» d.d., Beograd. pp. 425–498.

LAKATOŠ, J., 1992: Ornithofauna of fishpond in Svilojevo. Ciconia **4**, 28–42.

LUKAČ, Š., 1996: Sabljarka modronoga. Trag **18**, 26–27.

NEWTON, I., 1998: Population Limitations in Birds. Academic Press, London.

PELLE, I., I. HAM, J. RAŠAJSKI & T. GAVRILOV, 1977: Pregled gnezdarica Vojvodine. Larus **29–30**, 171–197.

PELLINGER, A. & S. MOGYOROSI, 1994: Artificial islets for Common Terns (*Sterna hirundo*). Aquila **101**, 243–245.

PUZOVIĆ, S., 1995: Šećeranske bare vraćaju život. Trag **16**, 6–7.

PUZOVIĆ, S., 1998: Ramsar areas in Serbia and their function in preservation of diversity of birds in watery habitats. Zaštita prirode **50**, 283–290.

PUZOVIĆ, S., 1999: Usklađivanje intenzivnog gajenja riba i očuvanja raznovrsne faune ptica na šaranskim ribnjacima u Vojvodini. In: ŠIMIĆ, S. & A. IVANC: Zaštita životne sredine pri intenzivnom gajenju riba. Prirodno – matematički fakultet & Ekološki pokret grada Novog Sada, Novi Sad. pp. 164–179.

PUZOVIĆ, S., 2000: Troprsti zlatar (*Pluvialis apricaria*), zlatar pijukavac (*Pluvialis squatarola*) i rusogrla treptaljka (*Anthus cervinus*) retke prolaznice Srema. Ciconia **9**, 181–183.

PUZOVIĆ, S. & B. GRUBAČ, 2000: Federal Republic of Yugoslavia. In: HEATH, M. F. & M. I. EVANS: Important Bird Areas in Europe: priority sites for conservation (2: Southern Europe). BirdLife International, Cambridge. pp. 725 – 745.

PUZOVIĆ, S., D. SIMIĆ, D. SAVELJIĆ, J. GERGELJ, M. TUCAKOV, N. STOJNIĆ, I. HULO, I. HAM, O. VIZI, M. ŠĆIBAN, M. RUŽIĆ, M. VUČANOVIĆ & T. JOVANOVIĆ, 2003: Ptice Srbije i Crne Gore: veličine i trendovi gnezdilišnih populacija 1990 – 2002. Ciconia **12**, 35–114.

RÖSSLER, M. & T. ZUNA-KRATKY, 1992: Die vogelkundliche Bedeuntug der Absetzbecken der Zuckerfabrik Hohenau/March. Vogelschutz in Österreich **7**, 2–12.

SCHMIDT, F.-U., 1985: The use of settling ponds of sugar-factories by breeding and resting waders. Wader Study Group Bulletin **43**, 34–36.

STEVANOVIĆ, V. & V. VASIĆ, 2000. Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja. Ekolibri Bionet & Biološki fakultet, Beograd.

ŠTUMBERGER, B & F. BRAČKO, 1996: Breeding by the Black-winged Stilt *Himantopus himantopus* in wastewater pools at Ormož (NE Slovenia). Acrocephalus **78–79**, 135–143.

TINARELLI, R., 1988: Importanza dei bacini di decantazione degli zuccherifici per la nidificazione e la sosta dell'avifauna acquatica. Picus **14**, 31–39.

TINARELLI, R. & N. BACETTI, 1989: Breeding waders in Italy. Wader Stydy Group Bulletin **56**, 7–15.

TINARELLI, R., 1991: Habitat preference and breeding performance of the Black-winged Stilt *Himantopus himantopus* in Italy. Wader Study Group Bulletin **65**, 58–62.

TUCAKOV, M. & A. ŽULJEVIĆ, 2002: Origin and breeding fauna of birds in two collecting facilities of industrial wastewaters in Backa: importance of artificial wetlands. Ciconia **11**, 52– 69.

ZUNA-KRATKY, T., 2001: Der erste Brutnachweis des Stelzenläufers in Niederösterreich an den Absetzbecken Hohenau-Ringelsdorf. Vogelkundliche Nachrichten aus Ostösterreich **4/2001**: 69–71.

ZUNA-KRATKY, T., 2005: Lebesraum-Enhaltung und Monitoring des Vogelschutzgebietes »Absetzbecken Hohenau – Ringelsdorf» – Bericht 2005. Auring, Hohenau an der March.

Summary

Breeding waterbirds on wastewater pools of four sugar refineries in Vojvodina

M. Tucakov & S. Puzović

The following species have been found to nest on four complexes of waste water pools of sugar refineries in Vojvodina: the Black-necked Grebe *Podiceps nigricollis*, Little Grebe *Tachybaptus ruficollis*, Mallard *Anas platyrhynchos*, Garganey *A. querquedula*, Common Pochard *Aythya ferina*, Ferruginous Duck *A. nyroca*, Common Coot *Fulica atra*, Moorhen *Gallinula chloropus*, Black-winged Stilt *Himantopus himantopus*, Avocet *Recurvirostra avosetta*, Little Ringed Plover *Charadrius dubius*, Northern Lapwing *Vanellus vanellus*, Black-headed Gull *Larus ridibundus*, Common Tern *Sterna hirundo* and Whiskered Tern *Chlidonias hybrida*. Four basic habitat elements created by sugar beet processing and wastewater treatment attracted breeding waterbirds to these secondary (man-made) wetlands: 1. eutrophic water, especially in the shallow (5–20 cm) pools, 2. islets originating from sedimentation of soil from wastewater (bare or with sparse and short vegetation), 3. mosaic of emergent and ruderal vegetation on the banks and islets and 4. absence of comparable habitats in surrounding agricultural land. At least one of the elements was of high importance for all species, while for all breeding waders eutrophic water and islets had high importance. The creation of this and other wetlands by human activity has influenced the distribution and numbers of Black-winged Stilt and Avocet in Vojvodina. The Black-winged Stilt is the only species to have been found nesting in all the studied wastewater pools of sugar refineries in Italy, Slovenia, Hungary, Austria, Croatia, and Serbia and Montenegro, and therefore can be considered a characteristic breeder of this habitat in central Europe. Such insular habitats are separated from the influence of natural water dynamics, and their hydrographical features are completely dependent on human activity. Because of their high importance for threatened bird species there is a need for the establishment of a system of proper utilization, management and maintenance of wastewater pools of sugar refineries for conservation in Vojvodina.

Vodene ptice koje se gnijezde na bazenima za otpadne vode četiriju šećerana u Vojvodini

M. Tucakov & S. Puzović

Na četiri kompleksa bazena za otpadne vode šećerana u Vojvodini gnijezde se: crnogli gnjurac *Podiceps nigricollis*, mali gnjurac *Tachybaptus ruficollis*, divlja patka *Anas platyrhynchos*, patka pupčanica *A. querquedula*, glavata patka *Aythya ferina*, patka njorka *A. nyroca*, liska *Fulica atra*, mlakuša *Gallinula chloropus*, vlastelica *Himantopus himantopus*, modronoga sabljarka *Recurvirostra avosetta*, kulik sljepčić *Charadrius dubius*,

vivak *Vanellus vanellus*, riječni galeb *Larus ridibundus*, obična čigra *Sterna hirundo* i bjelobrada čigra *Chlidonias hybrida*. Četiri osnovna stanišna elementa, stvorena procesom prerade šećerne repe i tretmana otpadnih voda, privukla su navedene gnjezdarice na ta umjetno stvorena staništa: 1. eutrofna voda, osobito u plitkim (5–20 cm) bazenima, 2. otočići koji potječu od nataloženog tla iz otpadne vode (goli ili obrasli rijetkom niskom vegetacijom), 3. mozaik emerzne i ruderalne vegetacije na rubovima i otočićima i 4. nedostatak sličnih staništa na okolnom poljoprivrednom zemljištu. Najmanje jedan element je bio visoko značajan za sve vrste, a za sve gnijezdeće kulike eutrofna voda i otočići su bili od velikog značaja. Stvaranje ovih i drugih vodenih staništa ljudskom djelatnošću utjecalo je na rasprostranjenje i brojnost vlastelice i modronoge sabljarke u Vojvodini. Vlastelica je jedina vrsta koja gnijezdi na svim proučavanim odlagalištima otpadnih voda tvornica šećera u Italiji, Sloveniji, Mađarskoj, Austriji i Srbiji, i stoga može biti smatrana karakterističnom gnjezdaricom ovakvih staništa u srednjoj Europi. Ovakva izolirana staništa su odvojena od utjecaja prirodne hidrodinamike, a njihove hidrološke značajke su potpuno ovisne o ljudskim aktivnostima. Zbog njihovog velikog značaja za ugrožene vrste ptica, postoji potreba za uspostavljanjem sustava prikladnog korištenja, upravljanja i održavanja.