

On food and feeding habits of the White Stork, *Ciconia c. ciconia*, in the Central Balkans

Nahrung und Nahrungsgewohnheiten des Weißstorchs, *Ciconia c. ciconia*,
auf dem mittleren Balkan

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Key words: White Stork *Ciconia c. ciconia*, Central Balkans, feeding, diet, pellets.

Summary

Mužinić, J., & J. Rašajski (1992): On Food and feeding habits in the White Stork, *Ciconia c. ciconia*, in the central Balkans. — Ecol. Birds 14: 211-223.

Research on the diet and feeding habits of the White Stork (*Ciconia c. ciconia*) was carried out in the Central Balkans by the method of qualitative and quantitative analysis of 504 pellets collected from 257 active nests and by analysis of food remains which do not form part of the pellets. The research was carried out in the months from May to July in the period from 1976-1990 and covered 34 villages (5 in Croatia, 18 in Vojvodina, 6 in Serbia, 2 in Kosovo and 3 in Macedonia) and 25 sites in the countryside in the nesting area of this species in the Central Balkans (Figure 1).

Two kinds of pellets were distinguished, depending on the maturity of the bird and on the pellet composition (Figure 2). The pellets of adult birds were larger and oval-shaped with median dimensions of 5×4 cm, while the pellets of young birds were smaller and more elongated with median dimensions of 4×3 cm.

The diet of the White Stork in the area investigated was found to include 3 species of oligochaetes, 8 mollusc species, 11 fish species, 3 amphibian species, 8 reptile species, 10 bird species, 7 mammal species and 44 insect species (Tab. 1-3). With reference to the ratio of the taxonomic groups, White Stork pellets may contain a predominance of fish remains or mammal remains or insect remains.

Young birds up to 20 days old are fed on earthworms (*Lumbricus* spp.) and insects from the Tettigoniidae family, after which they begin regurgitating pellets. The first pellets to be regurgitated contained remains of the following species: *Tettigonia* sp., *Musca* sp., *Libellula* sp., *Bombus* sp., *Vespa* sp., and some representatives of the Scarabaeidae family.

Food remains found in White Stork nests which do not enter into the composition of the pellets belonged to 10 bird species, 5 fish species, 5 reptile species, and two snail species one of which, i.e. *Limax* sp., is digested entirely, while shell remains of the other, i.e. *Planorbis corneus*, are discarded separately and deposited in the nest.

The most frequent species of prey in the diet of the White Stork were the following: *Tropidiscus planorbis*, *Tropidiscus carinatus*, *Planorbis corneus*, *Bathymophthalmus contortus*, *Rana esculenta*, *Microtus arvalis*, *Dytiscus* sp. and *Acilius* sp.

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Zusammenfassung

MUŽINIĆ, J., & J. RAŠAJSKI (1992): Nahrung und Nahrungsgewohnheiten des Weißstorchs, *Ciconia c. ciconia*, auf dem mittleren Balkan. — Ökol. Vögel 14: 211-223.

Es wurden Untersuchungen zur Nahrung und über Nahrungsgewohnheiten des Weißstorchs (*Ciconia c. ciconia*) auf dem mittleren Balkan durchgeführt. Dabei wurden 504 Gewölle von 257 besetzten Horsten sowie Nahrungsbestandteile außerhalb von Gewöllen qualitativ und quantitativ analysiert.

Die Untersuchungen erstreckten sich auf die Zeit von Mai bis Juli in den Jahren 1976 bis 1990. Es wurden Brutplätze in 34 Dörfern (5 in Kroatien, 18 in der Vojvodina, 6 in Serbien, 2 im Kosovo, 3 in Mazedonien) sowie 25 Horstplätze in der freien Landschaft innerhalb des Brutgebietes der Art auf dem mittleren Balkan erfaßt (Fig. 1).

Es ließ sich zwischen zwei Typen von Gewöllen je nach Alter der Vögel und Zusammensetzung der Gewölle unterscheiden (Fig. 2). Gewölle von Altvögeln waren größer und oval mit mittleren Ausmaßen von 5×4 cm. Gewölle von Jungvögeln waren kleiner und länglicher mit mittleren Ausmaßen von 4×3 cm.

Die vom Weißstorch im Untersuchungsgebiet festgestellten Nahrungsreste enthielten Bestandteile von 3 Borstenwürmerarten, 8 Weichtierarten, 44 Insektenarten, 11 Fischarten, 3 Amphibienarten, 8 Reptilienarten, 10 Vogelarten und 7 Säugetierarten (Tab. 1-3). Weißstorchgewölle lassen sich nach besonders häufigen Anteilen von Fisch-, Säugetier- oder Insektenresten in diese drei Typen klassifizieren.

Bis zum Alter von 20 Tagen bestand die Nahrung von Jungvögeln aus Regenwürmern (*Lumbricus spec.*) und Singschrecken (*Tettigoniidae*). Danach beginnen sie Gewölle auszuwürgen. Diese ersten Gewölle enthielten Arten von Heupferden (*Tettigonia spec.*), Stubenfliegen (*Musca spec.*), Hummeln (*Bombus spec.*), Wespen (*Vespa spec.*) und aus der Familie der Mistkäfer (*Scarabaeidae*).

Nahrungsreste außerhalb von Gewöllen aus Nestern des Weißstorchs stammten von 10 Vogel-, 5 Fisch-, 5 Reptilien- und 2 Schneckenarten. Von letzteren wird eine Egelschneckenart (*Limax spec.*) völlig verdaut, während von der Posthornschncke (*Planorbis corneus*) Schalenreste im Nest übriggelassen wurden.

Die häufigsten Beutereste in der Nahrung (Index 10 in Tab. 1-3) waren: Posthornschncken der Arten (*Tropidiscus planorbis*, *Tropidiscus variatus* und *Planorbis corneus*, die Tellerschnecke *Bathymophthalmus contortus*, Wasserfrosch (*Rana esculenta*), Feldmaus (*Microtus arvalis*), Schwimmkäfer (*Dytiscus spec.*) und Furchenschwimmer (*Acilius spec.*).

1. Introduction

The biology of the White Stork, *Ciconia c. ciconia*, (nesting, migrations, numbers in the central Balkan area has been relatively well studied (JOVETIĆ 1963; PELLE 1972; MUŽINIĆ 1985; RAŠAJSKI 1988 and others). However, there are little data on its diet available from this area. According to previous research on the diet of the White Stork in Croatia, it feeds mainly on small mammals and large insects, snakes, frogs and fish (MUŽINIĆ, 1987). SCHULZ (1989) reports that the White Stork population in Lonjsko Polje in Croatia feeds on tadpoles and adult frogs (*Rana esculenta*, *R. ridibunda* and *R. lessonae*), insects, grass snakes (*Natrix natrix*) and mice.

Birds feeding on animal food, are unable to digest bones, as well as horny, chitinous, and some other parts, regurgitate these in the form of pellets. This phenomenon is known to occur in almost all species of birds of prey and owls as well as in some other bird species, such as *Ardea cinerea* and *A. purpurea*, and it has also been observed by RAŠAJSKI (unpublished data) in *Corvus frugilegus*.

Research on the diet of the White Stork by analysis of pellets has been carried out in Hungary, France and Spain by SZIJJ et al. (1955), SCHIERER (1962), BOUDOIN (1973), REKASI (1975), MELENDRO et al. (1977), LAZARO (1986) and the authors DOLDERER and HAVERSCHMIDT according to LAZARO (1986).

2. Area, material and methods

The investigation covered the nesting area of the White Stork in the Central part of the Balkans, i.e. in Croatia, Serbia and Kosovo, Macedonia and Vojvodina (Central and Southern Banat) (Figure 1). The pellets were collected in the following villages: in 5 villages in Croatia (Slavonski Kobaš, Lipovljani, Čigoč, Mužilovčica, Drenov Bok), 6 villages in Serbia (Ram, Kličevac, Drmno, Gdelica, Toponica, Vlasina), 18 villages in Vojvodina (Kupinovo, Obrež, Vršac, Pavliš, Nikolinci, Vlajkovac, Dobrica, Ritiševo, Vatin, Mali Žam, Margita, Grebenac, Baranda, Čenta, Opoovo, Sakule, Jabuka, Alibunar), 2 villages in Kosovo (Bujanovac, Lužane) and 3 villages in Macedonia (Negotino, Katlanovo, Preševo). Pellets were also collected in the countryside on 25 sites in Vojvodina.

An investigation of the food composition and feeding habits of the White Stork was carried out by observation of the food remains in the nests and by analysis of the pellets collected in some parts of the Central Balkans. The material was collected from May to July in the period from 1976 to 1990. During this time, a total of 504 White Stork pellets were collected from 257 active nests in 34 villages and on 25 sites in the countryside in the nesting area of this species (Figure 1).

Observations on diet were made during the feeding of young birds in the first weeks of their life and by inspecting the nest in order to find food remains which would supplement our knowledge of the composition of their diet. Pellets were sometimes found in the nests, but most often on roofs behind the chimney or in gutters.

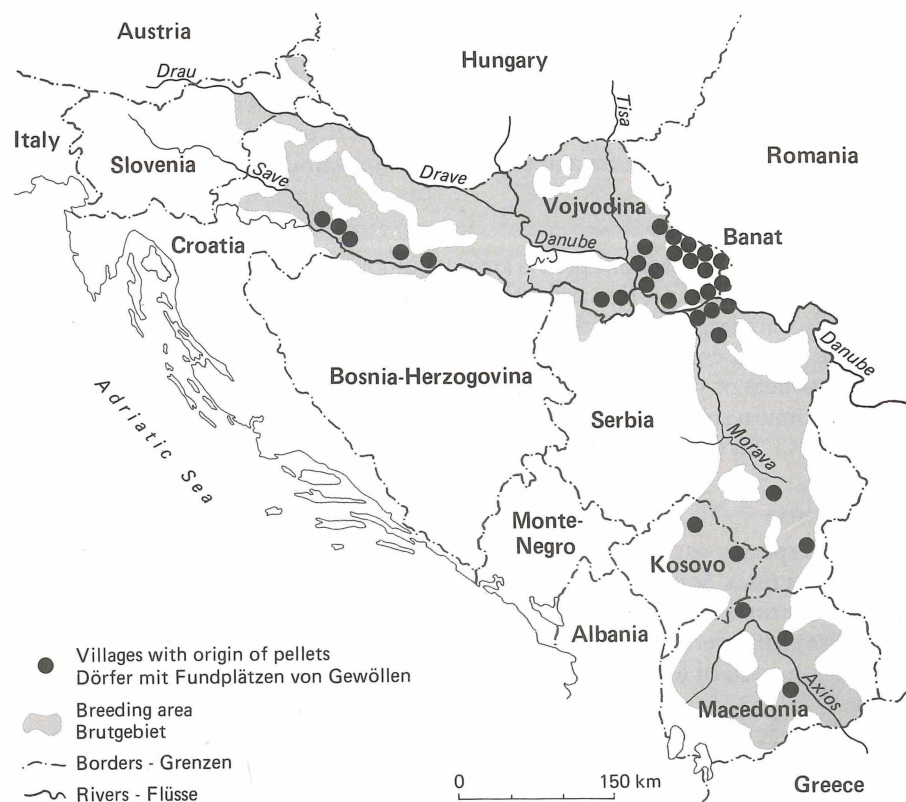


Figure 1. Breeding area of the White Stork, *Ciconia c. ciconia* in the Central Balkans; ● Villages (34) where pellets were collected.

Brutgebiet des Weißstorchs, *Ciconia c. ciconia* auf dem mittleren Balkan; ● Fundplätze der Gewölle in 34 Dörfern.

During the pellet analysis, bones, mammal hairs, mollusc shells, chitinous parts of insects and other indigestible remains were isolated according to the «dry method» (SCHMIDT 1967). An analysis was also made of indigestible food remains which were not part of the pellets, but which had been previously removed and discarded by the birds.

The pellets were analyzed for their shape, size, content and stability. The length and width of the pellets was measured in cm. A total of 85 pellets was measured. The length in cm and the weight in kg of the food remains which were removed and registered in the nest were also measured.

Determination of a part of the mammal remains was carried out according to SCHMIDT (1967), while a part of the insect remains were determined according to REITTER (1908) and GUEORGUIEV (1971). A part of the remains of smaller insects, belonging to a total of 42 species, remained undetermined due to heavy damage during digestion. A part of the bird remains (feathers) were determined according to SWENSSON (1984). Determination of the species of a part of the fish remains was carried out according to VESELOV (1977), while the amphibian remains were determined according to PAUNOVIĆ (1990).

Taking into consideration the ratio among the species of fauna found in the pellets, the pellets were classified into three categories according to the predominance of representatives of one of the large groups which were represented. These groups were: mammals, fish and insects.

3. Results

The regurgitation of pellets was recorded in adult White Storks and in young birds. Birds sometimes regurgitate pellets onto the nest, but more often outside the nest, so they can be found on the roof around the chimney and in the gutters. Young birds start regurgitating pellets when they are about 20 days old, when a qualitative change in their dietary regimen takes place. During the first twenty days, young birds feed on species of the *Lumbricidae* and the *Tettigoniidae* families (Table 1).

3.1 Analysis of pellets

It was found that White Stork pellets are not compact and that they crumble easily. An analysis of the shape, size and stability of 85 pellets showed that the pellets of adult birds were larger and oval in shape, with a maximum size of 7×6 cm, a minimum size of 2×2 cm and an average size of about 5×4 cm, and that these differed from the pellets of young birds which were smaller and more elongated in shape, with a maximum size of 4,5×2,5 cm, a minimum size of 2×2 cm and an average size of about 4×3 cm (Figure 2).

3.1.1 Pellets with a predominance of fish (Pisces) remains

A total of 6 species was recorded in pellets with a predominance of fish remains: *Esox lucius*, *Tinca tinca*, *Scardinius erithrophthalmus*, *Rutilus rutilus*, *Abramis ballerus* and *Carassius carassius* (Tab. 1).

The fish remains were most frequently fragmented with a maximum size of up to 3 cm, and consisted of lower jawbones, pointed rib bones, and whole skulls of small fishes.

The pellets containing mostly fish remains, always contained some mammal remains as well, and these made them more compact. In these pellets, fish remains made up not more than 40% of the pellet, while the remainder consisted of mammal and insect remains, most often representatives of Coleoptera. The pellets according to this description were recorded in the first half of June.

The proportion of fishes in the diet of young White Storks amounted to about 35% in the period from mid-June to mid-July.

Table 1. Frequency of occurrence of oligochaetes (Oligochaeta), molluscs (Mollusca) and fishes (Pisces) in the diet of the White Stork *Ciconia c. ciconia* on the Central Balkans (1-10=index of incidence of species: 1=min ... 10=max; —=absence of species).

Häufigkeit des Auftretens von Borstenwürmern (Oligochaeta), Weichtieren (Mollusca) und Fischen (Pisces) in der Nahrung des Weißstorks *Ciconia c. ciconia* des mittleren Balkans — 1-10=Häufigkeitsklassen einzelner Arten bzw. Gattungen: 1=Minimum ... 10=Maximum; —=fehlend).

Species	Area				
	C. Banat	S. Banat	Croatia	Macedonia	Serbia & Kosovo
OLIGOCHAETA:					
1. Lumbricidae 3 spp.	9	9	8	6	9
TOTAL: 3					
MOLLUSCA:					
1. <i>Galba palustris</i>	6	2	—	—	1
2. <i>Tropidiscus planorbis</i>	10	1	1	1	—
3. <i>Tropidiscus carinatus</i>	10	1	—	—	—
4. <i>Bathymphalus contortus</i>	10	2	2	—	1
5. <i>Succinea putris</i>	3	—	7	—	—
6. <i>Limax</i> sp.	3	2	—	2	2
7. <i>Helix pomatia</i>	—	2	2	1	1
8. <i>Planorbis corneus</i>	10	—	—	—	—
TOTAL: 8					
PISCES:					
1. <i>Esox lucius</i>	2	—	—	—	—
2. <i>Tinca tinca</i>	3	1	—	—	—
3. <i>Scardinius erithroptthalmus</i>	4	2	2	1	2
4. <i>Rutilus rutilus</i>	4	1	2	1	2
5. <i>Leuciscus</i> 3 spp.	5	3	2	—	3
6. <i>Abramis brama</i>	7	4	3	—	2
7. <i>Abramis ballerus</i>	3	1	?	—	—
8. <i>Cyprinus carpio</i>	5	3	3	1	3
9. <i>Carassius carassius</i>	2	3	—	—	1

TOTAL: 11

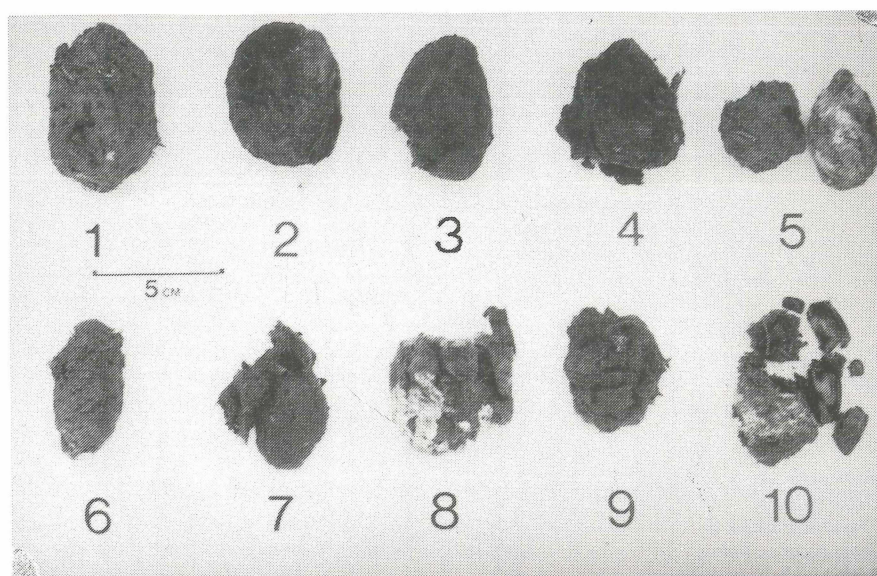


Figure 2. The typical shape, size and composition of pellets regurgitated by the White Stork, *Ciconia ciconia*; adult (1-4) and young (5-10) birds. 1-2=90% mammal and 10% insect remains; 3-4=40% mammal, 40% insect, 8-10% fish and 8-10% amphibian remains; 5-6=45% insect, 40% mammal and 15% reptile remains; 7-8=50% insect and 50% mammal remains; 9-10=10% mammal and 90% insect remains. Typische Form, Größe und Zusammensetzung von Gewölln des Weißstorks — 1-4: von Altvögeln, 5-10 von Jungvögeln. — 1-2: mit 90% Säugetier- und 10% Insektenbestandteilen; 3-4: 40% Säugetier-40% Insekten-, 8-10% Fisch- und 8-10% Amphibienbestandteile; 7-8: 50% Säugetier- und 50% Insektenbestandteile; 9-10: 10% Säugetier- und 90% Insektenbestandteile.

3.1.2 Pellets with a predominance of mammal (Mammalia) remains

A total of 7 species was recorded in pellets composed mainly of mammal remains: *Neomys* sp., *Talpa europaea*, *Cricetus cricetus*, *Clethrionomys glareolus*, *Microtus arvalis*, *Rattus norvegicus* and *Mustella nivalis* (Table 3).

Pellets with a predominance of mammal remains contained mostly hairs from the animals' fur, while the rest was made up of medium-sized bones belonging to small skulls, femoral bones and vertebrae.

In Vojvodina, over 90% of the pellet contents were made up of representatives of mammals, especially in the period from the beginning of June to mid-July.

3.1.3 Pellets with a predominance of insect (Insecta) remains

A total of 44 species was recorded in pellets composed mainly of insect remains: *Libellula quadrimaculata*, 3 species of *Libellula* spp., *Calopteryx virgo*, *Gryllotalpa gryllotalpa*, *Tettigonia viridissima*, *Tettigonia* sp., 3 species of *Decticus* spp., 2 species of *Stenobothrus* sp., *Pyrhocoris apterus*, 3-5 species of *Bombus* spp., 3 species of *Vespa* spp., 2 species of *Dyciscus* spp., *Acilius* sp., *Hydrous piceus*, *Lucanus cervus*, *Cetonia*

Table 2. Frequency of occurrence of amphibians (Amphibia), reptiles (Reptilia) and birds (Aves) in the diet of the White Stork *Ciconia c. ciconia* on the Central Balkans (1-10=index of incidence of species: 1=min ... 10=max; —=absence of species).

Häufigkeit des Auftretens von Amphibien (Amphibia), Reptilien (Reptilia) und Vögeln (Aves) in der Nahrung des Weißstorks *Ciconia c. ciconia* des mittleren Balkans — (1-10=Häufigkeitsklassen einzelner Arten bzw. Gattungen: 1=Minimum ... 10=Maximum; —=fehlend).

Species	Area				
	Vojvodina		Croatia	Macedo- nia	Serbia & Kosovo
	C. Banat	S. Banat			
AMPHIBIA					
1. <i>Salamandra salamandra</i>	—	1	—	—	—
2. <i>Rana esculenta</i>	10	10	10	5	8
3. <i>Hyla arborea</i>	—	1	3	—	1
TOTAL: 3					
REPTILIA					
1. <i>Emys orbicularis</i> juv.	1	3	1	—	—
2. <i>Testudo hermanni</i> juv.	—	—	—	5	2
3. <i>Lacerta agilis</i>	—	—	3	2	3
4. <i>Lacerta viridis</i>	—	3	3	4	4
5. <i>Anguis fragilis</i>	—	2	2	2	—
6. <i>Elaphe longissima</i>	—	1	3	2	4
7. <i>Natrix natrix</i>	9	9	8	1	3
8. <i>Natrix tessellata</i>	5	1	?	3	3
TOTAL: 8					
AVES:					
1. <i>Coturnix coturnix</i> juv.	2	1	—	—	—
2. <i>Phasianus colchicus</i> juv.	3	2	—	1	—
3. <i>Gallinula chloropus</i> juv.	3	1	1	—	—
4. <i>Fulica atra</i> juv.	2	—	—	—	1
5. <i>Anas platyrhynchos</i> juv.	2	—	—	—	—
6. <i>Anas platyrhynchos dom.</i> juv.	3	2	—	—	—
7. <i>Anas</i> sp. juv.	1	1	1	—	2
8. <i>Columba</i> sp. juv.	2	1	1	—	2
9. <i>Acrocephalus</i> sp.	3	2	1	—	—
10. <i>Pica pica</i> juv.	2	1	—	—	2

TOTAL: 10

Tab. 3. Frequency of occurrence of mammals (Mammalia) and insects (Insecta) in the diet of the White Stork *Ciconia c. ciconia* in the Central Balkans (1-10=index of incidence of species; 1=min...10=max; —=absence of species).

Häufigkeit des Auftretens von Säugetieren (Mammalia) und Insekten (Insecta) in der Nahrung des Weißstorks *Ciconia c. ciconia* des mittleren Balkans — (1-10 Häufigkeitsklassen einzelner Arten bzw. Gattungen; 1=Minimum...10=Maximum; —=fehlend).

Species	Area				
	Vojvodina		Croatia	Macedo- nia	Serbia & Kosovo
	C. Banat	S. Banat			
MAMMALIA					
1. <i>Neomys</i> sp.	2	1	—	—	—
2. <i>Talpa europea</i>	3	2	—	—	1
3. <i>Cricetus cricetus</i>	1	2	1	—	1
4. <i>Clethrionomys glareolus</i>	—	2	—	—	1
5. <i>Microtus arvalis</i>	10	10	7	8	9
6. <i>Rattus norvegicus</i>	2	1	1	—	—
7. <i>Mustella nivalis</i>	5	3	1	1	2
TOTAL: 7					
INSECTA					
1. <i>Libellula quadrimaculata</i>	3	4	2	2	2
2. <i>Libellula</i> 3 spp.	2	3	1	1	—
3. <i>Calopteryx virgo</i>	2	1	—	1	—
4. <i>Gryllotalpa gryllotalpa</i>	8	8	1	—	2
5. <i>Tettigonia viridissima</i>	6	5	1	1	5
6. <i>Tetigonia</i> sp.	6	5	1	1	5
7. <i>Decticus</i> 3 spp.	3	3	1	2	4
8. <i>Stenobothrus</i> 2 spp.	3	2	3	2	3
9. <i>Pyrhocoris apterus</i>	1	1	—	—	—
10. <i>Bombus</i> 5 spp.	3	3	1	—	2
11. <i>Vespa</i> 3 spp.	3	2	3	4	1
12. <i>Dytiscus</i> 2 spp.	10	10	10	4	10
13. <i>Acilius</i> sp.	9	10	8	4	10
14. <i>Hydrous piceus</i>	—	1	—	—	—
15. <i>Lucanus cervus</i>	1	—	1	—	—
16. <i>Cetonia aurata</i>	3	3	—	1	4
17. <i>Oryctes nasicornis</i>	—	1	—	—	—
18. <i>Leptinotarsa decemlineata</i>	2	2	2	—	2
19. <i>Saperda carcharias</i>	—	1	2	—	1
20. <i>Papilio machaon</i>	1	1	1	1	1
21. <i>Pieris brassiacea</i>	2	1	1	1	1
22. <i>Coenonympha</i> sp.	—	2	2	—	—
23. <i>Tabanus bovinus</i>	3	4	3	2	3
24. <i>Muscidae</i> 8 spp.	6	6	4	4	4
25. <i>Schizophyllum</i> sp.	2	2	2	—	1

TOTAL: 44

aurata, *Oryctes nasicornis*, *Leptinotarsa decemlineata*, *Saperda carcharias*, *Papilio machaon*, *Pieris brassicae*, *Coenonympha* sp., *Tabanus bovinus*, Muscidae (8 species) and *Schizophyllum* sp. (Table 3).

Another 42 insect species were found, mostly belonging to the Scarabaeidae family, which were not determined due to a high degree of damage during digestion.

Pellets made up of insect remains contained mostly chitinous parts, especially wings. The pellets containing about 90% insect remains, mainly Coleoptera, were recorded in the period from the end of May (or beginning of June) to mid-June. The species most frequently represented in this period were *Dytiscus* sp., *Acilius* sp. and *Tabanus bovinus*.

Pellets with a predominance of fish or mammal or insect remains were also found to contain representatives of amphibians, reptiles and molluscs. Among the representatives of Amphibia in the pellets, 3 species were recorded: *Salamandra salamandra*, *Rana esculenta* and *Hyla arborea* (Table 2). Among the representatives of Reptilia in the pellets, 3 species were recorded: *Lacerta agilis*, *L. viridis* and *Anguis fragilis* (Table 2). Mollusca were represented in the pellets by six species of snails: *Galba palustris*, *Tropidiscus planorbis*, *T. carinatus*, *Bathyomphalus contortus*, *Succinea putris* and *Helix pomatia* (Table 1).

3.2 Analysis of food remains in the nest

Food remains in the form of whole skeletons, large turtle shell bones, shells and soft parts of molluscs, fishes, reptiles, birds and mammals were recorded in the nests of White Storks. A total of 270 nests were found to contain 5 reptile species (*Emys orbicularis*, *Testudo hermanni*, *Natrix natrix*, *N. tessellata* and *Elaphe longissima*), 10 bird species (a total of 33 young birds): *Coturnix coturnix*, *Phasianus colchicus*, *Gallinula chloropus*, *Fulica atra*, *Anas platyrhynchos*, *A. platyrhynchos dom.*, *Pica pica*, and 1 undetermined species each of *Anas* sp., *Columba* sp., and *Acrocephalus* sp.) (Table 2). The nests were also found to contain remains of 5 fish species (*Abramis brama*, 3 species of *Leuciscus* spp. and *Cyprinus caprio*) (Table 1).

Remains of young birds found in nests, *Fulica atra*, *A. platyrhynchos* and *A. platyrhynchos dom.*, were comparable in size to birds of the genus *Streptopelia*. The fish remains, *Abramis brama*, *Leuciscus* sp. and *Cyprinus carpio*, weighed 1 kg. The length of *Leuciscus* sp. was 33 cm, and that of *Cyprinus carpio* was 31 cm.

A total of 40 nests were found to contain relatively large bones and skulls belonging to 4 species of mammals: 4 skulls and over 50 hind limbs of *Rattus norvegicus*, 3 skulls and 4 vertebrae of the species *Cricetus cricetus*, 24 skulls of the species *Mustela nivalis* and 20 skulls of the species *Microtus arvalis* (Table 3).

Among the snails found in White Stork nests, a total of 7 species was determined in the form of whole or broken shells (*Galba palustris*, *Tropidiscus planorbis*, *Tropidiscus carinatus*, *Bathyomphalus contortus*, *Succinea putris*, *Planorbis corneus* and *Helix pomatia*), as well as one species which had no shell (*Limax* sp.) (Table 1). In the villages of Čenta and Baranda, a total of 16 nests were found with about 400 shells belonging to various snail species among those mentioned above, 8 nests with about 800 snail shells, 2 nests with about 1,000 snail shells and 6 nests with about 2,000 snail shells.

4. Discussion

The White Stork only fully digest the soft parts of its prey, and it eliminates indigestible parts 1) by regurgitating pellets made up mostly of mammal hairs, chitinous parts of insects, small bones, pieces of snail shells, bird feathers, etc., and 2) by discarding parts of the skeleton such as the skull, backbone, and other large bones, as well as whole turtle shells, snail shells, etc. Soft prey which is entirely digested by the White Stork includes three species of earthworms (*Lumbricidae*) and a snail which has no shell (*Limax* sp.). However, findings of this snail in nests indicate that the White Stork does actually feed on it.

During the first twenty days of their life, young White Storks do not regurgitate pellets because they feed on species belonging to the *Lumbricidae* family, which are fully digestible, and on insects belonging to the *Tettigoniidae* family, which are partly digestible, while the remaining parts enter into the composition of the first pellets to be regurgitated following this period. As a qualitative change takes place in their diet, and parts that cannot be digested appear in their food (chitinous parts of *Coleoptera*), the young birds start regurgitating pellets.

Pellets regurgitated by young birds and pellets regurgitated by adult birds differ in shape, size and stability (Figure 2). The shape and the degree of compactness of the pellets depend on their composition. The most compact and most stable pellets are those containing a combination of *Microtus* sp. — *Rana* sp. — and some fish species. The most stable pellets are those containing over 50% insects (*Musca* sp. — *Dytiscus* sp.).

An analysis of pellets and food remains in White Stork nests shows that in the Central Balkan area this bird feeds on a great variety of animal species, i.e. oligochaetes, mollusca, fishes, amphibians, reptiles, birds, mammals and insects.

Crushed snail shells form part of the pellets, but whole or broken snail shells may also be found in nests. Out of a total of 8 recorded mollusc species, the pellets were found to contain 6 snail species (*Galba palustris*, *Tropidiscus planorbis*, *Tropidiscus carinatus*, *Bathyomphalus contortus*, *Succinea putris* and *Helix pomatia*), one snail species (*Limax* sp.) was digested entirely, while one snail species, *Planorbis corneus*, was discarded entirely and separately (Table 1). *P. corneus* was also the only snail species with a shell the remains of which were not regurgitated in pellets, but were discarded separately, and were therefore recorded only in the nests of White Storks. Out of a total of 11 recorded fish species, the remains of 6 species were regurgitated in the form of pellets (*Esox lucius*, *Tinca tinca*, *Scardinius erithrophthalmus*, *Rutilus rutilus*, *Abramis ballerus* and *Carrassius carrassius*), while the remains of 5 species were discarded separately (*Abramis brama*, 3 species of *Leuciscus* sp. and *Cyprinus carpio*) (Table 1). Remains of all three of the recorded amphibian species were regurgitated only in the form of pellets (*Salamandra salamandra*, *Rana esculenta* and *Hyla arborea*). Out of a total of 8 recorded reptile species, the remains of 3 species were regurgitated as pellets (*Lacerta agilis*, *Lacerta viridis* and *Anguis fragilis*), while the remains of 5 species were discarded separately (*Emys orbicularis*, *Testudo hermanni*, *Natrix natrix*, *Natrix tessellata* and *Elaphe longissima*). Remains of all 10 of the record bird species (*Coturnix coturnix*, *Phasianus colchicus*, *Gallinula chloropus*, *Fulica astra*, *Anas platyrhynchos*, *Anas p. dom.*, *Anas* sp. *Columba* sp., *Acrocephalus* sp. and *Pica pica*) did not

enter into the composition of the pellets, but were discarded separately as large parts of the skeleton, so they were found in the nest (Table 2). Remains of all 7 mammal species (*Neomys* sp., *Talpa europea*, *Cricetus cricetus*, *Clethrionomys glareolus*, *Microtus arvalis*, *Rattus norvegicus*, and *Mustella nivalis*) were regurgitated in pellets, while the skulls and large bones of 4 of these species (*Rattus norvegicus*, *Cricetus cricetus*, *Mustella nivalis* and *Microtus arvalis*) were discarded separately (Table 3).

In young White Storks, the first pellets were composed mainly of representatives of insects which do not have a great proportion of chitinous parts: *Tettigonia* sp., *Musca* sp., *Libellula* sp., *Bombus* sp., *Vespa* sp., and some representatives of the Scarabaeidae family. After that, remains of tadpoles and frogs (*Rana esculenta*) began to occur in the pellets, as well as representatives of small species of Coleoptera, so these pellets show a transition towards those containing remains of large species of Coleoptera (*Dytiscus* sp. and *Acilius* sp.). These were followed by pellets containing a combination of fishes, amphibians and mammals. Finally, in the last stage, the pellets contained predominantly mammals, mostly small rodents. In Central Banat, the pellets predominantly containing small rodents also contained crushed snail shells. The difference in the diet of the White Stork in various parts of the Central Balkans are not great. On all the sites which were investigated, the bird was found to feed on 3 species of representatives of Lumbricidae, *Scardinius erithrophthalmus*, *Rutilus rutilus*, *Cyprinus carpio*, *Rana esculenta*, *Natrix natrix*, *Anas* sp., *Microtus arvalis*, *Mustella nivalis*, *Libellula quadrimaculata*, 3 species of the genus *Libellula*, *Tettigonia viridissima*, *Tettigonia* sp., 3 species of the genus *Decticus* sp., 2 species of the genus *Stenobothrus* sp., 3 species of the genus *Vespa* sp., 2 species of the genus *Dytiscus* sp., *Acilius* sp., *Papilio machaon*, *Pieris brassicae*, *Tabanus bovinus* and 8 species of the Muscidae family. *Salamandra salamandra* and *Hydrous piceus* occurred in the diet of the White Stork only in the Southern Banat area, although according to GARMS et al. (1981, pp. 261, 381), both of these species are widespread in all the areas where the diet of the White Stork was investigated. *Esox lucius* and *Planorbis corneus* occurred in the diet of the White Stork only in Central Banat, although according to GARMS et al. (1981, pp. 287, 482), they are widespread on the entire Balkan peninsula.

The most frequent species of prey in the diet of the White Stork (index 10 of Tables 1-3) were the following: *Tropidiscus planorbis*, *Tropidiscus carinatus*, *Planorbis corneus*, *Bathynomphalmus contortus*, *Rana esculenta*, *Microtus arvalis* and *Dytiscus* sp. in the central Banat area, *Rana esculenta*, *Microtus arvalis*, *Dytiscus* sp. and *Acilius* sp. in the Southern Banat area, and *Rana esculenta* and *Dytiscus* sp. in Croatia.

Fishes were an important part of the diet of adult birds, while insects were especially represented in the diet of young birds. Mammals were most frequently found in the diet of the White Stork in Central and Southern Banat.

The species *Cricetus cricetus* is most widespread in the Pannonian part of the Balkan peninsula, where it lives on cultivated steppes and in wheat fields (GARMS et al. 1981, p. 34). Since this species is active at twilight and at night, the fact that it was found in the diet of the White Stork in the Vojvodina area indicates that the White Stork still forages for food at twilight in this area.

5. Conclusion

Research on the diet and feeding habits of breeding populations of the White Stork (*Ciconia c. ciconia*) in the Central Balkans was carried out by qualitative and quantitative analysis of 504 pellets and food remains in the nests. Pellets consisting of remains of undigested food are regurgitated by young and adult birds. The shape of the pellets depends on the maturity of the birds and on the predominant species making up the pellet. A characteristic of pellets regurgitated by the White Stork is that they are not compact and crumble easily.

The White Stork digests the soft parts of its prey (earthworms, snails without shells), while it eliminates the indigestible parts by regurgitating them in the form of pellets containing small bones, hairs, chitinous parts of insects, snail shells, bird feathers, etc. Remains of prey in the form of large skull bones, turtle shells, etc., which do not enter into the composition of the pellets, are discarded and deposited in the nest. It was found that in the Central Balkans the White Stork feeds on the following groups: 3 species of oligochaetes, 8 mollusc species, 11 fish species, 3 amphibian species, 8 reptile species, 10 bird species, 7 mammal species and 44 insect species. With regard to the ratio among the groups of fauna, White Stork pellets may contain a predominance of fish remains or mammal remains or insect remains. Fishes, mammals and insects are the animals on which the White Stork most frequently feeds in the Central Balkans. The most frequent species found in its diet depending on the location, are the following: *Tropidiscus planorbis*, *T. carinatus*, *Bathymorphalmus contortus*, *Planorbis corneus*, *Rana esculenta*, *Microtus arvalis*, *Dytiscus* sp. and *Acilius* sp.

The first pellets to be regurgitated by young White Storks include: *Tettigonia* sp., *Musca* sp., *Libellula* sp., *Bombus* sp., *Vespa* sp. and some representatives of the Scarabaeidae family.

The most varied diet is available to White Storks in the following areas: Central and Southern Banat in Vojvodina, and Lonjsko Polje in Croatia.

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