

RESEARCHES REGARDING THE INFLUENCE OF THE WEATHER ON THE FLIGHT OF THE WHITE STORKS (*Ciconia ciconia*) IN THE SPRING MIGRATION ACROSS THE DOAMNEI RIVER HYDROGRAPHICAL BASIN (ARGEȘ COUNTY, ROMANIA) (II). OTHER CONSIDERATIONS ABOUT THE MIGRATION OVER THE AREA.

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Abstract. In this last part of the series of articles concerning the migration of the white storks (*Ciconia ciconia*) in the Doamnei River hydrographical basin, the authors make some considerations regarding the overflowed areas and habitats, the aerial activity depending on the lapse of time and the intra- and inter-specific bonds. The most individuals were observed in the hilly area, flying principally over the settlements and forests. April was the most intense month regarding the migration, the maximum of the aerial activity being between 16:00 and 17:00 for the observations per hour and between 17:00 and 18:00 for the observed individuals per hour. The birds avoided to fly on bad weather conditions and they preferred to use the soaring and gliding flights. Usually, they did not emit any sound. Rarely, the storks were temporarily accompanied in flight by other birds (*Pernis apivorus*, *Accipiter nisus* and *Falco tinnunculus*).

Keywords: white stork (*Ciconia ciconia*), migration, Doamnei River hydrographical basin, Romania.

INTRODUCTION

The paper is the last part of the two previous articles [16, 17] from this review regarding the migration of the white storks over the Doamnei River hydrographical basin.

In the context of the absence of data regarding the biodiversity from Romania at international level [9], actually Romania is one of the richest countries in Europe considering biodiversity. As a member of the European Union, the protection of nature has become here a priority [23].

The Doamnei River hydrographical basin is important because it shelters many protected species of birds in Romania - breeding species or passage and winter visitors: *Ixobrychus minutus*, *Egretta alba*, *Aquila chrysaetos*, *Circaetus gallicus*, *Falco peregrinus*, *Falco columbarius*, *Grus grus*, *Picoides tridactylus*, *Lanius minor*, *Ficedula parva* etc. Among the vertebrates, notable are: *Cottus transsilvaniae*, *Lissotriton montandoni*, *Pelophylax lessonae*, *Canis lupus*, *Felis silvestris*, *Lynx lynx*, *Ursus arctos*, etc. [4-7].

The white stork (*Ciconia ciconia*) is protected by Bern Convention, Bonn Convention, Bird Directive, etc. It is in the Red Book of the vertebrates from Romania [4]. Also, it is in SPEC 2 Category and vulnerable regarding the threat status [8]. Its migration is not fully known in Romania; only some sporadic information comes from the southern part of the Făgăraș Mountains [10, 12, 14, 20].

MATERIALS AND METHODS

The materials and methods are the same mentioned in the previous works [16, 17].

We remember that the Doamnei River is tributary of the Argeș River. It has the major part of the springs in Făgăraș and Iezer-Păpușa Mountains (Fig. 1),

witnesses of the past glacial erosion [15]. Its hydrographical basin covers 1822 km² and its discharge at the confluence of the Argeș River is 19.6 m³/s [25].

The vegetation is characteristic to the mountain and hilly floors, being constituted principally by woods of *Picea abies*, *Fagus sylvatica*, *Carpinus betulus*, *Quercus robur*, *Q. petraea*, *Acer pseudoplatanus*, etc. [1].

White stork is a well known bird from the Ciconiiformes order, with black and white feathers. It is ranged almost over all Europe [22].

The observations were effected mainly in the hilly part of the area, mostly in Dârmănești locality (Fig. 1, marked with interrupted line). During 1998 – 2010, we noted each observation, the date, the number of individuals, the exact time, the type of flight, the height of flight, the weather features, the locality and the type of overflow ecosystem, the intra- and inter-specific bonds, etc.

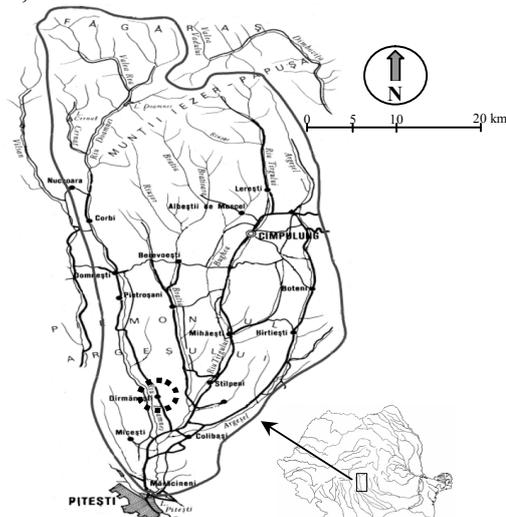


Figure 1. The hydrographical basin of the Doamnei River (modified [2]), with its borders (marked with grey curve) and the main place of observations (marked with interrupted line).

RESULTS

During the entire period of study (1998-2010), the most part of the observations were performed in the

hilly part of the Doamnei River hydrographical basin and few of them were performed in the plain, sub-mountainous and mountainous areas (Table 1).

Table 1. The variation of the number of observations and of the number of individuals observed in each zone from the Doamnei River hydrographical basin and their percentage during 1998 – 2010.

Period		Zone			
		Plain	Hill	Sub-mountainous	Mountainous
Spring migration	Number of observations	0	288	0	1
	Number of observations (%)	0	99.65	0	0.35
	Number of observed individuals	0	3150	0	3
	Number of observed individuals (%)	0	99.90	0	0.10
Autumn migration	Number of observations	1	12	1	0
	Number of observations (%)	7.14	85.71	7.14	0
	Number of observed individuals	6	394	5	0
	Number of observed individuals (%)	1.48	97.28	1.23	0
All period	Number of observations	1	300	1	1
	Number of observations (%)	0.33	99.01	0.33	0.33
	Number of observed individuals	6	3544	5	3
	Number of observed individuals (%)	0.17	99.61	0.14	0.08

The average of the number of observations per hour had its maximums in March and April (0.24, respectively 0.29 observations/hour), the minimum being registered in June (0.01 observations/hour). The

average of the number of individuals observed per hour had maximums in April (3.33 individuals/hour) and May (2.46 individuals/hour). The minimum was in July (0.03 individuals/hour).

Table 2. The monthly situation of the number of observations and of the average of the number of observations/hour and of the observed individuals/hour (March – July, 2007 - 2008).

Month		March	April	May	June	July
The total of the hours of field observations	2007	100	96	75.75	85	99
	2008	56	65	64	43	40.75
	2007-2008	156.25	161	139.75	128.25	139.75
Number of observations/hour		0.24	0.29	0.12	0.04	0.01
Number of individuals/hour		2.27	3.33	2.46	0.65	0.03

Considering the main habitats overflowed by the white storks (Tab. 3, Fig. 2) we found that the individuals which were observed crossing the human settlements had the biggest percentage (55.06% in the spring, 80.00% in the autumn and 57.90% for all period). The individuals seen overflying the forest had the second percentage (24.77% in the spring, 15.56%

in the autumn and 24.77% for all period). The individuals which were observed overflying the floodplain had 19.31% in the spring, 4.44% in the autumn and 17.62% for all period. The individuals which were observed crossing the riverbank parks had an insignificant percentage (under 1%).

Table 3. The distribution of the individuals depending on the overflow habitats.

Habitat	Human settlement	Forest	Floodplain	Riverside park
Spring migration	1736	781	609	27
Autumn migration	324	63	18	0
All period of migration	2060	844	627	27

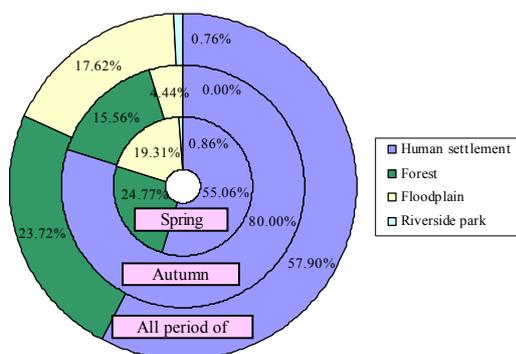


Figure 2. The percentage distribution of the individuals depending on the overflow habitats.

For April (2007-2008), the most intense month regarding the migration and with observations distributed on the entire period, we tried to find a relation between the rhythm of the aerial activity of migration of the birds and the hours of flight (Tab. 4; the grey colour corresponds to the data considered by us as insufficient: under 5 hours of field observations every time sequence).

Between 8:00 and 18:00 (Tab. 4), regarding the number of observations we remarked a maximum between 14:00 and 18:00. Regarding the number of observed individuals, high values were between 13:00

and 18:00, with the maximum between 17:00 and 18:00. Concerning the average of the observations per hour, we noticed an almost constant increase until 18:00 – 19:00, when its maximum value was registered. About the average of the individuals observed per hour, we remarked, like in the case of the

observations per hour, a maximum between 17:00 and 18:00, but more obvious. The first observation was at 11:40 and the latter at 19:25.

The average of the observations per hour was 0.29 observations/hour and the average of the individuals observed per hour was 3.33 individuals/hour.

Table 4. The situation of the number of field observations hours, of the observations number and of the observed individuals and the average of the observations and the observed individuals per hour in April (2007 -2008).

Lapse of time	Number of hours of field observations	Observations	Individuals	Observations / hour	Individuals / hour
4:00-5:00	0	0	0	0	0
5:00-6:00	1	0	0	0	0
6:00-7:00	3.5	0	0	0	0
7:00-8:00	3.75	0	0	0	0
8:00-9:00	7.75	0	0	0	0
9:00-10:00	13.5	0	0	0	0
10:00-11:00	24.5	0	0	0	0
11:00-12:00	14	2	44	0.14	3.14
12:00-13:00	15.5	5	31	0.32	2
13:00-14:00	17.5	3	84	0.17	4.8
14:00-15:00	20.5	9	76	0.43	3.7
15:00-16:00	20	8	75	0.4	3.75
16:00-17:00	13	8	76	0.61	5.84
17:00-18:00	5.25	8	129	1.52	24.57
18:00-19:00	0.5	1	4	2	8
19:00-20:00	0.5	2	17	4	34
20:00-21:00	0.25	0	0	0	0
21:00-22:00	0	0	0	0	0
22:00-23:00	0	0	0	0	0
Total	160.5	46	536	0.29	3.33

DISCUSSIONS

The observation from the Mateiaș (3 individuals on 19 April 2009) confirms some data from the scientific literature [13] which affirm that the white stork crosses the Carpathian Mountains through the Rucăr – Bran Corridor, but future researches will be further performed. Also, 9 individuals were observed in Bahna Rusului Depression (Nucșoara, 24 May 2009). The white storks can cross the Carpathian Mountains [12], too, and even other higher mountains, for example, the Alps, at an altitude of more than 2000 m [18].

The white storks prefer to migrate over the hills (across settlements and forests) where the ascendant air used in the economical flying (soaring and gliding) is formed. Probably, the hills are used as landmarks. Over the floodplain and over the riverbank parks the birds were rarely seen in flight, in transit from one hill to another.

Regarding the aerial activity depending on the lapse of time, we stated that in April (2007 - 2008) the most important peak was from 17:00 to 18:00. During all spring (1998 - 2010), as we showed [17], the principal maximum was between 14:00 and 15:00 and the second was between 17:00 and 18:00. Generally, an intense activity was in both cases between 12:00 and 18:00, demonstrating that the white storks travelled in the zone especially in the second half of the day, when the thermals were well formed and they arrived here from the departure grounds. The first observations

were noted beginning at 11:00 o'clock. The latest was until 20:00. During the spring (1998 – 2010) the individuals were observed in flight between 9:00 and 22:00 [17]. In Israel, the white storks were observed flying 2 to 3 hours after the sunrise, when thermals start to increase [11].

Other final considerations.

Regarding the intra- and inter-specific relations, the white storks were not observed performing in migration peculiar behaviours of flight.

During our research, we observed that the flight was always slowly and without sudden deviations in direction. Usually, it did not follow a straight line but rather a zigzag line, composed of linked segments, covered in gliding, which gave it a certain direction. The angle between these segments was usually only a few degrees. Only rarely it becomes much larger (as we found on 1 May 2000, when a flock of 7 individuals went first to the southwest, then south and finally to the southeast, although normally the direction of travel in this period should be exactly the opposite; in such cases, when the birds flew in a wrong direction, often, one or more individuals tried, with or without success, to correct the route, detaching temporarily of group).

The birds avoided to fly on strong wind, because it hinders their advancement. In such cases, generally, they preferred to stay, as we found on 7 April 2000, when we saw again a few individuals in migration only after the wind ceased (after it strongly blew in the previous days). However, especially at the beginning of

the migration, the storks were seen flying in such conditions. Thus, on 18 March 2001, we noticed 4 individuals which advanced in zigzag in gliding flight, on a category 4 wind, which blew from the opposite direction. They formed an enough compact flock, with a changeable shape, which varied from a frontal one to an elongated one and reverse. According to our appreciation, the birds flew with only 16 km/hour, with the outstretched wings and rare flaps. For a while, they advanced very slowly; when the wind was favourable, they did it faster. Wind assistance may explain part of the seasonal differences regarding the mean daily migration speed [21].

We did not perform researches about the speed of flight but we remarked that, sometimes, the birds flew very slowly even in excellent weather conditions (with favourable temperature of the air, atmospheric nebulosity, and wind speed). Thus, on 14 May 2000, a flock covers in 25 minutes a distance of only 6 km, consequently giving a local speed of flight of only 14.4 km/hour, while the mean daily migration speeds is, normally, 6.5 km/h in Europe [21]. Cross-country speed relative to the ground of migrating storks is between 33 km/h and 39 km/h in Israel and 44 km/h in Tanzania [3]. Conformable to other studies, the regional and seasonal differences in mean daily migration speed can be explained by at least three main factors: the physical condition of the bird, tailwind assistance and thermal convection [21].

Also, in periods with precipitations, the white storks were not seen in migration. They preferred to fly before or after the passing of the severe weather. Other authors conclude that the birds gather in such cases to the limit of the weather front, aggregating and waiting the raising of the cloudy level [24].

The **soaring flight** was performed in the ascendant draft, this method being for the birds the easiest and fastest mode to climb in elevation. Coupled with the gliding, it was the most used procedure of displacing in migration, thus the storks consuming much less energy than for the active flight. Thermals are the limiting factor in soaring flight [11].

This type of flight with the wings widely opened was sometimes associated with the active flight. In rising flight the members of the flock circulate in different direction in large circles that intersect at varying heights like a whirlwind. Trying to maintain into the thermal, the flock can move horizontally, too.

The ascension can keep from few seconds to a couple of minutes, at its end the birds entering occasionally in the base of clouds as we noted on 13 April 1999 when a flock disappeared from sight for a few moments into a Cumulus cloud, located at about 800 m height. Similar observations were registered in other places [24].

In the scientific literature is mentioned that the minimum level of flight in thermal was 40 - 50 m [24]. We noticed that this limit was more reduced: on 18 June 2007, 15 individuals started the soaring at 10 m height from the ground, on 14 April 2005, 13 individuals started the circling at circa 30 m height

from the ground, and on 25 March 1999, 11 individuals started the soaring at 30 m above the soil.

From the maximum level of flight attained in thermal, the birds leave in **gliding** to another thermal, where they begin again the soaring. The gliding is a slow flight, with wings outstretched, motionless and slightly curved back or with rare and short series of one, two or more beating of wings. Generally, the storks fly into a frontal and dispersed, rarely, compact group, which can be widened or elongated or, very rarely, even in trail, as we observed 6 individuals on 4 June 2000. Usually, the individuals from the inferior part of the flock start in gliding the latest, without reaching the maximum height reached by the others. The reason for the spreading in large front is that in this manner the birds increase their chance to encounter a lift, which can then be used by the all members of the flock [19].

The **active flight (flapping)** for long periods, composed of rhythmic and intensive beatings of wings, was the rarest performed, being, as we said, very expensive, only a flock of the 303 observed (0.33%) exclusively practicing it (while moving at approx. 150 m high, on 26 August 1999, on a completely overcast with clouds Nimbostratus). More frequently, it was combined with the others two types of flight: the gliding, in 91 cases (30.03%) and the soaring, in 41 cases (13.53%); all three types of flight are recorded together only in 40 cases (13.20%). In Israel, above land the storks used flapping flight on cloudy days; some flocks left before thermal conditions were good and flew up to tens of kilometers in flapping flight. The storks used also flapping flight to fly against the wind [3].

Typically, the white storks have not emitted any sound in flight. Only on 18 June 2008, the birds from a flock of 15 individuals, which traveled over the meadow at about 10 m high, frequently clattered.

Interspecific, we noticed that the white storks were associated but rarely in flight with specimens of other species. Thus, on 4 May 2006, 16 individuals were observed traveling in the company of a honey buzzard (*Pernis apivorus*) at a height of 900-1000 m and, on 1 April 2007, a flock of four individuals was noticed evolving for a short period of time at approx. 800 m height near a sparrowhawk (*Accipiter nisus*). Also, on 30 March 2000, three specimens were observed soaring for a while, at approx. 500 m height, near two kestrels (*Falco tinnunculus*).

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