EFFECTS OF THE ELECTROMAGNETIC FIELDS OF PHONE MASTS ON A POPULATION OF WHITE STORK (*Ciconia ciconia*)

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SUMMARY.– *effects of the electromagnetic fields of phone masts on a population of White Stork (Ciconia ciconia).* Monitoring of a population of White Stork in the vicinity of Cellular Phone Base Stations was carried out in Valladolid (Spain) with the objective to detect possible effects. **Very significant differences among the total productivity of the nests located within 200 meters and those located further than 300 meters of phone masts were found (U=240; p=0,001, test of Mann-Whitney)**. In another intensive monitoring carried out around four monuments, **failures in the breeding of this species in the nests near to antennae were observed**. **The productivity** obtained in this study **shows very low levels** regarding the censuses previously realized. **The most affected couples could not build the nest**, had disputes for the placement of the sticks and the sticks dropped to the ground. These results are compatible with the possibility that **the microwaves are interfering especially with the reproduction of the white storks** in the inhabited nuclei and would corroborate the results of laboratory research by other authors.

Key words: *Ciconia ciconia*, electromagnetic fields, microwaves, non thermal effects, phone masts, White stork

INTRODUCTION

The objective of this study was to investigate if the cellsites cause effects in wild birds effects similar to the laboratory studies, and to those recorded in studies carried out on people exposed to this radiation (Lilienfeld, 1978; Hyland, 2000, Hutter *et al*., 2002; Santini *et al*., 2003; Navarro *et al*., 2003) that could cause the abandonment of the area, the failure of the breeding, the decrease of the brood or other anomalies.

The white stork (*Ciconia ciconia*) was chosen to study because it is one of the most vulnerable species. The couple builds their nests on pinnacles and other very high places exposed to the microwaves. Also, they usually live inside urban environment, where the electromagnetic contamination is higher.

MATERIALS AND METHOD

During the 2002, 2003 and 2004 springs we carried out a monitoring of the reproduction of White Stork (*Ciconia ciconia*) in several nests of Valladolid (Spain).

The spring 2002 we take contact with the problem of the effects of phone masts on the species. That year we began to observe problems in the white storks breeeding nearer phone masts. Historical nests disappeared and we began to observe a reduction on the productivity (chicks/nest) and a high mortality of the youngs.

During the spring of 2003 we carried out a more exhaustive monitoring on the breeding success of white stork population. 30 nests were selected located within 200 meters of one or several cellsite antennae and another 30 nests located further than 300 meters of any cellsites, in Valladolid (Spain) (Table 1). The nests were visited in May and June of 2003. To compare the breeding success of both groups of nests a non parametric test was applied (U of Mann - Whitney).

We also carried out 15 visits between the months of February and June 2003 to four historical building (monuments) of Valladolid, with more than 20 nests of the species. The visits embraced all the phases of breeding, from the construction of the nest, until the appearance of youngs exercising the wings and practising flight. The monuments studied were San Pablo (A, B), San Martin (C), Las Angustias (D, E) and La Catedral (F, G) (Fig. 1). We made mensurements of the of Electric Field Intensity (radiofrequencies) in the proximity of the monuments.

The results of the previous censuses of white stork carried out in Valladolid and in other Spanish counties were consulted for comparison as a reference for the results obtained in this study.

During the spring of 2004 we are studying by means of observations, the behavior of the most affected white storks.

RESULTS

The total productivity (number of young flown by couple, including the nests with 0 chicks), in the nests located within 200 meters of antennae, was 0,86±0,16. For those located further than 300 meters, the result was practically duplicated, with

an average of 1,6±0,14 (Fig. 2). Both groups showed very significant differences in the breeding success (U=240; P=0,001, Test U of Mann-Whitney) (Fig. 2).

In partial productivity (number of young flown by number of couples with some chicks, excluding the nests with 0 chicks), an average of 1,44±0,16 was obtained for the first group (within 200 m. of antennae.) and of 1,65±0,13 for the second (further than 300 m. of antennae) respectively. The difference between both groups of nests in this case were not statistically significant (U=216; P=0,26, Test U of Mann-Whitney).

Twelve nests (40%) located within 200 meters of antennae didn't have any chicks, while only one (3,3%) of those located further than 300 meters didn't have chicks.

The results of the monitoring realized during the spring of 2003 near the four monuments studied in Valladolid are presented (Fig. 1 and Table 2). The white storks had a total productivity of 0.6±0,18 chicks per nest, while the partial productivity was 1,33±0,23. The nests that didn't have chicks generally presented a very scruffy and compressed aspect, as if the couple had not placed sticks in the last months. This happened especially in those located within 200 meters of antennae and on those that the main beam impacted directly. In the nests from San Martin (Fig. 1-C) and San Pablo (Fig. 1-A and B) at least one or two young **died from unknown causes**. Five nesting sites located within 200 meters from antennae, that received the direct beam of waves, **were never built in spite of the couple's repeated attempts** (Fig. 1 and Table 2). In their vicinity high Intensity levels of Electric Field (higher than 2 V/m) were measured.

The results of the bibliographical revision are presented. The results of productivity of this study are generally less than those obtained in previous studies, especially for the nests located within 200 meters of the cellsite antennae (Table 3).

From the behavior of most affected white storks, the most interesting observations include:

- The couple frequently dispute for the sticks

- Fall of the sticks to the ground while the copuple try to build the nest.

- The couple don't advance in the construction of the nest.

- The most affected nests don't end up being built.

- Increases the number of nests without chicks.

- Frequent death of young in their first stages.

- The storks remain passively in front of phone masts.

DISCUSSION

The results of the difference of total productivity between the near nests and those far from the antennae indicate the existence of nests without chicks, or the death of young in their first stages in the nests most affected by the microwaves. In the monitoring (more exhaustive) of the monuments near to cellsite antennae, dead young were observed (Fig. 1 and Table 2). Also, several couples (adults) never built the nest. The results of productivity of this study are generally less than those obtained in previous studies, especially for the nests located within 200 meters of the cellsite antennae (Table 3).

Keeping in mind these results, the microwaves could be affecting one or several reproductive stages: the construction of the nest, the number of eggs, the embryonic development, the hatching or to the mortality of chicks and young in their first stages.

Other authors have obtained similar results in studies with birds carried out in laboratories (Farrel *et al*., 1997; Youbicier - Simo *et al*., 1998; Grigoriew, 2003). Our observations indicate that the most affected nests would be those that are within 200 meters of the cellsite antennae (exposed to the incident beams of one or several antennae focused directly).

A Greek study (Magras & Xenos, 1997) relates to a progressive drop in the number of births of rodents. The mice exposed to 0.168 μW/cm2 become sterile after five generations, while those exposed to 1.053 μW/cm2 became sterile after only three generations. The interaction seems to take place through the central nervous system more than on the reproductive gland directly. In the areas of breeding of white storks in this study intensity of electric field levels are overcome (Pers. Obs.).

Other studies find a decrease of fertility, increase of deaths after the birth in rats and dystrophyc changes in their reproductive organs (Nikolaevich *et al*., 2001). An increase in the mortality (Youbicier-Simo *et al*., 1999) and the appearance of morphological abnormalities, especially of the neural tube (Farrel *et al*., 1997) has been notified in chicken embryos exposed to pulsed magnetic fields, with different susceptibility among individuals probably for genetic reasons. A recent study shows a statistically significant high mortality of chicken embryos subjected to the radiation from a cellphone, compared to the control group (Grigoriew, 2003). These waves can be affecting the wild birds in the polluted areas in the same way (Balmori, 2003).

The radiofrequency electromagnetic contamination from antennae in cities is much higher than in the rural environment (Pers. Obs.). For this reason urban birds especially can suffer the effects of this radiation. One of the effects that can take place is reduction of the population (specially urban), in places with high electromagnetic contamination. The birds are specially sensitive to the magnetic fields (Liboff & Jenrow, 2000) For this reason they abandon the electromagnetic polluted areas (Balmori, 2003). It is probable that each species, even each individual, show different susceptibility to the radiation, since the susceptibility depends on the genetic bias (Fedrowitz *et al.*, 2004), and of the irradiated living organisms physiologic and neurological state (Hyland, 2001).

In the electromagnetic polluted areas (within an approximate radius of 300-500 meters of an antenna, in the direct emission of the main beam), a deterioration of the good habitat, for the permanency of the birds, takes place. That can cause the abandonment of the breeding areas, sleeping places etc. (Balmori, 2003). In far away areas, where the radiation decreases progressively, the chronic exposure can also have long term effects (Adey, 1996; Magras & Xenos, 1997). The effects from phone masts on the habitat of birds are difficult to quantify, but they can cause a serious deterioration, generating silent areas without male singers nor reproductive couples. The deterioration of the ecosystem can also take place from the impact of the radiation on the populations of invertebrate prey and on the plants (Balmori, 2003).

Microwaves have the potential to induce adverse reactions in the health of people (Hyland, 2000 and 2001, Santini *et al.*, 2002 and 2003; Navarro *et al.*, 2003) and on the fauna that lives in the vicinity of the antennae (Balmori, 2003). The freedom of movement of the birds and their habit of settling in the proximity and even on the cellsites makes them potentially susceptible to the effects. The small organisms (children, birds, small mammals, etc…) are specially vulnerable, so much to approach their size to the frequency of resonance, like for the smallest thickness from their skull that facilitates a higher penetration of the radiation in the brain (Magras & Xenos, 1997; Santini, 2000; Hyland, 2001; Maisch, 2003; Balmori, 2003).

When the experimental conditions (power density, frequency, duration, composition of the tissue irradiated etc.) change, their biological effects also change (Kemerov *et al.*, 1999; Dasdag *et al.*, 1999). Below the levels (0,1 $\mu W/cm.^2$) recommended in the Salzburg conference adverse effects on health have never notified. At the same time when going away to more than 300 meters distance from the antennas, most of the symptoms notified in people diminish or disappear (Santini, 2003).

Recently it has also been demonstrated that the microwaves used in cellphones produce a non thermal response in several types of neurons of the Nervous System in the birds (Beason & Semm, 2002) and they can affect the blood brain barrier like it has been observed in rats (Salford *et al*., 2003).

It is recommended to consider the electromagnetic contamination in the microwave range a risk factor in the decline of some populations, especially the urban birds, subjected to higher radiation levels.

We consider that the birds most affected from the microwave electromagnetic contamination could be: 1) The ones bound to urban environments with more sedentary customs. In general those that pass a lot of time in the vicinity of the base stations. 2) Those that live or breed in high places, more exposed to the radiations and at higher power density levels. 3) Those that breed on open structures where the radiation impacts directly on adults and chickens in the nest. 4) those that spend the night outside of holes or structures that attenuate the radiation.

Future investigation should be carried out with long term monitoring of the breeding succes, of the sleeping places and of the uses of the habitat for species more vulnerable to the waves for its behaviour. Of special interest should be the investigations that try to correlate the numeric evolution with the results of the radiofrequency electromagnetic field mensurements. Field studies investigating populations of urban parks and territories surrounding cellsites should be hight-priority.

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FIG. 1

Sketch with the situation of the building monuments that have been studied.It is also represented the nests or colonies of White Storks (with capital letters) and the phone masts (black triangles with numbers) nearers to the same ones. The vertexes of the triangles point out the approximate direction of main lobe (beam)

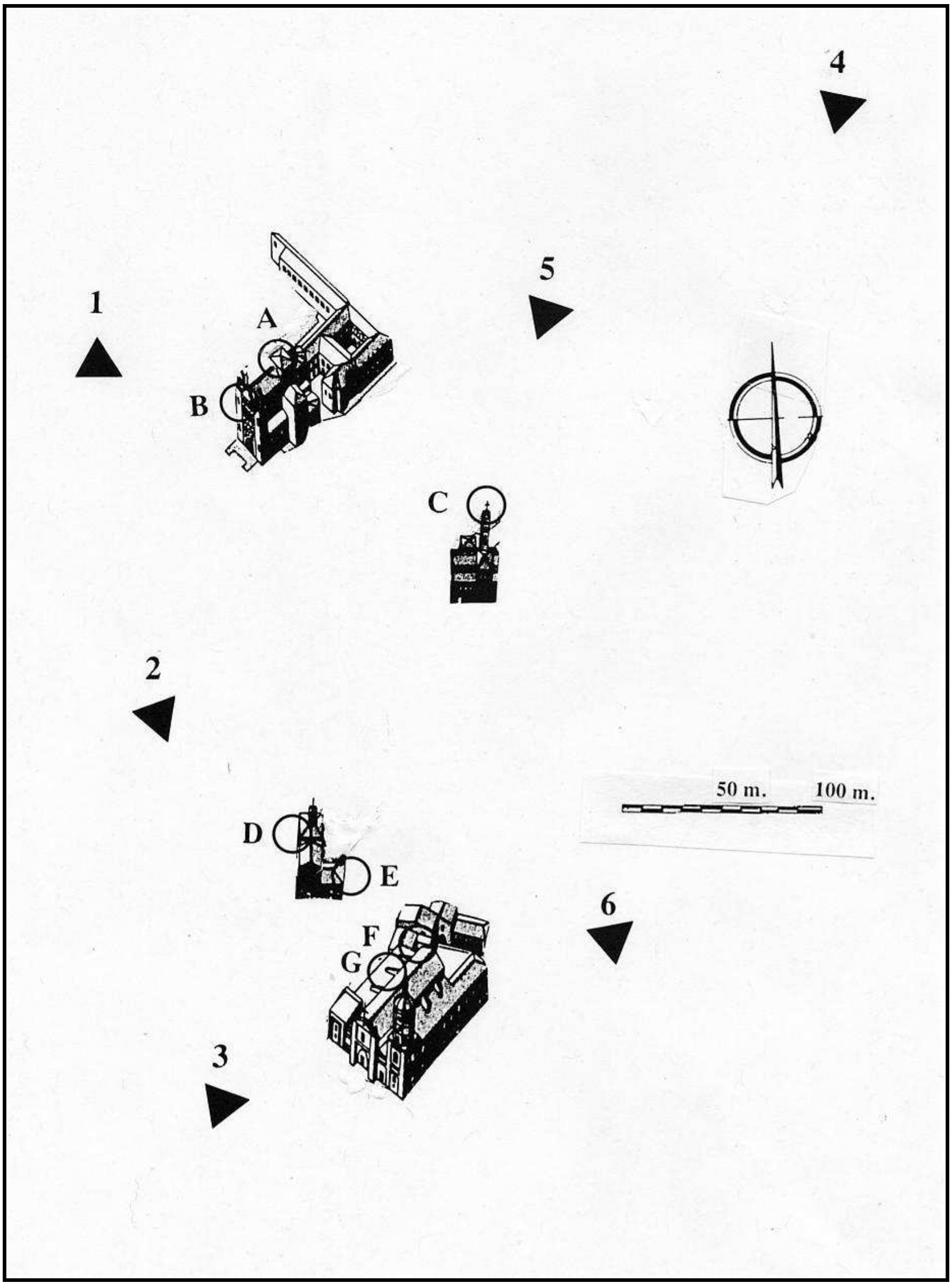

FIG.2

Comparison of the total productivity (breeding success or nº of chickens for nest) of white stork (Ciconia ciconia) in 30 nests located nearer than 200 meters and 30 located far away than 300 meters of the phone masts.

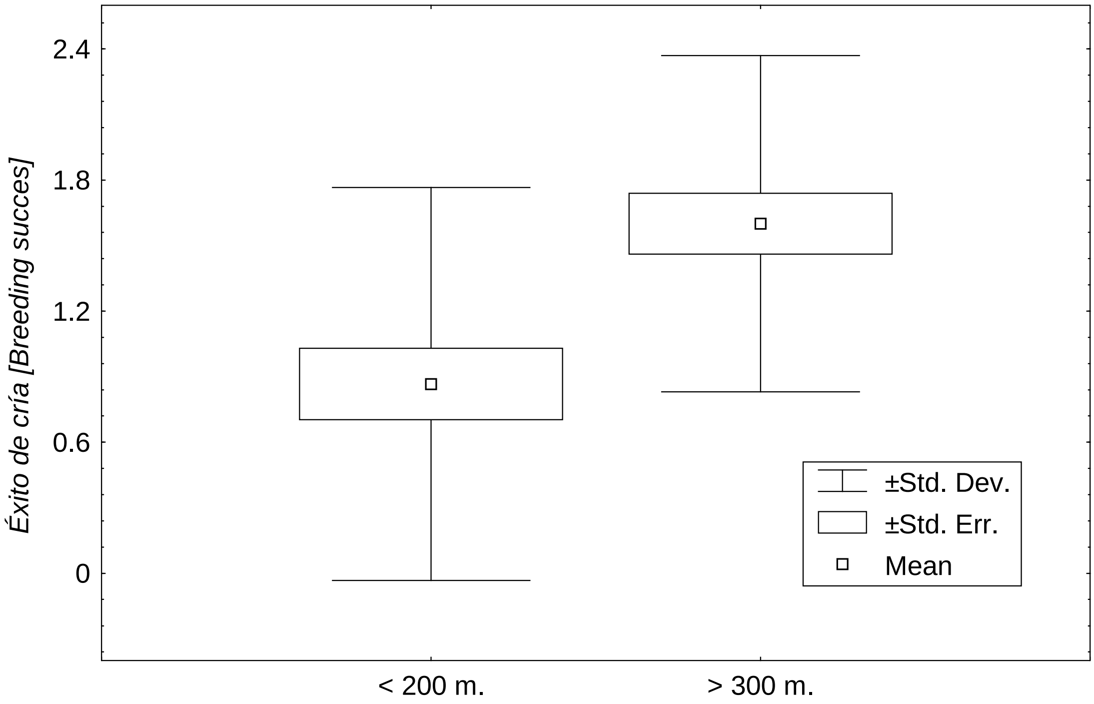

Table 1: Municipalities studied and number of white stork nests in each one

Distance to the more next phone masts

< 200 meters		> 300 meters	
Boecillo	7	Tordesillas	6
Laguna de Duero	1	Serrada	4
Pesquera de Duero	1	Villanueva de Duero	1
Villanubla	1	Viana de Cega	1
San Pablo (VA)	7	San Bernardo	1
San Martín (VA)	4	Esguevillas de Esgueva	1
Angustias (VA)	2	Villanueva de los Infantes	1
Catedral (VA)	7	Pozaldez	1
		Iscar	1
		Megeces	1
		Dueñas	2
		Cigales	1
		Mucientes	1
		Fuensaldaña	1
		Puenteduero	1
		Simancas	1
		Geria	1
		Villavieja del Cerro	1
		Mota del Marqués	1
		San Cebrián de Mazote	1
		Torrelobatón	1

TABLE 2.- *Results of monitoring of breeding white stork (Ciconia ciconia) at four building/ monuments in Valladolid. Spring of 2003. (See also Fig. 1)*

			FINISH NEST			
MONUMENT	**NEST**	**NOT FINISH NEST**	**COUPLES WITHOUT CHICKS**	**COUPLES WITH CHICKS**	**NUMBER OF CHICKS**	**PHONE MASTS NEAR**
SAN PABLO	A	0	4	3	1, 3, 1, 0, 0, 0, 0	1,2,4,5
	B	3	0	0	_	1,2,4,5
SAN MARTÍN	C	0	4	0	0,0,0,0	1,2,4,5,6
ANGUSTIAS	D	0	0	1	2	2,3,6
	E	0	1	0	0	2,3,6
CATEDRAL	F	1	1	2	1,1,0	3,6
	G	1	1	3	1,1,1, 0	3,6
TOTAL		**5 (20%)**	**11 (44%)**	**9 (36%)**	**12 (0,6 chicks/nest)**	

TABLE 3.

Results of bibliographical revision

COUNTY	YEAR	NUMBER OF COUPLES	TOTAL PRODUCTIVITY	PARTIAL PRODUCTIVITY	NUMBER OF UNSUCCESSFUL COUPLES (%)	REFERENCES
Palencia	1984	110	1,51	2,26	24,5	Lázaro *et al*., 1986
Soria	1984	61	1,6	2	1,6	Lázaro *et al*., 1987
Segovia	1984	246	1,01	2,06	45,9	Lázaro *et al*., 1988
Ávila	1984	188	0,97	1,81	42	Lázaro *et al*., 1989
Burgos	1984	77	1,39	2,04	27,2	Lázaro *et al*., 1990
León	1984	397	1,44	1,99	23,9	Lázaro *et al*., 1991
Salamanca	1984	591	1,68	2,03	11,1	Lázaro *et al*., 1992
Zamora	1984	260	0,96	2,14	16,5	Lázaro *et al*., 1993
Ávila (Valle del Tietar)	1985	78	2,69	3,04	8,97	Muñoz *et al*. 1988
Ávila (Valle del Tietar)	1986	71	2,17	2,62	14,08	Muñoz *et al.* 1988
Ávila	1986	151	2,22		18,5	Hernández, 1987
Zamora	1986	201		2,32		Ocellum durii, 1986
Ávila	1989	150	1,77	2,46		Hernández, 1989
León	1990	509	2,56	2,75	6	Urz, 1990
Palencia	1991	205	1,85	2,5		Gepopn, 1991
SPAIN	1984	6753	1,39	2,12	16,6	Lázaro *et al*., 1986
SPAIN	1994	16643	1,6	2,5	7,9	Martí *et al.*, 1999
Valladolid (provincial)	1984	113	1,69	2,13	7	Lázaro *et al*., 1986
Valladolid (provincial)	1992	115		1,93	5,2	Alauda, 1992
Valladolid (capital)	1994	24	1,84		7,6	Alauda, 1994
Valladolid (capital)	2001	35		2,43		García, 2001
VALLADOLID	2003 (<200 m.)	30	0,83	1,44	40	THIS STUDY
VALLADOLID	2003 (>300 m.)	30	1,6	1,65	3,3	THIS STUDY