

FEEDING IN URBAN REFUSE DUMPS: INGESTION OF PLASTIC OBJECTS BY THE WHITE STORK (*CICONIA CICONIA*)

ALIMENTACIÓN EN BASUREROS: LA INGESTIÓN DE OBJETOS DE PLÁSTICO
POR LA CIGÜEÑA BLANCA (*CICONIA CICONIA*)

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It is normally admitted that refuse dumps are predictable trophic resources that benefit a wide range of birds (Mendelssohn & Yom-Tov, 1999). In the Iberian Peninsula, this has been well documented in gulls (Donazar, 1992), herons (Sarasa *et al.*, 1993), raptors (Ceballos & Donazar, 1990) and storks (Gomez Tejedor & De Lope, 1993; Tortosa *et al.*, 2002). In fact, the increase in the breeding population of the White Stork (*Ciconia ciconia*) in Spain -rising from 6753 breeding pairs in 1984 (Lázaro *et al.*, 1986) to 16643 in 1994 (SEO/BirdLife, 1997)- has been attributed to the extended use of food provided by refuse dumps throughout the year (Martinez, 1995; Tortosa *et al.*, 1996), which helps to reduce mortality in first-year birds (Tortosa *et al.*, 2002). Feeding on dumps by White Storks would be also responsible of the new migration strategies of the species (Fernández-Cruz & Sarasa, 1998), which is currently wintering closer to breeding grounds or not migrating at all (Blanco, 1996; Medina *et al.*, 1998). In fact, the breeding and wintering distribution, as well as the migratory flyways, of the Iberian White Stork population could partly be explained in terms of the presence of refuse dumps across the Peninsula (Tortosa *et al.*, 2002). However, urban refuse contains not only suitable food for many bird species, but also certain non-profitable items such as plastic, wire, nylon, etc., which —if ingested— could be potentially dangerous to both adult birds (Moser & Lee, 1992; Garrido & Sarasa, 1999) and to nestlings (Ryan, 1988). The aim of the present work is thus to offer data about these «double-edged» feeding lots used by the White Stork.

A total of 94 stork gizzards were collected from birds found freshly dead in the field (32; 18 of them shot) or killed —electrocution or collision— by power lines (62 birds). The sample came from the Spanish provinces of Avila, Salamanca and Zamora (41° 30'–40° 50' N/ 6° 15'–5° 20' W), situated on the west-central northern plateau. The region lies between 800–1000 m.a.s.l. and its landscape is devoted mostly to cereal croplands, open grasslands, and wooded pasturelands, the latter mainly populated by Holm-oaks (*Quercus ilex*). At sampling time, the area had an extensive supply of refuse dumps that are being used by the storks around the year. All the birds collected from power lines were found no more than 15 km away from a human settlement. Birds were found throughout the year, although 83 (82.3%) were collected from April to July, when breeding and migration occurs. As early as possible after collection, the bird carcasses were administered an oesophageal injection of 1 cc of 10% formalin to arrest post-mortem digestion. The sex and age of each individual were determined at the laboratory. Oesophagus and gizzards were removed and their contents examined after placing them in a solution of 50% ETOH. The contents were divided into four categories: plastic, organic garbage (chicken, pork, spaghetti, etc.), plant/animal food and the grit content. Afterwards, the volume of each ingested item was dried on filter paper and placed in a suitable graduate test tube filled with alcohol. The difference between the levels of alcohol before and after placing the item in it was found. Although this method of measuring does not en-

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sure a perfect accuracy of readings, the results obtained provide sufficient information about the volume proportions between the food categories. The colour of the plastic ingested was not recorded because some colours can be diluted by stomach acid. All dead birds were obtained between 1994 and 2000 and were pooled together for stomach analysis.

Examination of the gizzards of 94 adult and independent juvenile storks yielded 77 usable samples, whose distribution is shown in table 1. All birds killed by power lines had apparently been in good condition and were therefore used, whereas only 15 of the other birds found dead provided suitable samples. Examination of all stomachs revealed that 63% of the juvenile birds had plastic material as compared with only 35.4% in adults, these differences being statistically significant ($X^2 = 4.59$, $df = 39$, $P = 0.64$). However, there were no statistically significant differences in the amounts of garbage consumed between adult and juvenile birds ($X^2 = 2.52$, $P = 0.11$), in plant/animal food ($X^2 = 0.21$, $P = 0.64$) and in grit ($X^2 = 1.16$, $P = 0.28$).

However, a highly statistically significant association was observed between the percentages of plastic and garbage taken as food between adults and juvenile birds ($X^2 = 14.97$, $P < 0.01$, with Yates' Correction), plastic objects being much more ingested by juveniles than by adult birds, which seemed to select mainly organic food from the dumps.

More plastic objects were found in the stomach of birds killed by power lines than on those sampled elsewhere, and these differences are statistically significant ($X^2 = 4.75$, $P < 0.05$, with Yates' Correction). However, no statistically significant differences ($X^2 = 1.31$, n.s.) were observed in plastic intake, between females ($n = 36$) and males storks ($n = 41$). Of all the plastic items observed, 61% had sharp or pointed edges and 14% had penetrated the stomach muscle.

The White Stork is an opportunistic species that feeds on whatever is available; although its natural diet is entirely animal (Del Hoyo *et al.*, 1992). Post-mortem digestion in the samples studied here may be responsible for the loss of certain soft items such as invertebrates, but fails to eliminate plastic objects and other hard items. The data on stork diets obtained by pellet analysis during the seventies in the same study region (Melendro *et al.*, 1977) did not point to the ingestion of plastic or garbage, even though the pellet method does satisfactorily assesses the intake of plastic. However, current studies have shown that as from the mid 1980s open rubbish dumps are used by the species as a source of food (Tortosa *et al.*, 2002) and from that time onwards a mixture of natural food and garbage has been incorporated into their diet (Martínez, 1995), although to date, no data on non-food items ingested are available. In our study area, organic garbage made up 68.8% of the food items in both sexes and in

TABLE 1

Occurrence of items categorized from the stomachs of 77 adult and first-year White Storks (*Ciconia ciconia*) from west-central Spain. Numbers are total birds observed with each item. Frequencies in volume (cubic centimetre) of the observed consumed categories are in parentheses.

[Categorías de alimentos encontradas en los estómagos de 77 cigüeñas blancas (*Ciconia ciconia*) adultas y del primer año calendario de edad, procedentes del centro-oeste español. Los números representan las aves que han consumido cada categoría. Entre paréntesis se da la frecuencia en volumen (centímetro cúbico) de los elementos observados en el total de las aves.]

Item [Elemento]	Adult birds [Aves adultas] $n = 31$	Juvenile birds [Aves juveniles] $n = 46$
Plastic [Plástico]	11 (14.0%)	29 (41.0%)
Garbage [Basura]	25 (65.0%)	28 (47.0%)
Plant / Animal food [Alimento vegetal/animal]	18 (20.7%)	23 (11.4%)
Grit [Guijarros]	28 (0.3%)	36 (0.6%)

both age classes; indeed, this is now a common food of the White Stork during the breeding season. This increased intake of refuse material could be responsible for the ingestion of plastic and other debris materials, which are abundant at dumps. Perhaps owing to attraction through its colour and/or for its use as grit, the intake of plastic reduces the body conditions and chance of survival of other bird species such as seabirds (Ryan, 1987) and terrestrial birds—especially pre-adult specimens—due to gizzard impaction and stomach lesions (Reissig & Robles, 2001). In storks, and according to ringing recoveries, the mortality rate among individuals younger than 4 years old in western Spain is 40% (Chozas, 1985), although currently this rate could be higher in storks that feed at dumps. Also, some juveniles and adult birds have been observed with wires or plastic snares entangled on their tarsi (Ortega, 1997), although no quantitative data on mortality due to this cause are available. Finally, birds with plastic items in their stomach—in our case, mostly juvenile storks—show lethargy and are less sensitive to orientation (Reissig & Robles, 2001) and could thus be more prone to accidents involving power lines.

The general success of the Stork as a breeding species in Spain argues in favour of refuse dumps as foraging sites, as occurs in other bird species and countries (Kilpi & Ost, 1998; Rodríguez-Estrella & Rodríguez, 1997). Refuse offers an unlimited food supply to the increasing numbers of wintering birds (Tortosa *et al.*, 1995a; Blanco, 1996) and helps to reduce the mortality rate of juveniles (Tortosa *et al.*, 1995b). In fact, up to 10,000 birds have been counted during migration at dumps in southern Spain (Fernández-Cruz & Sarasa, 1998) and 80% of the wintering birds are observed close to them (Tortosa *et al.*, 2002). The latter authors also reported that up to 75% of Stork nests in southern Spain are located close to open rubbish dumps, with a higher breeding success than birds breeding 25 km away from the dumps. Janns & Sánchez (1997) observed a higher number of chicks per nest in the Spanish countryside than in densely populated areas. These authors did not explain the differences in nestling productivity, but since most dumps in southern Spain are outside suburban areas (Tortosa *et al.*, 2002), food intake from rubbish dumps could explain the high survival rate ob-

served. In any case, certain dietary items obtained from such dumps have null or poor energy content for birds (Ryan & Jackson, 1987), especially in sensitive periods such as the breeding and post-breeding season—when flocks larger than 130 individuals have been observed at refuse dumps in the study area—while other items—if consumed—are very dangerous for the birds.

According to our data, refuse dumps provide a staple food for storks throughout the year, but expose some birds, especially the juveniles, to the potential consumption of plastics and other potentially dangerous materials. Due to the healthy and increasing Spanish White Stork population—to a certain extent a direct consequence of the presence of refuse dumps—the potential juvenile mortality due to the ingestion of plastic is density-dependent (Newton, 1998) and—currently—may not necessarily affect the bird populations. In any case, since new systems of garbage treatment are currently being planned—including compaction and removal of the waste—throughout Spain (Contreras, 2001) it would be wise, when such new treatments have been implemented, to test whether plastics or other dangerous items will be more available to the birds in the future.

RESUMEN.—*Se muestreó el consumo de plásticos por la Cigüeña Blanca en comparación con otras categorías de alimento en individuos accidentados o encontrados muertos en el centro-occidente de España. Las cigüeñas jóvenes consumen más plástico que las adultas y aquellas accidentadas en postes eléctricos tienen mayor proporción de plástico en sus estómagos. Un 14% de las aves que habían ingerido plástico, tenían heridas estomacales. Es posible, que el consumo de plásticos en los basureros favorezca una mayor mortalidad—directa y por accidentalidad—entre la aves jóvenes. La futura gestión de residuos sólidos urbanos debería prever este riesgo, tanto para la Cigüeña como para otras especies animales susceptibles de ingerir productos letales.*

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