C 6

The Condor 95:739–741

FOOD HABITS OF THE SCARLET AND WHITE IBIS IN THE ORINOCO PLAINS[1]

EDUARDO AGUILERA, CRISTINA RAMO AND BENJAMIN BUSTO
Estación Biológica de Doñana, C.S.I.C., Apartado 1056, 41080 Sevilla, Spain

Key words: Scarlet Ibis; White Ibis; Eudocimus; *diet; Venezuelan Llanos.*

The Scarlet Ibis is neotropical and distributed from the northeastern coast of South America from Colombia to Brazil and the Orinoco Llanos. The White Ibis occurs from the coastal plain of southern North America, through Central America, into Venezuela (Hancock et al. 1992).

Because of frequent hybridization between the two ibises in the area of overlap, Ramo and Busto (1982) proposed that the Scarlet and White Ibis be considered a single species composed of two subspecies, *E. ruber ruber* and *E. r. albus* respectively. Posterior studies of breeding behavior (Ramo and Busto 1985) and foraging behavior and feeding habitat (Frederick and Bildstein 1992) revealed no differences between these two ibises in their area of sympatry.

In the Llanos, both forms coexist but the Scarlet Ibis is much more abundant, accounting for more than 90% of the whole population (Ramo and Busto 1987, Aguilera 1988).

Although the diet of the White Ibis is well documented for North America (Nesbitt et al. 1974, Kushlan 1979, Kushlan and Kushlan 1975, Bildstein et al. 1990), the diet of Scarlet Ibises is poorly known, existing only as qualitative data from coastal populations in Surinam and Trinidad (Ffrench and Haverschmidt 1970), and inland populations in Venezuela (Kushlan et al. 1985, Van Wieringen and Brower 1990, Frederick and Bildstein 1992).

The purpose of this paper is to provide quantitative data on food habits of both ibises in the Llanos of Venezuela, and compare the diets of the Scarlet and the White forms in their area of overlap.

METHODS

We analyzed the stomach contents of 59 birds collected from 1979 to 1982 in the Hato El Frío (7°35′N, 68°50′W) and nearby cattle ranches located in the southwestern Llanos in Apure State (Venezuela). The study area is a tropical wet savanna with a highly seasonal distribution of rainfall, 90% of which fall between May and October. A detailed description of the vegetation can be found in Ramia (1967) and Castroviejo and López (1985).

Stomachs were washed into a Petri dish, and food items were sorted using a binocular microscope and identified in as much detail as possible. Wet mass of prey items was calculated from regression equations based on body length of specimens captured in the area, or from those given in Zug and Zug (1979). To study seasonal variation in diet, we divided the year into two periods: a dry season, from November to April, and a wet season from May to October.

We separately analyzed the stomach contents of White ($n = 9$) and Scarlet Ibis ($n = 50$) to examine differences in the diet of these forms. Comparisons were made using the chi-square test, after grouping prey categories of lower representations in the diet. We also applied an analysis of variance (ANOVA) (General Linear Model, SAS) to the arcsine of the square root of the proportion of the main prey categories in each stomach, to examine how much of the variation in the diet was explained by differences among individuals rather than between forms.

RESULTS

Scarlet Ibises show little seasonal variation in the diet (Table 1). Most of the prey in both seasons were insects, mainly Coleoptera. Two terrestrial families, Scarabaeidae and Carabidae, predominated over aquatic forms. The predominance of terrestrial forms was even more acute during the wet season, when *Dyscinetus dubius* (Scarabaeidae, subfamily Dynastinae), an approximately 29 mm long beetle, accounted for most of prey eaten by Scarlet Ibises. In fact, some of the stomachs contain this prey exclusively. Stomachs in which more than 80% of the prey items were *D. dubius* were one of a total of seven in March, seven of nine in April, four of five in May and one of five in June. The predominance of this species coincides with the beginning of the rains (April, May). In this period, it was common to observe great numbers of this beetle attracted by lights at night. Heteroptera, mainly giant water bugs (Belostomatidae), were the next most common prey during the dry season, although their importance in terms of relative prey abundance remained much less than that of Coleoptera. Diptera were the third most common prey. Calliphoridae larvae accounted for more than 10% of prey items during the dry season, however all of them came from only one Scarlet Ibis which was collected while it was feeding on a large pile of capybara (*Hydrochaeris hydrochaeris*) carcasses. Other invertebrates included in the diet were spiders, crabs (*Dilocarcinus dentatus*), water snails and bivalves. Among vertebrates, fishes especially the freshwater eel (*Synbranchus marmoratus*) were the most important group.

As a whole, the diet of the White Ibis (Table 1) differed significantly from that of the Scarlet Ibis ($\chi^2 =$

[1] Received 29 December 1992. Accepted 29 March 1993.

TABLE 1. Food of the Scarlet and White Ibis in the Venezuelan Llanos. (% N = percent of prey number; % M = percent of prey mass; % F = percent occurrence by stomachs).

	Scarlet Ibis									White Ibis		
	Dry season			Wet season			Total			Total		
Prey type	% N	% M	% F	% N	% M	% F	% N	% M	% F	% N	% M	% F
Coleoptera	76	75	97	82	81	92	77	76	96	48	52	100
Adults:	75	73	97	81	81	92	76	75	96	48	48	100
Scarabaeidae	28	52	—	76	74	—	39	60	—	14	19	—
Carabidae	27	7	—	1	5	—	21	7	—	3	5	—
Hydrophilidae	12	9	—	1	T*	—	10	6	—	26	20	—
Others	9	6	—	4	1	—	9	3	—	5	4	—
Larvae	1	2	16	1	1	8	1	2	12	1	3	11
Heteroptera	4	2	53	1	T*	25	4	2	46	18	11	67
Odonata (Larvae)	2	1	24	9	4	50	3	2	28	4	1	44
Ephemeroptera	—	—	—	—	—	—	—	—	—	13	4	22
Diptera (Larvae)	13	5	3	1	T*	17	10	4	6	4	T*	11
Orthoptera	1	2	11	1	1	17	1	1	12	—	—	—
Dermaptera	T*	T*	5	—	—	—	T*	T*	4	—	—	—
Unidentified insect larvae	T*	T*	3	—	—	—	T*	T*	2	—	—	—
Aracnea	T*	T*	11	—	—	—	T*	T*	8	T*	T*	11
Miriapoda	T*	2	3	—	—	—	T*	1	2	—	—	—
Crustacea (Crabs)	1	1	24	2	2	67	1	2	34	3	4	22
Gastropoda	1	3	29	4	5	8	2	4	24	T*	1	11
Bivalva	T*	T*	3	T*	T*	8	T*	T*	2	—	—	—
Oligocheta	—	—	—	—	—	—	—	—	—	T*	1	11
Pisces	1	4	29	T*	3	8	1	4	24	7	9	56
Anura	T*	4	11	T*	4	17	T*	4	12	1	16	22
Sauria (Teiidae)	T*	1	3	—	—	—	T*	1	2	—	—	—
Ophidia	T*	1	3	—	—	—	T*	1	2	—	—	—
Total	1,543	367	38	425	172	12	1,968	539	50	182	55	9

* T: values less than 1.

200.1, df = 5, $P < 0.01$). The main prey consumed by the White Ibises was, as in the case of the Scarlet Ibis, adult coleopteran, however the diet of White Ibises included a greater proportion of Heteroptera, Crustacea and fishes than that of Scarlet Ibises. It also included Ephemeroptera, a taxon not present in the food of Scarlet Ibises. Most of the difference was apparently due to when the stomachs were collected. As above mentioned, coleopteran, especially *D. dubius,* were the exclusive or nearly exclusive component of the Scarlet Ibis diet during April and May. While we examined 14 stomach contents (28%, $n = 50$) of the Scarlet Ibis from those two months, we only analyzed one stomach (11%, $n = 9$) of the White Ibis in the same period. When we applied ANOVA to examine how much of the variation in the proportion of the main prey categories was due to differences among individuals, and how much due to the differences between forms, we found no significant differences in any of the prey categories considered (Coleoptera: $F = 2.95$, df = 1,43, $P > 0.05$; Heteroptera: $F = 1.15$, df = 1,43, $P > 0.05$; Odonata: $F = 0.27$, df = 1,43, $P > 0.05$; Pisces: $F = 2.37$, df = 1,43, $P > 0.05$). Differences between ibis forms only accounted for 12.9% of the variance in the case of Coleoptera, 1.1% in Heteroptera, 5.2% in Odonata and 9.4% in Pisces.

DISCUSSION

Insects were the most frequently consumed prey of both Scarlet and White Ibises in the Llanos. This coincides with qualitative information given in two previous studies (Kushlan et al. 1985, Van Wieringen and Brower 1990). By contrast, on the coast of Surinam, the Scarlet Ibis mainly feeds on small crabs and molluscs, and in Trinidad the principal prey are fiddler crabs (Ffrench and Haverschmidt 1970). In North America, crustaceans, mostly crayfish (*Procambarus* spp.), are the main prey of White Ibis, followed by aquatic insects and fishes. When ibises feed in saltwater habitats, they eat a greater proportion of fishes than when they feed on freshwater habitats and also include a considerable number of fiddler crabs (*Uca* spp.), a prey not present in freshwater (Nesbitt et al. 1974, Kushlan and Kushlan 1975, Bildstein et al. 1990).

In the Llanos, the high variation in the food items among individuals reflects opportunistic feeding habits. Nevertheless the high percentage of stomachs containing coleopterans (more than 95% in each season), most of them terrestrial, shows a certain degree of specialization in this taxon.

The geographical variations in the diet of the ibises probably result from a combination of preference by highly clumped small to medium size prey (Kushlan 1979), and local differences in the availability of these prey. In the Everglades, when there are high fish concentrations, ibises shift from crayfish to fishes (Kushlan 1979). In South Carolina, in drought years, crayfish burrow into the substrate and White Ibises turn to alternative sources of food such as fishes, fiddler crabs or insects (Bildstein et al. 1990). In the Llanos, we have also observed that when there are extremely high concentrations of a prey type, such as *Dyscinetus* beetles or fly larvae, ibises feed nearly exclusively on this prey, otherwise they eat a wider range of prey.

Geographical differences in diet provide a viable explanation for differences in breeding phenology throughout the range of this genus. In North America, breeding is restricted to the spring dry season, because drying of surface waters is necessary to creating the concentrated prey that ibises need to breed (Bildstein et al. 1990). In the Llanos, breeding occurs in summer rainy season (Ramo and Busto, in press), which provides an explosion of insect prey exploited by the breeding ibises.

Frederick and Bildstein (1992) did not find any substantial difference in foraging habitats or foraging behavior between Scarlet and White Ibises in the Llanos during dry season. However, we found a significant difference in the food composition between these forms. Although we have no conclusive data, the results of the ANOVA suggest that these differences are more attributable to variation among individuals than between forms.

We thank J. Ayarzagüena, E. Herrera, P. Jodra, R. Roca, A. Thomas, M. N. de Visscher, and the staff of the Biological Station of El Frío, for their assistance during the field work. S. Reid kindly identified the fishes and M. Baez and J. Gélvez the insects. K. L. Bildstein and P. C. Frederick made valuable suggestions that improve the manuscript very much. The Ministerio del Ambiente y los Recursos Naturales Renovables of Venezuela provided the permission to collect the ibises. Financial and logistic support were provided by C. A. INVEGA and UNELLEZ. We are especially grateful to J. Castroviejo for his encouragement during the study. E. Aguilera was funded by a grant from the Spanish M. A. E.

LITERATURE CITED

AGUILERA, E. 1988. La comunidad de íbises (Threskiornithidae) en los Llanos de Venezuela. Mem. Soc. Cienc. Nat. La Salle 130:59–75.

BILDSTEIN, K. L., W. POST, J. JOHNSTON, AND P. FREDERICK. 1990. Freshwater wetlands, rainfall, and the breeding ecology of White Ibises in Coastal South Carolina. Wilson Bull. 102:84–98.

CASTROVIEJO, S., AND G. LÓPEZ. 1985. Estudio y descripción de las comunidades vegetales del Hato El Frío, en los Llanos de Venezuela. Mem. Soc. Cienc. Nat. La Salle 124:79–151.

FFRENCH, R. P., AND F. HAVERSCHMIDT. 1970. The Scarlet Ibis in Surinam and Trinidad. Living Bird 9:147–165.

FREDERICK, P. C., AND K. L. BILDSTEIN. 1992. Foraging ecology of seven species of Neotropical ibises (Threskiornithidae) during the dry season in the Llanos of Venezuela. Wilson Bull. 104:1–21.

HANCOCK, J. A., J. A. KUSHLAN, AND M. P. KAHL. 1992. Storks, ibises and spoonbills of the world. Academic Press, London.

KUSHLAN, J. A. 1979. Feeding ecology and prey selection in the White Ibis. Condor 81:376–389.

KUSHLAN, J. A., AND M. S. KUSHLAN. 1975. Food of the White Ibis in southern Florida. Fla. Field Nat. 3:31–38.

KUSHLAN, J. A., G. MORALES, AND P. C. FROHRING. 1985. Foraging niche relations of wading birds in tropical wet savannas, p. 663–682. *In* P. A. Buckley, M. S. Foster, E. S. Morton, R. S. Ridgely, and F. G. Buckley [eds.], Neotropical ornithology. Ornithological Monographs, No. 36.

NESBITT, S. A., W. M. HETRICK, AND L. E. WILLIAMS, JR. 1974. Foods of White Ibis from seven collection sites in Florida. Proc. S. E. Assoc. Game and Fish Commission 28:517–532.

RAMIA, M. 1967. Tipos de sabanas en los Llanos de Venezuela. Boletín de la Sociedad Venezolana de Ciencias Naturales 27:264–288.

RAMO, C., AND B. BUSTO. 1982. Son *Eudocimus ruber* y *E. albus* distintas especies? Doñana Acta Vertebrata 9:404–408.

RAMO, C., AND B. BUSTO. 1985. Comportamiento reproductivo del Corocoro Rojo (*Eudocimus ruber*) en los Llanos de Venezuela. Mem. Soc. Cienc. Nat. La Salle 123:77–113.

RAMO, C., AND B. BUSTO. 1987. Hybridization between the Scarlet Ibis (*Eudocimus ruber*) and the White Ibis (*Eudocimus albus*) in Venezuela. Colon. Waterbirds 10:111–114.

RAMO, C., AND B. BUSTO. 1988. Status of the nesting population of the Scarlet Ibis (*Eudocimus ruber*) in the Venezuelan Llanos. Colon. Waterbirds 11: 311–314.

RAMO, C., AND B. BUSTO. In press. Colonias de nidificación de aves acuáticas en los Llanos occidentales. Mem. Soc. Cienc. Nat. La Salle.

VAN WIERINGEN, M., AND K. BROWER. 1990. Morphology and ecology of Scarlet (*Eudocimus ruber*) and White Ibis (*E. albus*): a comparative review, p. 7–15. *In* P. C. Frederick, L. G. Morales, A. L. Spaans and C. S. Luthin [eds.], The Scarlet Ibis (*Eudocimus ruber*): Status, conservation and recent research. IWRB Special Publications No. 11, Slimbridge, United Kingdom.

ZUG, G., AND P. B. ZUG. 1979. The marine toad, *Bufo marinus*: a natural history resumé of native populations. Smithson. Contrib. Zool. No. 284:1–58.