

plement to the check-list of the birds of the West Indies (1956), Acad. Nat. Sci., Phila., 1973). In contrast to Puerto Rico and the Virgin Islands only a single West Indian genus has undergone a range expansion in recent times anywhere in the Lesser Antilles. That is the case of *Eulampis*, another hummingbird, which has been found in Grenada and Barbados (Bond, Eleventh supplement to the check-list of the birds of the West Indies (1956), Acad. Nat. Sci., Phila., 1966). The expansion of *L. noctis* into the Puerto Rico-Virgin Islands region strengthens the hypothesis suggested by Robertson (1962) that the species arriving there may be part of a contingent that moved through the Lesser Antilles more or less at the same time. Certainly the 3 endemic West Indian genera extending their ranges through the Virgin Islands to Puerto Rico as compared to the 1 for all of the Lesser Antillean islands combined suggests an unusual circumstance that needs an explanation, particularly with respect to the source area and time of initiation of such a dispersal.

Loxigilla noctis is surviving well on St. John and habitat similar to that which the species inhabits there abounds on other nearby islands. We might therefore expect the dispersal of *L. noctis* through the Virgin Islands to Puerto Rico where it may compete with its congener *L. portoricensis*. Should the ranges of *L. noctis* and *L. portoricensis* come to overlap, the interaction of the species should be carefully observed as this might shed light on the extinction of *L. p. grandis* on St. Kitts which at one time coexisted with *L. noctis* there.

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Foraging behavior of the White Ibis.—The foraging behavior of many ciconiiforms is fairly well known. There is a particularly extensive literature on herons (Kushlan, Auk 93:86–94, 1976) and storks (Kahl, Behaviour 27:76–106, 1966; J. Ornithol. 112: 21–35, 1971; Ibis 114:15–29, 1972; Condor 75:17–27, 1973). However, little is known about the feeding behavior of ibises. Most accounts note merely that they probe in the water or on land. Bent (U.S. Natl. Mus. Bull. 135, 1926) reported Audubon's claim that the American White Ibis (*Euducimus albus*) can force crayfish from burrows by placing mud in them, and Vestjens (Emu 73:21–22, 1973) reported that the Australian White Ibis (*Threskiornis molucca*) breaks mussels on stones. The purpose of this paper is to document the various behaviors used by the American White Ibis and to note some of the circumstances in which they are used. I hope that this will provide a foundation for future study of this generally neglected group. Observations reported here were made both in the field and under various experimental conditions on captive birds.

The White Ibis is primarily a non-visual, tactile forager, and most techniques involve placing the partially opened bill in the water or bottom sediment and closing the tip on encountered prey. Ibises often swallow items by thrusting the head downward. Prey can also be worked upwards to the gullet by closing the bill tip since there is a gap between the mandibles midway up the bill when the tips are closed. This may permit backward propulsion of a food item when the bill tips are brought together. The gap between

the ibis' bill is similar but not as extensive as that of the Limpkin (*Aramus guarana*) (Snyder and Snyder, Living Bird 8:117-223, 1969) or the 2 openbill storks (*Anastomus* spp.) (Kahl, J. Ornithol. 112:21-35, 1971). Although it has been hypothesized that this feature is an adaptation for mollusc predation in other birds, particularly catching and extracting snails, the ibis does not extract snails. It is possible that the primary function of the bill gap in all 4 species is to effect a tweezer-like apposition of the bill tips for better grasping of prey as has also been suggested by Wetmore (Howell, Florida Bird Life, Coward-McCann, N. Y., 1932).

The *probe* is the most characteristic and most commonly used feeding behavior. Several types of probing can be distinguished by the depth and rapidity of the stab and the extent of accompanying locomotion. *Shallow probing* is directed to the top or less than 2 cm into the sediment. It may consist of multiple tactile nibbles at the sediment or ground surface. *Deep probing* is the insertion of the slightly open mandible deep into the sediment, under plant roots, or under rocks. A deep probe may consist of multiple exploratory thrusts in the same hole. Several types of movement accompany probing. In *stationary probing*, ibises remain in one place. In *step-probing*, ibises generally alternate a single shallow probe with 2 or more steps. In *multi-probing*, ibises take several steps followed by several shallow or deep probes. Obviously intermediate behavior occurs.

Other feeding behaviors are used less frequently. *Pecking* is the picking up of sighted objects without inserting the bill into the substrate. This is usually used on land. In water, even when prey items are visible, ibises generally use vision only to choose a particular area and then probe non-visually to locate prey. This was demonstrated repeatedly by captive birds in a 10 cm deep pool. *Groping* is holding a widely gaping bill in the water while moving the tip along the bottom. This is similar to the behavior of Wood Storks (*Mycteria americana*). *Head swinging* is moving the partially submerged and gaping bill from side to side in the water. At the termination of each swing, the ibis' bill and head face to one side, with the plane of the dorsal surface of the bill perpendicular to the water. This behavior is similar to that used by spoonbills (*Platalea* spp.) except that spoonbills swing their head and neck from side to side while the dorsal surface of the bill remains at an angle of about 45° to the surface of the water. I have also seen head swinging in the Scarlet Ibis (*Eudocimus ruber*) and Glossy Ibis (*Plegadis falcinellus*), suggesting the behavior is widespread in ibises. Since spoonbills also probe, it is probable that both probing and head swinging are homologous behaviors in the 2 sub-families and each group typifies a line of adaptation leading to the perfection of one of the feeding techniques.

Although White Ibis foraging behavior is labile and almost any technique may be used in any situation, certain behavior patterns are characteristic of particular habitat conditions. The more usual behavior sequences observed under particular foraging circumstances are shown in Fig. 1. Birds feeding with flocks in shallow open marshes are generally restricted to probing-while-walking behaviors (Fig. 1a). Often the entire flock moves as a loose unit through a feeding location. When movement is fast, as in a tight flock or on land (Fig. 1b), probing is generally shallow. Stationary multi-probing is used especially along the roots of plants (Fig. 1c) and around and under other objects in the water. Deep probing is characteristic of feeding in locations with soft, drying mud and little surface water (Fig. 1d). Birds feeding alone in deeper water (Fig. 1e, f) use a succession of techniques such as deep probing and groping. Figure 1g is a particularly varied sequence of a lone bird feeding in deep water and around a rock. Exploration around and under the rock occupied much of the birds' time. Head swinging was restricted to deep, open water (Fig. 1e, g) and was often performed after observing an

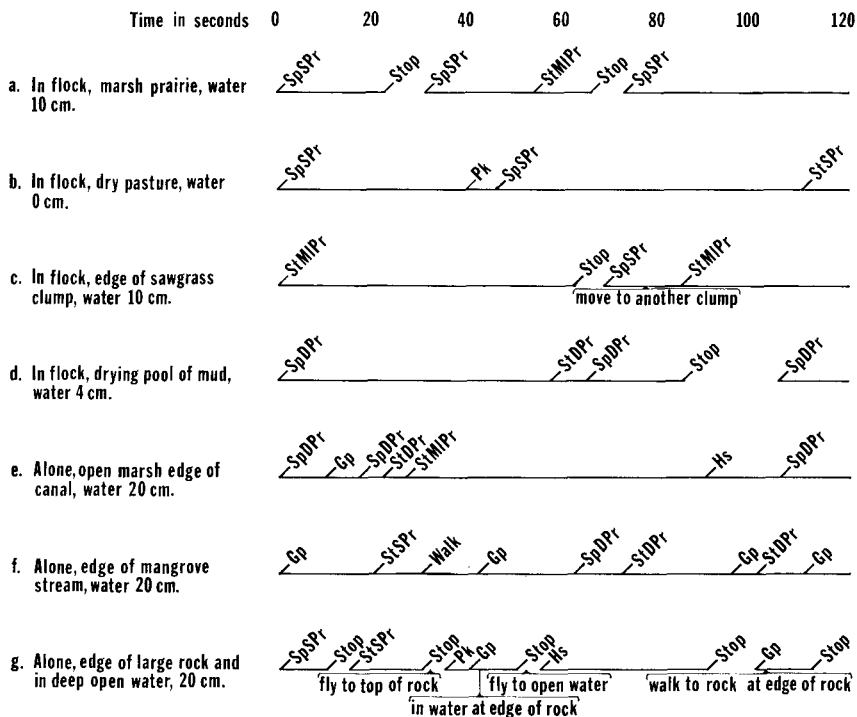


FIG. 1. Ethogram of feeding behavior of White Ibis in various circumstances. Abbreviations: Sp-SPr = step-shallow probing, St-SPr = stationary-shallow probing, Sp-DPr = step-deep probing, St-DPr = stationary-deep probing, St-MIPr = stationary-multiple deep probing, Pk = pecking, Gp = groping, Hs = head swinging.

other bird head swinging. In the sequence of Fig. 1g, the ibis flew to within 2 m of a foraging Roseate Spoonbill (*Ajaia ajaja*) before beginning to head swing.

These sequences illustrate the nature of ibis foraging behavior. Foraging is generally restricted simply to probing, groping for and picking up objects, usually without specific visual cues. Variability in behavior is primarily a matter of speed of movement and water depth. Yet within the narrow constraints imposed by morphology, a number of subtle behavioral variations are formed by combinations of probing and locomotor movements that can be used to explore various microhabitats for prey. Thus the feeding behavior of the White Ibis is characterized by use of relatively few primary techniques but a number of subtle variations that permit tactile foraging in any location shallow enough to allow walking or standing. The adaptable repertoire available suggests the White Ibis could obtain a wide variety of prey but specializes on those types easily caught by its non-visual techniques (Kushlan and Kushlan, *Florida Field Nat.* 3:31-38, 1975). Ibis feeding behavior, as presently understood, is less diverse than that of many herons and storks, lacking aerial components and making no special use of feet or wings. Future studies of the White Ibis and comparative work on other species may reveal additional

components and complexity.—JAMES A. KUSHLAN, *Dept. of Biology, Univ. of Miami, Coral Gables, FL* (Present address: *U.S. National Park Service, Everglades National Park, Homestead, FL 33030*). Accepted 14 Mar. 1976.

Birds of five families feeding from spider webs.—Burt et al. (Wilson Bull., 88: 157–158, 1976) observed a Cedar Waxwing (*Bombycilla cedrorum*) removing specks from 2 spider webs in the top of a dead tree. They suggested that the waxwing was removing insect prey that had become entangled in a possibly abandoned web. Since reports of web-feeding are scarce in the literature, Burt et al. (1976) suggested that opportunities for web-feeding might be rare. Because of their hovering abilities, hummingbirds appear to be pre-adapted for web-feeding, and, indeed, the only literature reports we have found come from the family Trochilidae (Wolf, Condor 72:1–14, 1970; Bent, U.S. Natl. Mus. Bull. 176:377, 1940; Bullock, 1825, in Bent, op. cit., 431). Therefore, we thought it important to report our observations on web-feeding in species of 5 avian families, and in 1 species to compare web-feeding with gathering of web material, possibly for use in a nest. The first 4 species mentioned were observed by R.B.W. in Mexico, the last by J.P.H. in Madison, Wisconsin.

On 26 March 1973, a nesting Fawn-breasted Hummingbird (*Amazilia yucatanensis*: Trochilidae) pecked repeatedly at a vertically-oriented spider web in an area of dry deciduous forest 16 km south of Xpujil, Campeche. The bird hovered in front of the web and darted forward several times, touching the web with its bill on each occasion. Whether or not the bird removed insects from the web could not be determined because of poor light. The bird did not appear to be grasping web materials, nor did it begin nest-building after it left the spider web.

On 16 March 1974, a Blue Bunting (*Cyanocompsa parellina*:Fringillidae) pecked at an orb-weaver (Family Araneidae) web located about 50 cm off the ground. The bird flew up from a perch 10 cm above the ground and hovered near the spider web. The bird pecked several times at the web and then returned to its perch near the ground. The bird repeated its actions 3 times, the third time directing its pecks toward a second web adjacent to the first. Whether the bird was taking insect prey or small spiders could not be determined. This sequence occurred about 200 m from the first observation.

In December 1974, at the Chicanna Archaeological Zone, 8 km west of Xpujil, Campeche, another Blue Bunting was observed dismantling a spider web about 3 m from the ground. The bird approached the web along a twig, grasped a strand of the web and pulled. In pulling, the bird assumed an upright posture with the long axis of the body perpendicular to the perch and the head held perpendicular to the body axis. The bird struggled with the web for 15 sec and finally broke off the strand and flew away. The action of web-gathering appeared substantially different from the pecking motions described above.

Another instance of web-feeding occurred at Chicanna on 17 July 1975 while a White-bellied Wren (*Uropsila leucogastra*:Troglodytidae) was foraging in a tree 4 m above the ground. The bird was moving rapidly from twig to twig, actively foraging by pecking at twigs and hawking insects. At one point, the bird pecked twice at a twig, turned, and delivered 2 pecks to a spider web, and then moved away. The web which the bird pecked appeared abandoned and had a large amount of vegetable or animal matter entangled in it.

A Yellow-green Vireo (*Vireo flavoviridis*:Vireonidae) also pecked at a spider web while foraging at Xpujil on 5 July 1974. The bird was foraging 10 m up in a 13-m tree at the edge of a clearing. The bird grasped a speck in a spider web with its bill, pulled force-