

#### THE SIGNIFICANCE OF PLUMAGE COLOUR IN THE FORMATION OF FEEDING AGGREGATIONS OF CICONIIFORMS

Although many species of birds form feeding flocks or aggregate at sites of prey abundance (Rand 1954), factors influencing the formation of such feeding groups have been little studied. Armstrong (1946, 1970) hypothesized that the white plumage of many seabirds functions as a signal because it is the most visible colour in marine environments. I have proposed extending Armstrong's suggestions to ciconiiform aggregations in freshwater marshes (Kushlan 1976a). There are two aspects to this problem: whether white is maximally visible, and whether white functions in local enhancement at feeding sites. The first aspect is difficult to study although observation from aeroplanes consistently confirms that white birds are more visible than dark (Kushlan 1976a). This paper reports a test of two elements of the second aspect: whether marsh-foraging ciconiiforms feed by local enhancement, and whether white plumage is more effective than dark in bringing about aggregations in marshes.

Feeding aggregations were studied in the freshwater marshes of the Everglades of southern Florida, U.S.A., where falling water levels during the dry season (December-May) concentrate fish and other aquatic prey in scattered pools of deeper water (Kushlan 1976a,b). Participating ciconiiforms were the American Wood Stork *Mycteria americana*, American White Ibis *Eudocimus albus*, Glossy Ibis *Plegadis falcinellus*, Roseate Spoonbill *Ajaia ajaja*, Great Blue Heron *Ardea herodias*, Great Egret *Casmerodius alba*, Snowy Egret *Egretta thula*, Little Blue Heron *Florida caerulea* and Louisiana Heron *Hydranassa tricolor*. The stork, White Ibis, immature spoonbills, Great and Snowy Egrets and immature Little Blue Herons are white or light-coloured; the others have dark dorsal plumage.

## METHODS

Tests were conducted during 5–10 March 1975 in a part of the Everglades where aggregations were forming at scattered feeding sites. The test area was a marsh near one such feeding site, an artificial channel slightly deeper than the surrounding marsh in which an aggregation formed each morning at dawn. The aggregation was composed of birds flying from a mixed roost located 10 km away. Preliminary observations showed that the marsh itself was little used. Models approximately the size and shape of medium-sized ciconiiforms (e.g., White Ibis, Snowy Egret) were fabricated from polystyrene wire and paper. Three plots were selected in the marsh 150 m apart. One, the control, had no models. At the others 13 white models and 13 blue models, respectively, were set out in clusters 3 m in diameter. Assignment of a plot to a model group or the control was made randomly each day. Models were set out by 07.15 hrs daily (dawn was about 07.40) by three persons who each simultaneously waded out to one of the plots. From 07.30 to 08.30 hrs, birds landing within a radius of 10 m of each model group or within 10 m of a similar area in the control site were counted. For comparison, counts were also made at the nearby feeding site. Feeding success was defined as the number of prey caught per minute, as measured by the number of swallowing motions made. Tests for significance were made using *t*-tests,  $\chi^2$  and the nonparametric Kruskal-Wallis test (Sokal & Rohlf 1969).

## RESULTS

The control plot attracted virtually no ciconiiforms, whereas both model groups attracted birds (Table 1). White models attracted significantly more birds than did the blue models (Kruskal-Wallis test,  $P < 0.01$ ), notably on day 2. On other days most birds entering the test area went to the channel feeding site, and comparatively few birds landed near the models. On day 2, dense fog prevailed and many more birds went to the white models. It would appear that, with other landmarks obscured, the white models (and, subsequently, birds present near them) served as the principal landing stimulus. The results demonstrate both the existence of local enhancement in wading birds and the superiority of white plumage in attracting birds to feeding sites.

TABLE 1

*Number of birds landing within 10 m of models or of specified point in control site from 07.30 to 08.30 hrs*

Day	White models	Blue models	Control
1	176	35	0
2	753	5	0
3	90	17	2
4	155	25	1

Except on day 2, there were no significant differences in the colour of birds attracted to the two colours of model ( $P < 0.05$ ). On the foggy day, as noted above, more birds of both colours landed at the white models than would otherwise be expected ( $P < 0.05$ ). Overall, dark birds made up 13% of the birds attracted to model sites; a similar proportion occurred in the aggregation at the feeding site.

Although the models clearly attracted birds to a specific plot, their presence was not sufficient to keep birds at that spot; most left within minutes after their arrival. In the usual sequence of events (Fig. 1), birds that initially landed at the site of the models later moved to the feeding site. On the day figured a temporary shift was made after disturbance, to the models, followed again by movement to the feeding site.

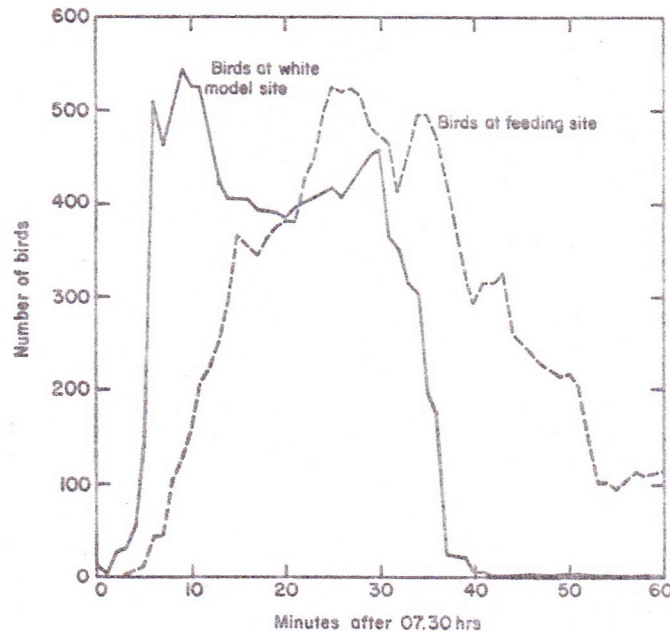


FIGURE 1. Number of birds present at different times at the white model site and feeding site.

It appeared that birds remained only at a site where feeding success was high. Comparative records of feeding success were obtained for two species. Snowy Egrets caught an average of 0.03 items/min ( $n = 34$ ) at the model site and 0.44 items/min ( $n = 41$ ) at the feeding site; Great Egrets caught no items in 24 one-minute observations at the model site and 0.48 items/min ( $n = 33$ ) at the feeding site ( $t$ -tests,  $P < 0.05$ ). The behaviour of birds at the model site suggested that they often saw more successful birds at the nearby feeding site before moving towards them, but they may also have responded to feeding noises (Kushlan 1976a). Clearly, a second level of local enhancement occurred within the single large feeding area.

Gadgil (1972) argued that mixed roosts are primarily an adaptation for predator avoidance, and Lack (1968: 110), discussing heron species that only nest in colonies, argued that mixed-species colonial nesting is related to site safety because these species differ in their choice of food. Although different species using a communal roost or colonial nest site probably differ in food choice, they often feed at the same location, forming aggregations such as those studied in this paper. Thus feeding dispersion, rather than food choice, may be the relevant point in considering the adaptive significance of colonial nesting and communal roosting by mixed species of wading birds.

I thank especially Marilyn Kushlan and Jane Anderson for their assistance, Mark Kelleher and Debbie White for help in the field, Charles Hilsenbeck and Sue Galloway for assistance in design and analysis, Luther Hoven and Lovett E. Williams for preliminary discussions and William B. Robertson, Jr, Oscar T. Owre, Charles Hilsenbeck and John C. Ogden for comments.

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26 January 1976

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