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A Study of Feeding Methods in Five Species of Herons and Egrets in Korea

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ABSTRACT: Feeding methods of five species of herons and egrets were studied in an agricultural landscape in Asan city, Chungcheongnam-do, Korea in 2006. Grey herons primarily hunted while standing, whereas great egrets fed while walking slowly. Two smaller species, little and cattle egrets, were active foragers, feeding both while walking quickly and walking slowly. Little egrets were the only species using the foot stirring method. The medium-sized heron, intermediate egrets, foraged mainly while walking slowly or leaning. For grey herons, great egrets and little egrets, the frequency of use of different feeding methods was different between habitats: these species used the leaning method more frequently in rice fields than in reservoirs and ditches. Also, most herons (all species other than great egrets) showed seasonal changes in their feeding methods that are related to changes in habitat condition.

Key words: Ardeidae, Egrets, Feeding methods, Habitat, Herons

INTRODUCTION

Feeding behavior is one of the most important behavioral characteristics of animal species. Foraging activity is an essential aspect of the life of birds, being necessary for their survival and reproduction (Perrins and Birkhead 1983). The feeding behavior of herons and egrets has been the subject of many field studies because of their large size and conspicuous activities, which facilitate observations (Kushlan and Hancock 2005). Herons and egrets (family Ardeidae) are birds that wade in shallow water to capture aquatic prey with their bills. Many of their morphological and biological characteristics influence and reflect the way they feed. So far, about 50 feeding behaviors have been described in the various species of Ardeidae; these behaviors were described based on movements, body or head postures, and the use of wings or feet (Kushlan and Hancock 2005). Food preferences and feeding techniques are fundamentally related to the morphology of each species, particularly the size and shape of the bill, which used exclusively for seizing food, and the length of the legs and neck, which govern the bird's reach and the depth of water in which the bird can operate (Kushlan and Hancock 2005).

Feeding behaviors and their efficiencies in ardeids are affected by several factors, including: prey density and availability (Draulans 1987, Wong et al. 2000, Richardson et al. 2001), time of year (Erwin 1985, Campos and Lekuona 1997), and habitat characteristics (Dimalexis et al. 1997, Matsunaga 2000). Flexibility in feeding behavior may be advantageous, because birds can choose the most appropriate method given the actual circumstances (Smith 1996). Most herons feed at times while standing and walking, and usually shift to the next feeding place by walking after capturing prey, but some species catch prey while walking continuously (Kushlan and Hancock 2005). Herons may also use their feet, head, wings, or body in various ways to access particular prey depending on habitats (Hom 1983, Rodgers 1983, Kent 1987), weather condition (Rodgers 1983), and availability of prey (Richardson et al. 2001).

Studies of feeding behavior can make an important contribution to the understanding of heron ecology. The objective of this study was to describe the feeding methods of Korean herons as an initial step toward more intensive studies of ardeid foraging ecology. In this paper, we describe the feeding methods of five common species of Ardeidae and relate these to the types of habitats in which they forage: grey herons (*Ardea cinerea*), great egrets (*Egretta alba modesta*), intermediate egrets (*E. intermedia*), little egrets (*E. garzetta*), and cattle egrets (*Bubulcus ibis*).

METHODS

Field observations were conducted in an agricultural landscape in Asan city, Chungcheongnam-do in Korea (36°48'～36°54' N, 126°58'～127°05' E) from April to October 2006. We observed feeding herons using binocular (8×) and a spotting scope (20～60×) for 2～3 minutes and recorded the feeding methods that they used most frequently during observations and the habitat types in which they

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foraged. As some behaviors were difficult to differentiate, we restricted behavioral categories to body postures, body movements, and foot movements and did not distinguish wing movements, and head and neck movements. Feeding methods of egrets and herons in this study were described following Tojo (1996) and Richardson et al. (2001) and were categorized as follows: 1) standing (S) - birds stood upright and virtually motionless, with the neck fully extended, and waited for prey to approach; 2) leaning (L) - waiting birds crouched or leaned with the neck extended, while holding the body more or less parallel to the water surface. This behavior also included the "peering over" posture, with the head or neck swaying; 3) walking slowly (WS) - birds walked or waded slowly, measured as $\leq$ 1 step/sec.; 4) walking quickly (WQ) - walking quickly and running, measuring as > 1 step/sec.; 5) foot stirring (FS) - vibrating the foot and leg. To study seasonal variation in feeding methods, we divided the period into three stages: 1) from April to May, 2) from June to July, and 3) from August to October. Three types of feeding habitats were studied: reservoirs, ditches, and rice fields including rice banks. The effects of habitat and season on the feeding methods were examined using the Chi-square test or Fisher's exact test using SPSS software (version 11.5) and statistical methods described in Zar (1999). As intermediate and cattle egrets were mostly observed in rice fields (Choi et al. 2007), the effects of variation among habitats on feeding methods was only examined for grey herons, great egrets, and little egrets.

RESULTS

Comparisons of Feeding Methods among Species

When data were pooled for all months, there were significant differences ($\chi^2_{16} = 380.2$, $p<0.001$) among species in the relative frequency of use of feeding methods (Table 1). Grey herons primarily used the standing method (85.9%). They generally waited with upright posture for a long time before striking at their prey or moving on to another site, while a few individuals (8.5%) hunted prey while wading slowly. The primary feeding method was walking slowly (58.2%) in great egrets. They were most often observed walking with an erect posture, with the head and neck well extended. Great egrets also used two motionless methods (standing 25.8% and leaning 16.0%) but waited in each location for a shorter time than grey herons. The most frequent feeding behaviors observed for intermediate egrets were walking slowly (43.4%) and leaning (40.2%). They also occasionally foraged while walking quickly (3.8%), unlike grey herons and great egrets. In little egrets, walking slowly was the most common feeding method (53.0%), but walking quickly was also observed (17.3%). Little egrets were also the only birds in this study observed using the foot stirring method (16.9%). For cattle egrets, the dominant feeding technique was walking slowly (57.0%), but walking quickly (25.3%) was also used at a moderate frequency.

Table 1. Frequency (%) of main feeding methods used by five species of herons. Figures in parentheses are the number of observations.

Feeding methods	GH (n = 462)	GE (n = 380)	IE (n = 159)	LE (n = 438)	CE (n = 395)
Stand and wait (S)	85.9	25.8	12.6	5.7	2.5
Lean and wait (L)	5.6	16.0	40.2	7.1	15.2
Walking slowly (WS)	8.5	58.2	43.4	53.0	57.0
Walking quickly (WQ)	–	–	3.8	17.3	25.3
Foot stirring (FS)	–	–	–	16.9	–

Species: GH, grey herons; GE, great egrets; IE, intermediate egrets; LE, little egrets; CE, cattle egrets.

Changes in Feeding Methods in Relation to Seasons and Habitats

Most herons showed seasonal changes in their feeding methods. Grey herons predominantly foraged while standing in all habitats, but they leaned more frequently in rice fields than in other habitats ($\chi^2_4 = 66.81$, $p<0.001$ for pooled data). Grey herons also showed seasonal changes in their feeding methods in rice fields (Fig. 1): the primary method changed from standing to leaning and walking slowly ($\chi^2_4 = 20.66$, $p<0.001$) in the later months of the study. However, the feeding method of grey herons in reservoirs and in ditches did not change seasonally ($\chi^2_4 = 8.17$, n.s. and $\chi^2_4 = 2.46$, n.s., respectively).

For great egrets, while walking slowly is the main feeding method, leaning was more frequently observed in ditches and rice fields than in reservoirs ($\chi^2_4 = 28.26$, $p<0.001$ for pooled data). Great egrets were the only species not to show seasonal change in feeding methods in any habitat ($\chi^2_4 = 6.54$ in reservoirs, $\chi^2_4 = 3.41$ in ditches, and $\chi^2_4 = 4.70$ in rice fields. All tests were not significant).

For little egrets, the frequency of use of each method differed among habitats ($\chi^2_8 = 29.64$, $p<0.001$ for pooled data): Leaning and walking quickly were adopted more often in rice fields than in the other two habitats. The feeding method of little egrets changed from highly active methods (walking quickly and foot stirring) to less active behaviors (walking slowly and leaning) in the later months of the study in reservoirs ($\chi^2_8 = 45.23$, $p<0.001$) and rice fields ($\chi^2_8 = 100.99$, $p<0.001$), but its behavior did not show seasonal changes in ditches ($\chi^2_8 = 9.25$, n.s.; Fig. 1).

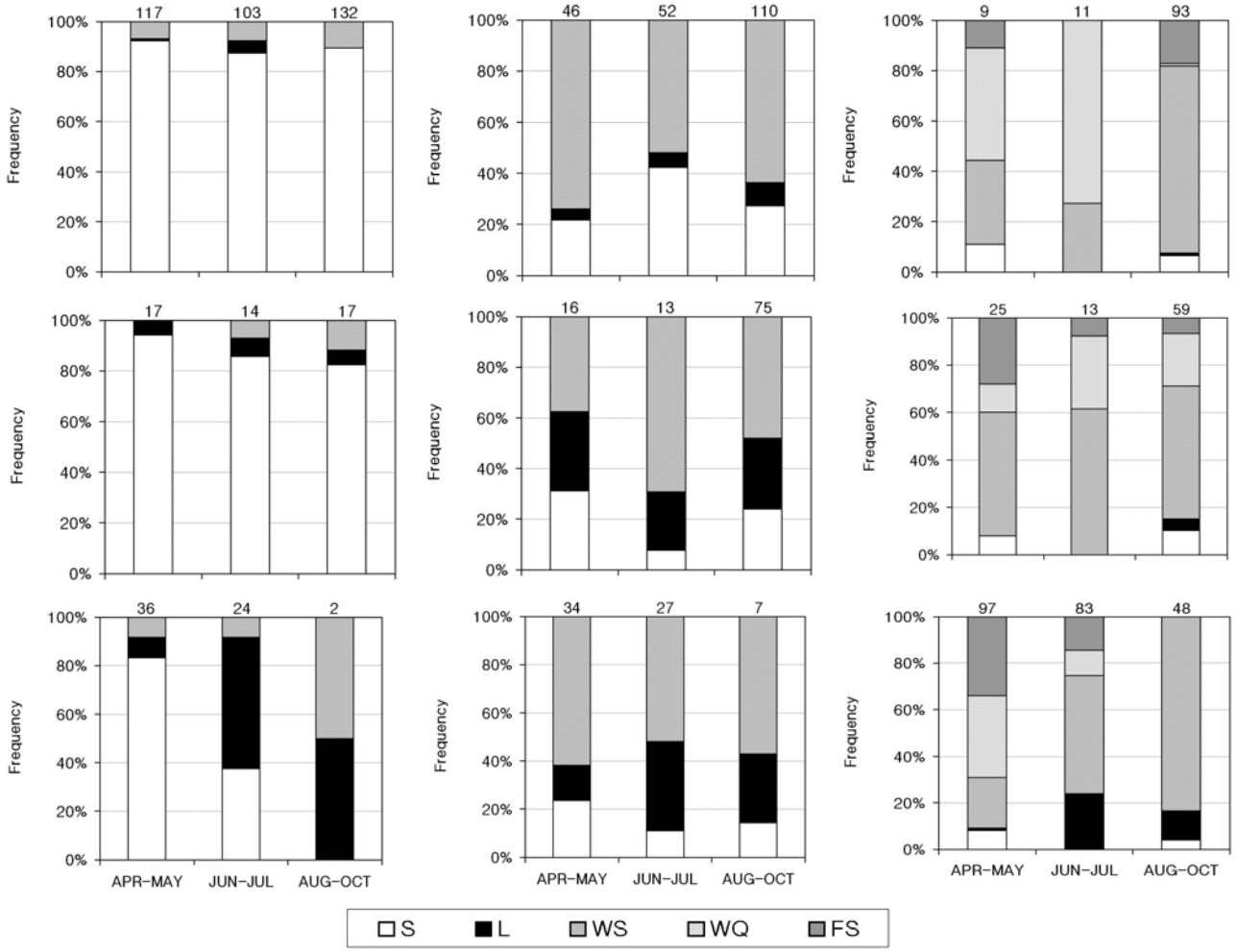

Fig. 1. Seasonal changes in the feeding methods of grey herons (left), great egrets (middle) and little egrets (right) in relation to habitat types. Habitat type: reservoirs (top), ditches (middle), rice fields (bottom). Feeding methods: S - standing, L - leaning, WS - walking slowly, WQ - walking quickly, FS - foot stirring. Numbers above each bar are observation numbers.

Intermediate egrets showed significant seasonal changes ($\chi^2_6 = 30.25$, $p<0.001$) in their feeding methods: they shifted from walking slowly to leaning in the later months of the study (Fig. 2). The feeding method of cattle egrets also changed from walking to waiting and searching ($\chi^2_6 = 134.50$, $p<0.001$) (Fig. 2).

DISCUSSION

The difference in feeding methods among heron species is probably related with their body size. In general, larger herons feed using less active methods while the smaller herons use more active methods (Kushlan 1976, Hom 1983, Recher et al. 1983, Rodgers 1983, Kent 1986, 1987, Tojo 1996, Richardson et al. 2001). Tojo (1996) suggested that the longer toes of large herons may prevent their feet from sinking into the soft mud while standing and the shorter toes of smaller herons may permit the birds to run and turn quickly.

We also observed differences in feeding methods of some species between habitats and seasons. These differences may have resulted from shifts in the different prey taken (Recher and Recher 1980, Hom 1983, Forbes 1987, Dimalexis et al. 1997). The waiting method is better for catching relatively large prey in deep water areas or for finding hidden or cryptic prey (Mock and Mock 1980, Recher et al. 1983, Tojo 1996, Richardson et al. 2001), whereas the walking method is appropriate for catching sedentary or slow moving prey in shallow water (Hafner et al. 1982, Kent 1986, Dimalexis et al. 1997). Almost all grey herons, which hunted mainly in reservoirs and deep water areas (Choi et al. 2007), stood in an upright posture with fully extended necks and waited for prey until it moved within striking range. Mock and Mock (1980) showed that

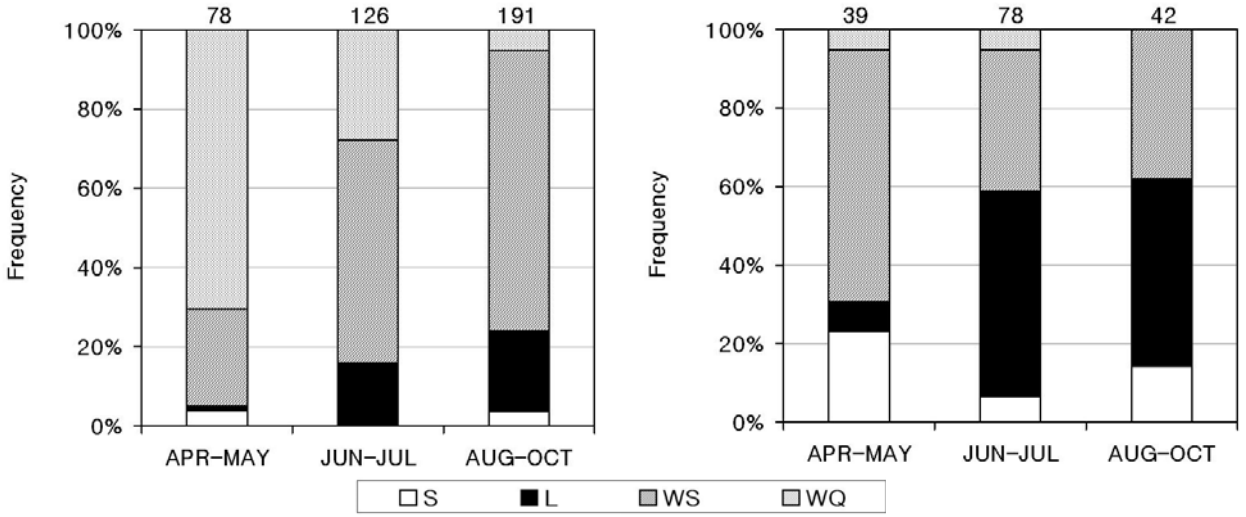

Fig. 2. Seasonal changes in the feeding methods of cattle egrets (left) and intermediate egrets (right) in rice fields. Numbers above each bar are observation numbers.

an upright posture may allow herons to detect prey in a greater volume of water than other searching behaviors. In spite of their low strike rates, grey herons often caught large fishes during this study (Choi Y.S. personal observation). On the other hand, the other four species primarily foraged while walking slowly, which was more appropriate for finding prey in shallow water or vegetated areas of reservoirs and in rice fields. Although their overall diet is diverse, their preys are usually small (Recher et al. 1983, Tojo 1996, Richardson et al. 2001). Little egrets were the most active foragers, using foot stirring as well as foraging while walking quickly. Most little egrets walked constantly while searching for prey; this mobility increases their chances of locating prey (Hafner et al 1982, Dimalexis et al. 1997). Foot stirring may allow birds to encounter prey flushed out from the mud or vegetation; this method produced the highest mean strike rate for little egrets (Kushlan 1976, Willard 1977, Hom 1983).

Seasonal changes in feeding methods were observed most frequently in rice fields, where conditions changed most dramatically between seasons (i.e., from dry to wet and densely vegetated) (Tojo 1996, Richardson et al. 2001). When no rice was planted or the rice crops were very short, most ardeids foraged while walking slowly or standing, but they shifted to leaning to find hidden prey as the rice crops developed and fields became more densely vegetated. The main food items for many ardeids in rice fields were loaches (*Misgurnus* spp.) and invertebrate prey (insects and spiders) (Choi Y.S. personnel observation). In the early stages of rice farming, most ardeids (except cattle egrets) walked slowly or stood while searching for loaches concealed in the mud in rice fields. However, in the later seasons, they shifted to leaning to find and catch invertebrate prey in the dense rice crops. This feeding method may be suitable for finding hidden or cryptic preys that are easy to catch once detected (Recher et al. 1983, Richardson et al. 2001). In the present study, both great and intermediate egrets often adopted the peering over posture and used head or neck swaying behavior to find hidden prey in densely vegetated areas. The peering over posture may be useful for locating prey where visibility is restricted by the vegetation (Recher et al. 1983) and may also reduce refraction or distortion in open water (Kushlan 1978). In addition, the head or neck swaying posture is used to obtain parallax and to gain a more accurate estimate of a prey item's location and distance (Kushlan and Hancock 2005).

In conclusion, the choice of a feeding method is likely to be a function of the availability of prey the habitat type; herons may adjust their feeding methods in response to changes in the availability of resources. A previous study (Choi et al. 2007) showed that different heron species preferred different feeding habitats. Two large species, grey herons and great egrets, used reservoirs and ditches as their primary feeding habitat, whereas intermediate egrets and cattle egrets were dependent entirely on rice fields, and the little egret was a habitat generalist using all types of habitats. Differences in feeding behaviors and habitat selection among sympatric species has long been interpreted as part of an evolutionary strategy to partition limited resources among potentially competing species (Jenni 1969, Willard 1977, Recher and Recher 1980). As predicted, we found that each heron foraged in different ways. However, to understand the resource partitioning mechanism more clearly, future studies should also consider the effects of habitat and prey availability on foraging efficiencies (e.g. Hom 1983, Kent 1986, Wong

et al. 2000, Richardson and Taylor 2003) as well as the behavioral differences between species.

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