セグロセキレイとキセキレイの比較生態学*

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Comparative Ecology of *Motacilla grandis* (Japanese wagtail) and *Motacilla cinerea* (Grey wagtail)

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Summary

CHAPTER I Introduction

Competition theory predicts that ecologically similar species coexist only if they partition resources to reduce interspecific competition (Schoner 1974). One of the most common ways by which ecologically similar species minimize competitive interactions within a habitat is avoiding spatial overlap (Morse 1973). However, where all available space within a habitat is occupied, territorial overlap among ecologically similar species cannot be avoided (Holmes 1979).

The Japanese wagtail *Motacilla grandis* and grey wagtail *Motacilla cinerea* are two common, ecologically similar passerines bird species found in Japan. Both are highly territorial birds and defend discrete territories (Higuchi & Hirano 1989, Cramp 1988). They are insectivores' birds and feed mostly on the ground (Bures 1995, Higuchi & Hirano 1989). The similarity of foods and foraging methods results in an intensive interspecific competition and a dominance hierarchy when they occur in spatially overlapping territories (Hirano & Higuchi 1986). The present study concentrated to clear the food preference and the effects of interspecific competition between Japanese and grey wagtails.

CHAPTER II Materials and Methods

Study areas

The study was conducted along a one-km stretch of a sewage canal running parallel to a traffic route and along a six-km stretch of the Kamo River in Higashi-Hiroshima (132° 44' E, 34° 25' N), and along a three-km stretch of the Takayama River (132° 30' E, 34° 30' N), which is a tributary of the Ota River in the Hiroshima Prefecture, from February 1997 to June 2001. Japanese wagtails were the commonest wagtail species while only few grey wagtails occurred in the Higashi-Hiroshima area. The Takayama River is located 30 km northeast

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to the Higashi Hiroshima study area. Grey wagtails occupied the Takayama River during the breeding season but vacated in winter.

Breeding schedule and the territory size

Study areas were visited frequently from early March to late June in each year. At each visit, wagtails were observed for a period of one hour per territory and the positions of individual wagtails, their aggressive behavior, arrival dates of the grey wagtails were recorded on a topographical map. Nests were located by observing the nest building behaviour. Once the nests were located, they were closely observed until the eggs were hatched and the parent birds started feeding the nestlings. It was possible to clearly observe the parent wagtails as they made feeding forays from the nest and then return there to feed the nestlings. Movement of each individual wagtail during such foraging trips to and from the nests was recorded on a 1:5000 scale topographical map. The outer most observation points were enclosed by straight lines to form a polygon defining the total area utilized (Stenger & Falls 1959). The area of the polygon was determined using a computer coordinating area curvimeter (Ushikata, X-plan 360i).

Nestling diet and food preference

Nestling food was collected from twelve grey wagtail nestlings (two nests, 1_{st} and 2_{nd} breeding season) in the Higashi-Hiroshima study area, using neck ligatures (Bures 1986) in 2000. Nestling food was collected from twenty-nine Japanese wagtail nestlings (six nests, 1_{st} and 2_{nd} breeding season). The territories of the grey wagtail totally overlapped with the three territories of Japanese wagtails from which the nestling food was collected. Thus, the food we recovered was suitable for comparison of the nestling diet of the two species. Food samples were preserved in 70% alcohol. They were sorted, counted and identified in the laboratory.

A 25 cm x 25 cm suber sampler, 25 cm x 25 cm quadrate sampler and a 15 cm entomological net were used to collect invertebrates and potential food items in the foraging habitats of wagtails. An electivity index was calculated to compare the food preference of wagtails by the method of Ivlev (1961). The equation, $E=(r-p)/(r+p)$ was used to calculate the electivity index. (E = electivity index, r = percentage representation of a prey family in the nestling diet, p = percentage representation of the same prey family in the foraging habitat).

The values of E were arbitrarily subdivided into ranges to describe the magnitude of selection by the method of Schreck & Moyle (1990): -1.00 - -0.50 strong avoidance, -0.49 - -0.26 moderate avoidance, -0.25 - +0.25 neutral selection, +0.26 - +0.49 moderate selection, +0.50 - +1.00 strong selection. Neutral stage represents a situation in which a species uses food resources approximately in proportion to their availability. Electivity index values in the moderate and strong ranges indicate important behavioural avoidance or selection of a food resource. Preferences were determined only for the food that occurred ≥10 (number at family level) in the nestling diet.

CHAPTER III Results and Discussion

Breeding schedule

A total of 72 breeding Japanese wagtail pairs were observed during the study period. Japanese wagtails raised two broods in March-April (the early breeding season) and May-June (the late breeding season). On average 81.9 % pairs raised two broods and 18.1 % pairs raised a single brood. A total of 24 breeding grey wagtail pairs were observed along the Takayama River. They raised two broods in late March-April (the early breeding season) and May-June (the late breeding season). On average 79.1 % of pairs raised two broods and

20.9 % pairs raised a single brood. The first egg laying date of sympatric grey wagtails in the Higashi-Hiroshima area tended to delay and they rarely raised second brood. 14 broods of grey wagtails were recorded in Higashi-Hiroshima. On average 71.4% raised a single brood while only 28.6 % raised two broods. Both wagtails compete for food and nesting sites during the breeding season. Therefore, the observed delay in the start of the breeding season and the low number of two broods of sympatric grey wagtails in Higshi-Hiroshima could be due to interspecific competitive affects.

On average, parent Japanese wagtails built nests in 5.9 (±1.6) days, incubated eggs in 14.9 (±0.3) days after laying the first egg. The parents fed the chicks in nests for 14.3(±0.6) days including the hatching date. On average, parent grey wagtails at the Takayama River built nests in 5.8 (±1.3) days and incubated eggs in 14.8 (±0.5) days after laying the first egg. The parents fed the chicks in nests for 15.6(±0.5) days including the hatching date. The sympatric grey wagtails in Higashi Hiroshima spent a considerable time on selecting a nest site. They sometimes made as much as 8 nests before finally settling in to a nest. On average parent grey wagtails at Higashi Hiroshima built nests in 11.3 (±3.1) days, incubated eggs in 14.7 (±0.5) days after laying the first egg. The parents fed the chicks in nests for 14.8 ((0.8) days including the hatching date.

There was a remarkable similarity in the nest sites of the two species in the Higashi-Hiroshima. On average 50% nests of the Japanese wagtails were built in (Polly Vinyl Chloride) pipes inserted into the protective walls of a traffic route, 45.8 % were built on roofs and 4.1% were built in abandoned vehicles. On average, 38.5% nests of the grey wagtail were built in PVC pipes, 46.2% on roofs and 15.4% in abandoned vehicles. All nests of grey wagtails at the Takayama River were found in rock crevices.

Nestling diet

Parent Japanese wagtails fed the nestlings with Lepidopterons (42.8% dry wt), Tipulidids -crane flies (21.2% dry wt) and Odonata - dragon flies (10.2). Sympatric parent grey wagtails fed the nestlings with Lepidopterons (31.2% dry wt), Tipulidids -crane flies (17% dry wt) and Odonata - dragon flies (7.7% dry wt). There was a remarkable similarity in the nestling diet of Japanese and grey wagtails that bred sympatricaly in over lapping territories (Spearman's rho = 0.764, $p<0.001$). The nestling diet of the Japanese wagtail comprised of 37 prey families. The nestling diet of the grey wagtail comprised of 33 prey families. On dry weight basis, insect prey accounted for 93.1% of the nestling diet of the Japanese wagtail and for 87.9% of the nestling diet of grey wagtail. These were followed by Arachnida (5.9%) and Chilopoda (0.1%) in the nestling diet of the Japanese wagtail and by Arachnida (11.8%) in the nestling diet of the grey wagtail.

Both wagtail species exhibited food preference when selecting prey for the nestlings. They showed a strong selection for Lepidoptera order and Tipulidae, Libellulidae, Dytiscidae and Lycosidae families. These families had high positive Electivity index values. Japanese Wagtails showed a moderate selection for spiders belonging to Gnaphosidae and Thomasidae families and for insects of Mycetophilidae family. Grey wagtail showed a strong selection for insects of Mycetophilidae family. Small and numerous preys belonging to Baetidae and Chironomidae families were selected in comparison to their availability in the habitat by both species.

Aggressive behaviour

Japanese wagtails became highly aggressive towards both inter and intra specific competitors during the courtship period from early March to mid April. Chasing of grey wagtails by the Japanese wagtails from March to April was significantly more frequent than that of May to June (Kruskal-Wallis H= 16.03, $p<0.01$). The aggressive behaviour by the Japanese wagtails towards the grey wagtails could be owing to the similarity of nest sites and nestling diet of the two species.

Wagtail population

The number of grey wagtails in Higashi-Hiroshima, decreased significantly during the breeding season when compared to the winter season. Only few grey wagtails were able to breed in spatially overlapping territories with the Japanese wagtails. Grey wagtails were not observed in the Takayama River in winter. Their numbers increased significantly during the breeding season. In winter heavy snow cover forced the grey wagtails to abandon the Takayama River. In contrast interspecific competition forced the grey wagtails to leave the Higshi-Hiroshima area during the breeding season.

Territory size and spatial arrangement

The spatial overlap of territories among different pairs of the Japanese wagtails was very narrow. Similarly, the spatial overlap of territories among different pairs of the grey wagtails in the Takayama River was also narrow. However, there was a high degree of spatial overlap among the territories of the Japanese and grey wagtails in Higashi-Hiroshima. The territories of grey wagtails sometimes overlapped with three or more territories of the Japanese wagtail and only few grey wagtails were able to raise broods in spatially overlapping territories with the Japanese wagtail.

Mann-Whitney U test indicated that grey wagtails tend to have large territories when breeding in spatially overlapping territories with the Japanese wagtails. The mean territory size was larger for grey wagtails breeding in spatially over lapping territories with the Japanese wagtails in Higshi-Hiroshima than for grey wagtails breeding in territories without the Japanese wagtails in Takayama River (Mann-Whitney U-test: $z = -4.166$, two-tailed $p<0.001$). The mean territory size was also larger for grey wagtails breeding in spatially over lapping territories with the Japanese wagtails than for grey wagtails breeding in territories without the Japanese wagtails in Higshi-Hiroshima study area (Mann-Whitney U-test: $z = -2.496$, two-tailed, $p<0.001$). The mean territory size of the Japanese wagtail territories without grey wagtails, did not differ from the Japanese wagtail territories with grey wagtails (Mann-Whitney U-test: $z = -0.371$, two-tailed, ns). The dominant Japanese wagtails enjoy a competitive advantage over grey wagtails. Therefore, the sympatric grey wagtails were forced to have large territories to find sufficient food resources in the presence of Japanese wagtails. The breeding territories of the sympatric grey wagtails were very large and spatially extend over three to four territories of the Japanese wagtails.

CHAPTER IV Conclusions

We suggest that interspecific competition cause the grey wagtails to migrate to sites without Japanese wagtails during the breeding season. Grey wagtails that bred in spatially overlapping territories with the Japanese wagtails were forced to have large territories to reduce the inter-specific competition. Our data suggest that food niche overlap and the similarity of nesting sites result in an inter-specific competition, which caused a delay in the breeding schedule of the subordinate species (grey wagtail), when both species occur sympatrically in overlapping territories.