Local Movement of Shorebirds for Roosting between Ganghwa and Yeongjong Island in the West Coast of Korea

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ABSTRACT : Movement of shorebirds for roosting was studied to find their response to insufficient roosting area on Ganghwa Island. It was taken from two kinds of aspects of population fluctuation and direct observation of movement from March to October in 2002. Based on the data from their weekly fluctuation and flight observation, shorebirds on Ganghwa Island moved to roosts located far away. Shorebirds feeding at southern Ganghwa Island moved to Yeongjong Island for roosting during the spring tide period. High tide count showed that the number of shorebirds on Yeongjong Island increased strikingly, while the number of birds on Ganghwa Island decreased. As the tide level increased, the number of shorebirds on Ganghwa Island decreased in the fall migrating season (r_s =-0.81, p<0.001), whereas that on Yeongjong Island was not correlated significantly. Direct observation showed that some of the birds on the upper tidal zone of Ganghwa Island moved directly to the northern mudflat of Yeongjong Island during the flowing tide or dropped by flat zone on Seondu-ri. Insufficient coastal wetlands on Ganghwa Island induced them to move away from the island for roosting place and to endure costly flight energy expenditure. The development of wetlands on the southern Yeongjong Island would make them have no place available to roosts. Therefore this study proposes that shorebird roosts on Ganghwa Island should be created to conserve their habitat.

Key words : Movement, Roosts, Shorebirds, Tide level

INTRODUCTION

The exposure time of intertidal patches for foraging shorebirds is changed by tide cycles. Because there is little or no feeding area available at high tide, the shorebirds move to roost (Howes and Bakewell 1989). Their movement from feeding areas to roosts occurred inevitably in the two periodical high tide of each day. They usually forage on the flats in the immediate neighborhood of their roost (Swennen 1984). This flying involves a trip of 15 km or more (Hale 1980, Symonds *et al*. 1984). Typically, shorebirds in tidal areas roost at high tide and at night (Goss-Custard 1969, Wolff 1969, Kelly and Cogswell 1979, Puttick 1979). Movement of shorebirds between feeding areas and roosting areas is induced by high tide more strongly than daily pattern on Ganghwa Island (Kim 2003).

Tide range at these islands is the largest along the West Coast of South Korea. Shorebirds on these study sites meet frequently the flooded feeding area, so they require the roost sites more necessarily than other sites. The flat zone on southern Ganghwa Island is immersed in the tide level over ca. 7.5 m, except for the neap tide period. Coastal wetlands are often used by shorebirds for roosting at high tide and near their feeding areas. Most shorebird roosts are established by a long tradition (Hale 1980). Some shorebird species at Bodega Bay, for example, have roosted there for at least 10 years (Myers 1984). But most of traditional shorebird roosts in the West Coast of Korea have been lost by regional development.

A fishpond at Yeocha-ri has been known a traditional roost site on the southern Ganghwa Island for 14 years. Past studies on shorebird roosting sites of Ganghwa Island showed that the shorebirds over 80% of Yeocha-ri flock used the fishpond for their roosts (Won 1990, Kim and Won 1993). At times the water level of the fishpond fluctuates because of the artificial sluice manipulation and rainfall making it unavailable roosts. And it has been discussed that shorebirds moved "somewhere else" when they could not use the fishpond (Won 1990). Coastal wetlands such as a shallow fishpond at Yeocha-ri used as a shorebird roost are owned privately and not managed nor conserved. The fishpond supported a maximum number of 3000 shorebirds (22% of the maximum number of shorebirds on Ganghwa Island) in 2002 (Kim 2003). Recently it becomes not to be used as roosts by shorebirds because of constant flooding for fishing.

Where do they use as alternative roosts instead of the fishpond? They might use adjacent roosts far from Ganghwa Island. Since the flight is costly energy expenditure, there must be advantages in

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expending the energy required for such flights (Hale 1980). If the alternative roosts would be developed for other purpose, shorebirds on Ganghwa and Yeongjong Island would wander. The data on their movement and habitat use will require for their conservation. This study provides some information on roosts and movement of shorebirds on Ganghwa Island. It also shows their response to insufficient roosts in case of Ganghwa Island to inform the importance of coastal wetlands for roosts. Insufficient roost adjacent to feeding area seems to be a factor limiting the number of birds using the stopover sites.

STUDY SITES AND METHOD

The study sites on Ganghwa Island (37°35、~ 37°36、N, 126°23、~ 126°32、E) and Yeongjong Island (37°27、~ 37° 33、N, 126°29、~ 126°35、E) locate in middle parts of the West Coast of Korea. Large mudflat area (82 km^2) locates on south Ganghwa Island and its tide range varies between 8.6 m at spring tides and 6.4 m at neaps (NORI 2001). Mean sea level in fall is higher than in spring on the West Coast. Coastal wetlands such as fishponds, ricefields, saltpans and saltmarshes distribute along the shoreline of the study sites.

Shorebirds aggregated on the upper tidal zone (mudflat roost) and inland roosts were counted for three hours before the predicted time of high tide by NORI (2001) in the daytime from March to October, 2002. Routine observing sites were along the southern flat of Ganghwa Island (Fig. 1). Survey areas on Yeongjong Island were the flat zone and roosts on Unbuk, Unnam and Unseo. Se-eodo islet locates close to Donggeom-ri on Ganghwa Island was included with Yeongjong Island. This is because it's northern parts is bordered by a deep channel, and few shorebirds flew across the channel at low tide (Kim 2003).

Roost sites were located by observing the flight paths of flocks during the high tide and by visiting frequently during the spring tide period from September 2001 to October 2002. The location noted through direct observation of their arrival was marked on maps. They tended to stay on the upper tidal zone, but they moved from the subroosting areas to inland wetlands when the tidal zone was flooded (Kim 2003). During the neap tide period, they roosted at the upper tidal zone at eight sites on Ganghwa and Yeongjong Island (Fig. 1). Roosts used by shorebirds during the spring tide period were ricefields (RF) on Seondu-ri, and the fishpond (FP) including nearby bank of the shrimp pond on Yeocha-ri in Ganghwa Island. There was a semi-enclosed mudflat area (EM) on Unnam and three active saltpans (SP) on the southern parts of Yeongjong Island, and a saltmarsh complex (SC) on Unbuk of the northern parts (Fig. 1). RF and SC was excluded in this study site, since RF was used by shorebirds temporarily in spring and SC supported small number of the birds.

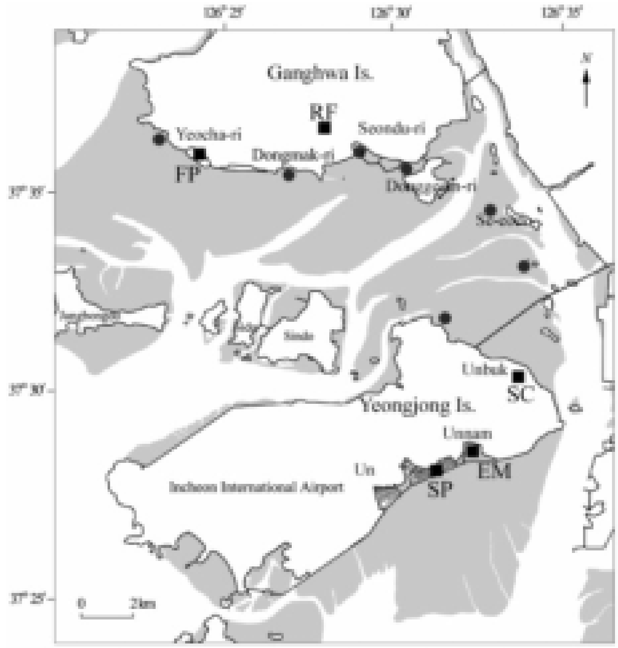

Fig. 1. Roost site distribution of shorebirds on Ganghwa and Yeongjong Island in the West Coast of Korea. Shaded area shows mudflat zone. Solid circles represent the upper tidal zone used as roosts during the neap tide period and as subroosts during the spring tide period. Solid squares indicate inland wetlands used as roosts during the spring tide period. FP, fishpond; RF, ricefields; SC, saltmarsh complex; EM, semi-enclosed mudflat; SP, saltpan.

Shorebird movement was surveyed at four observing sites; Yeocha-ri, Dongmak-ri and Seonduri (including Donggeom-ri) on Ganghwa Island, and Unbuk on Yeongjong Island (Fig. 1). Surveys were conducted on four consecutive days during three peak migration periods from September 2001 to October 2002. Surveys were carried out before and after high tide for 4 hours, respectively, during the spring tide period (tide level over 8 m). Species, flock size, flight direction and flight patterns were recorded. Patterns of flight directions were determined in eight directions; N, S, E, W, NE, NW, SE, SW. The same method was applied to the returning flocks after high tide.

The data of the number of birds related to tide level were analyzed using the SAS program. To compare the Spearman rank correlation coefficients of the two study sites, the equality of the coefficients was tested (Zar 1999).

RESULTS

Shorebird fluctuation in relation to tidal cycle

The fluctuation curves of shorebirds on Ganghwa and Yeongjong

Island from March to October were represented in Fig. 2. The curve of the shorebird numbers on Yeongjong Island fluctuated similarly to the fluctuation of the tide level in fall. Shorebirds of Yeongjong Island increased strikingly at spring tide above 8 m, but those on Ganghwa decreased sharply from August to October (Fig. 2). And these fluctuations were closely related to the periodical change of the tide level and weekly spring-neap cycles (Fig. 3). The number of shorebirds on Ganghwa Island was negatively correlated with the

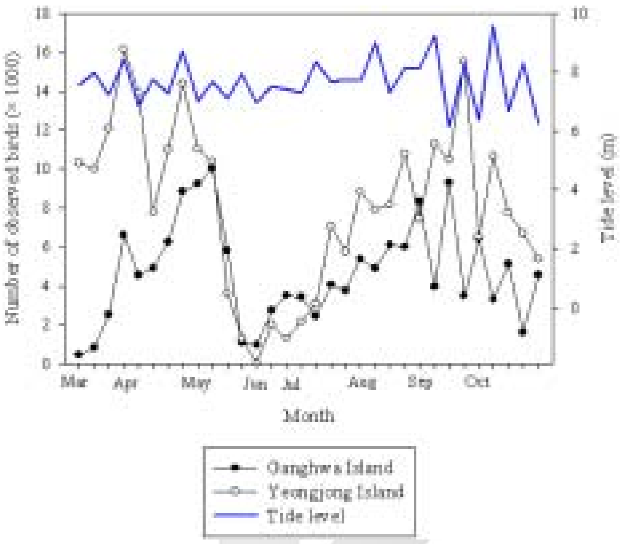

Fig. 2. Number of shorebirds observed at two study sites and the fluctuation of tide level from March to October in 2002.

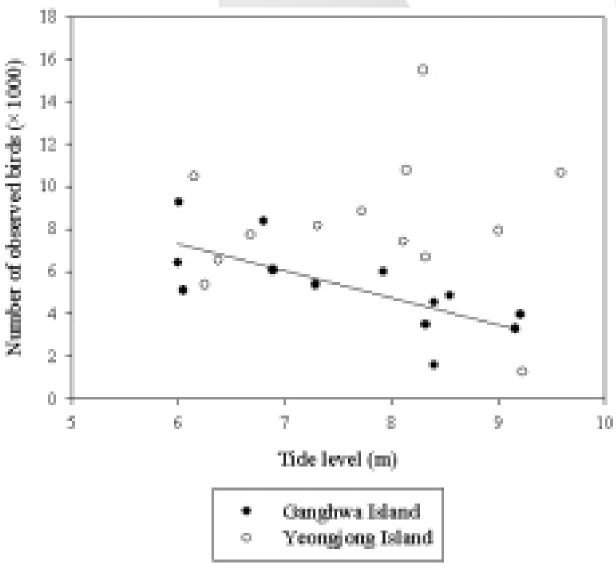

Fig. 3. Relationship between tide level and shorebird numbers on Ganghwa Island (r_s = -0.81, p<0.001) and Yeongjong Island in fall migration season, 2002. The line is for the relationship between numbers of shorebirds on Ganghwa Island and tide level.

tide level in the fall migrating season (Spearman rank correlations, r_s = -0.81, p<0.001), whereas the number of shorebirds on Yeongjong Island was not correlated significantly. Comparing the two correlation coefficients, they were found to be significantly different (Two-tailed Z-test, Z = 3.063, p<0.01).

Movement of shorebirds between the two islands

Subroosting shorebirds on the upper mudflat in Yeocha-ri moved mainly towards the southeast or the east (Table 1). And shorebirds on the upper mudflat in Seondu-ri moved to the southeast or the south and landed on the northern mudflat of Yeongjong Island. Most shorebirds moved eastward at Dongmak-ri mudflat. On the other hand, the shorebirds of the northern flat zone of Unbuk on Yeongjong Island flew to the south or the southwest.

Large flocks were formed to move to Unbuk and Yeocha-ri, but the ones in Seondu-ri crossed over the channel in small flocks or individually. Mean flock size of each frequency of movement was ca. 30 birds on Seondu-ri and over 150 birds on Unbuk before high tide. Returning flock size to Seondu-ri was 6~8 birds and the frequency of movement is highest after high tide. Total observed number of shorebirds returning to the upper tidal zone on Ganghwa Island after high tide was less than the number of them had left before high tide. Returning direction was mainly from the southeast and the east of Yeocha-ri, and from the southeast and the south of Seondu-ri. Shorebirds at Dongmak-ri flat returned from the east.

DISCUSSION

Flocks feeding on Ganghwa Island moved to Yeongjong Island for roosting during the high tide period. Such movement of shorebirds between feeding areas and roosting areas was demonstrated by two cases of evidence. One was the fluctuation of shorebird numbers related closely to tide cycle (Fig. 2 and Fig. 3). The number of shorebirds observed on Yeongjong Island was larger than that on Ganghwa Island during the spring tide period, but shorebirds on Ganghwa Island increased during the neap tide period and decreased during the spring tide period. This means that the birds feeding at Ganghwa Island moved off the island at high tide and the birds at roosts on Yeongjong Island were fulfilled by outside ones. Mean sea level on the West Coast is the highest in August, which explained the shorebird fluctuation in fall. In spring they had more available roosts such as ricefields in Ganghwa Island, but in fall they depended entirely on the fishpond. Ricefields were used by shorebirds during the spring migration, and this coincides with flooding of fields for the replanting of rice (Farmer and Parent 1997, Kim 2003). Thus shorebirds except for the roosting number in the fishpond could not help moving away other roosts. Most of the roosts

Table 1. Flight direction of shorebirds before and after high tide at three sites of upper tidal zone in the southern Ganghwa Island and a site(*) in the northern Yeongjong Island. Mean size (± S.E.) of movement flocks and percentage of birds moved to each four direction (E, east; SE, southeast; S, south; SW, southwest) is shown with the total number observed at each site and frequencies of movement during study period

	E	SE	S	SW	Observed bird Numbers	Frequency of movement
Before high tide						
Yeocha-ri	48.8±22.2 18.7%	111.0±32.7 81.3%	-	-	2868	32
Dongmak-ri	56.7±31.6 100.0%	-	-	-	794	14
Seondu-ri	1.7±0.3 0.9%	28.6±10.0 81.2%	3.8±1.0 17.9%	-	2466	200
Unbuk*	-	-	166.0±76.4 33.9%	152.8±23.1 66.1%	8323	53
After high tide						
Yeocha-ri	31.7±10.2 29.5%	11.5±1.7 69.9%	6.0±2.0 0.7%	-	1828	130
Dongmak-ri	64.0±21.1 100.0%	-	-	-	320	5
Seondu-ri	-	6.0±1.1 84.9%	8.1±2.3 15.1%	-	3665	585

were the areas on the northern flat and the southern wetlands of Yeongjong Island, and other small-scale areas available.

The other evidence was taken from direct observations of their flight during the high tide period. The movement of shorebirds from the upper tidal zone before high tide occurred in a constant direction. The flocks at Yeocha-ri and Dongmak-ri flew toward the Seondu-ri mudflat area. And the shorebirds aggregated on Seondu-ri flat moved to the northern flat on Yeongjong Island, which were exposed later than the southern mudflat of Ganghwa Island. Thus the flocks moving from Yeocha-ri and Dongmak-ri were directed to the northern Yeongjong Island. When the flat zone on the northern Yeongjong Island was flooded by very high water, most of shorebirds moved the southwest or the south. These two directions of movement indicated that they headed to inland roosts along the southern parts of the island. Therefore all the flight flocks of Ganghwa Island moved south to Yeongjong Island via the northern flat of the island at spring tide. When they return to their foraging sites they moved in the same direction as they started. Shorebirds came and went the routine course and stayed at a certain roost. Therefore the roosting flocks of the two islands mixed at southern Yeongjong Island at spring tide. If the count carried during the spring tide period, some of shorebirds on Ganghwa Island might overlapped on Yeongjong Island.

Flight is energetically expensive behavior for birds (Paynter 1974). Assumed flight metabolism is approximately 12~15 times basal metabolism (Raveling and Lefebvre 1967, King 1974, Robbins 1983), the flight expenditure is four times daily energy expenditure which is three times the basal metabolic rate (Kersten and Piersma 1987). For example, if maximal continuous power is given for flight, the estimated energy expenditure of Grey Plovers with a weight of 224 g (Cramp and Simmons 1983) would be 14.3 kcal per hour (Berger and Hart 1974). This is approximately 10 times the daily energy expenditure of Grey Plovers. Thus, frequent movement at stopovers may increase flight energy cost (Piersma *et al*. 1993, Rehfisch *et al*. 1996) and delay their fat reserve (Fredrickson and Reid 1988). They had more energy expenditure than the expected cost, because they moved longer distance than linear distance. Therefore roosting area located near feeding areas would make shorebirds reduce their flight energy expenditure. Why do shorebirds move between the two islands and not feed near their roosts? It depends on their selection of site in relation to distribution and abundance of food and the quality of roost (Zwart 1988, Kalejta and Hockey 1994). The movement of between feeding areas and roosting areas was induced by their needs of the areas.

The wetlands on Yeongjong Island have also been threatened by alteration for regional development. And insufficient roosting area was a serious problem on Ganghwa Island. Conservative efforts for shorebird roost are possible to be taken by creating a few newly roosting site on the proper location or designating the existing roost as protected area. Therefore roosting sites as well as feeding sites should be considered to protect their stopover sites at the same time.

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