The Visitation Aspect and Habitat Preference of Plover (*Pluvialis* spp.) in the Nakdong Estuary

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Abstract: The study is performed in the Nakdong Estuary located in the city of Busan. The study focuses on understanding the visitation aspect of plover (*Pluvialis* spp.) and their habitat preference through long-term monitoring in the Nakdong estuary where nearby environment rapidly changes based on comparison and analysis of data from early 1990s and mid-2000s. Among the total of 6,672 individuals in 3 genus and 10 species during the survey, the number of *Pluvialis* spp. was 910 (13.64%) for 2 species including 57 Pacific Golden Plover (*Pluvialis dominica*) and 853 Grey Plover (*Pluvialis squatarola*). Among 295 of 910 individuals, 2 genuses of *Pluvialis* discovered in the first half of 1990s, the number of Pacific Golden Plover (*Pluvialis dominica*) and Grey Plover (*Pluvialis squatarola*) is 41 and 254, respectively. 615 individuals discovered in mid-2000s consist of 16 Pacific Golden Plover (*Pluvialis dominica*) and 599 Grey Plover (*Pluvialis squatarola*). The number of individuals recorded per month for the 2 periods show no significant difference (P=0.522) and the number of individuals in the mid-2000s (Mean=102.50) is larger than that of early-1990s (Mean=73.75). Visitation aspect per month states that the number of individuals in August was the highest of 369, followed by 168 in April, 120 in May, 63 in September and 55 in October, respectively. The average number of individuals for the 5 regions visitation number showed 26.74 including 69.33 in DMD, 18.50 in JJ and SJD, 9.17 in SJ and DY and 6.88 in LUD, showing significant differences among regions (P=0.027). DMD showed the highest number of individuals (Mean=69.33) and LUD recorded the lowest (Mean=6.60) and there was no individual in USD. Regional visitation number showed that the total of 615 individuals have been discovered for 6 years and 416, 111, 55 and 33 individuals in DMD, JJ and SJD, SJ and DY and LUD, respectively. Monthly recorded individuals stated that DMD had 218 individuals in August, 105 in April and 45 in May of 416 in DMD and 42 in August and 22 in September of 111 in JJ and SJD. The results showed that the number of plovers here was not fluctuated much in the early 1990s and mid-2000s despite many environmental changes in the Nakdong Estuary, and there was regional difference among JJ, SD, SJ and DYD, showing preference difference. Future researches will be required whether these results show that the places are still good for habitat of migrant birds or they have no other choices.

Keywords: *Pluvialis* spp., Pacific Golden Plover, Grey Plover

Introduction

The Nakdong Estuary is located in the southernmost part of the Korean peninsula, the protruded part of the continent and has many birds. In the summer, little terns (*Sternula albifrons*) and Kentish plover (*Charadrius alexandrinus*) groups are breeding at the sand bars in the southern site of the estuary and this place is used temporary for snipes and plovers going north for breeding and going south for wintering. It is considered as an important place for swans, sea gulls and ducks going south to spend winter. *Charadriidae* around the estuary consist of 6 *Charadrius* genus, 2 *Pluvialis* genus and 2 *Vanellus* genus, a total of 10 species. Among them, the *Pluvialis* genus shows mid- and large sizes and includes Pacific Golden Plover (*Pluvialis dominica, Pluvialis fulva*) and Grey Plover (*Pluvialis squatarola*).

For its importance as habitat for migrant birds, the Nakdong Estuary is designated as a habitat for migrant birds (No. 179 of Protective Area for Endangered Species, July 13, 1966: 247,933,884 m²). The Nakdong Estuary is a stopover located in the center of East Asia and plays the most important role as a stopover for migrant birds during winter (Post, 1983; Hong, 1997). In addition, the Nakdong Estuary is a place with very high degree of natural preservation for its mud flat, wetland, abundant fishery resources and habitat for migrant birds. This area is the only place in Korea with 5 preservation zones including an area for endangered species as a habitat for migrant birds.

The only researches for *Charadriidae* in the Nakdong Estuary are about snipes and plovers (Hong, 2005) and...
Kentish plover (*Charadrius alexandrinus*; Hong and Higashi, 2008) and there have not been many researches on *Pluvialis* genus.

Most researches of *Pluvialis* genus focus on breeding place habitat (Moser, 1998; Pearce-Higgins, 1998; Pearce-Higgins and Yalden, 2002; Pearce-Higgins *et al.*, 2005; Ratcliffe, 1976) and vegetarian behaviors (Dugan, 1982; Turpie & Hockey, 1993) and there has not been much information on using habitats and paths while migration (Rae *et al.*, 2009). Survival in the winter may affect individuals of Golden Plover (*Pluvialis dominica*) (Parr, 1992) and using habitat preferred for the winter is important for their survival (Whittingham, 2002). In addition, their stopover (layover) is considered very important for them to reach their breeding area for their survival while keeping good shape (Rae *et al.*, 2009). It is because survival and reaching their habitat while keeping good shape are very important for their successful breeding.

Pacific Golden Plover (*Pluvialis dominica*) in the *Pluvialis* genus and Grey Plover (*Pluvialis squatarola*) use the estuary as a place for the winter and breeding as migrant birds and a stopover for migration. Plovers live in Siberia and spend winter in South Asia, Southeast Asia, Australia and islands in the Pacific Ocean like New Zealand and Grey Plover (*Pluvialis squatarola*) live in the northern part of Eurasia and spend winter in South Asia and Southeast Asia (Snobe and Usui, 1993).

Long-term monitoring Charadriidae using the Nakdong Estuary as a stopover shows that understanding advent and habitat preference for the birds is important to preserve habitat of migrant birds and keep the area as a sound ecosystem.

The study compares and analyzes data in the early 1990s and mid-2000s to understand advents and habitat preference of *Pluvialis* genus, Charadriidae around the estuary.

**Method**

The study was performed 1-3 times a month in the early 1990s (May, 1989 - April, 1993) and 1-2 times a month during mid-2000s (May, 2002 - April, 2008) to figure out individuals on monthly basis (taking the number of individuals in a month for the same species).

The survey areas include ① DMD, ② JJ and SJD, ③ SJ and DYD, ④ LUD and ⑤ USD (Fig. 1).

The study compares and analyzes data in the early 1990s and mid-2000s to understand advents and habitat preference of *Pluvialis* genus, Charadriidae around the estuary.

**Results**

**Overall Pattern**

Up to now, a total of 10 types of Charadriidae are observed and recorded in the Nakdong Estuary.

For the survey period (10 years), the Charadriidae observed in the Nakdong Estuary consists of 3 genus, 10 species and 6,672 individuals including 6 *Charadius* genus (Little Ringed Plover; *Charadrius dubius*, Long-billed Ringed Plover; *Charadrius placidus*, Kentish Plover; *Charadrius alexandrinus*, Lesser Sand Plover; *Charadrius mongolus*, Great Sand Plover; *Charadrius leschenaultii*, Eastern Sand Plover; *Charadrius veredus*), 2 *Pluvialis* genus (Pacific Golden Plover; *Pluvialis fulva*, Grey Plover; *Pluvialis squatarola*), 2 *Vanellus* genus (Grey-headed Lapwing; *Vanellus cinereus*, Northern Lapwing; *Vanellus vanellus*). The *Pluvialis* genus of Charadriidae includes 2 genus and observed through naked eyes or binoculars and all their individuals are recorded after the observation. The identification and categorization were performed based on Lee *et al.*, (2000) and Howard and Moore (1994), respectively. Mann-Whitney U test and Kruskal-Wallis test were implemented for monthly comparison and regional comparison for two groups in the statistical analysis, respectively.

**Fig. 1.** Study area. Dark line shows the survey route between May 1989 and April 1993, and white dotted line the survey route between May 2002 and April 2008.
910 individuals (13.64%).

The number of individuals of Pluvialis Genus
A total of 2 species and 910 individuals of Pluvialis genus are observed during the observation period in the Nakdong Estuary including 57 Pacific Golden Plover (Pluvialis dominica) (6.26%) and 853 Grey Plover (Pluvialis squatarola) (93.74%).


Comparison of the migration pattern of Pluvialis by month
The Mann-Whitney U test was performed using mean numbers of individuals during the early 1990s and mid-2000s to understand the trend of Pluvialis individuals of plover (Charadriidae).

As shown in Table 1, monthly advent for the 2 period above show no significant difference (P=0.522) and the number of individuals in the mid-2000s (Mean=102.50) is larger than that of early 1990s (Mean=73.75).

The Mann-Whitney U test was performed using mean numbers of individuals during the early 1990s and mid-2000s to understand the monthly trend of Pluvialis individuals of plover (Table 2).

As shown in Table 2, there is no significant difference between May and next April in both periods.

The mean numbers of the two period show that no or just a small number appeared between June and July, November and next March. Meanwhile, no or just a small number individuals appeared in June and between November and next March for the mid-2000s. The individuals appeared from April or May in spring and July in autumn. The number peaked in August and gradually decreased from September and October. Both periods show similar trend in monthly visitation aspect. Monthly average number of shows that the mid-2000s is 1.4 times larger than that of the early 1990s (Fig. 2).

The Pluvialis birds in the Nakdong Estuary migrate in spring and autumn and are typical migrant birds using the estuary as a stopover. The largest number appears in April and May to move to north for breeding and in August for spending winter and most birds complete advent in September and October. Birds stay in the Nakdong Estuary in April and May to go to north and from July to October to spend winter and the number of individuals in the latter shows 1.8 times larger (August, September and October; Mean=55.0) than that of the former (April and May; Mean =30.6).

Regional Pattern of Pluvialis Genus
Table 3 and Fig. 3 show the mean number of individuals in the mid-2000s for regions.

As shown in Table 3, the average number of individuals for the 5 regions pattern showed 26.74 including 69.33 in DMD, 18.50 in JJ and SJD, 9.17 in SJ and DY and 6.60 in LUD, showing significant differences among regions.
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(P=0.027). DMD showed the highest number of individuals (Mean=69.33) and LUD recorded the lowest (Mean=6.60) and there was no individual in USD.

**Monthly Trend of *Pluvialis* Genus for Regions**

Regional pattern showed that the total of 615 individuals have been discovered for 6 years including 416, 111, 55 and 33 individuals in DMD, JJ and SJ, SJ and DY and LUD, respectively. Monthly individuals stated that the total number of individuals in the DMD was 416 including 218 in August, 105 in April and 45 in May. Also, the total individuals in JJ and SDJ were 111 including 42 in August and 22 in September (Fig. 4).

**Discussion**

The Nakdong Estuary is a place for migrant birds for all the seasons and 2 species and 910 migrant birds were discovered including 57 Pacific Golden Plover (*Pluvialis dominica*) and 853 Grey Plover (*Pluvialis squatarola*) of *Pluvialis* genus in Charadriidae. Among 295 of 910 individuals, 2 genuses of *Pluvialis* discovered in the first half of 1990s, the number of Pacific Golden Plover (*Pluvialis dominica*) and Grey Plover (*Pluvialis squatarola*) is 41 and 254, respectively. 615 individuals discovered in mid-2000s consist of 16 Pacific Golden Plover (*Pluvialis dominica*) and 599 Grey Plover (*Pluvialis squatarola*). The result shows that the Pacific Golden Plover (*Pluvialis dominica*) decreases in the 2000s compared to the 1990s.

The habitat of Pacific Golden Plover (*Pluvialis dominica*)
mainly reside in intertidal zones, wide mud flats, sandy coasts, salty or occasionally submerged islands, not relatively wide areas with ponds (Cramp and Simmons, 1983), estuary or coastal mud flats, inland agricultural land and wet grass (Snobe and Usui, 1993).

In the early 1990s, a large number of individuals occasionally appeared in rice paddies in Chilsan, Gimhae for planting rice in the spring. It is judged that Pacific Golden Plover (Pluvialis dominica) preferred inland agricultural and to the watershed of the Nakdong Estuary. The results showed that the number of Pacific Golden Plover (Pluvialis dominica) individuals in the Nakdong Estuary decreased due to decreasing agricultural lands from development, decreasing habitat from prospering reeds in the estuary, causing the birds to move to places with large crop lands.

Grey Plover (Pluvialis squatarola) largely consists of the birds, 853 of 910 individuals (93.74%) of 2 species of Pluvialis genus. Grey Plover (Pluvialis squatarola) amounts to 254 of 295 in the early 1990s (86.10%) and 599 of 615 (97.40%) in the mid-2000s, showing that the number increases. The reason of increasing the number of Grey Plover (Pluvialis squatarola) in the 2000s compared to the 1990s is that the environment is deteriorated due to developing Janglim and Myeongji residential complex but mud flats in DMD, JJ and SJD are preserved well, providing good environment for the birds.

The paths of Grey Plover (Pluvialis squatarola) are bound for the southwest Europe (mainly via Baltic) and South Asia and Southeast Asia and Australia (Cramp and Simmons, 1983). Also, one individual of mother Grey Plover (Pluvialis squatarola) which attaches orange-colored tag was found on the upper part of the left bridge (face-to-face) in the survey of the estuary (September 19, 2008). It was found out that the tag on the Grey Plover (Pluvialis squatarola) was attached in Victoria, Australia. Therefore, it is confirmed that a path of Grey Plover (Pluvialis squatarola) is from the breeding place in North Eurasia to South Asia, Southeast Asia and Australia to spend winter and the Nakdong Estuary is used as a stopover.

The monthly trend of Grey Plover (Pluvialis squatarola) in the Nakdong Estuary shows 369 in August, 168 in April, 120 in May, 63 in September and 55 in October and the figure in August reaches the highest. The results show that migrant birds use the estuary more as a stopover going north than going south to spend winter.

Pluvialis genus is known as a typical migrant bird visiting the Nakdong Estuary as a stopover in spring and autumn. The largest number appears in April and May to move to north for breeding and in August for spending winter and most birds complete advent in September and October. Birds stay in the Nakdong Estuary in April and May to go to north and from July to October to spend winter and the number of individuals in the latter shows 1.8 times larger (August, September and October; Mean=55.0) than that of the former (April and May; Mean=30.6).

It means that the Grey Plover (Pluvialis squatarola) moves from the breeding place to winter-spending place in August. In the White Sea, adult birds move from the end of July to early September and young birds move from September to the mid-October (Cramp and Simmons, 1983). The adult Grey Plover (Pluvialis squatarola) mainly appears in the end of August and young birds appear in September and October in the Nakdong Estuary.

Regional pattern showed that the total of 615 individuals have been discovered for 6 years and 416, 111, 55 and 33 individuals in DMD, JJ and SJD, SJ and DY and LUD, respectively. Pluvialis genus of Charadriidae tends to visit...
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DMD and its nearby JJ and SJD as a habitat in the estuary when they move to breeding and winter-spending places in spring and autumn. This may be related to habitat and foods which Grey Plover (*Pluvialis squatarola*) prefers.

The preys of Grey Plover (*Pluvialis squatarola*) are mainly insects, invertebrates on land in breeding places of tundra and polychaete worms, molluscs and crustaceans in the ocean or seasons other than breeding (Cramp and Simmons, 1983).

The Busan Metropolitan City (2006) reported various features in advent genus and changes in the Myeongji residential complex located in the west and north of DMD. The places around Myeongji mud flat, DMD and artificial habitat, major habitats for migrant birds in the Nakdong Estuary are considered as an important place representing biodiversity and soundness of eco-system (Hong, 2004b) and systematic management shall be required to preserve eco-system by preventing water pollution and eliminating factors which reduce habitat due to developing DMD including residential complex.

**References**


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