

Distribution of Birds in the Jeju Seonheul Gotjawal Region, a Survey Site of Long-term Ecological Study

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Abstract: The study on the avifauna of the Seonheul Gotjawal region of Jeju-do (Is.), a survey site of long-term ecological study, was conducted between February of 2011 and January of 2012. A total of 54 species and 1,039 individuals of birds were observed, with 30 species and 164 individuals observed during spring, 31 species and 174 individuals during summer, 30 species and 206 individuals during fall and 28 species and 868 individuals during winter. In terms of dominant species, Mandarin Duck (*Aix galericulata*) was the most dominant at 500 individuals (48.12%), followed by Rook (*Corvus frugilegus*) at 250 individuals (24.06%), Black-billed Magpie (*Pica pica*) at 36 individuals (3.46%), Barn Swallow (*Hirundo rustica*) at 34 individuals (3.27%) and Great Tit (*Parus major*) and Japanese White-eye (*Zosterops japonicus*) at 26 individuals (2.50%) each. The overall species diversity was 1.95, with the value 2.69 during spring, 2.87 during summer, 2.81 during fall and 1.29 during winter. The species diversity was low during the winter, because Mandarin Duck (*Aix galericulata*) and Rook (*Corvus frugilegus*) were observed at a relative high level when compared to other species, at 500 individuals and 250 individuals respectively. Government protected species included 8 natural monument species, such as Mandarin Duck (*Aix galericulata*), Common Kestrel (*Falco tinnunculus*), Peregrine Falcon (*Falco peregrinus*), Cinereous Vulture (*Aegypius monachus*), Eurasian Sparrowhawk (*Accipiter nisus*), Northern Goshawk (*Accipiter gentilis*), Lesser Cuckoo (*Cuculus poliocephalus*) and Fairy Pitta (*Pitta nympha*), and 8 endangered species of Japanese Night Heron (*Gorsachius goisagi*), Peregrine Falcon (*Falco peregrinus*), Cinereous Vulture (*Aegypius monachus*), Crested Honey Buzzard (*Pernis ptilorhynchus*), Northern Goshawk (*Accipiter gentilis*), Eurasian Sparrowhawk (*Accipiter nisus*), Fairy Pitta (*Pitta nympha*) and Black Parasite Flycatcher (*Terpsiphone atrocaudata*). Since subtropical birds, such as Japanese Night Heron (*Gorsachius goisagi*), White-bellied Green Pigeon (*Treron sieboldii*) and Chestnut-winged Cuckoo (*Clamator coromandus*) were observed during the study, there is a need for a continuous monitoring of their migratory pattern and breeding.

Keywords: Dominant species, Protected species, Species diversity, Subtropical birds

Introduction

With the recent designation of Jeju-do (Is.) as a biosphere reserve, natural world heritage site and global geopark by UNESCO and the designation of wetlands, such as the Mulyeongari-Oreum Wetland, Muljangori Wetland and the 1100-goji Wetland, as Ramsar wetlands, the ecological resources of Jeju-do has received much focus as mankind's natural asset. Among the many natural ecological resources, the geological and biological importance and diversity of Gotjawal have led to a number of institutional measures, such as the establishment of the Gotjawal Trust of Jeju, the registration of protected wetlands, designation of Ramsar wetlands and national parks, additional candidates for

global geoparks and the renovation of the Olle trail, in order to shed new light on the ecological values of Gotjawal.

Gotjawal of Jeju-do was formed from volcanic activity at 200~600 meters above sea level region and lava flowing to lower altitude, and the region can be divided broadly into the Hangyeong-Andeok Gotjawal region, the Aewol Gotjawal region, the Jocheon-Hamdeok Gotjawal region and the Gujwa-Seongsan Gotjawal region (Song, 2000). The Gotjawal region has been considered a barren land, with its volcanic block and lack of arable land, but the region has recently gained much attention following its recent discovery of unique geological structure which serve as cave resource, source of groundwater recharge, unique vegetation distribution and resting ground for wildlife. Gotjawal includes dense forest which remains green throughout the year and succession of forest as a result of artificial interference.

The terrestrial ecosystem of Jeju (Is.) stretches over the intertidal zone, arable land-*Pinus thunbergii* forest, Gotjawal-

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evergreen forest and shrub forest, grassland, deciduous forest, coniferous forest-subalpine zone with altitude. Therefore, Gotjawal is a crucial transition space for avian ecosystem connecting sub-sea level region to the Hallasan (Mt.) Forest.

Jeju-do (Is.) is located to the very south of the Korean peninsula, and the results of studies conducted in Jeju-do receive much attention, since the region is used as wintering ground, nesting ground and resting stop during migration of migratory birds. Gotjawal region especially may become the best place for monitoring migration and changes in colonies as a result of climate changes and habitat destruction. Past avifauna studies of Gotjawal region include studies conducted by Park and Kim (1998) and Kim and Kim (2005), and recently, the Ministry of Environment has been conducting long-term ecosystem monitoring in Gotjawal since 2008. Therefore, this study examined the avifauna of the east region of Jeju-do's Gotjawal region to obtain basic data for climate change, to maintain species diversity of birds and to manage their habitat.

Materials and Methods

Study area

Seonheul Gotjawal is located in Seonheul 1-ri, Jocheon-eup of the city of Jeju, at north latitude 33°31'20" and east longitude 126°43'22" (Fig. 1). The area is included in Jocheon-Hamdeok Gotjawal and its main vegetation includes evergreen broad leaved forest and needle-leaved evergreen forest (Kim *et al.*, 2009). Seonheul Dongbaekdongsan, Gotjawal has been designated as Jeju-do's 18th monument and was registered as a Ramsar wetland in March of 2011. The area was formed when evergreen broad leaved forest formed on top of volcanic activity at 80 to 100 m above sea level. The pond located within Dongbaekdongsan is used as



Fig. 1. Map of the study site.

spawning ground for amphibians and food source for reptiles, as well as water source for wild birds.

Important vegetation of Dongbaekdongsan include the dominant evergreen forest species of *Quercus glauca*, *Castanopsis cuspidata* var. *sieboldii*, *Quercus salicina*, *Camellia japonica* and *Eurya japonica*. Therefore, the area is considered to be an optimal location for long-term ecological studies related to the interspecific growth influenced by factors, such as future successional mechanism of evergreen forests and climate changes (Koh and Kim, 2011).

Methods

The study was conducted between February of 2011 and January of 2012, with focus on the narrow trail for ecological exploration and the surrounding 50 m radius of the survey area. Wild birds in each site were observed using telescopes and binoculars, and their numbers were determined via the naked eye, their sounds, flight pattern, remnants of excretion or nesting and carcass. The point count method was used after selecting a location in which the entire bird colony can be sighted, and the line census method, which is conducted along a specific study trail, was conducted in order to confirm number of individuals (Bibby *et al.*, 1992). The point count method incorporated the selection of four 50 m×50 m grids and recording the number of species and individuals observing while using binoculars (Nikon 8×36), naked eye and hearing. Furthermore, confirmation of breeding was done using the line transect method, in which the 500 m of survey trail in the area with the same vegetation as that of the site of the point census method was used.

Dominance (Simpson, 1948) and species diversity (Shannon and Weaver, 1949) were calculated based on all species observed for analysis of the colonies observed. In the case of the number of individuals per season, the maximum number of individuals per survey session, with disregard to the number of sessions conducted monthly, was used. Methods of analysis are as follows.

1) Dominance (*Dom.*)

$$Dom. = (n_i/N) \times 100 (\%)$$

n_i : number of individuals in the i th species

N : total number of individuals in the survey area

2) Species Diversity (H')

$$H' = -\sum(n_i/N) \times \ln(n_i/N)$$

n_i : number of individuals in the i th species

N : total number of individuals in the survey area

Results

A total of 54 species and 1,039 individuals of birds were observed, with 30 species and 164 individuals observed during spring, 31 species and 174 individuals during summer, 30 species and 206 individuals during fall and 28 species and 868 individuals during winter (Table 1). 6 species were observed throughout the study period, including Rufous Turtle Dove, Black-billed Magpie (*Pica pica*), Great Tit (*Parus major*), Brown-eared Bulbul and Japanese White-eye (*Zosterops japonicus*). In terms of dominant species with relation to the seasons, Mandarin Duck (*Aix galericulata*) was the most dominant at 500 individuals (48.12%), followed by Rook (*Corvus frugilegus*) at 250 individuals (24.06%), Black-billed Magpie (*Pica pica*) at 36 individuals (3.46%), Barn Swallow (*Hirundo rustica*) at 34 individuals (3.27%) and Great Tit (*Parus major*) and Japanese White-eye (*Zosterops japonicus*) at 26 individuals (2.50%) each. In February, 500 individuals of Mandarin Duck (*Aix galericulata*) were found wintering in the Meonmulgyak Wetland within Dongbaekdongsan (includes the nearby Jocheon-eup Crown Gold Course).

The overall species diversity was 1.95, with the value 2.69 during spring, 2.87 during summer, 2.81 during fall and 1.29 during winter. The species diversity was low during the winter, because Mandarin Duck (*Aix galericulata*) and Rook (*Corvus frugilegus*) were observed at a ratio greater than that of other species, at 500 individuals and 250 individuals respectively.

10 species were added to the species observed between 2008 and 2010, including Japanese Night Heron (*Gorsachius goisagi*), Striated Heron (*Butorides striatus*), Chinese Pond Heron (*Ardeola bacchus*), Black-crowned Night Heron (*Nycticorax nycticorax*), Crested Honey Buzzard (*Pernis ptilorhynchus*), Cinereous Vulture (*Aegypius monachus*), White-bellied Green Pigeon (*Treron sieboldii*), Crested-winged Cuckoo (*Clamator coromandus*), Fork-tailed Swift (*Apus pacificus*) and Oriental Dollarbird (*Eurystomus orientalis*), and among these, Striated Heron (*Butorides striatus*), Chinese Pond Heron (*Ardeola bacchus*), Crested Honey Buzzard (*Pernis ptilorhynchus*), Fork-tailed Swift (*Apus pacificus*) and Oriental Dollarbird (*Eurystomus orientalis*) have also been confirmed by Kim and Kim (2005) (Table 2).

20 species observed during all 4 years of the long-term study conducted by the Ministry of Environment, between years 2008 and 2011, include Ring-necked Pheasant (*Phasianus colchicus*), Rufous Turtle Dove (*Streptopelia orientalis*), Common Cuckoo (*Cuculus canorus*), Lesser Cuckoo (*Cuculus poliocephalus*), White-backed Woodpecker (*Dendrocopos leucotos*), Fairy Pitta (*Pitta nympha*), Black Paraside Flycatcher (*Terpsiphone atrocaudata*), Eurasian Jay (*Garrulus glandarius*), Large-billed Crow (*Corvus*

macrorhynchus), Barn Swallow (*Hirundo rustica*), Great Tit (*Parus major*), Varied Tit (*Parus varius*) and Grey-capped Greenfinch (*Carduelis sinica*). Analysis of the number of species observed each year in the Seonheul-ri Dongbaekdongsan region shows that 29 species were observed in 2008, 32 species in 2009, 32 species in 2010 and 54 species in 2011. With the inclusion of records of past studies, a total of 73 species were observed.

The protected birds confirmed during the study include 8 natural monument species, including Mandarin Duck (*Aix galericulata*), Common Kestrel (*Falco tinnunculus*), Peregrine Falcon (*Falco peregrinus*), Cinereous Vulture (*Aegypius monachus*), Eurasian Sparrowhawk (*Accipiter nisus*), Northern Goshawk (*Accipiter gentilis*), Lesser Cuckoo (*Cuculus poliocephalus*) and Fairy Pitta (*Pitta nympha*), and 8 endangered species, including Japanese Night Heron (*Gorsachius goisagi*), Peregrine Falcon (*Falco peregrinus*), Cinereous Vulture (*Aegypius monachus*), Crested Honey Buzzard (*Pernis ptilorhynchus*), Northern Goshawk (*Accipiter gentilis*), Eurasian Sparrowhawk (*Accipiter nisus*), Fairy Pitta (*Pitta nympha*) and Black Paraside Flycatcher (*Terpsiphone atrocaudata*) (Table 3). 500 individuals of Mandarin Duck (*Aix galericulata*) were confirmed in the Meonmulgyak Wetland of Seonheul-ri, Gotjawal, and they tend to rest near nearby golf course pond during the day and feed on acorns within Gotjawal during the night. A single Japanese Night Heron (*Gorsachius goisagi*) was confirmed in the hiking trail of Seonheul-ri Gotjawal, and the species is the first summer migratory bird species to successfully reproduce in Jeju-do (Oh *et al.*, 2010). Predatory bird species, such as Common Kestrel (*Falco tinnunculus*), Peregrine Falcon (*Falco peregrinus*), Crested Honey Buzzard (*Pernis ptilorhynchus*), Cinereous Vulture (*Aegypius monachus*), Eurasian Sparrowhawk (*Accipiter nisus*), and Northern Goshawk (*Accipiter gentilis*) are highly migratory birds and were confirmed while they were flying over Gotjawal or resting on trees. Among these, 2 individuals of Cinereous Vulture (*Aegypius monachus*) from the original individuals which arrived in November of 2002 were left in the area, and reproduction of the species has yet to be sighted. Fairy Pitta (*Pitta nympha*) and Black Paraside Flycatcher (*Terpsiphone atrocaudata*) is believed to occur in Seonheul-ri. The result of the study on the population density of Black Paraside Flycatcher (*Terpsiphone atrocaudata*) in Jeju-do's east and west Gotjawal confirmed a single individual per 8,213 of the Seonheul-ri region (Kim *et al.*, 2011).

Discussion

The Seonheul Gotjawal region of Jeju-do (Is.), which is a site of long-term ecological study, include evergreen broad leaved forest and needle-leaved evergreen forest consisting

of *Castanopsis cuspidata* var. *sieboldii*, *Quercus glauca*, *Camellia japonica* and *Torreya nucifera*. The area also provides habitat for mammals such as Roe Deer (*Capreolus pygargus*) and Eurasian Badger (*Meles meles*) and amphibians such as Narrow-mouthed Toad (*Kaloula borealis*), Dybowski's Brown Frog (*Rana dybowskii*), Ussuri Mamushi (*Gloydius ussuriensis*) and Cat Snake (*Elaphe dione*). Fairy Pitta (*Pitta nympha*) and Black Paraside Flycatcher (*Terpsiphone atrocaudata*) were also confirmed to use Seonheul-ri Gotjawal region for breeding (Kim *et al.*, 2003; Kim *et al.*, 2011). Fairy Pitta (*Pitta nympha*) and Black Paraside Flycatcher (*Terpsiphone atrocaudata*) are species which breed in the main valleys of Hallasan (Mt.) and are index species which enable measurement of the ecological environment of birds in Hallasan (Mt.) (Kim, 2006). Therefore, future changes in the vegetation of Gotjawal caused by future climate changes are predicted to affect the breeding frequency and the number of individuals of wild birds.

The result of this study exhibited the increase in the annual number of species observed, and this may be the result of increasing the number of study sessions conducted per season and including birds observed outside the forest, since there was no significant changes in the habitat environment. Furthermore, the addition of species observed over the past few years may have also affected the appearance of sub-tropical birds. Recent changes in the climate have led to birds in Europe to migrate towards the east (Huntly *et al.*, 2007), and there has also been an increasing number of report in Asia on birds which were typically found in sub-tropical region in the past (Park and Kim, 1995; Park *et al.*, 1995; Kim *et al.*, 2005; Kim and Lee, 2006; Jin *et al.*, 2006; Kim and Choi, 2007; Kim *et al.*, 2009; Oh *et al.*, 2010; Kim *et al.*, 2010). With the confirmation of Japanese Night Heron (*Gorsachius goisagi*), White-bellied Green Pigeon (*Treron sieboldii*) and Chestnut-winged Cuckoo (*Clamator coromandus*) for the first time in this study on the Dongbaekdongsan evergreen forest, there is a need to continuously monitor the future migratory path, migratory pattern and breeding trend of sub-tropical birds.

Furthermore, according to the recent 10 years of study on Seonheul-ri Gotjawal region, 72 species were observed, and 6 additional species, including Japanese Night Heron (*Gorsachius goisagi*), Black-crowned Night Heron (*Nycticorax nycticorax*), Eurasian Teal (*Anas crecca*), Cinereous Vulture (*Aegypius monachus*), White-bellied Green Pigeon (*Treron sieboldii*) and Chestnut-winged Cuckoo (*Clamator coromandus*), were confirmed. The bioindex species of climate changes reported recently by the National Institute of Biological Resources confirmed 7 species, including Great Tit (*Parus major*), Japanese White-eye (*Zosterops japonicus*), Grey Heron (*Ardea cinerea*), Little Egret (*Egretta garzetta*), Chinese Pond Heron

(*Ardeola bacchus*), Great Egret (*Egretta alba*) and Fairy Pitta (*Pitta nympha*). Migratory birds of Jeju-do, Great Tit (*Parus major*) and Japanese White-eye (*Zosterops japonicus*), were observed in all 4 regions, and there is a need to select the 2 species as the representative species of the region for the monitoring of changes in the colonies in relation to changes in climate and vegetation changes.

Since Seonheul Gotjawal includes small-scale wetlands and arrival grounds for migratory birds in Hado-ri, Gujwa-eup and Ojo-ri, Seongsan-eup within 30km radius, the area is frequently used as stopping grounds during migration. Therefore, continuous study in the area will lead to the confirmation of more species.

The wildlife diversity of a region is directly influenced by the area's food resource, water source, plant resource, hiding place, nesting ground and artificial interference, so artificial interference must be minimized. With the recent increase in the focus on Gotjawal, there has been an increase in the number of ecological studies conducted in the area. Therefore, appropriate measures must be taken to protect wild bird habitat. On December 30th of 2011, 1,546,757 of Gotjawal of Daejeong-eup, Seoguipo-si was designated as the Jeju Gotjawal National Park, and this is highly encouraging in terms of efforts being made to preserve the biodiversity and ecology of Gotjawal.

Since changes in biodiversity are caused by factors such as climate change, habitat change and artificial interference, there is a need to establish regular monitoring as an appropriate measure of preserving wildlife habit.

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