


SHORT COMMUNICATION

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Re-emergence of the Glossy Ibis (*Plegadis falcinellus*) in inland South Korea



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Abstract

Glossy Ibis (*Plegadis falcinellus*), which has never been recorded in South Korea, appeared on Jeju Island in 2018 and re-emerged in the inland area of Seocheon-gun (South Chungcheong Province) and in Goyang-si (Gyeonggi Province) in the following year. This study aims to report the progress in observing *P. falcinellus* in the inland areas of South Korea in 2019 and to predict its origin region and future propensity for habitats in the country through literature review. On 5 May 2019, an individual of *P. falcinellus* with breeding feathers was observed in a farmland in Wolsan-ri, Seocheon-gun. Twelve days later, another one was identified in a farmland in Janghang-dong, Goyang-si, about 173 km north of Wolsan-ri. The observed birds fed and rested in the area and stayed for only a day. The individual birds spotted in South Korea in 2019 are conjectured to have come from either Southeast Asia or Australia, among areas located in East Asian-Australasian Flyway (EAAF). This is because *P. falcinellus*, a species with excellent dispersal capacity, forms a population in new areas during extreme environmental changes in their current habitats, especially droughts. For 2 years, *P. falcinellus* was observed to be migrating in spring; however, in the future, they may exhibit the same propensity for breeding and habitats as that of birds migrating in autumn. As it is a conspicuous species, effective detection of their arrival requires a survey system that classifies the country by habitat type and involves periodic and multiple observations by experts and citizens.

Keywords: Dispersal, *Plegadis falcinellus*, Propensity, Re-emergence, Rice field, South Korea

Background

There are 36 species of Threskiornithidae, including ibises and spoonbills (Gill and Donsker 2019). The Glossy Ibis (*P. falcinellus*) is among the smaller species at about 60 cm in length and weighing approximately 650 g (Hancock et al. 1992). It is found on all continents, except Antarctica (Matheu and del Hoyo 1992; Hagemeyer and Blair 1997; Davis Jr. and Kricher 2000; Figuerola et al. 2004; Clobert et al. 2012; Gill and Donsker 2019), thereby demonstrating fragmented distribution (Birdlife International 2019). *P. falcinellus* is a type of wader (Santoro 2019), which is a biomarker group sensitive to global environmental changes. It is a least concern (LC) species on the International Union

for Conservation of Nature (IUCN) Red List. Moreover, it is a protected species under the African-Eurasian Migratory Waterbird Agreement (AEWA) and is listed in Annex II of the Convention on Migratory Species (CMS). However, its population is in decline on a global scale (Birdlife International 2019).

The Stork, Ibis, and Spoonbill Specialist Group (SIS-SG), one of the 18 bird specialist groups in IUCN, which was founded in 1981, has 97 specialists over five continents (Rodríguez 2019). The SIS-SG published the SIS Conservation Journal in 2019 to disseminate information on the conservation and management of population ecology and habitats of SIS distributed across the world. The theme of the first issue is the ecology and conservation of Glossy Ibis (*Plegadis falcinellus*), thus implying its significance (Gopi-Sundar and Cano-Alonso 2019).

Compared to other bird species, *P. falcinellus* is nomadic, thereby making its ecological research difficult (Hancock et al. 1992; Zwarts et al. 2009; Santoro et al.

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2013; Santoro et al. 2016; Santoro 2019). *P. falcinellus* was breeding in Morocco and Algeria in North Africa until the nineteenth century (Thévenot et al. 2003). After no confirmation on its breeding for nearly a century, it has been reconfirmed in Morocco since the 1980s and in Algeria since 1998 (Nedjah et al. 2019; Nefla et al. 2019). In Europe, the species was breeding in the southern Italian island and the Sardinia islands in the central Mediterranean region until the early 1980s (Grussu 2019). After a hiatus of about a decade, it began colonization in the Spanish Donaña National Park located on the Iberian Peninsula in the western Mediterranean region in 1996 (Figuerola et al. 2004). Another colonization occurred in Camargue in southern France in 2006 (Champagnon et al. 2019).

Meanwhile, in Asia, *P. falcinellus* inhabits mostly the Middle East and Southeast Asia (Matheu and del Hoyo 1992; Eaton et al. 2016; Lee et al. 2018). In Northeast Asia, it is a known vagrant, which emerges occasionally (Brazil 2009). In Japan, there are official records of observations from Tokashiki Island and Kin-cho in Okinawa in 2014 (Morita et al. 2014; Miyajima et al. 2015). In China, it has been observed intermittently since 2009 in the Yunnan Province, adjacent to Myanmar and Laos; in 2019, its breeding was confirmed in Hanzhong, Shaanxi, where there had not been a single observation before (available on <https://news.cgtn.com/news/2019-07-25/Rare-glossy-ibis-eggshells-found-in-NW-China-IBRMov4A9O/index.html>). In South Korea, unlike Japan and China, there was no record of *P. falcinellus*, but in 2018, three individuals were first identified in the Yongsu-ri wetland in Hankyung-myeon, Jeju (Kang et al. 2019). Jeju is the southernmost region of South Korea, with China to its west and Japan to its east, and thus is on the bird migration route, making it a location where various bird species make an appearance (Oh et al. 2010; Kim et al. 2011). Therefore, it is difficult to determine whether the *P. falcinellus* individuals appearing in Jeju were simply lost after deviating from their path or whether they have expanded their area. The re-emergence of *P. falcinellus* in 2019 in Seocheon-gun of the South Chungcheong Province and Goyang-si of the Gyeonggi Province, which are both located north of Jeju, indicates that the species is more likely to use the country as their habitat. The purpose of this study is to report the progress of *P. falcinellus* observed in inland areas of South Korea in 2019 and to predict its region of origin and future propensity of inhabitation in the country through a study of foreign literature.

Methods

This study was conducted in a farmland located in Wolsan-ri, Hwayang-myeon, Seocheon-gun, South Chungcheong Province, and a site in Janghang-dong, Ilsandong-gu, Goyang-si, Gyeonggi Province. Wolsan-ri farmland (Fig. 1

(A)) is close to a two-lane Hwahan-ro in the southeast and a solar power plant in the southwest; however, it stretches about 400 m in the direction of the forest zone connecting to Gamtubong Peak. Except for farmers cultivating in the area, few people have access. Janghang-dong farmland (Fig. 1 (B)) is included in the Janghang wetland. The Janghang wetland stretches 7.6 km to Beopgot-dong, Ilsan Seo-gu, on the west and to Sinpyeong-dong, Deokyang-gu, on the east with a maximum width of 0.6 km and an area of 7.5 km² (land 2.7 km² and mudflats 4.8 km²). This wetland is rich in biodiversity and is composed of different types of habitats, including a variety of forest wetlands mainly consisting of a *Salix subfragilis* community, wet meadows with herbaceous plants, mudflats, and farmlands (Han et al. 2010, 2012; Yang et al. 2019). In recognition of this, the Janghang wetland was designated as a protected wetland area (Ministry of Environment Notice No. 2006-58) in 2006 and the EAAF Network site 143 (available on <https://www.eaaflyway.net/rok/>) in 2019.

As this study area was a type of open habitat, the bird survey employed a census methodology using telescopes and binoculars. Whenever nationally protected species (endangered wildlife, natural monument, and marine protected organism) or vagrants appeared, they were photographed or recorded using devices, such as smartphones and cameras.

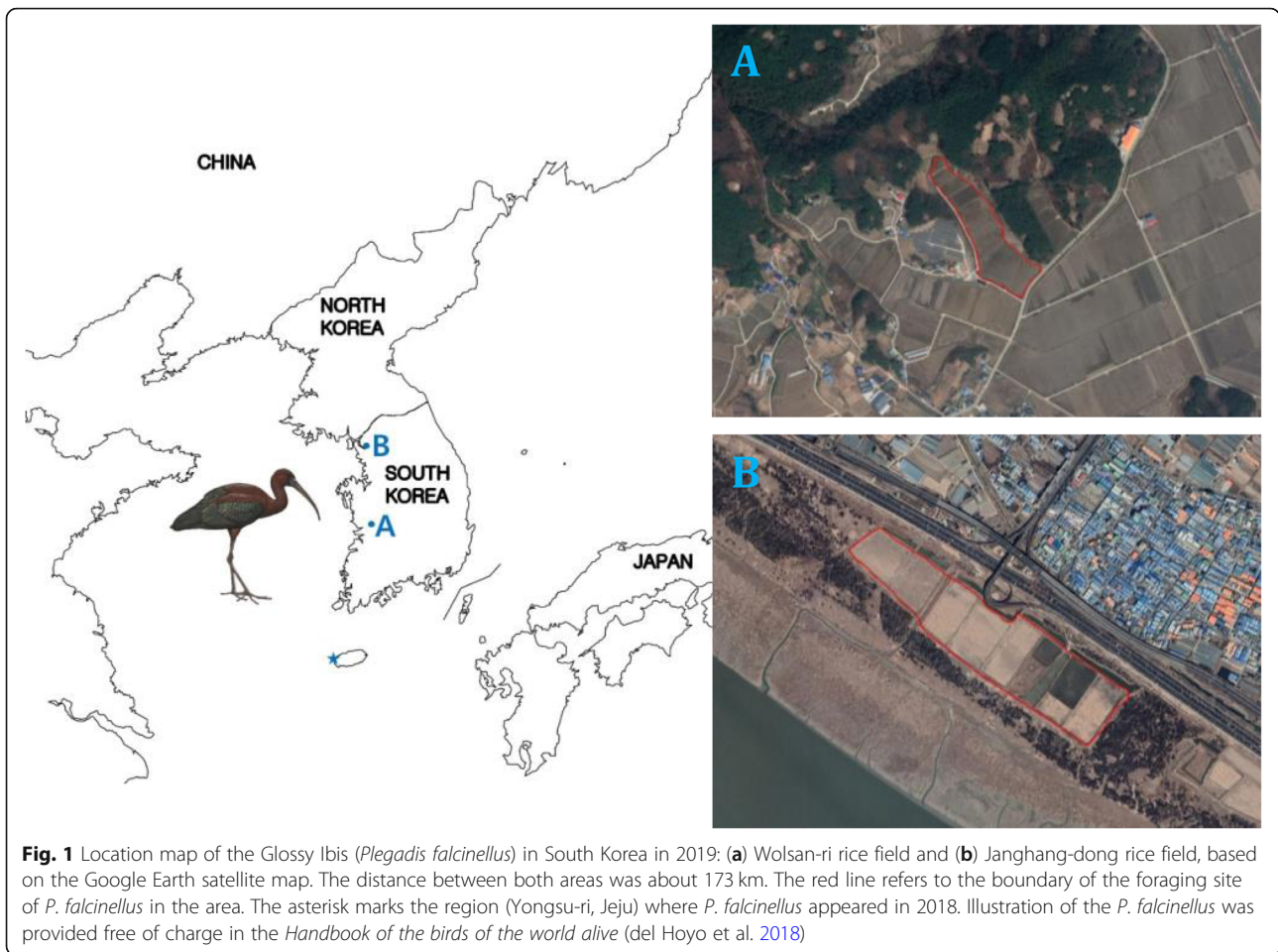
Results

On 5 May 2019, one *P. falcinellus* appeared in the farmland of Wolsan-ri (Fig. 2). It had breeding feathers (Lee et al. 2018) with reddish-brown feathers on its head, neck, back, chest, and belly; moreover, it had glossy green and purple feathers on its upper wings. It slowly roamed in the middle of the farmland and used the pecking method of contacting the substrate with its bill to search for prey items. Then, it repeatedly picked up and put down the animal prey items with its bill before swallowing it. Furthermore, it obtained water from its bill to preen the feathers (Video S1). The following day, full-scale planting took place in the area, after which *P. falcinellus* was no longer observed. Twelve days later, on 17 May 2019, *P. falcinellus* appeared in the farmland of Janghang-dong, which was about 173 km north of Wolsan-ri (Fig. 2). Like the observations in Wolsan-ri, one individual with breeding feathers was spotted and it showed the same behavioral pattern. Shortly after the appearance of *P. falcinellus*, planting on the farmland of Janghang-dong was done, and the individual was no longer there.

Discussion

Commonalities between the two regions

There are a few commonalities in the observations of *P. falcinellus* in both areas in 2019. First, *P. falcinellus* is an



opportunistic species that uses a variety of strategies to obtain prey items, of which pecking and probing techniques using tactile sensation are commonly employed (Kushlan 1978; Trocki and Paton 2006). Their main prey items are aquatic insects and crustaceans, and they are known to feed on fish, amphibians, and occasionally reptiles (Hancock et al. 1992; Matheu and del Hoyo 1992). However, they tend to eat these animal diets mostly during the breeding periods when energy and nutritional

requirements are high (Kushlan 1981; Acosta et al. 1996). The fecal analysis of adults using 15 *P. falcinellus* nests in 2000 and 36 vomits of fledglings just before leaving their nests in 2001 revealed that they were varying types of animal diets (Macias et al. 2004). In addition, analyses of prey items of chicks conducted in 2004, 2005, and 2007 found that animal diets were predominant (Nedjah et al. 2019). *P. falcinellus* individuals were all observed in May, and the months from April to



June are the migration and breeding season for birds inhabiting and arriving in South Korea (NIE 2019); thus, it is believed that they mainly fed on animal diets in the areas. Second, both areas are farmlands irrigated before planting. By the time of the arrival of waders, such as *P. falcinellus*, most rice paddies in the country have already been irrigated and farming activities, such as plowing, have taken place, forming various types of physical structures and providing important foraging sites for the species (Choi et al. 2014; Nam and Kim 2017). For *P. falcinellus*, which was in need of animal diets, the farmlands were the optimal places for eating them. Third, both areas are located in the western part of the country and are adjacent to the mouth of major rivers. The Wolsan-ri farmland is separated by about 2 km from the waterfront area at the mouth of the Geumgang River, and the Janghang-dong farmland is next to the mouth of the Han River. Western South Korea has 83% of the country's total mudflats as well as a variety of wetland environments, including major river estuary, farmland, and reservoirs, which are home to a wide variety of benthos (Park et al. 2007). The case of *P. falcinellus*, which appeared in Jeju in 2018, also shows geographic commonality in that Yongsu-ri, Hangyeong-myeon, is a wetland adjacent to the west coast of Jeju, although it is an island separate from the inland area. Finally, only one individual with breeding feathers was found and the duration of stay in the areas was 1 day. Given the distance between the two areas and the difference in the dates of each spotting, it is highly probable that it was the same individual, even though no ringing was done. In conclusion, *P. falcinellus*, which appeared in the inland areas of South Korea in 2019, is believed to have been around farmlands and wetlands distributed in the western part of the country. The pattern is different from the month ranging from mid-April to mid-May 2018, when its activity was limited to a narrow area of wetlands of Yongsu-ri and Yongdang-ri, Hangyeong-myeon, Jeju (Kang et al. 2019).

Why did they disperse to South Korea?

Dispersal of birds can be used as important data for studies on the population structure and dynamics of the species, behavioral ecology research, and the development of conservation strategies (Clobert et al. 2012). It is typically determined by a variety of internal factors, including age, gender, and body condition, and can be distinguished by external factors, such as social status, climate, and habitat environment change (Figuerola 2007; Clobert et al. 2012). *P. falcinellus* has the greatest dispersal capability of any bird species (Patten and Lasley 2000). An individual born in the Spanish Donana National Park was observed in the Bermudas and Trinidad, about 6000 km away across the Atlantic Ocean (Santoro

et al. 2013). The populations inhabiting North America were formed by the European populations that had crossed the Atlantic Ocean (Oswald et al. 2019). Judging from their dispersal abilities, the fact that the appearance of *P. falcinellus* had no observable record of the species in South Korea, but often observed in Japan and China adjacent to South Korea, can be seen as a natural event. However, it is necessary to infer the fundamental cause of the arrival of *P. falcinellus* in the country. According to the recent study, drought has been cited as a cause of their recent dispersal. Drought is a known determinant of breeding of water birds (Santoro et al. 2013). In the case of ibises, the mortality rate of the fledglings increases as adults give up breeding nests during drought (Kingsford and Johnson 1998). Among the ibis species, *P. falcinellus* is sensitive and vulnerable enough to skip breeding in severe droughts. In fact, populations living in the Spanish Donana National Park did not reproduce in 1999 and 2005 when severe droughts occurred (Toral et al. 2012). In addition, *P. falcinellus* was reported to leave the area, where it was originally breeding in catastrophic drought, and form a population in a new area (Santoro et al. 2013).

P. falcinellus, which appeared in South Korea in 2018 and the following year, is highly likely to be from a population coming from Southeast Asia, which is one of the most important breeding grounds in the world (Matheu and del Hoyo 1992), and is the closest to South Korea in terms of distance, among all the regions located on the East Asian-Australasian Flyway (EAAF). Furthermore, droughts in Southeast Asia have been serious over the past few decades, including 2019, when *P. falcinellus* first appeared in South Korea. According to a report published by the UNESCAP (2019), drought in Southeast Asia over the past three decades has been caused by declining precipitation due to the El Niño phenomenon. The report added that unless nations do not take countermeasures, the areas affected by drought will expand by 2050 to include the northern parts of Southeast Asia, including Vietnam, Cambodia, and Thailand; moreover, the rate of droughts in Java, Indonesia, will increase from 62 to 72%. If *P. falcinellus* observed in South Korea indeed came from Southeast Asia, it could be related to the sustained drought in the region. However, the odds of it arriving from the Australian region cannot be entirely ruled out. The Australian population of *P. falcinellus* is observed in freshwater wetlands and coastal areas throughout the country, with the core breeding ground being the Murray-Darling Basin located in the state of New South Wales. Over the past 230 years since European settlement, more than 50% of the wetlands in Australia have disappeared due to the water level control and drainage installations (Finlayson and Rea 1999). The dams built in the Murray-Darling river have changed the flow of water, posing a

grave threat to the maintenance of the wetland environment that *P. falcinellus* favor (Brandis et al. 2011). Most of all, in 2019, Australia witnessed high temperatures and the lowest humidity and precipitation on record, causing a wildfire that began in New South Wales in September, which spread across the country (AGBM 2019). Although *P. falcinellus* is known to be an indigenous species of Australia (Marchant and Higgins 1990), there is a real possibility that it will risk a long-distance travel to settle elsewhere, given that some of these wader species, such as shorebirds, have arrived in South Korea flying from the Oceanian continent, including Australia (Park et al. 2013). However, the *P. falcinellus* that arrived in South Korea in 2018 and the following year cannot be identified as the same individual; thus, further studies with ringing to mark individual birds or movement tracking studies with attached transmitters will be required.

Inference of inhabitation propensity in South Korea

P. falcinellus, which arrived in South Korea in 2018 and the following year, came during the spring season and did not attempt to breed. If it continues to arrive in the future, it may appear only during spring, or it may show different inhabitation propensities. Among them, it is likely to show a different propensity for breeding. *P. falcinellus*, which occasionally nests in emergent vegetation, such as *Phragmites communis* and *Typha orientalis*, but generally nests in shrubs and trees separated from the ground (Davis Jr. and Kricher 2000), breeds more with other kinds of water birds, especially egrets and herons, rather than breeding within a single colony (Marchant and Higgins 1990; Amezian et al. 2012; Nefla et al. 2012; Grussu 2019; Iankov and Popgeorgiev 2019; Nedjah et al. 2019; Onmuş and Karauz 2019; Sultanov 2019; Vera et al. 2019). The NIER (2012) data, which summarize the status of egrets and herons in South Korea through literature and field studies, record 174 breeding grounds of egrets across the country, most of which are located in areas linked to human activities. Although *P. falcinellus* is sensitive to human interference during the breeding season (Nedjah et al. 2019), it is likely to enter the local breeding grounds of egrets and herons and reproduce in a mixed way. Moreover, it arrived in 2019 for the first time in Hanzhong, Shaanxi, where there was no record of observation before and even reproduced in a region close to South Korea (available on <https://news.cgtn.com/news/2019-07-25/Rare-glossy-ibis-eggshells-found-in-NW-China-IBRMov4A9O/index.html>). This raises expectations for its breeding in South Korea. Another potential inhabitation propensity type is that autumnal migratory bird's exhibit. *P. falcinellus* shifted to plant diets, especially fallen rice grains during non-breeding periods, unlike the breeding period, when it relies on animal diets (Taylor and

Schultz 2010; Toral et al. 2012). Counting populations in agricultural areas in the Sancti Spiritus region of Cuba by breeding and non-breeding periods has resulted in a greater concentration of populations during the non-breeding season (217 individuals/ha) compared to the breeding season (1.4 individuals/ha). This result is supported by the significant amount of grit entering body in the process of digesting fallen rice grains in the non-breeding season. In fact, fallen rice grains were found in the stomach of a *P. falcinellus* found in February 1995 in Louisiana, USA (Acosta et al. 1996). In South Korea, a large number of ducks, geese, and cranes started arriving in the fall season and fed mostly on fallen rice grains obtained from farmland after harvest. Thus, if the path of *P. falcinellus* for spring and fall migration is the same, they could feed on fallen rice grains from farmland.

Recommendation of effective survey system

P. falcinellus has prominent reddish-brown, glossy green, and purple feathers (Lee et al. 2018). Due to its continued use of agricultural land (Matheu and del Hoyo 1992; Hancock et al. 1992; Taylor and Schultz 2010), there is no particular difficulty in identifying them. However, when they appeared, there should be a periodic survey system that can effectively detect their presence. South Korea has been conducting the National Ecosystem Survey for more than 30 years since 1986, a survey which spans the whole country to identify the distribution and status of biodiversity components for efficient management of national land (NIE 2019). The National Ecosystem Survey, which began its fifth round in 2019, sought to move away from the conventional biospecies inventory-based survey system in order to focus on habitat type-specific surveys and to avoid focus on only parts of habitat types. In addition, it used to be carried out only by professional experts; thus, it was not able to raise public awareness on the importance of the ecosystem. Many countries are expanding the application of citizen science to collect results by utilizing citizens' contribution. The 5th National Ecosystem Survey also aimed to introduce such type of citizen science (NIE 2019). In fact, *P. falcinellus* that was observed in the Janghang-dong farmland in 2019 was confirmed by citizen's scientific monitoring.

Conclusions

P. falcinellus is the most common species of SIS-SG, but it is one of the few species with an expanding distribution area (Gopi-Sundar and Cano-Alonso 2019). Furthermore, with extreme climate change events taking place globally, it has demonstrated excellent dispersal ability and ecological flexibility (Santoro 2019), indicating the necessity for an ecological study on *P. falcinellus*.

As for South Korea, the Crested Ibis (*Nipponia nippon*), which was extinct in 1979, drew national attention

when 40 individual birds were released on May 22, 2019, by a restoration project started from a donation obtained from China in 2008 (available on <http://www.cng.go.kr/tour/ibis.web>). At the same time, two consecutive years of identifying *P. falcinellus*, an ibis species that has not been recorded in the past in South Korea, serves as an encouraging event for further research. It will be interesting to observe whether this will end up as a fragmentary phenomenon without further effect or if it will turn South Korea into a region with a new metapopulation of *P. falcinellus* with its continuous appearance.

Supplementary information

Supplementary information accompanies this paper at <https://doi.org/10.1186/s41610-020-00162-x>.

Additional file 1 : Video S1. Glossy Ibis (*Plegadis falcinellus*) in Seocheon-gun foraging and preening on May 5, 2019.

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Authors' contributions

DH and JYC carried out the field survey. SYL and HCS conducted the relevant reference study. SYL drafted the manuscript. HCS, DH, and JYC reviewed/edited the manuscript draft. DH and JYC made equal contributions to this study. All authors have read and approved the final manuscript.

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Availability of data and materials

The photo and video generated during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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