Research note

Breeding Biology of the Invasive Asian Glossy Starling (*Aplonis panayensis*) in Urban Parks of Kaohsiung City, Southern Taiwan

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【Summary】

The Asian Glossy Starling (*Aplonis panayensis*) has been present in southern Taiwan since 1990. This study investigated the breeding biology of *A. panayensis* in Kaohsiung City of southern Taiwan from April to August 2000. We found 36 nests, which were constructed using both natural and artificial materials. Seventy-three eggs (2 were broken during the study period) in 25 clutches were found, and the modal number of eggs per clutch was 3. Heavier eggs showed greater hatching success. Forty-four chicks hatched from the 71 monitored eggs. The overall hatching success observed during the study period was 62.0%. Nineteen of the 44 nestlings (43.2%) fledged. The reproductive success of *A. panayensis* in southern Taiwan was therefore estimated to be 26.8% (19 fledglings from 71 eggs). The *A. panayensis* population has been reported throought the island, and reproduction records have been documented in Yilan, Taichung, Chiayi, Kaohsiung City, and Pingtung County during 1990~2010. Control methods, such as removing nests and netting adults, especially within the breeding season, have been suggested to decrease the population of *A. panayensis* in Taiwan.

Key words: *Aplonis panayensis*, breeding biology, exotic bird, Taiwan.

Shieh BS, Lin CJ, Liang SH. 2016. Breeding biology of the invasive Asian Glossy Starling (*Aplonis panayensis*) in urban parks of Kaohsiung City, southern Taiwan. Taiwan J For Sci 31(1):61-8.

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Received August 2015, Accepted October 2015. 2015年8月送審 2015年10月通過。

研究簡報

入侵鳥種菲律賓輝椋鳥在高雄市市區公園之生殖生物學研究

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摘 要

自1990年，外來鳥種菲律賓輝椋鳥(*Aplonis panayensis*)即出現於南台灣，但是，對於該鳥種進入台灣後之生殖適應並無太多資料。本研究於2000年4~8月觀察該鳥種的生殖需求、生殖週期與幼鳥成長。研究期間，共發現36個巢，巢位均位於高雄文化中心樑柱凹槽內懸吊式日光燈燈管基座上方為減少晃動所置放之厚紙板上，使用巢材包含樹枝枝條、棉花等自然材料及塑膠線、魚線、銅線與厚紙板等人工材料。在25個監測之繁殖巢中，共發現73顆蛋。不過，監測過程中，其中兩顆蛋破裂。在持續監測的71顆蛋中，共孵化出44隻雛鳥。孵化率為62.0% (44/71)。每巢孵化雛鳥數以3隻最多，成功孵化的蛋重明顯重於孵化失敗的蛋。44隻監測之幼雛中，共有19隻成功離巢(離巢率43.2%)。由此估算，在南台灣之輝椋鳥生殖成功率估算為26.8% (71顆蛋，有19隻成功離巢)。在1990至2010年間，灰椋鳥繁殖記錄已出現於宜蘭、台中、嘉義、高雄市及屏東縣等區域，族群分布也已遍佈全島，在繁殖季節移除鳥巢及捕捉成鳥可能為較有效管制該入侵鳥種的方法。

關鍵詞：菲律賓輝椋鳥、生殖生物學、入侵鳥種、高雄市、台灣。

謝寶森、林宗鍵、梁世雄。2016。入侵鳥種菲律賓輝椋鳥在高雄市市區公園之生殖生物學研究。台灣林業科學31(1):61-8。

The introduction of exotic species throught the world has been described as causing substantial ecological and economical damage, such as habitat alteration, species extinction, and global homogenization (Shigesada and Kawasaki 2001). At least 93 species of exotic birds have been recorded in Taiwan, and one-third of these species are recorded as having bred in the wild (Shieh et al. 2006). Although there have been several studies of bird invasions, there has been very few autecological research on introduced birds of Taiwan (Severinghaus and Li 1999, Shieh et al. 2006).

The Asian Glossy Starling (*Aplonis panayensis*) was originally distributed from India to the Philippines (Tan 2001). This bird has a slim body that allows it to fly rapidly, and it may travel long distances to urban and natural areas to survive. Craig and Feare (2009) indicated that this species is highly gregarious, roosts in flocks, and feeds mainly on fruits, nectar, and insects. It breeds during the entire year in its native range, with a peak in March through June. It nests in tree holes and in the tree canopy (Craig and Feare 2009). This species is often considered to be a pest that damages fruit trees and agricultural crops (Tan 2001).

Aplonis panayensis was first recorded in Kaohsiung City, Taiwan in 1990 (Chang 2008). *Aplonis. panayensis* has since expanded its distribution and increased its population on the island. Its presence has been noted in highly urbanized areas, such as city cultural centers, residence areas, and urban parks (Lin 2001). Lin (2001) documented that at least

134 individuals were found in 15 cities in Taiwan in 2001, and 90% of them were found at elevations of < 200 m. Shieh et al. (2006) found that *A. panayensis* is one of 28 exotic birds that has been reported to breed outside of captivity in Taiwan. However, Craig and Feare (2009) reported that *A. panayensis* was listed as a rare exotic escapee and that its breeding status in Taiwan was unconfirmed. The published record thus provides a limited understanding by international researchers of the current status and biological adaptation of *A. panayensis* after it was introduced into Taiwan. This study therefore collected field information on the breeding biology, including nest sites, nest materials, clutch size, and brood size, of *A. panayensis* in 2000. The results of this study were intended to establish the basic reproductive characteristics of *A. panayensis* in an urban environment of Taiwan and suggest a management strategy for this species within the island.

This study was conducted on a colony of more than 350 *A. panayensis* that inhabited the Houping campus of National Kaohsiung Normal University (NKNU) and Kaohsiung City Cultural Center (NCCC) during 2000. The NCCC has an area of 16.5 ha and contains 32 plant species, including 25 exotic species and 7 native species. The most common plant species are *Livistona chinensis* and *Ficus microcarpa*. The area of the NKNU campus is approximately 10 ha with 71 documented plant species.

Nests of *A. panayensis* at NCCC were searched and found on the tops of hinged fluorescent lamps that were mounted in depressions in each pillar along all of the hallways. We documented the nests at NCCC and examined nest materials from April through August 2000.

We searched for *A. panayensis* nests at NCCC that had evidence of reproductive activities on Tuesday, Thursday, and Saturday of each week from 7 April to 20 August 2000. Egg laying was determined to be completed and clutch size was established when the number of eggs was unchanged on 2 or more visits that were separated by at least 24 h (Mayor-Gross 1972). The same criterion was used to determine the brood size. Durations of egg laying, incubation, and brooding were also recorded. These data could be collected for only a limited number of nests because continuous observation of a nest was difficult.

The length and width of each egg were measured. The body weight, body length, and tarsus length of nestlings whose time of hatching was known were measured each day.

Analysis of the data in this study was performed using SAS (vers. 6.12; Cary, NC. USA), and the significant level was set to 0.05. A *t-test* was used to test the significance of differences between the weights of eggs that hatched successfully and those that failed to hatch. A growth formula was established that was based on Ricklefs (1967).

Hatching success was defined as the percentage of eggs that hatched (Mayer-Gross 1972). Fledgling success was defined as the percentage of chicks that fledged (Kentish et al. 1995). Reproductive success was defined as the percentage of eggs laid that resulted in fledged chicks (Kentish et al. 1995).

In total, 36 nests were observed. All were built in the depressions of pillars along hallways and were situated 3~6 m above the ground. The distance between 2 nested pillars ranged 0.5~13.8 (mean ± 1standard error (SE): 4.8 ± 0.6) m. Nest heights were approximately 18 cm, and nest lengths varied 18~81 cm, with a mean of 52.2 (n = 33, SE = 2.7) cm.

The nest was cup-shaped and was built with both natural and artificial materials. The basal structures were mainly supported by

twigs of *Cassis siamea*, *Pterocarpus indicus*, and *Cassia surattensis*. Of the 28 nests whose constituents were identified, 9 (32.1%) included yellow palm (*Chrysalidocarpus lutescens*) and 16 (57.1%) used at least 1 type of artificial material, such as cotton and plastic thread, fishing line, copper wire, or cardboard.

Thirty-seven clutches in 21 nests were recorded in 180 observation hours over 136 study days. One to 3 clutches were observed in each nest. We observed 10 nests that had only 1 clutch, 6 nests that had 2 clutches, and 5 nests that had 3 clutches. The interval between successive clutches ranged 7~65 d, with an average of 21.8±5.9 d (n = 13).

In total, 73 eggs in 25 clutches were monitored, but 2 were broken during the study period (Table 1). The egg-laying period lasted 3~8 d, with a mean of 5.0±1.2 d (n = 5). Each clutch contained 1~4 eggs; the modal number of eggs was 3. The highest monthly total number of eggs (30) was laid in May, and the lowest monthly total (3) was laid in August (Fig. 1).

Egg weight ranged 2.8~6.5 g, with a mean of 5±0.1 g (n = 71). Egg length ranged 24~28.4 mm, with a mean of 26.1±0.1 mm. Egg width ranged 17.8~20.7 mm, with a mean of 19.1±0.1 mm.

The incubation period lasted for 11~15 d, with a mean of 13.5±0.3 d (n = 22). In total, 44 chicks (61.9%) hatched from the 71 eggs in 25 clutches. At least 1 egg hatched in 19 (75.8%) of the 25 clutches. Eggs that successfully hatched were heavier (5.2±0.7 g) than those that failed to hatch (4.7±1.2 g) (t = 2.6, $p < 0.05$, n = 71). Clutches that contained 3 or 4 eggs had a higher rate of hatching success than those that had 1 or 2 eggs (Kruskal-Wallis test, $p < 0.05$).

There were already nestlings present in the study area when this study began. In total, 87 nestlings were recorded. The highest number (28) was recorded in April, and the lowest number (4) was recorded in August (Fig. 1). In total, 62 (71%) of the 87 nestlings successfully fledged.

The first fledgling was observed on 12 April. The duration of the period from hatching to fledgling was 15~24 d (mean: 20.3±0.7 d, n = 14).

The hatching weight of nestlings ranged 3.9~16 g, with a mean of 7.7±0.5 g (n = 33). Tarsus length at hatching ranged 7.5~14.4 mm, with a mean of 10.2±0.3 mm (n = 33). The increase in tarsus length reached on asymptote at approximately 11 d after hatching.

The formulae used for the daily growth rate of body weight, body length, and tarsus length of the nestlings (n = 17, non-linear regression, $p < 0.05$) are listed as follows (Fig. 2): Body length = $132.7 / (1 + e^{-0.2\,(t - 5.3)})$;

Table 1. Total numbers of eggs, nestlings, and fledglings for 4 clutch sizes of *Aplonis panayensis* in urban parks of Kaohsiung City in southern Taiwan during April to August 2000. Hatching, fledgling, and reproductive success were also calculated based on monitored eggs, nestlings, and fledglings

	Eggs / clutch				Total	
	1	2	3	4		
Nests	2	3	15	5	25	
Eggs	2	6	45	20	73 (2 broken)	Monitored eggs 71
Nestlings	1	0	27	16	44	Hatching success 62.0% (44/71)
Fledglings	0	0	16	3	19	Fledgling success 43.2% (19/44)
Reproductive success (%)					26.8% (19/71)	

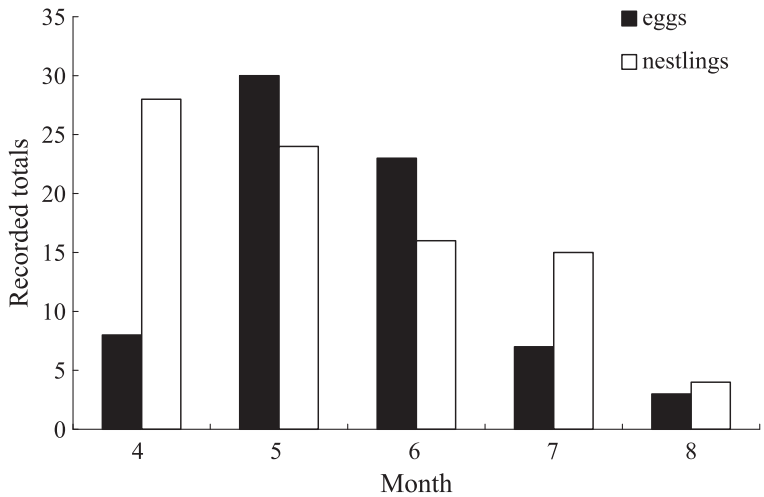

Fig. 1. Monthly totals of eggs and nestlings of *Aplonis panayensis* in urban parks of Kaohsiung City in southern Taiwan from April to August 2000.

Body weight = $45.7 / (1 + e^{-0.338 (t - 5.7)})$; and Tarsus length = $32.1 / (1 + e^{-0.17 (t - 4.7)})$.

Based on the 71 eggs (another 2 were broken) that were observed from hatching to fledgling from April to August 2000, the hatching success of *A. panayensis* was 62.0% (44 nestlings from 71 eggs) (Table 1). Nineteen of the 44 nestlings (43.2%) fledged. Based on these 2 estimates, the reproductive success rate of *A. panayensis* in southern Taiwan was 26.8% (19 fledglings from 71 eggs).

There is only limited information available on the breeding biology of *A. panayensis*. Craig and Feare (2009) listed the breeding seasons of *A. panayensis* in southern Asia, including Northeast India, Malaysia, Java and Bali, and the Philippines. They also noted that nests of *A. panayensis* are usually built in holes in cliffs or banks or in holes that had been excavated by kingfishers (Alcedinidae). The same authors stated that the clutch size of *A. panayensis* is 3 eggs. Much of the information reported by Craig and Feare (2009) had also appeared in Feare and Craig (1999). Additionally, Craig and Feare (2009) stated that there was no available information on the incubation and nestling periods of *A. panayensis*. This suggested that the information on the reproduction of *A. panayensis* had not been updated since 1999.

Although the original distribution of *A. panayensis* does not include Taiwan, the present study has made significant contributions to the understanding of the breeding biology of *A. panayensis*. Craig and Feare's (2009) speculation that *A. panayensis* breeds in Taiwan is confirmed. The clutch size of this introduced bird in Kaohsiung City of southern Taiwan is consistent with previous reports (Craig and Feare 2009). The present study also reports that *A. panayensis* lays eggs over a 3~8-d period (mean = 5 d), that eggs hatch between 11 and 15 d (mean = 13.5 d) after being laid, and that they fledge between 15 and 24 d (mean = 20.3 d) after hatching. The total time required from egg laying to successful fledgling in southern Taiwan was estimated to be between 29 and 47 d, with an average of approximately 38.8 d.

This study indicates that *A. panayensis* is reproductively active between April and August, but nesting had already started when

this study began in early April. Therefore, if at least 30 d elapse between egg laying and fledgling, the reproductive season of *A. panayensis* in urban environment of Kaohsiung City in southern Taiwan may begin in early March, or even late February, and last until August, i.e., a 6~7-mo reproductive season is very likely. With the exception of the reproductive season that is observed in peninsular Malaysia (January through August), this reproductive season for the Taiwanese population of *A. panayensis* may be the longest that is currently known, including those for NE India (Feb.~Apr.), Java and

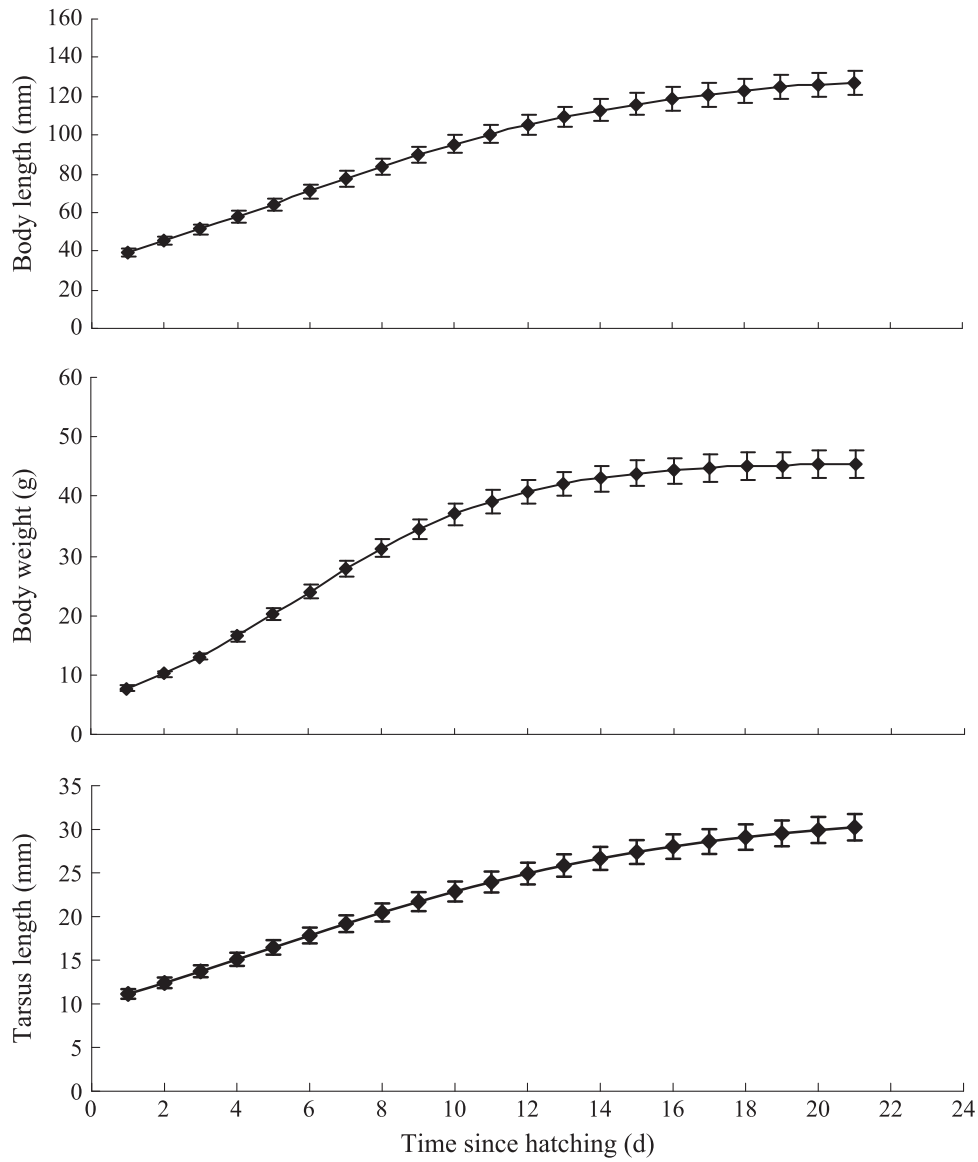

Fig. 2. Daily growth patterns (mean±SE) of body length (top), body weight (middle), and tarsus length (bottom) of nestlings of *Aplonis panayensis* in urban parks of Kaohsiung City, southern Taiwan

Bali (Jan.~June), Borneo (June~Sept.), and the Philippines (Feb.~June) (Craig and Feare 2009).

In the present study, which we conducted from April to August of 2000 but for which we did not differentiate the data of the first, second, and third clutches of the same nest, the hatching success of *A. panayensis* in an urban environment was found to be 62.0%, the fledgling success was 43.2%, and the overall reproductive success was 26.8%. *Aplonis panayensis* showed similar hatching success, but lower fledgling and reproductive success than an endemic Taiwanese bird, *Pycnonotus taivanus* (hatching success = 60.4%; fledgling success = 73.3%; reproductive success = 44.3%) (Hsu and Lin 1997) and *Pycnonotus sinensis* in an urban environment of Hangzhou, China (hatching success = 68.3%; fledgling success = 52.1%; egg success = 34.7%) (Lan et al. 2013).

Delacour and Mayr (1946) stated that elsewhere in its range, *A. panayensis* inhabits forests, secondary growth, and villages; these habitats are all present in Taiwan. This bird is also known to inhabit mangroves and other coastal vegetation, gardens, lowland and coconut plantations, urban areas and cities, and offshore islands (Abdulali 1967, Medway and Wells 1976, MacKinnon and Phillipps 1993). *Aplonis panayensis* nested in a slit under an air conditioner, in openings in a damaged traffic light and in electric poles, and in a crack in a wooden house in Kaohsiung City of southern Taiwan. *Aplonis panayensis* is currently reported to mainly live in metropolitan areas in Taiwan, such as Taipei, Kaohsinng, Chiayi, and Yilan (Liang et al. 2010). Liao (2012) also reported that this species could be found throughout the entire island. Therefore, the status of the current distribution of *A. panayensis* in Taiwan should be changed from a rare exotic escapee (Craig and Feare 2009) to a commonly species. Moreover, Feare and Craig (1999) indicated that *A. panayensis* is primarily a lowland bird that occurs from sea level to an elevation of approximately 700 m. Because it has reproduction adapted so well in Taiwan, the Taiwanese *A. panayensis* population should continue to increase if no effective management is established and executed.

There are complaints in Singapore about the noise made by *A. panayensis* and about its feces fouling sidewalks (Kang 1989). This bird is also a major raider of pepper plantations in Myanmar (Smythies 1960). However, despite this exotic bird is currently being widely distributed within Taiwan (Liao 2012), there has been little reported damage, although complaints about its feces were filed at NCCC (personal communication). Control methods, such as netting and removing adults and removing nests and nestlings between March and June (during the nesting season), have been suggested that may temporarily decrease the population of *A. panayensis*. However, to educate the general public about the impacts of exotic organisms on biodiversity and about the environmental damage that they cause is still necessary to stop the release of this species and other exotic birds into the wild.

ACKNOWLEDGEMENTS

This study was supported by the Council of Agriculture, Taiwan through a research grant (103-Foresty-07.1-C-26(2)) awarded to Shih-hsiung Liang and Bao-sen Shieh. Two anonymous reviewers who provided valuable comments and suggestions on drafts of this manuscript are extremely appreciated.

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