

Brood care behavior of the painted stork (*Mycteria leucocephala*) in Peninsular Malaysia

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Abstract. Zakaria MA, Daud UNS, Mansor MS, Md. Nor S. 2022. Brood care behavior of the painted stork (*Mycteria leucocephala*) in Peninsular Malaysia. *Biodiversitas* 23: 5406-5411. Waterbirds can serve as bio-indicators for their surrounding environments, indicating issues such as habitat degradation and climate change. One factor that contributes to successful reproduction for many bird species is parental behavior during the brood care stage. The painted stork (*Mycteria leucocephala*) is a waterbird species that provide biparental care throughout the breeding season. Although many studies have focused on populations of this species, information about their behavior, particularly during nestling rearing, remains lacking. Hence, this study was conducted to examine the parental behavior of painted storks between the early and late stages of brood care in two different colonies located in Peninsular Malaysia: Tasik Shah Alam (TSA) in Selangor and Upper Bisa Putrajaya Wetland (UBPW) in Putrajaya from May to September 2016. Three pairs of painted storks were monitored in every site, and seven behaviors were identified: roosting, preening, nest repair, wing opening, flying, feeding and brooding. Of all the behaviors recorded, flying, roosting and wing-opening behavior were the most frequently observed behaviors in both study areas during the early stage of brood care. However, painted storks were found to spend most of their time flying when the chicks had grown up by the late stage. This may be due to the food demand for the parents and their chicks. As the nestlings grow bigger, more food is required before the nestling can fledge independently. This is supported by increased feeding frequency observed from the early to late stages. Males were found to have a higher frequency of all behaviors than females. This data facilitates a greater understanding of painted stork behavior, which can help in their conservation and management processes.

Keywords: Behavior, brood care, *Mycteria leucocephala*, painted stork, waterbird

INTRODUCTION

Parental care is a complex behavior in terms of both the behaviors that are displayed and the causes that drive the evolution of these features. Birds typically raise their offspring together through a 'biparental' process because the care provided by a single parent is frequently insufficient to ensure the survival of offspring (Bruant et al. 2019). Biparental care is common in birds and was predicted to occur in 9% of bird species (Ripari et al. 2022), contributing to their successful reproduction. Biparental care is beneficial to the chick and requires a mutual understanding between both males and females, particularly during parental exchanges during incubation and provisioning (Daud et al. 2022). Strategies for nest success linked to nest attendance include the direct care of chicks, nest defense against predators (Harmon et al. 2021) and supplying food as chicks rely entirely on their parents while in the nest (Li et al. 2019). The availability of food for hatchlings has a significant impact on their development (Owen and Pierce 2014), while the ability of parents to feed their offspring depends on both their physical conditions and experience (Banach et al. 2021).

The painted stork (*Mycteria leucocephala*) is a large wading piscivorous bird in the family Ciconiidae that provides biparental care. Besides fish, their diet consists of crustaceans, mollusks and insects, which they capture

through tactolocation (Prabhakar and Dudhmal 2016). The painted stork is a colonial nesting species found across South and South-East Asia. In 1920, this species was a migrant in small numbers in northern Peninsular Malaysia and a vagrant south to Kuala Lumpur and is now a locally common resident in Selangor with free-flying populations successfully breeding at the National Zoo in Selangor (Jeyarajasingam and Pearson 2012). The painted stork was introduced from Sri Lanka to Zoo Negara for captive breeding in 1965 and was released from captivity in 1985 (Zakaria and Nor 2019). This population nested and roosted in the surrounding area and has continued to increase. In the last 10 years, due to its high adaptation, survival and breeding capability, this species has been spreading and occurs in artificial wetlands, lakes and ponds in Selangor and Kuala Lumpur, including in the Upper Bisa Putrajaya Wetland (UBPW) and Tasik Shah Alam (TSA) areas, where they coexist with other waterbirds (e.g., herons and egrets).

Due to their important function in regulating, filtering and treating waterbodies, man-made wetland ecosystems are increasingly being developed in many parts of the world. Additionally, they offer a wide range of habitats for many animal species, such as waterbirds (Rahman and Ismail 2018). Although man-made habitats may provide only short-term relief for waterbird communities during times of stress and food scarcity, their usefulness to waterbirds becomes more obvious with the continual loss of natural wetlands

worldwide (Maria et al. 2022). The presence of water bodies, including natural and man-made ponds, lakes, or streams in urban parks, is beneficial for many bird species, particularly for those associated with water (Ferenc et al. 2014).

An uncontrolled increase in the painted Stork population in certain areas is likely to cause this species to become a nuisance. Gut microbial populations in wild birds, especially in recreational areas (e.g., artificial lakes), have recently gained attention because they can be a source of human and animal diseases or serve as vectors for zoonotic pathogens (Capunitan et al. 2020). Additionally, it may also pose a threat to and interfere with the survival of other native birds (Arazmi et al. 2022). The spatial distributions are likely to overlap with those of other trophically similar species and cause competition for habitat, food and other resources (Mansor and Ramli 2017). While waterbirds serve as bio-indicators for seasonal, land use and climate changes (Benscoter et al. 2020), an increase in the number of waterbirds in urban areas could pose several threats to both humans and other animals due to the transmission of pathogens and viruses through their feces or nose secretions (Kuchipudi et al. 2022).

Although considered one of the most abundant Asian stork, this species is classified as Near Threatened (IUCN 2022) due to its undergoing moderately rapid population decline caused by hunting, wetland drainage and pollution (BirdLife International 2022). Therefore, it is important to understand the behavioral aspects of the species that are crucial to its survival and advantageous for conservation and management purposes (Mansor et al. 2015). However, there are no studies about the behavior of this species during the breeding season in Peninsular Malaysia. Information about the role of parents and their behavior, particularly during nestling rearing, also remains limited. This study aimed to investigate whether parental behavior varies during post-hatching (early stage) and pre-fledging (late stage). We also examine the brood care behaviors of male and female painted storks in two different populations.

MATERIALS AND METHODS

Study site

This study was conducted on recreational artificial habitats in Upper Bisa, one of the five branches of the Putrajaya Wetland (UBPW), and two sections of the island in Tasik Shah Alam (TSA), Selangor, Malaysia (Figure 1). Islands in the UBPW had been planted with tembusu tree (*Fagraea racemosa*) and ara akar (*Ficus globosa*), with a maximum height of the species reaching up to 7 meters and 9 meters, respectively. TSA is an artificial recreational lake located in Selangor and its dominant vegetation is comprised of ara akar, sealing wax palm (*Cyrtostachys renda*) and coconut (*Cocos nucifera*), with a maximum plant height reaching up to 11.3 meters. Temperature and rainfall in each month were obtained from the Malaysian Meteorological Department (MET) weather stations located nearest to the study area. Abiotic data were obtained from National Climate Centre stations, for the UBPW from the Serdang Agricultural Centre station

(within a 3.52-km radius from the UBPW) and for TSA from the Subang station (within an 8-km radius from TSA).

Data collection

Video recordings were collected on three random days for each stage, from May to July 2016, for the early stage, and from July to September 2016, for the late stage. Digital videos were recorded using a Panasonic HC-V380 video camera equipped with a 90x zoom lens (Panasonic, Kadoma, Japan) from 33-54 m from the nests. The focal observation method was used to monitor the behavioral activities of three targeted pairs of painted storks during the brood care stage. For each pair, the observations took place continuously from 0700 h to 1900 h. Seven types of behavior were identified: 1) roosting - standing on a branch or next to the nest; 2) preening - cleaning or positioning feathers using the beak or limbs; 3) nest repair - replacing damaged parts of the nest by inserting new twigs or leaves; 4) wing opening - spreading the wings in various postures to protect nestlings from direct sunlight and predators; 5) flying - flying out and leaving the nest; 6) feeding - feeding chicks with the beak; 7) brooding - sitting on chicks to keep them warm. The frequency and duration of each behavior were only recorded when a pair of painted storks were present in their nest. The periods in which birds were not observed on their nests were not included in the analysis. The data were separated into two stages (i.e., early stage and late stage) in each study location. The amount of time allocated to each behavior, as well as the frequency of each behavior, was written down and then recorded in Microsoft Excel for further analysis.

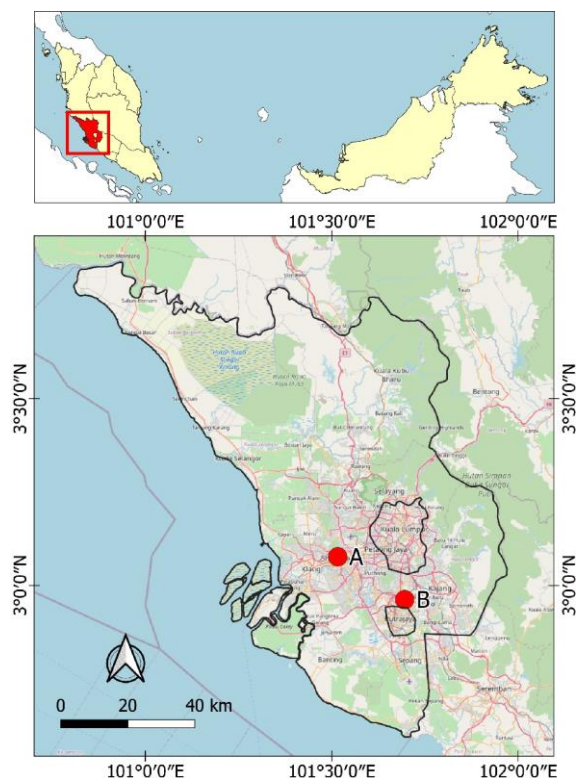


Figure 1. Peninsular Malaysia showing the location of Tasik Shah Alam (A) and Upper Bisa Putrajaya Wetland (B). The insert of southeast Asia (upper right corner) depicts Peninsular Malaysia in rectangle

Data analysis

The data were tested for normality using the Kolmogorov-Smirnov test ($p > 0.05$). If the data were normally distributed, a Pearson correlation test was performed to investigate the relationship between the frequency of each behavior at the early and late stages of the brood care phase based on sex. If the data was not normally distributed, the Spearman correlation coefficient test was used, and the Wilcoxon test was used to examine the relationship between the time allocation of each behavior between the early and late stages of brood care based on sex.

RESULTS AND DISCUSSION

All observed behavior exhibited a decrease in frequency from the early to late stages of nestling rearing in TSA and UBPW, except for feeding (Figure 2). Roosting behavior had the highest frequency recorded for both colonies in this study. In TSA, the most frequent behavior recorded by both males and females during the early stage was roosting (23.5%), followed by preening behavior (23.4%). The least frequent behavior displayed was feeding (4.0%). In the late stage, flying (25.27%) was the most frequent behavior recorded, whilst wing opening was the least frequent (3.20%) (Figure 2).

During the early stage in UBPW, the most frequent behavior observed was roosting (27.93%), followed by preening (22.39%). The frequencies of brooding and flying were the least frequent among all behavior types displayed at 4.54 and 7.42%, respectively. During the late stage of brood care in UBPW, preening was the most frequently observed behavior among painted storks (27.03%), whilst brooding (0.29%) was the least frequent behavior encountered in this study (Figure 3). However, brooding behavior by storks was observed only during the early stage in UBPW and not at all in TSA.

Overall, in both the early and late stages of all behavior types recorded in TSA, the frequency of male ($r: 0.967$, $P < 0.01$) behavior was significantly different and higher than that of females ($r: 0.755$, $P < 0.05$) in early and late stage (males: early: 53.8%, late: 64.05%; females: early: 46.2%, late: 35.9%). Males exhibited a higher frequency in all behavior except for feeding during the early stage, which was dominated by females. Although females in UBPW were recorded to have a higher frequency of brooding in the early stage, males had a relatively higher frequency of all other behaviors (males: early: 57.28%, late: 64.37%; females: early: 42.72%, late: 35.63%).

From the results, nest attendance was higher during the early stage of parental care in both sites (TSA: early: 76.2%, late: 38.4%; UBPW: early: 76.4%, late: 34.9%) and decreases during late stage. Although the frequency of flying was low, the duration of flying was highest during the early and late stages in both colonies, meaning that painted storks spent more time flying than carrying out any other behavior. Among all the behaviors of painted storks recorded in this study, flying was the only one that exhibited an increase in duration. Other behaviors, such as

roosting, preening, nest repair, flying and feeding, showed a greater decline over time. The greatest declines in painted stork behavior were in wing-opening in TSA (Figure 4) and brooding in UBPW (Figure 5).

Overall, males spent more time roosting than females in both the early and late stages of brood care. This demonstrates that males pay closer attention to their surroundings while female birds rest. During the last 3 days of observation, the frequency and duration of this behavior by males increased in the latter stage to twice the amount in the early stage. There have been numerous hypotheses on the benefits of roosting, such as improved protection from predators and improved hunting effectiveness (Mansor et al. 2020). The threat to juvenile birds grows as they get older (Mullers et al. 2015) and, therefore, a species' reproductive strategy might involve more aggressive behavior in response to an increase in the number and severity of the challenges they face (Urfi 2011).

Preening and feather arranging are both forms of maintenance behavior in birds that are essential for maintaining feather quality by eliminating dirt and oil (Ismail et al. 2020; McCullough et al. 2020) or lowering the prevalence of ectoparasites (Waite et al. 2012). All bird species depend on healthy feathers to maintain their body heat, which can only occur when the feathers are in good condition (Nascimento et al. 2014). Wing-opening behavior was observed to occur among both parents during at least the first 2 weeks after hatching. This behavior was more frequently observed during the early stage of nestling development, particularly by males rather than by females. The chicks are placed under their parent's wings for intensive protection during the post-hatching stage since chicks require heat during the first week after hatching (Blum 2012). Wing-opening behavior by the male and female parents was most often observed from 1100 h onwards, which is when nests are most heavily exposed to sunlight due to the location of the nests on top of trees. This behavior protects the young birds from extreme heat (Figure 6A), as excessively hot weather can be a problem for birds nesting in exposed areas, such as those nesting in higher trees with little shelter (Clauser and McRae 2017).

Flying is the primary mode of locomotion used by the painted stork and other bird species. Birds fly to forage for food, move from one location to another in search of a safe nesting spot during the breeding season and migrate between seasons. Since larger birds require more energy to fly, many of them will glide as far as they can without flapping. Additionally, the frequency of feeding and the amount of food given by parents depends on the size of the nestlings. During the first 2 weeks after hatching, nestlings can swallow only the foods regurgitated by their parents. Although both parents are involved in feeding nestlings, males in this study fed the chicks more frequently than females in the early stage of brood care. As a nestling grows up, its feeding frequency decreases. However, the quantity of food provided increases due to the nestling's increase in body size. Successful rearing depends on food availability, which depends on food supply and water levels (Kumar and Kanaujia 2015). Nestlings were also observed being fed chicken feet by their parents (Figure 6B).

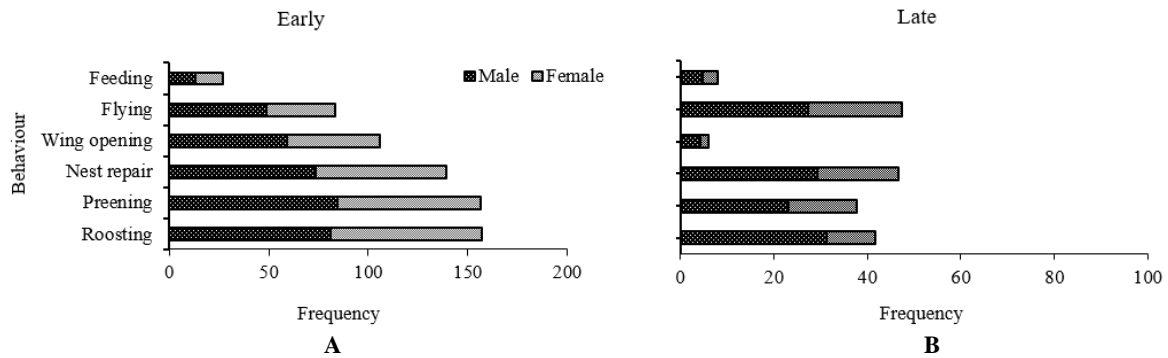


Figure 2. Frequency of each behavior per day displayed by painted storks during the early (A) and late stages (B) of the brood care in Tasik Shah Alam (TSA), Selangor, Malaysia

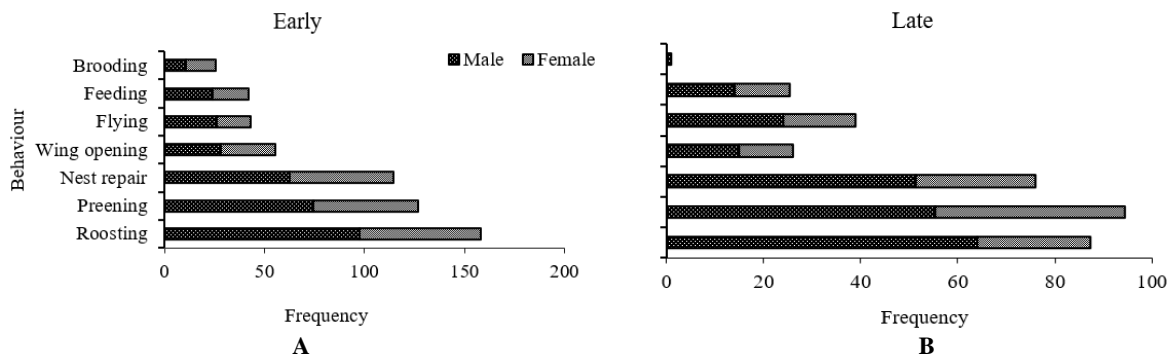


Figure 3. Frequency of each behavior per day displayed by painted storks during the early (A) and late stages (B) of the brood care in Upper Bisa Putrajaya Wetland (UBPW), Putrajaya, Malaysia

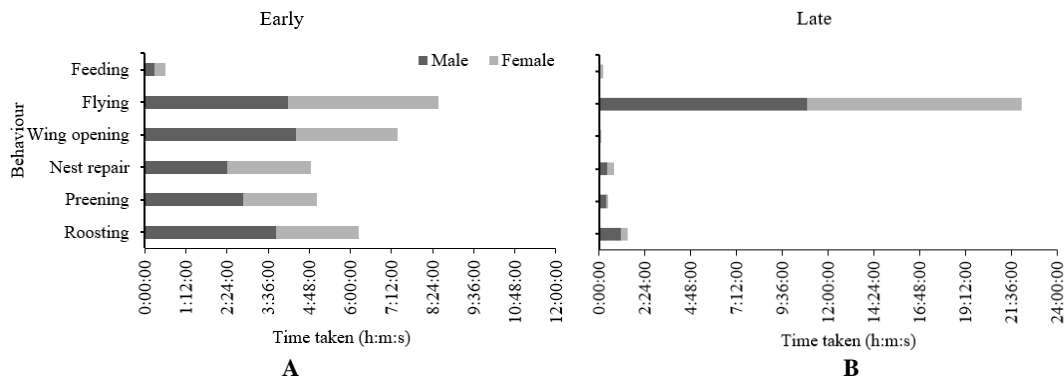


Figure 4. Duration of each behavior per day displayed by painted storks in the early (A) and late stages (B) of the brood care in Tasik Shah Alam (TSA), Selangor, Malaysia

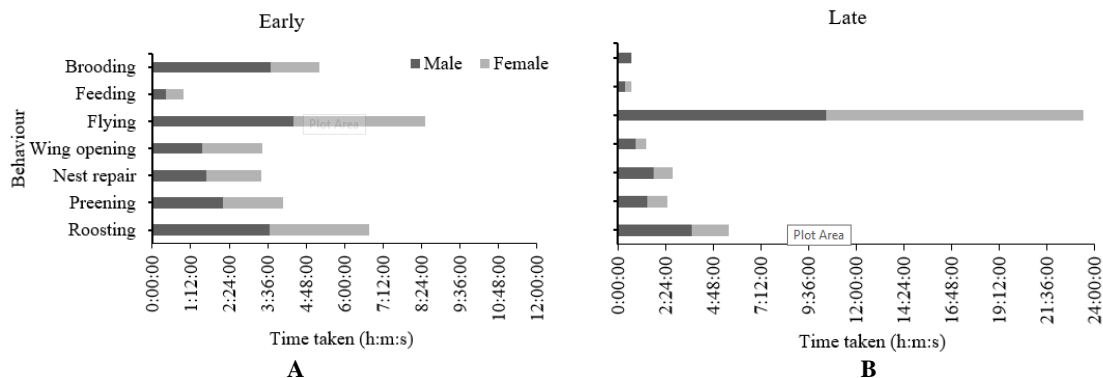


Figure 5. Duration of each behavior per day displayed by painted storks in the early (A) and late stages (B) of the brood care phase in Upper Bisa Putrajaya Wetland (UBPW), Putrajaya, Malaysia



Figure 6. A. Mucus flowing from a chick's beak due to extremely hot temperatures. The chick died after 3 days; B. Chicken feet being taken by a painted stork

This activity was witnessed by members of the public, who noticed that a bird went down to look for food in a ditch next to the wet market near the nesting area. This shows that this species can adapt easily to the urban environment. Additionally, while brooding still occurred during the brood care stage, it was not as much as incubation before hatching. During the late stage, the frequency and amount of brooding decreased as chicks became bigger since juveniles can produce heat of their own for development (Urfi 2011).

In conclusion, although the painted stork is a biparental carer, males were slightly more active than females during brood care. Roosting and preening were the most common behaviors displayed by painted storks in both study areas. No significant differences in the behavior of this species were observed between the two colonies involved in this study. This shows that this species is well adapted to its current surroundings. The selection of nesting location is the main successful nesting strategy of the painted stork. Artificial wetlands and lakes can provide shelter, resting, feeding and nesting places for breeding birds, not only for painted storks but also for other local and migratory bird species. This study facilitates a greater understanding of the role of both parents as a pair during the nestling-rearing stage. These findings provide information about the breeding activities of the painted stork in Peninsular Malaysia and highlight the importance of wetlands as nesting sites for waterbirds. These findings provide useful information which may be used in the conservation and management of the painted storks.

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