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Does Weather Play an Important Role in the Early Nesting Activity of Colonial Waterbirds? A Case Study in Putrajaya Wetlands, Malaysia

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Abstrak: Faktor persekitaran mampu mempengaruhi komuniti burung air. Cuaca khususnya mampu memberi pelbagai impak dari segi biologi dan ekologi terhadap aktiviti pembiakan burung air, namun kebanyakan kajian yang dilakukan lebih melihat kepada kesan cuaca di peringkat akhir pembiakan burung air (contohnya, kadar penetasan, kematian anak ayam dan lain lain). Sebaliknya, kajian ini cuba untuk mengkaji pengaruh cuaca terhadap aktiviti awal bersarang burung air melalui pemerhatian terhadap koloni burung air yang terdiri daripada pelbagai spesies yang baru terbentuk di Tanah Lembap Putrajaya, Malaysia. Keputusan menunjukkan bahawa hujan dan suhu mempunyai pengaruh yang besar ke atas aktiviti-aktiviti awal spesies yang sedang bersarang. Aktiviti hujan menunjukkan korelasi signifikan dengan kadar bersarang burung Pucung Seriap (hujan: r_s = 0.558, p = 0.03, n = 72) manakala kedua-dua suhu dan hujan berkait rapat dengan kepadatan burung Botak Padi (suhu: r_s = 0.573, p = 0.013; hujan: r_s = –0.662, p = 0.03, n = 48). Terdapat kemungkinan perubahan aktiviti hujan dan suhu memberi petunjuk kepada populasi burung air yang dikaji untuk mula bersarang khususnya bagi burung Botak Padi. Penulisan kajian ini turut mengemukakan kekangan yang dihadapi dalam kajian serta mencadangkan kajian jangka panjang dijalankan bagi mengesahkan penemuan kajian ini.

Kata kunci: Cuaca, Aktiviti Awal Bersarang, Burung Air, Tanah Lembap Putrajaya, Malaysia

Abstract: Environmental factors can play important roles in influencing waterbird communities. In particular, weather may have various biological and ecological impacts on the breeding activities of waterbirds, though most studies have investigated the effect of weather on the late stages of waterbird breeding (e.g., hatching rate, chick mortality). Conversely, the present study attempts to highlight the influence of weather on the early nesting activities of waterbirds by evaluating a recently established mixed-species colony in Putrajaya Wetlands, Malaysia. The results show that only rainfall and temperature have a significant influence on the species' nesting activities. Rainfall activity is significantly correlated with the Grey Heron's rate of establishment (rainfall: r_s = 0.558, p = 0.03, n = 72) whereas both temperature and rainfall are associated with Painted Stork's nesting density (temperature: r_s = 0.573, p = 0.013; rainfall: r_s = –0.662, p = 0.03, n = 48). There is a possibility that variations in the rainfall and temperature provide a cue for the birds to initiate their nesting. Regardless, this paper addresses concerns on the limitations faced in the study and suggests long-term studies for confirmation.

Keywords: Weather, Early Nesting Activity, Waterbirds, Putrajaya Wetlands, Malaysia

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INTRODUCTION

Environmental factors can play important roles in influencing waterbird communities. For example, weather can have various biological and ecological impacts on adults and young birds, and both adults and their nestlings have been reported to be particularly susceptible to temperature and rainfall during breeding (Sparks & Tryjanowski 2005). Some important examples have shown that adults were first affected by the weather conditions during migration and wintering (Saether *et al*. 2006) and after arriving at their breeding ground (Tryjanowski *et al*. 2004). Rainy and cold weather conditions have also been reported to cause high chick mortality in young storks, significantly reducing breeding success and survival (Zduniak 2009; Jovani & Tella 2004). Variations in rainfall and temperatures were also found to have adverse effects on the fledging success of White Storks with poor food resources (Denac 2006). Such evidence linking the effects of weather and waterbird populations provide a clear view of how weather may shape waterbird communities.

Many of these studies evaluated the effect of weather on the late stages of waterbird breeding, i.e., the hatching rate, mortality of the chicks and other post-reproductive parameters (Novoa *et al*. 2008; Jovani & Tella 2004). However, early nesting activities, such as successful nesting attempts or establishment and nesting densities, may also provide important evidence to relate weather to waterbird reproduction. Therefore, this study examines the possibility of understanding the influence of weather on the early nesting activities of waterbirds in Putrajaya Wetlands.

MATERIALS AND METHODS

Study Site

The colony studied is located in the southern part of Putrajaya Wetlands (Upper Bisa) (2°56´04.01´´N and 101°42´12.33´´E). In 2008, 4 waterbird species recently colonised an area of 0.30 ha. for nesting and breeding. The breeding species consist of Purple Heron [PH (*Ardea purpurea*)], Grey Heron [GH (*Ardea cinerea*)], Painted Stork [PS (*Mycteria leucocephala*)] and Night Heron [NH (*Nycticorax nycticorax*)]. These waterbirds nested on artificial islands in one of the Upper Bisa lake site areas (Fig. 1).

Sampling and Measurements

Field samplings were conducted for a year and a half from July 2008 to December 2009. The birds' activities were recorded 5 days a week, from 0700 to 1900 h, at a distance of 20–30 m from the colony. The colony was established on 2770 m^2 artificial islands. To minimise the effects of human disturbance, visits to the nesting ground were conducted only when required. A successful nesting attempt or establishment was considered achieved when paired activity was observed in a single nest for at least one day; the activities included pairing, nest building and mating activity, often occurring in short intervals during the birds' early nesting period. The rate of successful establishment (successful nesting attempt per hour of observation) was then calculated for the duration of the study. Nest density was calculated based on the number of nests established over each square metre of the occupied area. Other parameters included the nest height, nest number and size of the nesting area.

The weather data of the study area (i.e., mean temperature and evaporation, relative humidity, total rainfall, wind speed and barometric pressure) were obtained from the Malaysian Meteorological Department (MMD) for the Kuala Lumpur International Airport (KLIA)-Sepang area of the 18 month study period. A weather analysis was performed between semesters, with each semester consisting of 6 months of periodical data.

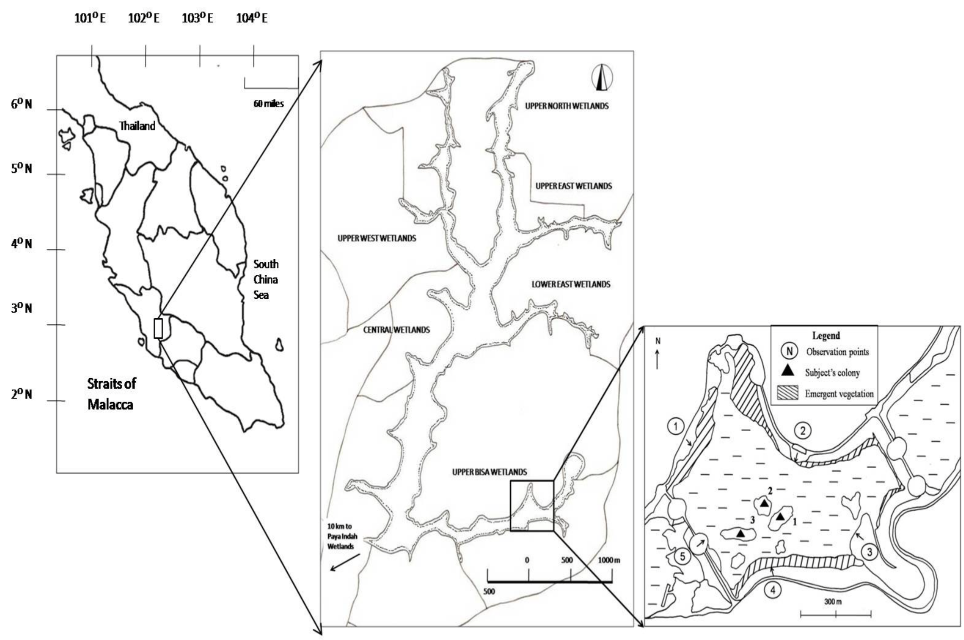

Figure 1: Waterbirds nesting sites on artificial islands in Upper Bisa lake site.

Statistical Analysis

A non-parametric analysis was used to analyse the data. For multiple groups, a Kruskal-Wallis test with a non-parametric multiple comparison was conducted (i.e., the establishment rate and nest densities); a Man-Whitney U-Test was employed for comparing two different groups. The Spearman Rho correlation was also applied to identify possible relationships between weather parameters and the rate of establishment and nest densities. Comparisons were made at the 95% level of significance. All the statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 17.

RESULTS

A total number of more than 2000 hours, including at least 180 days of field observation, was completed for this study. The climate in Putrajaya was consistent throughout the months, with minor variations between semesters. The monthly rainfall ranged from 1.2 to 10.7 mm (mean: 5.8±3.0 mm), with an increased pattern toward the end of the third semester. The first semester (July to December 2008) had the highest increase of rainfall toward the end of the time interval, followed by the second (January to June 2009) and third (July to December 2009). The temperature ranged from 26.4°C to 28.3°C (mean: 27.0±1.0°C), and the relative humidity was 82%. The barometric pressure ranged from 1005.5 to 1013.9 Hpa (mean: 1009.6±0.6 Hpa) and the wind speed from 0.3 to 4.2 m/s (mean: 1.5±0.3 m/s).

The Kruskal-Wallis analysis showed that both the rate of establishment and nest density varied significantly between the waterbird species [rate of establishment: 0.25±0.20 nests/day, H(2, N = 264) = 54.40, $p<0.01$ and density: 0.36±0.23 nests/m^2, H(2, N = 264) = 29.23, $p<0.01$]. Further tests showed that the establishment rate and nest density were significantly different among the species (Table 1). Table 2 highlights some of the characteristics of the colony studied.

Table 1: Establishment rate and nesting densities tests between species studied.

Species	N	Establishment rate (statistical value)	Nesting density (statistical value)
Purple Heron/ Grey Heron	144	z = –5.13 (*p*<0.05*)	z = 0.00 (*p* = 1.00)
Purple Heron/ Night Heron	144	z = –2.07 (*p*<0.05*)	z = –3.39 (*p*<0.05*)
Purple Heron/ Painted Stork	120	z = –5.14 (*p*<0.05*)	z = –3.17 (*p*<0.05*)
Grey Heron/ Night Heron	144	z = –4.07 (*p*<0.05*)	z = –3.42 (*p*<0.05*)
Grey Heron/ Painted Stork	120	z = –4.43 (*p*<0.05*)	z = –3.08 (*p*<0.05*)
Night Heron/ Painted Stork	120	z = –4.87 (*p*<0.05*)	z = –4.22 (*p*<0.05*)

With regard to the weather regime, only rainfall and temperature showed significant correlation; with the Grey Heron rate of establishment (rainfall: $r_s = 0.558$, $p = 0.03$, n = 72) and Painted Stork nesting density (temperature: $r_s = 0.573$, $p = 0.013$; rainfall: $r_s = –0.662$, $p = 0.03$, n = 48). The analysis of the nesting densities per island, however, showed no significant correlation with the weather [rainfall (n = 72): 1st island, $r_s = 0.256$, $p = 0.30$; 2nd island, $r_s = 0.210$, $p = 0.40$; 3rd island, $r_s = 0.114$, $p = 0.65$) and temperature (n = 72): 1st island, $r_s = 0.478$, $p = 0.55$; 2nd island, $r_s = 0.540$, $p = 0.83$; 3rd island, $r_s = –0.110$, $p = 0.96$)], suggesting that the colony's aggregation in general was independent of the parameters studied. Figure 2 summarises the variations in the rate of establishment, nesting densities and weather patterns during the study period.

Table 2: Some characteristics of the waterbirds colony in Upper Bisa, Putrajaya 2008–2009.

No.	Species	Estimated colony area (m^2)	N	Nest height (ft)	Mean nest number	Percentage of nest established at peak (%)
1	Purple Heron *Ardea purpurea*	366.15	67	8.79±1.34	110.24±27.20	44.50
2	Grey Heron *Ardea cinerea*	75.37	42	8.82±1.92	21.94±6.50	9.90
3	Night Heron *Nycticorax nycticorax*	140.00	91	4.37±1.77	92.73±31.73	39.50
4	Painted Stork *Mycteria leucocephala*	46.50	18	7.85±0.93	10.11±8.22	6.10

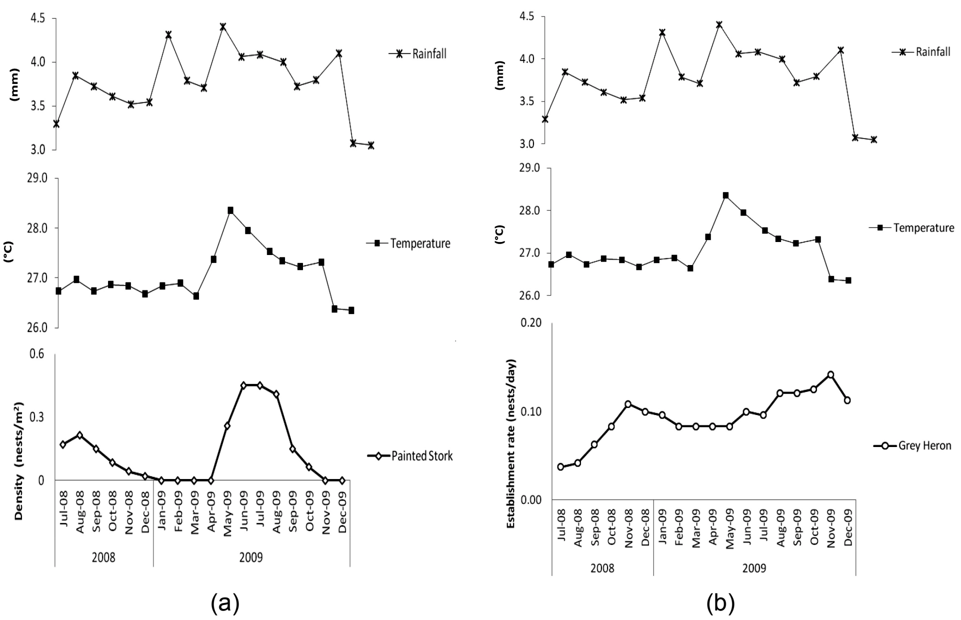

Figure 2: Rainfall and temperature activity in relation to (a) Painted Stork's density and (b) Grey Heron's establishment.

DISCUSSION

The moderately high value for successful nesting attempts for the Grey Heron suggests that rainfall alone cannot be used to explain the bird's successful attempts to nest, as observed throughout this study. Other factors, such as competition for nesting space, material availability, quality of foraging areas and safety, may have a significant influence on the nesting birds and should be examined. For the Painted Stork, its nesting density was positively correlated with temperature and negatively correlated with rainfall. There is a possibility that the changes in temperature and rainfall provide a cue to the storks of favourable conditions for them to initiate nesting activity because these birds may rely on thermal parameters while locating good foraging areas. However, there is a concern that the small number of stork populations (presumably with less sexually mature adults) included is unlikely to yield any significance in the rate of establishment over the period of the study. Considering the population status of stork species, it is difficult to obtain a sufficient number of subjects for study; however, continuous observation of a larger population size may be required to confirm the results. Nevertheless, our study found that the populations of Grey Herons and Painted Storks in the study area were more or less susceptible to changes in the weather compared to the other species. Inter-specific competition between Grey Herons and the more dominant population of Purple Herons, in addition to the seasonal breeding variation and behavioural activity of the Painted Stork population, may have caused the Grey Herons to be more sensitive to such environmental changes as the weather.

Studies on weather variability in Peninsular Malaysia has been conducted since the late 1950s (Carmelengo & Somchit 2000), greatly improving the understanding of the country’s weather and climate. Although some locations may receive more precipitation during monsoons, the study area is relatively free from such influence due to its position in the inland part of the peninsula. Therefore, any changes in the weather may not directly affect breeding waterbirds within the short period of nesting. Other studies that identified weather as an environmental factor that influences nesting or breeding waterbirds were performed in regions with seasonal climate (e.g., Fasola *et al*. 2009; Maddock & Baxter 1991; Bildstein *et al*. 1990), locations where birds are more susceptible to extreme weather changes during a short period of time.

Climate variation in the long term may influence an animal's food source, as food availability can be impacted by the weather (White 2008). As in the case of the waterbird colony in Putrajaya, long-term monitoring comprising years of surveys and studies may reveal significant roles of climate in influencing population size, density, survival and other ecological attributes. Such research is important for the future conservation of waterbird communities.

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CONCLUSION

The early nesting activity of the Grey Heron and Painted Stork populations in the study area were shown to be susceptible to the weather regime, particularly rainfall and temperature. Factors, including inter-specific competition, population size and seasonal breeding variations, may cause the populations to be more sensitive to such environmental changes as the weather. Further studies with long-term monitoring of the populations are required before the results can be verified, particularly for this mixed population of waterbirds in a small-sized habitat. Nevertheless, understanding weather patterns and their influence on waterbird communities may be beneficial for the conservation of the species in the long term.

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