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Nest-site Selection of the Greater Painted Snipe (*Rostratula benghalensis benghalensis*) in Fallow Fields of I-Lan, Taiwan

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ABSTRACT: Nest site quality often affects nest success and the fitness of avian breeders. Vegetation structure and water depth are possible factors evaluated in nest-site selection by ground nesting birds in wetlands. Vegetation structure may affect the predation risk, and water depth is linked to the possibility of being flooded. We examined these two factors in the nest site selection of a wetland bird, the Greater Painted Snipe (*Rostratula benghalensis benghalensis*), in I-Lan, Taiwan. We found 17 Greater Painted Snipe nests in wet fallow fields. By paired comparisons, we found the breeders tended to nest on sites with higher vegetation coverage and lower water depth than random sites. No significant difference was found in the vegetation height between the nest sites and the paired random sites. Five nests failed to hatch due to flooding or predation. The preference for nest sites with low water depth may be an effort to avoid being flooded and the preference for dense vegetation coverage at nest sites may be a response to predation risk.

KEY WORDS: Greater Painted Snipe, nest-site selection, predation risk, *Rostratula benghalensis benghalensis*, vegetation coverage, water depth.

INTRODUCTION

Nest site quality often affects nest success and the fitness of the breeders. Predation is a leading cause for nest failure in many species (Ricklefs, 1969; Descamps et al., 2005; Donehower et al., 2007). According to the nest concealment hypothesis, predation risk decreases while vegetation density around the nest site is high, because the vegetation could conceal the nest and interfere with the visual, auditory, or chemical detection of the predators (Martin, 1993). Vegetation structure was found to be important to the nest site selection of many passerines (Hatchwell et al., 1999; Flaspohler et al., 2000; Rangel-Salazar et al., 2008; Pobprasert and Gale, 2010; Wang et al., 2011) and other taxa (Fernandez and Reboreda, 2002; Traylor et al., 2004; Bentzen et al., 2009; Kolada et al., 2009; Wu and Liu, 2011).

To birds breeding inland near, on the ground or in the marshlands, being flooded is another possible cause of reproduction failing. In Saltmarsh Sharp-tailed Sparrows (*Ammodramus caudacutus*), flooding caused 17.6% of the nests failure (DiQuinzio et al., 2002). At Breezy Point, New York, 7% of the piping plover (*Charadrius melodus*) nests failed due to tidal flooding (Lauro and Tanacredi, 2002). The effect of flooding was also reported in gulls, terns and other waterbirds (Burger and Shisler, 1980; Rounds et al., 2004; Gilbert and Servello, 2005; Maxson et al., 2007). In addition, water regime affects the patterning of vegetation (Raulings et al., 2010) which in turn affects the availability of nest sites.

The Greater Painted Snipe (*Rostratula benghalensis benghalensis*) is a wetland bird living and feeding in rice fields, wet fields, swamps and marshes (Lowe, 1963; Muller, 1974). It has a polyandrous breeding system. After pairing, the couple makes a nest together before the female lays eggs. Once the clutch is completed, the female leaves to seek another mate, while the male stays and incubates the eggs (Komeda, 1983). During breeding season, they feed primarily in rice fields and their food composition is influenced by the stage of crop development (Cheng, 2002; Lee et al., 2002).

Although there have been several studies on the mating and feeding behaviors of Greater Painted Snipes, their nest-site selection remains unclear. In southern Taiwan, the height of plants near nests at the beginning of nesting was usually between 20 - 40cm, with 0 - 30% plants coverage (Lo, 2004). Another study found Greater Painted Snipes often concealed their nests in vegetation patches, although predation was a lesser cause of nest loss than being flooded (Hsieh, 2003). The inconsistencies in these findings suggest it is valuable to explore the nest site characteristics of the Greater Painted Snipes further. This knowledge is also important to wetland habitat management for its conservation, as this species is protected by Wildlife

Conservation Law in Taiwan.

This study investigated whether Greater Painted Snipes preferred nest sites with specific vegetation structure and water depth. We conducted paired comparisons between nest-sites used by birds and a set of random points in the vicinity of the used nest sites. We also tried to identify the causes of nest failure, and examined the relationship between nest-site selection and breeding success.

MATERIALS AND METHODS

Our study site was a 97 ha area at Shen-Gou, I-Lan County, Taiwan. This area contained mainly flooded fallow agricultural fields with vegetation, plus some cultivated rice fields, marshes, and houses. There were two types of fallow fields. One was dominated by self sprouting rice (*Oryza sativa*) left from previous cultivation events. The other one contained mostly Indian Sesbania (*Sesbania sesban*), with some rice and sedges. Indian Sesbania was a common green manure planted in fallow fields in Taiwan. Potential predators in this study site included wild dogs, oriental rat snakes (*Ptyas mucosus*), and raptors as common kestrel (*Falco tinnunculus*).

From July to November in 2005, we systematically walked along paths separating fields and marshes, and searched for Greater Painted Snipe nests. For each nest found, we noted the number of eggs it contained. We checked each nest every four to seven days and recorded the condition of the nest. A nest was considered successful if it fledged at least one young. A nest was considered failed if it was abandoned or if the eggs disappeared with no trace of hatching before the expected hatching time.

We measured habitat characteristics of the nest sites. For the nests found after mid-July, we also measured these characteristics at a paired random site around the nest. Each paired random site was chosen from the same field where the nest located, by using x and y coordinates generated from a table of random numbers (Burger, 1987). All measurements were taken after the young fledged or when the nest was abandoned in order to avoid affecting its hatching success. For each nest and random site, we measured (i) the vegetation coverage (%) within a 0.16 m^2 square centered on the nest or the random site by looking through a 0.4 m × 0.4 m cardboard; (ii) the average vegetation height (cm) in the same area described above; (iii) the depth of water (cm) right beside the nest or at the random site using a scaled stick.

We compared the nest and its paired random site data with Wilcoxon's Matched-Pairs Signed-Ranks Test for nest-site selection. The difference of vegetation coverage and the average vegetation height between successful and failed nests were compared using Wilcoxon's Rank-Sum Test. We also tried to determine the cause of nest failure by observation.

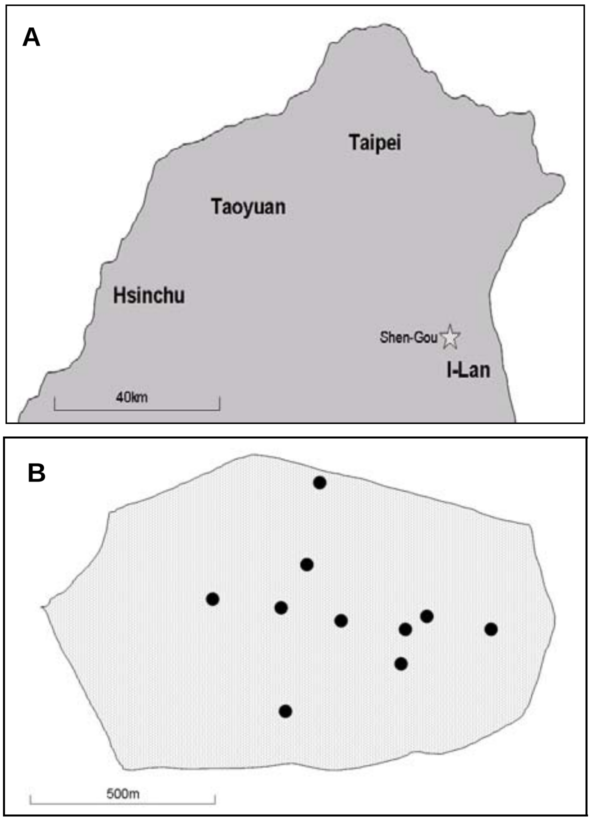

Fig. 1. A: The study location (24°43'N, 121°43'W) in Shen-Guo, I-Lan, northern Taiwan. B: Black circles indicated wet fallow fields with nests in the study area.

RESULTS

We found 17 Greater Painted Snipe nests in ten wet fallow fields of I-Lan (Fig. 1), but no nests in cultivated rice fields and marshes. Each nest contained two to four eggs. Plants near the nests included rice, Indian Sesbania and some sedge species. We collected random site characteristics for only eight nests. Two of the random sites were in the same field.

Within a fallow field, Greater Painted Snipes tended to nest on sites with higher vegetation coverage ($t = 0$, $p = 0.0078$, Fig. 2) and lower water depth ($t = 2$, $p = 0.0234$, Fig. 2) than random sites. The vegetation height at the nest sites did not significantly differ from that of the paired random sites ($t = 6$, $p = 0.1094$, Fig. 2). However, the difference of vegetation height between paired nest-random sites (vegetation height of the nest site minus that of the paired random site) varied from -18.75 to 43.75 cm.

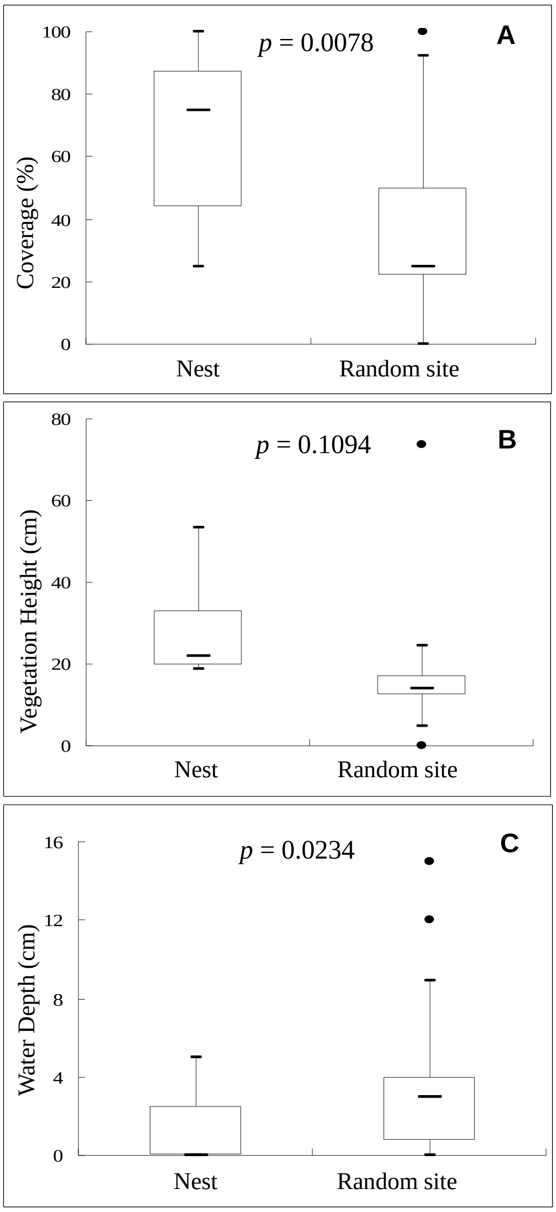

Fig. 2. The comparison of (A) vegetation coverage (%), (B) vegetation height (cm) and (C) water depth (cm) between the nest and random site (N = 8 pairs) and the *p* significance of the Wilcoxon's matched-pairs signed-ranks test. The ends of whiskers represent the lowest and the highest data still within the 1.5 interquartile range (IQR) of the 1st and the 3rd quartiles.

Reproductive success in our study site was 70.59%, with 12 out of 17 nests hatched at least one young. Among the five failed nests, three were drowned by heavy rain during three typhoons, one was lost to predation judging from egg shell fragments, and the last one vanished prematurely, presumably also lost to predation. The vegetation coverage at successful nests was marginally higher than that of failed nests (W_{Fail} = 26.5, p = 0.0625, Fig. 3), but the vegetation height did not significantly differ between successful and failed nests (W_{Fail} = 29, p = 0.125, Fig. 3).

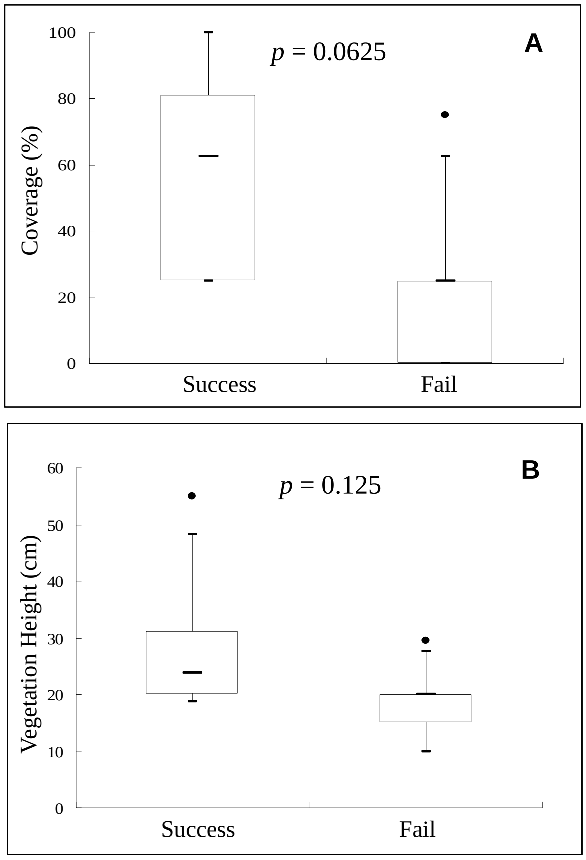

Fig. 3. The comparison of (A) vegetation coverage (%) and (B) vegetation height (cm) between the successful nests (n=12) and failed nests (n = 5) and the *p* significance of the Wilcoxon's Rank-Sum Test. The ends of whiskers represent the lowest and the highest data still within the 1.5 IQR of the 1st and the 3rd quartiles.

DISCUSSION

Greater Painted Snipes at Shen-Gou, I-Lan, preferred to build nests at places with dense vegetation coverage, but did not seem to select specific vegetation height. Greater Painted Snipes in Changhua also nested under dense vegetation, but the birds there were found to prefer nesting in places where the vegetation heights were lower than that in non-breeding area (Hsieh, 2003).

Preference for dense vegetation coverage at nest sites may be a response to predation risk because 40% (two fifths) of the failed Greater Painted Snipe nests were lost to predators in our study. Siberian Jays (*Perisoreus infaustus*) were found to use more concealed sites under increased predation pressure (Eggers et al., 2006). The nest concealment hypothesis suggests breeding birds would nest in places with higher concealment in order to reduce predation risk (Martin, 1993). Vegetation concealment was found to be important to open cup or scrape ground nesters like Hermit Thrushes (*Catharus guttatus*, Flaspohler et al., 2000), Acadian Flycatchers (*Empidonax virescens*, Chapa-Vargas and Robinson, 2006), Greater Rheas (*Rhea Americana*, Fernandez and Reboreda, 2002) and White-winged Scoters (*Melanitta fusca deglandi*, Traylor et al., 2004). Greater Painted Snipes build scrape nests on the ground. Vegetation around the nests could block the views of aerial predators and mammals at a distance, thus contributing to breeding success.

Potential prey-site hypothesis (Charnov, 1976) may provide an alternative explanation to why Greater Painted Snipes preferred nesting in dense vegetation. This hypothesis predicts that predation decreases when a predator needs to search a large number of sites before finding an active nest. This prediction was verified in Brewer's Sparrow (*Spizella breweri*) through manipulative experiments (Chalfoun and Martin, 2009). In Shen-Gou, Greater Painted Snipe nests suffered 40% predation among failed nests during the study period. This species nested within clusters of the two dominant plant species, the Indian Sesbania and rice, and sometimes used rice straw as nest materials. Although we did not perform any experiment on predation, their preference for dense vegetation coverage could result from the dilution effect a large number of potential nest sites have on predators.

Greater Painted Snipes built nests at sites with lower water depth than random sites. Since 60% (three fifths) of the nest failure was caused by flooding, Greater Painted Snipe's preference for nest sites with lower water depth than random sites may be an effort to avoid being flooded. Nest elevation strongly influenced the probability of eggs hatching in waterbird nests (Rounds et al., 2004). The nest loss of Black Terns (*Chlidonias niger*) in freshwater wetlands was mainly due to flooding caused by heavy rainfall (Gilbert and Servello, 2005). Other studies found similar results in Red-winged Blackbirds (*Agelaius phoeniceus*, Picman et al., 1988), Piping Plovers (*Charadrius melodus*, Espie et al., 1998) and other avian species (reviewed by Reinert, 2006).

Studying the effect of water on the reproduction of waterbirds in agricultural lands can increase our understanding of the interaction between avian species and human activities. King Rails (*Rallus elegans*) breeding in rice fields in Louisiana were found to have relatively high nest survival and stable nest densities, possibly based on the high-quality habitat due to flooding (Pierluissi and King, 2008). In our study, Greater Painted Snipes nested in wet fallow fields instead of cultivated rice fields. Preference for wet fallow fields was also found in Greater Painted Snipes in central Taiwan (Hsieh, 2003). Although cultivated rice fields provided more food during the breeding season (Cheng, 2002; Lee et al., 2002), the fact that young rice needs to be flooded and the farmers' frequent presence in rice fields probably made the birds prefer nesting in fallow fields. Our study contributes to agricultural land ecology by learning that Greater Painted Snipes preferred nest sites with dense vegetation and shallow water depth, both variables could affect nest success.

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彩鷸（*Rostratula benghalensis benghalensis*）在宜蘭休耕田中的巢位選擇

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摘要：巢位品質常會影響鳥類的繁殖成功與適存度。對在溼地中的地面繁殖的鳥，植物結構可能會影響掠食壓力，而水深則關乎巢會不會被水淹沒，所以可能是影響其巢位選擇的重要因子。我們以宜蘭深溝地區含水的休耕田為研究地點，檢視前述兩個因子對在當地繁殖的彩鷸之巢位選擇是否有影響。合計共在樣區中找到 17 個彩鷸的巢，並且在巢的附近選取隨機點測量環境狀況。透過成對檢驗，我們發現繁殖鳥較傾向於將巢築在植物覆蓋度高且水深較淺的地方，但營巢點的植物高度和隨機點間則沒有顯著差異。本研究共發現有五個巢因為被水淹沒或被掠食而失敗。彩鷸偏好在水位較淺處築巢，可能是為了要減少巢被水淹沒的機率；偏好植物覆蓋度高的位置築巢，則可能是為了因應掠食壓力。

關鍵詞：彩鷸、巢位選擇、掠食壓力、植物覆蓋度、水深。