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Short Communication

Diet and Breeding Biology of Asian Golden Weaver *(Ploceus hypoxanthus)*

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Introduction

The Asian Golden Weaver (*Ploceus hypoxanthus*) occurs in Myanmar, Thailand, Laos, Vietnam, Cambodia, and Indonesia and inhabits marshes, grasslands, reeds and rice fields close to water in the lowlands (Robson 2000) and natural waterholes in lowland dry dipterocarp forest (Round 1998). It is globally 'Near-threatened' due to habitat loss through the conversion of wetlands to agricultural and settlement areas (BirdLife International 2007). In Thailand it is local and uncommon in the north, north-east and central regions (Lekagul and Round 1991, Robson 2000). However, no quantitative data are available regarding its ecological requirements. Our objectives were to collect basic ecological data on: i) population structure, ii) nesting habitat characteristics, iii) food selection and foraging behaviour, and iv) parental care at the nest.

Study area and methods

Study area

The study was conducted on the 32 ha Bangkhuntien Campus of King Mongkut's University of Technology, Thonburi (KMUTT), Bangkok, Thailand (13° 34′ N and 100° 26′ E), elevation 2 m asl. The average annual rainfall is approximately 1,600 mm falling mostly between May and October (Meteorological Dept. Thailand, 1995–2004). This region was originally mangrove forest in the brackish coastal zone of the gulf of Thailand but now consists mostly of fish and shrimp-ponds. The campus study area at the time of the study consisted of a mix of grassy, heavily disturbed, unvegetated, filled-in drier areas, with six natural temporary wetlands and five artificial ponds adjacent to the campus buildings. The ponds were of brackish water (1–1.5 m deep), while the temporary freshwater wetlands were shallower (< 1 m) and derived mostly from rainwater. Both supported a dense growth of aquatic plants, especially Cattail (*Typha angustifolia*) around their margins where Asian Golden Weavers and other bird species were observed nesting (Figure 1). The area of Cattail cover in the four temporary wetlands in which the weavers nested ranged from 674–1,422 m^2 (a total area of approximately 0.4 ha).

Data collection

Most work reported here represents an intensive study conducted between 5 July and 24 September during the 2005 breeding season. However, we began ringing this population of Asian Golden Weavers in July 2001, although observations were infrequent up until 2005 (see below). The breeding of Asian Golden Weavers coincided with the rainy season, as is the case in African weavers (Collias and Collias 1980). Although our records on the exact timing of the

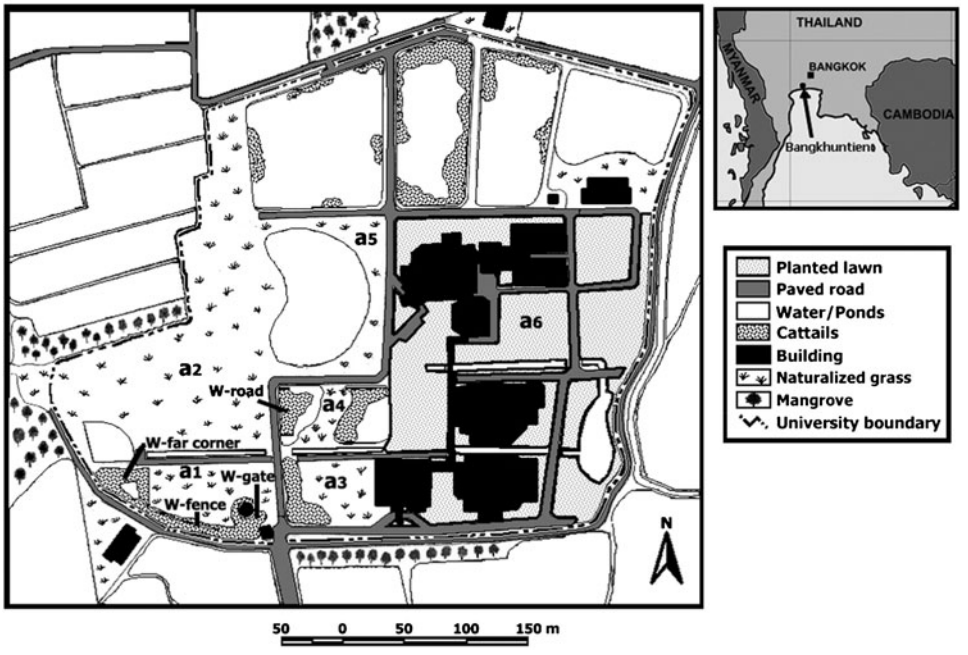

Figure 1. The study site is located in the far southwestern edge of the city of Bangkok. Cattail ''W-'' indicate the primary nesting areas. Foraging areas a1 to a5 are naturalized lawn after land was cleared for construction around wetlands, and a6 is planted lawn.

breeding season are sparse, males in full breeding plumage were observed in early April and confirmed nest building was observed as early as 23 May. This species occurred year-round in the study area, although only sporadic qualitative observations were made during the non-breeding season (November–April).

Population structure

Between 5 July and 24 September 2005 we used direct counts to estimate the numbers of weavers and their sex ratio in each of the wetlands. Four observers conducted simultaneous timed counts in four different patches of temporary wetland to avoid double counting birds when they moved among habitat patches. In July 2005 three females and one male were ringed with unique combinations of anodized metal colour rings (weavers are able to remove the plastic rings, often within a few days of fitting). Opportunistic observations were also made during the post-breeding period up to the end of October 2005.

Breeding and foraging behaviour

During the 2005 study period, four observers recorded foraging, feeding behaviour and food items eaten by adults during 78 man-hours of observations conducted from 06h00 to 18h00. Observations were distributed relatively evenly throughout the course of the day. One individual was followed, and its behaviour recorded, until it disappeared from view and then the next visible bird was observed. Food items were classified as invertebrate or seed when possible. The feeding behaviour in each habitat including Cattail, natural grass field and planted lawn was recorded.

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Nest- site characteristics

The nest site was defined as a 1 m^2 square area centred on the nest (both partial and complete nests). Vegetation at the nest site was measured by counting the number of stems and estimating percent cover of every plant species present. Plants were collected for identification and compared with reference material from the Chiang Mai University Herbarium (Chiang Mai, Thailand). We recorded six other habitat variables: 1) Cattail density, estimated by counting the number of Cattail stems in the 1 m^2 plots. Initially based on exact counts, we were able to reliably estimate density from simple visual estimates of percent cover, such that 100% Cattail cover was roughly equivalent to 100 stems m^{-2}; 2) maximum height of the Cattail within a plot measured from the ground to the tip of the highest stem; 3) height of nest above water, (from the water surface to the bottom-most outer surface of the nest); 4) relative position of the nest on the Cattail or other plant stem, measured from the distance from the top-most surface of the nest to the highest point of the supporting Cattail or other vegetation; 5) distance from nest to the nearest edge (road, fence, or lawn), and 6) water depth. Variables 2–6 were measured using a measuring tape. These measurements were also added together to estimate the height of nests above the wetland floor and the total height of the Cattail within a nest plot. All measurements were taken after all activity at a nest was terminated so as to avoid disturbance.

Parental care at nest

Six active nests were observed for a total of 30 hours to assess food delivery to nestlings in morning and late afternoon sessions. We recorded the time and duration of visits to the nests, food items fed to nestlings, and sex of the adult involved. Nests were observed for different amounts of time depending on when in the nesting cycle they were found, and when or if they failed. As our data were limited, we did not attempt to compare early versus late nestling periods. We were able to classify most insects to order since they were obvious and large enough to see when brought to the nest. Seed feeding was particularly difficult to confirm as the seeds were too small to observe in the bill and it was not possible to directly observe the transference of food, which could potentially bias observations in favour of insect consumption. However, adults were observed feeding on grass seeds and returning to the nest in which they appeared to make common feeding motions (repeatedly inserting their heads into the nest at short intervals). Visits without feeding could usually be determined as the adults would typically look inside the nest without the head in-out motion. As we were interested in feeding rates, such visits were not used in the analysis.

Diet

Since Asian Golden Weavers are mainly granivorous, we focused on measuring the grasses or other possible seed-food producers in six main foraging areas around the nesting areas. In the same study period, each foraging area was sampled using 30 systematically placed 1-m^2 plots. As a proxy for food availability, we measured plant cover and the relative frequency of each plant species following Smith (1990). We did not attempt to measure seed abundance of individual plant species, but based on our observations, the vast majority of grasses were producing seed throughout the study period and therefore we assumed that seed abundance was positively correlated with percentage cover of the species.

Data analysis

Mann-Whitney tests were used to compare habitat characteristics of complete and incomplete nests, while Kruskal-Wallis ANOVAs were used to compare habitat differences among wetland patches. Wilcoxon matched pairs test was used to test differences in feeding rates between males and females among nests.

Results and Discussion

Population structure and nesting success

There were at least 11 individuals, including five males (four marked) and six females (five marked) at the beginning of the study. During July-September 2005 we found 30 nests, of which eight were completed and used. Six nestlings fledged, two from each of three nests, on 29 August, 1 September, and 19 September 2005. Four nests failed and the fate one was unknown. The population was counted again during 20–24 September 2005 when all adults and fledglings were in a roosting flock, resulting in a minimum count of eight males, six females, and six fledglings.

There was no clear evidence of polygyny or cooperative breeding, but we observed one male feed young in one nest and then subsequently land on, and look into, three other nests in the same colony, although it did not feed. Two other males were also observed perching near this cluster of four nests, but were never seen to feed any nestlings.

Nest-site characteristics

As part of courtship, males initiated all nest building, while those nests used were completed together with females. The majority of nests were never completed. Thirty nests were attempted and habitat measurements were made at 26 of these. Habitat patches were used differently during the study period, and nesting patches and feeding patches were largely independent of each other. Nesting occurred almost entirely in four temporary wetlands which ranged in area from 674 to 1,720 m^2 (29 of 30 nesting attempts), while only one attempt was observed in the larger and deeper, permanent pond. No nests were attempted at the 1,720 m^2 temporary pond with young Cattails. Most of the nests recorded in other locations were found only in Cattail and reeds, but nests were built at least occasionally in shrubs or trees, including *Eucalyptus* sp., *Alstonia scholaris* (BCST 2005), *Samanea saman* (BCST 1998), *Sesbania javanica* (P. Saengkaew, pers. comm.) and *Sonneratia caseolaris* (S. Liu, pers. comm.).

Nine plant species were found at nest sites (Table 1). Nests were measured in four wetlands. Excluding one wetland where only one measured nest was located (W_gate, Figure 1), nests placed in different wetland patches were significantly different in terms of their habitat characteristics. These differences included: water depth (Kruskal-Wallis test: $H_2 = 16.5$; $P = 0.0003$, $n = 25$), total plant height ($H_2 = 15.3$, $P = 0.0005$, $n = 25$); height of nests above the wetland floor ($H_2 = 16.4$, $P = 0.0003$, $n = 25$), height of nests above the water ($H_2 = 8.7$, $P = 0.013$, $n = 25$), distance of nests from the top of the nest plant ($H_2 = 11.6$, $P = 0.003$, $n = 25$), and Cattail density surrounding the nest plants ($H_2 = 7.9$, $P = 0.012$, $n = 25$). There was no

Table 1. Relative percentage cover of plants in 1 m^2 plots at nest-sites ($n = 26$).

Plant	*Plant habit*	*Family*	*% relative cover*
Typha angustifolia	AQ-H	Typhaceae	64.4
Sporobolus indicus	AQ/G-H	Gramineae	11.6
Sesuvium portulacastrum	G-H	Aizoaceae	11.2
Fimbristylis ferruginea	AQ/G-H	Cyperaceae	5.1
unknown (planted) Grass	AQ-H	Gramineae	3.3
Eriochloa procera	G-H	Gramineae	2.4
Desmanthus virgatus	S	Mimosoideae	1.0
Ipomoea aquatica	AQ-H	Convolvulaceae	0.4
Ipomoea obscura	G-H	Convolvulaceae	0.3
Cyperus nutans	AQ/G-H	Cyperaceae	0.3

Plant habit: AQ = aquatic, G = ground, H = herb, S = shrub

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significant difference in the distance nests were placed relative to the wetland edge ($H_2 = 3.2$, $P = 0.201$, $n = 25$). These differences largely reflect differences in the age of the Cattail and water depth among wetlands.

Due to the differences among wetlands, we analyzed differences between completed and partially built nests separately for each wetland, with the exception of distance from edge. In the two wetlands containing sufficient numbers of nests to attempt statistical comparisons (*W_far corner* and *W_road*), completed nests were placed significantly closer to the water in both wetlands compared to partial nests, while only in the *W_road* wetland were completed nests placed over significantly deeper water and closer to the top of the Cattail (Table 2). While the trend in water depth was consistent in both sites, this was not the case with the relative distance to the top of the plant. Other measured variables were not significantly different (Cattail density, nest height above the wetland floor, total Cattail height (Table 2) and distance from wetland edge; 5 ± 2 vs 4 ± 3 m, $U = 62.5$, $P = 0.596$, $n = 8$ and $n = 18$ for completed and partially nests respectively).

Although we could find no studies which explicitly tested the same nest-site variables we examined here, our results were consistent with observations of marsh-nesting species nesting in higher densities in deeper water (Picman *et al.*1993) and both observational and experimental studies have demonstrated that predation rates decrease with increasing water depth (Post and Seals 1991, Picman *et al.*1993, Hoover 2006). Our results also indicated that Asian Golden Weavers chose mature or reproductive Cattails of about 1–2 years for nesting. Older, denser patches in the area were largely unused, and young Cattails, less than a year old were also unused. Both of these habitats were not measured, thus we can only speculate as to the reasons for this lack of use. While there is limited data on the relationship between Cattail and/or marsh structure on settlement patterns by birds, Linz *et al.*'s (1996) manipulation of Cattail density suggested that density was positively correlated with the abundance of several species of marsh birds.

Activity patterns

The activity budget of the major behaviours were perching (61 %), nesting (12.5%) and foraging (26.5%). One patch (*W_road*, Figure 1) was initially used as the centre of activity (primarily nesting and perching) up until four nests failed on 10 July, at which point all the birds left the patch. At least two males and one female re-nested approximately 130 m away (*W_far corner*, Figure 1). After breeding activity finished in late September, a flock of Asian Golden Weavers,

Table 2. Results of Mann-Whitney tests comparing habitat variables of complete and partial nests found in the two main nesting sites (*W_far corner* and *W_road*).

	Habitat variables (mean ± SD)					
	Height of nest above water (cm)	Water depth (cm)	Distance from nest to top of Cattail (cm)	Height of nest above wetland floor (cm)	Total Cattail height (cm)	Cattail density (stems m^{-2})
W_far corner						
complete ($n = 3$)	91 ± 6	53 ± 16	70 ± 14	144 ± 12	214 ± 10	23 ± 1
partial ($n = 5$)	110 ± 9	41 ± 4	65 ± 8	151 ± 5	216 ± 10	24 ± 1
U	0.5	3.5	6.0	3.5	7.0	6.5
P	0.035	0.169	0.655	0.227	0.881	0.693
W_road						
complete ($n = 4$)	79 ± 0	30 ± 0	31 ± 0	109 ± 0	140 ± 0	24 ± 0
partial ($n = 4$)	94 ± 11	18 ± 5	50 ± 19	111 ± 13	161 ± 30	30 ± 15
U	0.0	0.0	0.0	8.0	8.0	4.0
P	0.014	0.013	0.014	1.0	1.0	0.219

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including the ringed breeders and fledglings, reappeared in the *W_road* wetland. We had no observations of roosting during the nesting season, but based on extensive observations 20–24 September after nesting ceased, and casual observations after 24 September, the weavers used a different patch (*W_gate*), primarily comprised of younger Cattail for roosting, a patch not used for nesting during the study. However, we had too few observations of nesting and roosting to determine whether the patches used for nesting and roosting were significantly different.

Parental care at the nest

All of the observed, active nests contained two eggs or two nestlings when first examined. We have no observations of males incubating, and we had no records of males or females brooding. Adults delivered food to nestlings at the average rate of two trips hour^{-1} young^{-1}. However females brought food to the nest at a rate of approximately 3.6 trips hour^{-1}, which was significantly higher than males (0.5 trips hour^{-1}) (Wilcoxon matched pairs test: $Z = 2.2$, $n = 6$, $P = 0.028$). From 160 observations at nests, 89% of visits the adults appeared to regurgitate food to the nestlings and this was most likely seeds. Insects were delivered in 7% of visits while the remaining 4% was unknown.

Diet

A total of 24 species of plants (mainly Gramineae) covered the six foraging areas, of which at least eight species were consumed by the weavers. *Eriochloa procera* had the highest average percentage cover (27.1%), and was present in all foraging areas. The second most abundant species was planted grass (unidentified Gramineae; 7.5%) which was never seen to be eaten and was present only in one patch (zone a6, Figure 1).

Although *Eriochloa procera* had the greatest percentage cover, and was the most frequently eaten, there was a notable preference for *Echinochloa colona* which constituted over one-third (35%) of the diet even though it occurred at only approximately one thirteenth of the cover of *E. procera* (Figure 2). Observations in previous years showed *E. colona* was the most frequently consumed by Asian Golden Weavers, but there were no habitat measurements at that time (Chanapai and Trirachulee 2004, Songsakul and Sukung 2003). Insects contributed only a small proportion of their diet during the breeding season (7% in the present study compared with 6% in the previous year (Chanapai and Trirachulee, 2004)).

Conservation and future research

This study indicates that relatively few factors are important in maintaining viable habitat for Asian Golden Weavers, and suggests several avenues for further research, particularly related to management. Firstly, a broader scale study of weavers at several sites is needed to assess general patterns of habitat selection, such as the importance of Cattail. Secondly, if patterns found in our study are typical across the bird's range, there are potentially several site-specific management parameters that could be tested. For example, water depth maybe particularly important for maintaining Cattail, as also indicated by Picman *et al.*, (1993). As the Cattails get older and denser, experiments with selective cutting/thinning could be assessed to examine their impacts on nest-site preference. In addition, the weedy grasses, important in the weaver diet (particularly *Echinochloa colona*) may be relatively easily manipulated to maintain suitable feeding habitat. Because weavers are primarily granivorous, experiments in which supplementary grain is provided could also be attempted in areas where food resources are clearly limiting.

Finally, because the breeding male Asian Golden Weaver is a strikingly attractive bird, yet is reasonably disturbance-tolerant and does not appear to require large wetlands, it is an ideal flagship species and study species which, as demonstrated here, local students may use to learn basic ornithology, behavioural ecology, and wetland ecology while simultaneously gathering valuable data.

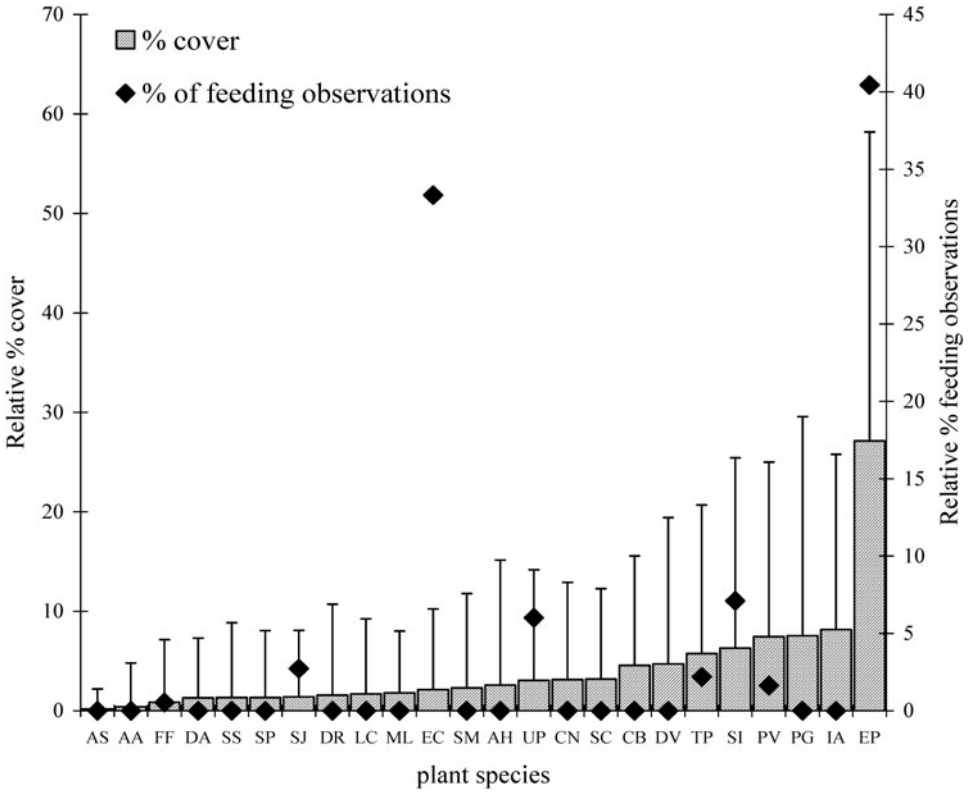

Figure 2. The relative percent cover (+ SD) of plant species in 6 foraging areas and proportion of feeding observations (both sexes) at the selected plant species; AA= *Aeschynomene Americana*, SS = *Sesbania sericea*, SJ = *Sesbania javanica*, ML = *Macroptilium lathyroides*, DV= *Desmanthus virgatus*, DA= *Dactyloctenium aegyptium*, LC= *Leptochloa chinensis*, EC = *Echinochloa colona*, DR= *Digitariana radicosa*, AH= *Arthraxon hispidus*, SC= *Sporobolus caromandelianus*, UP= *Urochloa panicoides*, SI = *Sporobolus indicus*, CB= *Chloris barbata*, PV= *Paspalum vaginatum*, PG = planted grass, EP= *Eriochloa procera*, FF= *Fimbristylis ferruginea*, CN= *Cyperus nutans*, IA= *Ipomeoa aquatica*, SM = *Suaeda maritima*, AS =*Alternanthera sessilis*, SP= *Sesuvium portulacastrum*, TP = *Trianthema portulacastrum*.

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