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Bird Communities in Rice Field and Grasslands during the Dry Season in the Mekong Delta, Cambodia

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Abstract : We studied bird communities among in rice field (46 plots), short grallland (47plot), and tall grass mixed shrub (21 plots) during dry season, January 2007 in Boeung Prek Lapouv (BPL) Important Bird Area, Mekong Delta, Cambodia using the point-count method. Water depth, vegetation height and shrub density were significantly different among the three study areas. We recorded, 60 bird species, of which 13 differed significantly among habitats. Landbirds such as Grey-breasted Prinia (*Prinia hodgsonii*) and Oliver-black Sunbird (*Nectarinia jugularis*) were much more abundant ($P<0.0001$) in the tall grass mixed shrub, whereas the Sarus Crane (*Grus antigone*), herons and egrets were more abundant in the short grass ($P<0.05$). Bird species richness and species abundances were not significantly different among habitats. Bird species diversity (H') was higher in grasslands than in rice fields. Mosaic habitat matrix, such as rice field, short grass, and tall grass mixed shrub, should be maintained for the extend and quality of wetlands, and the prevailing human-land use patterns, appear adequate and conductive for waterbirds in the Mekong Delta, Cambodia.

Key words **:** *bird community, Cambodia, dry season, grassland, mekong delta, rice field*

Introduction

Agriculture started about 10,000 years ago, when wild plants were domesticated in northern China, Mexico, and South America (Bolen and Robinson, 2003). Rice fields provide the staple food for people in at least 33 countries, including 15 in Asia and the Pacific, 10 in Latin America and the Caribbean, 1 in North Africa, and 7 in Sub-Saharan Africa (Bambaradeniya and Amerasinghe, 2004).

Cambodia is an agricultural country and the most widespread crop is rice (Sin and Nuth, 1995), covering 2,443,530 ha (13.50% of the country's area) (MAFF, 2006). The agricultural sector provided direct employment to approximately 80% of the labor force (ICEM, 2003). Moreover, rice fields also provided temporary aquatic ecosystems and play a significant role as habitat for waterbirds (Miller *et al*., 1989; Cunningham, 2005; Blanco *et al*., 2006). However, rice field may negatively affect some birds and aquatic species (Elphick and Oring, 1998), because it does not substitute for natural wetland and perhaps also due to human disturbance.

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In Cambodia, rice ecosystem is the most important terrestrial ecosystem, and is influenced by key factors such as rainfall or flooding pattern, soil suitability, and topography (Bambaradeniya and Amarasinghe, 2004). Dry season irrigated rice, or dry season rice field, is one of four rice ecosystems. Dry season rice fields usually occur along major rivers and floodplains. The period of cultivation depends on the local date of flood recession and the growing period and it is about four months.

Today, rice paddy fields are being converted from natural wetland habitats. The impact has been attracting concerns about the remaining natural wetland habitats and wildlife conservation (Koskimies, 1989; Blanco *et al*., 2006). On the other hand, information on species richness of bird communities as well as abundance in the dry season, is lacking in the rice fields or grasslands in Cambodia (Seng *et al*., 2003). Therefore, this study was conducted to clarify characteristics of bird communities between rice and non-rice fields during the dry season to provide for the proper management of birds in rice fields and wetland in Mekong Delta, Cambodia.

Methods

The study areas were rice fields and natural grasslands

in Boeung Prek Lapouv Important Bird Area (BPL, 10° 42'-47' N, 105° 00'-06' E), which is one of Cambodia's 40 important bird areas, located in the wetlands of southern Cambodia (Bauld, 2005). The area is known as one of the outstanding natural habitats remaining in the southern part the Mekong Delta in Cambodia (Seng *et al*., 2003; Bauld, 2005). BPL support a non-breeding habitat for over 2% of the Asian population of Sarus Crane (*Grus antigone*) in the dry season from December to May (Pilgrim unpublished work). The area varies in altitude between 4 and 5 m. The total land of the area was 10,787 ha, including 3,728 ha of dry season rice field and 7,058 ha of grassland areas (tall-grass mixed shrub 1,600 ha and short grassland 5,458 ha) (Bauld, 2005).

We surveyed wintering birds during January 2007 using the point count technique (Rosenstock *et al*., 2002) to monitor changes in bird population when an area is changed; and is generally used to compare bird densities in different habitats (Hostetler and Main, 2001). We visited each point twice daily (06h30-11h30 and 14h00-17h30) during peak hours of bird activity (Hostetler and Main, 2001; Cunningham, 2005). We only recorded birds heard or seen within a 100 m radius (3.14ha) from the center point during a 7-minute observation period. The points were located 400 m apart. The surveys were not conducted if weather conditions were bad, such as rainy and/or windy, because this affects bird activity (Hostetler and Main, 2001). We avoided disturbing the birds as much as possible during the research.

Habitats were classified and selected for a uniform coverage of the wetland's habitat structures, primarily rice fields and grasslands. Because grassland habitat structures differ in terms of vegetation height and species compositions, we divided grassland habitats into short grassland and tall grass mixed shrub. After counting birds, we spent about 3-5 minutes to count all individual shrubs within 16 m^2 plots (Bonham, 1989) and measured the amount of surface water around the plot center. We classified the habitat patch types as rice fields (R), short grassland (SG) and tall grass mixed shrub (TS).

Rice (*Oryza sativa*) was cultivated in our study area during the dry season for about 4 months (January-April); we had 46 sample plots in rice fields (R). The cover in each plot was >95% of rice plants.

In short grassland (47 sample plots), >90% of the cover was short grasses, averaging of around 20 cm in height. Dominant species were Wire Grass (*Eleusine indica*), Floating Heart (*Nymphoides indica*), and (*Poligonum tomentosum*). Wetland species, such as Chinese Water Chestnut (*Eleocharis dulcis*) and Water Lily (*Nymphaea* spp.), were often found in this habitat, but were rare in other habitats.

Tall grass mixed shrub was a distinct grassland community dominated by dense taller grasses and shrubs, providing >75% of the cover. The average vegetation was >90 cm in height. Dominant species were *Mosinda persiceaefolia,* Asian Bushbeech (*Gmelina asiatica*), and *Breynia vitis-idaea.* Moreover, the habitat had more stream channels, where *Sesbania javanica* and Catclaw Mimosa (*Mimosa pigra*) shrubs grew along channel banks. We had 21 sample plots in this habitat.

We measured species diversity indices using the Shannon-Weaver index (H'), which is used to characterize species diversity in a community (Shannon and Weaver, 1949). We used the Kruskal-Wallis one-way ANOVA on ranks to compare more than two groups of observations. Statistical tests were conducted using SAS (SAS Institute, 2003).

Results

Mean water depth in the rice fields was significantly different (Kruskal-Wallis test, H=25.09, P=<0.001) from that in the short grassland and the tall grass mixed shrub (Table 1). However, it did not differ significantly between the short grassland and the tall grass mixed shrub (H = 4.36, P = 0.09). The low water depth in the grassland may have been due to drought in the dry season. In stream channels or ponds, the water levels remained at 1 to 3 m. The vegetation height was significantly different among habitats (H=54.23, P<0.001); it was 6 times higher in the tall grass mixed shrub than in the rice fields and 4 times higher than in the short grass. Also, shrub density in the tall grass mixed shrub

Table 1. Differences in water depth (mean ± SE, cm), vegetation height (mean ± SE, cm), and shrub density (mean ± SE, no./m^2) in rice field (R), short grass (SG), and tall grass mixed shrub (TS) habitats in the Boeung Prek Lapouv Important Bird Area, Mekong Delta, Cambodia, with the results of Kruskal-Wallis tests.

	Habitats			P-value
	R	SG	TS	
Water depth (cm)	4.02 ± 0.59	2.09 ± 0.62	3.10 ± 2.20	< 0.001
Vegetation height (cm)	16.45 ± 1.41	23.23 ± 1.00	96.57 ± 8.22	< 0.001
Shrub density	0.15 ± 0.11	0.50 ± 0.35	7.29 ± 2.48	< 0.001

Table 2. Comparison of mean number of individual birds per plot and bird species richness abundances in rice field (R), short grassland (SG), and tall grass mixed shrub (TS) in the Boeung Prek Lapouv Important Bird Area, Mekong Delta, southern Cambodia, using one-way ANOVA (* P < 0.05, ** P < 0.01, *** P < 0.0001).

Bird species	R	SG	TS	P-value
Lesser Whistling Duck *Dendrocygna javanica*	1.52	0.04	-	0.052
Spot-billed Duck *Anas poecilorhyncha*	0.13	0.91	1.90	0.0002**
Garganey *Anas querquedula*	1.52	0.02	-	0.097
Little Grebe *Tachybaptus ruficollis*	-	0.06	-	0.494
Common Kingfisher *Alcedo atthis*	0.05	-	-	0.109
White-throated Kingfisher *Halcyon smyrnensis*	-	0.02	0.02	0.799
Blue-tailed Bee-eater *Merops philippinus*	0.33	0.08	-	0.102
Plaintive Cuckoo *Cacomantis merulinus*	-	-	0.02	0.482
Spotted Dove *Streptopelia chinensis*	0.10	0.09	0.13	0.901
Ruddy-breasted Crake *Porzana fusca*	0.05	-	-	0.109
Common Snipe *Gallinago gallinago*	0.38	0.26	0.33	0.833
Common Redshank *Tringa totanus*	-	0.51	0.11	0.076
Marsh Sandpiper *Tringa stagnatillis*	0.19	1.94	2.07	0.080
Common Greenshank *Tringa nebularia*	-	0.23	0.43	0.197
Nordmann's Greenshank *Tringa guttifer*	-	0.19	0.04	0.417
Wood Sandpiper *Tringa glareola*	3.52	4.60	0.29	0.037*
Terek Sandpiper *Xenus cinereus*	-	0.15	-	0.494
Common Sandpiper *Actitis hypoleucos*	-	0.02	0.13	0.361
Red-necked Stint *Calidris ruficollis*	-	0.45	-	0.300
Curlew Sandpiper *Calidris ferruginea*	-	0.02	0.02	0.799
Little Ringed Plover *Charadrius dubius*	0.95	2.43	2.02	0.558
Kentish Plover *Charadrius alexandrinus*	-	0.11	-	0.195
Red-wattled Lapwing *Vanellus indicus*	0.10	0.04	-	0.382
Whiskered Tern *Chlidonias hybridus*	-	0.13	0.89	0.362
Pallas's Fish Eagle *Haliaeetus leucoryphus*	0.05	-	-	0.109
Lesser Fish Eagle *Ichthyophaga humilis*	-	-	0.02	0.494
Black-shouldered Kite *Elanus coeruleus*	-	0.02	-	0.494
Oriental Darter *Anhinga melanogaster*	0.05	-	-	0.109
Little Cormorant *Phalacrocorax niger*	0.37	0.79	3.43	0.001**
Indian Cormorant *Phalacrocorax fuscicollis*	-	0.06	-	0.494
Little Egret *Egretta garzetta*	5.91	18.81	16.70	0.289
Intermediate Egret *Egretta intermedia*	2.50	12.43	6.62	0.025*
Great Egret *Egretta alba*	0.26	2.60	1.62	0.018*
Cattle Egret *Bubulcus ibis*	-	-	0.06	0.494
Grey Heron *Ardea cinerea*	0.13	4.40	1.67	0.005**
Purple Heron *Ardea purpurea*	-	0.53	0.33	0.043*
Javan Pond Heron *Ardeola speciosa*	2.02	3.30	7.81	0.007**
Black-crowned Night-heron *Nycticorax nycticorax*	-	0.02	0.02	0.799
Little Heron *Butorides striatus*	-	-	0.04	0.482
Cinnamon Bittern *Ixobrychus cinnamomeus*	0.48	0.40	0.24	0.525
Black-headed Ibis *Threskiornis melanocephalus*	-	0.06	-	0.494
Painted Stork *Mycteria leucocephala*	-	6.51	-	0.052
Sarus Crane *Grus antigone*	-	1.19	0.24	0.005**
Black Drongo *Dicrurus macrocercus*	0.33	0.32	0.09	0.101
Asian Brown Flycatcher *Muscicapa dauurica*	0.10	-	-	0.109
Common Stonechat *Saxicola torquata*	0.02	-	0.33	0.002**
Pied Bushchat *Saxicola caprata*	0.52	0.13	0.13	0.168
Sand Martin *Riparia riparia*	-	-	0.54	0.119
Barn Swallow *Hirundo rustica*	-	-	0.43	0.063

Table 2. Contunued.

Bird species	R	SG	TS	P-value
Yellow-vented Bulbul *Pycnonotus goiavier*	0.04	-	0.48	0.001**
Striated Grassbird *Megalurus palustris*	-	0.34	0.07	0.088
Grey-breasted Prinia *Prinia hodgsonii*	0.09	0.49	2.95	<0.0001***
Yellow-bellied Prinia *Prinia flaviventris*	0.10	-	-	0.109
Plain Prinia *Prinia inornata*	0.86	2.81	3.67	0.279
Common Tailorbird *Orthotomus sutorius*	0.24	0.04	-	0.055
Oriental Reed Warbler *Acrocephalus orientalis*	-	1.45	2.11	0.323
Olive-backed Sunbird *Nectarinia jugularis*	-	-	0.81	<0.0001***
Richard's Pipit *Anthus novaeseelandiae*	0.29	0.26	-	0.138
Paddyfield Pipit *Anthus rufulus*	-	1.40	2.04	0.205
Indochinese Bushlark *Mirafra marionae*	0.14	0.09	0.02	0.605
Total no. of observed individuals	1,859	3,180	897	5,936
Total no. of observed bird species	34	47	35	60

Table 3. Differences in species richness (mean ± SE, no. of species), species abundance (mean ± SE, no. of species), and species diversity (H', Shannon-Weaver Index) of bird communities among rice field (R), short grass (SG), and tall grass mixed shrub (TS) in the Boeung Prek Lapouv Important Bird Area, Mekong Delta, Cambodia, with results of Kruskal-Wallis test.

	Habitats			P-value
	R	SG	TS	
Species richness/plot	6.02 ± 0.39	7.36 ± 0.40	7.06 ± 0.71	0.08
Species abundance	40.41 ± 6.11	67.66 ± 11.08	42.71 ± 8.03	0.07
Species diversity	1.33	1.56	1.63	0.1

was significantly greater (H=44.58, P<0.001) compared to the rice fields and short grassland. The shrub density in the tall grass mixed shrub was 48 times higher than in the rice fields and more than 16 times higher than in the short grass. However, shrub density was not statistically different between the rice field and short grass habitats.

A total of 5,936 birds belonging to 60 species were encountered at 114 stations during the 7-minute observation periods. Of these, 1,859 individuals of 34 species were observed in the rice field, 3,180 individuals of 47 species in the short grass, and 897 individuals of 35 species in the tall grass (Table 2). Approximately 28% of the 17 species recorded in the BPL occurred in all three types of habitats and 35% of 21 bird species occurred only in one habitat.

One-way ANOVA tests indicated that only 13 bird species differed significantly in relative abundance among habitats. Among them, land birds, such as the grey-breasted prinia and Olive-backed Sunbird (P<0.0001) and Common Stonechat and Yellow-vented Bulbul (P<0.01) were significantly most common in the tall grass mixed shrub. Waterbirds, such as the Little Cormorant, Spot-billed Duck, and Javan Pond Heron, were significantly more common in the tall grass mixed shrub, where as the grey heron and Sarus Cranes were significantly more common (P<0.01) in the short grass. Moreover, Great Egret, Intermediate Egret, Purple Heron, and Wood Sandpiper were significantly more common (P<0.05) in the short grass (Table 2). Bird species richness, species abundances, and Shannon-Weaver (H') indices were not significantly different among habitats (Table 3).

Discussion

Habitat variables, such as water depth, vegetation height, and shrub density, were different among rice field, short grass, and tall grass mixed shrub. Also, some bird species differed significantly in relative abundance and habitats. Flooded rice crop ecosystems are sometime thought to be adequate to sustain waterbird populations, but there have been mixed results different species in different areas (Fasola and Ruiz, 1996; Elphick, 2000; Maeda, 2001; Sundar, 2006).

The higher bird species diversity in grassland habitats (short grass and tall grass mixed shrub) (Table 3) indicated that grassland was likely important for maintaining species richness. One reason for this might be the presence of underground tubers of native wetland vegetation in short grassland that are eaten by ground-feeding birds (Board *et al*., 2001). Moreover, the tall grass mixed shrub contained shrubs, which are important for land birds, especially birds that eat seeds and pollens. Alter-

natively, the number of observed birds may have been lower in the rice fields because there were temporary artificial wetlands that provided feeding habitat for waterbirds only during certain times, and due to human disturbance (Elphick and Oring, 1998; Maeda, 2001).

Studies in Japan and some parts of Europe have shown that some bird species might be strongly depended on natural marshes rather that rice fields for foraging, roosting, and nesting sites (Elphick, 2000; Maeda, 2005; Czech and Parsons, 2002; Sundar, 2006). However, in the Neotropics, waterbirds used rice fields more than natural habitats (Falosa *et al*., 1996; Blanco *et al*., 2006). Generally, rice fields on our study area were cultivated with only one dominant species of rice whereas grasslands contained many different plant species. Species richness and abundance of birds were probably influenced by vegetation diversity and structure (Bryan and Best, 1991).

The greater abundance of land birds, such as Common Stonechat, Grey-breasted Prinia, Olive-backed Sunbird, and Yellow-vented Bulbul in the tall grass mixed shrub may be due to shrub density (Waldan *et al*., 2004). Many fruits and flowers were found in the tall grass mixed shrub habitat during our field surveys, which attracted birds that eat fruit and pollen (Buckingham *et al*., 2006). Also, shrub cover should provide roosting, and nesting sites, mainly for seed-eating and insectivorous birds (Tubelis and Cavalcanti, 2000).

Greater numbers of Spot-billed Duck and Little Cormorant in the tall grass mixed shrub might be due to habitat structure. The tall grass habitat contains more shallow-water stream channels and shrub species, such as *Sesbania javanica*, which grow along the channel banks. The dry-season water level generally decreased to around 2-4 cm, except in ponds and stream channels, where water depth remained around 1-3 m. The shallow freshwater was important for these diver species to use as foraging and resting sites (Kennedy *et al*., 2000). Shimada *et al*. (2000) and Toureg *et al*. (2003) also mentioned that ducks usually rest on a roost in shallow water during the day. Similarly, cormorants forage underwater (Frere *et al*., 2002; Sapoznokow and Quintana, 2003). Moreover, when the water dried out, the dry channel banks and *Sesbania javanica* shrubs provided suitable perching sites for cormorants. Kennedy *et al*. (2000) reported that cormorants perch near water edges, holding their wings open to dry.

The Sarus Crane was common wintering bird in the short grassland (Table 2). During the dry season, the short grass habitat provided high-quality food in form of underground tubers of native wetland vegetation, such as Chinese Water Chestnut and Water Lily. These wetland vegetation species were commonly only in short grassland during this study. Except for aquatic animals, Borad *et al*. (2001) found that the diet of cranes consisted of tubers of aquatic sedges.

The high abundances of egret and heron species in the short grassland may be related to water levels and low shrub density. The short grass was drier than other habitats, which may have made insects and fishes more vulnerable for capture by egrets and herons (Shimada *et al*., 2000; Toureng *et al*., 2003). In addition, tall grasses and dense shrub habitat is not preferred by egrets and herons (Willard, 1977).

Flooded rice fields may be useful foraging habitat for some species of waterbirds when managed appropriately (Fasola and Ruiz, 1996; Fujioka *et al*., 2001). Mosaic habitat matrix, such as rice field, short grass, and tall grass mixed shrub, should be maintained for the extend and quality of wetlands, and the prevailing human-land use patterns, appear adequate and conductive for waterbirds in the Mekong Delta, southern Cambodia.

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