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SHORT COMMUNICATION

Species abundance and conservation of coastal wintering waterbirds in Hainan Island, China

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Abstract Wintering waterbirds surveys were conducted throughout the coastal areas of Hainan, China, from 2003 to 2005, with the aim of further strengthening the conservation and management of wetlands in Hainan Island. A total of 68 species were recorded at 20 coastal wetlands. Three recently found wintering sites for the globally endangered Black-faced Spoonbill (*Platalea minor*), i.e. Houshui Bay of Lingao, Beili Bay of Dongfang Counties and Sanya River in Sanya City were then extensively monitored during a period of 2003–2009. The largest number of birds were egrets and herons, followed by shorebirds, gulls and terns. On average, the total number of species and individuals at sites with mangrove forests were significantly greater than those of sites without mangrove forests. Some sites, important for conservation, were identified, such as Bopu Bay, Huanglonggang, Houshui Bay, Yangpugang, Beili Bay, Yinggehai, Sanya River, Qinlangang and Dongzhaigang. Thus, human disturbance at these important sites should be avoided.

Keywords Black-faced Spoonbill (*Platalea minor*), waterbirds, Hainan Island

Introduction

Hainan Island is located in the south of China (18°09′–20°11′N, 108°36′–111°04′) and has a land area of about 34000 km^2. Hainan is separated from continental China by the Qiongzhou Strait and lies only 20 km south of the Leizhou Peninsula in southwestern Guangdong Province (Zhou, 2006). Hainan has extensive wetland habitats, which support large numbers of migratory waterbirds for the duration of the winter period (Guangdong Institute of Entomology, 1983).

Swinhoe (1870) was the first to demonstrate the rich waterbird abundance in Hainan and recorded 47 waterbird species. Shaw and Hsu (1966) recorded 48 waterbird species in Hainan Island. A list of 103 waterbird species in Hainan was provided by the Guangdong Institute of Entomology (1983). Recent studies (Zou et al., 1999, 2000, 2001), which focused only on a few sites of the island, found that there were great changes in waterbird species compared with previous surveys (Shaw and Hsu, 1966; Guangdong Institute of Entomology, 1983) and identified three important sites for conservation of waterbirds in Hainan Island, i.e. Dongzhaigang Nature Reserve (NR), Qinglangang NR and Yinggehai wetland. Despite these studies, there is a shortage of detailed studies on the distribution and diversity of waterbirds

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wintering in Hainan Island.

We present a detailed analysis of the abundance of wintering waterbirds and their distribution in Hainan. Our main objectives were 1) to identify the waterbird species and their distribution; 2) to assess important sites with rich waterbird abundance and 3) to consider the conservation implications of our findings.

Study area and methods

A total of 20 wetlands were surveyed in January from 2003 to 2005 (Fig. 1). Habitats surveyed ranged from rivers, paddy fields to freshwater marshes and from brackish-water ponds and mangroves to intertidal mudflats. During the surveys, visual searching was the main method used. At each site, 2–4 observation points were established to scan for birds in open areas. Once flocks were identified, the surveyors approached the birds on foot to enable identification and counting. All censuses were carried out using 10 × binoculars and 20–60 × telescopes. Bird species, numbers and habitat types were recorded and observation sites were located with a GPS device. In addition, the wintering sites of the Black-faced Spoonbill (*Platalea minor*) were visited January 2004 and 2005 (Plate I). Relative species abundance at each surveyed site was calculated as the Shannon-Wiener index (*H*).

To analyze the effect of mangrove forests on waterbirds, except four sites, i.e. Huanglonggang, Yazhou Bay, Fengjia Bay and Tongguling, which have been heavily destroyed by local development, the other sixteen sites were divided into two habitat types. The eight sites with the mangrove forests were Houshui Bay, Yangpugang, Beili Bay, Yinggehai, Sanya River, Yalong Bay, Qinglangang and Dongzhaigang; the other eight sites did not include any mangrove forests. We used one-way ANOVA to test the significance of the differences in waterbird abundance between the two types of habitat.

Results

Wintering waterbird species

A total of 68 wintering waterbird species in Hainan Island were recorded during our surveys. The annual totals were as follows: 65 species in 2003, 60 in 2004 and 58 in 2005. For the entire list of species and their distribution sites, see Table 1.

Species composition

The most frequently encountered species were egrets and herons, followed by shorebirds, gulls and terns. The most widespread species was the Little Egret (*Egretta garzetta*), followed by the Chinese Pond-heron (*Ardea bacchus*), the Common Sandpiper (*Actitis hypoleucos*), the Grey Heron (*Ardea cinerea*), the Lesser Sand Plover (*Charadrius mongolus*) and the Kentish Plover (*Pluvialis alexandrinus*). The sites with the larger number of individual birds were Bopu Bay, Huanglonggang, Houshui Bay, Yangpugang, Beili Bay, Yinggehai, Sanya River, Qinlangang and Dongzhaigang (Tables 1 and 2).

Three new wintering sites of the Black-faced Spoonbill in Hainan were found for the first time in 2003 in Houshui Bay of Lingao County, in Beili Bay of Dongfang County in 2004 and the Sanya River in Sanya City in 2007 (Fig. 1). The size of the wintering population at Houshui Bay were 13, 10, 9, 5, 8, 11, 13 in January of 2003, 2004, 2005, 2006, 2007, 2008 and 2009, 51, 67, 75, 102, 118, 125 in January of 2004, 2005, 2006, 2007, 2008 and 2009 at Beili Bay and 3 in January of 2007 at Sanya River.

Distribution of waterbirds species at important sites

The distribution of waterbirds species abundance varied among the more important sites with the higher number of individuals (Fig. 2 and Table 2). For egrets, herons and bitterns, the relative number of individual birds are higher at Houshui Bay and Sanya River than elsewhere; for sandpipers and snipes, the number of individual birds at Huanglong Bay, Bopu Bay and Beili Bay are the highest; gulls were mainly recorded at Yangpugang, Qinlangang and Dongzhaigang; the number of individual plovers are almost the same at every site except for fewer birds at Houshui Bay and Yangpugang. For grebes, spoonbills, ducks, rails and stilts the number of birds are small at all sites.

Difference in waterbird abundance between two types of habitat

There were significant differences on waterbird abundance between the two types of habitat (Table 3). On average, the total number of species and individuals at sites with mangrove forests was significantly greater than that of sites without mangrove

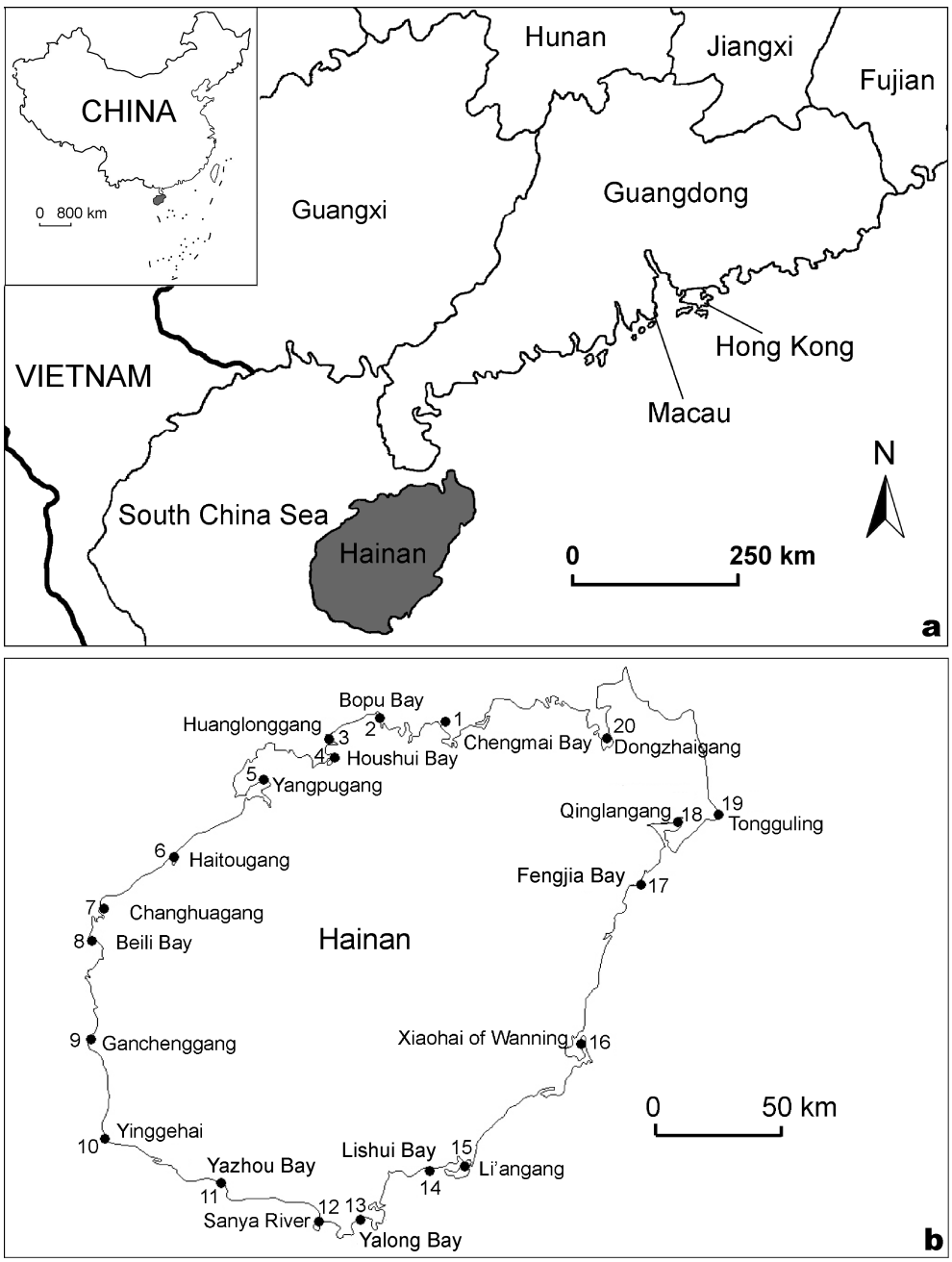

Fig. 1 Map of study area (**a**) and surveyed sites (**b**)

forests (species: $F = 9.04$, $p = 0.01$; individuals: $F = 37.73$, $p < 0.01$). During the surveys, we found the number of individuals and species such as Grey Heron, Little Egret, Chinese Pond-heron, Spotted Redshank (*Tringa erythropus*), Common Greenshank (*T. nebularia*), Marsh Sandpiper (*T. stagnatilis*) and Common Redshank (*T. tetanus*) to be more abundant at sites with mangrove forests.

Discussion

Of the 68 waterbird species, ten species with large populations on historical records (Swinhoe, 1870, Shaw and Hsu, 1966), i.e. Bean Goose (*Anser fa-*

Plate I Black-faced Spoonbill (*Platalea minor*) flock and their mangrove habitat (Photo by Xiaojie Su)

balis), Baikal Teal (*Anas formosa*), Falcated Duck (*A. falcate*), Common Crane (*Grus grus*), Lesser Adjutant Stork (*Leptoptilos javanicus*), Common Coot (*Fulica atra*), Spot-billed Pelican (*Pelecanus philippensis*), Purple Heron (*Ardea purpurea*) and Great Bittern (*Botaurus stellaris*), were not recorded during our surveys.

The present study shows that there is a much greater abundance of waterbirds at sites with mangrove forests than that of sites without mangrove forests. This suggests that mangrove forests might play an important role in the conservation of waterbird diversity and therefore, the remaining mangrove forests in Hainan Island should be effectively protected in the future.

The Black-faced Spoonbill is one of the endangered species in the world. Its two largest wintering sites are Hong Kong and Taiwan (BirdLife International, 2010). To date, four wintering sites of this bird were found in Hainan, i.e., in Dongzhaigang National Nature Reserve (Gao and Huang, 1994), Houshui Bay, Beili Bay and Sanya River (this study). It suggests that Hainan Island is a very important wintering site of the Black-faced Spoonbill in China and regular monitoring should be conducted.

Some sites, important for conservation, were identified in this study, i.e., Bopu Bay, Huanglonggang, Yangpugang, Yinggehai, Sanya River and Qinglangang. Thus, human disturbances, which may cause a general decline in the waterbird species richness and bird number, should be avoided at these important sites.

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Table 1 List of wintering waterbirds and their distribution on Hainan Island, China

Species	Site	Species	Site
Podicipedidae		*C. alexandrinus*	1, 2, 5, 6, 8, 9, 10, 11, 12, 14, 17, 18, 20
Tachybaptus ruficollis	5, 20	**Scolopacidae**	
Phalacrocoracidae		*Numenius arquata*	4, 5, 7, 8, 15, 17, 20
Phalacrocorax carbo	20	*N. madagascariensis*	20
Ardeidae		*N. phaeopus*	4, 5, 7, 20
Egretta alba	1, 2, 4, 5, 8, 10, 12, 13, 14, 17, 18, 20	*Limosa lapponica*	5, 20
E. intermedia	1, 2, 4, 5, 8, 10, 12, 13, 14, 15, 20	*L. limosa*	20
E. garzetta	1, 2, 4, 5, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	*Xenus cinereus*	14, 20
E. eulophotes	4	*Actitis hypoleucos*	1, 2, 5, 7, 8, 9, 10, 12, 14, 15, 16, 18, 19, 20
Bubulcus ibis	12, 13, 20	*Tringa ochropus*	2, 10, 12, 20
Ardeola bacchus	1, 2, 4, 5, 8, 12, 13, 15, 16, 18, 19, 20	*T. glareola*	1, 8, 18, 20
Ardea cinerea	4, 5, 7, 8, 10, 12, 13, 15, 16, 18, 19, 20	*T. erythropus*	2, 4, 8, 10, 12, 13, 20
Butorides striatus	12, 20	*T. totanus*	2, 4, 5, 8, 9, 10, 12, 13, 18, 20
Nycticorax nycticorax	5, 12, 20	*T. stagnatilis*	2, 4, 5, 8, 9, 10, 12, 13, 15, 18, 20
Ixobrychus sinensis	18, 20	*T. nebularia*	2, 4, 5, 7, 8, 9, 10, 12, 13, 17, 18, 20
I. eurhythmus	18, 20	*Arenaria interpres*	2, 6, 7, 18, 20
I. cinnamomeus	4, 14, 20	*Philomachus pugnax*	20
Threskiornithidae		*Calidris canutus*	1, 8, 9
Platalea minor	4, 8, 20	*Limicola falcinellus*	2,
P. leucorodia	8	*Calidris tenuirostris*	7, 8, 18
Anatidae		*C. ferruginea*	2
Anser anser	20	*C. alpine*	2, 7, 8, 10, 14, 18, 20
Anas querquedula	4	*C. temminckii*	2, 8, 10, 20
A. penelope	5	*C. subminuta*	8, 10, 20
A. clypeata	20	*C. ruficollis*	2, 7, 8, 10, 18
A. acuta	4, 9	*Capellinago gallinago*	2, 10, 12, 15, 20
A. platyrhynchos	4	*C. stenura*	10, 15, 18, 20
Rallidae		*Phalaropus lobatus*	20
Rallus striatus	18, 20	**Recurvirostridae**	
Amaurornis phoenicurus	12, 18, 20	*Himantopus himantopus*	18, 20
Porzana fusca	20	**Laridae**	
Gallinula chloropus	5, 12	*Larus argentatus*	4, 5, 7, 8, 20
Gallicrex cinerea	14	*L. ridibundus*	4, 5, 8, 18, 20
Charadriidae		*L. crassirostris*	4
Pluvialis squatarola	2, 4, 5, 6, 7, 8, 9, 10, 14, 15, 18, 20	*L.saundersi*	16
P. fulva	18, 20	*Chlidonias hybridus*	18
Charadrius mongolus	1, 2, 5, 6, 7, 8, 9, 10, 12, 17, 18, 19, 20	*C. leucopterus*	6, 18, 20
C. leschenaultii	2, 18, 20	*Hydroprogne caspia*	4, 5, 6, 8, 10, 18
C. dubius	2, 4, 8, 10, 11, 13, 18, 19, 20	*Gelochelidon nilotica*	5, 20

The figures indicate the survey sites. See Fig. 1 for identification of sites.

Table 2 Species abundance of wintering waterbirds at 20 survey sites on Hainan Island, China

Site	Number of individuals	Number of species	*H*	Site	Number of individuals	Number of species	*H*
Chenmai Bay	98	9	1.97	Yazhou Bay	25	3	0.41
Bopu Bay	573	22	2.73	Sanya River	1104	19	2.91
Huanglongang	960	16	2.39	Yalong Bay	256	11	2.46
Houshui Bay	1098	21	2.44	Lingshui Bay	73	10	2.80
Yangpugang	1650	23	2.77	Li'angang	63	10	2.54
Haitougang	198	6	1.51	Xiaohai of Wanning	330	18	3.22
Changhuagang	80	12	3.17	Fengjia Bay	21	6	2.03
Beili Bay	1354	28	3.67	Qinglangang	1354	29	1.92
Ganchenggang	44	9	2.31	Tongguling	18	6	2.51
Yinggehai	1208	21	3.44	Dongzhaigang	1569	49	3.95

Table 3 Comparison of waterbird diversity and number of species between two habitats with or without mangrove forests

Variance	Mean		*F*	Sig.
	With mangrove forests	Without mangrove forests		
Shanon-Wiener index (*H*)	2.95	2.53	1.66	0.22
Number of waterbird species	25	11	9.04	0.01
Number of waterbird individuals	1199	182	37.73	0.00

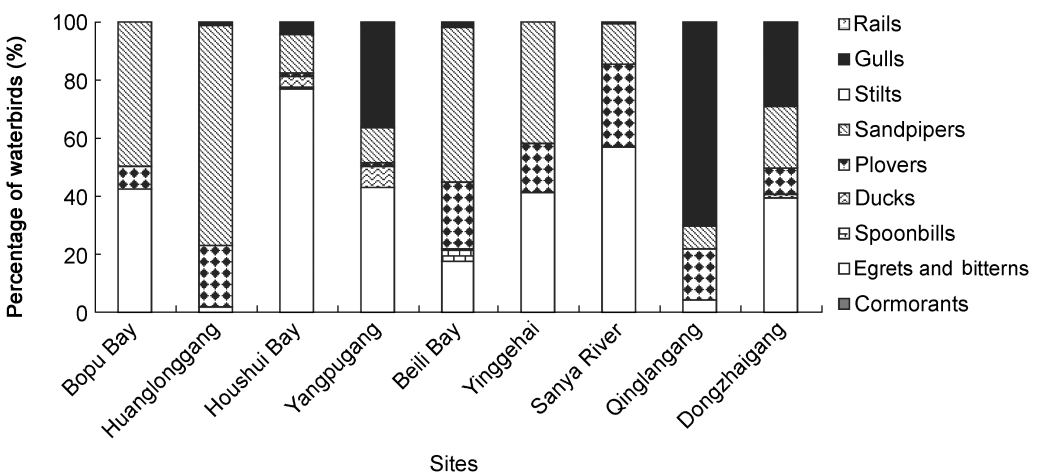

Fig. 2 Relative distribution of waterbird species at important sites in Hainan Island, China

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海南岛沿海越冬水鸟及其保护

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摘要：2003–2005年对海南岛沿海越冬水鸟进行了调查，旨在加强海南岛湿地的保护和管理。在调查的20个湿地中，共记录水鸟68种，新发现3处全球濒危鸟类黑脸琵鹭（*Platalea minor*）的越冬地，即临高后水湾、东方北黎湾和三亚河。2003–2009年冬季对黑脸琵鹭的越冬种群进行了持续调查。海南岛越冬水鸟数量最多的是鹭鸟，其次是鸻鹬类和鸥类。分析发现，在有红树林分布的湿地鸟类种数和个体数量均比无红树林分布的湿地明显增加。此外，博浦湾、黄龙港、后水湾、洋浦港、北黎湾、莺歌海、三亚河、清澜港和东寨港等地是海南岛鸟类优先保护的湿地，其人为干扰应该被禁止。

关键词：黑脸琵鹭（*Platalea minor*），水鸟，海南