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Bird Diversity Of Three Islands in the Straits Of Malacca

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ABSTRACT Bird species diversity of three islands (pulau) in the Straits of Malacca was studied in 2004 and 2007. A total of 12 species of birds was recorded from Pulau Perak, 21 species from Pulau Jarak, and 9 species from Pulau Lalang. Avifauna of these islands not only show differences in species diversity but also in community structures. Among the islands, Pulau Jarak had the highest bird diversity while Pulau Perak had the lowest bird diversity. Although Pulau Perak had more birds, this was contributed by the two most abundant species, i.e. Brown Noddy *(Anous stolidus)* and Brown Booby *(Sula leucogaster)* which comprised 98.7% of the island's bird population. On other islands, the most abundant species were White-bellied Sea Eagle, *Haliaeetus leucogaster* (31% in Pulau Jarak and 34.7% in Pulau Lalang) and Pied Imperial Pigeon, *Ducula bicolor* (17.5% in Pulau Jarak and 30.4% in Pulau Lalang). This study confirms several earlier records on distribution of certain unique and interesting components of the biodiversity of the islands.

ABSTRAK Kepelbagaian spesies burung di tiga pulau yang terletak di Selat Melaka telah dikaji pada tahun 2004 dan 2007. Sebanyak 12 spesies burung telah direkodkan di Pulau Perak, 21 spesies di Pulau Jarak, dan Sembilan spesies di Pulau Lalang. Avifauna di pulau-pulau ini bukan sahaja menunjukkan perbezaan dari segi kepelbagaian spesies malah juga dari segi struktur komuniti. Pulau Jarak mencatatkan kepelbagaian burung tertinggi manakala Pulau Perak mempunyai kepelbagaian burung terendah. Walaupun Pulau Perak mempunyai lebih banyak burung, tetapi ini hanya disumbang oleh dua spesies yang paling melimpah iaitu Burung Camar Angguk (*Anous stolidus*) dan Burung Dendang Laut (*Sula leucogaster*) yang membentuk 98.7% populasi burung di pulau tersebut. Di pulau-pulau lain, spesies paling melimpah adalah Lang Siput, *Haliaeetus leucogaster* (31% di Pulau Jarak dan 34.7% di Pulau Lalang) dan Pergam Rawa, *Ducula bicolor* (17.5% di Pulau Jarak dan 30.4% di Pulau Lalang). Kajian ini mengesahkan beberapa rekod awal mengenai keunikan taburan dan kepentingan komponen biodiversiti pulau.

(bird diversity, Pulau Jarak, Pulau Perak, Pulau Lalang, tropical islands, bird community)

INTRODUCTION

Most of the islands in the Straits of Malacca are located within coastal areas and few are situated in the middle of the straits. Among these islands, Pulau Perak and Pulau Jarak are the westernmost islands within Malaysian waters and have characteristics that resemble those of oceanic islands [1]. From the geological perspective, oceanic island is not situated on a continental shelf but had risen from the sea as a result of coral deposits, volcanic activity or tectonic forces [2]. From the zoogeographical point of view, oceanic island only receives its fauna and flora across the sea and not by way of land bridges [3]. All oceanic islands play significant roles in biodiversity conservation. This is because island species had concentrated in small and confined areas and were isolated from other land masses. This isolation will create unique evolutionary forces that result in the development of a distinct genetic reservoir and the emergence of highly specialised species or species with unusual adaptations. As a result, isolated islands have a tendency to harbour higher concentration of endemic species than continents, and the number and proportion of endemics rise with increasing isolation, island size and topographic variety.

As other oceanic islands, Pulau Perak and Pulau Jarak support unique diversity of species that deserve special attention. Species such as Brown Booby *(Sula leucogaster)* is present in Pulau Perak and has not been recorded in any other islands within western Malaysian waters. The locality and uniqueness of fauna and flora of these islands have attracted many visitors and nature lovers. Since the early nineteenth century (1906 to 1915), collectors such as Herbert C. Robinson, Eibert C.H. Seimund, and few others from Selangor Museum have regularly visited the islands to collect flora and fauna for museum specimens. Then, in the 1930s more expeditions were organised to Pulau Perak and other islands within the Straits of Malacca by various teams. After some expedition members were infected by scrub typhus after visiting Pulau Jarak in 1932, the Scrub Typhus Research Unit of the Institute for Medical Research (IMR) visited the island to study the ecology of scrub typhus [4]. Later, various groups had conducted visits to the island in the 1970s to document the island's flora and fauna.

The islands of Pulau Perak, Pulau Jarak, and Pulau Lalang do not have inhabitants but are frequently visited by fishermen and anglers either for shelter from storm or fishing activities. Recently, divers also visited the islands, especially to Pulau Jarak to admire its natural treasures such as corals and fishes. For national security and political reasons, an army camp is established on Pulau Jarak and Pulau Perak since 2005. These growing human activities (either from fishing related activity, ecotourism, and army establishment) have indirectly increased the threat to the islands, therefore, there is a pressing need for a more accurate and updated inventory of the island biodiversity. It is also hoped that the knowledge accumulated through previous studies and present visits would encourage and catalyse more comprehensive ecological studies in the coming years to help ascertain past and future anthropogenic effects on the islands' biodiversity.

STUDY SITES

Pulau Perak is a small outcrop island located 170 km off Penang or 120 km off Pulau Langkawi. It is about 500 meters long and 250 meters wide with the lighthouse at its highest point of 120 meters. In the 1950s, the island only had sparse vegetation, but in 1970s the island's lower and mid slopes were colonised by a dense, waist-high growth of ferns and grass, but absolutely no trees [5, 6]. The trees had grown well to a medium height that ranged from 2-4 meters as observed during our visit in 2004. All trees belonged to genus *Ficus*, with the most common species being *Ficus religiosa*. In addition, there was also a fern *(Lygodium* sp.*)* that grew in patches on various sites of the island. Pulau Jarak is located 32 km southwest of Pulau Pangkor in Perak. It is about 914 meters long and 457 meters wide. This tiny island rises 154 meters above sea level and is covered by lush green vegetation and on top of it is a lighthouse. The lighthouse has provided an excellent spot for watching birds. Pulau Lalang is one of nine islands that belong to a cluster of islands known as Pulau Sembilan (nine islands). This small island (about half a kilometer long) is heavily forested and it is located about 5 kilometers off Lumut and has fresh water supply.

MATERIALS AND METHODS

All islands were visited twice. We visited Pulau Perak in June and August 2004, Pulau Jarak in June 2004 and November 2007, and Pulau Lalang on June 2004 and November 2007. Duration of visits varied from one day to four days. During all visits, we applied standard procedures (direct observation and mist-netting) to record bird diversity on the island. Birds were observed using binoculars with 8 X 40 magnification. Observation sessions started immediately after sunrise (about 0700 hours) and lasted for whole day until sunset (about 1900 hours). The observation was conducted either along available trail within the island or by boat around the island to observe perching birds by the shore vegetation and the rocky shores that could not be accessed by land (steep cliff and sharp rocks denied our access to certain parts of the island to conduct observation). Although the observations were made from selected sites, the completeness of this study was assured due to the island small size. In addition to direct observation technique, we also setup five mist nets in Pulau Jarak and Pulau Lalang to capture understory birds. Setting mist-nets in Pulau Perak was inappropriate due to its sparse vegetation and rocky geographical structure. All observed and captured birds were identified up to species level.

We calculated diversity index for birds of all island using standard indices such Simpson's D,

Shannon-Weiner's H, Margalef's D, Menhinick's D, and Fisher's alfa. Then we conducted one-side randomization test to assess the degree of significance when one index value was higher than the other index value. In addition to diversity index, we also calculated evenness index (Pielou's J, Simpson's E, McIntosh's E, Smith & Wilson's 1-D, and NHC) to investigate the distribution pattern among birds that inhabited the islands.

RESULTS

In total, about 6,274 birds that belonged to 31 species were observed in this study (Table 1). Pulau Perak had the highest number of birds (6,080 individuals) compared to Pulau Jarak (148 individuals) and Pulau Lalang (only 46 birds). However, in terms of species richness, Pulau Jarak had the highest number of species (21 species), followed by Pulau Perak (12 species) and Pulau Lalang (9 species). The most abundant species, Brown Noddy *(Anous stolidus)* and Brown Bobby *(Sula leucogaster)* were recorded in Pulau Perak only. Both species had an estimated population of 5,000 and 1,000 individuals respectively. Therefore, although Pulau Perak had the highest number of birds, the diversity was low due to less species being present. Although each species was represented by only a small number of individuals, more species were observed in Pulau Jarak. Therefore bird population in this island was more diverse than other islands. On the other hand, Pulau Lalang had less species than Pulau Jarak and each species was also represented by a small number of individuals. Therefore, its bird diversity was lower than Pulau Jarak but higher that Pulau Perak. This finding is fully supported by all diversity indices (Simpson's D, Shannon-Weiner's H, Margalef's D, Menhinick's D, and Fisher's alfa) which indicate that Pulau Jarak had highest index value, followed by Pulau Lalang, and lastly Pulau Perak (Table 2).

Evenness index shows slightly different results. Most indices (except Simpson's E) indicate that the bird population in Pulau Jarak was more evenly distributed than Pulau Perak and Pulau Lalang, while that of Pulau Lalang was more evenly distributed than Pulau Perak. However, value given by NHC index indicates that although bird population of Pulau Jarak was more evenly distributed than Pulau Perak, distribution pattern of bird population of Pulau Jarak was similar to bird population of Pulau Lalang. The bird distribution of Pulau Lalang was not significantly different from the bird population of Pulau Perak (Table 3).

Few species were represented by moderate number of birds in Pulau Jarak or in Pulau Lalang. These included the White Bellied Sea Eagle *(Haliaeestus leucogaster)* and Pied Imperial Pigeon *(Ducula bicolor)*. We estimated 46 individuals of White Bellied Sea Eagle present in Pulau Jarak, while 16 individuals were recorded in Pulau Lalang. For Pied Imperial Pigeon, 26 birds were estimated in Pulau Jarak but only 14 individuals were observed in Pulau Lalang. Other birds were present in small numbers, usually less than six individuals. Majority of the species recorded in this study were represented by only a single individual presente either in one or more islands.

Some of the recorded species were present in a particular island and not others (locally endemic), indicating that they are habitat specialist and had limited distribution. Most birds in Pulau Jarak are locally endemic (13 species or 62%). Examples of locally endemic species in Pulau Jarak included the Black Baza *(Aviceda leuphotes)*, Japanese Sparrowhawk *(Accipiter gularis)*, Fork-tailed Swift *(Apus pacificus)*, Dollarbird *(Eurystomus orientalis)*, Ashy Drongo *(Dicrurus leucophaeus),* and Narcissus Flycatcher *(Ficedula narcissina)*. On the other hand, Pulau Perak had seven (or 58%) locally endemic species. This included the Brown Booby and Brown Noddy which were known to limit their breeding areas to this island only. Other species that been recorded in Pulau Perak only are House Swift *(Apus affinis)*, Yellow Wagtail *(Motacilla flava)*, Asian Glossy Starling *(Aplonis panayensis),* and Olive-backed Sunbird *(Nectarinia jugularis)*. Pulau Lalang had three locally endemic species. These were Lanceolated Warbler *(Locustella lanceolata),* Nicobar Pigeon *(Caloenas nicobarica)*, and Oriental Magpie Robin *(Copsychus saularis)*.

Three species recorded in this study (White Bellied Sea Eagle, Large Billed Crow *(Corvus macrohyncus*), and Pacific Swallow (*Hirundo tahitica*) showed wide dispersal by their presence on all islands. The distribution of these generalist species are not limited to these three islands only but have been recorded in various areas around Peninsular Malaysia. Pacific Swallow, for example, is distributed throughout Peninsular while White

Table 1. Bird recorded in this study according to its distribution on all islands and its status (Key: Residential Status; M = Migrant, R = Resident, V = Vagrant; Protection Status: TP = Totally Protected; NP = Not Protected)

No.	Species	Family	Number of individuals			Residential Status	Protection Status
			Pulau Jarak	Pulau Perak	Pulau Lalang		
1	Black Baza *Aviceda leuphotes*	Accipitridae	4	0	0	M	TP
2	Brahminy Kite *Haliastur indus*	Accipitridae	2	0	2	R	TP
3	Japanese Sparrowhawk* *Accipiter gularis*	Accipitridae	4	0	0	M	TP
4	White-Belied *Sea-Eagle, Haliaeestus leucogaster*	Accipitridae	46	2	16	R	TP
5	Tufted Duck *Aythya fuligula*	Anatidae	1	0	0	V	TP
6	Fork-tailed Swift *Apus pacificus*	Apodidae	4	0	0	M	TP
7	House Swift *Apus affinis*	Apodidae	0	4	0	R	TP
8	Silver-rumped Swift *Rhaphidura leucopygialis*	Apodidae	6	0	0	R	TP
9	Little Heron *Butorides striatus*	Aredeidae	6	0	0	R & M	TP
10	Nicobar Pigeon *Caloenas nicobarica*	Columbidae	0	0	1	R	TP
11	Pied Imperial Pigeon *Ducula bicolor*	Columbidae	26	0	14	R	TP
12	Spotted Dove *Streptopelia chinensis*	Columbidae	1	0	0	R	NP
13	Dollarbird *Eurystomus orientalis*	Coraciidae	4	0	0	R & M	TP
14	Large-Billed Crow *Corvus macrohyncus*	Corvidae	7	4	8	R	NP
15	Common Koel *Eudynamys scolopacea*	Cuculidae	2	0	0	R & M	TP
16	Ashy Drongo *Dicrurus leucophaeus*	Dicruridae	6	0	0	R & M	TP
17	Pacific Swallow *Hirundo tahitica*	Hirundinidae	5	6	3	R	TP
18	Bridled Tern *Sterna aenathetus*	Laridae	0	50	0	R	TP
19	Brown Noddy *Anous stolidus*	Laridae	0	~5000	0	R	TP
20	Yellow Wagtail *Motacilla flava*	Motacillidae	0	2	0	M	TP
21	Asian Brown Flycacther *Muscicapa dauurica*	Muscicapidae	4	1	0	M	TP
22	Mugimaki Flycatcher *Ficedula mugimaki*	Muscicapidae	4	0	0	M	TP
23	Narcissus Flycatcher* *Ficedula narcissina*	Muscicapidae	4	0	0	M	TP
24	Olive-backed Sunbird *Nectarinia jugularis*	Nectariniidae	0	1	0	R	TP
25	Black Naped Oriole *Oriolus chinensis*	Oriolidae	10	5	0	R & M	TP
26	Black Patridge *Melanoperdix nigra*	Phasianidae	1	0	0	R	TP
27	Oriental Scoops-owl* *Otus sunia*	Strigidae	1	0	2	M	TP
28	Asian Glossy Starling *Aplonis panayensis*	Sturnidae	0	5	0	R	NP
29	Brown Booby *Sula leucogaster*	Sulidae	0	~1000	0	R	TP
30	Lanceolated Warbler *Locustella lanceolata*	Acrocephalidae	0	0	1	M	TP
31	Oriental Magpie Robin *Copsychus saularis*	Turdidae	0	0	1	R	NP

*captured by mist nets

Table 2. Diversity indices values for bird population recorded from all islands.

Indices	Pulau Perak	Pulau Jarak	Pulau Lalang
Simpson D	1.422	7.133	4.623
Shannon-Weiner	0.5335	2.434	1.704
Margalef	1.263	4.002	2.067
Menhinick D	0.1539	1.726	1.299
Fisher's Alfa	1.487	6.682	3.269

Table 3. Evenness indices values for bird population recorded from all islands.

Indices	Pulau Perak	Pulau Jarak	Pulau Lalang
Pielou J	0.1554	0.7088	0.4963
Simpson E	0.1185	0.3397	0.5137
McIntosh E	0.2268	0.7904	0.7765
Smith & Wilson 1- D	0.3236	0.8967	0.8633
NHC	0.0603	0.1703	0.1617

Bellied Sea Eagle can be easily found along coastal areas. Large-Billed Crow is closely associated with coastal or mangrove habitats located close to human habitation.

Majority of the species recorded in this study are totally protected except four species that are not protected by Malaysian law. These are Spotted Dove *(Streptopelia chinensis)*, Large-Billed Crow *(Corvus macrohyncus)*, Asian Glossy Starling *(Aplonis panayensis)*, and Oriental Magpie Robin *(Copsychus saularis)*. In terms of breeding status, half of the species recorded were residents (16 species), nine species were migrant, and five species had resident and migrant populations. A single species (Tufted Duck, *Aythya fuligula*) has been classified as vagrant species.

DISCUSSION

Earlier studies have indicated that all islands (Pulau Perak, Pulau Jarak, and Pulau Lalang) have an interesting history of bird diversity. Robinson and Kloss [7] reported that Pulau Jarak had 29 species of birds but Harrison [8] only observed nine species with the Pied Imperial Pigeon being the commonest (probably some hundreds) and three or four pairs of White-bellied Sea-eagle. Gibson-Hill [9] believed that the total species number would increase to 49 if the presence of migrant species were taken into account. Based on previous reports and personal visits, Wells [10, 11] documented that all islands had an accumulated 57 species of birds; 23 species in Pulau Perak, 42 species in Pulau Jarak, and 7 species in Pulau Lalang. However, most of the recorded species were passage migrants that used the islands as their stopover sites during winter migration. Therefore, visiting the islands during the migratory season will document more species than during the non-migratory season. This explains why our visit in November 2007 had recorded more species than the earlier visit (June 2004). In addition, some birds may modify their migratory route and as a result would not be observed on the island anymore.

Although Brown Noddy and Brown Booby were present in Pulau Perak only, both have stable populations with appropriate size for survival. This finding is very encouraging since the island is the only known breeding site for the species in western Malaysian waters. During our visit in November 2007, we observed various stages of breeding related activities such as an adult incubating its egg, parents attending to their chick, and various stages of immature birds. The Brown Noddy lays either one or two eggs, but the Brown Booby only produces a single egg. Visits by earlier researchers in 1950s indicated that the Brown Booby had a breeding population size of around 400-500 pairs [6, 12, 13] before their numbers declined sharply due to egg poaching by fishermen. According to Wells [10 , 11], Brown Booby had maintained their numbers in late 1970s and during this study we

observed that their population had been thriving well and had increased four times. Therefore, we postulate that the population of this bird had reached its original size in 1950s, i.e. around 1000 individuals. However, previous studies also observed that the species have wider distribution; some of the individuals were observed near Pulau Jarak [14, 15]. However, our two visits did not reveal any Brown Booby or Brown Noddy outside Pulau Perak waters. In addition to these two most abundant birds, another species found in moderate numbers in Pulau Perak was the Bridled Tern (*Sterna aenathetus*). It is estimated that the population size of this bird in Pulau Perak is around fifty individuals, and although recorded it was not observed in other islands. Earlier studies recorded a maximum of 20 pairs of this bird in Pulau Perak while less than 20 pairs were observed in Pulau Sembilan [10]. It is also recorded that the bird was breeding while others were passage migrants. Therefore, it can be concluded that although Bridled Tern manage to survive in Pulau Perak, they failed to utilise resources available in other islands.

Another interesting finding from this study is the discovery of Nicobar Pigeon (*Caloenas nicobarica*) in Pulau Lalang. This bird is globally near-threatened due to relentless trapping and perhaps beach tourism that has intruded their inhabited sites [10]. Previous study had recorded this species in forested islands of Malaysian coasts [16], however it was never recorded in Pulau Lalang. Wells [10] documented that this species was observed in Pulau Rumbia, the island that is located adjacent to Pulau Lalang. Although the bird can fly to Pulau Lalang, there is no record of the species dispersal capability over water [10]. Therefore, this species can be considered a new record for Pulau Lalang. Another species that was recorded only on islands or islets of both coasts of Peninsular Malaysia is the Pied Imperial Pigeon [16]. In this study we observed many individuals of this species on Pulau Jarak and Pulau Lalang, indicating that the islands indeed provide suitable habitats for the species to survive. However, their numbers had declined enormously (only 26 individuals) since the 1950s (about hundred birds were observed by Harrison [8]).

It is apparent that forest species are absent from Pulau Perak since the island only has sparse vegetation. Forest species such as Mugimaki Flycatcher (*Ficedula mugimaki*), Narcissus Flycatcher (*Ficedula narcissina*), Oriental Scoops-owl (*Otus sunia*), and Pied Imperial Pigeon (*Ducula bicolor*) require trees or forest for shelter and food resources. Therefore, these species were unable to colonise Pulau Perak but not two other islands. The lack of big trees in Pulau Perak also cause predator species such as White-bellied Sea-Eagle to fail in fully utilising the island (only two individuals were recorded in Pulau Perak compare to 46 individuals in Pulau Jarak and 16 birds in Pulau Lalang). This species requires higher perching point to be used as vantage point to monitor the presence and movement of their prey.

In addition to Nicobar Pigeon, few other species observed in this study can be considered as new records and should be added into Pulau Perak's checklist. Species such as Black Patridge (*Melanoperdix nigra*), Black Baza and Narcissus Flycatcher have never been observed in any studied island. Black Patridge for instance is one of the Sunda lowland forest endemic species that had never been recorded in an island before [10]. In this study, we observed an individual foraging on the forest floor during our visit to Pulau Jarak in November 2007. During the same visit, we also observed a small flock of four individuals of Black Baza flying from one tree to another searching for food. Since this species was never recorded in any island before [10], they possibly used the island as their stopover site. Two individuals of Narcissus Flycatcher were captured in the mist nets during our study in Pulau Jarak. This small passerines utilised understory level while searching for food.

In the present study, the duration of stay was still insufficient for a thorough description of the current biodiversity status of the two islands but it was long enough to confirm earlier records of unique and interesting avian diversity. In addition to confirming the recorded list [4, 17] there are new additions to the list.

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