E-2.1 Biodiversity of wildlife community in the tropical rain forest

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Abstract: To evaluate the effects of forest destruction and fragmentation, and environmental condition on the diversity of wildlife in the tropical rain forest, we have studied the community structure and dynamics of mammals and birds in Pasoh Forest Reserve. Community structure were analyzed and dominant species were identified. The abundance and species richness varied remarkably with the locations of the study sites including the core and edge of forest, and secondary forest. The difference of community structure was probably due to an understory condition and a degree of disturbance of human activities. We conducted a series of artificial nest experiments at the core and edge of forest. Predation pressure was higher at forest edge than at core area.

Key Words Tropical rain forest, Biodiversity, Mammal and bird communities, Forest fragmentation, edge effect

1) Habitat preference of eleven species of small mammals in a tropical rain forest, Pasoh Forest Reserve, Malaysia

      We carried out a long-term and large-scale census of small mammal population in three adjacent forest types (primary, old regenerating and seasonal water-logged forests) in a lowland tropical forest, Peninsular Malaysia. In total, 22 species of mammals belonging to eight families of six orders were recorded in the main trapping period. The most dominant order was Rodentia, including 8 species of squirrels, 5 species of rats, 2 species of flying squirrels, and 2 species of porcupines. The number of species recorded in primary, secondary, and seasonal water-logged forests were 17, 15, and 15 species, respectively. Two species recorded only in PF were an arboreal squirrel (*Callosciurus prevostii*) and a flying squirrel (*Hylopetes spadiceus*). Except for some rarely captured species (*NI*<0.5 individuals/month on average), 13 species of common small mammals were subjected to the analysis below. They were *Echinosorex gymnurus* (Echinaceidae, Insectivora), *Tupaia glis* (Tupaiidae, Scandentia), *Lariscus insignis*, *Callosciurus notatus*, *Callosciurus nigrovittatus*, *Rhinosciurus laticaudatus*, and *Sundasciurus lowii* (Sciuridae, Rodentia), *Leopoldamys sabanus*, *Maxomys surifer*, *Maxomys rajah*, *Maxomys whiteheadi*, and *Rattus tiomanicus* (Muridae, Rodentia), and

Trichys fasciculata (Hystricidae, Rodentia).

Stevens[1] compiled the available information of the mammalian fauna in various habitats in Peninsular Malaysia and concluded that, in number of species, 18 out of 25 species (72%) of squirrels and 11 out of 26 species (42%) of rats were confined to primary forests. When including old secondary forests, the species found in natural forests account for 84% of squirrels and 65% of rats. Therefore, most of the Malaysian small mammals are considered to be forest dwellers.

The present study was generally consistent with this conclusion. Eight out of the 13 species (61.5%) showed significant preference for primary forest habitat over secondary forest habitat, and two species of rats (15.4%) tended to favor the secondary forest habitat. According to their habitat preference, the 13 species of small mammals can be categorized into four species groups; i.e. primary forest species, secondary forest species, water associated species, and ubiquitous species group. Small mammals are divided into four categories according to their trapability among the three habitats, such as primary forest species, dry forest species wet area species and ubiquitous species. Fourteen of seventeen species occurred in the regenerating forest. Squirrels were less in the secondary habitat, while *Leopoldamys sabanus* and *Maxomys surifer* were abundant there. The present study was generally consistent with the conclusions of studies that have been done in the past[2-4]. We conclude that forty years is not enough for the small mammal community to recover from the damage of selective logging.

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2) Effect of deforestation, disturbance, and fragmentation on mammalian community in a tropical rain forest

To examine how species abundance and richness change with increasing forest fragmentation, or with transformation of intact forests into secondary forests or other ecosystems, we compare data on abundance and composition of mammalian communities obtained from several kinds of habitats that show different environmental conditions. The purpose of this study is to elucidate what factors are responsible for a reduction of species richness and abundance of wildlife in a tropical rain forest.

We have selected 10 study sites in Pasoh Forest Reserve and adjacent areas including primary forests, secondary forests, forest margin, fragmented small forest, and oil-palm estate. We placed automatic camera system in each study site for 2-3 weeks to collect data on mammalian communities. A set of baits consisting of biscuits, dry fruits, and cat pellets was placed on the ground beneath a far-infrared sensor of the camera system[1]. The decrease in number of frames of film and the quantities of baits recorded every days. The baits were supplemented and the film was changed if necessary. We have obtained over 1,000 pictures which photographed mammalian visitors successfully. Based on these pictures, we identified the mammalian species, and evaluated visiting frequency.

A total of 16 mammalian species was identified at the 10 study sites. We used here the number of pictures per day as a criterion to compare visiting frequency of mammals in relation to habitat condition. The greatest number of pictures was obtained at the sites in the primary forests while the lest was at the site in the oil-palm estate. The number of pictures at the sites in the secondary forests was 10.5 which is almost equivalent to that in the margin of forest. The number at the sites in the remnant forest was somehow greater than that in the oil-palm estate. The reason of low frequency of mammals in the oil-palm estate is probably due to a lack of the understory of vegetation and continuous disturbance of human activity.

Species richness varied remarkably with the locations of the sites as reflected different environmental conditions. When the number of species identified at each site was compared as species richness, the highest diversity (14 species) was recorded at the sites in the primary forests. The diversity in the secondary forests ranked next (8 species). The difference in composition of species was detected between primary and secondary forests in spite of high diversities of the two forests. A total of 6 species was recorded at the site in the margin. Dominant species were pig-tailed macaque and short-tailed mongoose. Only two species of squirrels which were rare inside forest were recorded in the oil-palm estate.

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3) Studies on the edge effects on avian community in lowland rainforest at Peninsula Malaysia

Approximately 370 bird species inhabit rainforest and forest fringe, and lowland Dipterocarps forest supports the richest avifauna in Peninsula Malaysia [1]. Tropical lowland rainforest have drastically decreased and fragmented in last few decades in Peninsula Malaysia. Habitat fragmentation will increase the amount of edge relative to the amount of interior habitat, and will enable omnivorous predators to increase in numbers, and to disperse into the interior of habitat [2]. Therefore, edges adversely affect a wide range of avian species

by increasing depredation and parasitism rate of nests. Many studies of the edge effect were carried out in temperate forest [3)-5)] but few in tropics. In order to clarify how bird community structure response to forest edge, and how predaton rate of birds nests were changing close to the edge, we focused on the edge effect on birds at tropical lowland rainforest in Malaysia.

A study on rainforest birds was conducted virgin area and forest edge at Pasoh Forest Reserve. Though virgin forest is remaining in Pasoh, it is isolated forest island surrounded by oil palm plantation. Monthly mist-netting have been conducted at core area since 1992 and at boundary of forest reserve since 1996. Nets were set in lines along trail or in the understory during whole study period, and were opened before dawn and closed after dusk or earlier if it started raining. We put 20-24 mist-nets in a netting procedure at the Pasoh Forest. Mist-net operation were carried out for 3,291 day x net in a core area and for 903 day x net in forest edge during study period. All captured birds were measured and banded with a numbered aluminum ring, and released beside net site in which it was caught. In order to detect edge effect s in Pasoh Forest Reserve, 862 artificial nests with a few quail eggs were set in the understorey. A couple of nests were set on the ground and the folks of a tree at 1-2 m above ground at the same site near netting sites. Each net was checked every day until depredated for 4 days. If quail eggs were depredated, we add some extra eggs and set an automatic triggered camera set with infrared sensor near the nest to confirm predators. If edge effects occur, higher predation pressure is expected in the peripheral area than core area.

Nine hundred and three birds belonging to 81 species were captured in a core area, while only 323 individuals belonging to 39 species were captured at forest edge. The relative density of understory birds was 0.30 birds/net/day at core area and 0.36 birds/net/day at the edge respectively. The abundance of understory birds at the core was almost identical to that at the edge. However, the species diversity was clearly higher at core area than forest edge. Insectivorous ground forager like babblers and thrushes were decreasing from the core to boundary of forest, and insectivorous nectarinivore and insectivorous frugivore like sunbirds and bulbuls were oppositely increasing at the boundary.

The estimated number of understory species inhabiting core area was almost eighty-one. On the other hand, that at the forest edge was only 38. The species diversity and evenness was clearly higher at forest interior than oil palm plantation (Simpson's-λ index: 20.3 and 5.6 respectively). The top five dominant species were Siberian blue robin (*Luscinia cyane*), moustached babbler (*Malacopteron magnirostre*), black-backed kingfisher (*Ceyx erithacus*), hairy-backed bulbul (*Hypsipetes criniger*), and white-rumped shama

(*Copsychus malabaricus*) in the forest interior. On the other hand, those in the forest edge were white-rumped shama (*C.malabaricus*), little spiderhunter (*Arachnothera longistre*), purple-naped sunbird (*Hypogramma hypogrammicum*), and Siberian blue robin (*L.cyane*). Predominant birds in the oil palm plantation were not captured in the forest edge. It means few interactions occur between birds inhabiting inside and outside of rainforest, and rainforest birds cannot survive in boundary habitat.

Quail eggs disappeared faster on the ground than on the folk of tree. And, eggs disappeared faster according to closely approaching to forest edge. This showed that predation pressure on the artificial nests was severer near forest edge. Automatic triggered camera set reveled that rats, squirrels, treeshrews, monkey, moonrat, wild bore and mongoose were predator of them. Though more species were found as predators, fewer artificial nests were depredated in the core area with compared to forest edge. Among them, the predominant predators were common treeshrew, short-tailed mongoose, and pig-tailed macaque.

Species diversity of birds in Pasoh Forest Nature Reserve will be gradually decreasing from the core to the edge and dropping at boundaries, while predation pressure on nests was increasing near forest edge. It might be a reason why ground forager like babblers, which build nest on the ground, are decreasing from the core to the boundary. Predation pressure, however, could not account that bulbuls and sunbirds were also increasing at forest edge and boundaries. Forest edge would provided lighter environment for fruiting shrub trees, and could support more number of species and individuals of bulbuls and sunbirds. Predtion pressure on nests was still higher at Plot 1 than Plot 2 and NS1, though Plot 1 is including unlogged area and situated within 1000 meters from the edge. The edge effects on bird community might be evident up to 1000 meters into forest in the Pasoh forest. Edge effect regarding predation pressure should be the most important factor when designing forest reserves to conserve birds in rainforest.

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