A SMALL MAMMAL SURVEY WITHIN THE PLANTED FOREST ZONE, BINTULU, SARAWAK

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ABSTRACT

A small mammal survey was conducted in areas of planted forest and secondary growth forest in the Forest Department Sarawak's Planted Forest Zone (PFZ) in the Bintulu Division. Two comprehensive small mammal trapping surveys were conducted within the period 4 July until 29 July 2006 in order to study the small mammal assemblages in acacia plantation blocks and forest remnants of the PFZ. The two sites were Samarakan Planted Forest Zone (SPFZ) and Sg. Mina Wildlife Corridor (SMWC). For both sites the traps were paired within acacia plantings and in adjacent natural secondary forest. From a total effort of 1400 trap-nights, 13 species of small mammals comprising 33 individuals from the family Tupaiidae (4 species), Sciuridae (3 species) and Muridae (6 species) were captured, giving an overall capture rate of 2.3%. Ten species were trapped within the acacia blocks and six species in secondary forest (lowland forest and riparian forest) within the PFZ. This preliminary result suggests that species richness was not influenced by forest types (acacia blocks versus forest remnants) but rather by location of the sampling plot within the PFZ. When different acacia blocks were compared, it was found that more species of small mammals were recorded in older acacia compared to younger acacia blocks, e.g. eight versus two species. Between the two forest remnants, riparian forest of SMWC was the poorest while the lowland forest remnant of Samarakan was relatively rich in small mammals. In comparison with other plantations, e.g., Sabah Softwoods and Bukit Tarek Plantation Forest, the number of species was higher even though the number of individuals was much lower. The underlying ecological causes for the pattern of small mammal distributions in the PFZ remain unclear. Further studies within other areas of PFZ are planned in order to better understand the patterns seen so far.

INTRODUCTION

Small mammals, as defined by Stoddart (1979) are mammals with an adult weight of less than 5 kg. They are among the most successful group of mammals in the world in terms of number of species and the range of habitats that they occupy (see Tuen *et al.,* 2006). Although the small mammal species diversity and distribution in Sarawak tropical rain forests has been well studied (Tisen & Lading, 1997; Payne *et al.,* 1998; Han, 2000; Han, 2005; Wilson & Helgen, 2005; Tuen *et al.,* 2006; Dagang, 2006) not nearly as much is known about the assemblages and structure of small mammal communities in tree plantations, especially in plantations with a mixed mosaic of natural forest and sylvicultural habitats (Stuebing, 2005).

The portions of the landscape devoted to tree plantations in Sarawak are expanding rapidly due to the increasing demand for industrial wood. With a total land area of approximately 124, 500 km^2 (Rautner, 2005), the government of Sarawak has planned for about 1,000,000 ha of land to be developed, will be planted forests with fast growing tree species for use as industrial wood (Chan, 1998). In preceding sentence does she mean: to be developed as planted forests with fast growing tree specis to ge used for industrial wood? Over the past eight years, planted areas in Sarawak have increased to 55,000 ha in the Forest Department Planted Forests Project's Planted Forest Zone (PFZ) in Bintulu, Sarawak (Giman *et al.,* in press) compared to 13,000 ha in 1997 (FAO, 2002). The area of PFZ totals approximately 490,000 ha with a target of 205,000 ha to be planted by the end of 2009 (Stuebing, 2005).

Wildlife inventory and monitoring are critical to determine wildlife species diversity and community structure in this large area of patchy remnant forests and acacia trees. This study has been initiated in order to create baseline information for monitoring of subsequent community changes in terms of species richness, diversity, distribution and abundance of small mammals in several key areas of the PFZ. Live trapping techniques were used to compare small mammal composition among forested areas consisting of stream buffers, swamplands, steep lands (unsuitable lands for planting) and ex-shifting cultivation with stands of different ages of acacia trees. Preliminary findings from recent surveys at two different locations of PFZ will be discussed and compared with previous surveys in same areas (SPFZ and SMWC) and also different sites, by Wilson and Helgen (2005) and Han (2005; 2006).

MATERIALS AND METHODS

Study Area

The Planted Forest Zone (PFZ), is located in Bintulu Division, central Sarawak between longitude 113°00' and 113°15' E and latitude 3°15' and 3°00' N It is an area formerly covered by peat swamp forest and hill forest. Most of its lowland forest previously cleared for cultivation now lies in fallow under dense young secondary growth e.g., ex-shifting cultivation. This large scale of plantation development will continue to provide some forested areas as wildlife reservoirs.

Two specific study sites within the PFZ that are part of the acacia plantation still retain some forested areas are the following:

Site A (SPFZ): an area of seven year old *A. mangium* trees with neighboring lowland secondary forest near the plantations nursery at Samarakan (N 02°56.462' E 113°07.603'). The average canopy height of the acacia trees wereheight of the acacia trees was ±15 m which already mixed with a young dipterocarps, figs and secondary growth trees such as *Macaranga* sp. The understorey vegetation is relatively dense with *Calamus* sp. (rattan), Zingiberaceae (e.g. *Etlingera coccinea, Amomum coriaceum, A. dimorphum, Plagiostachys crocydocalyx* and *Hornstedtia reticulata*) and ferns. Acacia trees have fibrous roots and easily broken stems, resulting in gap formation when they fall, allowing enough light for the understorey to regenerate. These areas are already overridden by the secondary growth trees and shrubs. The adjacent forest was mixed with secondary growth of dipterocarp trees and only a few large trees (DBH and canopy heights, ±25 cm and ±25 m respectively) remain standing in this area. The canopy was moderately dense but adjoiningadjoining, which makes the understorey plants not highly dense.

Site B (SMWC): an area of three year-old *A. mangium* adjacent to the river buffer, the secondary growth forest at Sg. Mina Wildlife Corridor area (N 02º 47. 276' E 113º 10.936'). The acacia trees were young with canopy heights ±10 m and only a few numbers of *Macaranga* sp. occurs in this area. The understorey vegetation was very dense with weeds, shrubs and ferns as the canopy were apart.not sure how to reword this previous sentence. Meanwhile, the neighboring forest was mixed with secondary growth trees and the canopy is joining. However this forest was fragmented with several abandoned logging roads that lead to an open area. The understorey plants were sparse with young dipterocarp trees, some rattans and quite a few lianas.

Field Methods

This study involved two trapping visits of seven trap nights each, which were made from 04–14 July and 19–-29 July, 2006. One hundred collapsible wire live-traps (43 × 16 × 16 cm) were used to catch any trappable small animals. A total of 100 traps were laid out in a line transect with 50 set up in the forest and another 50 in the neighboring plantation. Along these lines, traps were set within 25 m intervals with one trap on either side of the transect. On one side of each transect, arboreal traps approximately 2 m above ground e.g. on a horizontal fallen tree trunk or hand made bridges were set for the purpose of sampling climbing/arboreal non-volant small mammals, while on the other side traps were set on the ground for sampling terrestrial small mammals. A combination of banana, oil palm seed, banana with rodent's scents (lure), tapioca and roasted coconut were used as baits for all traps. Several types of baits were used in order to catch the attention of different species of small animals evenal though banana was preferred by both Langham (1983) and Lim (1973) to attract both forest and scrub species of rats, squirrels and treeshrews (see Stuebing & Gasis, 1989).

On the morning of every second day or after captures, all baits were replaced with new baits. All traps checked twice daily between 0800 and 1000 hrs in the morning and 1530 and 1730 hrs in the evening. Trapping was terminated immediately after seven nights. Animals were taken to the laboratory, killed(do you want to say euthanized instead of killed?) with chloroform, weighed, measured, and their reproductive condition assessed. Females which were lactating, or that possessed embryos/fetuses, and males with scrotal testes were classified as reproductively active. All the animals were identified based on morphological characteristics and body measurements described in Payne *et al.* (1998) and Yasuma *et al.* (2003).

RESULTS

Wilson & Helgen (2005) and Han (2005; 2006), obtained a total of 11 species of non-volant small mammals from SPFZ and SMWC, consisting of moonrats (1), treeshrews (2), squirrels (3) and rats (5) (Appendix 1). From the present survey, another six species (two treeshrews, two squirrels and two rats) were added to the list. This makes a total of 17 species of non-volant small mammals recorded in two areas of the PFZ. However, this result does not include data collected such as that from direct observation or camera trapping.

The present study recorded a total of 33 individuals representing 13 species of small mammals from family Tupaiidae (4 species), Sciuridae (3 species) and Muridae (6 species), with an overall capture rate of 2.3% (based on individuals caught per trap-night). Among 13 species obtained, ten species were found in acacia plantation, and six species were in neighboring secondary forest remnants respectively. When different ages of acacia blocks are compared, older acacia contains more species than the younger acacia blocks (8 species versus 2 species) but none of the species that occur in older acacia were recorded from the younger acacia blocks during the sampling period. Regarding species composition, preliminary results showed no significant difference in the species abundance at both sites, possibly due to the small sample size.

The plantain squirrel *Callosciurus notatus,* well-adapted species of sciurids in monoculture plantations (Payne *et al.,* 1998), seems to be abundant in SPFZ (10 individuals or 30.3% of the total catch) but was absent from SMWC. *C. notatus* was the most frequently captured species followed by *Maxomys rajah* and *M. whiteheadi* with five individuals each comprising 15.2% of total catch. Eight other species,*Ptilocercus lowii, Tupaia gracilis, Sundasciurus lowii, Lariscus insignis, M.* cf. *baeodon, Lenothrix canus, Sundamys muelleri* and *Niviventer cremoriventer* had the lowest percentage abundance with only one individual captured per species during the sampling period (Appendix 2). None of the species occurred across all habitats sampled.

Only one species (two individuals) was obtained from the riparian forest of SMWC. Han (2006) sampled at the same site and obtained only three species (*M. rajah, M. whiteheadi* and *S. muelleri,* with an overall total of five individuals). Shadbolt (2006) sampled at a different patch of SMWC riparian forest and captured three species, *M. rajah, T. picta* and *S. lowii* with only one individual for each species. SMWC riparian forest seems to consistently show poor small mammal abundance as well as few total species present.

DISCUSSION

Stuebing and Gasis (1989) compared small mammal populations in logged forest surrounded by monoculture tree plantations of *Eucalyptus deglupta, Gmelina arborea, Paraserianthes* (*Albizia*) *falcataria,* and *P. falcataria* underplanted with cocoa (*Theobroma cacao*) within a single large plantation development project (Sabah Softwoods). They found more species in the plantation (13 species) than in the forest (11 species). In contrast, Laidlaw (1989) when comparing the virgin, logged, fragmented and plantation forests in Peninsular Malaysia, found only 2 species (*C. notatus* and *T. glis*) in an acacia plantation and 13 species in several types of forest within the general area. Compared with Laidlaw's results, we recorded five times the number of species in the acacia plantation but only about half the number of species from adjacent remnant forest. If the findings of Wilson and Helgen (2005) and Han (2005; 2006) are includeincluded into our present list, a total of 17 species, 11 in plantation and 12 in forest have been recorded in PFZ. It is possible that Laidlaw either used ineffective bait, or a trapping period that was too short. In fact, we suspect that with long-term trapping effort that more species are yet to be discovered.

There were several unusual patterns of species occurrence in the PFZ compared to Stuebing and Gasis' (1989) and Laidlaw's (1996) findings. The plantain squirrel, *C. notatus* captured in SPFZ both in acacia and lowland forest remnant was not reported from Sabah Softwoods. The slender treeshrew, *T. gracilis* found exclusively in logged forest of Sabah Softwoods, was found in acacia plantation of the SPFZ. The brown spiny rat, *M. rajah* found only in an upland *G. arborea* plot within Sabah Softwoods, was found to be restricted to forest remnants in the PFZ. Laidlaw (1996) claimed that *S. hippurus* is restricted to virgin forest and is sensitive to habitat changes, but was recorded in the SPFZ acacia plantation (Wilson & Helgen, 2005). Considering this information, perhaps site selection for trapping and the experimental design used may play a rather important role. Moreover in an area undergoing forest conversion such as the PFZ, forest mammals either die (e.g., through injury, starvation or fire) or move into adjoining areas of natural vegetation in which survival rates are unknown. Furthermore, the home range of the small mammals may influence the capture rate in specific areas sampled. For example, treeshrews have large home ranges, from 1.5 ha to 10.5 ha (Emmons, 2000). It is possible to trap them in acacia plantation (e.g. *T. tana, T. picta, T. gracilis* and *P. lowii*) although they might not actually reside (reproduce and nesting) in the altered environment, but perhaps only forage for food. All treeshrew eat a mixed diet of fruits and invertebrates and may enter the acacia plantation as a rich source of invertebrate prey, such as earthworms and terrestrial insects (Belden Giman, pers comm.).

Ecological factors that contribute to some of the patterns seen so far still remain to be worked out and further studies are planned in other areas of PFZ. Perhaps understandingPerhaps better understanding the pattern of small mammal distributions in tree plantations will assist in providing better plantation design for conserving their communities. This is fundamental to success in conserving small mammal diversity within the larger landscape.

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REFERENCE

Chan, B. 1998. Concerns of the industry on tree plantations in Sarawak. In: Chan, B., Kho, P.C. and Lee, H.S. (eds.). *Proceedings of Planted Forests in Sarawak—An international Conference.* Forest Department Sarawak, Sarawak Timber Association and Sarawak Development Institute.

Dagang, P. 2006. Small mammals survey at Batang Ai National Park, Sri Aman, Sarawak. *Hornbill Workshop.* Biodiversity and Totally Protected Areas, Sarawak Forestry Corporation.

Emmons, L.H. 2000. *Tupai: A field study of Bornean Treeshrews.* University of California Press, Berkeley.

FAO. 2002. Case study of the tropical rainforest plantations in Malaysia. In: M. Varmola (ed.). *Working Paper FP/23.* FAO, Rome (Italy).

Giman, B., Stuebing, R., Megum, N., McShea, W.J. and Steward, C.M. (in press). A camera trapping inventory for mammals in a mixed use tree plantation in Sarawak. *Raffles Bulletin of Zoology*.

Han, K.H. 2000. Small mammals. In: Soepadmo, E. and Chai, P.P.K. (eds.). *Development of Lanjak-Entimau Wildlife Sanctuary as a Totally Protected Area Phase I & II: Scientific Report.* ITTO, Japan and Sarawak Forest Department, Malaysia.

Han, K.H. 2005. *Field report on inventory study of small mammals and plants in Samarakan Nursery, Bintulu Planted Forest Area, Ulu Tatau from May 10 through 20, 2005.* Grand Perfect Sdn Bhd, Unpublished Report.

Laidlaw, R.K. 1996. A comparison between populations of primates, squirrels, treeshrews and other mammals inhabiting virgin, logged, fragmented and plantation forests in Malaysia. *Conservation, Management and Development of Forest Resources* 141–159.

Mohamed, M. 2003. Uniqueness of Biodiversity in Bornean Forest Ecosystem. Pg. 45–51. In: Hashimoto, Y. and Rahman, H. 2003. *Inventory and Collection: Total Protocol for Understanding of Biodiversity.* Research and Education Component Programme, Kota Kinabalu. 310 pp.

Payne, J., Francis, C.M. and Phillipps, K. 1998. *A Field Guide to the Mammals of Borneo*: *3rd edition.* The Sabah Society, Kota Kinabalu.

Rautner, M. 2005. *Borneo: Treasure Island at Risk*. WWF Germany.

Shadbolt, A. 2006. *Why did(n't) the treeshrew cross the road? Small mammals in the Planted Forest Zone (PFZ), Sarawak.* Grand Perfect Sdn Bhd, unpublished report.

Stuebing, R. and Gasis, J. 1989. A survey of small mammals within a Sabah tree plantation in Malaysia. *Journal of Tropical Ecology* 5: 203–214.

Stuebing, R. 2005. Wildlife conservation in the planted forests of Sarawak: Blind Ambition? In Tuen, A.A. and Das, I. (Eds.). *Wallace in Sarawak-150 Years Later: Proceedings of an International Conference on Biogeography and Biodiversity.* Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak.

Stuebing, R. 2005. An integrated approach to biodiversity conservation for a planted forest in Sarawak. *14th Malaysian Forestry Conference*. Kota Kinabalu, Sabah.

Tisen, O.B. and Lading, E. 1997. *Small mammals in Lambir Hill National Park*. National Park and Wildlife Office, Forest Department, Kuching, unpublished report.

Wilson, D.E. and Helgen, K.M. 2005. *Small mammal survey of Bukit Sarang and Samarakan.* Grand Perfect Sdn Bhd, unpublished report.

Yasuma, S., Andau, M., Apin, L., Yu, F.T.Y. and Kimsui, L. 2003. *Identification keys to the mammals of Borneo.* Park Management Component BBEC Programme, Kota Kinabalu.

Appendix 1. Aging pig by dentition and tooth eruption comparison table (Barrett, 1978 and Diong, 1973):

Age	Incisor			Canine	Premolars				Molars			Remarks	
	1	2	3		1	2	3	4	1	2	3	Barrett (1978)	Diong (1973)
80 d[1] in utero			○	○								**x**	**x** i^3 i_3 c^1 c_1
At birth[1]			○	○								**x**	**x**
10 d[1]			○	○				○				**x**	**x** p^4 1st pair of cusps visible
20 d[1]	○		○	○				○				**x**	**x** i_1 appearing above gum line
1/2 m[2]	○	○	○	○			○	○				**x**	**x** p^4 2nd pair of cusps visible, p_3 erupted before i_2
2–4 m[2]	○	○	○	○		○	○	○				**x**	**x**
4–6 m[2]	○	○	○	○	●	○	○	○	●			**x**	**x** M_1 1st pair of cusps visible, when p_1 erupted
6–8 m[2]	○	○	●	●	●	○	○	○	●			**x**	**x** loss of i_3
8–10 m[2]	○	○	●	●	●	○	○	○	●			**x**	**x** I_3 fully erupted
10–12 m[2]	○	○	●	●	●	○	○	○	●			**x**	**x** M_2 1st pair of cusps about to erupt
12–14 m[2]	●	○	●	●	●	○	○	○	●	●		**x**	**x** replacement of i_1
13 m[2]	●	○	●	●	●	○	○	○	●	●		**x**	**x** M_2 still erupting
14–16 m[2]	●	○	●	●	●	○	●	●	●	●		**x**	**x** replacement of p_4, p_3
16–18 m[2]	●	○	●	●	●	●	●	●	●	●		**x**	**x** M_1 show wear, replacement of p_2
18–20 m[2]	●	○	●	●	●	●	●	●	●	●		**x**	**x**
20–22 m[2]	●	●	●	●	●	●	●	●	●	●		**x**	**x** loss of all di teeth
22–24 m[2]	●	●	●	●	●	●	●	●	●	●		**x**	**x** all fully erupted?
[1] Day	●	●	●	●	●	●	●	●	●	●	●	**x** newly erupted	**x** M_3 1st pair of cusps just erupt
[1] Month 24–26 m[2]													
26–30 m[2]	●	●	●	●	●	●	●	●	●	●	●	**x** 75–95% eruption	**x** +26 months
36 m[2]	●	●	●	●	●	●	●	●	●	●	●	**x** complete eruption	-
48 m[2]	●	●	●	●	●	●	●	●	●	●	●	**x** height of 3rd molar reduced 25–50%	-
60 m[2]	●	●	●	●	●	●	●	●	●	●	●	**x** height of 3rd molar reduced 60–90%	-
+72 m[2]	●	●	●	●	●	●	●	●		●	●	**x** 3rd molar completely worn, lost of M1	-

Appendix 2. Aging pig by dentition and tooth eruption comparison table (Matshke, 1967 and Tuen *et. al*, 1999):

Age	Incisor 1	Incisor 2	Incisor 3	Canine	Premolars 1	Premolars 2	Premolars 3	Premolars 4	Molars 1	Molars 2	Molars 3	Remarks: Matshcke (1967)	Remarks: Tuen *et. al* (1999)
80 d[1] in utero			○	○								–	**x** < 4 months, deciduous
At birth			○	○								**x** 0–6 days	teeth not worn out
10 d[4]			○	○				○				**x** 7–22 days, p^3	and cusp are prominent
20 d[1]	○		○	○				○				**x** 6–7 weeks, p3	on premolars: Infant
1/2 m[1]	○	○	○	○			○	○				–	
2–4 m[2]	○	○	○	○		○	○	○				**x** 7–19 weeks	
4–6 m[2]	○	○	○	○	●	○	○	○	●			**x** 20–33 weeks	**x** 4–12 months, M1 with
6–8 m[2]	○	○	●	●	●	○	○	○	●			**x** 30–51 weeks	sharp cusp: Juvenile
8–10 m[2]	○	○	●	●	●	○	○	○	●			–	
10–12 m[2]	○	○	●	●	●	○	○	○	●			–	
12–14 m[2]	●	○	●	●	●	○	○	○	●	●		**x**12–15 months	**x** 12–24 months, full set
13 m[2]	●	○	●	●	●	○	○	○	●	●		–	of permanent teeth, cusps
14–16 m[2]	●	○	●	●	●	○	●	●	●	●		–	blunt but no dentine shown:
16–18 m[2]	●	○	●	●	●	●	●	●	●	●		**x** 14–18 months	Sub adult
18–20 m[2]	●	○	●	●	●	●	●	●	●	●		**x** 18–22 months, i^2 I_2	
20–22 m[2]	●	●	●	●	●	●	●	●	●	●		-	
22–24 m[2]	●	●	●	●	●	●	●	●	●	●		-	
24–26 m[2]	●	●	●	●	●	●	●	●	●	●	●	**x** 21–26 months, M_3	
26–30 m[25]	●	●	●	●	●	●	●	●	●	●	●	**x** +26 months, M3	**x** 24–48 months, dentine
36 m[2]	●	●	●	●	●	●	●	●	●	●	●	-	visible where cusps have
48 m[2]	●	●	●	●	●	●	●	●	●	●	●	-	worn out: Adult
60 m[2]	●	●	●	●	●	●	●	●	●	●	●	-	**x** > 48 months complete bridging
+72 m[2]	●	●	●	●	●	●	●	●		●	●	-	of dentine: Old adult