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TO DETERMINE THE EFFECTS OF LOGGING AND TIMBER EXTRACTION, AND CONVERSION OF PRIMARY FOREST TO TREE CROP PLANTATIONS, ON HERPETOFAUNAL DIVERSITY IN PENINSULAR MALAYSIA

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INTRODUCTION

Malaysia comprises the eleven states of Peninsular Malaysia, Sabah and Sarawak, and forms a crescent over 1000 miles (1609 km) long between latitudes 10° and 7° N. and longitudes 100° and 119° E. Peninsular Malaysia abuts the Thai border in the north, and extends from the isthmus of Kra to the Singapore Strait, with the South China Sea on the east coast and the Straits of Malacca on the west. The climate is tropical with the year commonly divided into the south-west and north-west monsoon seasons. The Federation of Malaya became an independent member of the Commonwealth in 1957, and, as Malaysia, acceded also Sabah (formerly British North Borneo) and Sarawak from 1963. Kuala Lumpur, the capital, was proclaimed Federal Territory from 1974. Bahasa Malaysia (Malay) is the official language, but English, various dialects of Chinese, and Tamil are also widely spoken.

As the result of discussions prompted by the Tropical Forest Forum with the British Government's Department of the Environment, concern was expressed on the impact of logging activities on faunal and floral diversity in pristine habitats that the world's primary rain forests represent, including those of Malaysia. A consequence of this was the signing of a Memorandum of Understanding between the Governments of Malaysia and the United Kingdom in May 1992 for a joint five-year programme on Conservation, Management and Development of Forest Resources. Respective ecological and economic aspects of the programme were defined by two sub-programmes:

- A. Conservation of biodiversity and sustainable use of forest genetic resources, and
- B. Valuation of the costs and benefits of non-timber forest products and services.

The initially thirteen projects (now twelve) of sub-programme A included A9: "Comparative studies of the biodiversity of amphibian and reptilian fauna in various forest types and tree crop plantations", which was one of the Malaysian contributions to the sub-programme, with the University of Malaya as Participating Institution.

Following a brief visit, mainly to the east coast of Malaysia, during a week's stop-over in Singapore, 23-29 October 1988, a second official visit to Malaysia was made by M.R.K. Lambert, 26 February-26 March 1995. The main objective of the assignment was to initiate a work programme and enable Malaysian herpetologists, Drs Kiew Bong Heang (Department of Zoology, University of Malaya) and Lim Boo Liat (Council member, Malayan Nature Society - formerly of the Institute of Medical Research, Malaysia, and

WHO), to become involved and be provided with funds for the project's ecological studies. The project was to be managed officially by FRIM (the Forest Research Institute Malaysia), Kepong, situated some 12 km outside Kuala Lumpur.

To gain appreciation of the problems associated with working in primary rain forest, compared with tree crop plantations, and thus assist with project design and methodology, Lambert had the opportunity to stay for a few days at the Pasoh Forest Reserve, near Simpang Pertang (Negeri Sembilan), south-east of and some 160 km by road from Kuala Lumpur.

THE PROJECT

Discussions between the authors and Dr Chan Hung Tuck (senior researcher in the Environmental Sciences Division, FRIM, responsible for the UK-Malaysia programme), resulted in the following research plan:-

- a. Comparison of the diversity of amphibians (especially important in pristine forest and highly sensitive to habitat change) in primary rain forest before and in relation to time after logging - pre-logging survey to be conducted May/July 1995 in the Serting Forest Reserve Extension (some 18 km west-south-west of Pasoh Forest Reserve) for which a licence will allow timber extraction in August/September 1995. Further surveys would subsequently be conducted in parallel with Phases I and II after logging has taken place.
- b. Phase I. Comparison of herpetofaunal diversity of primary rain forest with that in oil palm, rubber and forest tree plantations from early 1996. [The last plantation type was included because it was believed by some that biodiversity in forest tree plantations does not differ from that of primary forests].
- c. Phase II. Changes of herpetofaunal, especially amphibian, diversity in logged forest in relation to method of timber extraction and time after logging, with surveys in 1997.

A list of expected species in forests and plantations of Malaysia was prepared by Kiew B.H. (Appendix 1), while provisional lists of anurans and reptiles were compiled specifically for the Pasoh Forest Reserve area (Tables 1 and 2) based on information provided by Kiew B.H. and Lim B.L., and species recorded by Lambert in March 1995.

With his specialised knowledge of the Malaysian amphibian fauna, as well as reptiles, and with zoology students in his University department for use as field assistants (the study would constitute part of their formal course of tuition), the project was to be led by Kiew B.H.

The aim of this article, therefore, is to provide, during an early stage of the project, provisional information on forest herpetofaunal diversity in Peninsular Malaysia which could form an initial work of reference for further studies.

Table 1

Amphibians and reptiles recorded in Pasoh Forest area, near Simpang Pertang (Negeri Sembilan), Malaysia, March 1995, including those observed outside primary forest previously. Figures in parentheses based on verbal reports only. 1 - Primary forest; 2 - secondary forest; 3 - Rest House area (within secondary forest) and other human dwellings, and 4 - oil palm plantation with riparian valley vegetation.

Species	1	2	3	4	Comments
AMPHIBIA					
Anura					
Bufonidae					
Bufo melanostictus 1	-	-	8		
Leptophryne horbonica	1		-	-	
Ranidae	-				
Occidozvea laevis	-	-	(5)	-	
Rana chalconota ²	25	-	2	-	In small pool
nunu chuiconoiu	(larvae)		4		at 1
Rana erythraea	(101 + 100)	-	25	-	ut i
Rana alandulosa		_	+		At 3 by Kiew (1978)
Rana hosai 2		-	(1)		At 5 by Riew (1770)
Rana limnocharis	-	-	11	4	
Rana umnocharis	-		11	4	
Nuctivalus mistus	- 20	1.25	2		
Nyclixalus picius		-	12	-	Traludes two foom roots
Polypeaales leucomyslax	-	-	15	-	Includes two roam nests
Micronylidae		1.	0		
Kaloula pulchra	-	1	2		
Microhyla butleri	-	3	-	-	
Microhyla heymonsi	-	-	5	-	
REPTILIA					
Chelonia					
Emvdidae					
Cuora amboinensis	-	1	-	-	In pond
Heosemys spinosa	_		(1)	1	During heavy rain
Sauria			(-)		During nearly runn
Agamidae					
Bronchocela cristatella	_	_	(1)	_	
Draco volans	-	-		-	
Gekkonidae			(5)		
Gekko smithi	4	1	3	2	All but one (at 3) heard only
Hemidactulus frenatus	-	-	5	-	All but one (at 5) heard only
Scincidae	-	-	5	_	
Mahuya multifasciata	1	2	-	1	
Voronidoe	1	4	-	1	
Varanus nebulosa	2		100	7	
Varanus nebulosu	~	1(2)		'	
Varanus salvalor	-	$\mathbf{I}(i)$	-	-	
Deidee					
Doldae Doub on water later	(1)				190mm diamater
Python reliculatus	(1)	-	-	-	180min diameter
			(2)		
Bolga aenarophila	(2)	-	(3)	-	
Gonyosoma oxycephala	(3)	-	-	-	
Macrophisthodon rhodomelas	2	-	-	-	
Elapidae				-	
Naja sumatrana	-	-	-	1	
¹ Indicator species of man-chan	iged hab	itat			
² Forest species - absent from p	antation	15			

Table 2

Species	Kiew (1978)	Lim (in prep.)1	% (n = 65)	
Pelobatidae				
Leptobrachium hendricksoni	+	4	6.2	
Leptobrachium nigrops	+	2	3.1	
Megophrys nasuta	*	2	3.1	
Bufonidae				
Leptophryne borbonica	*	- (+ 1 ²)	1.5	
Bufo asper	+	7	10.8	
Bufo parvus	+	9	13.8	
Ranidae				
Occidozyga laevis	+	2	3.1	
Rana blythi	+	9	13.8	
Rana chalconota	+	$12(+1^2)$	20.0	
Rana glandulosa	+	2	3.1	
Rana hosei	+	-	0	
Rana laticeps	+	1	1.5	
Rana paramacrodon	+	-	0	
Rana stignata	+	2	3.1	
Rhacophoridae				
Polypedates colletti	+	1	1.5	
Rhacophorus appendiculatus	+	-	0	
Rhacophorus bimaculatus	+	3	4.6	
Rhacophorus nigropalmatus	+		0	
Rhacophorus promianus	_	2	3.1	
Microhylidae				
Chaperina fusca	+	1	1.5	
Microhyla inornata	+	3	4.6	
Microhyla superciliaris (? = palmatus)	-	1	1.5	
Kalophrynus pleurostigmata	+	-	0	

Records of amphibians in primary forest of Pasoh Forest Reserve, near Simpang Pertang (Negeri Sembilan), Malaysia.

¹List of Lim Boo Liat compiled from incidental collections on 10-19.i.1968, 13-22.v.1969, 2-12.xii.1972 and FRIM Sains Alam Sekitar 1989-91 (identifications by P.Y. Berry, pers. comm., after Berry, 1975)

²Recorded by Lambert, 7 and 14-19.iii.1995

RESEARCH PROGRAMME

Background literature

The earliest works published on the amphibians and reptiles of Peninsular Malaysia were by Flower (1896, 1899), Boulenger (1912) and Smith (1931). With further papers on the reptiles, especially snakes (e.g. Kopstein, 1938), Tweedie (1961) published his work on the snakes of Malaysia which he subsequently revised (Tweedie, 1983) using further information, most of it provided by Lim B.L., additional to that in papers published by Lim in the Malayan Nature Journal (1956-1975). With useful photographs of many of the snake species to be found in Peninsular Malaysia included with Lim & Lee (1989), and venomous snakes having medical significance, Lim (1991) was published subsequently. Montane amphibians and reptiles in Pahang were examined by Grandison (1972) and in northern Trengganu by Dring (1979). Grandison (1978) also covered the snakes of western Malaysia and Singapore island. Following a bibliography on the ectothermic vertebrate groups by Berry (1973), a definitive work by her on the amphibians of Peninsular Malaysia was prepared subsequently (Berry, 1975). The snakes and lizards of Singapore island, all of which occur also on mainland Peninsular Malaysia, were respectively listed by Sworder (1923, 1925), and a useful field guide with colour photographs of both amphibian and reptile species was produced by Lim & Lim (1992). With such works as Inger (1979, 1980) to hand, the conservation status of respectively amphibians and chelonians in Malaysia was given in species listings by Kiew (1984a, 1984b), who also produced a small educational booklet on Malaysian frogs (Kiew, 1989). A booklet on the Leatherback Turtle and its conservation for educational and publicity purposes was also published by Chan & Liew (1989), whose work is ongoing (Chan & Liew, 1995; Liew et al., 1995), together with conservation and management work on freshwater species (Sharma, 1995). There is no comprehensive listing to date of the crocodilians and lizards of Peninsular Malaysia, and one, especially for the latter group, is urgently required.

Aims

The aims of the research programme were to compare diversity in primary forest before and in relation to method of timber extraction and time after logging, and with diversity in forest converted to oil palm, rubber and forest tree plantations. Species surveys were therefore to be conducted in primary forest for direct comparison with each of the tree crop plantation types, and in secondary forest of known logging history.

In addition to the pre-logging survey in the Serting Forest Reserve Extension not far from Pasoh Forest Reserve, a survey would be conducted in primary forest within a 50ha study plot that has been established at Pasoh. A list of the amphibians expected there had been prepared by Kiew (1978) for the International Biological Programme, and numbers observed incidental to investigations on vertebrates generally were also recorded by Lim (in prep.) and M.R.K. Lambert (Tables 1 and 2). The list provides useful preliminary information on species richness (composition and frequency) and relative abundance.

Three constituents to the programme were drawn up to address these aims:-

- 1. To compare amphibian diversity (species composition, percent frequency and relative density as numbers ha-1) in primary forest before and after logging, and in relation to post-logging changes/recovery with time.
- 2. Phase I. Comparison of herpetofaunal diversity in primary forest with that in forest converted to oil palm, rubber and forest tree plantations (static diversity).
- 3. Phase II. Record changes in herpetofaunal diversity in logged forest in relation to method of timber extraction and time since logging activities took place (dynamic diversity).

Surveying precepts

- 1. Primary rain forest with trees of up to 30 or 35 m is a habitat type with a strong vertical component compared with oil palm, rubber and forest tree plantations, which represent generally similar habitats in a more horizontal plane.
- 2. Forest tree plantation should be included with surveys of other plantation types, for it is believed by some that this vegetation type and habitat differs little from that of primary or secondary forest, which can therefore be replaced with little ecological damage.
- 3. Secondary forest results from the logging of primary forest. Timber extraction can range from the selection only of economic species and removal by animal traction to the wholesale removal in recent years of all sizeable trunks with very destructive mechanical methods of extraction. Thus extraction method as well as time since logging has last occurred needs to be taken into account.
- 4. Primary forest yields a high number of species, especially amphibians, at low density while plantations yield a lower number of species (a greater proportion of reptiles) at higher densities.
- 5. Because amphibians, representing the main herpetofaunal component in primary forest, are primarily active at night, surveys must be conducted during the first two or three hours of darkness, as well as during the day. For purposes of comparison, night surveys must also be undertaken in plantation habitats with the aim to spend equal proportions of surveying time in daylight and darkness.
- 6. Diurnal reptiles in primary forest emerge to bask and hunt during the hottest two or three hours of the day, when the sun is vertically overhead and can penetrate the canopy layer to some parts of the ground litter surface. In plantations, reptiles emerge during the morning when sunshine has become warm about 2 hours after sunrise or after emerging from cloud later in the day.
- 7. With distinct dry and wetter periods of the year, behaviour and population structure of forest amphibians are subject to seasonal change.
- 8. Because amphibians tend to congregate at pond and stream edges in primary forest, especially at night, species recording is facilitated, although a correction factor may have to be introduced for the size of catchment area represented.
- 9. Because amphibians are an important herpetofaunal component in primary rain forest, high competence in species recognition is required during surveys. Ability to recognise amphibians in plantations is less acute. Reptile species recognition in both habitats is also required. Ability to recognise tadpole species is also needed in forest streams and pools.
- 10. Oil palm plantations occur on drained soil, usually on slopes intersected by stream valleys, supporting riparian vegetation. Surveys must include riparian habitat.
- 11. Surveys in plantation types need to take distance from primary and logged forest into account, since forest habitat provides a harbour from which species to varying degrees of ability can invade.

12. To yield sufficient numbers for statistical purposes, the survey area in primary forest will need to be five, ten or more times that in plantation habitats, in which 2 or 4 ha should suffice. An area of 50 ha, with a proportionally greater surveying period may be required in primary forest in order to yield a cumulative number of 300 records desired for statistical comparisons.

Surveying methodology

- 1. Primary and secondary forest: To ensure that sufficient numbers of amphibians in particular are recorded, 50-ha plots would be subdivided into one-hectare plots. Five field assistants trained in amphibian identification will walk in straight lines through each plot with 10 m separating observers. Each assistant would therefore be responsible for 5 m either side. The basic method will be visual encounter survey at night, supplemented by aural census for animals identified by their calls but not seen [Note that unidentifiable calls can be tape recorded]. Position relative to any nearby breeding site or water body will be noted. The date and time of each survey, weather conditions, phase of the moon, temperature and relative humidity will be recorded at each study site. The team would cover five 1-ha plots per night for 10 nights. Night surveys will be supplemented by 2-3 hour day surveys between 08.00 and 11.00 h, depending on sunshine, in order to record also diurnal species and basking reptiles. Bodies of water will be examined by day or night for the presence and abundance of amphibian larvae and eggs - number of larvae and eggs to be estimated (giving an indication of the number of adult females laying them). Identification will be carried out in the field wherever possible. If tadpoles or adults cannot be identified, samples will be collected and brought back to the laboratory for identification (voucher specimens of unidentified material to be preserved). Tadpoles may also be reared in the laboratory for positive species identification.
- 2 Oil palm, rubber and forest tree plantations: One to four or five randomly selected 1ha subplots within a 10-ha plot in each plantation type would be equal-effort sampled initially. For direct comparison with forest species, the same surveying method during the night and day would be carried out as in forests. The number of sub-plots in plantation types will be increased if numbers of animals sighted remain low.
- 3. Timing: To account for seasonal and weather changes, surveys covering wet and dry seasons would be carried out during four different times of the year.
- 4. Species richness: From species and the numbers recorded in each of the habitats, the aim would be to determine species composition, percentage frequency and relative density (no. ha-1) in order to make direct comparisons. It may also be possible to compare the data for present day assemblages with those of similar forest habitats recorded by Inger (e.g. 1980) some 30 years ago.
- 5. Surveying Serting Forest Reserve Extension: A herpetofaunal survey of primary forest in the Serting Forest Reserve Extension may have two options. One may simply involve following the river course through the length of the forest during the hours of darkness and daylight recording species visually and by call. The other may be to record species in three or four 100-m transects established to include forest on either side of the river.

HERPETOFAUNA OBSERVED DURING VISITS TO MALAYSIA (BY M.R.K. LAMBERT)

A number of amphibians and reptiles were observed by Lambert during journeys through Peninsular Malaysia and Singapore. Since locality records and other general information may be useful in future distribution studies, sightings are recorded here of species likely to be seen during cursory visits to a range of locations.

1969

A first visit only to Singapore was made 16-20 September 1969. An observation of a skink photographed in mangrove vegetation just outside the town (18.ix) was included with Lambert (1985). From a photograph in Lim & Lim (1992), the correct identification is the Mangrove Skink *Emoia atrocostata*, not to be confused with *Mabuya multifasciata* (Common Sun Skink), another rather more widespread species with which it is sympatric in Singapore and whose immature stages resemble it.

1988

A further visit to Malaysia was made during another stop-over at Singapore, 22-29 October 1988. A journey by bus from Singapore town in the morning of 23 October crossed the Causeway to Johor Bahru at the southern end of Malaysia, and followed a route through secondary forest, oil palm and rubber tree plantation mosaic to make first contact with the South China Sea at Mersing. Continuing north up the east coast with overnight halts at Cherating and Marang, the journey ended at Kota Bahru having passed through Kuantan, capital town of Pahang, and Kuala Terengganu, capital of Terengganu State. Leaving Kuala Dungun on 25 October, a big Monitor Lizard, Varanus salvator (a large species commonly seen throughout the Peninsula), ponderously crossed the road (13.13 h) at a point 68 km S. of Kuala Terengganu, and made its way through an agriculturally developed area with many kampung houses on stilts interspersed amongst coconut palms. Called iguanas by people locally, this impressive monitor is typically seen in areas of human interference, often scavenging at rubbish tips. The island of Pulau Kapas was opposite Marang, and travellers who had stayed on other of Terengganu State's offshore islands reported that their nights' sleep on the beaches were often disturbed by large monitors scavenging for food nearby. The road also passed Rantau Abang with its famous turtle breeding beach and Information Centre. Further details on the turtle conservation programme at this location is given in the booklet of Chan & Liew (1989). Northern Terengganu state was also Dring's (1979) study area. The return journey, via Kuala Lumpur and Melaka, ended back at Singapore on 29 October.

1995

Quite a number of amphibians and reptiles were observed during a further visit to Malaysia, 26 February-26 March 1995, in addition to those at the Pasoh Forest Reserve area (Table 1).

Kuala Lumpur: Being the capital of Malaysia and a built-up area, few species of herpetofauna were expected in the general vicinity of Kuala Lumpur. House Geckos, *Cosymbote platyurus*, with flattened tail (commoner than *Hemidactylus frenataus* with rounded tail) were frequently seen on inside and outside walls of town buildings (1-2.iii). Once in the afternoon (9.iii), beside a small partially vegetated mud island at the edge of the discoloured fast-flowing water of the Sungai Kelang in the city centre, and just

downriver of the confluence with the Sungai Gombak, a terrapin was observed to climb slowly out of the water, cross the mud island, re-enter the water and remain suspended over a shallow. The carapace was approximately 200 mm long, uniform black and the vertebral scutes each bore a midline ridge. It could have been one of two or three species, but compared well with *Siebenrockiella crassicollis*, the Black Marsh or Pond Terrapin, which according to Lim & Lim (1992) is found in canals, ponds and reservoirs in forest and agricultural land, and may be seen for sale in fish markets. It is also a species observed in temples in Malaysia, and is frequently purchased mainly for release, which is common Taoist and Buddhist practice (Kiew, 1984b).

At FRIM, near Kepong, some 12 km from Kuala Lumpur centre, a number of species were observed in the grounds of the institute buildings. At a pool formed by a dam, containing a large number of carp-like fish, terrapins emerged to bask in sunshine on the pool bank (27.ii). They were unmistakably Red-Eared Sliders, *Trachemys scripta elegans*, an introduced species from North America which is sold in thousands as hatchlings in local pet shops and, surviving into adulthood, are often released into the wild (Lim & Lim, 1992). Such feral animals could pose a danger to native species by being more vigorous and out-competing them. Beside the gecko, *Cosymbote platyurus* on inside and outside walls of FRIM buildings, two or three Variable Lizards, *Calotes versicolor*, were observed on and by cut hedges (27.ii, 20.iii). On 20.iii, an adult monitor, *Varanus nebulosa* was observed basking in the morning (08.10 h) on a lawn and seeking refuge in a drainage channel upon disturbance. All three of these reptile species are commonly associated with man-disturbed habitats.

Penang: The opportunity was taken to visit Penang Island, 10-12 March. Arriving by overnight bus at Georgetown and continuing to Teluk Bahang in the north-west of the island, a scattering of several geckos, Cosymbote platyurus greeted my entry into a guest house bedroom; the species was seen on village buildings everywhere. With two heads each poking out of drainage holes at the edge of a concrete-lined ditch (10.iii) in the morning, and two more basking in morning sunshine (10.00 h) at the edge of a bridge over a stream (11.iii), immature Varanus nebulosa were present in the village vicinity. I also saw an adult (10.iii) in the middle of the day (ca. 13.00 h) lazily picking at food waste on a rubbish tip by a polluted-looking stream at the end of a garden. A brightly coloured adult Sun Skink, Mabuya multifasciata was observed basking on the edge of a concrete-lined drain (10.iii), and a drab brown sub-adult was sighted walking in morning sunshine (10.00 h) along a metal pipe above a drainage ditch (11.iii). A Variable Lizard Calotes versicolor was seen by a bush on a wire-mesh fence (10.iii) and another (11.iii) basking in morning sunshine (10.00 h) on the tap-scarred trunk of a rubber tree. A much larger individual of this species was also observed sunning itself on a garden wall (10.iii) in another part of the village. That evening, about an hour after sunset at approximately 19.30 h, frogs were heard croaking (29°C; 85% R.H.) from the edge of a stream flowing through the village; only Rana limnocharis would be expected to survive in this disturbed habitat. In a room of the guest house still later (22.45 h), a toad Bufo melanostictus was found hopping across the polished concrete floor, inevitably foraging for termites or flying ants, which in Malaysia's tropical conditions may enter human dwellings. None of the species seen was unexpected, for all are associated with, and therefore indicators of human-changed habitats.

In the morning of 12 March, an 8-km return trek was made from Teluk Bahang to the lighthouse on Muka Head, the north-westernmost point of the island, which involved following a rough track through a coastal forest reserve. Setting off at 10.00 h, the scramble over rocks and through the undergrowth was disturbed by crashing branches as



Plate 1. Rana chalconota, a small forest frog (32-60 mm) in Malaysia whose relative abundance is increased by selective timber extraction. (Photographed in Belum Forest Reserve, Perak, March 1994, by C H Diong).



Plate 2. Rana blythi, a forest frog (c. 100 mm), whose relative abundance in Malaysia is highest in forests, but is also found in tree crop plantations in Malaysia. (Photographed in Belum Forest Reserve, Perak, March 1994, by C H Diong).



Plate 3. Cyrtodactylus quadrivirgatus, a gecko not uncommon in forests of Malaysia, and found in forest tree and rubber plantations, but not in oil palm plantations. (Photographed in Belum Forest Reserve, Perak, March 1994, by C H Diong).



Plate 4. Primary rain forest habitat, Pasoh Forest Reserve, Negeri Sembilan, Malaysia. (Photographed 14 March 1995 by M.R.K. Lambert). two large monitors, Varanus salvator (known as the Water Monitor - found along sea shores and rivers) on the outward journey, and two different individuals on the return, made their presence known. Passing the Marine Field Station of the University of Malaya, the next beach was Mermaid Beach, popular for barbecues. Tapped spring water was provided in a forestry building. Two *Calotes versicolor* were perched on coconut palm trunks. On the last kilometre climb up to Muka Head and return from the lighthouse to Teluk Bahang (5 km), seven *Mabuya multifasciata* were recorded in 100 min between 11.45 h and 13.25 h (4.2 per man-h). The first was photographed. Finally, just before re-entering the village, a snake, followed a few minutes later by another, slid through grass tufts and leaf litter at the edge of the track. Both had black and yellow dorso-lateral bands with reddish-brown in between and compared with the photograph of the Painted Bronzeback, *Dendrelaphis pictus* in Lim & Lee (1989). This species is found in forest and from agricultural to urban areas (Lim & Lim, 1992).

Pasoh Forest Reserve area, Negeri Sembilan: A list of the species observed in the Pasoh Forest Reserve area was prepared (Table 1).

Pasoh primary forest: In a small pool deep in primary forest on 7 March morning, there was a shoal of orange coloured tadpoles the product from spawn of a single female of Rana chalconata, a species whose relative abundance is enhanced by selective timber extraction from primary forest. Returning to Pasoh a few days later, the orange-coloured tadpoles of Rana chalconota had increased somewhat in size since last seen 8 days before, and 25 were counted. A small snake of ca. 50 cm, reddish coloured dorsally with an ash-grey neck laterally, quietly slid across the partially obscured track in the denselyvegetated 50-ha plot of primary forest in the morning of 15 March (10.00 h; 24.5°C; 96% R.H.). Without much difficulty, it was identified as the Blue-Necked Keelback, Macrophisthodon rhodomelas, a back-fang which proudly bared its teeth upon capture. That afternoon (14.30 h; 28°C; 85% R.H.), an immature monitor, Varanus salvator (nostril near end of the nose) was photographed basking in a sunny patch on a fallen log. Subsequent to heavy rain overnight (17 March), and shortly after hearing the characteristic bark of a Gekko smithi, a small toad was spotted at just midday (12.00h; 25.5°C; 96% R.H.) resting on a buttress at the trunk base of a tall dipterocarp, taglabelled Shorea maxwelliana, in the 50-ha plot. The thin relatively long hind limbs had mid-brown bars, and there was a double dark spot between the eyes; it remained quite still for a long-exposure photograph and was identified as Leptophryne borbonica, not previously recorded at Pasoh. Beams of sunshine penetrated the canopy foliage of the forest at noon the next day (18 March) enabling an immature Mabuya multifasciata basking on a sunny leaf patch (27.5°C; 82% R.H.) to be photographed.

Oil palm plantation, Pasoh: Starting a search in oil palm plantation adjacent to logged forest in the late morning of 16 March (11.27 h; 28.5° C; 75% R.H.), four *Rana limnocharis* were seen on dried fronds on the ground, two *Varanus nebulosa* were disturbed basking, and the black coils of a large snake moved sinuously under a dipterocarp log and protruded the head briefly to give itself away as the Sumatran Cobra, *Naja sumatrana*, an active predator of plantation rats. Just at the end of the search (13.18 h - 111 min; 29.5°C; 72% R.H.), a 2 m-long monitor not far from a stream which at that size must be *Varanus nebulosa* crossed the dirt track just in front and re-entered the secondary forest. The following afternoon (15.07-15.31 h), another *Varanus nebulosa* was disturbed, shortly after hearing the bark of *Gekko smithi*, and an immature skink *Mabuya multifasciata* moved along the stem of a palm frond (31.5°C; 67% R.H.). Travelling through the oil palm plantation in a vehicle along the main dirt track from Pasoh Forest Reserve to the main road, *Varanus nebulosa* were frequently seen plodding across the track's surface.

Pasoh secondary forest: After passing through oil palm plantation, the main track to Pasoh Forest Reserve went through secondary forest (selective timber removal by animal traction in the 1950s) and ended at the Office and Rest House area. During the late afternoon of 6 March (18.00 h; 28.5°C; 85% R.H.), a newly metamorphosed frog. Kaloula pulchra, was recorded on the track - pale brown dorsally with an hour-glass pattern and dark sides. With sunshine (12.30 h; 27.5°C; 89% R.H.) on 7 March, basking on a rotten stump back in secondary forest was a dark-coloured adult of the Sun Skink, Mabuya multifasciata. The mainly wooden buildings of the Rest House bungalows all teemed with geckos, Hemidactylus frenatus, and the barks were frequently heard, and individuals occasionally seen, of giant geckos, Gekko smithi. A foam nest with eggs of Polypedates leucomystax was attached under a beam above water in an external butt of a rest house bungalow; a common species indicative of human-disturbed habitat. After rain during early morning hours of darkness (17 March), two rhacophorid frogs were seen on the porch of a building at 11.30 that night (24°C, 92% R.H.): Polypedates leucomystax (three), with a foam nest on the grass, and Nyctixalus pictus (two). An immature Mabuya multifasciata was seen scuttling rapidly through grass at the edge of the track, and basking on branches of a fallen tree drooping into a pond, a terrapin with yellow lines on the neck and head, almost certainly *Cuora amboinensis*, plopped rapidly into the water upon disturbance. A number of other species were recorded by two American forest researchers who had been staying at the Rest House for some days during March (Table 1); in particular several Flying Lizards Draco volans were often seen chasing each other up trunks and amongst branches of trees at the edge of the residential area.

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Editorial Note: A list of amphibians and reptiles in forests of Peninsular Malaysia, and their relative abundance, has not been prepared previously, and this is the first published check list for lizards.

APPENDIX

Checklist, with relative abundance, of expected amphibian and reptile fauna in primary (PF) and logged-over (secondary) forests (LF), and forest - Acasisa or Pinus (FP), rubber estate (RU) and oil palm plantations (OP) in Peninsular Malaysia. Prepared by Kiew Bong Heang, March 1995. Key:-

0	-	Not likely to be present at all.
1	-	Rare; Not likely to be encountered owing to behaviour,
		low numbers and/or distribution.
2		Number is extremely low, estimated at 1 per 50 hectares;
		Chance of encounter in a day/night search is negligible.
3	-	Number low, estimated at 1 per 10 hectares;
		Chance of encounter in a day/night search is slight.
4	-	Number poor, estimated at 1 per 5 hectares;
		Chance of encounter in a day/night search is poor.
5	-	Number high, estimated at 1 or more per hectare;
		Chance of encounter in a day/night search is good.

SPECIES	VEGETATION TYPE					
	PF	LF	FP	RU	OP	
AMPHIBIA						
Caecilidae						
Caudacaecilia nigroflavus	2	2	0	0	0	
Ichthyophis monochrous	2	2	0	0	0	
Pelobatidae						
Leptobrachium hendricksoni	4	3	2	3	2	
Leptobrachium nigrops	2	2	2	2	0	
Megophrys monticola nasuta	3	3	0	0	0	
Bufonidae						
Ansonia longidigita	2	2	0	0	0	
Ansonia malayana	1	1	0	0	0	
Bufo asper	4	4	2	0	0	
Bufo biporcatus	2	2	0	0	0	
Bufo macrotis	1	1	0	0	0	
Bufo melanostictus	0	0	0	3	3	
Bufo parvus	4	4	3	3	2	
Bufo quadriporcatus	1	1	0	0	0	
Leptophryne borbonica	2	2	0	0	0	
Pedostibes hosei	3	2	0	0	0	
Pelophryne brevipes	1	1	0	0	0	

Ranidae					
Occidozyga laevis	3	4	1	1	1
Rana baramica	2	2	0	0	0
Rana blythi	4	4	3	3	3
Rana chalconota	4	4	0	0	0
Rana erythraea	0	2	2	3	3
Rana glandulosa	2	2	2	2	2
Rana hosei	3	2	0	0	0
Rana kuhlii	2	2	0	0	0
Rana laticeps	2	2	0	0	0
Rana limnocharis	0	2	3	4	4
Rana luctuosa	2	2	0	0	0
Rana malesiana	2	2	2	3	1
Rana miopus	2	2	2	2	2
Rana nicrobariensis	2	3	3	2	2
Rana paramacrodon	2	2	0	0	0
Rana plicatella	2	2	0	0	0
Rana stignata	3	2	0	0	0
Staurois larutensis	2	2	0	0	0
Rhacophoridae					
Nyctixalus nicta	2	2	0	0	0
Polypedates colletti	2	2	0	0	0
Polypedates leucomystax	ō	2	4	4	4
Polynedates linki	Ō	2	2	2	2
Polypedates macrotis	3	3	0	0	0
Rhacophorus appendiculatus	2	3	õ	0	0
Rhacophorus himaculatus	1	1	0	0	0
Rhacophorus nieropalmatus	Î	1	0	Õ	0
Rhacophorus nardalis	î	1	0	0	0
Rhacophorus promianus	2	2	0	0	0
Rhacophorus reinwardti	1	1	Ő	0	0
Rhacophorus robinsoni	ī	1	Ő	Õ	0
Theloderma asper	1	1	0	0	0
Theloderma horridus	î	î	Ő	0	0
Theloderma leprosa	1	1	õ	0	0
Microhylidae	-	-	Ŭ	0	
Calluella volzi	1	1	0	0	0
Chaperina fusca	î	2	Ő	Õ	Ŏ
Kalophrvnus palmatissimus	2	1	Ő	Õ	Ő
Kalophrynus pleurostioma	1	2	0	Ő	0
Kalophrynus robinsoni	1	1	Ő	Ő	Ő
Kaloula haleata	1	1	Õ	Ő	0
Kaloula pulchra	Ô	Ô	1	2	2
Microbyla annectens	1	1	Ô	õ	õ
Microhyla herdmorei	2	2	0	Ő	0
Microhyla bornensis	2	2	0	Ő	0
Mic ohyla butleri	1	2	3	3	3
Microhyla hevmonsi	2	3	3	3	3
Microhyla inornata	1	1	ő	Ő	0
Microhyla ornata	1	1	Ő	Ő	0
Microhyla palmines	1	1	ő	0	0
Microhyla superciliaris	1	î	õ	0	Ő
	-	-		-	-

REPTILIA					
Chelonia					
Emvdidae					
Cuora amboinensis	1	2	2	2	2
Cyclemys dentata	1	1	1	1	1
Hoesemys spinosa	ĩ	1	0	0	0
Notochelys platynota	2	2	0	0	0
Testudinidae	_				
Geochelone elongata	1	1	1	1	1
Geochelone emys	1	1	2	2	2
Trionychidae	-	-	_	-	-
Dogania subplana	2	2	1	1	1
Amyda cartilagineus	1	1	1	1	1
Sauria	-	-	-		
Agamidae					
Acanthosaura armata	2	2	0	0	0
Anhaniotis fusca	2	2	Ő	Õ	Ő
Bronchocela cristatella	õ	ñ	t	2	2
Bronchocela emma	Ő	Ő	1	1	1
Calotes versicolor	2	2	2	2	2
Deaco fimbriatus	1	1	õ	0	ñ
Diaco formosus	1	1	0	0	0
Diaco maculatus	1	1	0	0	0
Draco maximus	1	1	0	0	0
Diaco malanonoaon	2	2	1	1	1
Diaco volans	2	2	2	2	2
Conocanhalus hornaansis	1	1	0	0	ő
Gonocephalus orandis	1	1	0	0	0
Gonocephalus granais	1	1	0	0	0
Gohocephalus herveyi	1	1	0	0	0
A employed abotes folinges	1	1	0	0	0
Cramannia affinia	1	1	0	0	0
Chemaspis ajjinis	1	1	0	0	0
Chemaspis kenaalii	1	1	1	1	1
Cosymboles platyurus	1	1	1	0	0
Cyrtodactylus consodrinus	1	1	0	0	0
Cyrtoaactylus malayanus	1	1	0	0	0
Cyrtodactylus puichettus	1	2	1	1	0
Cyrtoaaciyiiis quaarivirgatus	2	2	1	1	0
Gehyra mutilata	0	0	0	1	0
Gekko gecko	0	0	0	1	0
Gekko monarchus	0	0	0	1	0
Gekko smithi	2	2	0	0	0
Hemidactylus brooku	0	0	0	1	0
Hemidactylus frenatus	0	0	0	1	0
Hemidactylus garnotii	0	0	0	1	0
Lepidodactylus lugubris	0	0	0	1	0
Mimetozoon craspedotus	1	1	0	0	0
Ptychozoon horsfieldii	1	1	0	0	0
Ptychozoon kuhli	1	1	0	0	0
Scincidae	-	-			
Dasia olivacea	2	2	1	0	0
Emoia atrocostata	2	2	1	0	0

Mabuya longicaudata	1	1	1	1	1
Mabuya multifasciata	2	3	3	3	3
Mabuya rugifera	1	1	1	1	1
Mochlus bowringi	0	0	I	2	2
Sphenomorphus indicus	1	1	0	0	0
Sphenomorphus praesigne	1	1	0	0	0
Sphenomorphus scotophilus	1	1	0	0	0
Sphenomorphus stellatus	2	2	1	0	0
Varanidae					
Varanus nebulosa	1	1	2	2	2
Varanus rudicollis	1	1	1	2	3
Varanus salvator	1	1	1	2	3
Serpentes					
Typhlopidae					
Ramphotyphlops albiceps	1	1	0	0	0
Ramphotyphlops braminus	1	1	1	1	1
Typhlops diardi	1	1	1	1	1
Aniliidae					
Anomochilus leonardi	1	1	1	1	1
Cylindrophis rufus	1	1	i	1	1
Xenopeltidae					~
Yenopeltis unicolor	1	1	1	1	1
Roidae	<u>_</u>	<u></u>		<u></u>	
Puthon curtus	1	1	1	1	1
Python raticulatus	î	î	1	î	2
Colubridoo		<i>x</i> .	1		2
Abastulla fassiolata	1	1	1	1	1
Anaetulla jasciolala	1	1	1	1	1
Anaetulia mycterizans	1	1	1	1	1
Anaetulia prasina	1	1	1	1	1
Amphiesma conspicillata	1	1	1	1	1
Amphiesma peterii	1	1	1	1	1
Aplopeltura boa	1	-	0	0	0
Boiga cynodon	1	1	1	1	1
Boiga dendrophila	1	1	1	1	1
Boiga drapiezii	1	1	1	1	1
Boiga jaspidea	1	1	1	1	1
Calamaria albiventer	1	1	1	1	1
Calamaria pavimentata	1	1	1	1	1
Calamaria schlegeli	1	1	1	1	1
Chrysopelea ornata	1	1	1	1	1
Chrysopelea paradisi	1	1	1	1	1
Chrysopelea pelias	1	1	1	1	1
Dendrelaphis caudolineatus	1	1	1	1	1
Dendrelaphis pictus	1	1	1	1	1
Dendrelaphis formosus	1	1	1	1	1
Dendrelaphis striatus	1	1	1	1	1
Dryocalanus subannulatus	1	1	1	1	1
Dryophiops rubescens	1	1	1	1	1
Elaphe flavolineata	1	1	1	1	1
Elaphe taeniura	1	1	1	1	1
Elaphe radiata	1	1	1	1	1
Elaphe prasina	1	1	1	1	1
	1.10	122		0.50	

Gonyophis margaritatus	1	1	0	0	0
Gonyosoma oxycephalum	1	1	1	1	1
Homalopsis buccata	1	1	1	1	1
Lepturophis borneensis	1	1	1	1	1
Liopeltis baliodeira	1	1	1	1	1
Liopeltis longicauda	1	1	1	1	1
Liopeltis tricolor	1	1	1	1	1
Lycodon aulicus	1	1	1	1	1
Lycodon butleri	1	1	1	1	1
Lycodon effraenis	1	1	1	1	1
Lycodon subcinctus	1	1	1	1	1
Macrophisthodon flaviceps	1	1	1	1	1
Macrophisthodon rhodomelas	1	1	1	1	1
Macropophis maculatus	1	1	1	1	1
Natrix trianguligera	1	1	1	1	1
Oligodon octolineatus	1	1	1	1	1
Oligodon purpurascens	1	1	1	1	1
Olioodon signatus	1	1	1	1	1
Pareas carinatus	1	1	1	1	1
Pareas laevis	î	1	1	î	î
Pareas malaccanus	î	1	1	1	1
Pareas margaritophorus	î	î	1	î	i
Psammodynastas pictus	î	î	î	î	î
Promodynastes pictus	î	î	1	1	î
Psaudorhabdion longicans	î	î	i	î	î
Physe carinatus	î	î	1	î	î
Phys fuscus	î	î	1	î	î
P tyus juscus	1	1	1	î	1
Phahdonhis chrysgrous	î	î	1	î	î
Rhabdophis chi ysurgus	î	-	1	1	- î
Siburankia collaria	î	1	1	1	î
Sibynophis collaris	1	1	1	1	1
Venelaphia heraconotus	- î -	1	1	- î	- î
Veneral pris nexagonolus	î	î	1	- î:	- î
Yanadammua jayanjaya	1	1	1	1	÷.
Electidee	1	1	1	1	1
	1		1	÷.	1
Bungarus canataus	1	1	1	1	1
Bungarus fasciatus	1	1	1	1	1
Bungarus flaviceps	1	1	1	1	1
Calliophis gracilis	1	1	1	1	1
Calliophis maculiceps	1	1	1	1	÷.
Maticora bivirgata	1	1	1	1	1
Maticora intestinalis	1	1	1	1	1
Naja kaouthia	0	0	0	-	1
Naja sumatrana	1	1	1	1	2
Ophiophagus hannah	1	1	1	1	-1
Viperidae			~	20	
Agkistrodon rhodostoma	0	0	0	1	1
Trimeresurus hageni	I	1	0	0	0
Trimeresurus puniceus	1	1	0	0	0
Trimeresurus sumatranus	1	1	0	0	0
Trimeresurus wagleri	1	1	0	0	0