
Research article

Frogs of populated localities at West Coast and Kudat Divisions, Sabah, Malaysia: Assemblage of merely commensal species or not?**KUEH Boon Hee***

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ABSTRACT. Inventory-based studies on frogs in Sabah have focused on protected areas. However, frogs also inhabit populated localities i.e. areas in the vicinity of human habitations and in highly disturbed habitats outside of protected areas. Such observation, coupled with the necessity for taxonomical and geographical comprehensive inventory-based studies, prompted this study aimed at investigating whether populated localities contain an assemblage of merely commensal species or not. Samplings were done at eight sites at West Coast and Kudat Divisions of Sabah between 13 December 2000 and 28 April 2001. Frogs were located through opportunistic examination, calls and eye shines. Eleven species of frogs representing three families: Microhylidae, Ranidae and Rhacophoridae, were recorded. Of the 11 species, five were human commensals, contributing 90% of the total specimens. Four commensal species, namely *Bufo melanostictus*, *Kaloula baleata*, *Hoplobatrachus rugulosus* and *Rana*

nicobariensis were absent from the inventory. However, six non-commensal species were also recorded; *Limnonectes kuhlii*, *Occidozyga baluensis*, *Rana chalconota*, *Philautus hosii*, *Polypedates ottilophus* and *Rhacophorus angulirostris*. *Rhacophorus angulirostris* was previously known only from primary forests higher than 500 m above sea level. The endemism level was 18% with two species endemic to Borneo. Locality wise, Bavanggazo Longhouse had the highest number of species, as well as the highest number of non-commensal species recorded. Hence, frogs at populated localities are not an assemblage of merely commensal species.

INTRODUCTION

Inventory-based studies on frogs (Amphibia: Anura) in Sabah have always focused on protected areas such as national parks, reserves, sanctuaries and conservation areas. Indeed, protected areas are gazetted for the conservation of tropical rainforest habitats and more directly, key faunal species from local or total extinction. The historical résumé of the protected areas in Sabah commenced with the gazettelement of Kabili-Sepilok Forest Reserve

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in 1931 and Sipadan Island as a bird sanctuary in 1934, both through the Land Ordinance 1930 which has been revised as the Land Ordinance 1930 (Chapter 68 of the 1996 reprint). The coverage of protected areas in Sabah at present totals 8,571.49 km² (Regis, 2000). A corollary of this is that protected areas become 'Holocene refugia' (McNeely, 2000) for hordes of flora and fauna, including frogs, which quite effortlessly appear environmentally conspicuous (Kueh & Maryati, 2005) as compared to unprotected areas in between. Herpetologists interested in frogs have been actively undertaking inventory-based studies at protected areas that are exemplified by Inger *et al.*, 2000; Ramlah *et al.*, 2001; Shinokawa *et al.*, 2002; Kueh & Maryati, 2003; Wong, 2003; Kueh, 2004a; Kueh *et al.*, 2004; Kueh & Maryati, 2005. There are many other such published papers. However, the mentioned publications represent publications within the last five years.

Undoubtedly, the studies were imperative and the inventories yielded were utmost precious, but frogs inhabit populated localities outside of protected areas too. These areas should not and must not be neglected and it should not be conveniently assumed that inventory-based studies done here shall amass merely commensal species. Inventory-based studies for the frog species of Sabah have to fulfil taxonomical as much as geographical comprehensiveness (e.g., Stuebing, 1998; Das, 2002; Stuebing, 2005) in order to mitigate bias and hopefully, generate new discoveries and knowledge (Kueh, 2003).

MATERIALS AND METHODS

Sites

The study was conducted at eight sites at West Coast (three sites) and Kudat (five sites) Divisions of Sabah, a Malaysian State in north-

eastern Borneo. At West Coast Division, samplings were done at Kampung Raganan, Mengkabong (6°9'6.2" N 116°12'26.2" E) in Tuaran District, Kampung Tarab, Bongawan (5°32'4.5" N 115°51'14.4" E) in Papar District and Kampung Paginatan (5°45'59.5" N 116°49'14.3" E) in Ranau District. At Kudat Division, samplings were carried out at Kampung Tiga Papan (7°0'9.1" N 116°45'0.8" E) and Bavanggazo Longhouse (6°45'33.4" N 116°41'29.1" E), both in Kudat District, Kampung Datong (6°46'30" N 117°7'00" E) and Kampung Rosob Laut (6°43'15" N 116°58'45" E), both in Pitas District as well as Kampung Tandek (6°31'15" N 116°50'45" E) in Kota Marudu District. All the sites are flat lowlands with altitude less than 100 m above sea level. The sites are surrounded by secondary growth, grassy fields, marshes and cultivated land, i.e. paddy fields.

Sampling Dates and Duration

Samplings were done on eight different visits between 13 December 2000 and 28 April 2001 with four days spent on each visit (Table 1).

Sampling and Preservation Procedures

The same procedures were employed at all sites. Samplings were done at night by two to four people for four hours from 20:00h onwards. Opportunistic examination was conducted on vegetations, paddy fields, marshes, temporary ponds and pools, puddles, seepages, tree stumps, leaf litter, rocks on paths as well as man-made structures. Frogs were also located by their calls and eye shines due to reflection from torchlights and headlamps. These are standard sampling methods for arboreal, terrestrial and riparian frogs (e.g., Inger, 1980; Andreone *et al.*, 1998; Klemens, 1998). Frogs were captured by hand and each put into a separate, clean and transparent plastic bag to be kept overnight.

Table 1. Sampling dates and duration for each visit.

No. of Visit	Locality	Date	Duration (Days)
1	Kampung Raganan, Mengkabong	13 ~ 16 December 2000	4
2	Kampung Tarap, Bongawan	10 ~ 13 January 2001	4
3	Kampung Paginatan	5 ~ 8 February 2001	4
4	Kampung Tiga Papan	5 ~ 8 March 2001	4
5	Bavanggazo Longhouse	9 ~ 12 March 2001	4
6	Kampung Datong	16 ~ 19 April 2001	4
7	Kampung Rosob Laut	21 ~ 24 April 2001	4
8	Kampung Tandek	25 ~ 28 April 2001	4

On the following day, the frogs were identified based on Inger & Stuebing (1997), recorded (frogs observed but not captured were also recorded) and photographed. They were killed in a chlorobutanol solution so that they remained soft to ease positioning. Specimens were properly positioned in flat Tupperware® containers or aluminium trays layered with tissue paper (soaked with 10% formalin) and sprayed with 10% formalin with a syringe. Fleishy specimens were injected with the same chemical into the abdominal cavities, throats and limbs. The specimens were left overnight and subsequently, hardened specimens were fixed in 10% formalin.

All collected specimens were deposited at BORNEENSIS, specimens collection centre of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. All specimens were assigned unique BORNEENSIS identification numbers. Specimens are kept in 70% ethanol in air tight specimen jars.

RESULTS AND DISCUSSION

Accumulatively, 11 species of frogs representing three families were recorded (Table 2). The species were from Microhylidae

(one species), Ranidae (six species) and Rhacophoridae (four species) with 96 specimens sampled and individuals of two species observed. Except for Kampung Tarap with records from three families, every site denoted records from just two families. Records for Kampung Raganan differed from other sites in where rhacophorids were absent, and together with the records for Kampung Tarap displayed discrepancy from the others in where there were records from Microhylidae.

It is acknowledged that the inventory is not complete as the sampling durations were short. As a result, the diversity and abundance of frog species recorded are vulnerable to weather influence (precipitation), natural fluctuations of frogs over time (months and years), variations within habitats and disparities among species in breeding activities (as agglomeration and calls during breeding times gravely expose the frogs to collectors) (Inger, 2003). Nevertheless, the general topography and vegetation of the sampling sites are very similar. Hence, the inventory yielded is still valid for ecological and distributional discussion.

Borneo houses nine commensal species of frogs: species that live in the vicinity of

Table 2. Frogs recorded from eight populated localities at West Coast and Kudat Divisions, Sabah, Malaysia.

Family	Species	Locality								Total Specimen
		Kampung Raganan	Kampung Tarab	Kampung Paginatan	Kampung Tiga Papan	Bavangazo Longhouse	Kampung Datang	Kampung Rosob Laut	Kampung Tandek	
MICROHYLIDAE	<i>Kaloula pulchra</i> Gray, 1831	3 specimens	1 specimen	-	-	-	-	-	-	4
RANIDAE	<i>Fejervarya cancrivora</i> (Gravenhorst, 1829)	-	-	-	1 specimen	-	4 specimens	3 specimens	1 specimen	9
	<i>Fejervarya limnocharis</i> (Gravenhorst, 1829)	4 specimens	1 specimen	4 specimens	2 specimens	Observed	9 specimens	4 specimens	2 specimens	26
	<i>Limnonectes kuhlii</i> (Tschudi, 1838)	-	-	1 specimen	-	5 specimens	-	-	-	6
	<i>Occidozyga batuensis</i> (Boulenger, 1896)	-	-	-	-	-	1 specimen	-	-	1
	<i>Rana chalconota</i> (Schlegel, 1837)	-	-	-	-	Observed	-	-	-	Observed
	<i>Rana erythraea</i> (Schlegel, 1837)	1 specimen	14 specimens	5 specimens	1 specimen	Observed	3 specimens	2 specimens	-	26
RHACOPHORIDAE	<i>Phyllotritus hostii</i> (Boulenger, 1895)	-	1 specimen	-	-	-	-	-	-	1
	<i>Polypedates leucomystax</i> (Gravenhorst, 1829)	-	1 specimen	1 specimen	6 specimens	3 specimens	1 specimen	8 specimens	1 specimen	21
	<i>Polypedates otilophus</i> (Boulenger, 1893)	-	1 specimen	-	-	1 specimen	-	-	-	2
	<i>Rhacophorus angulirostris</i> Ahi, 1927	-	-	-	-	Observed	-	-	-	Observed
Total Species (Total Specimen)		3 (8)	6 (19)	4 (11)	4 (10)	7 (9)	5 (18)	4 (17)	3 (4)	11 (96)

humans or in severely disturbed habitats (Inger & Stuebing, 1997; Inger & Voris, 2001; Malkmus *et al.*, 2002). The species are *Bufo melanostictus* Schneider, 1799 (Bufonidae), *Kaloula baleata* (Müller, 1836), *Kaloula pulchra* Gray, 1831 (Microhylidae), *Fejervarya cancrivora* (Gravenhorst, 1829), *Fejervarya limnocharis* (Gravenhorst, 1829), *Hoplobatrachus rugulosus* (Wiegmann), *Rana erythraea* (Schlegel, 1837), *Rana nicobariensis* (Stoliczka, 1870) (Ranidae) and *Polypedates leucomystax* (Gravenhorst, 1829) (Rhacophoridae). Some of the species even depend solely on humans to create the suitable habitats and are completely absent in forests, such as *Bufo melanostictus*, *Kaloula pulchra*, *Fejervarya limnocharis*, *Hoplobatrachus rugulosus* and *Rana erythraea*. The species were introduced to Borneo within the past few thousand years, all unintentionally except for *Hoplobatrachus rugulosus*, which was imported from Taiwan into Sabah in the 1970s for meat (Inger & Stuebing, 1997; Inger & Voris, 2001).

Of the 11 species recorded, five were human commensals, namely *Kaloula pulchra*, *Fejervarya cancrivora*, *Fejervarya limnocharis*, *Rana erythraea* and *Polypedates leucomystax*. Specimens of these species constituted approximately 90% ($n = 96$) of the total specimens of which 85% ($n = 86$) were from *Fejervarya limnocharis*, *Rana erythraea* and *Polypedates leucomystax*. The scarcity of *Kaloula pulchra* sampled is rather puzzling as it is one of the rigid commensal species. All the sampling sites do not lack stagnant water bodies required for eggs laying. *Polypedates leucomystax* is a forest edge species that is more ubiquitous in disturbed habitats. Nonetheless, it was sampled in all eight sites making it the most evenly sampled species in this study, to be followed by *Fejervarya limnocharis* and *Rana erythraea* that are strictly human commensals.

The absence of *Hoplobatrachus rugulosus*, *Rana nicobariensis* and *Kaloula baleata* in the inventory is another puzzle. The population of *Hoplobatrachus rugulosus* could be pressured due to harvesting by local people for consumption and trading as interviews with the local people revealed that indeed the species is consumed by the Dusuns at Kampung Paginatan (including *Rana erythraea*), Rungus at Bavanggazo Longhouse as well as Orang Sungai at Kampung Datong. The Muslim Bruneis and Bajaus at the rest of the sampling sites collect the frogs too, but for Chinese buyers who are willing to pay lucratively on a weekly basis. Ethnozoological studies should be carried out at such localities to better understand and elucidate the effects of consumption and collection for trading by local people on *Hoplobatrachus rugulosus* and even other frog species. As tacitly known, *Hoplobatrachus rugulosus* has been one of the ultimate worries among herpetologists since its introduction into Sabah pertaining to the ecological repercussions on indigenous species.

On the other hand, the absence of *Bufo melanostictus* is dichotomous with the case of the three earlier mentioned species. The bufonids are widespread in Sarawak and Kalimantan in Borneo as well as Peninsular Malaysia. The species can be found particularly under street lights patiently waiting for falling insects or more glumly, as flattened road kills. The dispersal of the species is slow and therefore, it has only been sampled at Kampung Kibunut, West Coast Division, Sabah (Inger & Stuebing, 1997). However, the status quo is very likely to change when more and longer samplings are carried out.

Intriguingly, the inventory encompassed six non-commensal species: *Limnonectes kuhlii*, *Occidozyga baluensis*, *Rana chalconota*

(Ranidae), *Philautus hosii*, *Polypedates otitophus* and *Rhacophorus angulirostris* (Rhacophoridae). The number of specimens from these species accounted for about 10% ($n = 96$) of the total inventory. Two species, *Limnonectes kuhlii* and *Polypedates otitophus*, were sampled at two sites each while the other four were recorded from one site each with *Rana chalconota* and *Rhacophorus angulirostris* were observed. *Rhacophorus angulirostris* was previously known only from primary forests higher than 500 m above sea level (Inger & Stuebing, 1997; Malkmus *et al.*, 2002). Specimens of *Limnonectes kuhlii* contributed 60% ($n = 10$) of the total specimens for non-commensal species.

Endemism of the frog species recorded at the eight populated localities was 18% (two endemic species out of 11 species). *Occidozyga baluensis* and *Philautus hosii* are endemic to Borneo with the former having Gunung Kinabalu, Sabah and the latter having Batang Patah, Sarawak as type locality respectively (Inger & Stuebing, 1997; Malkmus *et al.*, 2002). Surprisingly, the endemism level surpasses the 14% reported at four peat swamps in Borneo (Inger *et al.*, 2005).

Locality analysis revealed that Bavanggazo Longhouse had the most species recorded with three species sampled and four others observed, although the number of specimens was low. The same locality also had the most non-commensal species recorded: *Limnonectes kuhlii*, *Rana chalconota*, *Polypedates otitophus* and *Rhacophorus angulirostris*. As Bavanggazo Longhouse is a touristic site, there is fervent possibility that frogs and 'frogging' to see, admire, enjoy and learn more about these enchanting organisms could be researched on and promoted under a new nature tourism product, named 'Anurans Tourism', at the locality and eventually, throughout Sabah. Nature tourism is one of the most feasible tools for conservation in the

contemporary setting to synergize the necessary economic demand and crucial environmental conservation in the least destructive manner (Kueh, 2004b).

This paper does not support unplanned and excessive land conversion into human settlements at all. However, human settlements have existed and shall inevitably be augmented proportional to human population expansion. As much as conservationists and environmentalists are obligated to thoroughly understand and reveal the diversity and abundance of frogs in protected areas for conservation, similar effort needs to be devoted to populated localities. Populated localities encase forest and forest edge species of frogs as well, besides the expected commensal species. So, is it an assemblage of merely commensal species at populated localities? Absolutely not.

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