Species composition of Amphibians and Reptiles in Krau Wildlife Reserve, Pahang, Peninsular Malaysia

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INTRODUCTION

The Krau Wildlife Reserve (KWR) is situated at the east of the Malaysian Main Range (= Titiwangsa Range) and near the basin of Gunung Benom in the Malaysian state of Pahang. This reserve covers an area of 624 km², which makes it the third largest protected area in Peninsular Malaysia. The highest peak within the reserve is Gunung Benom (2,108 m), the third highest mountain in Peninsular Malaysia. Inventories and surveys on the herpetofauna in KWR have commenced since 1972 when the first expedition to Gunung Benom was conducted (Grandison 1972). Since then, other studies have been conducted at various stations within the reserve, such as at Sg. (=River) Chenderoh (Jasmi et al. 1999), Bukit Rengit (Salman et al. 1999; Norsham et al. 2001; Ahmad Shukri 2004; Grace 2006), and Kuala Gandah (Chan et al. 2008). These studies, however, were isolated in manner. It is not easy to estimate the actual biodiversity of amphibians as a whole, but diversity of amphibians in KWR has been believed to be relatively well studied based on the many studies listed above. However, this assumption has proven to be erroneous as re-analyses of faunal diversity using different methods (eg. molecular techniques) have resulted in the revision and addition of many new taxa whose status was previously based on morphology (Grandison 1972).

Molecular techniques for associating adult and larval forms of some anurans have resulted in numerous novel species descriptions (Shimada et al. 2007a), while others have been synonymized (Matsui et al. 2007a), resurrected (Matsui et al. 2007) or revised under a different nomen (Chan and Grismer 2010). Another method that was used to delimit species boundaries is acoustic characteristics that can be used as a proxy for reproductive isolation. Two new amphibian species were recently described from the Peninsular Malaysia using this technique (Matsui et al. 2009; Matsui 2009). This paper provides an overview of the herpetofauna of KWR, with additional data based on an intensive 12 month period of drift-fenced pitfall trappings and visual encounter surveys of amphibians at Kuala Gandah field station (one of the five field stations in KWR) and with some notes on revised taxa, ecology, and distribution of the less common species based on compilation of species list from all previous studies in KWR. Knowledge of species richness and community structures is important for conservation and governance on sustainable management of the environment. Such clarification is required to focus effort at crucial areas such as areas with high density of rare species, and areas that are threatened by landscape alteration to initiate mitigation process. Thus, the objectives of this study were to: (1) to document species richness in the region from past and current studies with notes on their current taxonomic status. (2) to examine patterns of community structure and composition, (2) to document taxa occurring species richness in the region from past and current studies with notes on their current taxonomic status.

MATERIALS AND METHODS

Study Area

KWR is predominantly covered with lowland dipterocarp forests at the east and highland forests at the west. The reserve is drained by three major river systems, Sg. Krau, Sg. Lompat, and Sg. Teris. The landscape ranges from flat lowlands to undulating hilly terrain, with altitude ranges of 43 – 2,107 m. The reserve was established in 1923, starting with a total area of 552 km². It was regazetted twice in 1965 and 1968 until it reached its present size of 624 km² (Perhilitan/Danced 2001). The average annual
rainfall is about 2000 mm and the daily temperature fluctuates between a minimum of 23°C to a maximum of 33°C. There are five stations within this reserve, all of which are under the management and administration of the Department of Wildlife and National Parks (DWNP) or PERHILITAN: Kuala Lompat Research Station (KL), Lubuk Baung (LB), Kuala Sungai Serloh (KS), Kuala Gandah (KG), and Jenderak Selatan (JS).

**Study site**

The study focused on Kuala Gandah (3°36′00″ N, 102°09′04″ E) (Figure 1), which is located at the south of KWR, where the National Elephant Conservation Centre is also located. Permission to study here was granted by the DWNP. There are several villages of the indigenous Orang Asli Che Wong (Che Wong tribe) villages in the area, with a total of 45 households around the reserve (Haemamalar et al. 2010). The Che Wong is of the Senoi sub-group, who resides mainly in the forest of Pahang state in Peninsular Malaysia. They depend substantially on forest produce. Other tribes that live here are Temuan and Jah Hut. They maintain many narrow motorbike trails in the reserve as their means of travelling in and out of the forest to the nearest town to get supplies. Some of these trails are included in the plot.

**Method**

Survey methods include drift-fenced pitfall trapping, diurnal and nocturnal censuses, and opportunistic searches. A total of 126 traps were set up in a 400 x 400 m grid (Figure 2). The grid was further subdivided into 16 sub-grids, each measuring 100 x 100 m. A total of 9 traps were set upper line in this subgrid, with a distance of 5 m between traps. Galvanized metal drift fences 0.3 m in height were buried ~5 cm below soil surface to prevent animals from burrowing under them. Pitfall traps consist of 18-L plastic buckets (0.5 m deep and 0.2 m in diameter) (Figure 3). Drain holes were punched at the bottom of each bucket and buried flush with the ground surface, with the drift fence overhanging the lip of each pitfall trap. The traps were opened for 7 continuous days each month for 12 consecutive months and were examined once a day before noon.

The visual encounter survey procedure consisted of active searching for animals using wide-beam headlights at a steady pace within a constrained area along the trails at a specific time at night, usually within the first 2-4 h after dark fall (Table 1). Surveys were conducted for 7 continuous days per month for 12 months. Time spent surveying depended on the density of animals per unit area, based on the pit-fall collection. Animals were caught by hand and brought back for measurements.

Voucher specimens for most taxa were collected to aid the identification of unknown taxa and to collect tissue samples for taxonomic groups requiring further taxonomic resolution. All specimens are deposited at the Institute of Biodiversity, DWNP, Bukit Rengit, KWR. Taxonomic nomenclature follows the Amphibian Species of the World 5.3 by the American Museum of Natural History (http://research.amnh.org/herpetology/amphibia/), last accessed on 5 June 2009. Taxonomy for *Hemidactylus* follows Carranza and Arnold (2006); *Draco* taxonomy follows (Manthey 2008).
Figure 2. The 400 x 400 m grid at Kuala Gandah where the traps were laid along 14 designated lines A to N.

Figure 3. A line where 9 pitfall traps were laid every 5 m apart along the fence.

Table 1. The dates of pitfall trappings and visual encounter surveys (VES).

| MONTH | PITFALL TRAPPING | VES         |
|-------|------------------|-------------|
| Aug 2009 | 19 - 25 Aug 2009 | 25 - 31 Aug 2009 |
| Sep | 11 - 17 Sep 2009 | 05 - 11 Sep 2009 |
| Oct | 15 - 21 Oct 2009 | 22 - 28 Oct 2009 |
| Nov | 02 - 08 Nov 2009 | 15 - 21 Nov 2009 |
| Dec | 16 - 22 Dec 2009 | 09 - 15 Dec 2009 |
| Jan 2010 | 19 - 25 Jan 2010 | 25 - 31 Jan 2010 |
| Feb | 22 - 28 Feb 2010 | 15 - 21 Feb 2010 |
| Mar | 01 - 07 Mar 2010 | 07 - 13 Mar 2010 |
| Apr | 24 - 30 Apr 2010 | 15 - 21 Apr 2010 |
| May | 21 - 27 May 2010 | 13 - 19 May 2010 |
| Jun | 22 - 28 Jun 2010 | 15 - 21 Jun 2010 |
| Jul | 17 - 23 Jul 2010 | 22 - 28 Jul 2010 |

Results and Discussion

A total of 1,045 individuals were obtained, comprising 13 families and 38 species (Table 2). The total frogs was 929, comprising 6 families and 24 species; Bufonidae (2 species), Dicroglossidae (6 species), Megophryidae (3 species), Microhylidae (6 species), Ranidae (6 species) and Rhacophoridae (1 species). For reptiles, a total of 116 individuals were sampled, comprising 7 families and 14 species: Agamidae (2 species), Bataguridae (1 species), Colubridae (2 species), Gekkonidae (2 species), Scincidae (4 species), Typhlopidae (1 species) and Varanidae (2 species). The most sampled anuran species were Micryletta inornata (about 45% of the total amphibians), followed by Ingerophrynus parvus (19%), and Megophrys nasuta (6%). Among the reptiles, Cyrtodactylus quadririrgatus was the most frequently sampled (29% of the total reptiles), followed by Ansonia fusca (27%) and Eutropis multifasciata (18%).

The species accumulation curve shown in Figure 4 reflects the same scenario in most studies of vertebrate communities in which the curve rises steeply at first and levels off in later samples as increasingly rare taxa are added (Gotelli and Colwell 2001). Meanwhile, the asymptote point shows the estimated species richness in the area of study was 38. The species accumulation curve showed no leveling off into an asymptote, suggesting that our sampling did not represent the true species richness in the area.

The total number of amphibian species from Krau Wildlife Reserve includes five that were recently revised and one new locality record. The revised taxa are: Hylarana labialis (previously H. raneiceps: Inger et al. 2009), H. picturata (previously H. signata: Brown and Guttman 2002), Ansonia latiffi (previously A. leptopus: Wood et al. 2008), and Microhyla mantheyi (previously M. borneensis: Das et al. 2007); and Rhacophorus norhayatae (previously R. reinwardtii: Chan and Grismer 2010). From the current study, Ingerana tenasserimensis (Ranidae) represents new locality record for KRW.

Gonocephalus bornensis (Schlegel, 1848) was included in the list by Grandison (1972), but it is not known to occur in Peninsular Malaysia (Grismer 2011). It is reported from Indonesian Borneo (de Rooij 1915), Sabah and Sarawak (Das 2004), and Thailand, but reported only once near the border of Surat Thani and Nakhon Si Thammarat (fide Taylor 1963). Thus, this species is omitted from the current list. Cnemaspis affinis (Stoliczka, 1870) has been restricted to Penang Island (Grismer et al. 2008), and thus, C. affinis reported by Grandison (1972) should be assigned to Cnemaspis flavolineata (fide Grismer et al. 2008). Cyrtodactylus marmoratus is not known to occur in Malaysia (Grismer 2011), and thus, omitted from the current list. From the current study, there are four reptile species of new locality records for KRW: Varanus dumerilii (Varanidae), Ramphotyphlops braminus (Typhidiidae), Dryocalamus subannulatus (Colubridae) and Heosemys spinosa (Bataguridae).

Referring to Table 3, Rana chalconota (indicated by asterisks) was recently resolved at the species level to be Hylarana labialis (Inger et al. 2009). Draco fimbriatus Kuhl, 1820 and Draco punctatus Bouleneger, 1912 are actually synonyms. Meanwhile, those indicated by the symbol ^ were reexamined and described as new species, such as Ansonia (leptopus) latiffi (Wood et al. 2008), Rhacophorus (reinwardtii) norhayatae (Chan and Grismer 2010) and Microhyla (borneensis) mantheyi (Das et al. 2007).

The latest publication on the herpetofauna of Krau was by Chan et al. (2008), in which many new records were obtained using pit-fall traps, which captured numerous ground-dwelling frog species, such as Ingerophrynus quadriporcatus, Limnonectes paramacrodon, L. malesianus, Kaloula balearia, Leptobrachium nigrops, Calluella minuta, Kalophrynus palmatissimus, Microhyla mantheyi, Micryletta inornata, Hylarana siberu and H. laterimaculata. The current study, which also used pit-fall method,
### Table 2. Species and relative abundance of amphibians and reptiles sampled at Kuala Gandah, Krau Wildlife Reserve, Pahang (numbers in brackets are in percentages).

| NO. | TAXA                              | VOUCHER NO. | PITFALL | VES | TOTAL  |
|-----|-----------------------------------|--------------|---------|-----|--------|
|     | **Order Anura**                   |              |         |     |        |
|     | Bufonidae                          |              |         |     |        |
| 1   | *Ingerophrynus parvus*             | UKMHC065     | 147     | 27  | 174 (18.7) |
| 2   | *Ingerophrynus quadriporcatus*     | UKMHC066     | 43      | 0   | 43 (4.6) |
|     | Dicroglossida                      |              |         |     |        |
| 3   | *Fejervarya limnocharis*           | UKMHC067     | 15      | 8   | 23 (2.5) |
| 4   | *Limnonectes blythii*              | UKMHC068     | 1       | 11  | 12 (1.3) |
| 5   | *Limnonectes kuhlii*               | UKMHC069     | 1       | 0   | 1 (0.1)  |
| 6   | *Limnonectes paramacronodon*       | UKMHC070     | 1       | 0   | 1 (0.1)  |
| 7   | *Limnonectes plicatellus*          | UKMHC071     | 12      | 0   | 12 (1.3) |
| 8   | *Occidozyga laevis*                | UKMHC072     | 30      | 12  | 42 (4.5) |
|     | Megophryidae                       |              |         |     |        |
| 9   | *Leptobrachium nigrops*            | UKMHC073     | 0       | 3   | 3 (0.3)  |
| 10  | *Megophrys nasuta*                 | UKMHC074     | 49      | 4   | 53 (5.7) |
| 11  | *Xenophrys aceras*                 | UKMHC075     | 1       | 0   | 1 (0.1)  |
|     | Microhylidae                       |              |         |     |        |
| 12  | *Calliella minuta*                 | UKMHC076     | 0       | 30  | 30 (3.2) |
| 13  | *Kalophrynus palmatissimus*        | UKMHC077     | 4       | 0   | 4 (0.4)  |
| 14  | *Kalophrynus pleurostigma*         | UKMHC078     | 3       | 0   | 3 (0.3)  |
| 15  | *Kaloula baleata*                  | UKMHC079     | 41      | 0   | 41 (3.3) |
| 16  | *Kaloula pulchra*                  | UKMHC080     | 0       | 12  | 12 (1.3) |
| 17  | *Micryletta inornata*              | UKMHC081     | 413     | 0   | 413 (44.5) |
|     | Ranidae                            |              |         |     |        |
| 18  | *Hylarana erythraea*               | UKMHC082     | 0       | 13  | 13 (1.4) |
| 19  | *Hylarana nicobariensis*           | UKMHC083     | 0       | 3   | 3 (0.3)  |
| 20  | *Hylarana labialis*                | UKMHC084     | 0       | 13  | 13 (1.4) |
| 21  | *Hylarana laterimaculata*          | UKMHC085     | 10      | 0   | 10 (1.1) |
| 22  | *Hylarana picturata*               | UKMHC086     | 5       | 11  | 16 (1.7) |
| 23  | *Ingerana tenasserimensis*         | UKMHC087     | 1       | 0   | 1 (0.1)  |
|     | Rhacophoridae                      |              |         |     |        |
| 24  | *Polypedates leucomystax*          | UKMHC088     | 0       | 5   | 5 (0.5)  |
|     | **Total Order Anura**              |              | **777 (83.6)** | **152 (16.4)** | **929 (100)** |
|     | Orders Squamata and Testudines     |              |         |     |        |
|     | Agamidae                           |              |         |     |        |
| 25  | *Aphiophis fusca*                  | UKMHC089     | 31      | 0   | 31 (26.7) |
| 26  | *Draco melanopogon*                | UKMHC090     | 1       | 0   | 1 (0.9)  |
|     | Gekkonidae                         |              |         |     |        |
| 27  | *Cyrtodactylus quadrivirgatus*     | UKMHC091     | 34      | 0   | 34 (29.3) |
| 28  | *Onnaspis kendallii*               | UKMHC092     | 6       | 0   | 6 (5.2)  |
|     | Colubridae                         |              |         |     |        |
| 29  | *Calamaria lumbricoidea*           | UKMHC093     | 1       | 0   | 1 (0.9)  |
| 30  | *Dryocalamus sabotanulatus*        | UKMHC094     | 2       | 0   | 2 (1.7)  |
|     | Typhlopidae                        |              |         |     |        |
| 31  | *Ramphotyphlops braminus*          | UKMHC095     | 5       | 0   | 5 (4.3)  |
|     | Scincidae                          |              |         |     |        |
| 32  | *Eutropis multifasciata*           | UKMHC096     | 21      | 0   | 21 (18.1) |
| 33  | *Lipinia vittigera*                | UKMHC097     | 1       | 0   | 1 (0.9)  |
| 34  | *Lygosoma bowringii*               | UKMHC098     | 2       | 0   | 2 (1.7)  |
| 35  | *Sphenomorphus cyanolaemus*        | UKMHC099     | 3       | 0   | 3 (2.6)  |
|     | Varanidae                          |              |         |     |        |
| 36  | *Varanus dumerili*                 | UKMHC100     | 3       | 0   | 3 (2.6)  |
| 37  | *Varanus salvator*                 | UKMHC101     | 1       | 0   | 1 (0.9)  |
|     | Bataguridae                        |              |         |     |        |
| 38  | *Heosemys spinosa*                 | UKMHC102     | 5       | 0   | 5 (4.3)  |
|     | **Total Orders Squamata and Testudines** | **116 (100.0)** | **0 (0.0)** | **116 (100)** |
|     | **Grand Total**                    |              | **893 (85.5)** | **152 (14.5)** | **1045 (100.0)** |
managed to obtain another additional record, which is *Ingerana tenasserimensis* (Ranidae). From the latest checklist provided in Table 3, there are now 61 species of amphibians and 68 species of reptiles recorded in KWR, which are approximately 56% and 24% of the total number of species recorded from Peninsular Malaysia, respectively.

Habitat loss of many organisms is still occurring in vast areas of tropical Asia including Malaysia. Herpetofaunal diversity, especially of frogs, that are well-known environmental indicators, can provide valuable data usable for environmental conservation relating to the monitoring of biological diversity in Malaysia. This updated checklist can serve as a starting point to help future researchers form long-term strategies in response to habitat and climate change.

Figure 4. Accumulation graph of average Species Richness Index of herpetofauna sampled using the pit-fall traps.

Table 3. Updated and revised checklist of herpetofauna of Krau Wildlife Reserve, Lanchang, Pahang.

| No. | Family/Species | Grandison (1972) | Norskim et al. (2001) | Jasmi et al. (1999) | Salman et al. (1999) | Lim, B. L. 1999 | Grace (2006) | Chan et al. (2008) | Grismer (2011) | This study |
|-----|----------------|------------------|-----------------------|---------------------|----------------------|----------------|---------------|-----------------|---------------|------------|
| 1   | Caudacaecilia nigroflava (Taylor 1960) | + | | | | | | | | |
| 2   | Ichthyophis glutinosus (Linnaeus, 1758) | + | | | | | | | | |
| 3   | Ansonia latiflora Wood, Grismer, Ahmad & Senawi, 2008^ | + | | | | | | | | |
| 4   | Duttaphrynus melanostictus (Schneider, 1799) | + | + | + | + | | | | |
| 5   | Ingerophrynus parvus (Boulenger, 1887) | + | + | + | + | + | | | |
| 6   | Ingerophrynus quadripporus (Boulenger, 1887) | + | + | | | | | | |
| 7   | Leptophryne borbonica (Tschudi, 1838) | + | | | | | | | |
| 8   | Pedostibes hosii (Boulenger, 1892) | + | + | | | | | | |
| 9   | Pelophryne signata (Peters, 1867) | + | + | | | | | | |
| 10  | Phrynoidis aspera (Gravenhorst, 1829) | + | + | + | + | + | | | |
| 11  | Fejervarya cancrivora (Gravenhorst, 1829) | + | | | | | | | |
| 12  | Fejervarya limnocharis (Gravenhorst, 1829) | + | + | + | + | + | | | |
| 13  | Limnonectes blythii (Boulenger, 1920) | + | + | + | + | + | | | |
| 14  | Limnonectes kuhlii (Tschudi, 1838) | + | + | | | | | | |
| 15  | Limnonectes laticeps (Boulenger, 1882) | + | + | | | | | | |
| 16  | Limnonectes malesianus (Kiew, 1984) | + | | | | | | | |
| 17  | Limnonectes paramerodon (Inger, 1966) | + | + | | | | | | |
| 18  | Limnonectes plicatellus (Stoliczka, 1873) | + | + | + | | | | | |
Table 3. Continued.

| No. | Family/Species | Grandison (1972) | Norsham et al. (2001) | Jasmi et al. (1999) | Slamani et al. (1999) | Lim, B. L. 1999. | Grace (2006) | Chan et al. (2008) | Grismer (2011) | This study |
|-----|----------------|------------------|----------------------|-------------------|---------------------|-----------------|----------------|------------------|----------------|-----------|
| 19  | Limnonectes tweediei (Smith, 1935) | +                |                      |                   |                     |                 |                |                   |                 |           |
| 20  | Occidozyga laevis (Günther, 1858) | +                | +                    | +                 | +                   |                 |                |                   |                 |           |

**Megophryidae**

21 Leptobrachium hendecksoni Taylor, 1962
22 Leptobrachium nigrops Berry & Hendrickson, 1963
23 Leptolalax gracilis (Günther, 1872)
24 Leptolalax heteropus (Boulenger, 1900)
25 Megophrys nasuta (Schlegel, 1858)
26 Xenophrys acerus (Boulenger, 1903)

**Microhylidae**

27 Caliella minuta Das, Yaakob & Lim, 2004
28 Chaperina fusca Mocquard, 1892
29 Kalophrynus palmatissimus Kiew, 1984
30 Kalophrynus pleurostigma Tschudi, 1838
31 Kaloula baleata (Müller in Van Oort & Müller, 1833)
32 Kaloula pulchra (Gray, 1831)
33 Metaphrynella pollicaris (Boulenger, 1890)
34 Microhyla annectans Boulenger, 1900
35 Microhyla berdmorei (Blyth, 1856)
36 Microhyla butleri Boulenger, 1900
37 Microhyla heymonsi Vogt, 1911
38 Microhyla mantheyi Das, Yaakob & Sukumaran, 2007*
39 Micryletta inornata (Boulenger, 1890)
40 Phrynella pulchra Boulenger, 1887

**Ranidae**

41 Amolops larutensis (Boulenger, 1899)
42 Humerana miopus (Boulenger, 1918)
43 Hylarana erythraea (Schlegel, 1837)
44 Hylarana glandulosa (Boulenger, 1882)
45 Hylarana labialis (Boulenger, 1887)*
46 Hylarana laterimaculata (Barbour & Noble, 1916)
47 Hylarana lucuosa (Peters, 1871)
48 Hylarana nicobariensis (Stoliczka, 1870)
49 Hylarana picturata (Boulenger, 1920)
50 Ingerana tenasserimensis (Sclater, 1892)
51 Odorrana hosii (Boulenger, 1891)

**Rhacophoridae**

52 Philautus petersi (Boulenger, 1900)
53 Philautus vermiculatus (Boulenger, 1900)
54 Polypedates colletti (Boulenger, 1890)
55 Polypedates leucomystax (Graevenhorst, 1829)
56 Polypedates macropis (Boulenger, 1891)
57 Rhacophorus appendiculatus (Günther, 1858)
58 Rhacophorus nigropalmatus Boulenger, 1895
59 Rhacophorus pardalis Günther, 1858
60 Rhacophorus prominentus Smith, 1924
61 Rhacophorus norhayatae Chan & Grismer 2010*

**LACERTILIA (Lizards, geckos, skinks, varanids)**

**Agamidae**

1 Aphanotis fusca (Peters, 1864)
2 Bronchocela cristatella (Kuhl, 1820)
3 Gonocephalus bellii (Duméril & Bibron, 1837)
4 Gonocephalus liogaster (Günther, 1872)
Table 3. Continued.

| No. | Family/Species                                      | Grandison (1972) | Norsham et al. (2001) | Jasmi et al. (1999) | Salim et al. (1999) | Lim, B. L. (1999) | Grace (2006) | Chan et al. (2008) | Grismer (2011) | This study |
|-----|-----------------------------------------------------|-------------------|-----------------------|---------------------|---------------------|-------------------|--------------|-------------------|---------------|-------------|
| 5   | *Draco abbreviatus* Hardwicke & Gray, 1827          | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 6   | *Draco blanfordi* Boulenger, 1885                   | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 7   | *Draco fimbriatus* Kuhl, 1820                       | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 8   | *Draco formosus* Boulenger, 1887                    | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 9   | *Draco maximus* Boulenger, 1893                     | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 10  | *Draco melanopogon* Boulenger, 1887                 | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 11  | *Draco fimbriatus* Kuhl, 1820                       | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 12  | *Draco quinquefasciatus* Hardwicke & Gray, 1827     | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 13  | *Draco sumatranus* Schlegel, 1844                   | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 14  | *Pseudocalotes dringi* Hallermann & Böhme, 2000     | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 15  | Varanidae                                           |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 16  | *Varanus dumerili* (Schlegel, 1839)                 | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 17  | *Varanus nebulosus* (Gray, 1831)                    | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 18  | *Varanus rudicollis* (Gray, 1845)                   | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 19  | Gekkonidae                                          |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 20  | *Gekko monochirus* (Schlegel, 1836)                 | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 21  | *Gekko smithii* Gray, 1842                         | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 22  | *Hemidactylus frenatus* Schlegel, 1836              | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 23  | *Hemidactylus platyurus* (Schneider, 1792)          | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 24  | Scincidae                                           |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 25  | *Eutropis multisignata* (Kuhl, 1820)                | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 26  | *Sphenomorphus cyanolaemus* (Gray, 1835)            | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 27  | *Sphenomorphus indicus* (Gray, 1835)                | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 28  | SNAKES                                              |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 29  | Typhlopidae                                         |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 30  | *Ramphotyphlops braminus* (Daudin, 1803)            | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 31  | *Typhlops mulleri* Schlegel, 1839                   | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 32  | Pythonidae                                          |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 33  | *Malayopython reticulatus* (Schneider, 1801)         | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 34  | Colubridae                                          |                   |                       |                     |                     |                   |              |                   | +             | +           |
| 35  | *Boiga cyanodonta* (Boie, 1827)                     | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 36  | *Boiga drapiezii* (Boie, 1827)                      | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 37  | *Calamaria lumbricoidea* Boie, 1827                 | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 38  | *Dendrelaphis formosus* (Boie, 1827)                | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 39  | *Dryocalamus subannulatus* (Duméril, Bibròn & Duméril, 1854) | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 40  | *Gongylosoma baliodeirus* (Peters, 1871)            | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 41  | *Gongylosoma longicauda* (Peters, 1871)             | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 42  | *Lepturophis albofuscus* (Duméril, Bibròn & Duméril, 1854) | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
| 43  | *Lycodon subcinctus* Boie, 1827                     | +                 | +                     | +                   | +                   | +                 | +            | +                 | +             | +           |
Table 3. Continued.

| No. | Family/Species               | Grandison (1972) | Norsham et al. (2001) | Jasi et al. (1999) | Sahman et al. (1999) | Lim, B.B. (1999) | Grace (2006) | Chan et al. (2008) | Grimsler (2011) | This study |
|-----|------------------------------|------------------|-----------------------|-------------------|---------------------|-----------------|--------------|------------------|-----------------|-----------|
| 17  | Macrolamalus jasoni Grandison, 1972 |                  |                       |                   |                     |                 |              |                  |                 |           |
| 18  | Megalagama flaviceps (Duméril, Bibron & Duméril, 1854) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 19  | Macrophistodon rhodomas (Boie, 1827) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 20  | Xenochrophis trianguligerus (Boie, 1827) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 21  | Astenolopas malaccanas Peters,1864 |                  |                       |                   |                     |                 |              |                  |                 |           |
| 22  | Astenolopas vertebralis (Boulenger, 1900) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 23  | Pseudobradon longiceps (Cantor, 1847) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 24  | Pityas korros (Schlegel, 1837) |                  |                       |                   |                     |                 |              |                  |                 |           |

Elapidae

| No. | Family/Species               | Grandison (1972) | Norsham et al. (2001) | Jasi et al. (1999) | Sahman et al. (1999) | Lim, B.B. (1999) | Grace (2006) | Chan et al. (2008) | Grimsler (2011) | This study |
|-----|------------------------------|------------------|-----------------------|-------------------|---------------------|-----------------|--------------|------------------|-----------------|-----------|
| 25  | Calliophis gracilis Gray, 1835 |                  |                       |                   |                     |                 |              |                  |                 |           |
| 26  | Calliophis intestinalis (Laurenti, 1768) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 27  | Bungarus flaviceps Reinhardt, 1843 |                  |                       |                   |                     |                 |              |                  |                 |           |
| 28  | Naja sumatrana (Müller 1890) |                  |                       |                   |                     |                 |              |                  |                 |           |

Viperidae

| No. | Family/Species               | Grandison (1972) | Norsham et al. (2001) | Jasi et al. (1999) | Sahman et al. (1999) | Lim, B.B. (1999) | Grace (2006) | Chan et al. (2008) | Grimsler (2011) | This study |
|-----|------------------------------|------------------|-----------------------|-------------------|---------------------|-----------------|--------------|------------------|-----------------|-----------|
| 29  | Paria sumatranus (Raffles, 1822) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 30  | Popeia fucata (Vogel, Panwels & David, 2004) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 31  | Tropidolaemus wagleri (Boie, 1827) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 32  | Paria hageni (Lithd de Jeude, 1886) |                  |                       |                   |                     |                 |              |                  |                 |           |
| 33  | Trimeresurus wiroti (Boie, 1827) |                  |                       |                   |                     |                 |              |                  |                 |           |

TESTUDINES (Tortoises)

| No. | Family/Species               | Grandison (1972) | Norsham et al. (2001) | Jasi et al. (1999) | Sahman et al. (1999) | Lim, B.B. (1999) | Grace (2006) | Chan et al. (2008) | Grimsler (2011) | This study |
|-----|------------------------------|------------------|-----------------------|-------------------|---------------------|-----------------|--------------|------------------|-----------------|-----------|
| 34  | Heosemys spinosa (Gray, 1830) |                  |                       |                   |                     |                 |              |                  |                 |           |

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