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Herpetofauna of disturbed forest fragments on the lower Mt. Kitanglad Range, Mindanao Island, Philippines

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Abstract. While the knowledge of the Philippine reptiles and amphibians is steadily increasing, there is still a lack of knowledge on the herpetofauna of Mindanao, the second largest island of the country. The herpetofaunal composition of the Mt. Kitanglad Range in north-central Mindanao is only partially known, whereas the relatively extensive but fragmented forest patches along the altitudinal gradient of the range potentially harbour a high number of species. During 12 days in April of 2010, standardized time searches were made at four sites within the municipality of Sumilao in the northern area of the range to record reptiles and amphibians within lowland dipterocarp forest. A total of 22 reptiles (12) and amphibians (10) were found of which 15 constitute new records for the area. The herpetofauna of the Mt. Kitanglad Range Nature Park and surrounding areas is compared to other studied assemblages of reptiles and amphibians in Mindanao. Despite the increase of new records there is still a lack of knowledge on the herpetofauna of the Mt. Kitanglad Range, while forests in the lowland areas support considerable herpetofaunal species diversity but are threatened by habitat modification or disappearance.

Key words. Reptiles, amphibians, new records, lowland dipterocarp forest, disturbance, conservation.

Introduction

The Philippines are one of the global centres of herpetological diversity and endemism (Diesmos et al. 2002). During the current 'fifth research phase' (Brown et al. 2008) of Philippine herpetological history, species numbers have displayed a major increase as a result of integrative taxonomical methods and intensified research. The knowledge on the Philippine reptiles and amphibians is steadily increasing, whilst showing that biogeographical patterns are more complex than traditionally thought (Hall 1996, Brown & Diesmos 2009). However, the Philippine herpetofauna faces severe environmental threats (Diesmos et al. 2002, 2008) that make a comprehensive overview increasingly important.

The herpetofauna of the Mindanao Pleistocene Aggregate Island Complex (PAIC; Samar, Leyte, Biliran, Bohol, Mindanao, Dinagat, Siargao, and smaller associated islands) is still relatively poorly known, not in the least place due to its politically complicated situation and cultural diversity. Additionally, several recent studies concerning reptiles and amphibians of this region have remained unpublished (Delima et al. 2007), leaving significant gaps in knowledge unplugged. Especially on Mindanao, the geographically complex, second largest island of the country, numerous taxa are expected to await discovery (Delima et al. 2006, Nuñeza et al. 2010), whereas several have been described in recent years (e.g., Brown et al. 2009, Siler et al. 2009a, Welton et al. 2010). Habitat destruction, which has resulted in the disappearance of vast tracts of forest, mostly restricting primary forest to mountain ranges or peaks throughout the island, remains a major threat to the herpetofauna of Mindanao. Among other areas, the forests of the Mt. Kitanglad Range (Bukidnon Province, north-central Mindanao) are severely threatened (e.g., Townsend Peterson et al. 2008). The majority of forest occurs from 900–1200 m mostly continuously up to the peaks of the mountain range including the 2938 m high Kitanglad Peak, with a large part of the higher area falling under the protection of the Mt. Kitanglad Range Natural Park (MKRNP; Fig. 1). However, isolated forest fragments located at lower altitudes, which are known to host faunal assemblages not found at high altitudes (e.g., Heaney et al. 2006, Townsend Peterson et al. 2008) are highly threatened with disappearance. The herpetofauna of the Mt. Kitanglad Range has not been studied in detail (but see Heaney & Peterson 1992, Amoroso 2000), resulting in a lack of information on those reptile and amphibian species assemblages in lowland habitats in particular that are able to sustain high herpetological species diversity in Mindanao (e.g., Delima et al. 2007). To provide a contemporary overview of the herpetofauna of the lower Mt. Kitanglad Range, records gathered during April of 2010 are presented here.

Materials and methods

Study sites

From 16 to 28 April 2010, four sites were visited within the Sumilao Municipality, Bukidnon Province, Mindanao (Fig. 1), about 10 km north of the boundary of the MKRNP.

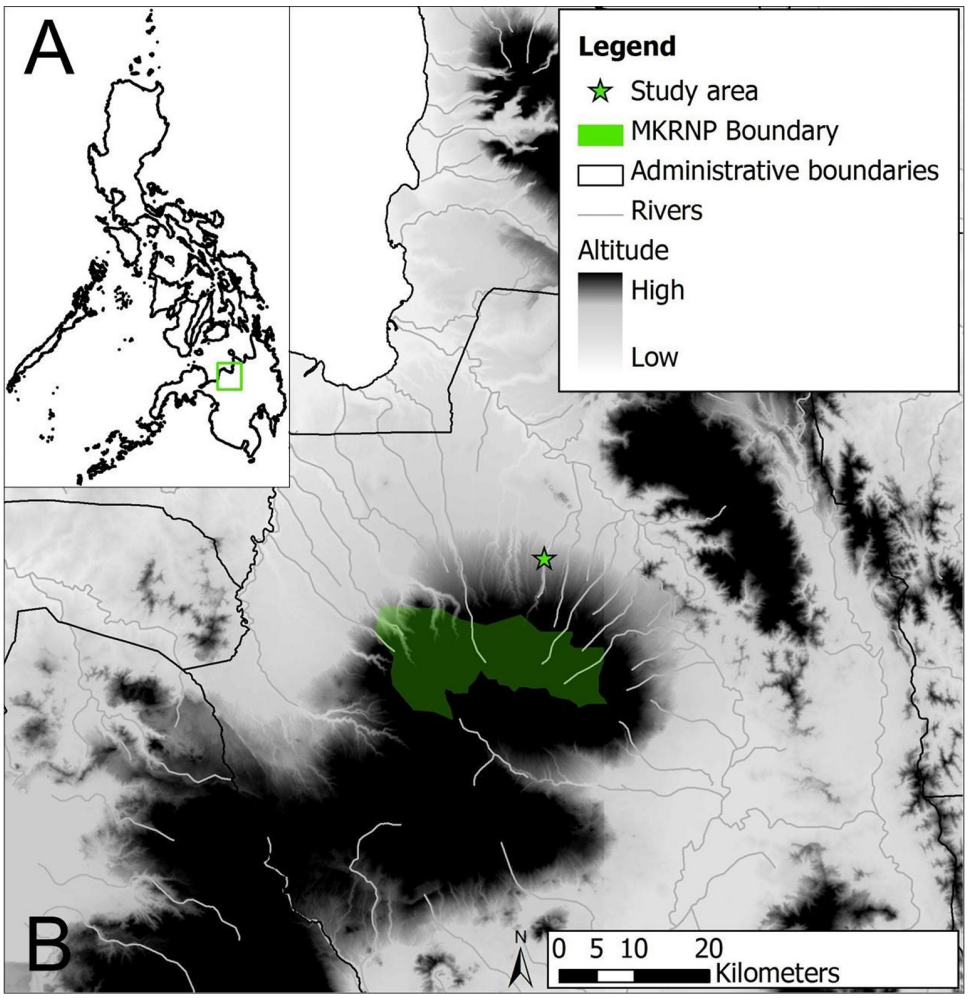

Figure 1. (A) The location of the Mt. Kitanglad Range in the Philippines; (B) Northern Bukidnon with the Mt. Kitanglad Range and the study area. The locations of the study sites at Mt. Kitanglad, Mindanao, Philippines.

The general area consists mainly of cattle pastures, banana- and pineapple plantations, and patches of disturbed lowland dipterocarp forests, which are mostly confined to stream or river valleys. The steep Kulaman River valley divides the area into two parts. Site 1 (8°16' N, 124°56' E, approx. 800 m a.s.l.) is located just west of the town centre of Barangay Poblacion and consists of an approximately 2 m wide, rocky, slow-flowing stream ('Piglarn', Fig. 2A), which runs through highly disturbed lowland forest and banana plantations. Several areas of the stream are flanked by low to moderately high vegetation that provides shade, while most sections running through agricultural land are almost fully exposed to the sun. The stream is occasionally used for washing. Site 2 (8°16'17" N, 124°55'42" E, approx. 690 m a.s.l.) consists of a small (0.5–1 m wide) stream crossing a small footpath southwest of Barangay Poblacion (Fig. 2C), which runs through dense lowland forest with a thick layer of leaf litter and drains into the Kulaman River (Fig. 2B) after several meters. The canopy cover of the small stream at Site 2 is high, while dense vegetation of low to medium height surrounds the stream. Human disturbance is limited to people crossing the stream. The Kulaman River at Site 2 is fast-flowing, approximately 3–4 m wide, and surrounded by disturbed secondary forest. Only minor patches of grasses were present in the river at the time of visit. The river is used by the local population for washing, fishing and frequent swimming, creating considerable disturbance during the day. Site 3 (8°16'24" N, 124°55'31" E, approx. 800 m a.s.l.) is located a few hundred metres east of Barangay Culasi on the western slope of the Kulaman River valley. It consists of a tributary of the Kulaman, which has carved out a deep valley that is vegetated with dense, relatively undisturbed forest on steep hillsides (Fig. 2D). The canopy cover and amount of low to medium vegetation are high, creating a humid atmosphere. Site 4 is located within Barangay Poblacion, roughly 100 m east of Site 1.

Data collection

Site 1, 2 and 3 were all visited twice during the research period, with prospecting being limited to two hours performed by two persons on each occasion. One of the two visits to Site 1 took place at night. Only casual observations were made at Site 4, which therefore do not qualify for standardized time searches. Opportunistic, random field searches were done with special emphasis on particular kinds of microhabitats known to be preferentially inhab-

ited by herpetofauna (leaf axils, cavities in rocks and rock caves, under logs and in leaf litter). Prospecting by night was done with torchlights.

Due to legislative issues regarding voucher collection (Brown et al. 2001), all located reptiles and amphibians were photographed for taxonomic identification and subsequently released. For reptiles, photographs were taken of the dorsal, lateral and ventral sides to facilitate scale counts. For amphibians, dorsal and ventral sides were photographed, in addition to the front and hind feet, to document the degree of webbing. Identification was done by using the works of Inger (1954), Marx & Inger (1955), Brown & Alcala (1980), Alcala & Brown (1998) and McGuire & Alcala (2000).

Sampling bias

All taxa were observed at the end of the dry season, during an El Niño year that caused extensive droughts. Therefore, both the diversity and abundance of all species must be interpreted accordingly. Additionally, as only a single night search was performed, the present nocturnal herpetofauna is likely to be under-sampled.

Results and discussion

A complete list of species previously recorded from within the MKRNP and records from the current study per

Figure 2. Prospected sites. (A) Site 1, Piglarn stream near Poblacion; (B) and (C) Site 2 within the forest and adjacent Kulaman River, respectively. (D) Site 3 near Culasi.

Table 1. Reptiles and amphibians recorded from the Kitanglad Range during previous and the current surveys . The column 'Endemism' is subdivided into M (Mindanao and satellite islands), P (Philippines) and SE (South-East Asia).

Species	IUCN status (2010)	Endemism	Site 1	Site 2	Site 3	Site 4	Reference
Bufonidae Gray, 1825							
Rhinella marina	Least Concern	–				X	This work
Ansonia mcgregori	Vulnerable	M					Amoroso (2000)
Ansonia muelleri	Vulnerable	M		X			Heaney & Peterson (1992)
Ceratobatrachidae Boulenger, 1884							
Platymantis corrugatus	Least Concern	P					Amoroso (2000)
Platymantis dorsalis	Least Concern	P					Amoroso (2000)
Dicroglossidae Anderson, 1871							
Limnonectes diuatus	Vulnerable	M			X		Amoroso (2000)
Limnonectes leytensis	Least Concern	P	X		X		This work
Limnonectes magnus	Near Threatened	P			X		Heaney & Peterson (1992)
Megophryidae Bonaparte, 1850							
Leptobrachium lumadorum	Not assessed	M					Brown et al. (2009)
Megophrys stejnegeri	Vulnerable	P					Heaney & Peterson (1992)
Microhylidae Günther, 1858							
Chaperina fusca	Least Concern	SE		X			This work
Kaloula picta	Least Concern	P					Amoroso (2000)
Ranidae Rafinesque-Schmaltz, 1814							
Sanguirana everetti	Data Deficient	P			X		Amoroso (2000)
Rhacophoridae Hoffman, 1932							
Philautus acutirostris	Vulnerable	P					Amoroso (2000)
Philautus worchesteri	Vulnerable	M					Heaney & Peterson (1992)
Philautus leitensis	Vulnerable	P		X			This work
Philautus surdus	Least Concern	P			X		Amoroso (2000)
Philautus sp. 1	Not assessed	–		X			This work
Polypedates leucomystax	Least Concern	SE					Heaney & Peterson (1992)
Geoemydidae Theobald, 1868							
Cuora amboinensis	Vulnerable	SE		X			This work
Agamidae Spix, 1825 or Fitzinger, 1826							
Draco cyanopterus	Least Concern	M	X				This work
Draco guentheri	Least Concern	M			X		This work
Gekkonidae Gray, 1825							
Ptychozoon intermedium	Near Threatened	P					Amoroso (2000)
Hemidactylus platyurus	Not assessed	SE				X	This work
Cyrtodactylus annulatus	Least Concern	P					Heaney & Peterson (1992)
Scincidae Oppel, 1811 or Gray, 1825							
Eutropis multifasciata	Not assessed	SE	X			X	This work
Eutropis multicarinata	Not assessed					X	This work
Sphenomorphus abdictus	Least Concern	P			X		This work
Sphenomorphus coxi	Least Concern	P	X		X		Heaney & Peterson (1992)
Sphenomorphus decipiens	Least Concern	P					Heaney & Peterson (1992)
Sphenomorphus fasciatus	Least Concern	P	X				This work
Sphenomorphus kitangladensis	Least Concern	M					Heaney & Peterson (1992)
Sphenomorphus mindanensis	Near Threatened	M					Amoroso (2000)
Tropidophorus misaminius	Least Concern	M	X				Amoroso (2000)
Tropidophorus partelloi	Least Concern	M			X		Heaney & Peterson (1992)
Colubridae Oppel, 1811							
Calamaria lumbricoidea	Least Concern	SE				X	This work
Calamaria gervaisii	Least Concern	SE					Amoroso (2000)
Cyclocorus nuchalis	Least Concern	M					Heaney & Peterson (1992)
Rhabdophis auriculata	Least Concern	P					Heaney & Peterson (1992)
Lamprophiidae Fitzinger, 1843							
Oxyrhabdium modestum	Not assessed	P					Heaney & Peterson (1992)
Psammodynastes pulverulentus	Not assessed	SE					Heaney & Peterson (1992)

Figure 3. Anurans encountered inthe Mt. Kitanglad Range. (A) *Limnonectes leytensis*; (B) *Limnonectes diuatus*; (C) *Chaperina fusca*; (D) *Philautus leitensis*; (E) *Philautus* sp.; (F) *Ansonia muelleri*.

site can be found in Table 1. In addition to these verified records, a dark *Brachymeles* sp. was observed at Site 2, but could not be caught for identification. In total, 12 reptile- and 10 amphibian species were located of which 15 had not previously been recorded from the MKRNP. A selected number of species representing either geographically or morphologically noteworthy records are discussed below.

Noteworthy records

Limnonectes leytensis (Boettger, 1893) (Fig. 3A)
Diagnostic features: long hind limbs; dorsolateral fold interrupted; mid-dorsum with elongated ridges; occasionally an inverted v-shaped mark at the level of the fore limbs; webs of toes not as broad as in *L. magnus*, especially not between the 4th and 5th toe.

Remarks: dorsal colouration varied from light to dark brown, sometimes greyish, while individuals could be either completely uniformly coloured, show a mixture of tones, and/or display transverse light brown bars from the anterior edge of the eye to the venter. In the majority of the observed individuals, a black stripe on the head connects to both eyes and separates the darker colour of the dorsum from the lighter colour of the snout.

This was the most commonly encountered and phenotypically variable species of *Limnonectes*. Individuals of all life stages were found at Sites 1 and 3 under rocks during the daytime and while being active at the former site at night. This record is the first for the Kitanglad Range. Despite the fact that *L. leytensis* was considered uncommon by Alcala & Brown (1998), the species seems to be locally abundant (Ferner et al. 2001, pers. obs.). Ferner et al. (2001) noted that the Visayan populations might represent another species.

Limnonectes diuatus (Brown & Alcala, 1977) (Fig. 3B)
Diagnostic features: stocky body and short limbs; toes webbed beyond base of disk except in the 4th, which is webbed to the disk; white-tipped tubercles in the dorsolateral region; faint barred pattern on limbs; upper jaw relatively uniformly brown dark with lighter blotches on the edge; lower jaw with narrow, light, irregular transverse bars.

Remarks: *L. diuatus* was described from Mt. Hilong-Hilong in north-eastern Mindanao, and was recently reported from the MKRNP based on a single individual (mentioned by Diesmos et al. 2004), and as *Limnonectes* cf. *diuatus* from Mt. Hamiguitan in south-eastern Mindanao by Delima et al. (2007), who stated that the identification needed confirmation but did not provide additional details. Current distribution data suggests that *L. diuatus* inhabits forest areas on both sides of the Agusan River valley and might be more widely distributed than previously thought. Two individuals were found at Site 3 in a steep rocky stream (Fig. 2D) during the day, hiding among leaf litter and rocks within the small stream.

Chaperina fusca Mocquard, 1892 (Fig. 3C)
Diagnostic features: dark brown to black; light reticulations all over the body; reticulations bolder on the venter; a dermal projection on elbow and heel each.

Remarks: Taylor (1920) described *Chaperina beyeri* from the northeast of Mindanao and distinguished it from *C. fusca* by the presence of the dermal spine on the heel and the absence of a visible tympanum. These characteristics were considered by Inger (1954) to fall within the intraspecific variation of *C. fusca*, placing *C. beyeri* into its synonymy. While the dermal spine was present in both individuals found, one individual lacked the visible tympanum. There is a high degree of inter-island morphological variation among individuals of this species (e.g., Inger 1954, Malkmus et al. 2002), creating a need for future systematic studies.

Both individuals were found on the forest floor next to the small stream, hiding among the leaf litter at Site 2. This is the first record of *C. fusca* from within the Kitanglad Range; other records from Mindanao have been summarized by Inger (1954) and supplemented by Delima et al. (2006) and Nuñeza et al. (2010).

Philautus leitensis (Boulenger, 1897) (Fig. 3D)
Diagnostic features: snout obtusely pointed; no webs on fingers; webs on toes; nostrils nearer to tip of snout than to eye; tympanum indistinct; supratympanic fold present; gular region smooth; abdomen coarsely granular; a row of tubercles along the outer edge of forearm; medioventral surface of lower leg with an extensive brown area.

Remarks: While Alcala & Brown (1998) restricted this species to Leyte and Bohol, records from Mindanao and Samar have recently been published (e.g., Brown et al. 2009, Siler et al. 2009a, 2009b), suggesting a wider distribution within the Mindanao faunal region than previously known. Two individuals were found at Site 1 hiding within leaf litter adjacent to the small brook, corresponding to the ecological remarks of Alcala & Brown (1998).

Philautus sp. 1 (Fig. 3E)
Diagnostic features: very small (10–15 mm); snout slightly obtuse; no webs on fingers; toes slightly webbed; tympanum distinct; pads of toes and fingers only slightly expanded; dorsum and venter smooth; minuscule white tubercles scattered over dorsum and extremities; dorsum brown-red with blackish spots; white spots on lower jaw; extremities vaguely barred; throat and upper part of venter dark with numerous white and few brown spots; lower venter and legs brown.

Remarks: A single individual of an unidentifiable *Philautus* sp. was found within the leaf litter at Site 2, directly adjacent to the small stream. The individual was very small but distinctive in its dorsal and ventral colouration (see above). At least three undescribed species of *Philautus* have recently been identified at the nearby Mt. Malindang (Nuñeza et al. 2010), illustrating the need for a revision of the currently eight recognised species within the Philippines.

Draco guentheri Boulenger, 1885 (Fig. 4A)
Diagnostic features: vivid malachite green colouration; ultramarine blue ciliaries.

Remarks: This species is known primarily from the Sulu Archipelago and the Zamboanga Peninsula of north-western Mindanao, although McGuire (1998) reported on a morphologically slightly aberrant population living near Malagos, Davao Province. The single individual located at Site 4 could not be captured for detailed examination, but is readily identifiable from photographs by its vivid malachite green colouration and ultramarine blue ciliaries that distinguish it from other Philippine *Draco* species (McGuire & Alcala 2000). This record is new for the Kitanglad Range and only the second reported from outside of the known distribution of *D. guentheri*.

Tropidophorus partelloi Stejneger, 1910 (Fig. 4C)
and *Tropidophorus misaminius* Stejneger, 1908 (Fig. 4D)
Diagnostic features: *T. partelloi*; 44 scale rows between parietals and base of tail; frontal in contact with 2 supraoculars; head shields without keels; dorsal and lateral scales on body with low keels, those on tail raised to posterior-orientated spines; dorsal ground colour dusky brown; 7 light transverse bands between neck and hind limbs. *T. misaminius*; 49 scale rows between parietals and base of tail; frontal in contact with 3 supraoculars; dorsal and lat-

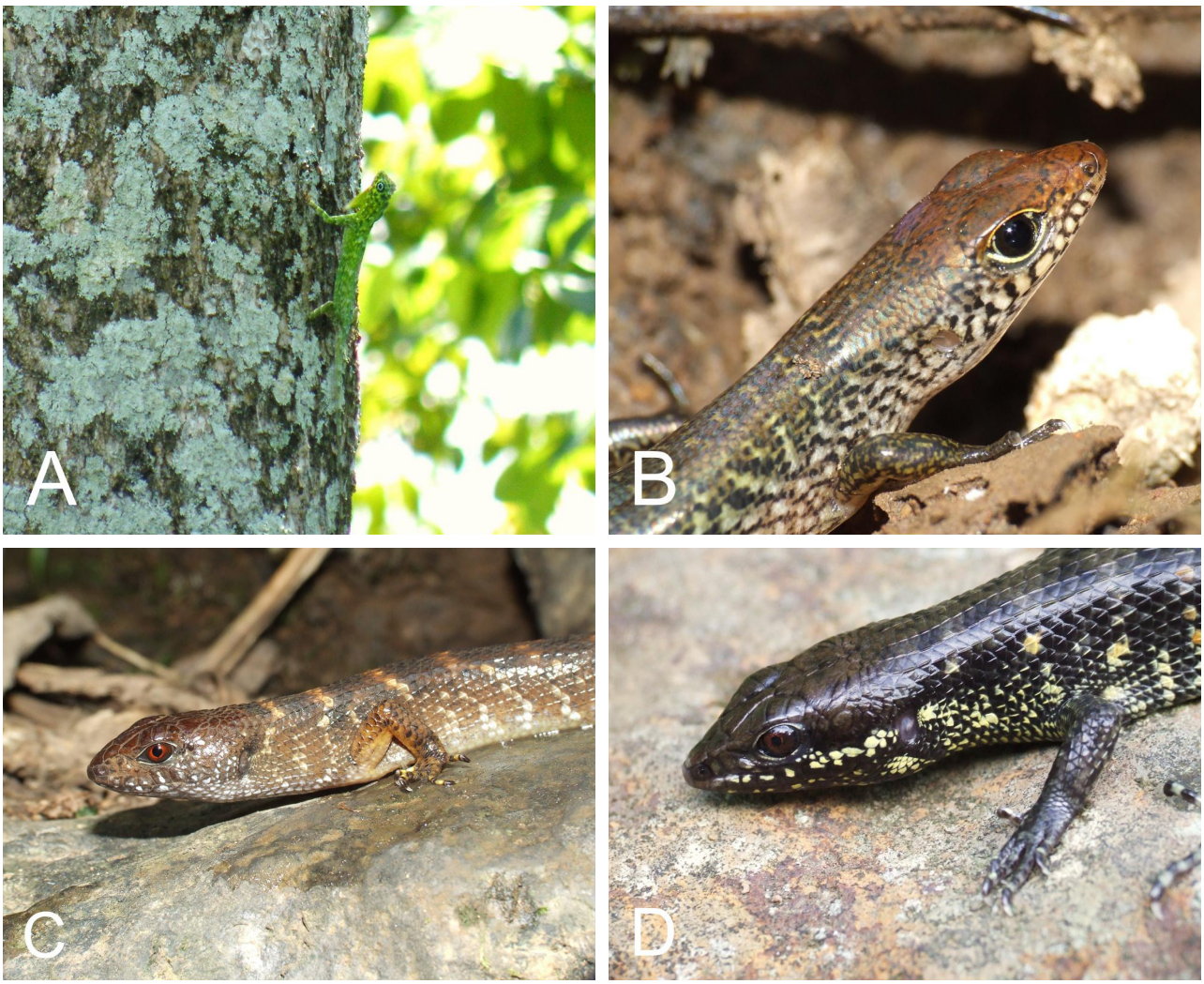

Figure 4. Lizards encountered in the Mt. Kitanglad Range. (A) *Draco guentheri*; (B) *Sphenomorphus abdictus*; (C) *Tropidophorus partelloi*; (D) *Tropidophorus misaminius*.

eral scales on body with low keels, without spines on the tail; dorsal colour very dark brown; vague dark transverse bands between neck and hind limbs; venter ivory except for underside of head and throat; numerous yellow scales on throat and lateral part of the body, gradually turning orange towards mid-body and tail.

Remarks: Little is known about the endemic *Tropidophorus* of the Mindanao PAIC. According to Brown & Alcala (1980), both species are found on moist soil under rotting logs and rocks in the forest, while *T. misaminius* can also be found between the rocks of streambeds. A single individual of *T. partelloi* was found hiding in a crevice within the steep, high and partially vegetated stream bank of Site 3 during the day. Two individuals of *T. misaminius* were found active at night during a visit to Site 1, swimming in the stream. Additionally, a juvenile was found during the day at the same site, moving about among the larger rocks on the side of the streambed. While Site 3 is steep and relatively undisturbed, Site 1 is frequently visited and utilized (both in terms of water use and agriculture) by the human population of Poblacion, showing that *T. misaminius* is able to tolerate a certain degree of habitat modification. Both these species have been previously cited by Amoroso (2000) as part of the MKRNP fauna.

Herpetological diversity

A total of 41 species (22 reptiles and 19 amphibians) have now been recorded from the Kitanglad Range, which is a considerable increase from Heaney & Peterson's (1992) results, who recorded 14 species while Amoroso (2000) recorded 23 species. The current number of species will likely rise when further more long-term inventories are complied for other sites within the range, as most families remain significantly underrepresented compared to other areas in Mindanao. Nuñeza et al. (2010) recorded a total of 59 species (26 amphibians and 33 reptiles) from the Mount Malindang Range, based on inventories in a much wider range of habitats. Delima et al. (2006) recorded a total of 25 amphibians from several sites within the Arakan Valley Conservation Area, while Delima et al. (2007) recorded during short surveys a total of 34 species (15 amphibians and 19 reptiles) from the Mount Hamiguitan Range.

Casual observations at Site 4 added several species that are characteristic for open and human-disturbed areas (e.g., *Rhinella, Eutropis*), but commonly go unrecorded in similar surveys due to an inventorial preference for undisturbed habitats (e.g., Delima et al. 2006, Nuñeza et al. 2010, but see Smith 1993).

While Amoroso (2000) listed *Cyclocorus lineatus* as present in the MKRNP, it is here omitted from Table 1, as this species does not occur in the Mindanao PAIC (Leviton 1967).

Conservation issues

The area in which the current inventories have been compiled is very close to the '1100-m Camp' approximately 9 km west of Dalwangan of Townsend Peterson et al. (2008) who described a high prevalence of agricultural lands in the region, even on the bottom of river valleys and occasionally up to the edge of the mossy forests. A considerable amount of lowland fauna of the Kitanglad Range is severely threatened by logging of lowland forests and habitat modification (Heaney et al. 2006, Townsend Peterson et al. 2008), which is likely to have already led to the disappearance of several bird species from the area (Townsend Peterson et al. 2008). While a relatively high number of reptile and amphibian species seem to persist in these forest fragments as indicated by the current results, the overall majority of these species were already known to tolerate at least a moderate degree of habitat modification (e.g., Smith 1993, Alcala & Brown 1998, McGuire & Alcala 2000). While finding species that are mainly found in primary forests, such as *Ansonia muelleri*, *Chaperina fusca* and *Tropidophorus partelloi* (Smith 1993, Alcala & Brown 1998), is encouraging, it also stresses the need for strict conservation measures to sustain these forest fragments. Indeed, the structurally rich border between forests and agricultural/human-modified landscapes can contain a relatively high species richness in lizards and anurans (Hampson 1999, Ledesma 1999). However, anuran richness increases with distance into the forest away from agriculture (Hampson 1999) while intact forest is known to support the highest species diversity of many reptile and amphibian assemblages (e.g., Auffenberg & Auffenberg 1988, Delima et al. 2007, Nuñeza et al. 2010). In conclusion, herpetofaunal surveys are needed along the entire altitudinal gradient of the MKRNP to assess the underrecorded herpetological diversity of the park. Additionally, many lowland forest fragments, which at the moment are not covered by the protection of the park, permit the fragmented existence of unique species assemblages (e.g., Heaney et al. 2006, Townsend Peterson et al. 2008, current study) and would benefit from protection in order to preserve biodiversity along the entire altitudinal gradient of the Mt. Kitanglad Range.

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