Preliminary report on the amphibians and reptiles of Balbalasang-Balbalan National Park, Luzon Island, Philippines

Arvin C. Diesmos[1,4], Rafe M. Brown[2,4], and Genevieve V. A. Gee[3,4]
[1]National Museum of the Philippines, Padre Burgos Avenue, Ermita 1000, Manila, Philippines; Current address: Department of Biological Sciences, National University of Singapore, Block S3 14 Science Drive 4, Singapore 117543
E-mail: kaloula@i-manila.com.ph
[2] Section of Integrative Biology, University of Texas, Austin Texas, 78712
Current address: Museum of Vertebrate Zoology, 3101 Valley Life Science Building University of California, Berkeley, CA 94720
E-mail: rafe@mail.utexas.edu
[3] Haribon Foundation for the Conservation of Natural Resources
4 Flr. Fil Garcia Tower, 140 Kalayaan Avenue, Diliman 1101, Quezon City, Philippines
E-mail: jutisha@yahoo.com
[4]Wildlife Conservation Society of the Philippines
Room 106 Institute of Biology, University of the Philippines
Diliman 1101, Quezon City, Philippines

We provide information on the amphibians and reptiles of Balbalasang-Balbalan National Park (BBNP) based on field surveys we conducted on several localities in 1998, 1999, 2000, 2001, and 2003. We recorded a total of 51 species of amphibians and reptiles from the area. Baseline data on species richness, habitat and altitudinal distribution, and natural history are presented. The herpetofauna exhibited high levels of endemicity and included at least 13 species that are potentially new to science (nine frogs of the genus Platymantis, three scincoid lizards of the genus Sphenomorphus, and one snake). We suspected that additional species await discovery after more thorough inventories have been completed especially targeting the low elevation forests of these vast mountain ranges. Apart from these exciting new discoveries, another significant outcome of our survey work is the rediscovery of five "lost species" from the Cordillera Central mountain range including Platymantis cornuta, Rana igorota, and Sphenomorphus luzonensis, all of which have been considered previously as either rare or in the verge of extinction.

Keywords: Central Cordillera Mountains, amphibians, reptiles, new species, rediscovery, Platymantis ,

Our data suggest that these species are fairly common within the national park. We provide accounts for these species and point out possible new areas of biological studies. The high species richness and endemism of the herpetofauna of BBNP is an indication of the overall excellent condition of its forests.

Edward H. Taylor was the first herpetologist to explore the rugged highlands of the Cordillera Central mountain range in north central Luzon Island, Philippines. His relatively brief collecting sorties took him to several areas of this vast mountain range (Taylor 1922a). Taylor described nine new species of frogs, lizards, and a snake from various mountain localities in the Cordilleras, all of which appeared, at that time, to be unique to this region (Taylor 1922a, 1922b, 1922c, 1925, 1963).

Few field collections of the herpetofauna from the Cordilleras took place after Taylor's work, save for a brief visit by members of the Philippine Zoological Expedition of the Chicago Natural History Museum (predecessor to Field Museum of Natural History), right after the Second World War (Inger 1954). More recently, herpetologists from the United States National Museum of Natural History surveyed the herpetofauna in several localities around the Cordilleras, in the late 1980s. Most of the results of this effort, however, remain unpublished.

In July 1998, in collaboration with Angel Alcala (Silliman University), we undertook a preliminary survey work on the herpetofauna of Balbalan, a region within the Cordilleras that was first visited by Taylor nearly 80 years back. Our brief survey was part of a larger effort to gain a better understanding of the diversity, ecology, and systematics of the herpetofauna of Luzon Island, which we believe is unreasonably underestimated from previous works (e.g. Inger 1954, Alcala 1986) and poorly studied (Brown et al. 1996, Diesmos 1998, Brown et al. 2001, Brown and Diesmos 2001). Beginning in 2000, biologists from the Haribon Foundation for the Conservation of Natural Resources and the Field Museum of Natural History conducted a joint biological expedition to inventory the biodiversity of Balbalasang-Balbalan National Park (BBNP) in Kalinga Province.

In this preliminary report, we present baseline information on the species diversity, relative abundance, and ecology of the amphibians and reptiles of BBNP based on the results of preliminary survey work undertaken in 1998 and 1999 and the systematic inventories conducted in 2000, 2001, and 2003.

Materials and methods

Taxonomic identification of herpetological specimens from BBNP was facilitated by direct comparison to specimens (including types whenever possible) housed at the California Academy of Sciences (CAS), the Field Museum of Natural History (FMNH), National

Museum of the Philippines (PNM), and the Texas Natural History Collection (TNHC) at the Texas Memorial Museum, University of Texas, Austin.

Study area

The Cordillera Central is a vast and rugged mountain range that dominates the skyline of the north central region of Luzon (see map in Heaney et al., this volume). Over a dozen peaks within the mountain range rise to over 2,000 m while a few reach nearly 3,000 m. There are numerous drainage systems and deep valleys that separate mountain massifs. The climate is cool and of the temperate type. Rainfall seasonality in the Cordilleras falls under two categories: Type I (dry from November to April and wet during the rest of the year) affects the eastern parts of the range and Type III (with no pronounced seasons) is prevalent on eastern regions. There are, at present, five national parks and forest reserves within the Cordilleras. One such protected area is the BBNP, located in the Municipality of Balbalan, Kalinga Province. It was declared as a national park in 1974 by virtue of Proclamation No. 1357 and covers an area of about 17,838 ha. The highest peak, Mt. Sapocoy, is at 2,456 m. BBNP was proposed for inclusion in the National Integrated Protected Areas System (NIPAS) of the Philippine government (Dickinson et al. 1991, Mallari et al. 2001, Ong et al. 2002).

Herpetofaunal inventories were conducted in 10 sites within BBNP, all located in the Municipality of Balbalan, Kalinga Province. With the exception of three sites (i.e., Balbalan, Naldaan, and Longolong), we sampled the herpetofauna in the same localities where inventories of birds and mammals were performed (see map and further descriptions of the sampling sites in Heaney et al., this volume). Brief descriptions of our sampling sites are summarized as follows:

1. Balbalan Municipality (750 m, coordinates not recorded; visited, 7-11 July 1998). The survey site was on a ridgetop above the town of Balbalan, in secondary forest of the transition lowland-montane type. Only a few huge dipterocarp trees remain and the cutting of trees was fairly evident. We heard chainsaws operating in the area. We observed many decaying tree stumps, logs, and slabs. The understorey is dense with tree saplings, screw pine (Pandanus), and rattan palms.
2. Naldaan, Barangay Balbalasang (1,200 m, coordinates not recorded; 19-21 December 1999). Naldaan is located 10-15 km northwest of Barangay Balbalasang. Pine forest dominate the vegetation in this area interspersed with patches of lower montane forest with trees reaching to a height of over 35 m. Surveys were conducted in such habitat and along the Naldaan River, a 5-7 m-wide swift flowing, cool, and clear mountain stream.
3. Barangay Balbalasang (925 m, 17° 29.1'N 121° 03.3'E; 25-27 March 2000, 9-11 March 2001, and 17-21 February 2003). We surveyed the herpetofauna in the vicinity of the town of Balbalasang, primarily in the agricultural lands (cropland and pasture) in the narrow band of flat areas and low hillsides that are adjacent to

the Saltan River. The original vegetation was lower montane forest with lowland rainforest elements but little evidence of the lowland forest remains. Pine forest with either fire-maintained grassland or brushy second- growth predominated on the adjacent hillsides.

4. Mapga (1,050 m, 17º 28.543'N 121º 04.354'E; 11-18 March 2001). This site is adjacent to the Mapga River. Vegetation includes a small area of pine forest on a steep hillside, fairly extensive second-growth and secondary forest on fairly flat land that was first cleared at the time of World War II, and mature lower montane rainforest on moderately to very steep slopes. We also surveyed the herpetofauna from a permanent pond (about 500 m^2 in area) located in a flat area about 10 m above and 30 m away from the river.
5. Longolong (1,025 m, 17º 28.42'N 121º 04.19'E; 23-25 March 2001). The habitat is a mixture of primary and mature secondary lower montane forest. Some patches of forest (30-50 m^2) on relatively flat ground have been cleared for agriculture 10-15 years ago. Primary forest occurs on steep slopes and along the Longolong creek.
6. Magdallao, lower (1,300 m, coordinates not recorded; 31 March-6 April 2000). The forest in this area is of the lower montane forest type with canopy reaching to a height of about 25 m. Surveys were conducted on ridge tops along and near forest trails.
7. Magdallao, upper (1,600 m, 17º 27.5'N 121º 04.1'E; 28 March-6 April 2000). This sampling area was in mature montane rainforest dominated by oaks that reached a height of ca. 15 m, with a grove of pine trees several hundred meters away. Several small streams and some relatively flat areas provided abundant moist habitat.
8. Amlicao (1,800 m, 17º 25.95'N 121º 04.55'E; 18-27 March 2001). Our camp was located along the mountain trail from Balbalasang to the town of Pasil, in mature transitional montane-mossy rainforest dominated by oaks. We sampled in areas from steep hillsides up to the top of the adjacent ridge where thickets of bamboo were present. Moss was especially common along the upper portion of the ridge.
9. Mt. Bali-it, lower (1,950 m, 17º 25.8'N 121º 00.1'E; 19-28 February 2003). Surveys were conducted from 1,500 m to 1,950 m elevation. We worked along and near existing trails, hill slopes and ridges, and in streams, at altitudes between 1,500 m to the base camp (1,950 m) on Mt. Bali-it, covering lower and upper montane forests and lower mossy forest.
10. Mt. Bali-it, upper (2,150 m, 17º 25.7'N 120º 59.8'E; 25 February-3 March 2003). Surveys were undertaken from an elevation of 1,950 m to 2,150 m. We surveyed the herpetofauna on and near the peak of Mt. Bali-it, in lower mossy forest dominated by oaks with a canopy height of 6-8 m in lower or protected spots, and as little as 3 m in high, exposed sites. Moss on the ground and trees were common and ground orchids and ferns were abundant.

Sampling techniques

Field techniques included a combination of timed searches, microhabitat sampling, and tape-recording of advertisement calls of male frogs (Heyer et al. 1994). Information on type of habitat and microhabitat (e.g., tree holes, burrows, rotten logs, tree buttresses, tree foliages, leaf litter, and isolated pools) where an individual of a species was observed or caught, the elevational distribution, time of observation or capture, behavior of the species before capture, and external morphological characters and measurements were taken. Adult specimens were caught either with the aid of nets or solely by hand while larvae (tadpoles) were collected from aquatic microhabitats through dip netting. We worked in small groups (2-4 persons) and spent most of the day and night walking along existing forest trails which served as our transect lines. We walked an average of 1.5 km per sampling day and spent an average of 10 person-hours/day sampling the herpetofauna from each site (typically from 0900 hr to 1200 hr, 1400-1600 hr, and 1900-2400 hr). Only one transect line in each survey site was sampled. Surveys were conducted in both day and night and in both wet and dry weather. Our sampling effort was generally uniform in all survey sites including the built up areas and human-modified environments in the Balbalasang village.

We assessed the relative abundance of each species based on the cumulative number of encounters of individuals of a particular species during the whole duration of the study. We qualitatively defined four abundance categories as "common" for species that were encountered more than 50 times, "fairly common" for those that were encountered 30-50 times, "uncommon" for those that were encountered 10-20 times, and "rare" for species that were encountered less than 5 times. Temporal (diel) activity of each species was also noted.

Specimens of each species encountered were collected as voucher materials particularly those that we were not able to identify in the field (as per stipulated protocols detailed in research permits) using standardized preservation techniques (Simmons 1987, Heyer et al. 1994). Those that were readily identified in the field were later released at the capture site. Representative tissue samples from each specimen were also taken. Vouchers were initially fixed in 10% buffered formalin and were eventually stored in 70% ethyl alcohol. These specimens are presently deposited at FMNH. Representative specimens of each species will be transferred to PNM at a later date.

Interviews with residents of Barangay Balbalasang and the Municipality of Balbalan were conducted to supplement data gathered from our direct field observations. Only those interview accounts that were ascertained to be valid (i.e., based on available literature and our personal knowledge of the species) are incorporated in this report.

Results and discussion

Species richness and composition

We recorded 51 species of amphibians and reptiles from BBNP comprised of 23 species of frogs, 16 lizards, 11 snakes, and one turtle (Table 1). Species endemicity is remarkably high with as many as 26 species (50% of the fauna) restricted to Luzon faunal region and up to 17 species (32%) possibly restricted to the mountains of the Cordilleras (Inger 1954, Alcala 1986, Alcala and Brown 1998, Brown et al. 2001). At least 30 herpetofaunal species are recorded from the Cordillera Central for the first time. Data on the occurrence of each species and other pertinent information are summarized in Table 1. We included in the list three snakes (Python reticulatus, Naja philippinensis, and Ophiophagus hannah) and a turtle (Cuora amboinensis) based on the strength of interview accounts with the local residents within BBNP.

Our inventories resulted in an astonishing discovery of 13 species that are highly likely to be new to science: nine frogs of the genus Platymantis, three skinks of the genus Sphenomorphus, and one snake (Table 1). Furthermore, our field surveys led to the rediscovery of several species that were previously known only from type specimens (ranging from one to half a dozen specimens) that were first collected by herpetologists 80-150 years ago (Taylor 1922a, 1922b, Brown and Alcala 1980, Brown et al. 2000a). Our survey results only underscore the fact that the herpetofauna of Luzon is poorly studied and that the diversity and endemism of this fauna was unreasonably underestimated (see comments in Diesmos 1998, Brown et al. 2000a, Brown et al. 2001, Brown and Diesmos 2001, Diesmos et al. 2002).

Notes on biogeography

Although information on the herpetofauna of BBNP and the Central Cordilleras is certainly far from complete, we venture a brief commentary on the biogeographic significance of this fauna.

An estimated 14 of the 51 species recorded from BBNP (i.e., 10 species of Platymantis, Rana igorota, two species of Sphenomorphus and a typhlopid snake; see Table 1), particularly those that were only recorded from high-elevation forest sites, may be restricted to the Cordilleras and perhaps, only to a few mountain peaks within BBNP such as Mt. Amlicao and Mt. Bali-it. We based this assumption from the almost recurrent pattern of discovery of endemic herpetofaunal species from high-elevation mountains (e.g. Brown et al. 1995, Ferner et al. 1997, Alcala et al. 1998, Diesmos 1998, Brown et al. 1999). Our preliminary information from the herpetofauna of Mt. Data, south of BBNP, also indicates that some of the species found in that area may be closely related to those from BBNP.

Table 1. Herpetofauna of BBNP (this species list and respective information are based on our own field studies). ▲= Cordillera endemic, ■ = Luzon faunal region endemic, • = Philippine endemic, † = non-endemic (native species). Sites: 1 = Balbalan, 2 = Naldaan, 3 = Balbalasang, 4 = Mapga, 5 = Longolong, 6 = Magdallao (lower), 7 = Magdallao (upper), 8 = Amlicao, 9 = Mt. Bali-it (lower), 10 = Mt. Bali-it (upper). Habitat types: F= forest, R= riverine forest, E= edges and second growth, O= open and built-up areas. Relative abundance: C = common, FC = fairly common, U = uncommon, R = rare, ND = no data. Diel activities: N = nocturnal, C = crepuscular, D = diurnal. Distributional data based on Inger (1954), Alcala (1986), Alcala and Brown (1998). Conservation status follows IUCN (2003, URL http://www.redlist.org/) and CITES (2003, URL http://www.cites.org/).

Species	Sites	Habitat	Elevational range (m)	Relative abundance	Diel	Remarks
Ranidae ■						
Limnonectes macrocephalus †	1-5	R	750-1050	C N	Collected for food	
Occidozyga cf. laevis ▲	1,3,5	O	750-1025	FC N	Taxonomic studies needed	
Platymantis cf. cornuta ■	1,2,4,5,6	F	750-1300	FC N	Taxonomic studies needed	IUCN: Data Deficient
Platymantis pygmaea ▲	1,3,5	F	750-1025	FC C	Taxonomic studies needed	IUCN: Vulnerable
Platymantis sp. A ▲	1,3,5	F	750-1050	C N	Possible new species	
Platymantis sp. B ▲	1	F	750	U	N	Possible new species
Platymantis sp. C ▲	3,5	F	1050	U	C	Possible new species
Platymantis sp. D ▲	7,8	F	1600-1800	C	D, C	Possible new species
Platymantis sp. E ▲	7-10	F	1600-2150	C	N	Possible new species
Platymantis sp. F ▲	7-10	F	1600-2150	C	N	Possible new species
Platymantis sp. G ▲	7-10	F	1600-2150	C	N	Possible new species
Platymantis sp. H ▲	9,10	F	1880-2150	C	N	Possible new species
Platymantis sp. I ▲	9,10	F	1500-1950	C	N	Possible new species
Platymantis sp. (cf. "rivularis") ▲	2-6	F	900-1600	FC N	Taxonomic studies needed	
Rana igorota ■	5	R	1025	U	N	Taxonomic studies needed
Rana luzonensis ■	2,3,6, 7,8,9	R	900-1950	C	N	
Rana similis •	1	R	750	R	N	
Rana (Fejervarya) vittigera	1,3	O	750-950	C	N	Collected for food
Microhylidae ■						
Kaloula kalingensis ■	1-7	F, E	750-1600	C N		
Kaloula rigida	1,3	E, O	750-925	U	N	

Table 1. Cont.

Species	Sites	Habitat	Elevational range (m)	Relative abundance	Diel	Remarks
Rhacophoridae						
Philautus cf. surdus †	1-7	F, E	750-1600	C N		Taxonomic studies needed
Polypedates leucomystax †	1,3,4	E, O	750-1050	C N		
Rhacophorus cf. pardalis	1,4	F, E	750-1050	U N		Taxonomic studies needed
Bataguridae †						
Cuora amboinensis	1,3	R	Below 925	ND	C	Based on reports by locals; CITES: Appendix II
Gekkonidae †						
Cosymbotus platyurus	1,3	O	750-950	C	N	
Gekko gecko †	1,3	E, O	750-950	C	N	
Gehyra mutilata	1,3	E, O	750-950	C	N	
Lepidodactylus sp.	3	E, O	925	R	N	Taxonomic studies needed
Agamidae						
Bronchocela sp.	3,4	F, E	900-1050	U D		Taxonomic studies needed
Draco spilopterus	3	F, E	925	ND	D	Taxonomic studies needed
Scincidae						
Mabuya cumingi	1,2,3,6	F, E	750-1200	C D		Taxonomic studies needed
Mabuya multicarinata borealis	1-7	E, O	750-1600	C D		Taxonomic studies needed
Sphenomorphus cf. abdictus	3,5	F, E	950-1050	U D		Taxonomic studies needed
Sphenomorphus cf. luzonensis	4	F, E	1600	R	D	Taxonomic studies needed
Sphenomorphus sp. A	1	F	750	R	D	Taxonomic studies needed

Table 1. Cont.

Species	Sites	Habitat	Elevational range (m)	Relative abundance	Diel	Remarks
Brachymeles cf. bonitae ●	3	F, E	950	R	D	Taxonomic studies needed
Varanidae †						
Varanus salvator marmoratus	1,3	E, O	Below 900	ND	D	Collected for food; CITES: Appendix II
†						
Pythonidae						
Python reticulatus	1,3	E, O	Below 950	ND	D	Based on reports by locals;
†						CITES: Appendix II
Typhlopidae ▲						
Ramphotyphlops braminus	3	E, O	950	FC	N	
Typhlopid sp. †	3	F, E	950	R	?	Possible new species
●						
Colubridae ●						
Ahaetulla prasina †	3	F, E	950	ND	D, N	Specimen not collected
Calamaria bitorques ●	3	F	900-1000	ND	D	
Cyclocorus lineatus ●	1	F	950	ND	D, N	
Dendrelaphis caudolineatus	3	F	950	ND	D	Specimen not collected
Oxyrhabdion leporinum	3	F	950	R	C, N	
Zaocys luzonensis †	Near 1	F, E	About 700	ND	D	Specimen not collected
Naja philippinensis	1,3	E, O	No data	ND	D, N	Based on reports by locals;

On the other hand, 27 of the 51 species recorded are widely distributed on Luzon with a few that are also found on other islands in the Philippines. These species essentially constitute the low-elevation Philippine herpetofauna and are typically found in lowland forest, but most can also thrive in human-controlled environments such as in secondary growth vegetation, agricultural areas, and built up areas. It has been documented that some herpetofaunal species in the Philippines [e.g., Rana (Fejervarya) vittigera, many gekkonid lizards] have become established into new territories through human-aided dispersion (Inger 1954, Alcala 1986).

Available data indicated that some degree of affinity exists among the herpetofauna of BBNP, the Sierra Madres, and the Zambales Mountains. At least six Philippine endemics are shared among these three mountain ranges. Kaloula kalingensis, Mabuya cumingi, and Sphenomorphus abdictus are known from both the Sierra Madres and Zambales Mountains while Platymantis pygmaea, K. rigida, and Brachymeles bicolor have been found in the Sierra Madres but not in the Zambales (Brown et al. 2000a). Noteworthy is the striking ecological variation and distribution exhibited by some species, which might reflect taxonomic distinctiveness. For instance, K. rigida, which is restricted to elevations above 700 m in the Cordilleras, has been found as low as 50 m in the Sierra Madres (Alcala and Brown 1998). Another interesting example is exhibited by P. pygmaea. This species was discovered from the Sierra Madres (Alcala et al. 1998) and is known from Aurora Memorial Park (Brown et al. 2000a), BBNP, and more recently, was found on Sibuyan Island (unpublished data). Surprisingly, P. pygmaea has not been found on mountain localities in between the Sierra Madres and Sibuyan despite intensive field surveys (Ross and Gonzales 1992, Diesmos 1998, Brown et al. 2002a, Diesmos et al. unpublished data), representing an intriguing disjunct distribution.

A great deal of work is needed to bridge the large gap of information pertaining to geographic distribution, phylogenetic relationships, and systematics of many Philippine species. Only when such issues have been addressed fully can the biogeography of the herpetofauna of the Central Cordilleras, and ultimately, that of Luzon can be fully understood.

Ecology and natural history

Our data show that majority (75%) of the herpetofauna of BBNP are forest-restricted species while the rest of the species are found in non-forested and disturbed habitats. In agricultural plantations, built up areas, and other man-modified environments, only a few tolerant species can be found [e.g., Rana (Fejervarya) vittigera, Occidozyga cf. laevis, Polypedates leucomystax, Gekko gecko, and Dendrelaphis caudolineatus]. In and around disturbed forest and rivers, several more species can be found. However, in deep forest, we

found 39 species of frogs, lizards, and snakes that we never encountered in open and disturbed habitats. These include most of the undescribed species of frogs, lizards, and snakes. In particular, Rana igorota warrants comment because this is a streamside frog that we never observed even in the cleanest of forested streams and rivers if any disturbance is present. We only encountered this frog in small mountain streams that were virtually undisturbed by human as judged by the presence of large males of the fanged frog L. macrocephalus in the same streams. The latter species is an excellent indicator of the presence of local hunting pressures. If any human predation on this species is present, the largest of the males are invariably absent as these are prized by gatherers. Only in streams that are rarely visited by hunters do we ever find large males in excess of 150-350 g with lengths of nearly 200 mm (Brown et al. 1996, 2000a). Because very large male fanged frogs were present in Longolong (Site 5) and were never found in rivers and streams from other sites, we assumed that hunters seldom visited this isolated area. In fact, the streams in this site are not tributaries of the larger Mapga River and we surmised that this is the reason for the absence of disturbance by hunters who usually follow waterways when hunting for frogs. The fact that R. igorota only occurs in the most isolated and relatively undisturbed mountain streams suggests that this species has little or no tolerance for human-caused disturbance and thus, may serve as an excellent "indicator species" for ecosystem health in the Cordilleras.

The distribution pattern of the herpetofauna of BBNP is positively related to elevation and the coinciding gradients of temperature and humidity. At lower elevations, forests are hotter and drier and support higher levels of reptile diversity and abundance in most species. At higher elevations, reptiles are scarcer and, when encountered, species are less abundant with fewer individuals encountered. Species richness was generally highest at lower elevations. At this elevation, most species of frogs were congregated around streams and rivers (L. macrocephalus, R. luzonensis, and R. igorota) or stationary pools of water (R. pardalis, P. leucomystax, O. cf. laevis). Interestingly, the diversity of certain groups of frogs increased with increasing elevation particularly at the montane forest (Table 1). This distribution pattern was particularly evident in frogs of the genus Platymantis and Philautus, which is similar to that exhibited by murid rodents (Rickart et al. 1991, Heaney 2001). The reason for this may be simple. The reproductive mode of these frogs is of the terrestrial development type (Alcala 1962; Alcala and Brown 1982, 1998). Being direct developers, these frogs do not require streams or standing water to reproduce, thus, enabling them to successfully thrive in montane and mossy forests, which are otherwise uninhabitable to many other groups of frogs (Duellman and Trueb 1994).

Several life history patterns of individual species deserve comment because they are rare or unique among Philippine amphibians and reptiles. For example, one of the new species of Platymantis that we discovered calls only during the day (Platymantis sp. D). This is atypical for Philippine frogs of the genus Platymantis and could be the first example of a diurnal species in this group. Two others species of Platymantis (Platymantis cf. "rivularis" and Platymantis spp. E, F) exhibit the unusual pattern of male parental care. We observed

males of these species (n=11) tend to the egg clutch, putatively as an act of guarding against predators or keeping them free of mildew (Duellman and Trueb 1994). Finally, we observed carnivory by the Luzon fanged frog (L. macrocephalus). A large male of this species was observed swallowing whole a large female of the Luzon stream frog R. luzonensis-the first observation of this kind for a species of Limnonectes in the Philippines.

Comments on particular species

Platymantis cornuta (Taylor 1922)

Platymantis cornuta was described by Taylor (1922a) based on a single specimen he collected from the town of Balbalan. Prior to our surveys, only the holotype (CAS 61476), presently deposited at the California Academy of Sciences represented this species. Our collecting effort resulted in the possible collection of an additional two samples of this arboreal species. We recommend that future survey efforts must include the collection of a larger series of specimens of P. cornuta coupled with studies on its geographic distribution in the Cordilleras. It is listed as Data Deficient by IUCN (2003).

Platymantis sp. (cf. “rivularis”) (Taylor 1922)

Taylor (1922a) described Cornufer (=Platymantis) rivularis from Balbalan, which was subsequently synonymized by Inger (1954) with P. hazelae, a related species which is otherwise restricted to high-elevation montane forests in Negros Island (Alcala and Brown 1998). We suspect one of our Platymantis frogs from BBNP is Taylor’s P. rivularis and ongoing taxonomic studies will address this issue specifically. One of us (RMB) has encountered P. hazelae in the field and recognizes extensive differences on morphology and advertisement calls between these two taxa.

Rana igorota (Taylor 1922)

As with other species from the Cordilleras, Inger (1954) considered Taylor’s R. igorota as a subspecies of R. everetti. Brown et al. (2000b) eventually established the taxonomic validity of R. igorota on the basis of Taylor’s original specimens from Balbalan (the type locality) collected in 1920. We did not find this species on our first visit to Balbalan in July 1998. But during our second inventory work at BBNP in March 2001, we discovered a healthy population of this species in just one locality within the park. We collected a total of 17 specimens considerably increasing the known museum collections for the species. This striking stream frog appears to prefer pristine or little-disturbed cool mountain streams in lower montane forests.

Brachymeles bicolor (Gray 1845)

This is an extremely rare species of Brachymeles in the Philippines. B. bicolor was described on the basis of two specimens without precise collection locality data (Gray 1845). More than 140 years later, this species was rediscovered from the northern tip of the Sierra Madre Mountains of northeastern Luzon (Crombie and Ota unpublished data) and more recently, at Aurora Memorial National Park in the central Sierra Madres (Brown et al. 2000a). Our record from BBNP is only the third known locality for this species. We recommend a full study of the range of morphological variation in the species and intensive collecting effort to determine its geographic distribution on Luzon.

Sphenomorphus cf. luzonensis (Boulenger 1845)

This is a rare forest species that is known only from a few specimens from the highlands of Lepanto, Mountain Province and was subsequently collected by R. Crombie (U.S. National Museum of Natural History) at the Municipality of Bauko, Mountain Province. Our specimens that we tentatively refer to this species were observed actively moving through forest litter in sunspots in the forest on dry ridges above Balbalasang.

Typhlopid sp.

Among the most exciting new discoveries from BBNP is a single specimen of a scolecophidian snake recorded during the 2001 field season. This snake may represent a record of a new genus for the Philippines and it appears to be related to species from the Solomons and Bismarck Archipelago (V. Wallach, in litt., 2003). Taxonomic study of this new species is currently underway and results will be published elsewhere.

Recommendations

Few herpetological collections have been conducted in the mountains of Cordillera Central in the past, leaving this extensive mountain range for the most part, unstudied. It is, thus, not surprising that our survey efforts at BBNP resulted in the discovery of an astonishing number of species that are possibly new to science. This only emphasizes the extent to which we are relatively ignorant of the herpetological faunal composition in the Cordilleras. We predict that additional species will be added to the herpetofaunal list of BBNP provided that more exhaustive field surveys are conducted especially in the remaining forest habitats at the lower elevations, such as in the Balbalan area, and in many other isolated mountain peaks within BBNP, such as Mt. Sapocoy.

In the interim, the new materials from BBNP present a rare opportunity to investigate the systematics of many of the “lost species” from the Cordilleras. The taxonomy of these species remains questionable up to now. But ultimately, an understanding of the herpetofauna of BBNP will contribute significantly to further our knowledge base of the diversity, ecology, and biogeography of the herpetofauna of Luzon Island.

Because we suspect that an under-appreciation of biodiversity is at least one factor contributing to the non-sustainable exploitation of Southeast Asian forests, it is critical that adequate survey efforts be conducted to gain a reasonable understanding of the present biodiversity for enactment of conservation and management efforts.

Large areas of BBNP are still heavily forested and remain intact and its wildlife is generally in excellent condition. Such a scenario is becoming more uncommon in the Philippines. The people of BBNP, especially members of the Banao tribe, should be given all possible encouragement to retain and maintain their age-old tradition and practices in terms of managing the natural resources of their ancestral land. We believe that BBNP is a shining example that people can, indeed, live harmoniously with their environment.

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Literature cited

Alcala, A.C. 1962. Breeding behavior and early development of frogs of Negros, Philippines Islands. Copeia 1962. 679-726.

Alcala, A.C. 1986. Guide to Philippine flora and fauna. Vol. X, Amphibians and Reptiles. Natural Resource Management Center, Ministry of Natural Resource Management Center, Ministry of Natural Resources and the University of the Philippines, Manila, Philippines. 195 pp.

Alcala, A.C., and W.C. Brown. 1982. Reproductive biology of some species of Philautus (Rhacophoridae) and other Philippine anurans. Kalikasan, Philippine J. Biol. 11: 203-226.

. 1998. Philippine amphibians: An illustrated field guide. Makati City: Bookmark.

Alcala, A.C., W.C. Brown, and A.C. Diesmos. 1998. Two new species of the genus Platymantis (Amphibia: Ranidae) from Luzon Island, Philippines. Proc. California Acad. Sci. 50(17): 381-388.

Brown, W.C., and A.C. Alcala. 1978. Philippine lizards of the family Gekkonidae. Silliman University Nat. Sci. Monogr. Ser. 1, Dumaguete City, Philippines. iii + 146 pp.

. 1980. Philippine Lizards of the family Scincidae. Silliman Univ. Nat. Sci. Monog. Ser. 2, Dumaguete City, Philippines.

Brown, R.M., and A.C. Diesmos. 2001. Application of lineage-based species concepts to oceanic island frog populations: The effects of differing taxonomic philosophies on the estimation of Philippine biodiversity. Silliman J. 42(1): 133-162.

Brown, R.M., A.C. Diesmos, and A.C. Alcala. 2001. The state of Philippine herpetology and the challenges for the next decade. Silliman J. 42(1): 18-87.

Brown, R. M., A.E. Leviton, and R.V. Sison. 1999. Description of a new species of Pseudorabdion (Serpentes: Colubridae) from Panay Island, Philippines with a revised key to the genus. Asiatic Herpetol. Res. 8: 7-12.

Brown, R.M., J.A. McGuire, J.W. Ferner, N. Icarangal, and R.S. Kennedy. 2000a. Amphibians and reptiles of Luzon Island II: Preliminary report on the herpetofauna of Aurora Memorial National Park, Philippines. Hamadryad. 25: 175-195.

Brown, R.M., J.A. McGuire, and A.C. Diesmos. 2000b. Status of some Philippines frogs referred to Rana everetti (Anura: Ranidae), description of a new species, and

resurrection of Rana igorota Taylor 1922. Herpetologica. 56(1): 81-104.

Brown, R.M., J.W. Ferner, and L.A. Ruedas. 1995. A new species of lygosomine lizard (Reptilia; Lacertilia; Scincidae; Sphenomorphus) from Mt. Isarog, Luzon Island, Philippines. Proc. Biol. Soc. Washington. 108: 18-28.

Brown, R.M., J.W. Ferner, R.V. Sison, P.C. Gonzales, and R.S. Kennedy. 1996. Amphibians and reptiles of the Zambales Mountains of Luzon Island, Republic of the Philippines. Herpetol. Natur. Hist. 4: 1-22.

Brown, R.M., R. Fernandez, C. Rivero, R. Buenviaje, and A.C. Diesmos. 2002a. Mt. Isarog's herpetological wonders. Haring Ibon. 3(3): 12-17.

Brown, R.M., A.C. Diesmos, and R.E. Fernandez. 2002b. The rising costs of cabbage and potatoes. Haring Ibon 9: 10-12.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2003. Appendices I, II, and III. <www.cites.org>.

Dickinson, E.C., R.S. Kennedy, and K.C. Parkes. 1991. The birds of the Philippines. British Ornithologists' Union, U.K.

Diesmos, A.C. 1998. The amphibian faunas of Mt. Banahao, Mt. San Cristobal, and Mt. Maquiling, Luzon Island, Philippines. Unpublished M.S. thesis. University of the Philippines at Los Baños, College, Laguna.

Diesmos, A.C., R.M. Brown, A.C. Alcala, R.V. Sison, L.E. Afuang, and G.V.A. Gee. 2002a. Amphibians and reptiles. In P.S. Ong, L.E. Afuang, and R.G. Rosell-Ambal (eds.). Philippine Biodiversity Conservation Priorities: A Second Iteration of the National Biodiversity and Action Plan. DENR-Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program-UP CIDS, and Foundation for the Philippine Environment, Quezon City, Philippines. pp. 26-44.

Diesmos, A.C., R.M. Brown, and A.C. Alcala. 2002b. A new species of narrow-mouthed frog (Amphibia: Anura: Microhylidae; genus Kaloula) from the mountains of southern Luzon and Polillo Islands, Philippines. Copeia 2002. (4): 1037-1051.

Duellman, W.E. and L.S. Trueb. 1994. Biology of amphibians. The Johns Hopkins University Press, Baltimore. 670 pp.

Ferner, J. W., R.M. Brown, and A.E. Greer. 1997. A new genus and species of moist closed canopy forest skinks from the Philippines. Jour. Herpetol. 31(2): 187-192.

Ferner, J.W., R.M. Brown, R.V. Sison, and R.S. Kennedy. 2001. The amphibians and reptiles of Panay Islands, Philippines. Asiatic Herpetol. Res. 9:34-70.

Gray, J.E. 1845. Catalogue of the specimens of lizards in the collection of the British Museum. Trustees of die British Museum/Edward Newman, London.

Heaney, L.R. 2001. Small mammal diversity along elevational gradients in the Philippines: An assessment of patterns and hypotheses. Global Ecology and Biogeography. 10: 15-39.

Heaney, L.R., A.C. Diesmos, Tabaranza, B.T.,Jr., N.A. Mallari, R.M. Brown, G.V.A. Gee, and D.S. Balete. 2000. Report on preliminary biological survey of Balbalasang-Balbalan National Park, Kalinga, Northern Luzon. (Unpublished report).

Heaney, L.R., N.A. Mallari, G.V.A.Gee, M.V. Lepiten-Tabao, D.S. Balete, R.E. Fernandez, N. Antoque, A.C. Diesmos, R.M. Brown, D. Davison, E.A. Rickart, S. James, and K. Daley. 2001. Final report on a faunal survey of Balbalasang-Balbalan National Park, Kalinga Province, Northern Luzon, Philippines. (Unpublished report).

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.-A.C. Hayek, and M.S. Foster. 1994. Measuring and monitoring biological diversity: Standard methods for amphibians. Smithsonian Institution Press, Washington DC. xvii + 364 pp.

Inger, R.F. 1954. Systematics and zoogeography of Philippine Amphibia. Fieldiana: Zool. 33: 181-531.

International Union for the Conservation of Nature (IUCN). 2003. 2003 IUCN red list of threatened species. <www.redlist.org>. Downloaded on 14 December 2003.

Lepiten-Tabao, M.V., G.V.A. Gee, R.E. Fernandez, and G.O. del Rosario. 2000. Mt. Balbalasang rapid site assessment final report of the biological team. Haribon Foundation. (Unpublished report).

Mallari, N.A.D., B.R. Tabaranza, Jr., and M.J. Crosby. 2001. Key conservation sites in the Philippines. A Haribon Foundation and Birdlife International Directory of Important Bird Areas. Bookmark, Inc. Makati City, Philippines.

Ong, P.S., L.E. Afuang, and R.G. Rosell-Ambal (eds.) 2002. Philippine biodiversity conservation priorities: A second iteration of the national biodiversity and action plan. DENR-Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program-UP CIDS, and Foundation for the Philippine Environment, Quezon City, Philippines.

Rickart, E.A., L.R. Heaney, and R.B. Utzurrum. 1991. Distribution and ecology of small mammals along an elevational transect in southeastern Luzon, Philippines. J. Mammalogy. 72: 458-469.

Ross, C.A., A.C. Alcala, and R.V. Sison. 1987. Distribution of Zaocys luzonensis (Serpentes: Colubridae) in the Visayan Islands, Philippines. Silliman J. 34: 29-31.

Ross, C.A. and P.C. Gonzales. 1992. Amphibians and reptiles of Catanduanes Island, Philippines. Nat. Mus. Papers (Manila). 2: 50-76.

Simmons, J.E. 1987. Herpetological collecting and collections management. Society for the Study of Amphibians and Reptiles Herpetological Circular. 16: 1-70.

Taylor, E.H. 1922a. Additions to the herpetological fauna of the Philippine Islands, I. Philippine J. Sci. 21: 161-206.

. 1922b. Additions to the herpetological fauna of the Philippine Islands, II. Philippine J. Sci. 21: 257-303.

. 1922c. The lizards of the Philippine Islands. Philippine Bureau of Sci., Monogr. 17. Manila, Philippines.

. 1923. Additions to the herpetological fauna of the Philippine Islands, III. Philippine J. of Sci. 22: 515-557.

. 1925. Additions to the herpetological fauna of the Philippine Islands, IV. Philippine J. Sci. 26: 97-111.

. 1963. New and rare Oriental serpentes. Copeia 1963. 429-433.