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Non-Volant Mammals of Mt. Hamiguitan, Eastern Mindanao, Philippines

Danilo S. Balete[1], Roselyn S. Quidlat[2], and Jayson C. Ibañez[2]

[1] Corresponding author. Field Museum of Natural History, Chicago, IL 60605, USA, and Laksambuhay Conservation Inc., 10241 Mt. Bulusan Street, U-2, Los Banos, Laguna, Philippines. danilo.balete@gmail.com

[2] Philippine Eagle Foundation, VAL Learning Village, Ruby Street Marfori Heights, Davao City, Philippines.

Abstract

Sampling of various forest habitats along an elevational gradient from 200 m to 1128 m on Mt. Hamiguitan resulted in the capture of six species of non-volant small mammals, consisting of one shrew (Soricidae), one gymnure (Erinaceidae) and four rodents (Muridae). With the exception of an introduced, commensal rat, *Rattus exulans*, the rest of the species are native. Additionally, information gathered from local people and direct observation indicate the presence on the mountain of one species of tree-shrew (Tupaiidae), one flying lemur (Cynocephalidae), one primate (Cercopithecidae), three squirrels (Sciuridae), two civets (Viverridae), one wild pig (Suidae) and one deer (Cervidae). Strong association of the endemic species with primary and slightly disturbed forest, and the exclusive association of the pest species with open and severely degraded habitats, were noted. At least two species from the montane forest, based on preliminary examination, are potentially new to science, highlighting the importance of Mt. Hamiguitan as a unique center of endemism in the Philippines. Protection of representative montane forest habitats of the native species on Mt. Hamiguitan is recommended.

Keywords: elevational gradients, endemism, Mindanao, Mt. Hamiguitan, non-volant mammals, species richness

Introduction

The diversity and endemism of Mindanao mammals are some of the highest in the Philippines (Heaney et al., 1998; Musser and Heaney, 1992). However, even after several major expeditions to various mountains on Mindanao, as well as on adjacent islands, in 1946–1947 (Hoogstraal, 1951; Sanborn, 1952), 1951–1952 (Salomonsen, 1953; Sanborn, 1953); and 1960 (Rabor, 1966; Ripley and Rabor, 1961), there remain substantial gaps in our knowledge of the pattern of their distribution, as suggested by the results of more recent mammal surveys on Mt. Kitanglad, and on the islands of Camiguin and Dinagat, all of which produced previously unknown species of mammals (Heaney et al. 2006a, 2006b; Musser et al., 1998; Rickart et al., 1998, 2002, 2003).

Current understanding of the geology of Mindanao indicates that this island is a complex of independent volcanic sectors of various geologic ages and histories that coalesced into the modern Mindanao island ca. 5 Ma (Sajona et al., 1997). The eastern Mindanao volcanic sector is the oldest among them, with deposits ranging from 47 to 3 Ma, and is comprised of at least four mountain ranges, each isolated from the others, consisting of Mt. Hilong-Hilong, Mt. Diwata, Mt. Kampalili/Mayo complex, and Mt. Hamiguitan (Sajona et al. 1997, see also Heaney et al. 2006b). Prior to the present report, the mammal fauna of most of the eastern Mindanao was hardly known (Heaney et al. 2002, 2006b; Musser and Heaney, 1992). A member of the Philippine Zoological Expedition visited Mati and adjacent localities, just north of the Pujada Peninsula, but the Mt. Hamiguitan range was never explored (Hoogstraal, 1951).

The results of the mammal survey on Mt. Hamiguitan that we present here are the first ever documentation of the native mammals on this mountain range. The study was undertaken to generate baseline information on patterns of diversity and distribution of small mammals in the Mt. Hamiguitan Wildlife Sanctuary.

Materials and Methods

Study area

Mt. Hamiguitan Range (ca. 1620 m) is the dominant feature of the Pujada Peninsula, forming the southernmost extension of eastern Mindanao (Figure 1), and is known for its ultramafic deposits. Certain sections of this range, now placed under protected area status as the Mt. Hamiguitan Wildlife Sanctuary, host extremely

stunted forest, less than 1 m height, locally known as *bonsai* forest. The area has an even distribution of rainfall throughout the year, with an estimated average annual rainfall of 1,377 to 1,421 mm in the lowlands, based on the rainfall records of Mati (Manalo, 1956).

The small mammal surveys were conducted at the following sites on Mt. Hamiguitan, Davao Oriental Province, as shown in Figure 1, between May 2005 and May 2006:

Site 1

The site is located 17.5 km S, 4 km E Mt. Hamiguitan peak, 200 m elevation, lat 06° 34′ 36″ N and long 126° 13′ 21″ E, Mati Municipality. Sampling was done on 24-30 November 2005. The study site is situated on a low-rising ridge on the east coast, facing the Pacific. Sampling was done in regenerating lowland dipterocarp forest. The forest floor had a thin layer of dry leaf litter with a thin humus substrate underneath; some areas were filled with large boulders. Signs of previous logging activities in the area were abundant, including many tree stumps and abandoned fallen logs. Large clearings were also present inside the forest as a result of slash and burn agriculture. Root crops and coconut groves were abundant at the edge of the forest near the settlement.

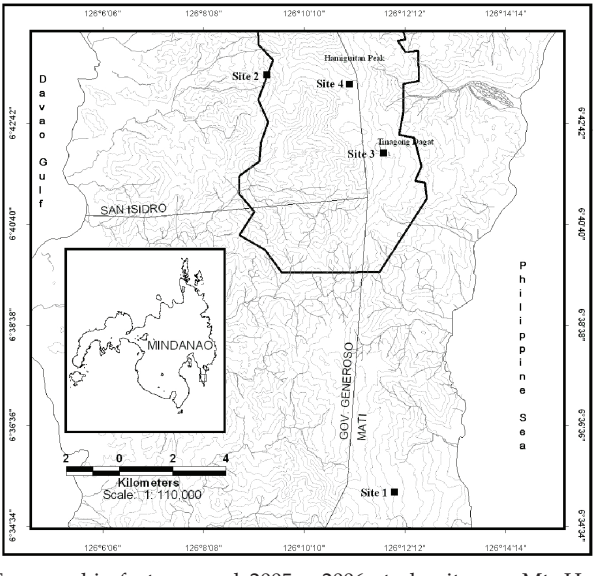

Figure 1. Topographic features and 2005 – 2006 study sites on Mt. Hamiguitan, showing Mt. Hamiguitan Wildlife Sanctuary (bold black line) and municipal (thin black line) boundaries; 100 m contour lines shown in gray dotted lines, rivers in gray branching lines. Inset shows Mindanao and adjacent islands, and section of the Pujada Peninsula enlarged to show study sites (open rectangle)

Site 2

The site is located 1.25 km S, 3.4 km W Mt. Hamiguitan peak, 525 m elevation, lat 06° 43′ 56.3″N, long 126° 09′ 3.2″ E, San Isidro Municipality. Sampling was done on 17-24 May 2005. Sampling was conducted in regenerating lowland dipterocarp forest on moderately sloping terrain. This site is located just outside the boundaries of the Mt. Hamiguitan Wildlife Sanctuary, and was part of a Community Based Forest Management site (CBFM) of the nearby community in La Union. Abundant tree stumps and rotting logs from past logging showed that dipterocarps were once common at the site. At the time of our survey, vegetation was dominated mainly by *malabayabas* (*Tristaniopsis* sp., Myrtaceae) of various age classes, with diameter at breast height (DBH) of 6 - 86 cm. The forest floor had a thick layer of dry leaf litter. Fresh forest clearings for *kaingin* (slash and burn agriculture) were evident.

Site 3

The site is located 3.7 km S, 1.4 km E Mt. Hamiguitan peak, 950 m elev., lat 06° 42′ 26.2″ N, long 126° 11′ 42.8″ N, Mati Municipality. Sampling was done on 20-27 July 2005 and 16 May 2006. This site is located around the area of *Tinagong Dagat*, a small, shallow seasonal lake. At the time of our survey toward the end of the dry season, at least three-quarters of the lake bottom was exposed and dry. This dry portion of the lake was covered largely with *cogon*, *Imperata cylindrica*, that extended to the very edges of the lake. Trapping along this grassy edge caught only the commensal pest species, *Rattus exulans*. Signs of recent burning of the cogon by local hunters to attract deer and other wildlife were evident.

Sampling at this site was done in the slightly disturbed transitional dipterocarp-montane forest, ca. 1 km from the *bonsai* forest. Vegetation was dominated by *Dacrydium elatum* (Podocarpceae), *Agathis philippinensis* (Araucareaceae), *Syzygium* spp. (Myrtaceae), and *Palaqium* spp. (Sapotaceae). Climbing *pandans* (*Freycinetia*), tree ferns (*Cyathea*), and pitcher plants (*Nepenthes* sp.) were abundant. The forest floor had thick leaf litter and humus. Additional trapping involving 48 Victor trap nights at this site was done on 16 May 2006, to further document *Podogymnura*. It also produced the first record of the Mindanao shrew, *Crocidura beatus*, at this site.

Site 4

The site is located 2.5 km S, 0.25 km E Mt. Hamiguitan peak, 1128 m elevation, lat 6° 43′ 3″ N, long 126° 11′ 1.9″ E, San Isidro Municipality. Sampling was done on 7-16 May 2006. This site lay at the eastern slope of the Tumadgo peak. The vegetation at

the sampling site was primary montane forest, with *bonsai* forest adjacent to it. Vegetation in the montane forest was dominated by *Agathis* stands, with moss covering tree branches and trunks, and over portions of the ground. The forest floor was covered by a thin layer of leaf litter, often exposing the reddish clay substrate. The *bonsai* forest had similar species composition of trees as the montane forest, only much reduced in height to as low as 0.5 m. Ground orchids were common in the *bonsai* forest and generally taller than the stunted trees. In wet, rocky areas along stream banks, *Pentafragma grandiflorum* (Pentafragmataceae) was common. The *bonsai* forest was relatively undisturbed except for foot trails and abandoned camping sites along the trail. Trapping was conducted mainly within the mossy forest, but limited sampling of the *bonsai* forest was also undertaken.

Methods

The survey followed the standard trapping techniques in sampling small mammals in the Philippines (Heaney et al. 1989, 1999, 2006b; Rickart, 1993; Rickart et al. 1991). Victor snap traps, Museum special traps, and locally manufactured cage traps were used. Traps were placed in various locations on the ground, including entrances of burrows, along runways, under root tangles, and under or on top of fallen logs. Limited trapping on leaning tree trunks, horizontal branches, and hanging vines was also undertaken. Traps were baited with either fried coconut strips coated with peanut butter or with live earthworms. Traps were rebaited and captured animals were collected twice each day, once in the morning (0600-0700 h) and once late in the afternoon (1600-1700 h).

At Site 4, various other baits were used to supplement coconut bait, due to the scarcity of earthworms. Trapping effort in the *bonsai* forest consisted of 219 trap-nights of Victors on the ground baited initially with pieces of dried fish, but were unbaited for the rest of the time due to lack of additional baits. The result of this trapping was excluded from the analyses of trapping success and bait attractiveness. To further standardize trapping effort, all captures and trap nights using cage traps were likewise excluded from analyses.

Voucher specimens were measured for external metrics, including total length, tail length, hind foot, ear, and weight, and examined for reproductive condition before they were fixed in formalin and preserved in 70% ethyl alcohol. Live individuals of common and

readily identifiable species that were already represented with voucher specimens were released close to their site of capture after photo documentation. Most voucher specimens were deposited at the Field Museum of Natural History, Chicago, for further studies, after which a portion will be transferred to the Philippine National Museum. The rest were deposited at the Central Mindanao University and University of the Philippines Mindanao.

Results and Discussion

Adequacy of sampling

Sampling effort at all three study sites was moderately intensive, averaging at least 700 standardized trap-nights each (Table 1). At Site 2 (lowland forest) and Site 4 (lower montane forest), the maximum number of species sampled was attained within 300 trap nights and plateaus were evident in less than 500 trap-nights (Figure 2A). While this contrasted markedly with the trapping efforts at higher elevations on Mt. Kitanglad and Mt. Isarog, where the asymptote of species accumulation curves typically occurred within 800 trap-nights, it is important to note that on these mountains the overall diversity of the non-volant small mammals was much higher than on Mt. Hamiguitan (Heaney et al., 1999, 2006b; Rickart et al., 1991). But the results of the sampling effort at lower elevations of Kitanglad, for instance, where the number of species present approximated those on Mt. Hamiguitan, show that asymptotes of the species accumulation curves were achieved within similar intensity of sampling (compare Figure 2A, this paper, to Figure 11 in Heaney et al., 2006b).

The exception was at Site 3 (in transitional lowland/montane forest at 950 m) where the asymptote was not evident, as a result of the limited trapping effort in May 2006 to collect additional information on the potentially new species of Podogymnura, which also documented the presence of the Mindanao shrew, *Crocidura beatus* at the site for the first time (Figure 2A). This would suggest that in situations where species diversity and densities are low, sampling over a longer period in any habitat type might be needed to achieve reliable estimates of species diversity.

Figure 2B, which shows the cumulative effort for all sampling sites on Mt. Hamiguitan, suggests that the trapping effort had successfully documented the level of diversity of murids and insectivores on Mt. Hamiguitan. While this provides a reasonable basis for estimating species richness and relative abundance of these taxonomic groups

at the sampled sites, we note here that the habitats above 1,128 m to the peak (ca. 1,620 m) remained unstudied. Similarly, the habitats below 500 m are either poorly sampled or unstudied. We recommend that future efforts to study the biodiversity of this mountain should focus on filling these gaps.

Species richness and relative abundance

Six species of small, non-volant mammals were documented on Mt. Hamiguitan by our trapping efforts (Table 1). Two were insectivores, consisting of a soricid shrew (*Crocidura beatus*) and an erinaceid gymnure (*Podogymnura* sp.), and four were murid

Table 1. Mammals recorded on Mt. Hamiguitan in 2005 and 2006. Philippine endemic species in boldface. Non-standardized captures and trap nights are shown in brackets. Number of native species documented using non-standardized methods is indicated in parentheses. Species occurrence based on reliable reports/observation by informants is indicated by R; inferred occurrence based on captures at elevations below and above a study site is indicated by P

Species	Common name	Study site (Elevation, m)				
		1 (200)	2 (525)	3 (950)	4 (1128[a])	4 (1128[b])
Podogymnura sp.	Mt. Hamiguitan gymnure	0	0	4	1	0
Crocidura beatus	Mindanao shrew	0	[1]	1	P	[1]
Urogale everetti	Mindanao tree-shrew		R			
Cynocephalus volans	Philippine flying lemur	R	R			
Macaca fascicularis	Long-tailed macaque	R	R			
Exilisciurus concinnus	Philippine pygmy squirrel		R			
Petinomys crinitus	Mindanao flying squirrel			R		
Sundasciurus philippinensis	Philippine tree squirrel		R			
Batomys sp.	Mt. Hamiguitan hairy-tailed rat	0	0	1	6 [+ 1]	0
Bullimus bagobus	Mindanao large forest rat	[4]	14 [+1]	5 [+2]	2	0
Rattus everetti	Common Philippine forest rat	[4]	3	3 [+1]	4 [+ 6]	[1]
Rattus exulans	Spiny rat	0	0	5	[1]	[3]
Paradoxurus hermaphroditus	Palm civet	R	R	R	R	R
Viverra tangalunga	Malay civet	R	R	R	R	R
Cervus mariannus	Philippine brown deer	R	R			
Sus philippinensis	Philippine warty pig	R	R			
Total captures		17 [+2]	18 [+3]	13 [+ 8]	[5]	
Total trap-nights		924 [+ 84]	784 [+ 68]	668 [+ 99]	[219]	
Total mammals per 100 trap-nights		1.83 [1.88]	2.30 [2.45]	1.95 [2.74]		
Number of native species		(2)	2 (+ 1)	5	4 (+ 1)	(2)

[a]lower montane forest, [b]bonsai forest

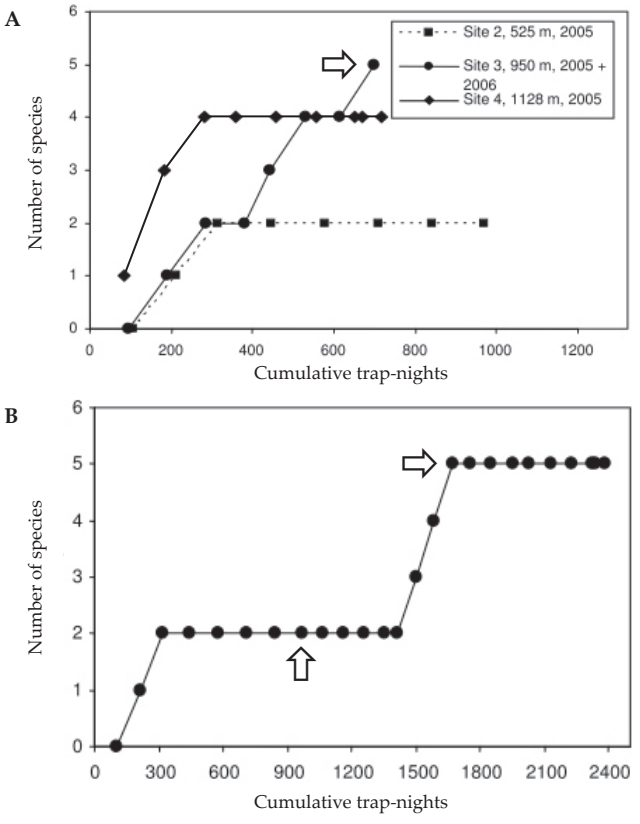

Figure 2. Species accumulation curves for non-volant small mammals at Sites 2 – 4 (A) and additively for all sites (B) on Mt. Hamiguitan; excluding trapping effort in the *bonsai* forest at 1128 m (Site 4). Arrow in A marks the result of one day of additional trapping at Site 3 (950 m) in May 2006. Arrows in B separate portions of curve from Sites 2, 3 and 4

rodents, including three native (*Batomys* sp., *Bullimus bagobus*, and *Rattus everetti*), and one alien pest species (*Rattus exulans*). The larger species of murid rodents are hunted for food, including *B. bagobus* and *R. everetti*, according to our local guides.

The large Mindanao forest rat, *B. bagobus*, was most abundant in regenerating lowland forest at Site 2 (525 m), accounting for more than 82% of the total captures at that site (Table 1). It showed a marked decrease in relative abundance with elevation, accounting for barely 15% of the total captures at Site 4 (1,128 m). In contrast, both the hairy-tailed rat, *Batomys* sp., and the common Philippine

forest rat, *R. everetti*, showed increasing relative abundance with elevation, while the Mindanao shrew, *C. grayi*, was consistently uncommon (Table 1). Limited trapping in the lowlands at Site 1 (200 m) using only cage traps recorded four individuals each of *B. bagobus* and *R. everetti* (Table 1). The results of trapping here were not included in the analyses due to the low intensity and the lack of standardized trapping effort. The spiny rat, *R. exulans*, a commensal pest species, was restricted to disturbed habitats, including the grassy edge of a small seasonal lake at Site 3 (950 m), and along a regularly used trail across the bonsai forest at site 4 (1128 m). It was not captured within the regenerating lowland forest (Sites 1 and 2) and in relatively intact primary montane forest (Site 3).

Our interviews with local guides and from observation of animal signs indicate that other non-volant mammals are present on Mt. Hamiguitan (Table 1), including tree shrews (*Urogale everetti*) and three species of squirrels: Philippine pygmy squirrel (*Exilisciurus concinnus*), Mindanao flying squirrel (*Petinomys crinitus*), and Philippine tree squirrel (*Sundasciurus philippinensis*). Others in the list are species commonly hunted for food, aside from the murid and sciurid rodents, including deer (*Cervus mariannus*), flying lemur (*Cynocephalus volans*), macaque (*Macaca fascicularis*), palm civet (*Paradoxurus hermaphroditus*), wild pig (*Sus philippensis*), and civet cat (*Viverra tangalunga*). Our failure to trap tree shrews and squirrels was reflective of the methods we used rather than of their abundance in the wild. Previous mammal surveys on Mindanao using similar methods that we employed on Mt. Hamiguitan experienced very poor trap success for both tree shrews and squirrels, though local residents using native traps had better success in catching those (Heaney et al. 2006b). This points to the need for future mammal surveys in areas where tree shrews and squirrels occur to employ additional methods, including native traps used by local hunters.

Three of the five native species of non-volant small mammals on Mt. Hamiguitan occurred in regenerating lowland forest at 525 m, all five were found in transitional lowland and lower montane forest at 950 m, and four were found in lower montane forest at 1,128 m (Figure 2). This is consistent with the observed pattern of increasing species richness with elevation in several parts of the Philippines, including Mt. Kitanglad, Mindanao (Heaney et al., 2006b; Rickart et al, 1991). However, the lack of standardized trapping efforts in the lowlands below 500 m (Site 1) and total lack of similar data in the mossy forest above 1,128 m (Site 4) did not permit the documentation of a complete pattern on Mt. Hamiguitan.

Our data failed to yield the curvilinear pattern in species richness common among well studied mountains, brought about by the decline of richness with further increase in elevation beyond transitional montane/mossy forest (Rickart et al., 1991; Heaney et al., 2006b). The consistency of the pattern of increasing species richness from the lowland to transitional montane forest, as seen in Table 1, led us to predict that this curvilinear pattern of species richness will be similarly observed on Mt. Hamiguitan once a thorough sampling of small mammals is done in the mossy forest up to the peak, which we strongly recommend.

As evident in Table 1, the relative abundance of the non-volant small mammals on Mt. Hamiguitan is remarkably lower than either Mt. Isarog or Mt. Kitanglad overall (Heaney et al., 2006b, 1999; Rickart et al., 1991). Only slight variations among the three study sites, with just a discernible slight increase in transitional lowland/montane forest at Site 3, and a comparable incremental decrease in primary montane forest at Site 4, are evident. It is interesting to note, however, that in comparable habitat types below the transitional montane/mossy forest, the observed densities (as number of mammals/100 trap nights) are higher on Mt. Hamiguitan (1.83 in lowland forest at 525 m, and 2.30 in montane forest at 925 m; Table 1, this study) than on Kitanglad (0.37 in lowland forest at 1100 m and 0.87 in montane forest at 1600 m; Table 2, Heaney et al., 2006), principally due to the presence of the large Mindanao forest rat, *B. bagobus*, and in higher abundance than *R. everetti*, at lower elevations on the former but not on the latter. On the other hand, the Mindanao shrew, *C. beatus*, appeared to be widespread elevationally and in naturally low numbers throughout the elevational range on both Mt. Hamiguitan and Mt. Kitanglad (Heaney et al. 2006; this study).

Biogeography and ecology of eastern Mindanao mammals

Eastern Mindanao is known for its extensive deposit of ultramafic soils which support a distinct vegetation type. However, the serpentine flora of this region is poorly known, as with the rest of the Philippines where it is estimated that about 5% of its area is comprised of ultramafites (Brooks, 1987). This report is the first documentation of non-volant mammals in ultramafic forest on Mindanao. Among the 17 species recorded on Mt. Hamiguitan, only the introduced spiny rat (*R. exulans*) is non-native and only three of the native ones (*M. fascicularis*, *P. hermaphroditus*, and *V. tangalunga*) are non-endemic. A remarkable three of every four species we documented are endemic. Preliminary analyses of the results of

our survey further indicate that several species are unique to Mt. Hamiguitan, including an erinaceid gymnure and a murid rodent that are now in the process of being described. It shows that a high percentage of the species we documented on Mt. Hamiguitan is shared with the rest of the Mindanao faunal region (Table 1; Heaney et al. 2006a, 2006b, 1998).

As summarized by Heaney et al. (2006b), the distribution of the mammals on Mindanao is strongly correlated with the extent of land connections among the islands that comprised Greater Mindanao (*sensu* Heaney, 1986) when sea level dropped to 120–125 m below current levels during the Pleistocene. Reflective of such Pleistocene connectivity, a high degree of homogeneity in composition of the mammalian fauna is observed among the present islands comprising the Mindanao faunal region: Samar, Leyte, Bohol, Mindanao, Dinagat and Basilan, among others (Heaney et al., 1998). As more detailed and comprehensive surveys are conducted on some of these islands, an increasing degree of local endemism of non-volant small mammals on the studied islands, especially at high elevations, is becoming apparent (Heaney et al. 2006a, 2006b; Heaney and Rabor, 1982; Musser et al., 1998; Rickart et al., 1998, 2002, 2003).

Mindanao provides a clear demonstration of this phenomenon, already evident on Luzon, with the patterns observed on the Kitanglad Range by Heaney et al. (2006b). Geologic investigations indicate that the present island of Mindanao is a complex of at least four originally isolated volcanic sectors that coalesced ca. 5 Ma (Sajona et al., 1997). The Kitanglad Range, situated in the central Mindanao volcanic sector, has three species currently only known to occur in the high elevation habitats of this mountain and nowhere else: *Alionycteris paucidentata*, *Crunomys suncoides* and *Limnomys bryophilus*. Heaney et al. (2006b) predicted that similar patterns might occur in the other volcanic sectors of Mindanao, including Eastern Mindanao, Zamboanga pensinsula, and Daguma-Saranggani. Our results on Mt. Hamiguitan, showing that a species of gymnure (*Podogymnura*) and hairy-tailed rat (*Batomys*) are potentially new to science and are both restricted to the transitional lowland/montane and montane forest at 950 m and higher, are consistent with this prediction.

The spiny ricefield rat, *R. exulans*, was documented only in heavily disturbed habitats on Mt. Hamiguitan, including the regularly burned grassy edge of the seasonal lake, *Tinagong Dagat*, at Site 3 and edges of frequently used trails at Site 4. This is consistent with

the pattern of distribution of commensal pest species on mountains with intact communities of native small mammals on Luzon and on Mt. Kitanglad (Heaney et al., 1999, 2005, 2006b; Rickart 1993) and supports the hypothesis that the number of native small mammals species in natural forest habitats on oceanic islands determines the successful colonization of such habitats by invading non-native mammals (Heaney, 2001; Heaney et al., 1999).

Conservation and management

Preliminary analyses of the results of our survey indicated that there are at least two potentially new species of small, non-volant mammals (*Podogymnura* and *Batomys*) restricted to the high elevation habitats on Mt. Hamiguitan (Table 1), highlighting the importance of this mountain range as a unique center of endemism in the Philippines. Both of these species appeared to be relatively uncommon overall and may occur naturally in low numbers, as our trapping data indicated. However, we recommend further studies to document the population biology of these species. We also recommend that representatives of the high elevation forest habitats of these species be placed under similar protection and management as the current Mt. Hamiguitan Wildlife Sanctuary, which presently covers mainly the *bonsai* forest. This is especially important as there is no permanent guarantee that the portions of this protected area already covered by Mineral Production and Sharing Agreements (MPAs) will not be exploited when profitable opportunities arise.

The other native species we documented, *C. beatus*, *B. bagobus*, and *R. everetti*, are known to be elevationally and geographically more widespread on Mindanao, and tolerant of some degree of habitat disturbance (Heaney et al., 1998; 2006b). Both *B. bagobus* and *R. everetti* appeared to be tolerant of some degree of hunting as well, as both of these species are hunted by upland settlers on Mt. Hamiguitan and Mt. Kitanglad (Heaney et al., 2006b; NORDECO and DENR, 1998; this study). We recommend further studies to document the hunting pressure on these species to enable viable and sustainable management of this important subsistence activity of the local people in the area. Several other species of mammals on the mountain are hunted for food, including macaques, squirrels, civets, deer, and wild pigs. Among them, the Philippine warty pig (*S. philippinensis*) and Philippine brown deer (*C. mariannus*) are the more heavily hunted throughout their range and have suffered drastic reduction of their populations (Heaney et al., 1998; 2006b). We recommend that hunting on Mt. Hamiguitan be restricted to the

native upland people using sustainable traditional hunting practices. Selling of game meat from animals hunted on the mountain should be discouraged as well.

Conclusion

This report provides the first extensive documentation of the non-volant mammals of Mt. Hamiguitan, including their patterns of diversity, abundance and distribution, as well as their utilization by the indigenous peoples of the mountain. The mammal survey showed that Mt. Hamiguitan supports a high diversity of native, non-volant mammals, of which 75% are endemic to the Philippines, including seven that are found only within the Mindanao Faunal Region and potentially two that are only on Mt. Hamiguitan and nowhere else (Table 1; Heaney et al. 1998). The two species of small, non-volant mammals now undergoing description indicate that Mt. Hamiguitan is a unique center of endemism. We recommend further protection of representative forest habitats of these native and endemic mammals.

Our trapping effort was shown to be adequate to document the patterns of species diversity and abundance of small, non-volant mammals at our study sites in regenerating lowland forest at 525 m to primary lower montane forest at 1128 m on Mt. Hamiguitan. The same patterns are unknown in the poorly studied or unstudied habitats in the lowland forest below 500 m and montane forest above 1128 m; we recommend that future biodiversity research on the mountain should try to fill this gap in knowledge.

In comparison with species diversity and abundance of small, non-volant mammals on mountains of higher elevations (e.g., Mt. Kitanglad, 2938 m, and Mt. Isarog, 1966 m) those of the sampled habitats on Mt. Hamiguitan (1620 m) were relatively lower but consistent with the pattern of increasing diversity with elevation predicted from similar studies elsewhere in the Philippines. Our results further suggest that aside from sampling intensity, sampling over a longer period of time might be necessary to reliably document pattern of species diversity and abundance in habitats that are naturally depauperate in native species.

Our results also revealed some level of utilization by the indigenous peoples of many of the non-volant mammals on the mountain, including sciurid and murid rodents, viverrid carnivores, deer and wild pigs. We recommend further research on hunting pressure on these animals to identify viable and sustainable management options for this subsistence activity of indigenous peoples.

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