Distribution and diet of small non-volant mammals along elevational gradients of Mt. Banahaw

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Wet and dry season samplings for small non-volant mammals in Mt. Banahaw were conducted in July 2013 and March to April 2014, respectively. Nine sites representing five habitat types in two sides of Mt. Banahaw (de Lucban and de Tayabas) were sampled. Nine species consisting of six native and three non-native species with a total of 290 individuals were recorded. Trap success was highest in agricultural sites for Lucban and Tayabas, at 16% and 17%, respectively, during the wet season. It was lowest in the secondary lowland forest in Tayabas with an average of 0.67% trapping success. The most abundant species were the non-native *Rattus tanezumi* and the Banahaw endemic *Apomys banahao.* One of the highlights of this survey was the first confirmed record of *Chrotomys mindorensis* in Mt. Banahaw de Lucban within the agricultural area. Diet of native species consisted mostly of arthropod parts while non-native species contained mostly plant or digested matter. Our data suggest that, in the Mt. Banahaw–San Cristobal Protected Landscape, non-natives may have little negative effects on native wildlife species. However, habitat integrity must be maintained, and further agricultural encroachment should be prevented.

KEYWORDS

rodents, disturbance, native, non-native, forest

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INTRODUCTION

The challenge for the Philippines as one of the 17 megadiverse countries of the world (Mittermeier et al. 1999) has been to protect and conserve its biological wealth and the integrity of its environment. Both species richness and endemism are high, and new species continue to be discovered in the Philippines. Forest destruction is the primary threat to Philippine wildlife (Rickart et al. 2007); yet another potential threat is the impact of introduced species on the native wildlife (Aplin and Singleton 2003). Small non-volant mammals (rats, mice, and shrews) are the most common introduced species, often found in association with human habitation and are potential invasive species in natural areas (Heaney et al. 2010, 2016).

Non-native rodents cause great economic losses in the lowlands through damage to crops and properties as well as their potential to transmit diseases. However, very little is known on their potential effects on our biodiversity. Non-native rats have been reported to have caused extinctions on oceanic islands and severe biodiversity losses elsewhere. As a result of increasing human population, local people have migrated to mountains and brought with them commensal rats and shrews. Thus, aside from destruction and conversion of forests, commensal species have also been introduced into lowland and primary forests.

Mt. Banahaw is an excellent area to investigate interactions between native and non-native species. It supports a variety of habitats, both natural and disturbed, including secondary-growth forest, mixed grassland and agro-forest areas, secondary lowland evergreen forest, and montane and mossy forests. The mountain supports a variety of endemic wildlife species. Two of the frog species endemic to Mt. Banahaw are *Platymantis pseudodorsalis* found at 600–1200 masl and *Platymantis indeprensus* found at the sub-montane forest 1080 masl (Brown

Table 1: Site description for Mt. Banahaw de Lucban and Tayabas

SITE	LOCATION	HABITAT	DESCRIPTION
L1	N 14^{0}06'09.5" E 121^{0}31'37.3" (698–720 masl) Bgy. Samil, Lucban	**Agricultural**	Vegetable cropland adjacent to South Luzon State University (SLSU) Botanical Garden; crops consisted of *sayote* and sweet potato.
L2	N 14^{0}06'03.4" E 121^{0}31'27.6" (745–771 masl) Bgy. Samil, Lucban	**Secondary Lowland**	There was 60-80% canopy cover and slope ranging from 0° to 20°. Medium-sized palms *Pandanus* and *Musa* were abundant in the understory and midcanopy level.
L3	N 14^{0}05'40.5" E 121^{0}31'08.0" (916–1305 masl) Bgy. Samil, Lucban	**Montane Forest**	There was about 70% canopy cover and slope ranging from 15° to 35°. Large *Pandanus* were abundant at understory and canopy level.
L4	N 14^{0}04'54.7" E 121^{0}30'58.2" (1494–1613 masl) Bgy. Samil, Lucban	**Mossy Forest**	There was about 80% canopy cover and slope ranging from 20° to 50°. Emergent tree height was around 8–12 meters with 20–30 cm diameter at breast height.
T1	N 14^{0}02'55.4" E 121^{0}32'43.9" (547–575 masl) Bgy. Lalo, Tayabas	**Agricultural**	Rice fields adjacent to grassland and chicken farm nearest the reforestation area.
T2	N 14^{0}03'08.6" E 121^{0}32'27.0" (626–651 masl) Bgy. Lalo, Tayabas	**Lowland Evergreen Forest**	A reforestation site with small to medium saplings and fruit trees. Previously a coconut plantation and currently adjacent to a municipality-established rain gauge surrounded by sweet potato cropland area.
T3	N 14^{0}03'21.8" E 121^{0}32'02.9" (754–1057 masl) Bgy. Lalo, Tayabas	**Lowland Evergreen Forest**	A regenerating secondary lowland forest with 20–40° slope. Understory vegetation includes ferns, rattan, *Medenilla*, and small trees ranging from 8 to 10 m in height.
T4	N 14^{0}03'40.5" E 121^{0}30'50.4" (1361–1449 masl) Bgy. Lalo, Tayabas	**Montane Forest**	There was 20-60° slope. Understory vegetation includes cypress, rattan, and *Pandanus*. Height of canopy is around 10–15 meters.
T5	N 14^{0}03'53.8" E 121^{0}30'35.9" (1494–1794 masl) Bgy. Lalo, Tayabas	**Mossy Forest**	There was 45–60° slope. Canopy height is 5–6 meters with moss, *Freycinetia* as epiphytes.

et al. 1999). Four recently described mammal species found nowhere else but in Mt. Banahaw are (1) the Banahao forest mouse, *Apomys banahao,* documented from 1465 m to 1750 m in mossy forest (Heaney et al. 2011), (2) the large Banahao forest mouse, *Apomys magnus*, found from 1100 to 1250 m, (3) the Banahao shrew rat, *Rhynchomys banahao*, found at 1250–1465 masl (Balete et al. 2007), and (4) the Banahao tree mouse, *Musseromys gulantang*, discovered in 2004 in a regenerating secondary forest at an elevation of 620 m (Heaney et al. 2009). In addition, Mt. Banahaw is an important center of native bird diversity, known to support 51 Philippine-endemic species (Dans and Gonzalez 2010). Due to Mt. Banahaw's popularity as a pilgrimage site during the Lenten season and as a mountaineering place, some of its areas are inhabited by upland settlers and are a popular destination for tourists and campers. Habitat disturbance associated with human visitation has likely encouraged the spread of non-native commensal species of which three (*Suncus murinus*, *Rattus exulans*, and *Rattus tanezumi*) have been recorded from the area (Heaney et al. 2013).

Thus there is reason to believe that native wildlife species in Mt. Banahaw may be susceptible to negative ecological effects of these commensals brought about by such human disturbances. One important potential effect involves competition for food resources. The aim of this study was to determine diets of both native and non-native small mammals through analysis of gut contents taken from specimens at various elevations on Mt. Banahaw. By identifying the diet of both native and non-native rats/shrews, the potential effects of non-native species on our native species can be inferred. Information gained can be used to design conservation strategies for our native species.

METHODOLOGY

Study Site

The Mt. Banahaw–San Cristobal Protected Landscape (MBSCPL) was declared a Protected Area via Presidential Proclamation No. 411 on June 25, 2003. It serves as a watershed for the provinces of Laguna and Quezon. It is an active volcano and is the highest mountain in the southwestern Luzon volcanic region. The MBSCPL is also one of the 128 identified Key Biodiversity Areas (Ong et al. 2002) and is classified as "Very High" priority for biodiversity conservation. For this study, two sides were chosen for our sites: Banahaw de Lucban and Banahaw de Tayabas. Table 1 shows the nine sites and the habitat at each site. A total of 5,400 trap nights were completed for the dry and wet season samplings.

For both Lucban (L1–L5) and Tayabas (T1–T5) sampling sites, disturbance ranged from severe in the agricultural areas to moderate in the secondary-growth lowland/regenerating forest and slight in the montane and mossy forests. L1 and T1 represent deforested areas that have continuously been tilled and have no chance of regenerating. In L2, T2, and T3, there were no established households present within the forested areas, but

Figure 1A: Mt. Banahaw de Lucban trapping sites (1—Agricultural, 2—Secondary lowland, 3—Montane, and 4—Mossy forest)

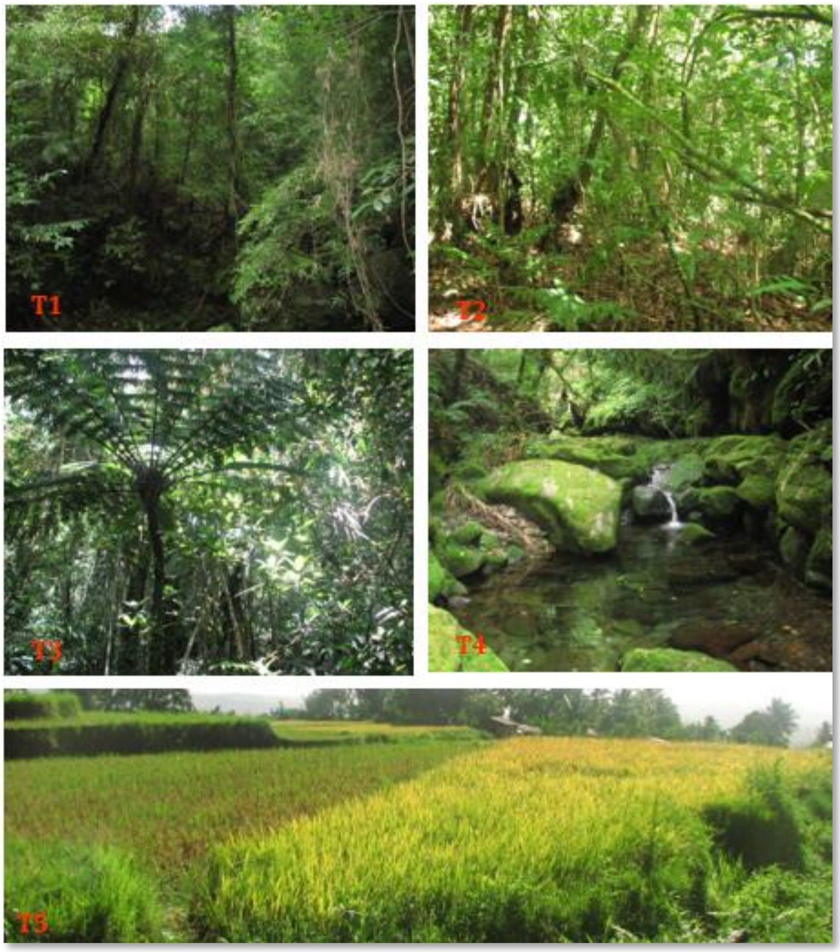

Figure 1B: Mt. Banahaw de Tayabas trapping sites
(1— Secondary lowland forest, 2—Secondary growth, 3—Montane forest, 4—Mossy forest, and 5—Agricultural)

temporary living quarters for rangers/guards or camping areas for visitors are located within the secondary-growth lowland forests. These sites represent areas that have been previously subjected to logging or other activities but are at various stages of regeneration. L3, L4, T4, and T5 are generally intact forests slightly subjected to human disturbances such as hiking activities.

Collection of specimens

We collected small mammals during the wet season (July 13 to 29, 2013) and dry season (March 29 to April 13, 2014) following the terms and conditions of the Wildlife Gratuitous Permit (R4A-WGP-10-2013-QUE-003). Four sites were established in Lucban, while five sites were established in Tayabas (figures 1A and 1B).

Table 2: Species recorded and trapping success per site for dry and wet season sampling

SITE	SPECIES	WET SEASON	DRY SEASON	WET SEASON TRAPPING SUCCESS	DRY SEASON TRAPPING SUCCESS
L1				**16.00%**	**6.67%**
	Apomys microdon	8	0		
	Chrotomys mindorensis	1	0		
	Rattus everetti	0	1		
	Rattus exulans	4	0		
	Rattus tanezumi	35	20		
	Suncus murinus	1	0		
L2				**0.67%**	**1.00%**
	Rattus exulans	1	0		
	Rattus tanezumi	1	3		
L3				**0%**	**2.33%**
	Rattus everetti	0	7		
L4				**1.67%**	**11.33%**
	Apomys banahao	1	25		
	Apomys magnus	3	3		
	Rattus everetti	0	6		
	Rhynchomys banahao	1	0		
T1				**17.33%**	**4.33%**
	Rattus exulans	3	0		
	Rattus tanezumi	9	12		
	Suncus murinus	0	1		
T2				**4.00%**	**5.00%**
	Rattus everetti	3	3		
	Rattus tanezumi	9	12		
T3				**0.67%**	**0.67%**
	Apomys banahao	0	1		
	Rattus everetti	2	1		
T4				**5.67%**	**3.67%**
	Apomys banahao	13	11		
	Apomys magnus	1	0		
	Rattus everetti	3	0		
T5				**11.00%**	**11.00%**
	Apomys banahao	30	30		
	Apomys magnus	2	2		
	Rattus everetti	1	1		

Small non-volant mammals (murid rodents and shrews) were captured using fabricated cage traps baited with roasted coconut meat mixed with peanut butter and/or mealworms. Sixty percent of the traps were set with coconut bait, while 40% were baited with both. Three hundred trap nights per site per season were completed. Traps were set starting around 1400 h and were checked the following morning at 0700 h. Traps were positioned 5 to 10 m apart in strategic areas suspected to be runways or burrows, such as root tangles, tree buttresses, near rotting logs, and small crevices under boulders. Upon capture, individual animals were measured and their sex, age category (adult, sub-adult, or juvenile), and reproductive condition recorded. We identified animals to species by using published references (Aplin et al. 2003; Balete et al. 2007; Heaney et al. 2011).

For native species, a maximum of 15 individuals per species per site were collected as voucher specimens; then all other captured individuals were released after data were recorded. For the non-native species, all captured animals were collected. The biometrics of individuals caught were noted, followed by excision of the gastrointestinal (GI) tract from the cardiac end of the stomach to the anus. Samples were placed in 10% formalin.

In addition to the specimens mentioned above, we obtained 40 stomachs of *Apomys banahao* from specimens that were deposited at the Field Museum of Natural History (Chicago, Illinois) and collected in 2004 by Lawrence Heaney and company. For these specimens, earthworm bait was used instead of mealworm.

A reference collection was made with arthropods collected within the sampling sites. The arthropod specimens were collected manually or with the help of an insect net and were mounted on glass slides.

Extraction and identification of gut contents

GI tracts were opened and the contents rinsed and swirled in 50 ml of 2% detergent solution (Joy™), then filtered by using a 35-mesh sieve and rinsed with tap water until the filtrate became clear. The debris remaining in the sieve was placed on a petri plate and sorted. This same procedure was used in the analysis of the 40 stomachs obtained from the Field Museum of Natural History (coded LRH).

The debris collected represented the gut contents of the rodent. They were air-dried and examined under the dissecting microscope. A 5x5 mm grid was placed under the petri plate, and contents were categorized into soil, hair, bait, arthropod, plant matter. Those that were unidentifiable were categorized as digested food. For every category, the number of squares in the grid that it covered was counted. To get the percentage, the number of squares of the specific category was divided by the total number of squares counted. The arthropods obtained from gut content specimens were further identified, when possible, to the lowest taxon using Calilung and Facundo (1999) and the reference collection.

Table 3: Percentage of each food category per species*

Species	No. of samples	Digested Food	Soil	Hair	Arthropod	Plant Matter	Bait
Suncus murinus	1	5.11	0	0	0.41	**94.48**	5.11
Apomys banahao	21	16.55	10.80	1.92	**52.36**	5.20	13.17
Apomys magnus	5	7.59	9.33	0.10	**56.63**	6.68	19.67
Apomys microdon	5	25.60	4.13	0.00	8.29	26.69	**35.29**
Chrotomys mindorensis	1	10.71	0.00	0.00	4.76	37.17	**47.35**
Rattus exulans	8	**35.17**	0.00	0.00	6.97	23.84	34.03
Rattus tanezumi	78	**35.96**	0.83	0.07	6.87	28.44	31.77
Rattus everetti	8	**39.30**	12.76	0.00	2.13	19.07	26.73
Rhynchomys banahao	1	0.00	16.00	0.00	15.5	0.33	**68.17**

* Highest percentages in **boldface type**

RESULTS

Trapping results

Nine identified species of small mammals were caught during both seasons (table 2), including one shrew and eight murid rodents. Of these nine species, three are non-native, while the remaining native species include three that are widespread Philippine endemics and three that are endemic to Mt. Banahaw. Although there have been unverified reports of *Chrotomys mindorensis* on Mt. Banahaw, our study yielded the first confirmed specimen of this species in this area. Four additional native species (*Apomys musculus*, *Bullimus luzonicus*, *Crocidura grayi*, and *Musseromys gulantang*) documented in earlier surveys of Mt. Banahaw (Heaney et al. 2013) were not captured during our study.

Table 2 also shows the trapping success for each site per season. Although the trapping success was higher for both agricultural sites (L1 and T1) during the wet season sampling, L1 had the highest number of species, both non-native and native, caught between the two sites. Trapping success for the secondary lowland, montane, and mossy forest habitats were consistently higher during the dry season sampling than during the wet season sampling with the exception of Tayabas Montane forest (T4). However, no significant difference was found for trapping success between the two seasons ($p = 0.33$).

Gut Contents

Table 3 shows the percentages of each food category per species. Gut content sample size was insufficient for species except for *R. tanezumi*. No significant difference ($p = 0.15$) was found in the diet of *R. tanezumi* during wet or dry season. The presence of soil may have been due to accidental ingestion during feeding, while presence of hair may be a result of grooming. Both *Rattus* species (*R. tanezumi* and *R. exulans*) contained large amounts of unidentifiable digested matter which was mixed with plant and bait parts. Gut contents of *Suncus murinus*, which is primarily an insectivore but occasionally eats fruits, showed a marked preference for plant matter (Heaney et al. 2016).

By contrast, the two Banahaw endemic species, *Apomys banahao* and *A. magnus*, showed a preference for arthropods. *R. everetti*, a widespread native, contained plant matter and mostly unidentifiable digested matter and bait. The other native species, *A. microdon*, *C. mindorensis*, and *R. banahao*, contained mostly bait pieces (either mealworm or coconut bait). The gut contents of native species contained mostly arthropod parts, while non-native species contained mostly plant or digested matter. When the arthropod category was further identified to the lowest taxon possible, the identified arthropods consisted of those that are mostly terrestrial in nature.

Due to the relatively high number of *A. banahao* samples, arthropod pieces were further divided into two classes: Diplura and Insecta. Diplurans are common decomposers that inhabit forest leaf litter and help break down and recycle organic nutrients (Meyer 2013). The rest of the identified arthropod pieces were representatives of Class Insecta, the true insects. Those that undergo a gradual change in body from larva to adult (incomplete metamorphosis) were represented in the arthropod pieces by four Orders: Orthoptera, Blattodea, Mantodea, and Pthiraptera. Those that undergo complete metamorphosis, enabling them to respond to different selective pressures at different life stages, were represented in the arthropod pieces by three Orders: Coleptera, Hymenoptera, and Diptera. Overall the identified arthropods consisted of those that are mostly terrestrial in nature.

For the *A. banahao* LRH specimens which were collected from a different sampling period, the gut content average percentages per category are as follows: arthropod category (60%), soil (18%), hair (14%), earthworm bait (4%), and plant matter (4%). Four orders comprise a majority of the arthropod identified pieces: Blattodea (33%), Coleoptera (25%), Orthoptera (19%), and Hymenoptera (15%). The remaining four taxa—Diplura, Mantodea, Diptera, and Pthiraptera—each comprise 2% of the identified arthropod individuals.

DISCUSSION

Distribution of native and non-native mammals

Natural forest ecosystems, such as lowland, montane, and mossy forests, are the typical habitats of native small non-volant mammals in the Philippines. Originally heavily forested, the Philippine landscape was greatly transformed due mainly to logging, leaving the remaining tracts of our forests exposed and exploited for agriculture, mining, agro-forestry, tree farms, and human occupancy (Bautista 1990). Consequently, in mixed landscapes with a mosaic of forest, grassland, riparian, and agricultural habitats, a diversity of native and non-native rodent species may coexist (Heaney et al. 2006). For Mt. Banahaw, elevations approximately below 720 and 575 masl in Lucban and Tayabas, respectively, have been converted to agricultural areas. Since non-native commensal rodents invade areas of agricultural land that was originally the habitat of native species some of which can tolerate disturbances, such areas (as observed in L1) have higher species richness due to the coexistence of native and non-native species.

Studies on the distribution of non-native small mammals in mountains suggest that degree of disturbance may obscure elevational patterns. Native species are most diverse and abundant in habitats that are relatively undisturbed, although many occur in disturbed forests (Rickart et al. 2007). Non-native species readily colonize disturbance sites and are predominant in severely disturbed habitats (Rickart et al. 2011; Reginaldo and de Guia 2014). Our results show that non-natives in Mt. Banahaw are found only up to the secondary-growth lowland evergreen forest, ~745 masl in Lucban and 651 masl in Tayabas.

Some native species, by contrast, persist in second growth, and a few may reach peak abundance in moderately disturbed habitats. Thus native species have variable tolerance for disturbance. Our results indicate that *R. everetti*, *Chrotomys mindorensis*, and *A. microdon* are able to tolerate certain degrees of disturbances and are able to persist within the same elevational gradient(s) as non-native species. This is further supported by the study of Stuart et al. (2011) in the lowland agro-forest of the SMBC (Sierra Madre Biodiversity Corridor) with evidence suggesting competition between native (*Rattus everetti*) and invasive rodent species (*R. tanezumi*) in complex agro-ecosystems. Their study further provided evidence of *R. everetti* outcompeting *R. tanezumi*.

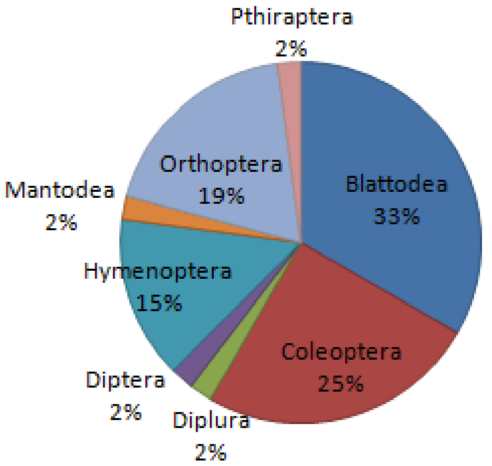

Figure 2: Percentage of arthropod pieces identified per taxon

The montane and mossy forests support rich communities of native small non-volant mammals composed of Mt. Banahaw–endemic *Apomys banahao*, *A. magnus*, and *Rhynchomys banahao* such that non-natives are unable to invade these areas (Rickart et al. 2007). However, future habitat degradation/conversion may cause overlap or range reduction of native species. This may drive changes in the dynamics of the ecosystem especially when keystone species are affected (St. Clair 2011; Sugihara 1997; Pisanu et al. 2011).

Ecological generalists versus ecological specialists

Our results suggest that the introduced small non-volant mammals are dietary generalists, and they do not compete with the food resources of the native rodents. They are known as opportunistic feeders, and in this case they have ample food available within the croplands. Food resources that are at lower elevations and are available in agricultural areas are sufficient to support the non-natives. This may be contrary to mountains with permanent households such as Mt. Makiling (de Guia and Quibod 2014), where *R. tanezumi* was recorded within the montane forest (~760–899 masl) and where there was evidence of predation on vertebrate wildlife and possibly competition for food resources with native rodents.

Rattus everetti is the only native rodent that has a widespread distribution throughout most of the Philippine islands. On mountain ecosystems it also has broad elevational ranges, though occurring more commonly at low-to-medium elevations. *R. everetti* also appear to be opportunistic feeders with broad diets and are ecological generalists.

Chrotomys mindorensis and *Rhynchomys banahao* are ecological specialists that burrow and are known to feed on earthworms. Both appear to be uncommon. However, they vary in terms of disturbance tolerance; *C. mindorensis* can be found in a variety of habitats including highly disturbed agricultural areas in Luzon and Mindoro islands, while *R. banahao* is known only from the mossy forests of Mt. Banahaw. Based on our results, *C. mindorensis* may not be entirely vermivorous but also take the opportunity to feed on vegetables in croplands. Thus it may be considered an omnivore. This needs further investigation as this observation was based on a single specimen only. Heaney et al. (2016) further discusses that the genus *Chrotomys*, as burrowers, are able to escape the daily temperature and humidity fluctuations in highly disturbed areas. *R. banahao*, meanwhile, has a restricted range as well as diet. It was caught using mealworm as bait, had a large percentage of it in the gut along with soil and arthropod parts.

Among the species examined, *A. banahao* and *A. magnus* had marked preference for arthropods. Orthopterans (grasshoppers, locusts, and crickets) are commonly encountered on the ground or vegetation. Blattodea (cockroaches) are usually found below or on the ground in low vegetation and debris. Their diet consists mostly of dead animal matter. Mantodea (mantids) are essentially terrestrial and solitary insects that mostly live in shrubs, herbs, or tree trunks, but a few species are also known to live on the ground. The Pthiraptera (biting and sucking lice) are obligate parasites of birds and mammals, and they spend their whole life on the body of their host (Calilung and Facundo 1999). Its occurrence in the stomach of *Apomys banahao* suggests that the rodent may have ingested the particular individual during grooming. This coincides with the known behavior of *A. banahao*, foraging on the ground at night (Heaney et al. 2011). Figure 2 shows a representation of the percentage of arthropod pieces from *A. banahao* specimens. These results coincide with the *A. banahao* specimens collected from this study, which may indicate that the diet of *A. banahao* is consistent across different years and seasons.

A markedly higher representation of Coleoptera (beetles) is not unusual since it is the largest order not only in the insect class but also in the animal kingdom. Their habits are extremely varied, but most are ground-inhabiting, living in soil or in decaying animal or plant matter, especially those that are scavengers. Other species are associated with herbaceous plants, shrubs, and trees owing to their herbivorous nature. Hymenoptera is represented by the ant Family Formicidae. Ants forage for food, which includes vegetation, seeds, or other insects. Dipterans (true flies) live in a wide range of habitats and display enormous variation in appearance and lifestyle (Meyer 2013).

Possible effects of non-natives on native species

Not all non-native species pose negative ecological effects which can be determined by studying significant changes in ecological patterns or processes at the population level (Simberloff et al. 2012). However, the negative effects far outweigh benefits that invasive non-native species may contribute to ecosystems. Threats to native wildlife species include predation, competition, and transmission of diseases.

Among the non-native species recorded in the sampling sites, *Rattus tanezumi* is the most abundant and widespread. Shiels et al. (2013) discussed the various effects of *R. rattus* in the Pacific Islands. Among the non-natives, this species continues to affect the human food supply negatively, spread disease, and alter native ecosystems. Interaction with native species may pose transmission of parasites and diseases. *R. rattus* can negatively affect native fauna through predation and competition for space and various food items. For example, birds that rely on either arthropods, fruits, or seeds may suffer from resource competition by *R. rattus* in areas where these animals have overlapping diets. Vertebrate species, such as turtles, lizards, and bats, are prey items of *R. rattus*, as evidenced by diet assessments or observations by some researchers. However, the community-level effects of this consumption have yet to be investigated.

In Mt. Banahaw there was no evidence of predation on other terrestrial vertebrates such as frogs, reptiles, and birds. Rather, the non-native rodents rely more on food crops within the agricultural areas. Since *R. tanezumi* is limited to the agricultural areas and secondary-growth lowland forest and overlaps with some native species in areas with sufficient food supplies, this indicates that there is no or minimal competition in terms of food resources. There is no overlap in elevation and habitat range with the Banahaw endemics, and this possibly drives the difference in their diet and suggests that they occupy two ecological niches. The Banahaw endemics are predominantly insectivorous, preying on terrestrial arthropods. By contrast, non-native *R. tanezumi* is an opportunistic omnivore which feeds on rice and root crops in the agricultural areas (Heaney et al. 2010*)* and on animal/plant matter and arthropods in forests (de Guia and Quibod 2014).

Ong and Rickart (2008) suggest that non-native pest rodents predominate in severely disturbed habitats and that practices minimizing habitat disturbance and promoting the regeneration of second-growth forest would be an effective management action against non-native pest rodents. Thus, despite the resiliency of the native species, their continued existence depends on forests (Heaney et al. 2016).

CONCLUSION

Our data suggest that in the MBSCPL non-native rodents may have little negative effect on native rodents and other wildlife species. This is due to the non-overlapping elevational and habitat range. Thus habitat integrity must be maintained, and further agricultural encroachment should be prevented.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

CONTRIBUTION OF INDIVIDUAL AUTHORS

All authors contributed to the form and content of this paper through data gathering, data analysis, and writing.

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