

SMALL MAMMALS AROUND A KAREN VILLAGE IN NORTHERN MAE HONG SON PROVINCE, THAILAND: ABUNDANCE, DISTRIBUTION AND HUMAN CONSUMPTION

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ABSTRACT

The aim of this study was to understand the ecology of small mammals around a Karen village and the relationships between small mammals and the lifestyle of the Karen people. The abundance, distribution and species diversity of small mammals were studied around a Karen village, Muang Pham, Pang Ma Pa District, in Mae Hong Son Province. Ten species were captured. *Menetes berdmorei*, *Rattus rattus*, and *Niviventer bukit* were the most common species around the village. *R. rattus* was abundant in paddy fields, whereas *M. berdmorei* was captured more often in corn fields. *N. bukit* was most common in multiple-use forest area. The highest abundance of small mammals was found in the agricultural area, whereas their greatest species diversity was in the community forest. Most species that occurred in the agricultural area were pest species. *Maxomys surifer* had low density around the village but was a valuable source of protein for Karen villagers. About 3,000 rats weighing a total of more than 300 kg were consumed in Muang Pham village during November 2004–January 2005. Disturbance from agriculture, and harvest of timber and non-timber forest products around the village have caused a high abundance of pest species around this Karen village. Most species were tolerant of disturbed areas, whereas species most sensitive to disturbance, such as *M. surifer*, were rare near the village. The consumption of rat meat is tending to decrease in the younger generations.

Key words: Abundance, Human consumption, Karen, Northern Thailand, Small mammals

INTRODUCTION

Small mammals are good ecological indicators for the condition of terrestrial habitats (WILES, 1981; ELLIOTT *ET AL*, 1989; KANCHANASAKA, 1992; WALKER & RABINOWITZ, 1992; PINNOY, 1993; LYNAM, 1997; HAMARIT, 1997). They are important seed dispersers and seed predators, and are also food for several predators. Many species of small mammal are serious pests in agricultural areas around the world (DAVIDSON, 2000; DOA, 2001, WOOD & CHENG, 2003). Most studies of small mammals have focused on their ecological roles and role as pests. Few studies have examined all linkages between small mammals and the local community. This research focused on the density and species diversity of small mammals around a Karen village in Mae Hong Son Province, and on their roles as pests and human food.

The Karen are the largest hill tribe group in Thailand (SANTASOMBAT, 1999). They are farmers who practice rotational swidden cultivation in mountain valleys. The Karen cultivate rice, their most important agricultural crop, in both dry fields and paddy fields

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(UNDP, 2004). The Karen are known to have high environmental awareness and are good conservationists (PROSAO & SIRALUK, 1999; SANTASOMBAT, 1999; UNDP, 2004). They believe that most wild animals are homes of human spirits (PROSAO & SIRALUK, 1999). They hunt wildlife, but are not dependent on this activity as are other hill tribe groups such as the Lahu and Hmong (STEINMETZ & MATHER, 1996; TUNGITTIPLAKORN *ET AL*, 1999). The food of Karen people comes mostly from agriculture and includes rice, corn, beans and many kinds of vegetables. In addition to agricultural products, other food for the Karen family comes from forest areas around the village, and includes wild vegetables, insects, amphibians, birds and many species of small mammals including those that are agricultural pests.

STUDY AREA

Muang Pham village lies in Mae Hong Son Province, northern Thailand (98° 19–35', UTM 0427650, 2165500). This village lies at an altitude of 800–1200 m with surrounding areas covered mostly by mixed deciduous, dry dipterocarp, and bamboo forest. There are several major streams running through the area including the Huai Nam Pam, Huai Kut-on, Huai Pa Muang, Huai Rai and Huai Pong.

Muang Pham village is about 40 years old, and consists of about 120 households (CHAEKPIMAI *ET AL*, 2001). Most villagers are farmers who still practice rotational swiddening. Rice is planted in both dry fields and paddy fields; their minor crops include corn, beans, garlic and many other vegetables. Agricultural areas are mostly located near the village. The Karen people generally classify forest areas around their villages according to the resources utilized from the forest, or on their activities in the forest. The four main types are: multiple-use forest, cemetery forest, conserved forest, and community forest (SANTASOMBAT, 2001).

The forest area nearest the village was mostly multiple-use forest where the villagers harvested both timber and nontimber forest products (NTFPs). The main vegetation was mostly deciduous forest with some areas dominated by bamboo. Gibbons and hornbills were still found in the multiple-use forest north of the village. Generally, the villagers avoided disturbing the habitat of these two species. The cemetery forest, where dead people were buried, was small in area and near the village. The conserved forest included the watersheds where major streams of the village originated, and consisted of mixed deciduous forest and dry dipterocarp forest. Strict rules for protecting the forest are still enacted; human activities such as cutting wood and hunting are prohibited in this area. Most of conserved forest has been declared as a part of Sun Pan Dan Wildlife Sanctuary. The community forest covers a small area south of the village, where Mixed Deciduous Forest dominates. It contains two sites of special interest: Pong Luang, the largest mineral lick in Muang Pham village, and Wang Pla, a small reservoir with a temporary dam to provide water and conserve fish for consumption. There are strict rules prohibiting both villagers and outside people from catching fish in this area. The villagers avoid doing any activities in the Community Forest, especially hunting and cutting timber, because they believe that this area is a holy place. Most trees in this forest have been ordained, which is a way for local people to protect large trees. In addition, everybody in the village must help to make firebreaks to prevent forest fires each year.

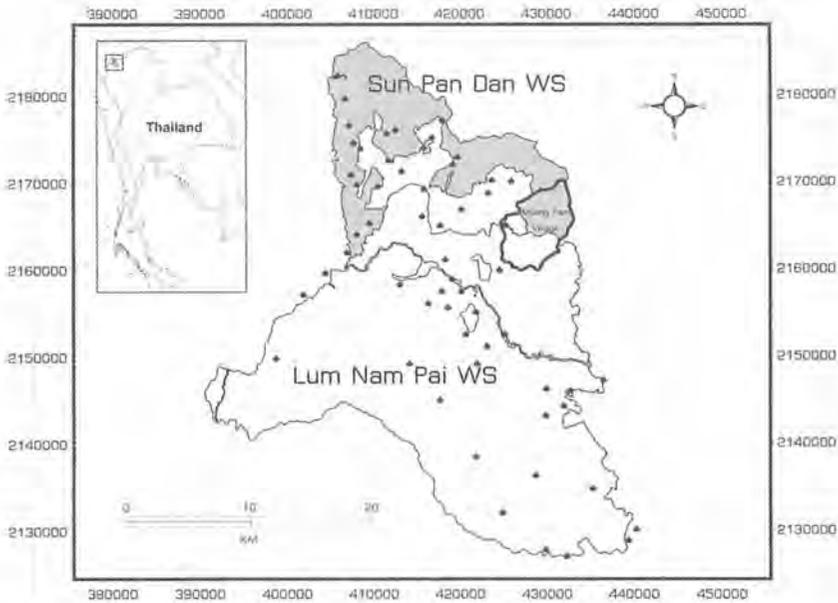


Figure 1. Locations of hill tribe villages in Sun Pan Dan and Lum Nam Pai Wildlife Sanctuaries. The highlighted area outlines the watershed surrounding the main study village, Muang Pham.

METHODS

Trapping

Six square grids were placed around the Karen village in both the agriculture area and forest areas (Table 1, Fig. 2). Grids 1–2 were located in agricultural area, Grids 3–5 were set in multiple-use forest, and Grid 6 was laid in the small Community Forest.

Each grid contained 36 traps in a 6 x 6 square, covering 1 ha. Traps were spaced 20 m apart. Live traps 14 x 14 x 24 cm were placed on the ground. The traps were set for 4 consecutive nights and baited for an average of 144 trap-nights. Traps were baited with ripe banana and were checked twice a day (0800–1000 h and 1600–1800 h) while set. After checking the traps were cleaned of old bait and feces, and rebaited. Captured mammals were weighed, individually marked by hair-clipping, and released at the point of capture. Animal species were identified with ASKINS (1977), MARSHALL (1977) and CORBETT & HILL (1992). Data on sex and age class were also collected. The recaptured animals were recognized by unique patterns of hair clipping.

The abundance of captured animals was measured as individuals captured per 100 trap-nights, and species richness was the number of species captured on each grid.

Interview Method

Data on the numbers of rats trapped by villagers were collected by interviewing the villagers. We had one Karen assistants who could speak Thai help to translate the language.

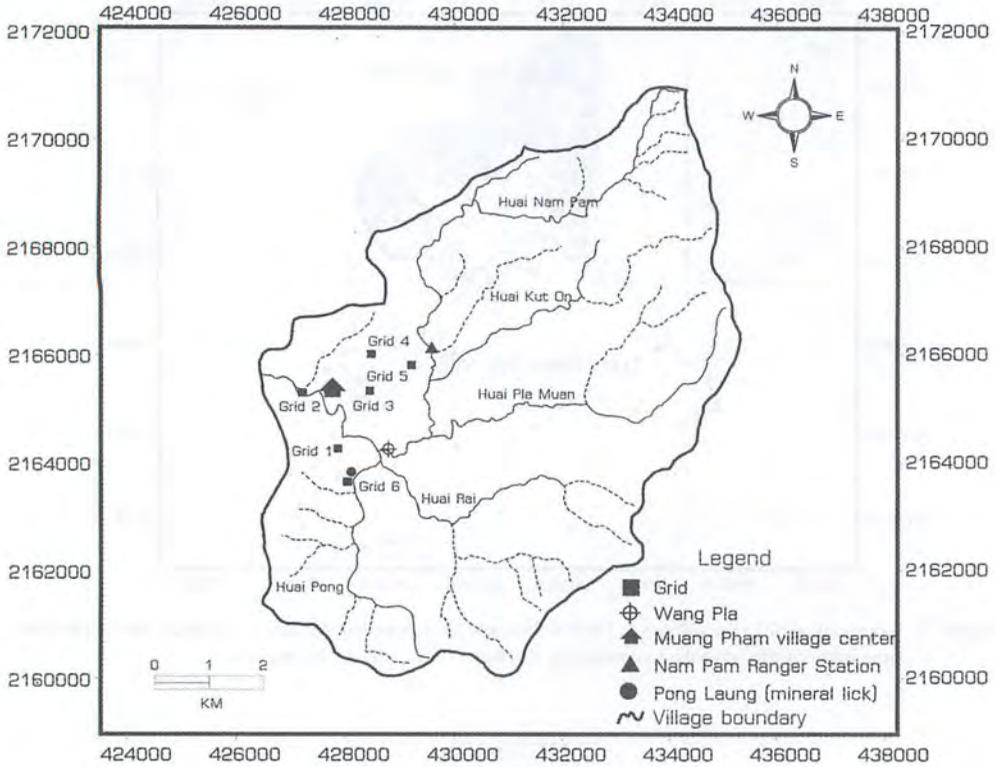


Figure 2. Locations of 6 square trapping grids around Muang Pham village. The boundary marks the total village area which includes approximately the local watershed.

Table 1. Locations and forest types of trapping sites

Trap site	Forest type	Description
Grid 1	Abandoned corn field about 1 month ago	Agricultural wastes still remain in the area
Grid 2	Abandoned corn field about 4-5 month ago	Many thorn plant in the area
Grid 3	Deciduous Forest + Bamboo Forest	Near road
Grid 4	Deciduous Forest	Near gibbon habitat
Grid 5	Deciduous Forest	Near San Pun Daen WS
Grid 6	Deciduous Forest	Huai Pong running through grid site

Table 2. Number and abundance of small mammals captured around Muang Pham Village. (Relative abundance (RA) = number of captured individuals x 100 / total number of trapnights)

Species	Habitat type	Grid Sites												Total	
		Grid 1		Grid 2		Grid 3		Grid 4		Grid 5		Grid 6			
		Agri.		Agri.		Muti.		Muti.		Muti.		Commu.			
		No.	RA	No.	RA	No.	RA	No.	RA	No.	RA	No.	RA	No.	RA
<i>Bandicota savilei</i>		-	-	-	-	-	-	-	-	-	-	1	0.7	1	0.1
<i>Berylmys berdmorei</i>		-	-	-	-	-	-	-	-	-	-	1	0.7	1	0.1
<i>Rattus rattus</i>		1	0.7	4	2.8	4	2.8			1	0.7	3	2.1	13	1.5
<i>Niviventer bukit</i>		2	1.4	-	-	2	1.4	2	1.4	4	2.8	3	2.1	13	1.5
<i>Maxomys surifer</i>		-	-	-	-	-	-	-	-	-	-	3	2.1	3	0.3
<i>Menetes berdmorei</i>		1	0.7	8	5.6	-	-	5	3.5	-	-	-	-	14	1.6
<i>Tupaia belangeri</i>		-	-	2	1.4	1	0.7	1	0.7	-	-	-	-	4	0.5
		4	2.8	14	9.8	7	4.9	8	5.6	5	3.5	11	7.7	49	5.7
No. of species		3		3		3		3		2		5			

(Agri. = Agriculture area, Muti. = Multiple-used forest, Commu. = Community forest)

Table 3. Biomass of some captured small mammals

Species	Biomass (g/ha) on grid trapping
<i>Rattus rattus</i>	333.4
<i>Niviventer bukit</i>	224
<i>Menetes berdmorei</i>	536.3
<i>Tupaia belangeri</i>	-
Total	1480.7

RESULTS

Abundance, Distribution and Species Diversity of Small Mammals

A total of 49 individuals of 7 small mammal species were captured during 864 trap-nights of grid trapping (Table 2). There were 5 species of Muridae, a ground squirrel (*Menetes berdmorei*) and a tree shrew (*Tupaia belangeri*). The abundance of small mammals around Muang Pham village was about 5.67 individuals/100 trap-nights with biomass of 1.37 kg ha⁻¹. *M. berdmorei* was the most abundant species with 1.62 individuals/100 trap-nights and biomass of 536.3 g ha⁻¹, followed by *Rattus rattus* and *Niviventer bukit* with equal abundance, 1.5 individuals/100 trap-night, and biomasses of 333.4 and 224 g ha⁻¹, respectively (Table 3).

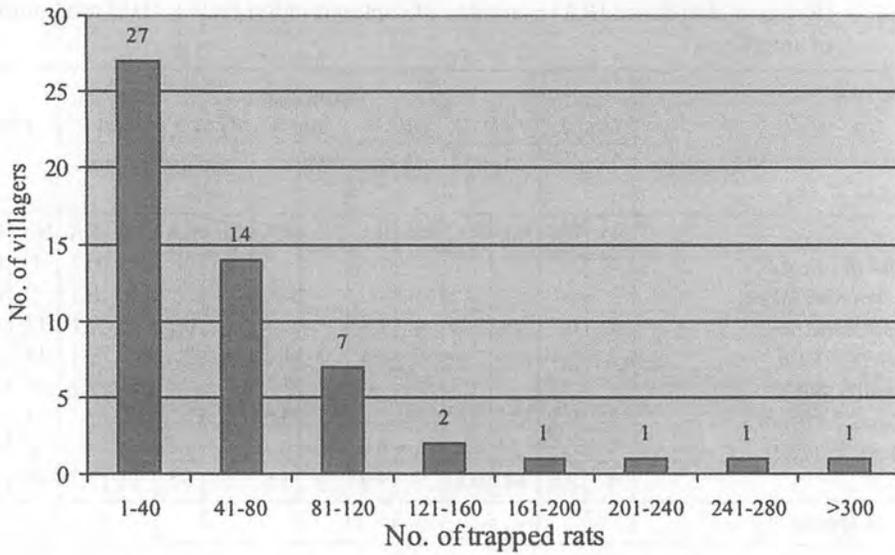


Figure 3. Distribution of rats trapped by villagers.

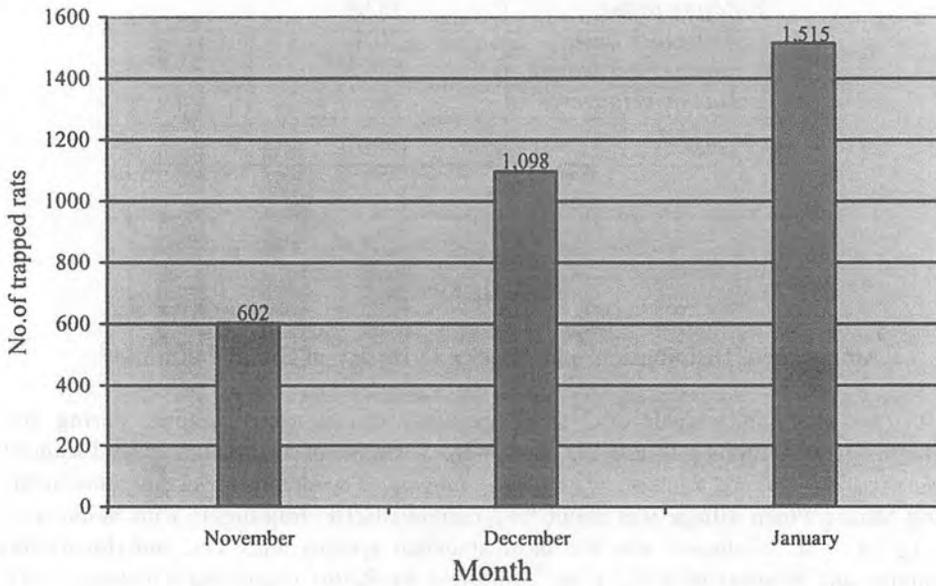


Figure 4. Number of rats trapped during November 2004–January 2005 (Total Number = 3,215).

The highest number of species was captured in Grid 6, in the community forest (Table 2). *R. rattus* and *N. bukit* were captured in the most grid sites, while *M. berdmorei* and *T. belangeri* were found only in the agricultural area and the forest near the village. *M. berdmorei* and *T. belangeri* were more agitated than the murids when trapped. Both were captured only during the day (found when traps were checked in the evening).

The other species, *Bandicota savilei*, *Berylmys berdmorei* and *Maxomys surifer*, were captured only in communal forest. The Variable squirrel (*Callosciurus finlaysonii*) and Burmese striped tree squirrel (*Tamiops mccllellandii*) were frequently observed in the trees around the village, but were not captured. *Leopoldamys sabanus*, *Rattus koratensis* and *Mus cervicolor* were each trapped once time during the preliminary study period.

Predators of Small Mammals around Muang Pham village

Civets are predators of small mammals found around Muang Pham village. The footprints of one civet appeared twice in the cornfield near the village during the preliminary study period. It also hunted domestic fowl. During trapping in Grid 3 a severed rat's tail, apparently left by predator, was found under a tree. The numerous domestic cats in the village were also predators of small mammals, and often hunted in the nearby forest. Furthermore, two Spot-bellied Eagle Owls lived in the cemetery forest near Grid 4.

Small Mammals as a Protein Source for Villagers

The Karen people consume rats in the dry season during November to January. At least 1,500–2,000 rats were trapped by villagers each year. The villagers trapped most of them in the forest. Data were collected from 54 villagers who trapped rats in 2004. Most rat trappers could harvest up to 40 individuals, while only 6 persons got more than 120 rats (Fig. 3). One old villager trapped more than 300 rats during November to mid-December. About 3,000 rats were trapped for consumption during November 2004–January 2005 (Fig. 4). In 2004, the villagers in Muang Pham village consumed about 352 kg of rat meat, and the average per household was 7.2 kg. BURANAKHET (2004) reported that the price of rat meat was about 80 baht/kg. Thus, the economic value of the rats consumed in Muang Pham was approximately 28,000 baht during November 2004–January 2005. Karen villagers trapped rats only for home consumption.

There were some problems in species identification, as the Karen could not translate the names of rats into the Thai language. Consequently, rats that were not captured could not be identified from interviews. The Karen people classify rats only as black or red according to pelage color. "Red rat" meant a red or brown-bodied rat species such as *M. surifer* or *N. bukit*, while "black rat" referred to other rats such as *Rattus* spp.

Generally, Karen people preferred to consume *M. surifer*. The villagers did not consume *R. rattus* because they felt that this species was dirty due to its black body and bad taste. The other small mammals that villagers consumed were *Leopoldamys sabanus*, *Menetes berdmorei* and *Tupaia belangeri*. These species have larger body size, so they were worth cooking and consuming; villagers did not eat small species such as *Mus* spp. The Karen did not eat the Pig-tailed Shrew (*Hylomys suillus*), which has short tail, because they believe that eating it brings bad luck.

The Karen people did not trap rats in village areas for consumption because they thought that these rats might have eaten dirty food left by humans. Some villagers ate squirrels more than rats because they felt that rats are dirty because they feed on the ground, while squirrels feed arboreally. They classified the ground squirrel (*Menetes berdmorei*) as other squirrels that feed in trees.

In cooking rats, villagers roasted them to remove the hairs, and then the rat meat was cooked like other meats. Any leftover meat was roasted until it was dry to preserve it for future meals. Unlike people in some other rural area, the Karen did not sell trapped rats. If large numbers of rats were harvested, they gave some to their relatives or neighbors. However, after leptospirosis had affected some villagers, they largely stopped eating rat meat.

Small Mammals as Pests

Squirrels and rats are regarded as pests that damage crops such as rice and corn in Muang Pham village. Although field owners often set traps around their fields to protect their crops, a large amount of production was still lost each year. In paddy fields, rats were more serious pests than squirrels but the villagers did not use rodenticides. During this study, some villagers eradicated the rats in their paddy field. They use fish nets to capture the rats in paddies at night after finishing other work. They captured at least 80 rats each time and most of them are *Rattus* spp.

Trapping Equipment Used by Villagers

The villagers used homemade trap called, *bowk nu*, which are simple and easily made using local materials such as bamboo. The trap is light in weight, and 20 to 30 traps were used at one time. The villagers usually laid traps near rat trails, mostly along the streams or moist areas in the forest. The traps were laid down during the night and picked up in the morning. The mechanism of this trap is a loop of string, which strangles the rat when it enters the trap, and a trigger which releases it. Milled rice mixed with turmeric is the usual bait for trapping rats. One advantage of this trap is that the rat's body is not damaged, so it may be kept for cooking. However, the traps that villagers used around agricultural fields to protect the crops, *ka tam*, differed from the traps used in the forest. The mechanism of the trap used in the field, *Ka tam* traps employ a thick stick or log which, when released, smashes down on the victim. These traps are placed at about 3-meter intervals around their agricultural areas (GARRETT, 1929). The names *bowk nu* and *ka tam* are Thai names obtained from GARRETT (1929); the Muang Pham villagers did not know these names. The traps are shown in Figure 5.

DISCUSSION

Community Structure of Small Mammals around Muang Pham Village

The small mammal community around Muang Pham village consisted of few dominant species with many rare species, as in most small mammal communities in tropical forest



a



b

c



Figure 5. Pictures of local traps used in Muang Pham Village: a and b, *bowk nur*; c, *ka tam*.

(FLEMING, 1975). Most trapped animals were common species that forage on the ground in the deciduous forest (ASKINS, 1977; LEKAGUL & MCNEELY, 1977; MARSHALL, 1977; WILES, 1981; ELLIOTT *ET AL*, 1989; WALKER & RABINOWITZ, 1992; HAMARIT, 1997; PARR, 2003).

The replacement of forest area by agricultural fields and human settlements is a major cause of the increase in numbers and biomass of small mammals (JEFFREY, 1977). The agricultural area probably influences the abundance of small mammal around this Karen village. Some species benefit from this change (LYNAM & BILICK, 1999). *R. rattus* in particular thrives in disturbed areas (WILES, 1981; ELLIOTT *ET AL*, 1989, HAMARIT, 1997; KANCHANASAKA, 1992, PINNOY, 1993; LYNAM & BILICK, 1999). *R. rattus* had high abundance and was found in all forest types around Muang Pham village, including the agricultural area. The appearance of rare species and the high diversity of small mammal in the community forest probably results from the high humidity and vegetation associated with the stream the passes through the area. Furthermore, the community forest has a relatively low level of disturbance by villagers.

The abundance of *M. berdmorei* in this study was near that found in deciduous forest in Doi Suthep–Pui National Park (ELLIOTT, 1989), but greater than found in Huai Khaeng Wildlife Sanctuary (WALKER & RABINOWITZ, 1992). The higher biomass in this study than in Huai Khaeng WS might be due to the large number of *M. berdmorei* captured.

R. rattus is probably the most ubiquitous small mammal species in Southeast Asia. It can live in both natural and disturbed habitats (MARSHALL, 1977; PANTUWATANA, *ET AL*, 1969; WILES, 1981; ELLIOTT *ET AL*, 1989; WALKER & RABINOWITZ, 1992; KANCHANASAKA, 1992; PINNOY, 1993; LYNAM, 1995; HAMARIT, 1997; WOOD & CHUNG, 2003). Nevertheless, the density of *R. rattus* in this study was lower than that in other disturbed areas of Thailand (KANCHANASAKA, 1992; PINNOY, 1993; HAMARIT, 1997; LYNAM & BILICK, 1999). Furthermore, *R. rattus* is liable to displace disturbance-sensitive species such as *Maxomys surifer*, which was uncommon in this study (STEPHENSON, 1993; LYNAM, 1995; LYNAM & BILICK, 1999).

Small Mammals and Karen People

A small mammal is animal around Karen village that take both advantage and disadvantage to villager. They are important agricultural pest and provide some of protein for Karen people in the same time.

Small mammals such as squirrels and rats are common protein sources for Karen people as they are for many other rural people in the country (TUNGITTIPLAKORN *ET AL*, 1999, DOA, 2001, STEIN *ET AL*, 2002, WOOD & CHENG, 2003). The Karen have consumed rat meat for at least 70 years (PROMSAO & SIRALUK, 1999; TUNGITTIPLAKORN & DEARDEN, 2002). They harvest rats mainly during November–January because they believe that during this period rat meat has the best taste, without the musty odor, and their trails are also easier to find (BURANAKHET, 2004; WATTANARATCHAKIT, 2005).

Small mammals are also pests, and villagers try to control them in their fields. *M. berdmorei* is particularly notorious, as they often dig up and eat rice and corn (ASKINS, 1997). However, the villagers do not use rodenticide because they do not want to spend money and their crops are not grown for cash. Mostly, the villagers use their home-made traps to protect their crops.

Some studies have considered rat consumption by local people as a way of controlling agricultural pests (DOA, 2001, WOOD & CHENG, 2003). However, Karen people deny eating the major pests such as *R. rattus*. In many rural areas of Thailand bandicoots are consumed and sold because they are large sized rats (WATTANARATCHAKIT, 2005). WEMMER & AUNG (1998) studied one Burmese man who had a job as a rat trapper. This man trapped about 3–47 individuals/night, higher than villager in Muang Pham village. Moreover, the species that Burmese rat trapper caught (*R. rattus*, *Bandicota bengalensis*, *B. indica* and *B. savilei*) are species the Karen people do not eat.

Nevertheless, trapping skills and rat consumption have been declining among the new generation, and only 43% of households in Muang Pham village still trapped rats in the last year (WATTANARATCHAKIT, 2005). Most teenagers leave the village for school or get jobs in town. They do not invest their time to learn such subsistence skills from their parents. *M. surifer* is a species that villagers should be aware of if the villagers stop eating rats. Although it has never been reported as an agricultural pest, it can be a seed predator in Moist Evergreen Forest and Dipterocarp Forest (CURRAN & WEBB, 2000; DOA, 2001; APLIN ET AL, 2003; KITAMURA ET AL, 2004).

Karen People and Conservation

The traditions and culture of Karen people do benefit the environment. They have high awareness of the need to protect nature (PREECHPANYA & JIRASUKTAVEEKUL, 2001). The water from the forest is very important to Karen life because they cultivate both in dry fields and paddy fields, while other tribal group plant only in dry fields. The Karen are therefore still serious about protecting forest areas that provide the water and streams that they depend on.

There are many publications referring to the conservationist character of Karen people (PROMSAO & SIRALUK, 1999; PUGINNIER, 2001; SANTASOMBAT, 2001; BUERGIN, 2003). Nevertheless, their conservation practices seem to focus primarily on the important natural resources that they use, such as water and fish (PREECHPANYA & JIRASUKTAVEEKUL, 2001). Karen people are more concerned about decreases in fish than terrestrial wildlife, because fish is their major protein food while wildlife meat is taken only opportunistically.

Hunting is still carried out by Karen villagers and it is hard to stop this activity. It is deeply rooted in their culture, as in all hill tribe people. However, Karen people are not such notorious hunters as other hill tribe groups (STEINMETZ & MATHER, 1996), and in general, they spend much more time cultivating crops. They produce rice both by dry and wet cultivation, so only 1–2 months of the year are available for other activities such as hunting. Furthermore, many of the traditional beliefs of Karen people place more value on the environment and wildlife species than do those of other ethnic groups. For example, the Karen hunt primarily for their own for consumption, and they do not seem to harvest and keep wildlife in large quantities as do other hill tribes do that hunt for the market (PROMSAO & SIRALUK, 1999).

TUNGITTIPLAKORN ET AL (1999) mentioned that strengthening the role of leadership can influence conservation in hill tribe villages. The present headman of Muang Pham village is aware of the decline of wildlife. However, this awareness has not been translated into action due to the difficulty of negotiation. There are so many issues that the Karen have to worry about and wildlife is a relatively minor issue. The rangers at the local

wildlife sanctuary station can enforce the law, but most of the rangers are Karen people. Hunting has long been a common pastime and it is difficult to prohibit.

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REFERENCES

- APLIN, K. P., P. R. BROWN, J. JACOB, C. J. KREBS, AND G. R. SINGLETON. 2003. *Field Methods of Rodent Studies in Asia and the Indo-Pacific*. BPA Print Group, Melbourne, Australia. 223 pp.
- ASKINS, R. A. 1977. Family Sciuridae. Pages 337–387 in B. Lekagul and J. A. McNeely (eds.), *Mammals of Thailand*. Association for the Conservation of Wildlife, Bangkok. 758 pp.
- BUERGIN, R. 2003. Shifting frames for local people and forests in a global heritage: the Thung Yai Naresuan Wildlife Sanctuary in the context of Thailand's globalization and modernization. *Geoforum* 34: 375–393.
- BURANAKHET, S. 2004. Doung Nu: eradicating the agricultural pests. *Art & Culture* 25(8): 43–44 (in Thai).
- CHAEKPIMAI, T., W. SAWANGPROH, S. DITYHAM, AND S. SRISOMBOONLERT. 2001. The effect of Sgaw Karen and Lahu Nyi people on wildlife communities around San Pan Daeng Wildlife Sanctuary, Mae Hong Son province, Thailand. Senior Project in Faculty of Science (Biology). Mahidol University, Bangkok, Thailand. (in Thai)
- CORBET, C. B., AND J. E. HILL. 1992. *The Mammals of the Indomalayan Region*. Oxford Univ., New York.
- CURRAN, L. M., AND C. O. WEBB. 2000. Experimental tests of the spatiotemporal scale of seed predation in mast-fruiting Dipterocarpaceae. *Ecol. Monogr.* 70(1): 129–148.
- DAVIDSON, S. 2000. Rat cunning. *Ecos.* 103: 12–16.
- DOA. 2001. Rodent Pests and Their Control. Agricultural Zoology Group. Insect and Zoology Division. Department of Agriculture, Bangkok, Thailand. 136 pp (in Thai).
- ELLIOTT, S., S. UA-APISITWONG, AND O. BEAVER. 1989. The small mammal communities of Doi Suthep-Pui National Park. Seminar of Wildlife in Thailand, Kasetsart University, Bangkok 10: 2-1 – 2-12.
- FLEMING, T. H. 1975. The role of small mammals in tropical ecosystems. Pages 269–298 in F. B. Golley, K. Petruszewicz, and L. Ryzkowski (eds.), *Small Mammals: Their Productivity and Population Dynamics*. The Pitman Press, Bath, UK. 451 pp.
- GARRETT, H. B. 1929. Notes on some traps made by the hill tribe people of Siam. *Nat. Hist. Bull. Siam Soc.* 9: 23–24, 17 pls.
- HAMARIT, K. 1997. Species diversity and ecology of murid rodents in forest and agriculture area along Mekong Riverbank, Amphoe Sangkhom, Changwat Nhonkai. M.S. Thesis, Kasetsart University, Bangkok, Thailand (in Thai).
- JEFFREY, S. M. 1977. Rodent ecology and land use in western Ghana. *J. Applied Ecol.* 14: 741–755.
- KANCHANASAKA, B. 1992. Murid rodent density and diversity in Chalerm Pha Kiet Somdej Prathep Rattana Rachasuda Wildlife Sanctuary. *J. Wildlife in Thailand* 2(1): 53–60 (in Thai).
- KITAMURA, S., S. SUZUKI, T. YUMOTO, P. POONSWAD, P. CHUAILUA, K. PLONGMAI, N. NOMA, T. MARUHASHI, AND C. SUCKASAM. 2004. Dispersal of *Aglaia spectabilis*, a large-seeded tree species in a moist evergreen

- forest in Thailand. *Trop. Ecol.* 20: 421–427.
- LYNAM, A. J. 1995. Effects of habitat fragmentation on the distribution patterns of small mammals in a tropical forest Thailand. Ph.D. Thesis. University of California, San Diego, USA. XIV+120 pp.
- LYNAM, A. J., AND I. BILLICK. 1999. Differential responses of small mammals to fragmentation in a Thailand tropical forest. *Biol. Cons.* 91: 191–200.
- MARSHALL, J. T. 1977. Family Muridae. Pages 397–487 in B. Lekagul, and J. A. McNeely, *Mammals of Thailand*. Association for the Conservation of Wildlife, Bangkok. 758 pp.
- PANTUWATANA, S., S. IMLARP, AND J. T. MARSHALL. 1969. Vertebrate ecology of Bang Phra. *Nat. Hist. Bull. Siam Soc.* 23: 132–183.
- PARR, J. 2003. *Mammals in Thailand*. Sarakadee Press, Bangkok. 216 pp.
- PINNOY, J. 1993. Comparison of Muridae Population in two different habitats at Bang Phra Reservoir Non-hunting Area. M.S. Thesis. University of the Philippines Los Banos, Philippines.
- PREECHAPANYA, P., AND W. JIRASUKTAVEEKUL. 2001. Karen knowledge about the sustainability of forested watershed and agoforestry. *Ecosystems* 3(10): 8–17.
- PROMSAO, K., AND B. SIRALUK. 1999. Seven level forest: learned man knowledge. Knowledge Foundation, Bangkok. Amarin Printing & Publishing, Bangkok, Thailand. 190 pp (in Thai).
- PUGINIER, O. 2001. Facilitating better linkages between hill-tribe communities and government agencies with digitized land use maps in Mae Hong Son Province, Thailand. Pages 171–178 in D. E. Stoot, R. H. Mohtar, and G. C. Stenhardt (eds.), *Sustaining the Global Farm*. Berlin.
- SANTASOMBAT, Y. 1999. Biodiversity and indigenous knowledge for sustainable development. Biodiversity and Indigenous Knowledge Studies Center for Research and Sustainable Development, Sociology and Anthropology Department, Faculty of Social Science, Chiangmai University. 308 pp (in Thai).
- SANTASOMBAT, Y. 2001. Ecotourism, cultural diversity and natural management. Biodiversity Research and Training Program (BRT). Nopburee Press. Chiang Mai. 234 pp (in Thai).
- STEINMTEZ, R., AND R. MATHER. 1996. Impact of Karen villages on the fauna of Thung Yai Naresuan Wildlife Sanctuary: a participatory research project. *Nat. Hist. Bull. Siam Soc.* 44: 23–40.
- STEIN, J. T., N. D. BAILEY, D. L. WADE, AND BCTF. 2002. BCTF Fact Sheet: African Rodents and the Bushmeat Trade. Bushmeat Crisis Task Force, Washington, D.C. 2 pages.
- STEPHENSON, P. J. 1993. The small mammal fauna of Reserve Speciale d'Analamazaotra, Madagascar: the effects of human disturbance on endemic species diversity. *Biodiversity and Conservation*. 2: 603–615.
- TUNGITTIPLAKORN, W., P. DEARDEN, AND C. WITTAYAPAK. 1999. Biodiversity conservation in the Thai highlands: human use of wildlife. Pages 778–784 in V. Baimai *et al.* (eds.), *Research Reports on Biodiversity in Thailand*. Biodiversity Research and Training Program, Bangkok.
- TUNGITTIPLAKORN, W., AND P. DEARDEN. 2002. Hunting and wildlife use in some Hmong communities in Northern Thailand. *Nat. Hist. Bull. Siam Soc.* 50(1): 57–73.
- WATTARATCHAKIT, N. 2005. Density, distribution and human consumption of small mammals around a Karen village in Mae Hong Son Province, Thailand. M.S. Thesis. Mahidol University, Bangkok, Thailand. X+99 pp.
- WALKER, S., AND A. RABINOWITZ. 1992. The small mammal community of a dry-tropical forest in central Thailand. *J. Trop. Ecol.* 8: 57–71.
- WEMMER, C., AND M. AUNG. 1998. A year in the life of a village rat catcher: an example of subsistence hunting in rural Burma. In *abstracts of International Meeting of Society for Conservation Biology*, Macquarie University, Sydney.
- WILES, G. J. 1981. Abundance and habitat preferences of small mammals in southwestern Thailand. *Nat. Hist. Bull. Siam Soc.* 29: 44–54.
- WOOD, B. J., AND G. F. CHENG. 2003. A critical review of the development of rat control in Malaysian agriculture since the 1960s. *Crop Protection* 22: 445–461.
- UNDP. 2004. *Community Forestry in Thailand*. United Nations Development Programme, Bangkok, Thailand. 144 pp.

