

The ecological distribution of Thai endemic rodents with a new distributional range of *Niviventer hinpoon*

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ABSTRACT.- Two species of Thai endemic rats, the limestone rat (*Niviventer hinpoon*), and the Neill's rat (*Leopoldamys neilli*), have not been reported in existence in their own type localities for at least 31 years since their first discoveries. The type localities are now continuously disturbed by human activities which remarkably result in driving them to the brink of extinction. Intensive surveys were conducted to uncover the present existence of these endemic mammals in 3 locations in Saraburi and Lop Buri provinces, Thailand, using live trapping techniques. The results revealed that the limestone rats were encountered in 2 areas, Wat Khudkham (Dondung) in Lop Buri province (15° 08' 35" N 100° 36' 44" E), the first record of its occurrence outside the known distributional ranges; and Wat Tham Prathat in Lop Buri province (14° 48' 15" N 100° 49' 30" E). The Neill's rats were found living in its type locality at Wat Tham Prapothisat in Saraburi province (14° 34' 31" N 101° 08' 43" E), same type locality as that of the limestone rats. The additional data of two specimens from the Centre for Thai National Reference Collections (CTNRC) revealed another locality in Nakhon Ratchasima province (14° 31' 27" N 101° 23' 33" E). Moreover, at least 17 samples collected from 8 provinces were likely misidentified e.g. *L. sabanus* as *L. neilli*. These provinces were considered as the expected distribution of *L. neilli*. The results indicated that the population numbers of Thai endemic rodents were extremely low and in very restricted distributional ranges. These implied that Thai endemic rodents were under the presumably high risk of extinction.

KEY WORDS: Thai endemic rats, *Niviventer hinpoon*, *Leopoldamys neilli*, limestone rat, Neill's rat, type localities, distributional ranges, risk of extinction.

INTRODUCTION

Thailand for some aspects, is the host of four living endemic mammals, Thailand roundleaf bat (*Hipposideros halophyllus* : Rhinolophidae), Surat serotine (*Eptesicus*

demissus : Vespertilionidae), Limestone rat (*Niviventer hinpoon* : Muridae), and Neill's rat (*Leopoldamys neilli* : Muridae) (Nabhitabhata, and Chan-ard, 2005). However, Surat serotine (*Eptesicus demissus*) has been reported that it is conspecific with an *E. dimissus* found in Nepal (Myers et al., 2000).

The distributional ranges of Thai endemic rodents are restricted to the central part of Thailand. The database of mammal specimens

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of the Center for Thai National Reference Collections (CTNRC) reveals that *N. hinpoon* and *L. neilli* share the same type locality at Wat Tham Prapothisat, Saraburi province (14° 34' 31" N 101° 08' 43" E). Lekagul and McNeely (1988) reported that the first six specimens of *N. hinpoon* were caught by William A. Neil at Wat Tham Prathat in Lop Buri province near the waterfall in April, May, and July 1973. One adult male collected in July became a holotype specimen for the new species. The second distributional range of *N. hinpoon* was at Wat Tham Prathat in Lop Buri province (14°48' 15" N 100° 49' 30" E) and discovered by Mr. Songsakdi Yenbutra, a former mammologist at CTNRC, on 22nd December, 1975. Since then, there has been no report on *N. hinpoon*.

Another Thai endemic rodent, *L. neilli*, was first captured by William A. Neil in 1973 (Lekagul and McNeely, 1988). The following year, two adult male specimens of *L. neilli* (CTNRC 54-4009 and CTNRC 54-4010) were obtained from Ban Tha Maprang in Nakhon Ratchasima province by CTNRC team on 29th July, 1974. This location became the last finding of *L. neilli* in the past 33 years.

Thai endemic rodents have been differently evaluated for their global and local status. The global status of *N. hinpoon* has been categorized by the International Union for the Conservation of Nature and Natural Resources (IUCN) since 1996 as LOWER RISK, Near Threatened subcategory (LR/nt) on the IUCN Red List (Baillie, 1996b). However, the local status of *N. hinpoon* is more intensely evaluated and has been classified as ENDANGERED (EN) (Nabhitabhata and Chan-ard, 2005). *L. neilli* has been identified as EN for its global status (Baillie, 1996a) and as (VULNERABLE) VU for its local status (Nabhitabhata and Chan-ard, 2005). The current status of Thai endemic rodents indicates that they are the key species in the country and high conservation required. However, there is insufficient information to indicate their current status. The type locality of Thai endemic rodents is situated outside the conservation areas where the law enforcement is inadequately stringent. It is highly possible that the rodents are under the heavily hunting pressure for food by local people. In addition,

no measures are applied to protect these animals because of the lack of their biological information and ecological ranges. The objective of the project is aimed at conducting the intensive field surveys for the current ecological ranges of Thai endemic rodents. By using the live traps, the transect line and animal capture were performed in the locations and the adjacent areas where the animals were reportedly found in the past. This is the first international report on Thai endemic mammals in the past 32 years.

MATERIALS AND METHODS

The survey of ecological distribution was carried out using two major techniques, the field study and literature citation. The field censuses were conducted during April 2005-March 2006. The present existence of these endemic rodents and the possible occurrence were intensively surveyed in adjacent areas of Saraburi and Lop Buri provinces. The surveys were focused on the study sites outside the conservation areas of Thailand, the major habitats of endemic rodents. Fifty live-traps with ripen banana baits were vertically and horizontally placed in the transect line around the hill for at least 4-consecutive nights in a particular study site. A daily check of the traps was performed and the banana baits were replaced each morning. The locations of the trapped animals were recorded using GPS device. The animals in the traps were transferred to the cloth bag and measured for their physical sizes e.g. lengths of head and body, tail, ear, hind foot, and weight.

The literature citation was gathered from the database of mammal specimens at CTNRC, Thailand Institute of Scientific and Technological Research (TISTR). CTNRC, founded in 1965, is the largest natural history museum of mammals in Thailand and consists of more than 7,500 mammal specimens.

RESULTS

Distributional Ranges

The populations of Thai endemic rodents were extremely low and the distributional ranges were locally restricted. Only six limestone rats (*Niviventer hinpoon*) and five Neillís rats

(*Leopoldamy neilli*) were captured during the intensive field censuses.

Six *N. hinpoon* samples were trapped from two locations. One adult male of *N. hinpoon* was captured in the cave at Wat Tham Prathat in Lop Buri province (14° 48' 15" N 100° 49' 30" E), and five *N. hinpoon* samples (two adult males and three adult females) were captured from the mixed deciduous forest at the foot hill of Wat Khudkham (Dondung) in Lop Buri province (15° 08' 35" N 100° 36' 44" E). In these areas, limestone rat has never been reported of its occurrence before. Therefore, Wat Khud Kham (Dondung) is a new distributional range of limestone rats and becomes the largest population site in this study. During the field survey, the number of *N. hinpoon* was extremely small. After the physical measurements of 4 samples were performed on *N. hinpoon*, only

one adult female rat was instantly released to minimize biological and physiological impacts that might be arising in the rats. Due to its type locality, it was not possible to trap *N. hinpoon* from Wat Tham Prapothisat, Saraburi province in this study (Figure 1).

The sizes of *N. hinpoon* were slightly smaller and their tails were relatively longer than those of the holotype specimen (CTNRC 54-3988) and specimen (CTNRC 54-4011) in the CTNRC (Table 1).

For Neill's rat (*L. neilli*), only one distributional location at its type locality was discovered at Wat Tham Prapothisat, Saraburi province (14° 34' 31" N 101° 08' 43" E). Five adults (three males and two females) of *L. neilli* were captured on the slope of the hill in the limestone forest, about 300 meters altitude. Three of five rats (two adult males and one adult

Table 1 The external measurements of *Niviventer hinpoon* captured from Wat Khud Kham (Dondung), Lop Buri province, a new distributional range, compared to two specimens in CTNRC.

External measurements	<i>Niviventer hinpoon</i> (n=4)			CTNRC 54-3988**	CTNRC 54-4011
	Mean	Range	SD		
Head and body length (mm.)	129.25	122.80-142.00	8.67	144	138
Tail length (mm.)	136.05	132.40-139.40*	3.51	141	131
Tail length (% of head and body)	104.98	98.17-111.03*	6.47	97.9	94.9
Ear length (mm.)	18.23	17.80-18.60	0.39	28	18
Hind foot length (mm.)	23.83	23.00-24.80	0.75	20	24
Weight (g)	65.00	59.00-65.00	7.79	54.5	60

Note: * refers to number of samples (n) = 3 since one rat's tail was cut off by the trap.
 ** refers to the holotype specimen (CTNRC 54-3988).

Table 2 The external measurements of *Leopoldamys neilli* captured from Wat Tham Prapothisat, Saraburi province, the type locality, compared to specimens from the CTNRC.

External measurements	<i>Leopoldamys neilli</i> (n=3)			CTNRC* 54-4330	CTNRC 54-4007	CTNRC 54-4009	CTNRC 54-4010
	Mean	Range	SD				
HB length (mm.)	210.20	200.00-220.00	10.01	220.00	230.00	215.00	215.00
Tail length (mm.)	246.90	210.00-270.00	32.29	275.00	273.00	292.00	285.00
Tail length (% of HB)	117.17	105.00-123.79	10.55	125.00	118.70	135.81	132.56
Ear length (mm.)	28.98	28.35-29.60	0.63	43.00	27.00	28.00	29.00
Hind foot length (mm.)	40.42	38.65-41.85	1.63	27.00	41.00	39.00	38.00
Weight (g)	na	na	na	285.60	230.00	na	na

Note: * refers to the holotype specimen (CTNRC 54-4330)

female) were measured for the external morphology and two rats (one adult male and one adult female) were immediately released at the captured sites to minimize the potential stress. In addition, the secondary data search on the previous distribution of *L. neilli* from the database was conducted at CTNRC. It was found that there were at least four *L. neilli* specimens in the collections. Two of which, CTNRC 54-4330 (the holotype specimens) and CTNRC 54-4007 were collected at the type locality, Wat Tham Prapothisat in Saraburi province. Two other specimens (CTNRC 54-4009 and CTNRC 54-4010) were caught from Ban Tha Maprang, Nakhon Ratchasima province (14° 31' 27" N 101° 23' 33" E) in 1974. These two locations are considered as the current distributional ranges of *L. neilli* (Figure 2).

Taxonomic considerations and spatial distributional ranges of *L. neilli*

The spatial ranges of *L. neilli* obtained from the database of mammals in CTNRC were indicated. It was also found that at least eight specimens of *L. sabanus*, two specimens of *Niviventer andersoni*, and five unidentified specimens in CTNRC were likely misidentified. The appearances of these specimens were similar to that of *L. neilli*. These specimens were collected from 7 different provinces in Thailand namely, Tak, Kanchanaburi, Loei, Phetchabun, Sa Kaeo, Nakhon Ratchasima and Chanthaburi. Therefore, these provinces were classified as expected distribution of *L. neilli* (Table 3 and Figure 3). Some rat specimens from Phrae province were similar to *L. neilli* (Jean-Pierre Hugot, personal communication). Moreover, Nabhitabhata and Chan-ard (2005) reported that *L. neilli* was found at Khlong Saeng Wildlife Sanctuary, Surat Thani province in the southern part of Thailand.

Table 3 The list of rats in CTNRC similar to *L. neilli*, are relatively misidentified.

No	Specimen ID	Specified species	Sex	External measurements (mm.)					Localities
				HB	T	%T of HB	HF	E	
1	CTNRC 54-3939	<i>L. sabanus</i>	F	235	298	126.8	30	42	Chantaburi
2	CTNRC 54-6894	<i>L. sabanus</i>	M	241	288	119.5	26	47	Petchabun
3	CTNRC 54-2842	<i>L. sabanus</i>	M	145	232	160.0	25	40	Nakhon Ratchasima
4	CTNRC 54-3938	<i>L. sabanus</i>	M	150	195	130.0	28	33	Chantaburi
5	CTNRC 54-651	<i>L. sabanus</i>	M	162	230	142.0	28	41	Nakhon Ratchasima
6	CTNRC 54-6893	<i>L. sabanus</i>	M	250	320	128.0	30	52	Petchabun
7	CTNRC 54-6895	<i>L. sabanus</i>	M	255	310	121.6	30	49	Petchabun
8	CTNRC 54-7157	<i>N. andersoni</i> *	M	186	223	119.9	27.1	38.6	Loei
9	CTNRC 54-7158	<i>N. andersoni</i>	M	187	224	119.8	27.8	41	Loei
10	CTNRC 54-7215	<i>L. neilli</i> **	F	182	236	129.7	25	39	Kanchanaburi
12	CTNRC 54-7221	Unidentified***	M	236	280	118.6	29	45	Kanchanaburi, Tak
13	CTNRC 54-7298	<i>L. sabanus</i>	F	230	329	143.0	31	40	Sa Kaeo
14	SW00213	Unidentified	F	195	247	126.7	28	41	Loei
15	SW00214	Unidentified	M	195	225	115.4	28	42	Loei
16	SW00215	Unidentified	M	195	cut	n/a	28	41	Loei
17	SW00219	Unidentified	M	180	232	128.9	27	39	Loei

Note: * refers to genus *Niviventer*.

** refers to a specimen without a skull and unable to precisely identify.

*** refers to unidentified specimen captured from Thungyai Naresuan Wildlife Sanctuary covering Kanchanaburi and Tak provinces.

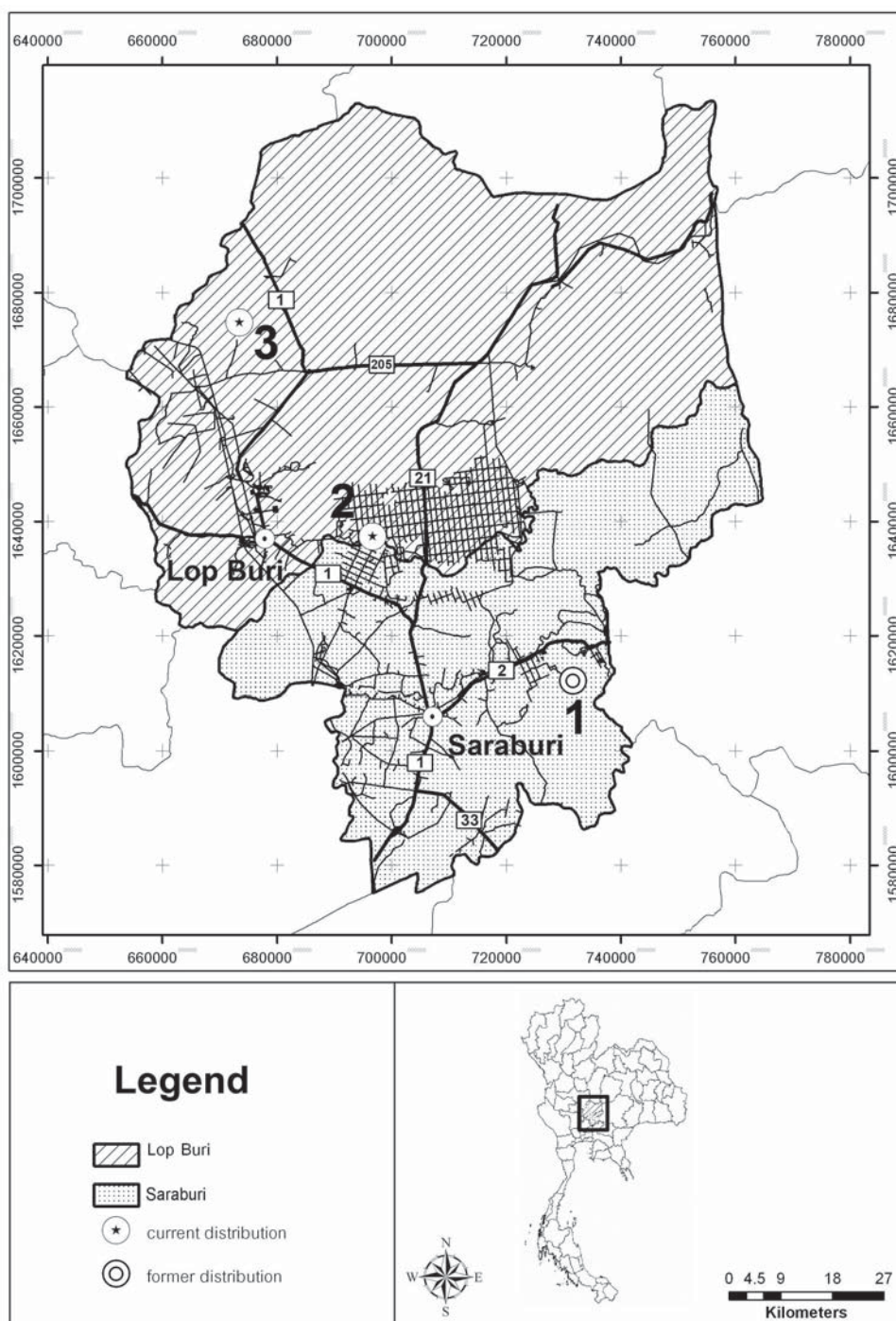


Figure 1 The distributional ranges of limestone rats (*Niviventer hinpoon*).
 1 = Wat Tham Prapothisat, Saraburi province (14° 34' 31" N 101° 08' 43" E), the type locality of limestone rat where no rats were found in the study.
 2 = Wat Tham Prathat, Lop Buri province (14° 48' 15" N 100° 49' 30" E).
 3 = Wat Khud Kham (Dondung), Lop Buri province (15° 08' 35" N 100° 36' 44" E), the location of the largest population of limestone rat.

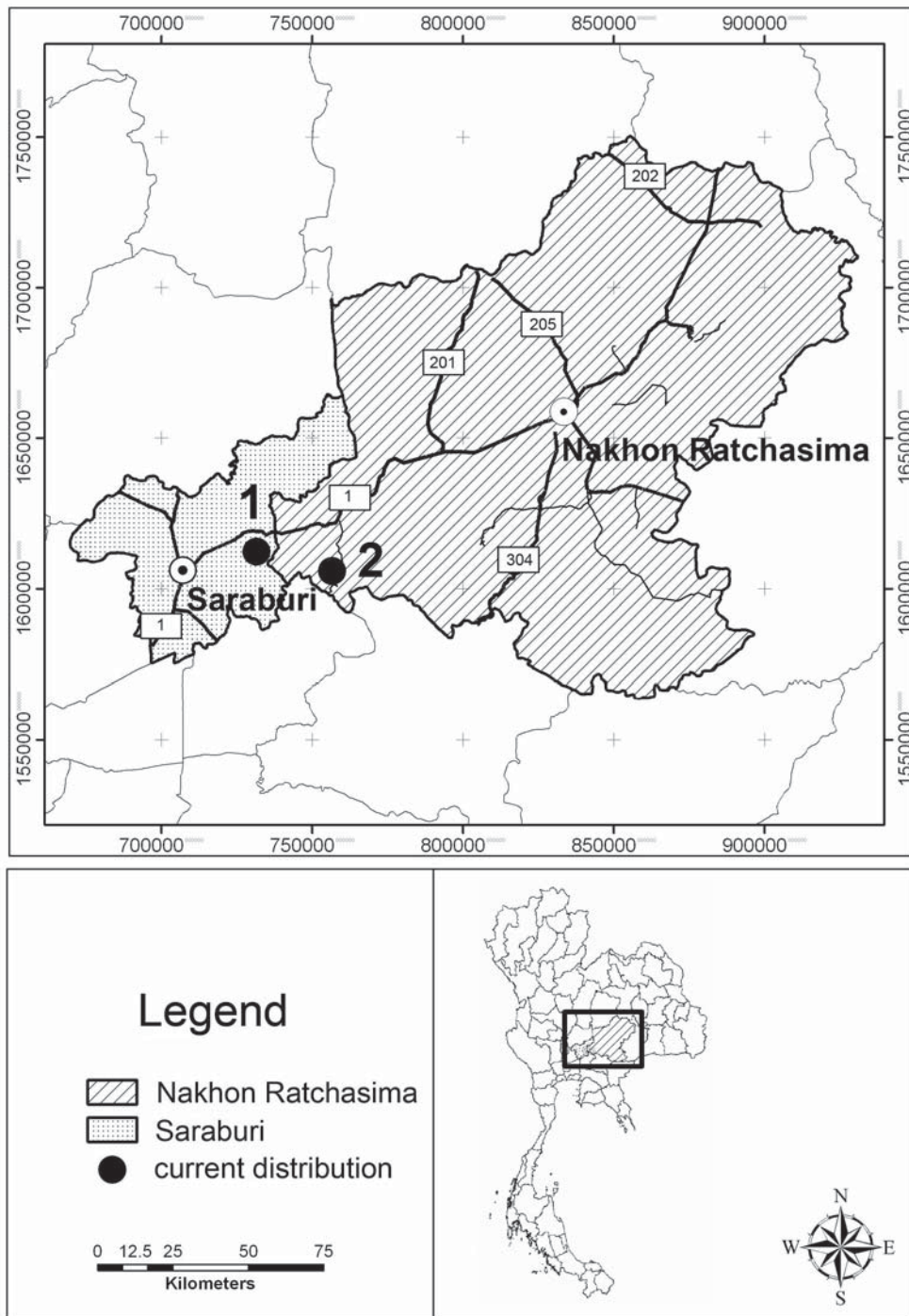


Figure 2 The distributional ranges of Neill's rats (*Leopoldamys neilli*).
 1 = Wat Tham Prapothisat, Saraburi province (14° 34' 31" N 101° 08' 43" E), the type locality of Neill's rat and 5 rats were trapped during the study.
 2 = Ban Tha Maprang, Nakhon Ratchsima province (14° 31' 45" N 101° 23' 56" E), the precedent site reported in 1974.

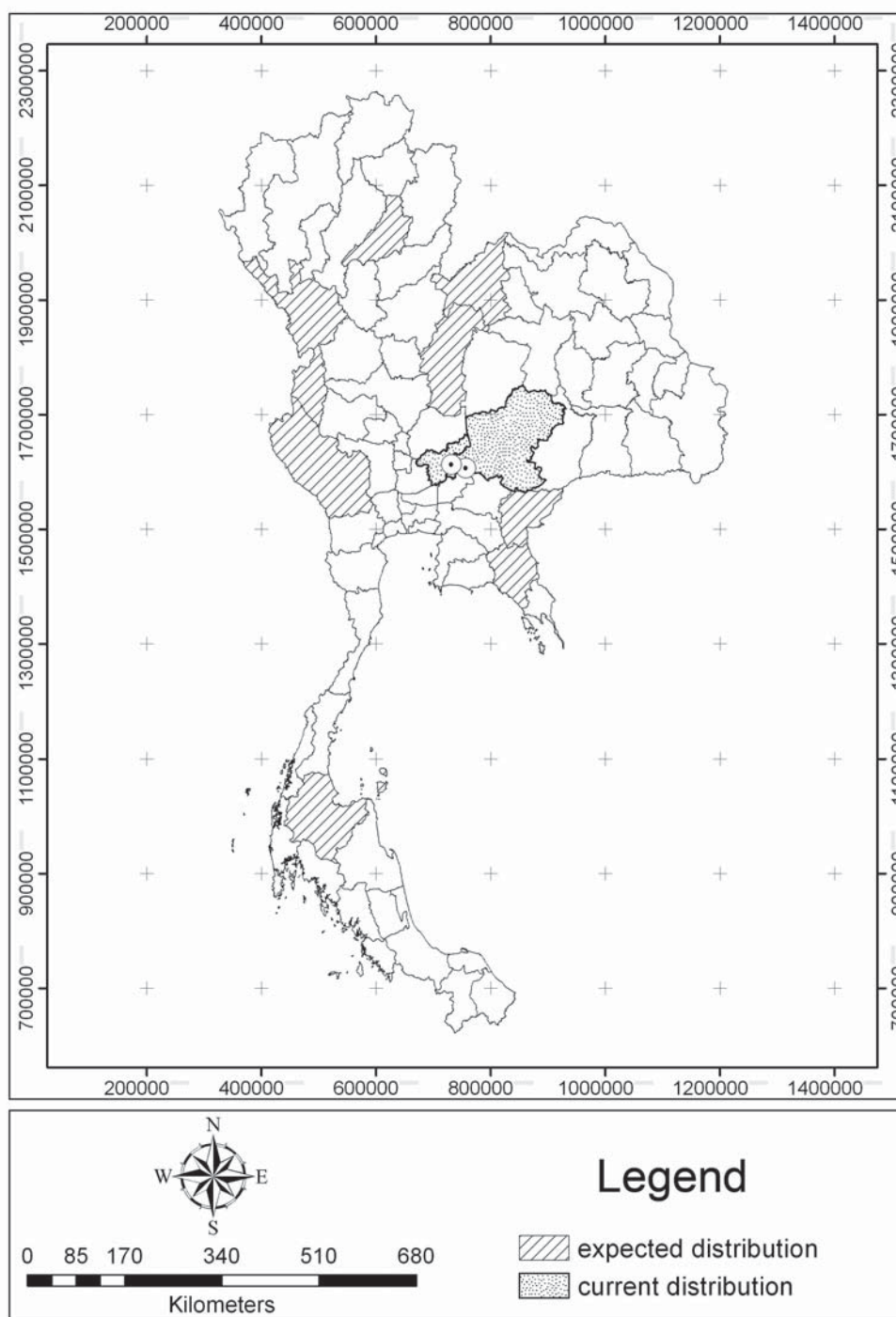


Figure 3 The circles represent the current locations of *L. neilli*. The spotted areas refer to the current spatial distributions of *L. neilli*, Saraburi and Nakhon Ratchasima provinces. The striped areas refer to the spatial expected distribution where *L. sabanus* specimens in the CTNRC were collected, and were likely misidentified. Those specimens have the external morphology similar to that of *L. neilli*.

DISCUSSION

1. The limestone rat (*Niviventer hinpoon*)

N. hinpoon is a small rat with the spiny upper-part, dark belly and bicolored tail. Its tail length is relatively equal to its head and body length. *N. hinpoon* was first trapped by William Neil in 1973 from the areas close to the entrance of the bat cave at Wat Tham Prapothisat, Saraburi province (14° 34' 31" N 101° 08' 43" E) (Lekagul and McNeely, 1988). The second location of *N. hinpoon* was discovered in 1976 at Wat Tham Prathat, Lop Buri province (14° 48' 15" N 100° 49' 30" E), 43 kilometers northwest of Wat Tham Prapothisat. The specimen was captured by Mr. Songsakdi Yenbutra, a former mammologist of the TISTR, from inside the cave.

The survey results revealed that the current distributional ranges of *N. hinpoon* were geographically restricted. *N. hinpoon* samples were trapped from two sites in Lop Buri province, at Wat Tham Prathat, and Wat Khudkham (Dondung) (15° 08' 35" N 100° 36' 44" E), the new distributional range of *N. hinpoon* (Figure 4). However, it was unsuccessful to trap *N. hinpoon* from its type locality at Wat Tham Prapothisat, Saraburi province. The results indicated very small ecological ranges of the species (Figure 1). The geographical distances of these three habitat sites were considerably adjacent. Therefore, it was expected that new locations of *N. hinpoon* on the limestone hill were situated along the ranges of the current and former distributional sites in Saraburi and Lop Buri provinces.

At Wat Tham Prathat, Saraburi province, one adult male was captured inside the cave on the last night of 4-night trapping with 0.5% of the successful rate. Previously, 50 live-traps were placed around the cave entrance and adjacent areas for three consecutive nights where none of *N. hinpoon* was found. This indicated an extremely low number of its population and restricted local distribution. At Wat Khudkham

(Dondung), five rats were captured with 2.5% of the successful rate. Moreover, some pieces of its skull were found inside the bat cave near the temple. In addition, *N. hinpoon* was not found in places away from Wat Khudkham (Dondung). The results indicated that the local geographical ranges of *N. hinpoon* were very narrow and relatively small as its type locality (Lekagul and McNeely, 1988). It was likely that they lived on the foot hill near the temple. Many factors such as the availability of food may influence the home range size of the rodents (Boutin, 1990). In Panama, the resource availability was related to the home range sizes of the spiny rat (*Proechimys semispinosus*), an endemic rodent (Endries and Adler, 2005). Nonetheless, it was uncertain about the biological and ecological factors that might influence the distribution ranges of *N. hinpoon* in the study sites. *N. hinpoon* lived in the temple areas which appeared to have a good protection from illegal poaching.

At Wat Tham Prapothisat, Saraburi province, a type locality of *N. hinpoon*, total of 400 live traps were placed around the areas of its habitats but none of them was caught. It was possible that the rats might be extinct from the area or its population was too small to detect. The study was not focused on identifying the causes of vanishing. However, it was observed that there were about 80 domestic dogs and 30 cats living in the temple. Some cats returned to the wild and became free-living animals. Both dogs and cats were high potential predators, especially for the rats. Therefore, *N. hinpoon* rats in the area were relatively under the pressure of the predators and under the serious situation of local extinction.

2. The Neill's rat (*Leopoldamys neilli*)

L. neilli is a large and long-tailed rat having grayish-brown upper part, pure white belly, dusky face, long tail, pale under part and tip. William A. Neill captured the first male rat in 1973 at Wat Tham Prapothisat, Saraburi province (Lekagul and McNeely, 1988; Corbet



Figure 4 Limestone rat (*N. hinpoon*) trapped from the mixed deciduous forest at the foot hill in the area of Wat Khudkham (Dondung), a timid and quiet species.



Figure 5 Neill's rat (*L. neilli*) caught from Wat Tham Prapothisat-its type locality, giant long tail, and pure white belly.

and Hill, 1992). Consequently, it was made the holotype specimen at CTNRC. It was found that the two specimens of *L. neilli* in the CTNRC were collected from Ban Tha Maprang, Nakhon Ratchasima province in 1974. This location is 35 kilometers southeast of the type locality.

In this study, trappings were carried out in two 5-day field trips with 50 live-traps. It was not possible to find *L. neilli* in the first field study. However, five adults of *L. neilli* were located at its type locality in the second field study. The population of *L. neilli* was very small. The success of the capture rate was 1%. It was also confirmed that the existence of current distribution of *L. neilli* was at its type locality (Figure 5). *L. neilli* in this area might confront the potential predators such as local dogs and cats as in *N. hinpoon* which possibly put them under the high risk of extinction from the type locality.

Another habitat location of *L. neilli* was verified and obtained from the specimens at CTNRC. Two specimens, CTNRC 54-009 and CTNRC 54-010 were collected from Ban Tha Maprang, Nakhon Ratchasima province (14° 31' 27" N 101° 23' 33" E) on 29th July, 1974. The areas are situated in the Khao Yai National Park boundary where it is very well protected by the park rangers. However, this project was focused on the study areas located outside the conservation areas of the country. Therefore, the animals were not trapped in this place. The second location of *L. neilli* was confirmed since the law was effectively enforced. It was also expected that the habitat and the illegal hunting were fully controlled. As a result, there are totally two ecological ranges of *L. neilli* as shown in Figure 2.

Taxonomic consideration and spatial distributional ranges of *L. neilli*

Lekagul and McNeely (1988) described *L. neilli* as "a dwarf version of *Rattus edwardsi*", the present taxonomic name of *L. neilli*. This rat species has a dusky face with a dull grayish-

brown upperpart and pure white under part as that of *L. edwardsi*. Its under-tail is pale as well as its tip as in *L. sabanus*. Its size is smaller than *L. edwardsi* and *L. sabanus* with 44 genetic chromosomes. *L. neilli* prefers the low altitude overlapped with *L. sabanus* (Lekagul and McNeely, 1988) while *L. edwardsi* occurs in the high altitude above the range of *L. sabanus* (from below 1,000 m up to 1,300 m) with the absence of *L. edwardsi* (Corbet and Hill, 1992). However, the taxonomy of *L. neilli* has not been still unclear and required an intensive revision (Musser, and Carleton, 2005).

The examinations of *L. sabanus* specimens of CTNRC were performed. At least 17 specimens were morphologically similar to *L. neilli* (Table 3). The external morphology was not clearly identified into species. Three specimens collected from Petchabun province possessed pure white bellies and grayish brown underneath as in *L. neilli*, and the body sizes as that of *L. sabanus*. The field survey was conducted by TISTR researchers for the small mammals in Loei province in January and March, 2005. Four unidentified specimens (SW00213, SW00214, SW00215, and SW00219) were collected. These were externally smaller than the holotype specimens of *L. neilli* but they were caught from the same cave with *L. sabanus*. According to the ecological preferences, these four unidentified specimens should be classified as *L. neilli*. These specimens were recognized by Dr. Jean-Pierre Hugot who caught the species near an entrance of a cave in the limestone hill from Phrae province. He marked and released the rats at the capture site. The next day, he found the marked rats at another entrance of the same cave, about 200 meters apart.

The specimens of *L. neilli* from CTNRC were examined. Lekagul and McNeely (1988) referred to two specimens of *L. neilli* collected from Kanchanburi province by G. J. Wiles. It was found that two specimens at CTNRC were identified as *L. neilli* (Wiles, 1981). A male rat (CTNRC 54-7216) was caught

from the mixed deciduous forest, Salakpra Wildlife Sanctuary on 14th October, 1976. Another female rat (CTNRC 54-7215) was captured from the same place on 23rd July, 1977. The external characteristics of those two specimens were examined comparing to the holotype specimens and other rat specimens in genus *Leopoldamys*. The results showed that a female specimen had pure white belly, grayish brown dorsal pelage without flattened spine, and the external measurements were similar to *L. neilli*. A male specimen had cream belly, yellowish dorsal pelage, and contained some flattened spine similar to that of *L. sabanus*. However, these two specimens have their skulls misplaced. It was not possible to specify the scientific name of these specimens from the external morphology. Therefore, the location of these specimens was defined as the expected spatial distribution of *L. neilli*.

The preliminary examination of the physiological study of specimens in genus *Leopoldamys* from CTNRC revealed that at least 12 specimens were physically similar to *L. neilli* (Table 3). It was not possible to clearly identify the species difference between *L. neilli* and *L. edwardsi*. Therefore, the taxonomic study of the *L. neilli* was required and intensively revised (Musser and Carleton, 2005). It was indicated the areas inhabited by the rats resembled to *L. neilli* were identified as “expected distribution” of *L. neilli*. These areas included Surat Thani province where Nabhitabhata and Cha-ard (2005) reported the most southern limit of *L. neilli*. The spatial distribution of *L. neilli* was determined in eight provinces (Figure 3). The potential areas of *L. neilli* were relatively wide spread in some areas such as Kanchanaburi and Tak provinces at the border between Thailand and Mynmar; Loei province at the border between Thailand and Laos; and Sa Kaeo and Chantaburi provinces at the border between Thailand and Cambodia. This information could indicate the much larger distribution of *L. neilli* known to the biologists and its possible finding

in neighboring countries of Thailand. Eventually, *L. neilli* could be taken off from the list of Thai endemic mammals. The expected distribution of *L. neilli* is reported here in order to meet the requirements for further intensive survey and taxonomic study in these areas.

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