Distribution and Abundance of Philippine Tube-Nosed Fruit Bat (*Nyctimene rabori* Heaney & Peterson) in Cebu, Philippines

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Abstract

A study on the distribution and abundance of the endangered Philippine tube-nosed fruit bat *Nyctimene rabori* was conducted from June 2014 to November 2015 in 11 sites in Cebu namely, Mt. Kapayas, Tabunan Forest, Basak, Mt. Lanaya, Nug-as, Mag-alambak, Suyac, Canbantug, Binalabag, Cansuje, and Sayao. Mist nets were used to capture bats, and the total sampling effort was 1012 net nights. A total of 74 tube-nosed fruit bats was recorded in eight areas except in Sayao, Binalabag, and Suyac with three new site distribution records namely, Cansuje, Mt. Kapayas, and Mt. Lanaya. Elevation where the species was captured ranged from 129 to 852masl. Capture rates were generally low ranging from 0.03 to 0.17, and relative abundance averaged only to 2.56%. More surveys in remaining areas throughout its range and radio telemetry may be pursued to determine food plants, roosting area, and extent of foraging grounds.

Keywords: natural fores; plantation forest; mix forest; endangered; bat

Introduction

Forest destruction in Cebu began during the Spanish colonization period (Vitug, 1993) and continued even more evidently in the 20th century leaving only less than 0.3% of its land area covered with forest (Jakosalem, 2011). The indiscriminate cutting of timber in Cebu has left highly fragmented forest habitats (Bagarinao, 2010). At present, there are only seven significant patches of forest left on various parts of the island (Gonzalez, et al., 1999; Paguntalan and Jakosalem, 2008; Jakosalem, 2011). This environmental catastrophe eventually resulted in the extinction of some of Cebu’s species such as the Visayan spotted deer *Cervus alfredi* and Visayan warty pig *Sus cebifrons* (Grubb and Groves, 1983; Gonzalez, et al., 1999 & Jakosalem 2011). The Cebu dwarf buffalo *Bubalus cebuensis* (Croft, et al., 2006) also was extinct even before it was discovered.

The Philippine Tube-nosed fruit bat *Nyctimene rabori* is the only species of *Nyctimene* in the Philippines (Mickleburgh, et al., 1992). It was only described in the early 80s by Heaney and Peterson (1984) after collecting a specimen in Negros at an elevation of 840masl. It was earlier known to occur only on Negros and Cebu and was considered endangered in 1988, critically endangered in 1996 then lowered to endangered in 2008 due to its record on Sibuyan island (Ong, et al., 2008). Previously, the species were thought to be found in forested areas in Negros, however; it was mist-netted along highly degraded areas in Cebu (Ong, et al., 2008).

In Cebu, its records were in Alcoy, Dalaguete and Tabunan (Paguntalan, pers. comm.), in Argao (Alburo, et al., 2006, Alcazar, et al., 2009) and in Badian (Obiso, et al., 2006). With the highly degraded conditions of Cebu’s forest due to expanding agricultural development and illegal cutting of trees even inside timberland areas, the survival of the species largely depends on the protection of the remaining forest patches.

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Presently, there is still limited information about the species, especially in Cebu. This paper provides updated distribution of *Nyctimene rabori* in Cebu as well as its abundance compared with other bats recorded in this study.

**Materials and Methods**

**A. Study Areas**

The study covers 11 sites throughout the island with nine areas concentrated in southern Cebu, one on central and another one on the northern part of the province (Figure 1).

**Argao.** Argao is a first class municipality with a population of over 70,000 and is located 66 km southeast of Cebu City. Among towns covered, Argao had the most number of areas considering its proximity to the University where the author is currently working. Sites included in Argao are Mt. Binalabag located at coordinates 51P 563330 N and 1095509 E using Universal Transverse Mercator (UTM). This site is a timberland area planted with exotic species like Mahogany *Swietenia macrophylla* which are growing together with some native species usually Malaiba, Malabakhaw, and *Neonauclea species*, among others. The site is predominantly limestone with trees rarely reaching five meters. The inclusion of this site in the study is due to the local government’s plan of establishing an ecotourism park at its summit.

The second site in Argao is the Cansuje forest patch. This patch of forest is probably next to Mt. Lantoy – an Important Bird Area (IBA) in Argao in terms of area, although in terms of tree size it has relatively bigger trees than Mt. Lantoy and can be found at coordinates 51P 563331 N and 1096934 E. Elevation in the area ranges from 600 to 750masl. Mahogany have now overgrown many of the native vegetation in the area which generally have changed the vegetative structure in certain portions of the site. Mountain agoho *Casuarina sp.* also naturally grows on the summit of Ka-intok range on the Kabongbongan side while plenty of Figs also grow on limestone karst formation, depicting big canopies from a distance.

The other two sites of the study in Argao are Canbantug and Suyac. Canbantug is located at coordinates 51P 555300 N and 1091560 E while Suyac is at 51P 555845 N and 1092855 E. Canbantug forest area is the laboratory forest of the Forestry Department of CTU Argao Campus with an area of approximately 105 hectares extending to Suyac. The two sites are close to each other and are both thickly planted to mahogany. *Nyctimene rabori* was recorded in the area in 2004 (Alburo, et al., 2006 and Alcazar et al. 2009). Elevation in the area ranges from 600 to 750masl. The Palinpinon Range in Dalguate, an identified conservation area under the New Conservation Areas of the Philippine Project (NewCAPP) is connected to the ridge of Canbantug and Suyac.

**Mag-alambak forest.** The Mag-alambak forest, located in Mantalongon, Dalguate has coordinates 51P 551405 N and 1084584 E. It has an approximate area of 40has and an elevation from 750 to 850masl (Paguntalan, et al., 2015). The site serves as the central nursery in the implementation of then SCRDP. Mahogany, *falcata Paraserianthes falcatoria*, and Agoho *Casuarina equisitofolia* are among the trees planted and have dominantly grown on the site.

**Nug-as Forest.** The Nug-as forest can be found in the municipality of Alcoy in the southeast portion of Cebu. It is the largest remaining patch of forest on the island with an area of over 800ha (Paguntalan, 2009; Jakosalem, 2011). The latest report shows that it has a total of 1200 has. extending to the other villages in the adjacent town of Boljoon (Paguntalan, et al., 2015). Some portions of the area were also planted to
Mahogany, although a much wider part is covered with native species. The site is also an IBA together with Mt. Lantoy in Argao (Mallari, et al., 2001) and is reported to have the most number of black shama and other birds recorded on Cebu, which was previously thought to be extinct on the island (Birdlife International, 2012). It is credited as one of the ten birdwatching sites in the Philippines (Libosada, 2008) and holds significant botanical resources growing on a limestone substrate (Pelser and Barcelona, pers. comm.)

**Mount Lanaya.** Mt Lanaya situated at the borders of Alegria and Malabuyoc towns on the southwest side of Cebu City has coordinates 51P 538815 N and 1072713 E. Mt. Lanaya is considered as one of the IBAs in Cebu (Mallari, et al., 2001). Its elevation at the Kalo-kalo peak is at 600masl although the netting areas were at 450 to 550masl. Native species growing in the area includes Hambabalud *Neonauclea spp.* and *Bakauan gubat* (*Carallia brachiata*). Like other reforestation sites covered in this study, vegetation structure is changing with the introduced species beginning to eliminate the native.

**Sayao.** Sayao is a mountain village in the Municipality of Sibonga in the southeast part of Cebu. It lies at an elevation of 400masl with coordinates 51P 564029 N and 1111738 E. The site is included in an attempt to assess more sites to determine the presence of *N. rabori*. Moreover, Sibonga is the only town covered by the SCRDP that was not assessed during field
works in the previous years. Unfortunately, the area is highly degraded with trees being cut to produce charcoal. Remaining trees rarely stand three meters. Remaining trees are usually figs growing on steep limestone areas and palms along the slopes.

**Tabunan Forest.** The Tabunan Forest is the last remaining forest within the political limits of Cebu City located in the village of Tabunan at coordinates 51P 589992 N and 1153993 E. It is part of the Central Cebu Protected Landscape (CCPL), and is the last village of Cebu City towards its adjacent town of Balamban. Tabunan had since been considered the last significant forest to have harbored Cebu’s biodiversity before the discovery of the Nug-as forest in the late 1990s. Among forest fragments left on the island, Tabunan holds the biggest remaining trees of Cebu’s natural forests (Bird Life International, 2012). Dipterocarp species like Lauaan are still found in the area.

**Mt. Kapayas Forest.** Mt. Kapayas is the only IBA in Cebu located on the northern part of the island (Mallari, *et al.*, 2001). It is probably the largest remaining forest in northern Cebu. It is located in the municipalities of Catmon and Carmen with coordinates 51P 602486 N and 1176582 E. Mt. Kapayas had been considered a significant site for Cebu’s biodiversity because of the rediscovery of the Phil. bare-backed fruit bat *Dobsonia chapmani* in 2001 (Paguntalan, 2006).

### B. Mist Netting

Bats were captured using 4x6 meters mist nets set strategically within each study site. Netting was done intermittently beginning June 2014 until November 2015 for a total of 1012 net nights across 11 areas. Although not categorically grouped according to height, nets were set at 1m above the ground (lower portion of the net) as the lowest and approximately 12m above the ground as the highest. Choice of height mainly depends on trees available that can support the nets.

Data collection relied on funding and available time, especially during term breaks. All captured bats were marked and released back to the wild immediately after taking essential data. Biometric measurements such as the forearm, hind foot, tail, ear, body length, total length were measured based on Ingle and Heaney (1992). Weight, sex and maturity of the bat, as well as, elevation and the height of net where bat was caught were recorded for every Philippine Tube-nosed fruit bat captured.

### C. Analysis of Data

Data were analyzed using capture rates and relative abundance. Capture Rate was determined by dividing the number of individuals captured over the number of net nights. On the other hand, Relative Abundance was computed by dividing the number of individuals captured for each species over the total number of individuals for all species multiplied by 100. Comparison between the capture rates and relative abundance of *N. rabori* across 11 sites, and with the rest of the species recorded in the study was conducted. The distribution of *N. rabori* was mapped out using ArcView.

### Results and Discussion

#### Distribution of Philippine Tube-nosed Fruit Bat

A total of 74 individuals of *Nyctimene rabori* excluding two recaptures were recorded on eight out of 11 study areas. These areas are Canbantug, Cansuje, Mag-alambak, Nug-as forest, Mt. Lanaya, Basak, Tabunan Forest, and Mt. Kapayas. Of the individuals captured, 36 were males and 38 were females; 51 were adults and 23 were sub-adults or juveniles. None of the captured mature individuals were either pregnant or carrying babies, unlike some *Cynopterus brachyotis*, *Macroglossus minimus*, *Ptenochirus jagori* and *Rousettus amplexicaudatus*. Elevations
where the species was captured range from 129 masl in Basak to as high as 758 masl in Mag-alambak. While no specific requirement on height in setting the mist nets from the ground, *N. rabori* were caught at the average of 4 m from the ground (range from 1 to 7 m) across eight sites. Site-specific average of net heights where the species was captured are as follows; Basak at 2.4 m, followed by Tabunan at 3.4 m, Canbantug, and Catmon both at 4 m, Nug-as at 4.1 m, Mag-alambak at 4.4 m, Cansuje at 4.5 m and the highest from Mt. Lanaya at 4.9 m. The lowest net was approximately 1 m above the ground while the highest net set was about 12 m. *Nyctimene rabori* were captured both in natural and mixed plantation forests, however, more captures were obtained in forest plantations. For example, fifteen were recorded in mixed mahogany plantations in Nug-as while only two individuals in the natural forest area. Likewise, all the ten individuals captured in Mag-alambak were from mixed plantation largely dominated by mahogany and falcata. Moreover, 40 were caught along forest edges, even at highly degraded areas than in forest interiors (Table 1), even though more nets were set along edges than interiors due to available space inside.

Table 1: Distribution of individuals captured across habitat location.

<table>
<thead>
<tr>
<th>Habitat location</th>
<th>No. of <em>N. rabori</em> captured</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural forest (interior)</td>
<td>6</td>
<td>8.11</td>
</tr>
<tr>
<td>Natural forest (edge)</td>
<td>12</td>
<td>16.22</td>
</tr>
<tr>
<td>Plantation (interior)</td>
<td>17</td>
<td>22.97</td>
</tr>
<tr>
<td>Plantation (edge)</td>
<td>6</td>
<td>8.11</td>
</tr>
<tr>
<td>Mixed forest (interior)</td>
<td>11</td>
<td>14.86</td>
</tr>
<tr>
<td>Mixed forest (edge)</td>
<td>22</td>
<td>29.73</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>74</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

These results verify early records of the species in Dalaguete (Paguntalan, pers.com); Badian (Obiso, *et al.*, 2006) and in Canbantug, Argao (Alburo, *et al.*, 2006 & Alcazar, *et al.*, 2008). Apparently, there is an increase in the number of sites where the *N. rabori* can be found since it was first recorded in 1998 in the Nug-as forest (Gonzales, *et al.*, 1999; Paguntalan and Jakosalem, 2008 & Paguntalan, *et al.*, 2015). The current data expands the distribution of *N. rabori* having new records on Cansuje, Mt. Lanaya and Mt. Kapayas. Overall, the species have now records on eight sites in Cebu namely Canbantug and Cansuje in Argao, Mag-alambak in Dalaguete, Mt. Lanaya, Alegria, Nug-as, Alcoy, Basak (Kawasan), Badian, Tabunan Forest, Cebu City and in Mt. Kapayas (Figure 2). With Cebu’s forests highly fragmented (Bagarinao, 2010), further assessments maybe essential on remaining areas surrounding Tabunan and Mt. Kapayas because most records of the species concentrated in southern Cebu.

Nearly an equal proportion of males and females captured with 31% juveniles or sub-adults suggest that the current population of *N. rabori* in Cebu is possibly increasing. All elevational records where the *N. rabori* was recorded fall within the limits of up to 1300 masl (Heaney and Peterson, 1984; Ong, *et al.*, 2008). However, the lowest elevation recorded in this investigation was at 129 masl in Basak unlike in Negros which is 200 masl (Ong, *et al.*, 2008). This difference is not significant and may only be caused by the clearing of forests on lowland areas which is commonly happening. Fortunately, in Basak some native forest patches remain on narrow and steep slopes lining the Matutinao River where the remaining population of *N. rabori* is probably roosting.

Regarding size, bats can be classified as small, medium or large which may tell their flight altitude. While many insectivorous bats can be seen flying high while searching for insects during dusk, Mohagan, *et al.*, (2009) found out that smaller bats were generally captured by ground nets while medium and large species are usually trapped in canopy and sky nets. Contrastingly, as a medium-sized bat some *N. rabori*, were captured at relatively low heights (1.5-7 m;
average = 4m) from the ground. It appears that not only the size of the bat dictates where a species flies but more importantly the height of feeding trees where they can get their food and available space where they can properly maneuver. Mohagan, et al., (2006) speculated that bats captured by ground nets were actually searching for insects as their food. Moreover, the wing structure of the bat also affects their ability to maneuver in their flight routes (Alviola, 2009). In areas where captures were very close to the ground (1m), the surrounding area is highly degraded; vegetation is too fragmented and nearly an open area on a mid-slope of a mountain. Moreover, the very low capture of *N. rabori* in the natural forest in Nug-as compared with the mixed plantations (2 against 15) is perhaps due to the density of trees and branches in the understory, which limits them to maneuver in the area. It can also be assumed that space for maneuvering while looking for food is a determining factor why many individuals are captured along the edge of the forest (Ong, et al., 2008).

**Abundance**

Seventeen species of bats were recorded across 11 study sites composed of 10 fruit bats and seven insect bats. *Nyctimene rabori* were only captured in 8 sites. Tabunan recorded the highest number of individuals with 29 followed by Nug-as with 17, Mag-alambak with 10, Basak with 7, Mt. Lanaya 5; and Canbantug, Cansuje, and Mt.
Table 2: *Species captured Abundance values of bats recorded from 11 sites in Cebu from June 2014-November 2015.*

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>Binalabag</th>
<th>Carsuje</th>
<th>Suyac</th>
<th>Canbantug</th>
<th>Mag-alamnak</th>
<th>Mt. Lanaya</th>
<th>Basak</th>
<th>Nug-as</th>
<th>Sayao</th>
<th>Tabunan</th>
<th>Mt. Kapayas</th>
<th>Totals</th>
<th>Rel. Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cynopteros brachyotis</em></td>
<td>132</td>
<td>154</td>
<td>44</td>
<td>98</td>
<td>32</td>
<td>39</td>
<td>127</td>
<td>95</td>
<td>134</td>
<td>210</td>
<td>353</td>
<td>1418</td>
<td>49.08</td>
</tr>
<tr>
<td><em>Eonycteris spelea</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>13</td>
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<td>0.45</td>
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<td><em>Haplonycteris fischeri</em></td>
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<td>10</td>
<td>2</td>
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<td></td>
<td>83</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>124</td>
<td>4.29</td>
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<td><em>Harpygonycteris whiteheadi</em></td>
<td>1</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
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<td></td>
<td></td>
<td>11</td>
<td>0.38</td>
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<td><em>Hipposideros dudema</em></td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td></td>
<td>0.21</td>
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<td></td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>insect bat</td>
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<td></td>
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<td></td>
<td>1</td>
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<tr>
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<td></td>
<td></td>
<td>1</td>
<td>0.03</td>
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<td><em>Macroglussos minimus</em></td>
<td>6</td>
<td>39</td>
<td>4</td>
<td>29</td>
<td>23</td>
<td>11</td>
<td>5</td>
<td>39</td>
<td>18</td>
<td>10</td>
<td>26</td>
<td>210</td>
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<td><em>Myotis muricola</em></td>
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<td>5</td>
<td>7</td>
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<td>29</td>
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<td><em>Nyctemene rubori</em></td>
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<td><em>Ptenochirus jogori</em></td>
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<td>8</td>
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<td>85</td>
<td>18</td>
<td>19</td>
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<td>150</td>
<td>206</td>
<td>555</td>
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<tr>
<td><em>Rousettus amplexicaudatus</em></td>
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<td>13</td>
<td>23</td>
<td>8</td>
<td>106</td>
<td>12</td>
<td>1</td>
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<td>96</td>
<td>74</td>
<td>452</td>
<td>664</td>
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<td><strong>Total</strong></td>
<td><strong>166</strong></td>
<td><strong>222</strong></td>
<td><strong>90</strong></td>
<td><strong>165</strong></td>
<td><strong>267</strong></td>
<td><strong>85</strong></td>
<td><strong>163</strong></td>
<td><strong>352</strong></td>
<td><strong>175</strong></td>
<td><strong>540</strong></td>
<td><strong>664</strong></td>
<td><strong>2889</strong></td>
<td><strong>100</strong></td>
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<tr>
<td>Number of Net nights</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>45</td>
<td>80</td>
<td>70</td>
<td>90</td>
<td>191</td>
<td>50</td>
<td>166</td>
<td>140</td>
<td>1012</td>
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</table>
Kapayas with two each. However, capture rates of *N. rabori* generally reveal very low with the highest value of only 0.17 in Tabunan followed by Mag-alambak with 0.13 and the rest were lower than 0.1. *Cynopterus brachyotis* obtained the highest abundance with 49.08% followed by *Ptenochirus jagori* with 19.21% and *Rousettus amplexicaudatus* with 15.65%. Furthermore, *N. rabori* ranked 6th among the 17 species with a relative abundance of 2.56%. There are not much abundance records from previous investigations which can be compared with current data except in Canbantug where it
decreased to 1.2% from 3.3% (Alccazar, et al., 2008). It shows that population of N. rabori tends to reduce in contrast with other species especially those that are generalists like C. brachyotis, P. jagori, R. amplexicaudatus and M. minimus. The highest capture rate of only 0.17 in Cebu is almost three times lower than the highest capture rate recorded in Negros with up to 0.46 (Patdu, 2015). It suggests that the population of N. rabori in Cebu is significantly lower than its population in Negros. It is also estimated by Ong et al. (2008) that remaining population of N. rabori in Negros is by thousands while it is only in few hundreds in Cebu. Interestingly, its abundance (2.56%) is higher than other non-threatened fruit bats like Harpionychteris whiteheadi (0.38%), Eonycteris spelea (0.45%), and Pteropus hypomelanus. However, being restrictedly distributed in Cebu, Negros and Sibuyan, it is important to undertake some conservation measures on the ground.

**Conclusion**

New distribution records of Nyctimene rabori are identified namely in Cansuje, Mt. Kapayas and Mt. Lanaya, which are added to Nug-as, Mag-alambak, Canbantug, Basak, and Tabunan, confirming the species presence on eight sites throughout the island. Moreover, relative abundance and capture rates of N. rabori remain low in proportion with other species base from available data for Cebu as well as those from Negros island.

**Recommendation**

1. Conduct similar study on other areas throughout the range like Sibuyan to expand survey particularly in Panay considering that the island is vast as well as closer to the present range of the species.

2. Further studies using radio telemetry may be pursued to determine food plants, roosting area and extent of foraging grounds of N. rabori.

**Acknowledgement**

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**References**


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