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Identification of bats on traditional market in dumoga district, North Sulawesi

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Abstract. Fruit bats are used as food by the Minahasan tribe in North Sulawesi. This is evident in some traditional markets where various species of fruit bats are sold. As a consequence, bats are continually over hunted for human consumption, threatening bat populations. This study aims to identify bat species sold in traditional markets in Dumoga district, North Sulawesi. Field surveys were performed and data collected in three traditional markets namely Ibolian, Imandi, and Dumoga, located nearby the Nani Warta Bone National Park. The collected samples were identified using morphometric measurements and physical characteristics, then analyzed by descriptive method. From these markets were identified and consisted of *Acerodon celebensis*, *Dobsonia exoleta*, *Neopteryx frosti*, *Styloctenium wallacei*, *Rousettus amplexicaudatus*, *Thoopterus nigrescens*, *Nyctimene chepalotes*, and unknown species. Five of these bat species are endemic to Sulawesi (*Acerodon celebensis*, *Dobsonia exoleta*, *Neopteryx frosti*, *Styloctenium wallacei*, and *Thoopterus nigrescens*). According to the International Union for Conservation of Nature (IUCN) Red-List, two species have declined status (*Styloctenium wallacei* Near Threatened (NT), and *Acerodon celebensis* Vulnerable (VU)), and one species is threatened with extinction status (*Neopteryx frosti* endangered (EN)).

1. Introduction

The Minahasa community in North Sulawesi has a culture that consumes bush meat such as warty pigs, rats, and bats [1], especially on special occasions and holidays. According to Sheherazade and Susan (2015), around 500 tons of bats are imported to North Sulawesi from other provinces to meet consumer demand. Currently, the consumption of bushmeat is popularized with the aim of attracting tourists with “extreme culinary” slogans [2].

Bats play an important role in the ecosystem and to maintain diversity in the forest. They are important animals with ecological functions as seed dispersers, plant pollinators and insect predators [3–6]. According to Suyanto (2001), there are 205 species in Indonesia, corresponding to 21% of all types of bats in the world [7]. They consist of 72 species from the suborder Megachiroptera (fruit-eating bats, leaves, nectar, and pollen) and 133 species from the Microchiroptera suborder (bats that mostly eat insects). There are 23 species of the suborder Megachiroptera found on the island of Sulawesi and surrounding small islands and 11 of these species are endemic [7,8]. On fruit bats in



North and Central Sulawesi obtained five species. Two species are endemic namely; *Acerodon celebensis* and *Thoopterus nigrescens* [9].

Dumoga District, North Sulawesi Province is one of the districts located beside the Nani Warta Bone National Park. The Minahasan people who live in this place consume bat meat as protein resources on a daily basis. Various types of bats can be found in traditional markets. This shows that bats are continually over hunted for human consumption and this activity is one of the major factors threatening bat populations, which will have an impact on the ecosystem balance. Therefore a bat survey has been carried out at the Dumoga District traditional market to identify the types of bats traded. This research is important to implement bat conservation measures, especially for endemic species whose populations are threatened with extinction. We expect that the data and information from this study will be the basis for establishing the rules and policies for bat conservation in Dumoga District by the local government.

2. Research methods

Surveys in three markets of East Dumoga Subdistrict, namely Dumoga, Imandi, and Ibolian were conducted in this study. The survey was conducted in February 2018 and May 2019. Good communication and relationships were established with the seller so that the seller allows the researcher to identify the bats before they are sold. Parameters measured were body weight, body length, ear length, arm's length under the wings, length of the hind legs of the bat. Observation and documentation for body color and shape. Furthermore, bats were identified using a bat identification key [7].

3. Results and Discussion

A total of 170 bats have been identified in three markets, namely Ibolian, Imandi and Dumoga. Identification based on morphometry and color characteristics and body shapes resulted in 9 species from 8 genera: *Acerodon* Jouran, 1837, *Dobsonia* Palmer, 1898, *Nyctimene* Borkhausen, 1797, *Neopteryx* Hayman, 1946, *Stylotecnium* Matschie, 1899, *Cynopterus* Cuvier, 1898, *Rousettus* Gray, 1821, and *Thoopterus* Matschie, 1899). All of them belong to the family Pteropodidae. Descriptions of 9 species are described as follows:

3.1. *Acerodon celebensis*

Bodyweight 290.21-312.47 g. Body length 180.14-187 mm. Head length 66.59-76.24 mm. Ear length is 30.18-30.29 mm. The length of the forearm is 122.86-123.81 mm. The length of the rear leg is 37.95 mm. The golden yellow color on the feathers of all parts of the body and wing fingers. Brown color on the snout, wings, and toes. (Figure 1). This species has no tail.



Figure 1. *Acerodon celebensis*

3.2. *Dobsonia exoleta*

Bodyweight 282.21-320 g. Body length 171-220 mm. Head length of 52 mm. Ear length 25-26.66 mm. The length of the forearm is 110-116.67 mm. Ear length 11-14.66 mm, Length of the rear leg 33-

33.33 mm. The greenish yellow color on body hair. Black color on the wing skin. Hairless back. (Figure 2). This species has a tail and no claws on the fingers of the two wings.



Figure 2. *Dobsonia exoleta*

3.3. *Neopteryx frosti*

Bodyweight 230 g. Body length of 175 mm. Head length of 65 mm. Ear length 21 mm. The length of the forearm is 110 mm. The back foot length is 30 mm. Light brown color on the feathers on the body and wings. Shaped mesh on the dark brown stripe-shaped wing. In the head of the lateral frontal side white lines are found from the bottom of both eyes to the mouth (Figure 3). This type is tailed and has no claws on the wings. According to Bergmans and Rozendal (1988) cited by Suyanto (2001), this type weighs 164-190 grams. Head length from 50.7 to 55.8 mm, wing length underwing 104.9-110.6 mm.



Figure 3. *Neopteryx frosti*

3.4. *Styloctenium wallacei*

Bodyweight 170-210 g. The body length of 160 mm. Head length 54-56 mm. Ear length 21-25 mm. The length of the forearm under 100-110 mm. The back foot length is 30 mm. Reddish brown color (cinnamon brown) on the entire body except for the wing ears and legs dark brown. There are short white lines above the eyes and the circumference of the eyes, nose, snout, and mouth of the left and right sides. (Figure 4).



Figure 4. *Styloctenium wallacei*

3.5. *Nyctimene cephalotes*

Bodyweight 57.71-58.75 g. Body length 84.44-86.75 mm. Head length 30.22-31.5 mm. Ear length 14.22-14.5 mm. The length of the forearm is 65.55-66.5 mm. Tail length 20.66-21.5. Length of back legs 14.11-14.5 mm. Grayish brown color on body hair. Yellow spots on the ears, wings, and fingers of the wings. Tubular protruding nose. The thin brown line along the back. Short tail (Figure 5).



Figure 5. *Nyctimene cephalotes*

3.6. *Cynopterus minutus*

Bodyweight of 45-50 g. Body length 80-85 mm. Head length 26.5-28 mm. Ear length 12.5-14 mm. The length of the forearm is 55 mm. Back foot length 10-12 mm. Grayish brown color on body hair. Short snout. The white line at the edge of the ear (Figure 6).



Figure 6. *Cynopterus minutus*

3.7. *Thoopterus nigrescens*

Bodyweight 81.32-93.69 g. Body length 110.03-112.69 mm. Head length from 41.5 to 42.92 mm. Ear length 14.74-15.23 mm. The length of the forearm is 73.21-74.77mm. The length of the rear leg is 16,19-16,31 mm. Gray black body, no tail, short snout (Figure 7).



Figure 7. *Thoopterus nigrescens*

3.8. *Rousettus amplexicaudatus*

Bodyweight ranges from 72.75 to 75.63 g. Body length 109.25-114.69 mm. Head length of 45.59-47.63 mm. Ear length of 15.86-16.16 mm. The length of the forearm is 71.66-72.75 mm. Tail length 18.94 mm. The length of the rear leg is 17.66-18.38 mm. The body is grayish brown, the snout is long, has a blackish-brown tail, wings (Figure 8).



Figure 8. *Rousettus amplexicaudatus*

3.9. *Rousettus* sp.

Bodyweight ranges from 150-216.66 g. Body length 95-165 mm. Head length of 39-53.3 mm. Ear length is 25.3-26 mm. The length of the forearm is 85-96.66 mm. Head length of 22-29.66 mm. According to body weight and morphometric size, this bat is not *Rousettus amplexicaudatus*. However, some other physical features are similar to *Rousettus amplexicaudatus* (Figure 9).



Figure 9. *Rousettus* sp.

Identification results show seven species of small fruit bats, namely: *Dobsonia exoleta*, *Neopteryx Frosti*, *Styloctenium wallacei*, *Rousettus amplexicaudatus*, *Thoopterus nigrescens*, *Nyctimene cephalotes*, and *Cynopterus minutus*. The seven bats are hunted in and around the Nani Warta Bone forest area and the Gunung Moosi community forest estate, near Dumoga sub-district. Table 1 shows the numbers and percentages of bats observed in these markets. *Thoopterus nigrescens*, *Rousettus amplexicaudatus*, *Acerodon celebensis*, *Nyctimene cephalotes* were the most common species (30%, 28%, 25% and 7.64%, respectively) whereas, *Dobsonia exoleta*, *Cynopterus minutus*, *Styloctenium wallacei*, *Neopteryx frosti* and the unidentified species of *Rousettus* were less frequently observed (2.35%, 1.76%, 1.17%, 0.5%, and 2.94%, respectively).

Table 1. Total, Percentage, Conservation Status (IUCN_Red List) and endemic status for each species

Species	Total Individu	%	Conservation Status (IUCN Red-List)	Remarks
<i>Acerodon celebensis</i>	43	25	Vulnerable (VU) Least	Endemic
<i>Dobsonia exoleta</i>	4	2.35	Concern (LC)	Endemic
<i>Neopteryx frosti</i>	1	0.59	Endangered (EN) Near	Endemic
<i>Styloctenium wallacei</i>	2	1.17	Threatened (NT) Least	Endemic
<i>Rousettus amplexicaudatus</i>	48	28.23	Concern (LC) Least	
<i>Thoopterus nigrescens</i>	51	30.00	Concern (LC) Least	Endemic
<i>Nyctimene cephalotes</i>	13	7.64	Concern (LC) Least	
<i>Cynopterus minutus</i>	5	1.76	Concern (LC)	
<i>Rousettus sp</i>	4	2.94	Least Concern (LC)	

4. Discussion

Of the nine species identified in this study, five are endemic to Sulawesi (*Acerodon celebensis*, *Dobsonia exoleta*, *Neopteryx frosti*, *Styloctenium wallacei*, and *Thoopterus nigrescens*). According to the International Union for Conservation of Nature (IUCN) Red-List 2019, *Styloctenium wallacei* is Near Threatened (NT), *Acerodon celebensis* is Vulnerable (VU), and *Neopteryx frosti* is endangered (EN). The existence of the bat trade in the Dumoga subdistrict traditional market shows that people's understanding of the role of bats in the ecosystem is not yet apparent. Actions need to be taken to carry out bat conservation activities, especially for endemic species and species thought to be endangered. Conservation education for school-age children and continuous education for hunters,

sellers, and bat-eaters is necessary. Another way to avoid declining bat populations would be to breed them and legalize the trade of the cultivated bat meat following the prohibition on the trade of wild bats from hunting.

5. Conclusion

Eight species were identified in Dumoga traditional markets: *Acerodon celebensis*, *Dobsonia exoleta*, *Neopteryx Frosti*, *Styloctenium wallacei*, *Rousettus amplexicaudatus*, *Thoopterus nigrescens*, *Nyctimene cephalotes*, and *Cynopterus minutus* and one unidentified species from the *Rousettus* genus. Five of these species, *A.Celebensis*, *Dobsonia exoleta*, *N. frosti*, *S.wallacei*, and *T.nigrescens*, are endemic to Sulawesi. The population of *Neopteryx frosti* is threatened.

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