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Alopecia in Bats from Tropical Urban Islands

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Abstract

Background: *Alopecia or alopecic syndrome is a hair loss condition on the body. Alopecia is caused by a wide variety of factors both internal to the individual (i.e. androgen activity, nutritional deficiencies, metabolic stress, hormonal imbalances) and external (i.e. human-induced pressures, allergens, ectoparasites, fungal dermatitis, bacterial, toxicities, environmental contaminant exposure, idiopathic disease, poor habitat conditions, anthropogenic activities, zinc deficiency, and ingestion of plant toxins).* **Methodology:** *This study was conducted at four locations in Batam City, consisting of two fragmented forests in the city center and two islands far from the city area. Bats were captured using mist nets and harp traps with a total sampling effort of 120 net nights and 120 harp trap nights.* **Findings:** *This study captured 417 bats across seven species, with an overall alopecia prevalence of 10.79 %. The highest prevalence was found in Pipistrellus tenuis (100%), Kerivoula pellucida (50 %), and Macroglossus minimus (20 %), likely due to the small sample sizes of these species. Larger sample sizes resulted in lower prevalence rates: Balionycteris maculata (22.2 %), Cynopterus horsfieldii (11.1 %), C. brachyotis (9.2 %), and C. sphinx (6.86 %). The most severe hair loss generally occurs on the shoulders and neck. Some individuals show hair loss on the back, head, chest, abdomen, and other parts of the body. Alopecia is found in both males and females from mild to severe. The prevalence of alopecia in all species was higher in fragmented forests in urban to periurban, and rural areas. This was associated with differences in the level of anthropogenic pressure.* **Contribution:** *These findings provide a scientific contribution to understanding the relationship between alopecia in bats and anthropogenic pressures and highlight the importance of habitat conditions in population health in fragmented environments.*

Keywords: *Alopecic syndrome; Anomalies; Skin disease; Urban landscapes*

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INTRODUCTION

Bat is one of the most diverse mammal groups in ecology and taxonomy. Their sensitivity to environmental changes is an invaluable indicator of ecosystem degradation (Bello-Gutiérrez et al., 2010). Human-induced landscape change associated with habitat loss and fragmentation places wildlife populations at risk such as a change in the prevalence of disease, which may result in increased mortality and reduced fecundity (Brearley et al., 2013). Urban environments with varying levels of anthropogenic disturbance can have an impact on animals, including bats. One of the disturbances observed in animals living in urban landscapes is hair loss on body parts such as the abdomen, back, head, shoulders, thorax, and other parts of the body which is called alopecia syndrome (Mühldorfer et al., 2011; Tang et al., 2012; Hernández-Aguilar et al., 2023). Histologically, the affected skin shows a reduced number of hair follicles but without inflammation and evidence of infectious etiology (Bello-Gutiérrez et al., 2010).

Alopecia has been observed in both captive and wild bats. The authors proposed that its causes include androgen activity, nutritional deficiencies, metabolic stress associated with pregnancy and lactation, or human-induced pressures (Bello-Gutiérrez et al., 2010; Tang et al., 2012; Fountain et al., 2017). On the other hand, hair loss or alopecic syndrome is a condition multifactorial in mammals that has been associated with allergens, ectoparasites, fungal dermatitis, bacterial, toxicities, hormonal imbalances, environmental stress, environmental contaminant exposure, idiopathic disease (Noxon 1995; Novak & Meyer 2009; Tang et al., 2012; Novak et al. 2014; Pugliares-Bonner et al., 2018; Cable et al., 2023; Martin & Wolters, 2023), poor habitat conditions, anthropogenic activities, and physiological stress (Tang et al., 2012), a zinc deficiency, ingestion of plant toxins (Pedersen et al., 2009), possible mineral deficiencies associated with the ingestion of ash as a consequence of severe alterations in the environment (Pedersen et al. 2012), Alopecia in small mammals is also caused by thallium poisoning (Dmowski et al., 1998).

Urban bats show a higher prevalence of syndromic alopecia (hair loss in body areas) than in periurban habitats, and this fact may be a response to nutritional deficiencies or endocrine imbalances (Bello-Gutiérrez et al., 2010). In bats, alopecia has been reported after disturbance events (Pedersen et al., 2012). Heiker (2017) reported a juvenile male *Nyctalus plancyi* showing alopecia on the back and neck. Syndromic alopecia has also been found in *Myotis ricketti* bats in Guilin, China. The prevalence of syndromic alopecia varies in relation to age and sex. Adult females show a higher incidence of syndromic alopecia than adult males. In immature bats, the alopecia pattern is not observed in either sex, only sparse hair occurs (Tang et al., 2012).

Urban environments are a major threat to biodiversity worldwide. However, before population declines are detected, individuals may suffer from chronic stress and impaired immunity, making bats more susceptible to pathogens and adverse weather conditions (Seltmann et al., 2017). Much of the current literature focuses on bat pathogens that impact human health, while publications on the disease status of bats themselves are rare (Buckles, 2015). The health issues of bats in urban areas are an

important point for future researchers to address (Nunes et al., 2017) as urban environments may have severe consequences on bat body condition (Russo & Ancillotto, 2015). This study aims to investigate the prevalence, distribution, and potential causes of alopecia in bat populations inhabiting tropical urban islands. By examining the correlation between alopecia and factors such as environmental stressors, habitat alterations, and biological characteristics, this research seeks to provide insights into the health and conservation status of bat species in urbanized tropical ecosystems.

METHOD

Study site

Batam is located in Indonesia, between 00°25'29″ and 1°15'00″ North Latitude, and 103°34'35″ to 104°26'04″ East Longitude. Administratively, it is bordered by the Singapore Strait to the north, Bintan Island to the east, Lingga Island to the south, and the Karimun District to the west. The city spans a total area of 3,868.97 km², which includes both land and marine regions. Batam's elevation ranges from 0 to 160 meters above sea level, with predominantly flat terrain interspersed with hilly areas. The city has a tropical climate, with average temperatures in 2022 ranging from 26.8 °C to 28.8 °C and humidity levels between 78 % and 86 % (Badan Pusat Statistik Kota Batam, 2023).

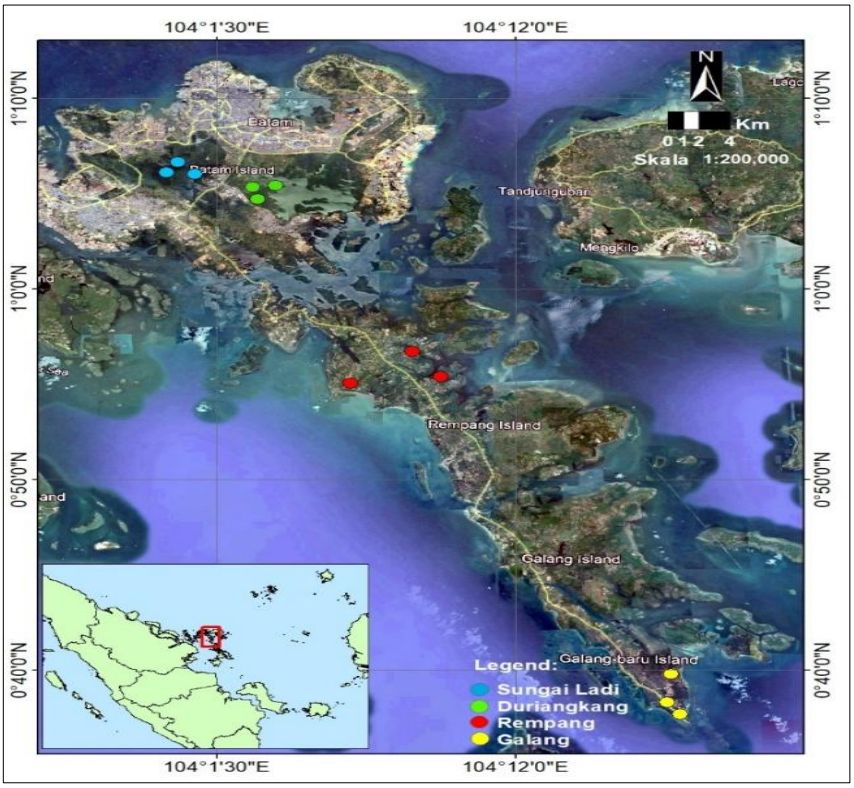

Figure 1. Location of bat sampling

The study was conducted from June to December 2021 at two forest fragments in urban areas (Sungai Ladi Protected Forest and Duriangkang Protected Forest), one

periurban island (Rempang), and one rural island (Galang) in Batam City, Indonesia. Sampling locations were determined based on distance from the city, assuming that locations close to the city have higher anthropogenic pressures that can impact the body condition of bats. Research stations were identified using purposive sampling at locations where bats were expected to be found. A total of 12 research stations were established, with three at each sampling location (Figure 1).

Bat Captures and Pelage Observations

Bats were captured with mist nets and harp traps. The total sampling effort amounted to 120 net nights and 120 harp trap nights. Data recorded for each bat included sex, the body weight of each individual was measured using a micro-scale, measurement parameters employed using calipers, and identification to species level. The body parts measured for species identification refer to Payne et al., (2000) and Kingston et al., (2009). Furthermore, an inspection was carried out on all parts of the bat's body to observe alopecia. A photograph was taken of each bat following the completion of processing. The bats were then released back into their natural habitat. We confirm that no bats were harmed during this study.

Data analysis

The prevalence of alopecia syndrome in each bat species was calculated as a percentage (the number of individuals with alopecia compared to the total number of individuals).

RESULT AND DISCUSSION

Alopecic Syndrome Patterns

Alopecic syndrome was diagnosed in seven species of bats (*Balionycteris maculata, Cynopterus brachyotis, Cynopterus horsfieldii, Cynopterus sphinx, Kerivoula pellucida, Macroglossus minimus, and Pipistrellus tenuis*). Hair loss was found in many parts of the body, from mild to severe, such as the shoulders, back, head, thorax, and abdomen. In some cases, we found extensive bare skin with lesions (Figure 1). Some publications have also reported alopecia syndrome in bats, i.e., Bello-Gutiérrez et al., (2010); Cable et al., (2023); Cable et al., (2024); Fountain et al., (2017); Garces et al., (2017); Hernández-Aguilar et al., (2023); Martin-Regalado et al., (2022). There have been no reports of alopecia in bats in Indonesia.

Alopecia is associated with five non-exclusive causes: endocrine factors related to reproduction and lactation, ectoparasites, toxin consumption, and environmental stress, especially in urban areas. The incidence of alopecia in urban areas reflects reproductive stress, limited food availability, nest disturbance, and environmental pollution (Martin-Regalado et.al., 2022). This syndrome may be related to nutritional or endocrine deficiencies. Spatial and seasonal aggregation in urban areas suggests that anthropogenic activities may interfere with nutritional processes (Bello-Gutiérrez et al., 2010).

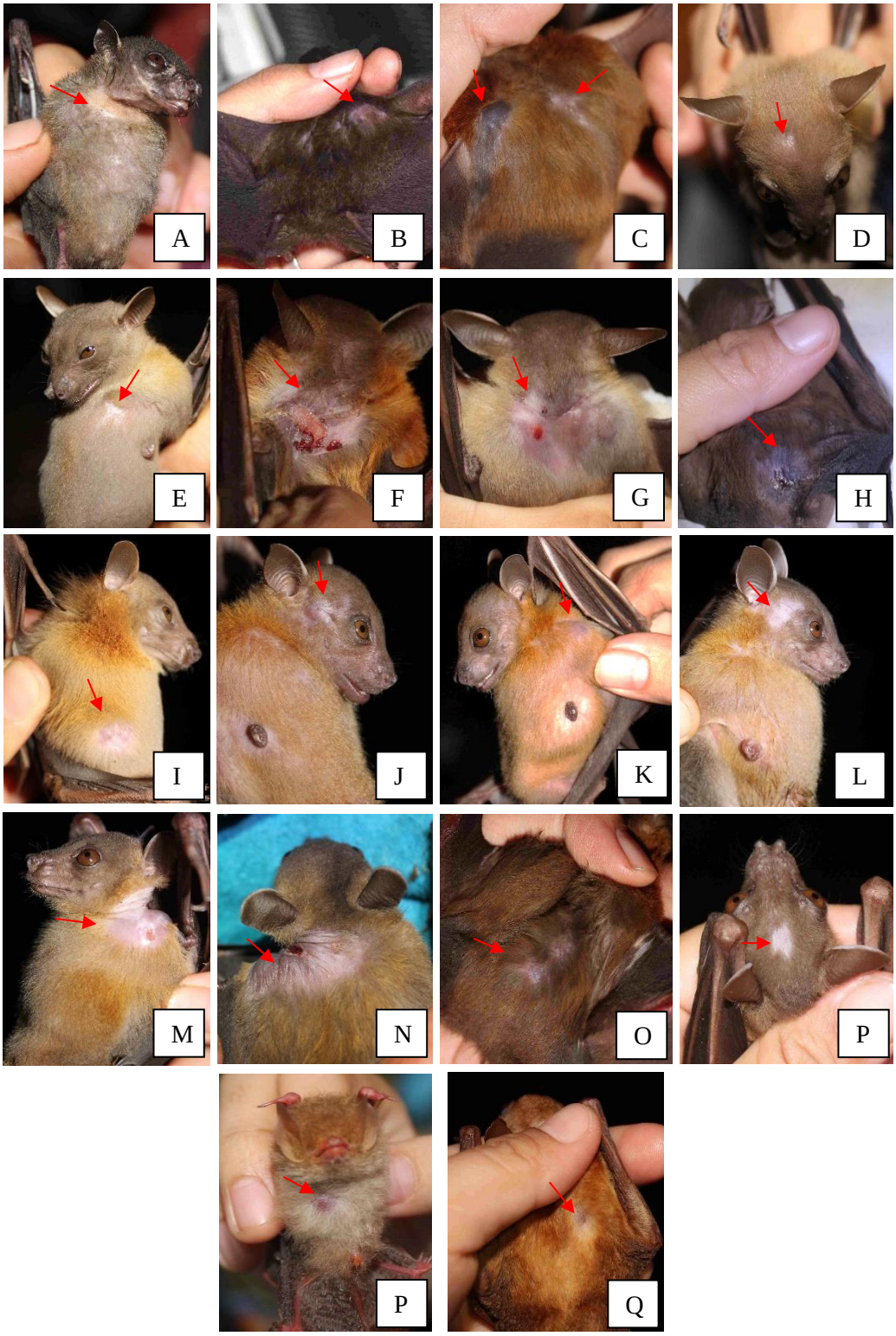

Figure 2. Hair loss in *B. maculata* on the thorax (A); shoulder (B). Hair loss in *C. brachyotis* on shoulder and back (C); head (D); thorax (E); shoulder and back (F; G); lower back (H); abdomen (I). Hair loss in *C. horsfieldii* on head (J); chest (K). Hair loss in *C. sphinx*: head (L); chest and back (M & N); back (O). Hair loss in *K. pellucida*: chest (P). Hair loss in *M. Minimus*: back (Q).

Alopecia has also been found in bats at the Wildlife Recovery Center in Portugal (Garces et al., 2017). According to Williams (2007), bats in captivity can experience alopecia due to factors such as stress, inadequate diet, and environmental changes. To avoid this, bats should be handled as little as possible, reduce environmental stress, and bats should be released into the wild as soon as possible. Bats with alopecia did not differ in body condition, determined by body mass, from bats without alopecia (Cable et al., 2024).

Table 1. Prevalence of alopecia bats in Batam City

Species	Number of bats	Number of Alopecia bats	Prevalence (%)
Balionycteris maculata	18	7	38.9
Cynopterus brachyotis	217	20	9.2
Cynopterus horsfieldii	72	8	11.1
Cynopterus sphinx	102	7	6.9
Kerivoula pellucida	2	1	50
Macroglossus minimus	5	1	20
Pipistrellus tenuis	1	1	100
Total	**417**	**42**	**10.79**

Individuals indicated alopecia were found in all study locations (Table 2). The location with the most alopecia species was the Duriangkang protected forest, which had 6 species; the next most were the Rempang Island forest with 4 species, and the Galang Island forest with 2 species. The location with the least number of alopecia species, which was 1 species, was Sungai Ladi. The large number of species indicated alopecia in Duriangkang was due to the forest being located in the middle of the city, so it was greatly affected by pressure from human activities. Following Tang et al., (2012) some species (including mammals, birds, and frogs) that inhabit urban areas may show differences in disease prevalence compared to species that inhabit more natural suburban and rural areas. Prevalence in urban areas indicates anthropogenic factors (Bello-Gutiérrez et al., 2010).

Table 2. Prevalence of alopecia in bats at each location

No	Species	n	Prevalence (%)			
			SL	DA	RP	GL
1	*Balionycteris maculata*	18	37.5	40	0	0
2	*Cynopterus brachyotis*	217	0	16.67	14.06	3.33
3	*Cynopterus horsfieldii*	72	0	21.43	22.22	6.67
4	*Cynopterus sphinx*	102	0	24	4	0
5	*Macroglossus minimus*	5	0	0	50	0
6	*Kerivoula pellucida*	2	0	100	0	0
7	*Pipistrellus tenuis*	1	0	100	0	0
	Number of species		1	6	4	2

Note: SL= Sungai Ladi Protected Forest; DA= Duriangkang Protected Forest; RP= Rempang Island; GL= Galang Island.

However, although the Sungai Ladi protected forest is also located in an urban area, only one species of bats indicated alopecia, namely *B. maculata,* with a prevalence of 37.5 %. Other species found at this location did not show symptoms of alopecia. This may be due to the good quality of the forest that supports the life of bats at the location, except for *B. maculata,* which is very sensitive to environmental changes and requires forest-dwelling trees for roosting (Meijaard et al., 2006). Urban-adjacent fragmented forests with healthy vegetation and complex habitats are more likely to support bat species (Syamsi, 2025). As a rural area with a low level of anthropogenic pressure, there are only two species indicated as alopecia on Galang Island, namely *C. brachyotis* and *C. horsfieldii,* with low prevalence, 3.33 % and 6.67 % respectively.

Table 3. Prevalence of alopecia by age and sex

Sex	Prevalensi Alopecia (%)			
	Adult	Juvenile	Infant	Total*
Male	17.50	3.77	0	13.29
Female	12.90	2.35	0	9.17

Note: *Total prevalence is simply divided by the number of adults and young individuals. Infants are not counted as they are assumed not to indicate alopecia.

Based on the age and sex of bats, the highest prevalence of alopecia is in adults, which is 17.50 % in females and 12.90 % in males, while juvenile bats only have a prevalence of 3.77 % in males and 2.35 % in females. The same results were also found by Tang et al., (2012) that the prevalence of alopecia is higher in adults than in juveniles. In this study, no alopecia was found in infants. This may be because the infants still get full protection from their mothers, both in terms of nutrition and from incoming disturbances.

The prevalence of alopecia also differs by sex. Males have a higher prevalence of 13.29 % of the total adult and juvenile male individuals, while the prevalence of alopecia in females is lower, at 9.17 %. Differences in the prevalence of alopecia by age and sex are thought to be due to parasitism, androgens, anthropogenic activities, or a combination of these factors (Tang et al., 2012).

CONCLUSION

The study found that Batam City had a high alopecia prevalence (10.79 %). Fragmented forests in urban and periurban areas had higher alopecia cases due to increased anthropogenic pressures. These findings suggest that environmental stressors play a significant role in the condition's occurrence and severity among bat populations. Reducing anthropogenic pressures and pollution can reduce the prevalence of alopecia. Regular health monitoring and habitat restoration through native vegetation are also important. Public education and multidisciplinary research can further support these efforts. Protecting roosting sites from disturbance is essential to maintaining healthy populations. By implementing these measures, we can effectively reduce the impact of alopecia and maintain populations.

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