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Cover: Freshly emerged Footman Moth *Nepita conferta* from the cocoon on a brightly painted wall in the Nilgiris. Digital art on Procreate. © Aakanksha Komanduri.

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ARTICLE

Ectoparasites of Sumatran Elephants at Tangkahan Elephant Camp, Langkat, North Sumatra

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Abstract: The Sumatran Elephant *Elephas maximus sumatranus* is an endemic species of Indonesia, currently classified as 'Critically Endangered'. To ensure its continued existence, conservation efforts are crucial. One of the health threats faced by Sumatran elephants is ectoparasites. The present study, conducted from January–February 2020, investigates types, prevalence, and intensity of ectoparasite infestations in Sumatran Elephants at the Conservation Response Unit (CRU) Tangkahan, Langkat, North Sumatra. Eight Sumatran Elephants were sampled, including three juveniles (4 years old) and five adults (aged 26–50 years). The research employed palpation and sweeping net methods. Sample examination was conducted at the Animal Systematics Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara. The study identified 10 species of ectoparasites from 317 specimens: *Haemadipsa jeylanica*, *H. picta*, *H. pluvialis*, *Musca domestica*, *Stomoxys* sp., *Tabanus* sp.1, *Tabanus* sp.2, *Tabanus* sp.3, *Tabanus* sp.4, and *Tabanus* sp.5. *Haemadipsa jeylanica* exhibited the highest prevalence at 87.5%, categorized as 'usually,' while *Tabanus* sp.4 had the lowest prevalence at 50%, categorized as 'frequently.' Additionally, *Haemadipsa jeylanica* showed the highest intensity at 6.42, categorized as 'moderate,' whereas *Tabanus* sp.5 had the lowest intensity at 3.4, categorized as 'light.'

Keywords: Biting flies, conservation response unit, ectoparasites, *Elephas maximus sumatranus*, identification, Indonesia, leeches, parasite intensity, parasite prevalence, Sumatran Elephant, *Tabanus*, Tangkahan, wildlife health.

Abstrak: Gajah Sumatra (Elephas maximus sumatranus) merupakan spesies endemik Indonesia yang saat ini berstatus Kritis (Critically Endangered). Upaya konservasi sangat diperlukan untuk menjamin kelangsungan hidup spesies ini. Salah satu ancaman terhadap kesehatan gajah Sumatra adalah infestasi ektoparasit. Penelitian ini dilakukan pada Januari–Februari 2020 dengan tujuan mengkaji jenis, prevalensi, dan intensitas infestasi ektoparasit pada gajah Sumatra di Conservation Response Unit (CRU) Tangkahan, Kabupaten Langkat, Sumatra Utara. Sebanyak delapan individu gajah Sumatra diamati, terdiri atas tiga individu juvenil berusia 4 tahun dan lima individu dewasa berusia 26–50 tahun. Metode pengambilan sampel dilakukan melalui palpasi dan penyapuan menggunakan jaring serangga. Pemeriksaan sampel dilakukan di Laboratorium Sistematika Hewan, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Sumatera Utara. Hasil penelitian menunjukkan terdapat 10 spesies ektoparasit dari total 317 individu yang teridentifikasi, yaitu Haemadipsa jeylanica, H. picta, H. pluvialis, Musca domestica, Stomoxys sp., Tabanus sp.1, Tabanus sp.2, Tabanus sp.3, Tabanus sp.4, dan Tabanus sp.5. Haemadipsa jeylanica memiliki prevalensi tertinggi sebesar 87,5% yang dikategorikan sebagai "biasanya", sedangkan Tabanus sp.4 memiliki prevalensi terendah sebesar 50% yang dikategorikan sebagai "sering". Intensitas tertinggi juga ditunjukkan oleh Haemadipsa jeylanica dengan nilai 6,42 yang termasuk kategori "sedang", sementara intensitas terendah terdapat pada Tabanus sp.5 dengan nilai 3,4 yang termasuk kategori "ringan".

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INTRODUCTION

The Sumatran Elephant is exclusively found on the island of Sumatra. Elephant health is crucial for maintaining populations (Berliani et al. 2022), where challenges include ectoparasites that live on exterior surfaces such as the skin, ear cavities, nose, fur, tail, and eyes (Iqbal et al. 2014). Elephant ectoparasites include flies, lice, mosquitoes, ticks, and mites that can impair animal health by reducing appetite and blood-sucking, leading to weakened immunity, weight loss, and decreased skin quality, and they can also aid transmission of pathogens such as viruses, bacteria, protozoa, worms, and fungi (Levine 1990). Severe infestations can result in death (Sahito et al. 2017), and symptoms can also cause discomfort and restlessness, disrupting animal activities (Hadi et al. 2016).

The Conservation Response Unit (CRU) Tangkahan is a conservation organization for Sumatran Elephants. One of CRU's functions is to patrol and protect the forest from illegal activities that threaten conservation efforts. Healthy elephants are essential for effectively performing their roles and functions. The local community in Tangkahan also benefits from the presence of Sumatran elephants, as they help protect the forest and boost community welfare through ecotourism activities. Maintaining the elephants' health, particularly against diseases caused by ectoparasites, is crucial to enhancing their role.

METHODS

Study Area

This study was carried out from January to February 2020 at the Conservation Response Unit (CRU) Tangkahan, situated in Namo Sialang Village, Batang Serangan District, Langkat Regency, North Sumatra Province. Renowned for its pristine rainforests, Tangkahan offers a rich natural environment that includes wild orangutans, waterfalls, caves, and hot springs. The area supports a wide array of flora and fauna, including numerous plant species vital to the diet of Sumatran Elephants. Characterized by a tropical rainforest climate, Tangkahan experiences high humidity and substantial rainfall year-round. These lush environmental conditions make it an ideal habitat for diverse wildlife, particularly the Critically Endangered Sumatran Elephant.

Sampling Procedure and Ectoparasite Collections

The research subjects included eight Sumatran Elephants, three juveniles (4 years old), and five adults (aged 26–50 years). Data collection on ectoparasites was carried out using the palpation method over the entire body of the elephants and the sweep net method (net traps). Temperature and humidity were also measured. Sampling took place over 14 days, with captures conducted twice a day. The first capture was performed from 0900–1100 h and the second from 1500–1700 h. Morning sessions typically ranged 25–27 °C with high humidity, while afternoon sessions reached 28–30 °C with slightly lower humidity. Leeches were more abundant in cooler, more humid conditions, while flies were more active during warmer hours. The captured ectoparasites were placed in collection bottles containing 70% alcohol and labelled for subsequent identification and counting.

Ectoparasite Identification and Analysis

The identification of ectoparasities captured and stored with the help of keys and descriptions provided by Leahy (1987) and Borror et al. (1992). The prevalence of ectoparasites was calculated using the formula by Soulsby (1982), and the intensity of ectoparasite infestations was determined using the formula by Williams & Williams (1996).

$$\text{Intensity} = \frac{\text{Total number of individuals of a given ectoparasite species}}{\text{Number of elephant infested by that species}}$$

RESULTS AND DISCUSSION

Data for ectoparasites collected are summarized in Table 1. Specimens were identified from two phyla (Arthropoda and Annelida), two classes (Insecta and Clitellata), two orders (Diptera and Arhynchobdellida), three families (*Tabanidae*, *Muscidae*, and *Haemadipsidae*), five genera (*Tabanus*, *Haematopota*, *Stomoxys*, *Musca*, and *Haemadipsa*), and 10 species: *Tabanus* sp.1, *Tabanus* sp.2, *Tabanus* sp.3, *Tabanus* sp.4, *Tabanus* sp.5, *Haematopota pluvialis*, *Stomoxys* sp., *Musca domestica*, *Haemadipsa jeylanica*, and *Haemadipsa picta*. The most dominant ectoparasite species found was *Tabanus* spp. from the family Tabanidae. This is likely due to the suitability of the *Tabanus* spp. fly's environment with the research location. Ectoparasites attached to the elephants' skin, such as leeches (*Haemadipsa jeylanica* and *H. picta*), were collected by palpation. In contrast, flying ectoparasites (*Tabanus* spp., *Haematopota pluvialis, Stomoxys* sp., and *M. domestica*) were collected using sweep nets as they approached the elephants. Sampling was carried out twice daily, with morning sessions (0900–

Table 1. Types of ectoparasites collected.

Phylum	Class	Order	Family	Genus	Species
Arthropoda	Insecta	Diptera	Tabanidae	*Tabanus*	*Tabanus* sp.1
Arthropoda	Insecta	Diptera	Tabanidae	*Tabanus*	*Tabanus* sp.2
Arthropoda	Insecta	Diptera	Tabanidae	*Tabanus*	*Tabanus* sp.3
Arthropoda	Insecta	Diptera	Tabanidae	*Tabanus*	*Tabanus* sp.4
Arthropoda	Insecta	Diptera	Tabanidae	*Tabanus*	*Tabanus* sp.5
Arthropoda	Insecta	Diptera	Tabanidae	*Haematopota*	*Haematopota pluvialis*
Arthropoda	Insecta	Diptera	Muscidae	*Stomoxyy*	*Stomoxy* sp.
Arthropoda	Insecta	Diptera	Muscidae	*Musca*	*Musca domestica*
Annelida	Clitellata	Arhyncobdellida	Haemadipsidae	*Haemadipsa*	*Haemadipsa jeylanica*
Annelida	Clitellata	Arhyncobdellida	Haemadipsidae	*Haemadipsa*	*Haemadipsa picta*

Table 2. Number of ectoparasites found on individual elephants.

Ectoparasite	Number of ectoparasites on elephants (individuals)								
	Agustina (43 y.o.)	Sari (30 y.o.)	Theo (30 y.o.)	Olive (28 y.o.)	Yuni (29 y.o.)	Eropa (4 y.o.)	Christ (4 y.o.)	Albertina (4 y.o.)	Total
Haemadipsa jeylanica	10	8	7	7	5	5	3	0	45
Haemadipsa picta	9	8	6	5	5	4	0	0	37
Haematopota pluvialis	7	8	6	5	4	0	0	0	30
Musca domestica	9	9	7	5	6	3	0	0	39
Stomoxys sp.	9	8	8	6	0	5	0	1	37
Tabanus sp.1	9	8	6	7	5	0	0	0	35
Tabanus sp.2	8	4	6	5	5	4	0	0	32
Tabanus sp.3	6	5	5	6	4	5	0	0	31
Tabanus sp.4	5	4	3	0	0	0	2	0	14
Tabanus sp.5	6	3	0	0	2	0	4	2	17
Total	78	65	57	46	36	26	9	3	317

1100 h) yielding more leeches, while afternoon sessions (1500–1700 h) yielded higher numbers of biting flies. During sampling, morning sessions were cooler and more humid (approximately 25–27 °C), whereas afternoon sessions were warmer at 28–30°C with slightly lower humidity, supporting the observation that leeches were more abundant in cooler, humid conditions and flies were more active during warmer periods.

Regarding collection timings, we observed that biting flies (*Tabanus* spp., *Haematopota pluvialis*) were more frequently trapped in the late afternoon session (1500–1700 h), consistent with their diurnal peak activity in warmer sunlight hours. Conversely, leeches (*Haemadipsa* spp.) were more commonly recovered in the morning session (0900–1100 h), often after the elephants had contact with moist vegetation and forest floor.

The CRU is located adjacent to the forest and close to a river. This setting provides an ideal habitat for *Tabanus* sp. According to Changbunjong et al. (2018), *Tabanus* spp. females typically lay their eggs on the surface of leaves or places situated above the water surface. The presence of ectoparasites tends to be higher in forests with dense trees and proximity to streams. In the morning and at night, these flies tend to hide, while during full sunlight and towards the evening, they become active and approach the elephants to feed on their blood. Additionally, when the weather is cold or during rain, the flies seek warm hiding spots, such as between the thick hairs on the elephant's belly or in the inguinal area.

A total of 568 individual ectoparasites were found on the eight Sumatran Elephants, comprising 10 different species (Table 2). *Musca domestica* was recorded during sampling but is not considered a true ectoparasite, as it does not attach to the host or feed on blood. Instead,

this species functions as a nuisance fly and mechanical vector that is commonly associated with animals and their surrounding environment. Therefore, *M. domestica* is treated as an associated dipteran and discussed separately from obligate ectoparasitic taxa in this study. The number of ectoparasites found on adult elephants was higher compared to juvenile elephants. When elephants are active, it is assumed that ectoparasites, especially insects, find it more difficult to attach and feed.

The higher ectoparasite load observed in adult elephants, despite generally stronger immune systems, is likely influenced by ecological and behavioral factors rather than immunity alone. Adults have a larger body surface area, spend more time feeding within dense vegetation, and tend to be less active than juveniles, all of which increase exposure to ectoparasites and facilitate attachment. Unlike endoparasites, most ectoparasites (except leeches) are temporary parasites with limited interaction with host immunity, making their infestation patterns more dependent on environmental exposure and behavior than age-related immune resistance. This contrasts with findings on endoparasites (Levine 1990) and highlights the need to consider parasite groups separately when evaluating host–parasite dynamics in elephants.

Table 3 presents the prevalence values of 10 types of ectoparasites found on eight Sumatran Elephants in the CRU Tangkahan area. The highest prevalence was observed for *Haemadipsa jeylanica*, with a prevalence rate of 87.5%, categorized as "usually". The lowest prevalence was observed for *Tabanus* sp.4, with a prevalence rate of 50%, categorized as "frequently". Adults carried a total of 282 ectoparasites, while juveniles carried 38, confirming that infestation levels were substantially higher in adult elephants.

Haemadipsa jeylanica, or the mountain leech, is a blood-sucking organism closely related to earthworms and equipped with a sucker. *Haemadipsa* is a species commonly found in Indonesia, particularly in high-humidity mountainous regions. The life cycle of such parasites heavily depends on a suitable environment, especially high humidity and an adequate temperature (approximately 27 °C). In this study, *Haemadipsa* sp. was frequently found on the elephants' bodies, especially on the trunk and legs, when they were herded into the forest. According to Kendall (2012), most *Haemadipsa* species suck mammalian blood to survive. During their juvenile stage, *Haemadipsa* attaches to smaller hosts like rats, but as adults, they attach to larger hosts such as pigs and primates. The host's body size also influences the size of *Haemadipsa*; the larger the host, the more diverse the ectoparasitic fauna. Consequently, if *Haemadipsa* attaches to an elephant in large numbers, it could cause significant harm, such as blood loss.

The lowest prevalence value was found in *Tabanus* sp.4, at 50%, categorized as "frequently". This species is most commonly found in elephant bathing areas. Their activity increases during the dry season compared to the rainy season. Male flies use nectar as a food source, while females suck blood and are often significant pests for animals, especially large mammals like horses, deer, cattle, and elephants. *Tabanus* spp. are diurnal and active during hot weather conditions with high intensity sunlight (Kaufman et al. 2005). According to Foil & Hogsette (1994), the flying activity of *Tabanus* spp. for feeding by landing on hosts varies greatly depending on rhythm, weather, and type of vegetation. These differences can vary significantly between species. Generally, after female flies suck blood from their host, they lay eggs on organic leaf litter, which then hatch into pupae and larvae, and finally become adults within 1–3 weeks.

The intensity levels of ectoparasites on eight Sumatran elephants are presented in Table 4, with Tabanus spp. showing moderate intensity, and *Tabanus* sp.1 being the most frequently encountered species on the elephants' bodies. This is likely due to the environmental conditions at the research location being suitable for this species. The ambient temperature ranged 25–30 °C, which is favorable for the presence of *Tabanus* sp.1, particularly during the daytime when the sun is at its peak. Most *Tabanus* flies are active during the day, with their activity threshold peaking at 25 °C.

Conversely, *Tabanus* sp.5 exhibited the lowest intensity level of 3.4, classified as light. This species was the least frequently found on the elephants. The lower numbers of *Tabanus* sp.5 may be due to the research environment being less conducive to its survival.

Table 3. Prevalence of ectoparasites.

	Ectoparasite species	Prevalence (%)	Category
1.	*Haemadipsa jeylanica*	87.5	Usually
2.	*Haemadipsa picta*	75	Usually,
3.	*Haematopota pluvialis*	62.5	Frequently
4.	*Stomoxys* sp.	75	Usually
5.	*Musca domestica*	75	Usually
6.	*Tabanus* sp.1	62.5	Frequently
7.	*Tabanus* sp.2	75	Usually
8.	*Tabanus* sp.3	75	Usually
9.	*Tabanus* sp.4	50	Frequently
10	*Tabanus* sp.5	62.5	Frequently

Environmental conditions significantly influence the population size of a species. The low number of these species on the host may also be attributed to the disturbance caused by sampling activities, which could have disrupted the flies' infestation.

Ectoparasites on elephants exhibit distinct characteristics. The terrestrial leech *Haemadipsa*, which feeds on the blood of both animals and humans, is frequently observed attached to elephants, particularly on their trunks, front legs, and hind legs. The images, sketches, and morphology of *Haemadipsa* found on Sumatran Elephants at the CRU Tangkahan can be seen in Image 1. The sketches illustrate the ventral (Image 1A) and dorsal (Image 1B) morphology of *Haemadipsa*. The habitat and environmental temperature at the research location are believed to be suitable for this species, particularly in forests with high humidity levels. This species thrives among tree trunks, leaves, and moist soil, such as in forests and swamps. Typically, this species is brownish, dark green, and generally reddish-brown.

According to Saywer (1986), *Haemadipsa* has a complete digestive tract. When feeding, this species extends its proboscis out of its mouth, then uses its pharynx to suck blood. The nervous system of these leeches is more developed than other Annelida, as they possess large ganglia around the pharynx in the fifth and sixth segments of their bodies. The Hirudinae phylum has specialized sensory organs, including eyes and papillae. This species reproduces hermaphroditically, cannot reproduce asexually, and lacks regenerative abilities. Most of the Hirudinae phylum are parasitic, causing significant blood loss in their hosts.

From Image 1, it can be seen that *Haemadipsa jeylanica* (C) and *Haemadipsa picta* (D) have specific characteristics. *Haemadipsa jeylanica* is brightly colored with stripes of red, yellow, and brown. Its sucker is black, and its body is larger. This species is more often found on leaves, and its bite is more painful compared to *Haemadipsa picta*. On the other hand, *Haemadipsa picta* is uniformly brown, has a slimmer body, and is more commonly found in moist soil.

According to Foil & Hogsette (1994), *Haematopota pluvialis* is an ectoparasite belonging to the family Tabanidae. This insect is smaller than species of the genus *Tabanus*. Its morphology and life cycle are similar to those of *Tabanus* species. *Haematopota pluvialis* is highly adaptable for hunting, particularly during the day. It has a greyish-black colouration with white spots on its wings and eyes, forming various patterns. The body of this ectoparasite is elongated and slender. Adult female *Haematopota pluvialis* take blood from their hosts to support egg development, while adult males only feed on nectar from various flowering plants. Female *Haematopota pluvialis* typically lay their eggs in moist soil.

In Image 2, the morphology of *Haematopota pluvialis* is depicted, illustrating the various parts of its body. This species typically attacks large mammals. *Haematopota pluvialis* possesses a large mouth comprised of three pairs of elements that function to cut and pierce the skin, causing deep wounds. Subsequently, the flowing blood is absorbed through the labrum, which serves to store the blood (Russell et al. 2013).

The parasite-borne diseases transmitted through these highly painful bites can cause significant losses, particularly for large mammal farmers (Taylor et al. 2012). These losses can include reduced profit margins due to decreased animal live weight, lowered meat production, and skin irritation. Ectoparasites can act as vectors of disease, such as transmitting *Trypanosoma evansi*, the causative agent of surra. This protozoan parasite inhabits the blood plasma and tissue fluids of infected animals (Desquesnes et al. 2012).

Stomoxys sp., a stable fly from the Muscidae family,

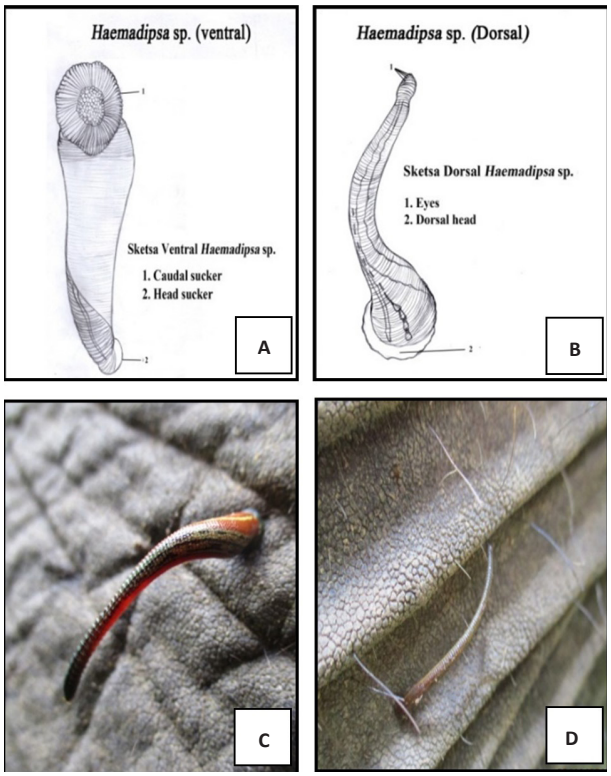

Image 1. A—Sketch of the ventral side of Haemadipsa | B—Sketch of the dorsal side of Haemadipsa | C—Photographic documentation of *Haemadipsa jeylanica* | D—Documentation of *Haemadipsa picta*. © Authors.

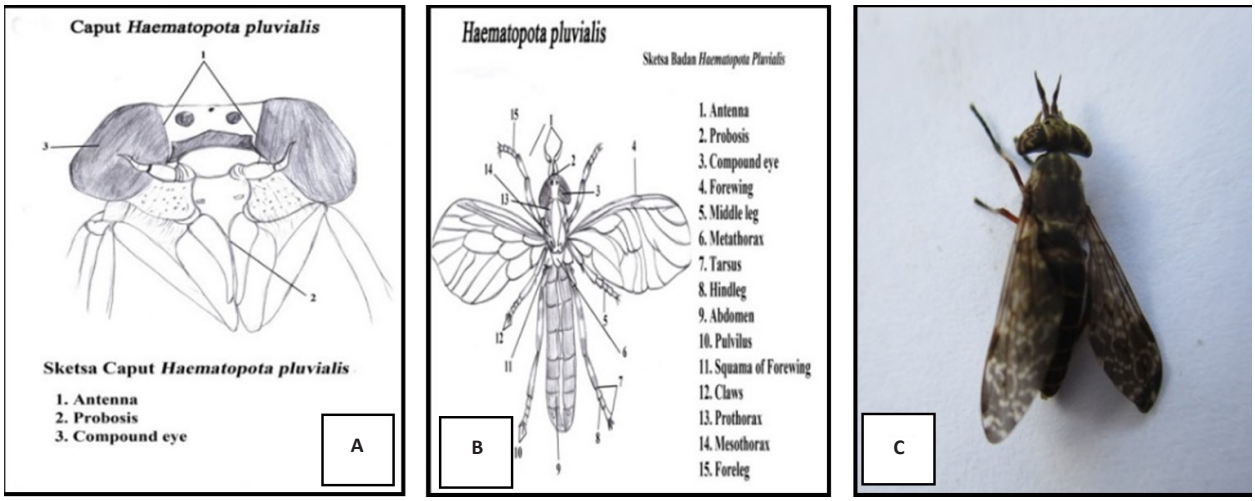

Image 2. A—Sketch of the body of *Haematopota pluvialis* | B—Sketch of the head of Haematopota pluvialis | C—Photographic documentation of *Haematopota pluvialis*. © Authors.

is an ectoparasite that attacks warm-blooded animals. *Stomoxys* sp. closely resembles the species *M. domestica* but differs in having a proboscis adapted for bloodsucking. Image 3 shows a morphological sketch of *Stomoxys* sp. found on a Sumatran Elephant. The body size of *Stomoxys* sp. ranges from 5–7 mm, with three dark stripes on the thorax and four veins on the wings. *Stomoxys* sp. is black, with a yellow abdomen; the antenna consists of three segments, with the last segment being the largest (Masmeatathip et al. 2006).

Stomoxys sp. feeds by sucking blood for 3–4 minutes per feeding session. The volume of blood ingested in a single session ranges from 0.05–0.10 cc per fly. This species reproduces by laying eggs. Its life cycle begins with eggs that hatch into larvae, then pupate, and finally mature into adults. These flies lay their eggs on manure, in animal enclosures, and in other places with high moisture and organic matter, such as animal waste (Cruz-Vazquez et al. 2004; Huang et al. 2007; Changbunjong et al. 2018). During the summer, these flies feed multiple times a day, and their bites are sharply painful. Once satiated, they seek preferred resting places to digest their meal. This species tends to aggregate in bright areas rather than dark ones (Chareonviriyaphap 2012). When they are hungry, cannibalism is common within their groups. They become highly active and aggressive, attacking each other and sucking blood by wounding the abdomen.

According to Phasuk et al. (2013), both male and female flies of this species are bloodsuckers with painful bites. In large numbers, they can prevent animals from resting properly. *Stomoxys* sp. can naturally act as a vector for the bacterium *Dermatophilus.* This species also serves as a mechanical vector for several pathogenic protozoa. For instance, *Trypanosoma evansi*, which causes Surra disease, and *Trypanosoma brucei*, which causes nagana disease in horses and cattle, can be transmitted by these flies (Desquesnes et al. 2012). Their repeated blood-feeding behaviour facilitates the transmission of nagana.

Table 4. Intensity of Ectoparasite Infestation.

	Type of Ectoparasite	Intensity	Category
1.	*Haemadipsa jeylanica*	6,42	Moderate
2.	*Haemadipsa picta*	6,16	Moderate
3.	*Haematopota pluvialis*	6,16	Moderate
4.	*Stomoxys* sp.	6,16	Moderate
5.	*Musca domestica*	6,5	Moderate
6.	*Tabanus* sp.1	5,8	Moderate
7.	*Tabanus* sp.2	5,3	Light
8.	*Tabanus* sp.3	5,16	Light
9.	*Tabanus* sp.4	3,5	Light
10	*Tabanus* sp.5	3,4	Light

Musca domestica is the most commonly encountered species worldwide and is generally found on farms or in human environments, making it a vector for several diseases affecting both humans and animals (Kaufman et al. 2005; Butler et al. 2010). This species thrives on manure, decaying garbage, foul-smelling drains, and spoiled wet food (Sanchez & Cappinera 2014).

Image 4 illustrates the anatomical features of *M. domestica*. This species is of medium size, measuring 6–8 mm in length. The thoracic cavity is grey, the abdomen is yellow, and it possesses compound eyes and antennae

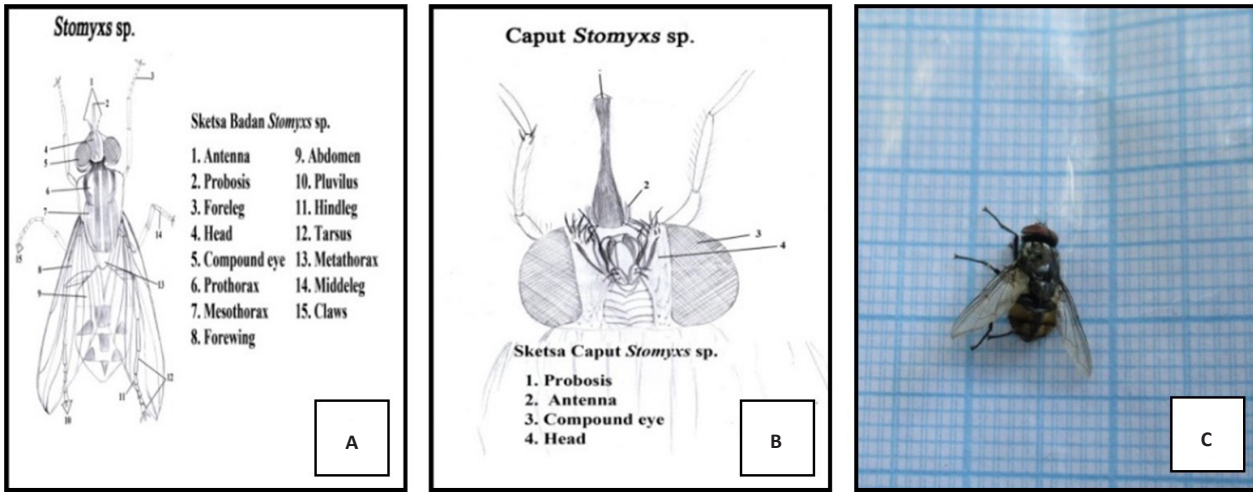

Image 3. A—Sketch of the body of *Stomoxys* sp. | B—Sketch of the head of *Stomoxys* sp. | C-—Photographic documentation of *Stomoxys* sp. © Authors.

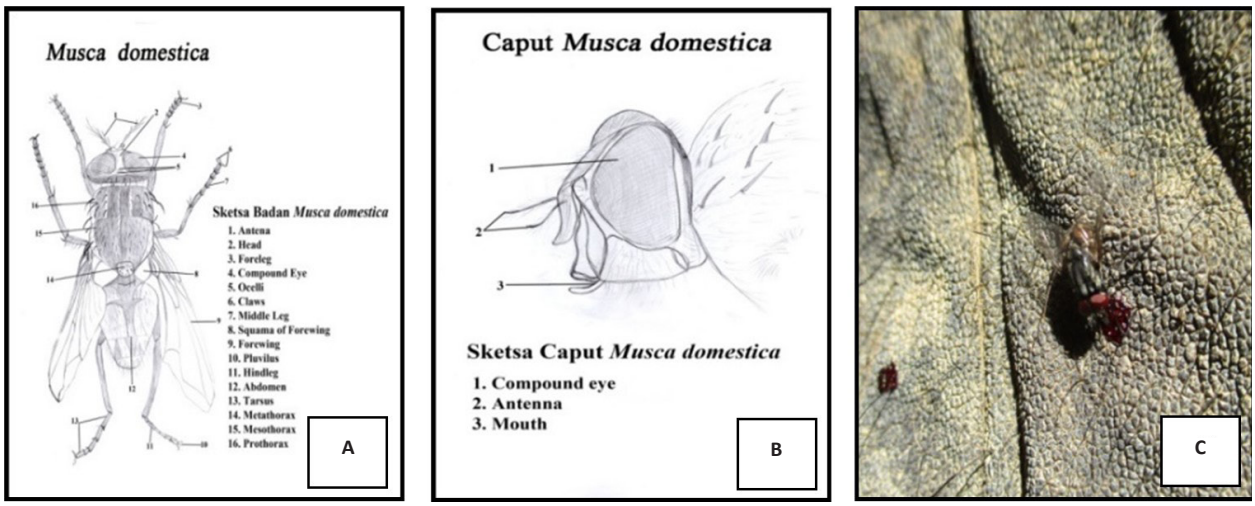

Image 4. A—Sketch of the body of *Musca domestica* | B—Sketch of the head of *Musca domestica* | C—Photographic documentation of *Musca domestica*. © Authors.

consisting of three segments, serving as both lickers and suckers. Adult female flies lay eggs on decaying organic matter and garbage contaminated with faeces and urine. The eggs are white, with a length ranging from 1.20–1.25 mm and a width of 0.25–0.30 mm. Their egg production can range from 120–150 eggs (Borror et al. 1992). The first instar larvae are small, slender, and white, with a length of 1.3–2.6 mm; the second instar measures 2.8–6.7 mm, while the third instar, whitish in color, ranges from 6.5–12.5 mm in length. Larvae typically mature within four to seven days. Development is hindered in cold weather, dry environments, or inadequate food supply, prompting them to leave breeding sites and pupate in the soil. The pupal stage of these flies generally ranges from 3–6 days and is reddish-brown in color during the summer. Food sources such as vegetables, decaying animals, bodily secretions, and wounds are their main diet. Most of them are active during the day, preferring light and sunlight, but their numbers decrease in winter (Borror et al. 1992).

The presence of *M. domestica* is suspected to act as a vector for disease transmission from contaminated body parts such as the mouth, feces, and other contaminated areas. According to Borror et al. (1992), favoured locations for these flies include moist areas, such as the eye can thus, mouth, ears, nose, vulva lips, and the surface of the penis hole. Ectoparasite attacks on the eyes can cause excessive tearing, attract more flies, and leading to keratitis and potential blindness.

Tabanus is a genus of the largest flies and is considered an important pest (Kalshoven 1981). These

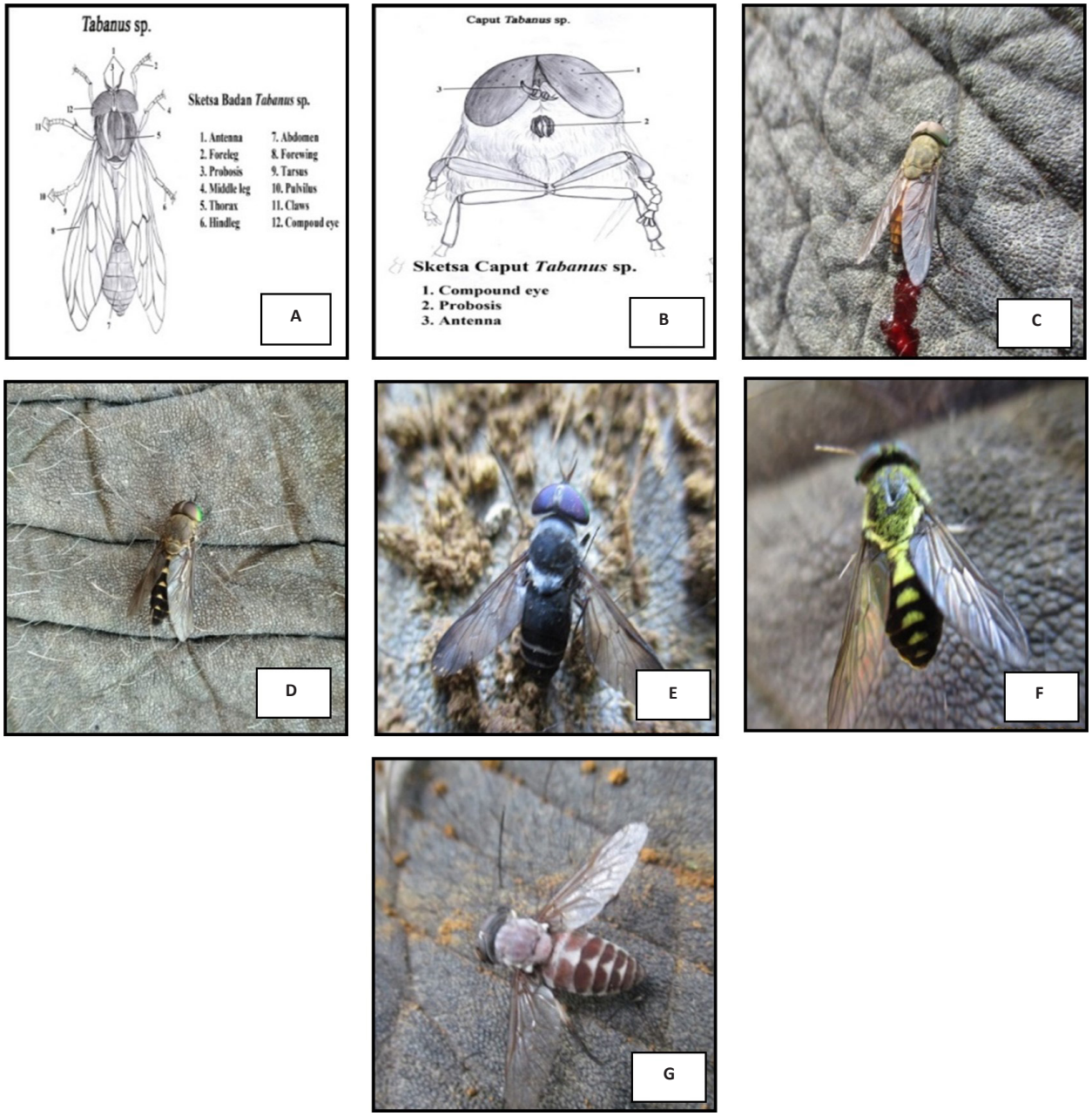

Image 5. A—Sketch of the body of Tabanus | B—Sketch of the head of Tabanus | C—*Tabanus* sp.1 | D—*Tabanus* sp.2 | E—*Tabanus* sp.3 | F—*Tabanus* sp.4 | G—*Tabanus* sp.5. © Authors.

flies are large, measuring up to 25–30 mm in length, with a sturdy body shape, wide wings, and strikingly large eyes. The wing veins have characteristic patterns, and their proboscis is short and soft, directed downwards. In the mouthparts, there are six organs fused into one used as a piercing apparatus, consisting of a pair of flat and sharply toothed mandibles, a pair of toothed maxillae, a hypopharynx, and an epipharynx. The mandibles are used for cutting, while the maxillae are used for piercing and tearing tissues along with the blood vessels (Borror et al. 1992). A morphological sketch of *Tabanus* spp. found on Sumatran Elephants in the CRU Tangkahan area can be seen in Image 5.

Based on Image 5, sketches of the body of *Tabanus* spp. (A), sketch of the head of *Tabanus* sp. (B), and documentation results of *Tabanus* sp.1 (C), *Tabanus* sp.2 (D), *Tabanus* sp.3 (E), *Tabanus* sp.4 (F), and *Tabanus* sp.5 (G) represent the morphology displaying various parts of *Tabanus*. Upon observation, these five species exhibit distinct characteristics, primarily in their respective

colours. In *Tabanus* sp.1, the thorax appears orangish-brown, with dark green eyes. *Tabanus* sp.2 exhibits a blackish-yellow thorax with bright green eyes. Moving on, *Tabanus* sp.3 has a whitish-black thorax, with bluish-green eyes. Furthermore, *Tabanus* sp.4 displays a black thorax with greenish stripes, along with dark blue eyes. Finally, *Tabanus* sp.5 presents a whitish-brown thorax and brown eyes.

Tabanus flies prefer laying their eggs on vegetation. Most egg clusters are found on plant clusters near elephant stall walls. These flies tend to seek places closest to their resting spots for egg deposition. They particularly favour leaf surfaces, presumably due to their relatively larger surface area compared to other plant parts. Therefore, they tend to deposit their eggs on the underside of leaves. According to Foil & Hogsette (1994), the eggs of these flies are laid on plant parts and neatly arranged in layers into a cluster.

Tabanus flies are commonly encountered during hot and sunny summer seasons, especially near their breeding grounds. They are highly active during hot and humid weather. Female flies are blood-sucking insects, while male flies feed on flower pollen or nectar from flowering plants. During the study, female flies were observed sucking blood from elephants, with their mouthparts acting as cutting and sucking tools. *Tabanus* primarily attacks large animals such as elephants, buffaloes, horses, and cattle. Their preferred feeding sites include the lower flank, around the navel, legs, and neck. Once engorged with blood, the flies leave the host and seek resting places on wood surfaces, rocks, building walls, or under leaf surfaces. Subsequently, they search for egg-laying sites (Foil & Hogsette 1994).

Each *Tabanus* fly can bite two to three times before feeding on blood. Animals bitten by these flies often bleed for a short period, causing painful wounds. Such biting behavior enhances their efficiency as mechanical vectors for various diseases. *Tabanus* also utilizes mandibles and serrated teeth. Their sharp upper jaws are used to pierce the skin and rupture blood vessels. The *Tabanus labrum* is then used to collect pooled blood formed from the fly's bites, known as telmophages (Seddon 1947).

According to Onyido (2011), Tabanus flies serve as primary intermediate hosts of *Trypanosoma evansi*, mechanically transmitting it. They can also transfer the blood parasite to elephants, horses, goats, dogs, and other animals. Other diseases transmitted by these flies include anthrax, equine infectious anemia, and anaplasmosis.

The low presence of ectoparasites on elephants in the CRU Tangkahan research site is attributed to the elephants receiving good care, including mandatory bathing twice daily—morning and evening—and regular cleaning of their pens. These practices are essential for preventing ectoparasite infestations and diseases. However, this condition should not be taken lightly by CRU management. There is a concern that neglecting ectoparasite control could lead to higher parasite burdens if not actively minimized. Hence, alongside the twice-daily bathing program, CRU Tangkahan management also provides medications to alleviate itching caused by ectoparasite bites and preventive medications for endoparasites.

Assisted by mahouts (elephant riders, trainers, or keepers), CRU Tangkahan management endeavours to meet the needs and understand the behaviour of captive Sumatran Elephants. This is evidenced by the elephants' overall good health and performance during various activities, whether as tourist attractions, in pens, or while grazing in the forest. Maintaining such conditions is crucial for enhancing ex-situ conservation efforts. This entails specific care for captive elephants, including bathing techniques, feeding, medications, and regular physical exercises. Considering the severity of ectoparasite infestations on elephants, their current condition is not alarming. However, CRU management also needs to assess the severity of endoparasite infestation levels to ensure optimal health care for Sumatran Elephants. Moreover, routine health examinations related to parasites are conducted.

According to Berliani et al. (2022), if worms are found in elephant faeces, further monitoring and treatment are carried out. Deworming of elephants is done every three months. Additionally, daily examinations of teeth, mouth, and hooves are performed. Furthermore, mahouts weigh the elephants once a month. In case of health deterioration in elephants, veterinarians and mahouts collect blood, urine, and faecal samples for laboratory analysis. Once the results are obtained, appropriate medications are administered based on the veterinarian's diagnosis. Therefore, by paying attention to and maintaining the health of elephants in the CRU Tangkahan area, efforts to conserve Sumatran Elephants' ex-situ are being enhanced.

CONCLUSION

Ten types of ectoparasites were identified: *Haemadipsa jeylanica*, *H. picta*, *Haematopota pluvialis*, *Musca domestica*, Stomoxys sp., *Tabanus* sp.1, *Tabanus* sp.2, *Tabanus* sp.3, *Tabanus* sp.4, and *Tabanus* sp.5.

The highest prevalence of ectoparasites were found in *Haemadipsa jeylanica*, with a prevalence rate of 87.5%, categorized as "usually", whereas the lowest prevalence was observed in Tabanus sp.4, at 50%, categorized as "frequently". The highest intensity value was recorded in Tabanus sp.1 among other *Tabanus* spp., with a score of 7, categorized as "moderate", while Tabanus sp.5 had the lowest intensity value of 3.4, categorized as "light".

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