

# Species diversity and daily infestation patterns of *Haematophagus* flies in cattle farms at Tanah Bumbu District, South Kalimantan Province, Indonesia

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**Abstract.** Hairani B, Hadi UK, Supriyono. 2023. *Species diversity and daily infestation patterns of Haematophagus flies in cattle farms at Tanah Bumbu District, South Kalimantan Province, Indonesia. Biodiversitas* 24: 2995-3003. Blood-sucking flies act as livestock pests and vectors of zoonotic diseases. This study aims to know the species diversity of blood-sucking flies, relative abundance, frequency, and dominance of species and their correlation to weather parameters on beef cattle farms with three different ecosystems in the Tanah Bumbu District, South Kalimantan, Indonesia. The research was conducted from August to October 2022 on 6 beef cattle farms in Tanah Bumbu District with different types of ecosystems, namely forest, non-forest, and coastal areas. The flies were collected by using sweep nets, NZI traps, and Vavoua traps. Blood meal activity was measured by counting flies infestation on the cow's body. The results showed that there were 11 species of blood-sucking flies, i.e., *Stomoxys calcitrans* Linnaeus 1758, *S. sitiens* Rondani 1873, *S. indicus* Picard 1908, *S. bengalensis* Picard 1908, *Haematobia exigua* Meijere 1903, *Therioplectes* sp., *Chrysops fixissimus* Walker 1856, *Tabanus optatus* Walker 1856, *T. striatus* Fabricius 1787, *T. rubidus* Wiedemann 1821, and *Hippobosca* sp. The *S. calcitrans* population appears to be dominant in each type of ecosystem. The peak of blood-sucking fly infestations on the body of beef cattle in each ecosystem occurred at 10AM-2PM. In addition, the environmental temperature and humidity were significantly correlated to fluctuations in blood-sucking fly infestations in each ecosystem, and the light intensity was significantly correlated to the population of *H. exigua* in coastal ecosystems, while the wind velocity was not significantly correlated to all species in all ecosystems.

**Keywords:** Cattle, ecosystem, *Haematophagus* flies, zoonoses

## INTRODUCTION

Humans, animals, and the environment play a significant role in the emergence and transmission of various infectious diseases that are increasing globally (Tompkins et al. 2015; Thompson and Kutz 2019). About 60% of new infectious diseases in humans come from animals (Bitome-Essono et al. 2017). The beef cattle breeding environment can potentially be a starting point for zoonotic disease transmission (Singh et al. 2018); this is supported by several factors, namely the presence of zoonotic disease agents and their vectors, the location of farms close to residential areas accompanied by livestock management that pays little attention to aspects of disease vector control. Traditional farmers are most at risk of contracting zoonotic diseases from livestock (Tebug et al. 2015; Singh et al. 2018). In the livestock environment, there is a strong interaction between breeders, livestock, disease vectors, and disease agents.

Blood-sucking flies are nuisance pests and important disease vectors in beef cattle farming. These flies can cause a decrease in livestock productivity to death due to blood loss or infection with infectious diseases. Disease transmission occurs simultaneously with the entry of fly saliva-containing disease agents into the host's body (Marcondes et al. 2017). Several zoonotic diseases in livestock, such as Trypanosomiasis and Leishmaniasis, are

transmitted by *Stomoxys* sp. and *Tabanus* sp. (Sawitri et al. 2019; Keita et al. 2020). These flies can attack and suck human blood, so they have the potential to transmit diseases from animals to humans (Keita et al. 2020; Rochon et al. 2021). Blood-sucking flies have a greater potential to transmit the disease because apart from carrying pathogens to external parts of the body, flies can also transmit pathogens contained within their bodies, such as *Trypanosoma*, *Mansonella*, *Onchocerca* worms, Toscana viruses, and others (Baldacchino et al. 2013; Es-Sette et al. 2014; Ta-Tang et al. 2018; Busari et al. 2021). The negative impact caused by blood-sucking flies is very significant from an economic point of view, with reduced livestock productivity and threats to public health (Narladkar 2018; Libera et al. 2022). The existence of blood-sucking flies as nuisance pests for beef cattle farms and vectors of zoonotic diseases needs to be watched out.

Tanah Bumbu District, South Kalimantan, Indonesia has a high potential beef cattle population compared to other districts in South Kalimantan. The population of beef cattle in Tanah Bumbu District in 2020 was 20,667 (Central Bureau of Statistics of Tanah Bumbu District 2021). Livestock businesses in Tanah Bumbu District are generally still on a small scale, located close to settlements, and spread fairly evenly in each sub-district, from the coastal areas and outskirts of town to the edge of the forest. The management system generally does not meet good

standards, especially concerning pest/disease vector control. In addition to the relatively high livestock population, Tanah Bumbu District is one of the entry points for distributing beef cattle from outside the island through the seaport. Cases of Surra disease (Trypanosomiasis) were reported to occur in beef cattle in Tanah Bumbu District in 2021 (Department of Food Crops and Animal Husbandry of Tanah Bumbu District 2022, unpublished data). The high livestock population spread around residential areas, the presence of disease agents, and aspects of disease vector control that have not been given sufficient attention are epidemiological factors that support the possibility of zoonotic disease transmission from beef cattle in Tanah Bumbu District.

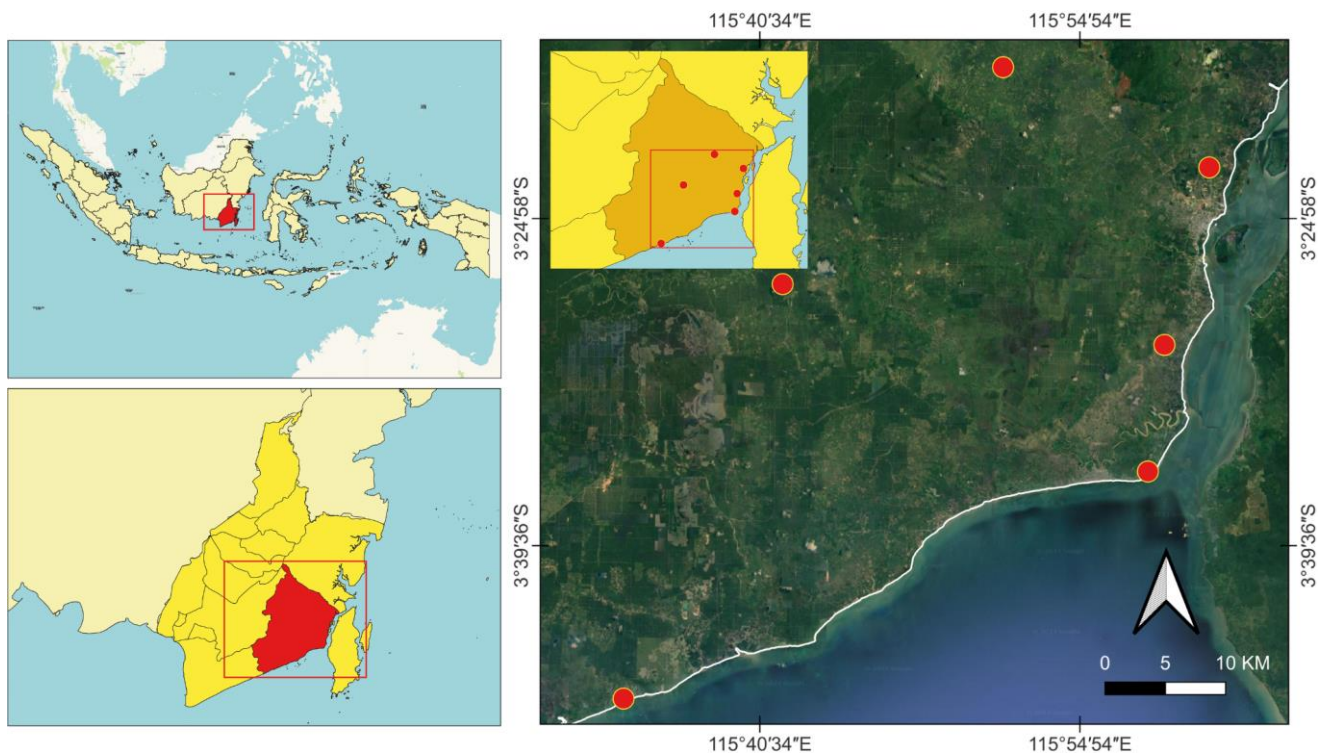
Potential losses to livestock businesses and the threat of zoonotic diseases caused by blood-sucking flies need to be prevented as early as possible. One of the early prevention stages is monitoring flies' presence and activity in endemic areas (Herczeg et al. 2014). Such monitoring can provide information about the vectors species present and the factors associated with their activities. Availability of locally specific data or information regarding the various types and activities of flies that have the potential to become disease vectors in beef cattle breeding environments is an important initial step in vector control efforts, especially in areas prone to prevention and control of zoonotic disease transmission. Therefore, it is necessary to research the species and activities of blood-sucking flies on beef cattle farms in the forest, non-forest, and coastal ecosystems in Tanah Bumbu District. This study aims to know the species diversity of blood-sucking flies, relative

abundance, frequency, and dominance of species and their correlation to weather parameters on beef cattle farms with three different ecosystems in the Tanah Bumbu District. The novelty of this study is to compare the diversity and population density of blood-sucking flies and fluctuations in their infestation levels on beef cattle farms that are managed traditionally by dividing the livestock environment into three different types of ecosystems, namely forest, non-forest, and coastal.

## MATERIALS AND METHODS

### Study area

The flies were collected on six beef cattle farms in Tanah Bumbu District, South Kalimantan Province, Indonesia which were categorized into 3 ecosystems: forest, non-forest, and coastal (Figure 1). For each ecosystem, 2 farms were selected as sampling locations: forest ecosystems in Waringin Tunggal Village, Kuranji Sub-district ( $S3^{\circ} 27.895' E115^{\circ} 41.578'$ ), and Sepakat Village, Mantewe Sub-district ( $S3^{\circ} 18.188' E115^{\circ} 51.456'$ ); non-forest ecosystem carried out in Sungai Kacil Village, Simpang Empat Sub-district ( $S3^{\circ} 22.672' E116^{\circ} 00.692'$ ), and Segumbang Village, Batulicin Sub-district ( $S3^{\circ} 30.617' E115^{\circ} 58.683'$ ); coastal ecosystems in Bunati Village, Angsana Sub-district ( $S3^{\circ} 46.448' E115^{\circ} 34.454'$ ), and Muara Pagatan Village, Kusan Hilir Sub-district ( $S3^{\circ} 36.284' E115^{\circ} 57.944'$ ).



**Figure 1.** Map of flies collection locations in 6 sub-districts in Tanah Bumbu District, South Kalimantan Province, Indonesia

## Procedures

### Collection and identification of blood-sucking flies

Blood-sucking fly samples were collected using three methods: NZI traps and Vavoua traps installed around cattle pens, as well as manual capture with a sweep net. Observations were made for 12 hours from 6AM-6PM. Flies were caught by NZI and Vavoua traps and were collected every hour, and sweep nets were caught for 5 minutes every hour. The collected flies were killed with chloroform and then pinned for identification purposes in the laboratory. The flies were identified using Nikon SMZ445 binocular stereo microscope. Flies photo taken with Optilab Advance Camera Microscope MTN004. Identification to the genus/species level using identification keys for the Muscidae family (Tumrasvin and Shinonaga 1978), Tabanidae family (Schuurmans Jr 1928; Abbasian-Lintzen 1964; Burger and Chainey 2000; Maity et al. 2016); and Hippoboscidae family (Hardy 1964; Lamerton 1965). The collection frequency is 1 time a month for 3 months (Afriyanda et al. 2019).

### Blood-sucking fly infestation measurements

The blood-sucking fly infestation was measured by counting the number of flies that landed on the cow's body using a counter on each farm by taking five cows as samples. Counting was carried out for 6 minutes for each cow and repeated every hour for 12 hours from 6AM-6PM (Smythe et al. 2017; Afriyanda et al. 2019; Lendzele et al. 2019).

### Measurement of weather parameters

Weather parameter measurements include each farm's temperature, humidity, wind velocity, and light intensity. Temperature and humidity measurements were carried out with HTC-1 digital thermohygrometer. Measuring wind velocity using Benetech GM816 digital anemometer. Measurement of light intensity in the livestock environment using Smart Sensor AS803 digital Lux meter. Measurement results are recorded every hour for 12 hours from 6AM-6PM (Afriyanda et al. 2019). In addition, this study also analyzed the correlation of fluctuations in blood-sucking fly infestations with weather parameters.

## Data analysis

Collection results, species identification and observation of blood-sucking fly infestation, and measurement of environmental weather parameters were displayed descriptively in tables and graphs. Statistical tests on the average differences in blood-sucking flies collection and infestation results and correlation with weather parameters were carried out with Minitab 18.0 Software. Correlation analysis using the Pearson formula with a category of correlation coefficient value ( $r$ ):  $0.7 < r < 1$  (strong),  $0.5 < r < 0.7$  (moderate), and  $0.0 < r < 0.5$  (weak) (Weaver et al. 2018). Analysis of flies population includes relative abundance, frequency, and dominance of species (Alvernita et al. 2016), as well as the Shannon – Wiener ( $H'$ ) species diversity index in each ecosystem type with categories of value: 3.0-4.5 (high), 2.0-3.0 (moderate), 1.0-

2.0 (less), and 0.0-1.0 (very less) (Magurran 2004; Albueajee et al. 2020).

## RESULTS AND DISCUSSION

### Description of the farm environment

Data was collected at 6 cattle farm locations and grouped according to ecosystem characteristics. Cattle farms in forest ecosystems are located on the outskirts of the forest at a considerable distance from settlements. The surrounding vegetation is tall trees (>10 m in height), shrubs, and grass. There are natural waters in small rivers and small ponds about 30 m from the cowshed. The cage is simply made of wood with a ground mat. Dirt and leftover feed are allowed to accumulate around the cage. A dense canopy of trees blocked sunlight around the cage (Figure 2A and Figure 2B). Cattle farms in non-forest ecosystems are located on the outskirts of the city. The stables are very close to settlements, rice fields, and gardens. The surrounding vegetation is grass, taro, spinach, shrubs, bananas, coconuts, and others. There are natural waters in the form of small ponds and rice fields about 20 m from the enclosure. The small cage is made of wood with a cement base. Dirt and leftover feed are piled up/burnt around the cage. The surroundings of the cage are shaded by a canopy of trees but not too dense (Figure 2C and Figure 2D). Farms in coastal ecosystems are about 200-400 meters from the shoreline, close to settlements, not protected by tree canopy, without pens, cows are allowed to be in open grass fields limited by fences, and there is shade in the form of simple wooden buildings with roofs. Surrounding the cattle farm are mangroves, Galam plants, and natural waters in the form of ponds and brackish swamps (Figure 2E and Figure 2F). The livestock business in the research location is generally a side business, so the population is small and managed traditionally. In general, housing conditions were inadequate even without housing. The livestock waste disposal system has not been managed properly, and cow dung and leftover feed are piled up around the stables. Efforts to control fly pests are only carried out soberly, namely by fumigating the cage by burning the remaining feed grass. Cows are left free during the day, so they are very easily affected by the surrounding environment.

### Species diversity of blood-sucking flies

There were 11 species of blood-sucking flies, with 4,022 individuals or 46% of the total number of individual flies caught. Species of blood-sucking flies that were collected during the study were from the Muscidae family (*Stomoxys calcitrans* Linnaeus 1758, *Stomoxys sitiens* Rondani 1873, *Stomoxys indicus* Picard 1908, *Stomoxys bengalensis* Picard 1908, and *Haematobia exigua* Meijere 1903), the Tabanidae family (*Therioplectes* sp., *Chrysops fixissimus* Walker 1856, *Tabanus optatus* Walker 1856, *Tabanus striatus* Fabricius 1787 and *Tabanus rubidus* Wiedemann 1821) and the family Hippoboscidae (*Hippobosca* sp.) (Figure 3).



Blood-sucking flies from the Muscidae family are found in every ecosystem. The Tabanidae family was the only *Theriopteces* sp. found in every ecosystem, *C. fixissimus* was only found in forest ecosystems, *T. optatus* was found in coastal and non-forest ecosystems, *T. striatus* is found in forest and coastal ecosystems, and *T. rubidus* was only found in non-forest ecosystems. *Hippobosca* sp. only found 1 individual in non-forest ecosystems. The species with the highest number of individuals collected were *S. calcitrans* (Table 1). The species of flies were grouped into 3 main groups, namely *Stomoxys* spp., *H. exigua*, and Tabanidae, for analysis purposes. At the same time, *Hippobosca* sp. was not possible to analyze because

there was only 1 individual. Statistical tests showed significant differences in the average number of blood-sucking flies caught between species groups and ecosystem types ( $p < 0.05$ ).

#### Relative abundance; frequency and dominance of blood-sucking flies

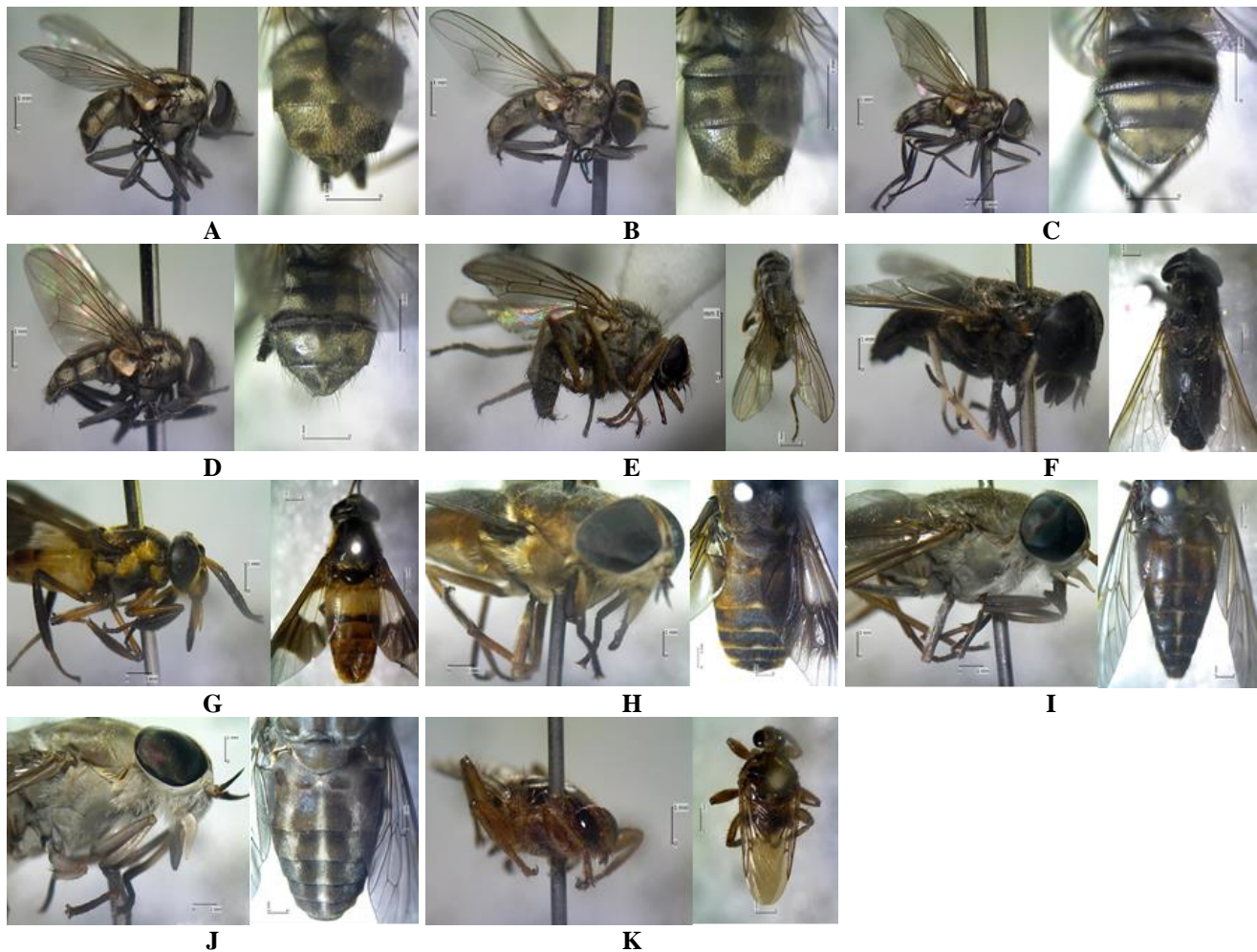
The *S. calcitrans* had the highest relative abundance, frequency, and dominance in each ecosystem, followed by *H. exigua*. *Hippobosca* sp. and species from the family Tabanidae showed low dominance in each ecosystem (Table 2).



**Figure 2.** Livestock environmental conditions in forest (A-B), non-forest (C-D) and coastal (E-F) ecosystems in Tanah Bumbu District, South Kalimantan Province, Indonesia

**Table 1.** Blood-sucking flies species collected from forest, non-forest and coastal ecosystems

Species	Number of individuals caught						Total	%
	Forest	%	Non-forest	%	Coastal	%		
<i>Stomoxys calcitrans</i>	373	40.90	653	48.55	1030	58.36	2056	51.12
<i>Stomoxys sitiens</i>	88	9.65	186	13.83	265	15.01	539	13.40
<i>Stomoxys indicus</i>	52	5.70	26	1.93	21	1.19	99	2.46
<i>Stomoxys bengalensis</i>	10	1.10	8	0.59	46	2.61	64	1.59
<i>Haematobia exigua</i>	333	36.51	394	29.29	357	20.23	1084	26.95
<i>Theriopteces</i> sp.	20	2.19	50	3.72	41	2.32	111	2.76
<i>Chrysops fixissimus</i>	34	3.73	0	0.00	0	0.00	34	0.85
<i>Tabanus optatus</i>	0	0.00	5	0.37	3	0.17	8	0.20
<i>Tabanus striatus</i>	2	0.22	0	0.00	2	0.11	4	0.10
<i>Tabanus rubidus</i>	0	0.00	22	1.64	0	0.00	22	0.55
<i>Hippobosca</i> sp.	0	0.00	1	0.07	0	0.00	1	0.02
Total	912	100.00	1345	100.00	1765	100.00	4022	100.00



**Figure 3.** Blood-sucking flies found in the beef cattle breeding environment in Tanah Bumbu District in Tanah Bumbu District, South Kalimantan Province, Indonesia. A. *Stomoxys calcitrans*; B. *S. sitiens*; C. *S. indicus*; D. *S. bengalensis*; E. *Haematobia exigua*; F. *Therioplectes* sp.; G. *Chrysops fixissimus*; H. *Tabanus optatus*; I. *T. striatus*; J. *T. rubidus*; K. *Hippobosca* sp.

**Table 2.** Relative abundance; frequency and dominance value of blood-sucking flies in forest, non-forest and coastal ecosystems

Species	Forest (H'= 2.30)			Non-forest (H'= 1.92)			Coastal (H'=1.50)		
	Ra	Fr	Dm	Ra	Fr	Dm	Ra	Fr	Dm
<i>Stomoxys calcitrans</i>	24.78	0.85	21.00	27.12	1.00	27.12	21.16	0.99	20.86
<i>S. sitiens</i>	5.85	0.50	2.92	7.72	0.79	6.12	5.44	0.85	4.61
<i>S. indicus</i>	3.46	0.42	1.44	1.08	0.13	0.13	0.43	0.17	0.07
<i>S. bengalensis</i>	0.66	0.08	0.06	0.33	0.06	0.02	0.94	0.36	0.34
<i>Haematobia exigua</i>	22.13	0.90	19.98	16.36	0.63	10.23	7.33	0.97	7.13
<i>Therioplectes</i> sp.	1.33	0.28	0.37	2.08	0.42	0.87	0.84	0.35	0.29
<i>Chrysops fixissimus</i>	2.26	0.28	0.63	-	-	-	-	-	-
<i>Tabanus optatus</i>	-	-	-	0.21	0.07	0.01	0.06	0.04	0.00
<i>T. striatus</i>	0.13	0.03	0.00	-	-	-	0.04	0.01	0.00
<i>T. rubidus</i>	-	-	-	0.91	0.21	0.19	-	-	-
<i>Hippobosca</i> sp.	-	-	-	0.04	0.08	0.00	-	-	-

Note: H': Shannon – Wiener species diversity index; Ra: relative abundance; Fr: frequency; Dm: dominance

### Blood-sucking flies infestation fluctuations and weather parameters

The dominant flies species infesting the cattle body were *Stomoxys* spp. and *H. exigua* (Figure 4). There was a significant difference in the average infestation of *Stomoxys* spp. and *H. exigua*, and Tabanidae ( $p < 0.05$ ),

while there was no significant difference between each ecosystem ( $p > 0.05$ ).

An infestation of flies on the cow's body to suck blood occurred at the beginning of the observation at 06.00 AM. This activity increases every hour between 10AM-2 PM, then decreases gradually from 2PM-6PM. There were

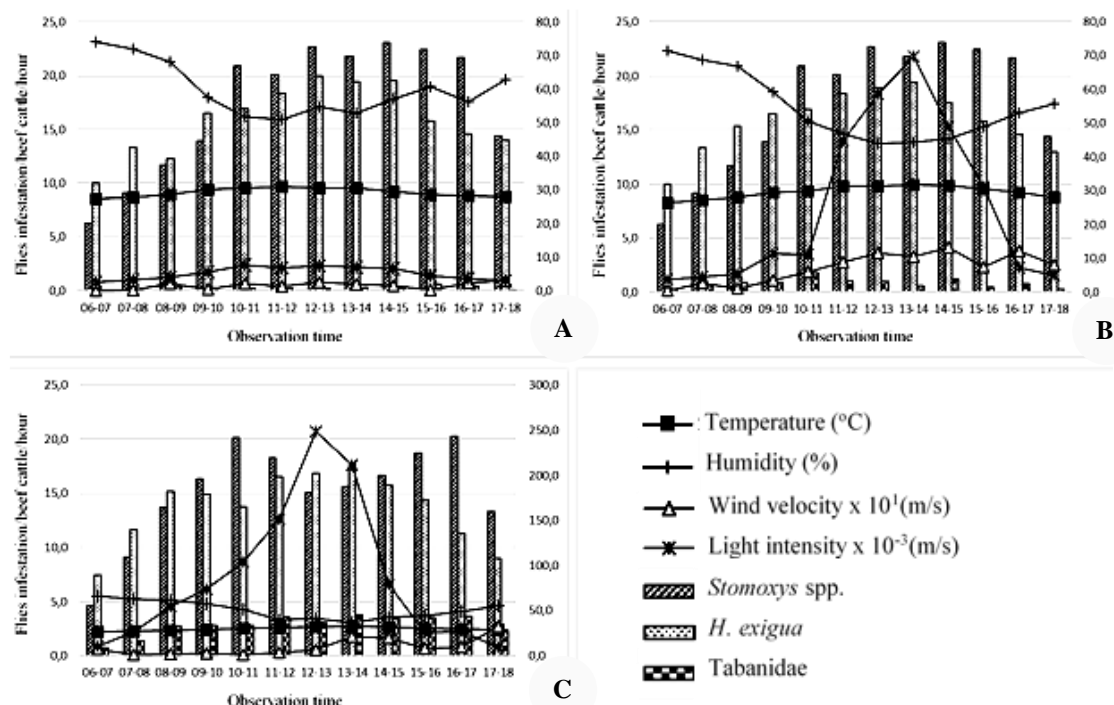
significant differences in the average of fly infestations in the time range I (6AM-10AM), II (10AM-2PM), and III (2PM-6PM) ( $p < 0.05$ ) with the highest average infestation or peak of blood-sucking activity at time range II (10AM-2PM).

The average ambient temperature for 12 hours of observation ranged from 26.5°C-33.1°C. The lowest temperature was in the forest ecosystem, while the highest is in the coastal ecosystem. Air humidity ranges from 37.2% to 74.2%. The lowest humidity was in the coastal ecosystem, while the highest was in the forest ecosystem. The average wind velocity measurement results range from 0.0-3.2 m/s. The highest wind velocity in the coastal ecosystem. The high average wind velocity in coastal ecosystems was influenced by wind blowing from the sea and a very open environment. The average light intensity

ranges from 2,633-248,978 lux. The lowest light intensity was found in forest ecosystems, while the highest is in coastal ecosystems; this is probably due to the livestock environment in the forest ecosystem being shaded by the surrounding tree canopy. In contrast, the livestock environment in the coastal ecosystem was very open, and there was no shade.

#### Correlation of blood-sucking flies infestation fluctuations and weather parameters

The results of the Pearson correlation test on the research data showed a correlation between fluctuations in blood-sucking fly infestations in cattle and several weather parameters in each ecosystem ( $p < 0.05$ ) (Table 3).



**Figure 4.** Fluctuation of blood-sucking fly infestation and weather parameters in: A. Forest; B. Non-forest; and C. Coastal ecosystems

**Table 3.** Correlation index of fly infestation fluctuations and weather parameters in forest, non-forest, and coastal ecosystems

Ecosystem type/Species	Temperature		Humidity		Wind velocity		Light intensity	
	r	p	r	p	r	p	r	p
Forest								
<i>Stomoxys</i> spp.	0.63*	0.03	-0.87*	0.00	0.44	0.15	0.37	0.24
<i>Haematobia exigua</i>	0.84*	0.00	-0.86*	0.00	0.32	0.31	0.54	0.07
Tabanidae	0.19	0.55	-0.40	0.19	0.03	0.93	0.31	0.33
Non-forest								
<i>Stomoxys</i> spp.	0.79*	0.00	-0.82*	0.00	0.45	0.15	0.46	0.13
<i>Haematobia exigua</i>	0.79*	0.00	-0.75*	0.01	0.23	0.47	0.53	0.08
Tabanidae	0.45	0.14	-0.41	0.18	0.15	0.65	0.17	0.59
Coastal								
<i>Stomoxys</i> spp.	0.66*	0.02	-0.66*	0.02	-0.02	0.96	0.28	0.38
<i>Haematobia exigua</i>	0.77*	0.00	-0.72*	0.01	-0.16	0.62	0.77*	0.00
Tabanidae	0.85*	0.00	-0.85*	0.00	0.17	0.59	0.48	0.11

Note: r: Pearson correlation index; p: p value; \*significant correlation



The temperature significantly correlates with *Stomoxys* spp. and *H. exigua* infestation in each ecosystem. Correlation values range from 0.63-0.85 (moderate–strong). Humidity significantly correlates with *Stomoxys* spp. and *H. exigua* infestation in each ecosystem. Correlation values range from -0.66 to -0.87 (moderate–strong). There was no significant correlation ( $p>0.05$ ) between wind velocity and fly infestation. Most of the correlations were positive, except for *Stomoxys* spp. and *H. exigua* in coastal ecosystems. Almost all light intensity had a non-significant correlation with a fly infestation ( $p<0.05$ ), except for *H. exigua* in coastal ecosystems, which showed a strong positive correlation (0.77).

## Discussion

The type of ecosystem can affect the composition of the species of organisms found. Except the cage sanitation, the presence of vegetation, shade, and water can influence the species' existence (Nangoy et al. 2022). An open livestock rearing system was very attractive and made it easier for various insects, including flies, to come. Raising free-release cattle (extensive and semi-intensive) has a higher potential for interaction with nuisance insects when compared to rearing in pens (Vanbergen et al. 2014; Le Gall et al. 2019; Nangoy et al. 2022). The various species of blood-sucking flies indicate the existence of beef cattle farms were a very important feed source for these flies.

The diversity of flies and the dominance of species in an area can be seen from the diversity index. The index value of diversity in each ecosystem is in the less - moderate category, which means that the condition of the community was still stable. Still, there was a tendency for several species to dominate. The forest ecosystem has the highest diversity index value of 2.30, meaning that in that area, the most species of flies were found, and the dominance level of some species was not too high. The results of other study that compared the diversity of ectoparasitic insects in Bali, Indonesia cattle in dry areas and forest edges also showed higher diversity in forest ecosystems (Widaswari et al. 2016). The high diversity of flies in forest ecosystems was due to supporting factors e.g., habitat that is protected and away from disturbances, varied food sources, and the presence of waters that allowed more species of flies to live and develop in the region. The farm's location was far from settlements, so flies could carry out their life activities (looking for food, resting, and breeding) without much human disturbance. The forest was a habitat for various wild animals, such as mammals and reptiles, which can be alternative hosts for flies besides livestock. Certain flies from the Tabanidae family can also suck nectar as a food source besides sucking blood (Karolyi et al. 2014). The diverse vegetation in the forest ecosystem can be a food source for the nectar-sucking flies. The existence of tall trees and shrubs that are dense enough to provide shade and protection for the fly's habitat from direct sunlight and strong winds. The protected farm environment also keeps the humidity high which supports fly breeding. Tabanidae flies in the larval stage generally live in water (Baldacchino et al. 2014), and

natural waters around farms can be the habitat of these fly larvae.

The results of catching flies in this study showed that *S. calcitrans* was the dominant blood-sucking fly on every farm. Several studies conducted in other area of Indonesia and Thailand also showed that *S. calcitrans* was a species of blood-sucking fly that predominated at each catching location (Malaithong et al. 2019; Soviana et al. 2019). The number of *S. calcitrans*, which tends to be high on farms, was likely due to high host densities supported by the existence of breeding sites such as stacked cow manures around the pens, making it easier for *Stomoxys* spp. flies to thrive (Cook et al. 2018; Cook 2020). In addition, breeders' limited knowledge and ability to control these flies make their population development almost uninterrupted.

The *S. calcitrans* spreads cosmopolitan and can attack more than 30 host species including mammals, birds, reptiles, and some amphibians (Rochon et al. 2021). *Stomoxys* spp. acts as a vector for zoonotic pathogens in animals and humans (Baldacchino et al. 2013; Sawitri et al. 2019). The transmission mechanism of this parasite occurs mechanically, so the transfer between hosts must occur quickly because the parasite does not last long in the fly proboscis. The behavior of *S. calcitrans* in sucking blood strongly supports mechanical transmission. These flies can suck blood several times, and if, during the sucking is disturbed by the host, this fly can move to another nearby host (Baldacchino et al. 2013). These flies will become nuisance pests for humans, especially when there are no livestock hosts (Rochon et al. 2021). Transmission of *T. evansi* by *S. calcitrans*, thought to only occur in animals, has been broken by cases of Surra in humans in several countries caused by this parasite (Parashar et al. 2016). A study on the potential for Surra to become a new zoonotic disease in Indonesia was carried out in 2012 by conducting serological tests on farmers on Sumba Island, Indonesia. The test results showed that 16.7% of farmers were positive; this indicates relatively active contact between farmers and blood-sucking flies as the Surra vector, (Sawitri et al. 2019). Besides *Trypanosoma*, a zoonotic pathogen that can be transmitted by *Stomoxys* spp., Among others: West Nile Fever Virus (MNFV), Rift Valley Fever Virus (RVFV), and Anthrax bacteria (Baldacchino et al. 2013). The existence of the dominating blood-sucking fly species, namely *S. calcitrans* must be watched out for as a potential vector in endemic areas.

Other research results showed that populations of some flies species could be affected by climate parameters such as temperature, humidity, wind velocity, and light intensity (Phasuk et al. 2013; Lutz et al. 2019). The positive correlation value indicated that the fluctuation of the infestation was directly proportional to the temperature. Insects are poikilothermal organisms, so ambient temperature greatly affects body temperature. The negative correlation value showed humidity fluctuations inversely related to the blood-sucking activity. Insect bodies are very sensitive to water shortages; reduced air humidity also affects the body's need for water, so insects try to increase body fluids, one of which is by sucking blood. Most of the correlations were positive, except for *Stomoxys* spp. and *H.*

*exigua* in the coastal ecosystem. Although not significant, this indicates that wind velocity may be a supporting factor as well as inhibiting flies' activity in sucking blood. Wind can help disperse chemicals produced by livestock (hormones and CO<sub>2</sub>) which are attractants for flies, but wind velocities that are too high can interfere with the ability to fly insects, making it difficult to reach livestock bodies (Martínez-De La Puente et al. 2009; Nangoy et al. 2022). Exposure to very strong and long exposure to the intensity of sunlight in open livestock areas can increase the temperature, so with increasing temperatures, the possibility of increasing the activity of flies to suck blood.

This study concluded that the species diversity of blood-sucking flies in the beef cattle breeding environment in Tanah Bumbu District consisted of 11 species, with almost the same proportion of abundance, frequency, and dominance the forest, non-forest and coastal ecosystems. The blood-sucking fly species that dominated in every ecosystem was *S. calcitrans*. The peak of blood-sucking fly infestation in each ecosystem occurred in the same time range, between 10AM-2PM. Environmental temperature and humidity significantly correlated with *Stomoxys* spp. and *H. exigua* infestation fluctuations in the forest, non-forest, and coastal ecosystems. The light intensity significantly correlated with *H. exigua* flies in coastal ecosystems, while wind velocity showed no significant correlation for all species and each type of ecosystem. Surveillance of beef cattle disease needs further improvement, accompanied by education for farmers regarding the risks of blood-sucking fly infestations and methods of controlling them. Further research needs to be carried out to detect the pathogens present in blood-sucking flies and the risk of zoonotic disease transmission by blood-sucking flies.

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