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COPROPHILIC DIPTERAN COMMUNITY ASSOCIATED WITH CATTLE DUNG IN KELANANG, BANTING, SELANGOR

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ABSTRACT

Coprophilic or coprophagous dipterans are a specific group of true flies that feed on dung and feces. Most coprophilic fly species are vectors of various animal and human pathogens. Although these flies pose a serious health threat, knowledge on the community structure of coprophilic dipterans associated with animal dung is limited in Malaysia. In this study, we investigated the coprophilic dipteran community associated with cattle dung in Kelanang, Banting, Selangor. Thus, five field visits were conducted to a cattle farm located in Kelanang from August to September 2022. The sample representativeness was ensured by collecting five field replicates at the cattle farm. During the field visits, from 11.00 a.m. till 3.00 p.m., adult dipterans associated with 50 cattle dung pats were captured using sweep nets and they were then examined. A total of 347 dipteran specimens from 13 families including Calliphoridae, Muscidae, Sepsidae, Dolichopodidae and Chloropidae were collected. The house fly (*Musca domestica* L.) was the most abundant dipteran associated with cattle dung, followed by Sphaeroceridae flies and *Chrysomya megacephala* Fabricius. Additionally, five hematophagous fly species i.e., *Musca ventrosa* Wiedemann, *Musca inferior* Stein, *Stomoxys calcitrans* (Linnaeus), *Musca crassirostris* Stein, and Tabanidae flies were also collected at the farm. Among these blood-sucking flies, *S. calcitrans* was found to be the most abundant hematophagous dipteran associated with cattle dung. This study provides preliminary data on cattle dung-associated coprophilic diptera which can serve useful to the cattle industry and the public health of Kelanang as well as to any future epidemiological studies in that location.

Keywords: Cattle dung, coprophilic flies, hematophagous flies, *Musca*, *Stomoxys*

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INTRODUCTION

Insects of the diptera order are immensely noteworthy as they not only play significant roles in the ecosystem as decomposers and pollinators but they also possess great medical and veterinary importance (Yaakop *et al*., 2022). Several species of diptera have been identified to serve as mechanical and biological vectors for various animal and human pathogens. Due to their coprophagous and synanthropic nature, flies often facilitate the transmission of pathogens from dung to living organisms especially humans (Jones *et al*., 2019). For instances, studies have found that coprophilic houseflies (*M. domestica*) are capable of transferring pathogens such as *Salmonella* spp. and *Enterococcus faecalis* from animal dung to humans through mechanical translocation either via their bodily hairs or by defecation and regurgitation (Gioia *et al*., 2022; Collinet-Adler *et al*., 2015; Doud & Zurek, 2012; Wang *et al*., 2011). In the case of humans, *Musca domestica* L. has been found to act as a mechanical vector for diseases such as infantile diarrhea, cholera, dysentery and typhoid as well as for pathogens such as *Salmonella* and *Shigella* species (Issa, 2019). Some coprophilic fly species have also been identified to cause myiasis, a condition where the larvae (maggots) of flies infest wounded human and vertebrate animals (Saari *et al*., 2018). Upon infestation, the larvae will then proceed to feed on the host tissue and liquid body substance (Rothe, 2014). Some of the species of flies that have been identified to cause myiasis include *Wohlfahrtia magnifica* (Schiner), *Lucilia sericata* (Meigen), *Fannia canicularis* (Linnaeus) and *Cochliomyia hominivorax* (Coquerel) (Mathison & Pritt, 2022). In Malaysia, dipteran species such as *Clogmia albipunctata* (Williston) and *Chrysomya bezziana* Villeneuve have been identified to cause myiasis (Mokhtar *et al*., 2016; Ahmad *et al*., 2009).

Some coprophilic dipterans are also hematophagous in nature which refers to their tendency to feed on the blood of humans and animals. When a hematophagous (blood-sucking) fly such as *Stomoxys calcitrans* (L.) or Tabanidae finds a suitable host, it will use its scissor-like mouthpart to lacerate the skin and ingest the pooled blood that flows to the surface (Klowden, 2010). Hematophagous flies are noteworthy because, besides being vectors for various pathogens, their bites can also hinder the healthy development of farm animals, particularly cattle. For example, *Musca crassirostris* Stein, through the annoyance, irritation and stress that they cause, are capable of reducing cattle milk production, inducing weight loss, weakness, and sometimes even death, especially when present in large numbers (Desquesnes *et al*., 2018). On top of that, *M. crassirostris* has also been studied to act as mechanical carriers of *Moraxella bovis* and *Staphylococcus aureus* (Desquesnes *et al*., 2018). In Malaysia, several pathogens such as *Campylobacter jejuni* and *Salmonella hadar* have been successfully isolated from *M. domestica*, particularly from their external surface (Choo *et al*., 2011).

Having discussed the significance of coprophilic diptera, it is evident that studying them is crucial as it aids in our understanding on the transmission of infectious diseases; moreover, it also allows us to make better decisions related to risk management and vector control programs. Previous studies have been done in Malaysia to investigate the community structure of coprophilic dipterans associated with horse and buffalo dung. In the study on horse dung, they found that Sphaeroceridae was the most abundant coprophilic fly whereas in the buffalo dung study it was found that Sepsidae was the most abundant (Khofar *et al*., 2019; Heo *et al*., 2015). In terms of cattle dung, a study was done in Sentul Timur, Kuala Lumpur, Malaysia in 2010 where it found flies such as Sepsidae and *Musca inferior* Stein as the most dominant types of coprophilic dipterans (Heo *et al*., 2010).

However, research on coprophilic diptera associated with cattle dung is still limited in Malaysia. There is a lack of new and updated information on the community structure of coprophilic diptera associated with cattle dung, especially in a rural area such as Banting. The cattle industry is an important economic sector in Malaysia. The population of cattle livestock in Malaysia has been steadily increasing every year, particularly from the year 2016 to 2020, which naturally increases the amount of manure that they excrete daily (Zayadi, 2021). Hence, it is evident that there is a need to document the biodiversity of diptera associated with cattle dung, especially the blood-sucking species, as the information would be immensely important to the prosperity of this industry. Banting was picked as the location for this study owing to the fact that it is one of the main agricultural hubs of Malaysia that has a prospering cattle industry. Kelanang being a rural and poorly studied area within Banting would benefit much from studies of this nature. The main objective of this study was to examine the community structure (i.e., the diversity and abundance) of coprophilic dipterans associated with cattle dung in Kelanang, Banting, Selangor.

METHODOLOGY

Study site

This study was conducted in a cattle farm located in Banting, Selangor, Malaysia (2°47'26.9''N 101°24'58.0''E, 10m a.s.l). The farm housed about 100 individuals of cattle (*Bos taurus*) that are reared primarily for their meat (Fig 1). In terms of its surroundings, the Banting cattle farm was located within the vicinity of an oil palm (*Elaeis guineensis* Jacq.) plantation. The farm was also surrounded by lush wild vegetation (e.g. *Davallia sp., Dryopteris* sp. and *Imperata* sp.) accompanied by the presence of wild animals such as monkeys. Cattle in this farm were reared in pens and were seldom let out to graze due to the risk of injury and accidental consumption of fertilizers used for the palm trees. On this farm, animal waste is removed daily whereby the dung of the cattle will be washed out from the pen to a trench dug about one meter away from the farm, where the animal waste is let to decompose naturally.

Fig 1. The cattle farm studied at Banting, Selangor, Malaysia.

Sample collection

A total of five field trips were conducted to the study site between August and September 2022. The interval between each sampling was 48 h. For each day of sampling, insect collection was performed continuously from 11.00 a.m. to 3.00 p.m. for a duration of four hours. This time window was chosen because this window is within the period in which flies are most biologically active. Average temperature and humidity during the collection period was 31°C - 33°C and 60 - 80%, respectively. There was a lack of significant rain throughout the collection period and the weather conditions were mostly sunny and occasionally cloudy.

During the sampling process, a total of 50 cattle dungs were examined. During each trip, approximately 10 dung pats were examined and fresh pats were given priority. One dung pat was sampled at a time. Adult flies either resting on or swarming around the dung pats were collected using a sweep net. The captured flies were then killed in a killing jar containing acetone-soaked cotton balls. Upon collection, the dipteran specimens were brought back to the Parasitology Laboratory, Institute of Medical Molecular Biotechnology (IMMB), Faculty of Medicine, Universiti Teknologi MARA, Sungai Buloh Campus where they were processed. At the lab, the adult dipteran specimens were pinned, labelled and were left to dry in an oven at 40°C for three days. After three days, the dried samples were transferred into plastic containers for storage.

Taxonomic identification

The identification of the dipteran specimens to the family level was conducted using the keys of Triplehorn *et al*. (2005). Next, the identification of Muscidae specimens to the species level was performed using the keys of Shinonaga (2009) whereas for Calliphoridae, the identification was performed using the keys of Kurahashi *et al*. (1997). In regards to the Sarcophagidae specimens, the identification to the species level was performed using the keys of Kurahashi *et al*. (2021). For confirmation and further identification of the other dipteran specimens, they were identified with the help of the second author.

Data analysis

The data collected were analysed for ecological indices (i.e. Dominance, Species Richness, Simpson's Index, Shannon-Wiener Index, Evenness and Biodiversity index) according to Heo *et al*. (2015) and Khofar *et al*. (2019). The equation that was used to calculate Dominance (D_i) is as below:

$$D_i = \frac{n_i}{N} \times 100$$

Where,

n_i = The number of individuals of a particular species collected during the study

N = The total number of specimens collected during the study

The dominance of all dipteran species and families was classified using Tischler's scale (Table 1) retrieved from Heo *et al*. (2015) and Tischler (1949).

Table 1. The Tischler's scale is used to describe species dominance (Tischler, 1949).

Symbol	Description	Range
Sr	Subrecedent	0% ≤ Di ≤ 1%
R	Recedent	1% ≤ Di ≤ 2%
Sd	Subdominant	2% ≤ Di ≤ 5%
D	Dominant	5% ≤ Di ≤ 10%
E	Eudominant	10% ≤ Di ≤ 100%

The total number of different species present in the sample is indicated by Species Richness (S) while Simpson's Index (D) indicates both the richness and proportion of each species in a given community. In short, Simpson's index refers to the probability of two individuals picked randomly from a particular community belonging to the same species. Simpson's Index was quantified via the following formula:

$$D = \sum_{i=1}^{S} P_i^2$$

Where,

P_i = The proportion of species *i*

S = Species richness

The Simpson's index score was then interpreted using Table 2 retrieved from Guajardo (2015).

Table 2. Guidelines for interpreting Simpson's Index scores (Guajardo, 2015).

Simpson's Index Score	Interpretation
0.00	Absence of diversity (homogeneity)
0.01 – 0.40	A low degree of diversity/heterogeneity
0.41 – 0.60	A moderate degree of diversity/heterogeneity
0.61 – 0.80	A moderately high degree of diversity/heterogeneity
0.81 – 0.99	A high degree of diversity/heterogeneity
1.00	Absolute (perfect) diversity/heterogeneity

Shannon-Wiener Index (H') is also another metric used in this study to quantify the diversity of species in a given community. Shannon-Wiener Index takes into account the number of species present in a habitat and their relative abundance.

$$H' = -\sum_{i=0}^{n} P_i(ln\ P_i)$$

Where,

P_i = The proportion of species i.

$ln\ P_i$ = Natural log of the proportion of species i.

The Shannon-Wiener Index score was interpreted as below (Ulfah *et al*., 2019):

$H' \leq 1$ = Low diversity

$1 < H' \leq 3$ = Moderate diversity

$H' \geq 3$ = High diversity

Evenness (E) represents the relative abundances of different species within a community. A scale from 0 to 1 is utilized to quantify Evenness in which zero indicates a high degree of variation in the community whereas as an Evenness of one indicates an absolute evenness in the community. Evenness was measured via the following formula:

$$E = \frac{H'}{ln\ S}$$

Where,

H' = Shannon-Wiener Index

$ln\ S$ = Natural log of Species Richness (S)

Evenness index scores were categorized as below (Ulfah *et al*., 2019; Krebs, 1989):

$0 < E \leq 0.5$ = Depressed community

$0.5 < E \leq 0.75$ = Unstable community

$0.75 < E \leq 1$ = Stable community

Biodiversity index is utilized to describe the magnitude of species diversity in a particular area. The biodiversity index is quantified in a scale of zero to one, in which a value closer to one indicates a higher degree of species diversity in that given area. The Biodiversity Index is obtained using the formula described below:

$$Biodiversity\ Index = \frac{S}{N}$$

Where,

S = The total number of different species in the area

N = The total number of individuals in the area

The Effective Number of Species (ENS) was derived from Shannon-Wiener's Index using the formula shown below:

$$ENS = EXP\ H'$$

If the value of ENS is closer to one, it indicates that the dipteran community has the same diversity as a community with one equally-common species.

RESULTS

A total of 347 dipteran specimens from 13 families were collected from all 50 cattle dung pats studied. The families consisted of Muscidae, Calliphoridae, Ulidiidae, Tabanidae, Sepsidae, Asilidae, Dolichopodidae, Sphaeroceridae, Chloropidae, Tachinidae, Sarcophagidae, Platystomatidae and Anthomyiidae (Table 3). In this study, the most abundant dipteran families that were caught were Muscidae (61.38%), Sphaeroceridae (17.29%), Calliphoridae (12.97%), Sepsidae (3.75%) and Dolichopodidae (1.15%) followed by the other eight dipteran families (<1% each) (Table 3). In terms of the Tischler's Scale, Muscidae, Calliphoridae and Sphaeroceridae were eudominant in the farm whereas Sepsidae was subdominant (Table 3). The rest of the dipteran families were either recedent or subrecedent.

Table 3. Families and species of Diptera sampled from cattle dung and their respective dominance indices.

Family	Species	Number of Individuals	Dominance (%)	Tischler's scale
Muscidae	*Musca domestica*	201	57.93	Eudominant
	Stomoxys calcitrans	3	0.86	Subrecedent
	Musca inferior	2	0.58	Subrecedent
	Musca crassirostris	2	0.58	Subrecedent
	Neomyia lauta	1	0.29	Subrecedent
	Neomyia Indica	1	0.29	Subrecedent
	Atherigona orientalis	1	0.29	Subrecedent
	Musca ventrosa	1	0.29	Subrecedent
	Neomyia coeruleifrons	1	0.29	Subrecedent
Total		**213**	**61.40**	**Eudominant**
Calliphoridae	*Chrysomya megacephala*	43	12.39	Eudominant
	Lucilia cuprina	1	0.29	Subrecedent
	Hemipyrellia ligurriens	1	0.29	Subrecedent
Total		**45**	**12.97**	**Eudominant**
Sphaeroceridae	Unidentified sp.	60	17.29	Eudominant
Sepsidae	Unidentified sp. 1 Unidentified sp. 2	13	3.75	Subdominant
Dolichopodidae	Unidentified sp.	4	1.15	Recedent
Ulidiidae	*Physiphora* sp.	2	0.58	Subrecedent
Chloropidae	Unidentified sp.	2	0.58	Subrecedent
Sarcophagidae	Unidentified sp.	2	0.58	Subrecedent
Tabanidae	Unidentified sp.	2	0.58	Subrecedent
Asilidae	Unidentified sp.	1	0.29	Subrecedent
Tachinidae	Unidentified sp.	1	0.29	Subrecedent
Anthomyiidae	Unidentified sp.	1	0.29	Subrecedent
Platystomatidae	Unidentified sp.	1	0.29	Subrecedent
Total		**89**	**NA***	**NA***

*not applicable

During the period of this study, 213 individuals from nine species were collected from the Muscidae family. The species of muscid flies according to their decreasing abundance is as follows: *Musca domestica* (57.93%), *Stomoxys calcitrans* (0.86%), *Musca inferior* (0.58%), *Musca crassirostris* (0.58%), *Neomyia lauta* (0.29%), *Neomyia indica* (0.29%), *Atherigona orientalis* (0.29%), *Musca ventrosa* (0.29%) and *Neomyia coeruleifrons* (0.29%) (Table 3). Muscidae, being the most abundant coprophilic Diptera family in the farm, were frequently found swarming around cattle dungs and feeding on them. Both within the Muscidae family and also overall, *M. domestica* was studied to be the most abundant dipteran species associated with cattle dung (Table 3). *Musca domestica* along with *Chrysomya megacephala* were the only two eudominant species in the cattle farm (Table 3).

The second most abundant coprophilic dipteran family that was present in the farm was Sphaeroceridae also known as lesser dung flies (17.29%). Sphaeroceridae are very well known for their coprophilic behavior and in this study they were found gathering on the cattle dung pats in large numbers. On the other hand, the third most abundant Diptera family that was collected in the farm was Calliphoridae. *Chrysomya megacephala* (12.39%) was the most abundant calliphorid species that was caught followed by *Lucilia cuprina* (0.29%) and *Hemipyrellia ligurriens* (0.29%) (Table 3). Overall, *Chrysomya megacephala* was the second most abundant dipteran species that was present in the cattle farm.

Five species of blood-sucking or hematophagous dipterans were collected from the cattle dungs. These species include *Musca ventrosa* Wiedemann (0.29%), *Musca inferior* Stein (0.58%), *Stomoxys calcitrans* (0.86%), *Musca crassirostris* (Linnaeus) (0.58%) and a Tabanidae fly (0.58%). Among them, *Stomoxys calcitrans* was the most abundant blood-sucking fly species.

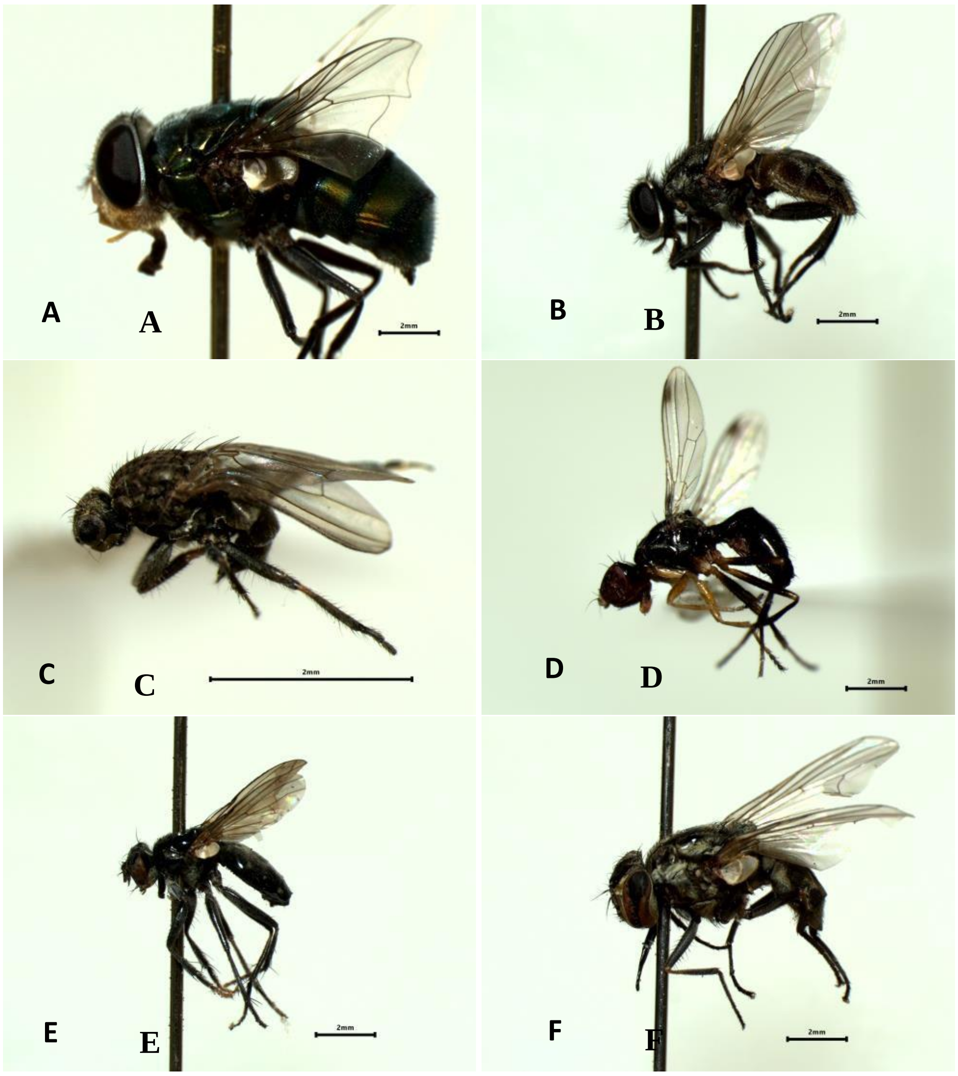

Fig 2. Among the flies that were caught from cattle dung. A. *Chrysomya megacephala*; B. *Musca Domestica*; C. Sphaeroceridae; D. Sepsidae; E. Dolichopodidae; F. *Stomoxys calcitrans*. Scale bar = 2 mm for all figures.

Table 4. Standard ecological indicators of dipteran families found on cattle dung.

Ecological Indicators	**Value**
Species Richness (*S*)	13
Simpson's index (*D*)	0.424
Shannon-Wiener Index (*H*')	1.230
Evenness (*E*)	0.480
Biodiversity Index	0.037
Effective Number of Species (ENS)	2

Results of ecological indices obtained from the formulas mentioned in the methodology were presented in Table 4. As stated in Table 4, the dipteran community sampled in this study has a Species Richness of 13. The community also has a Simpson's Index of 0.424 and a Shannon-Wiener Index of 1.230, both indicating that the community has a moderate degree of diversity. The Biodiversity Index of the community was 0.037 and has an Effective Number of Species of two. Moreover, this dipteran community with an Evenness of 0.480 can be classified as a depressed community.

DISCUSSION

Insects, especially coprophilic dipterans, are highly attracted to animal dung because they serve as a great source of nutrients as well as an excellent oviposition substrate to lay eggs (Hussein *et al*., 2017). In this study, we found that Muscidae was the most abundant Diptera family (61.38%) associated with cattle dung. This finding was different from results obtained from previous similar studies that investigated coprophilic dipterans associated with animal dung (Table 5). Specifically, a study done by Heo *et al*. (2015) on horse dung in Malaysia found that Sphaeroceridae (93.8%) was the most abundant coprophilic dipteran family whereas Khofar *et al*. (2019) found that Sepsidae (64.96%) was the most abundant coprophilic dipteran family associated with buffalo dung. Moreover, a study done by Heo *et al*. (2010) found that Sepsidae (43.8%) was the most abundant dipteran family associated with cow dung.

Table 5. Comparison of coprophilic dipteran community collected from cow, horse, buffalo and cattle dungs.

Study	**Cow dung** (Heo *et al*., 2010)	**Horse dung** **(**Heo *et al*., 2015)	**Buffalo dung** **(**Khofar *et al*., 2019)	**Cattle dung** **(**Present study)
Location of study	Sentul Timur, Kuala Lumpur (3°11' N 101°41' E)	Tanjung Rambutan, Perak (4°41'13" N 101°09'31" E)	Beranang, Selangor (2°54'11"N 101°52'59"E)	Banting, Selangor (2°47'26.9"N 101°24'58.0"E)
Total number of dipteran collected	321	1480	2775	347
Total number of Diptera family collected	16	9	14	13
Most abundant Diptera family	Sepsidae (43.8%)	Sphaeroceridae (93.8%)	Sepsidae (64.96%)	Muscidae (61.38%)
Total number of blood- sucking species	6 species	4 species	3 species	5 species
Most abundant blood-sucking species	*M. inferior*	*M. conducens*	*M. conducens*, *M. crassirostris* *S. calcitrans*	*S. calcitrans*
Percentage of blood-sucking muscid collected	51.5%	29.4%	18.3%	2.31%

As described in Table 5, we can observe that different animal dungs have different dipteran community structures. There may be several intrinsic factors that contribute to this phenomenon which include aspects such as the different physical composition, chemical composition, nutrient composition and the volatile organic compound (VOC) profile of the animal dungs. However, among these factors, the VOC profile of the dung is likely to be the most pivotal factor that determines the community structure of coprophilic dipterans. For example, studies have found that the VOC profiles of dung and manure have a significant impact on the foraging behavior of flies and the dung's attractiveness towards flies and even coprophilic beetles (Stavert *et al*., 2014; Shah *et al*., 2016). Therefore, it can be postulated that in this study, Muscidae was the most dominant coprophilic dipteran family because the VOC profile of the cattle dung may have been significantly attractive to Muscidae flies. However, further studies are needed to verify this hypothesis.

On the other hand, the varying results of these studies may have also been a result of external factors such as the environment and the different geographical locations of the farms. Particularly, the cattle farm that was visited in this study was situated in a rural, not urbanized, agricultural area that had a lot of organic waste primarily in the form of animal waste, animal feed leftovers, animal carcasses, and dead or decaying oil palm trees. There were also a few residential houses and small commercial buildings in the close proximity of the farm. Therefore, external factors such as the ones mentioned here may have made the environment of the cattle farm different and distinct from the farms investigated in the studies mentioned in Table 5. This difference in environment and surrounding may have been significant enough to influence the structure of the local dipteran community which may have then caused the difference in the results. It is noteworthy to state that although Muscidae was the most abundant dipteran family in this study, similar to the previous studies, both Sepsidae and Sphaeroceridae were still highly abundant in the farm.

In this study, *M. domestica* was the most dominant coprophilic fly species that was collected. This finding was not uncommon because *M. domestica* is not only one of the most abundant flies globally but is also well studied to be coprophilic. These flies are often associated with animal faeces which they utilize as a source of food as well as a place to lay their eggs (Issa, 2019; Lam *et al*., 2009). *M. domestica* is synanthropic in behavior and serves as a biological and mechanical vector for numerous human and animal pathogens. In terms of cattle, *M. domestica* has been studied to have the capability to spread pathogens associated with Bovine Respiratory Disease (BRD) which is a disease that can be fatal to cattle (Neupane *et al*., 2019). In Malaysia, *M. domestica* has been studied to act as a carrier for pathogens such as rotavirus and human helminths (Tan *et al*., 1997; Sulaiman *et al*., 1988). Besides the genus of *Musca*, several flies from the genus *Neomyia* were also caught. These flies include *Neomyia lauta*, *Neomyia indica* and *Neomyia coeruleifrons*. In terms of dominance, flies of the *Neomyia* genus were subrecedent in the farm. In Malaysia, the association between *N. lauta* and animal dung has been well studied, specifically they have been found in relatively high abundance around buffalo and cow dung (Khofar *et al*., 2019, Heo et al., 2010). *Neomyia* spp. are commonly found on cow and horse dung as the females of this genus tend to lay their eggs under the dung surface which serves as a great food source to the growing larvae (Heo *et al*., 2010). Besides *Neomyia*, in this study we also caught dipterans such as *Atherigona orientalis* and *Stomoxys calcitrans*.

Sphaeroceridae was the second most abundant dipteran family that was collected in this study. In this cattle farm they were eudominant according to the Tischler's scale. Sphaeroceridae are small sized flies that are generally black or brown in color. Sphaeroceridae species such as *Norrbomia tropica* (Duda), *Coproica rufifrons* Hayashi and *Coproica coreana* Papp are commonly found in Malaysia and are well studied to be coprophilic (Heo *et al*., 2015). Other than cattle dung, Sphaeroceridae in Malaysia have also been associated with horse and buffalo dung (Khofar *et al*., 2019, Heo *et al*., 2015).

Calliphoridae was the third most abundant dipteran family that was caught in this study. Along with Muscidae and Sphaeroceridae, Calliphoridae was another dipteran family that was eudominant in the farm. Within the family, *C. megacephala* was the most abundant species. *Chrysomya megacephala* are medically very important because they are synanthropic and are capable of serving as vectors for several pathogens. In a study conducted in Thailand, it was found that *C. megacephala* was not only capable of carrying and transmitting human pathogens such as *Salmonella typhi*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* through their external surface but was also able to carry a larger bacterial load than the common house fly, *M. domestica* (Chaiwong *et al*., 2014). *Chrysomya megacephala* also has immense veterinary importance, especially among cattle, as they are capable of inducing myiasis which may hinder the healthy development and growth of the animal (Bambaradeniya *et al*., 2019). Additionally, calliphorids such as *Lucilia cuprina* and *Hemipyrellia ligurriens* were also collected in this study. *Hemipyrellia ligurriens* has been known to have the capability to live and develop in animal dung (Klong-klaew *et al*., 2018). Specifically, *H. ligurriens* has been previously captured around buffalo and cow dung in Malaysia (Khofar *et al*., 2019, Heo *et al*., 2010). On the other hand, *L. cuprina* is also of medical and veterinary importance as they can cause animal as well as human myiasis (Azevedo *et al*., 2015).

Furthermore, five blood-sucking dipteran species were recovered in this study. These species were *Musca ventrosa*, *Musca inferior*, *Stomoxys calcitrans*, *Musca crassirostris* and a Tabanidae fly species. Blood-sucking flies have scissor-like mouthparts which they use to lacerate the skin of animals or humans to acquire blood for nutrition (Saari *et al*., 2018). In the context of cattle farms, blood-sucking flies hold immense veterinary importance because the stress, blood loss, skin irritation and the loss of grazing time that they cause may reduce the weight gain rate as well as the milk production rate of the livestock (Zhu *et al*., 2021). Blood-sucking flies, although they do not particularly feed on animal dung, they are often coprophilic because they utilize the dung as breeding grounds and/or as oviposition substrates. Female hematophagous flies will lay their eggs on fresh animal droppings and upon hatching the dung will serve as a nutrient-dense food source for the larvae. Among the blood-sucking flies that were caught in this study, *S. calcitrans* was the most abundant (0.86%); however, overall they were only subrecedent in the farm. *S. calcitrans* has a rigid and slender sucking proboscis protruding from the front of their head. They can be identified by four characteristic, longitudinal stripes on their thorax and by the dark spots that are present on top of their abdomen (Newberry, 2003). In livestock such as cattle, *S. calcitrans* often induce disturbance, stress, skin lesions, loss of blood, reduction of food intake and a global immunosuppressive effect (Baldacchino *et al*., 2013). Besides, *S. calcitrans* is also capable of acting as a mechanical vector for pathogens and is able to facilitate the transmission of pathogens such as African swine fever, Equine infectious Anemia (EIA), West Nile virus. *Anaplasma marginale* and lumpy skin disease virus (LSDV) (Makhahlela *et al*., 2022; Baldacchino *et al*., 2013). Other blood-sucking flies that were caught in this study such as *M. crassirostris* are known to breed in cattle dung and are also capable of facilitating the transmission of a number of pathogens (Desquesnes *et al*., 2018; Soler Cruz & Capinera, 2008).

This study found that Muscidae was the most abundant and diverse coprophilic dipteran family associated with cattle dung, at least in Kelanang where this farm is situated. Additionally, house flies (*M. domestica*) were found to be the most abundant dipteran species associated with cattle dung. Five species of blood-sucking flies were caught in the cattle farm in which *Stomoxys calcitrans* was the most abundant hematophagic species. Overall, this study provides preliminary data on coprophilic dipterans associated with cattle dung which can be useful for further epidemiological studies and studies related to species-specific pest control measurement. There are several limitations in this study that are noteworthy to mention. Firstly, some of the dipterans collected in this study that were significantly low in abundance were not identified to the species level. Additionally, in this study, the cattle dungs were not inspected for dipteran larvae which may have enhanced the quality of the findings in regards to the dipteran species that use the cattle dung as an oviposition substrate. In this study, we recommend larger epidemiological studies in the area of Banting to see if the results obtained in this study are still accurate on a larger geographic scale. It would also allow us to accurately describe the community structure of coprophilic dipterans in the area of Banting. On top of that, we recommend future studies to collect fly larvae that are present in cattle dung as it would allow us to pinpoint which dipteran species utilize them as oviposition substrates. Lastly, we recommend pathogen screening studies on coprophilic dipterans associated with cattle dung as it will elucidate the medical importance of the dipterans and dipterans that are hazardous to public health.

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STATEMENTS & DECLARATIONS

Author Contributions

All authors contributed to the conception and design of the study. Data collection was performed by NIS. Material preparation and data analysis were performed by both Dr. HCC and NIS. The first draft of the manuscript was written by NIS and was commented on by Dr. HCC. All authors read and approved the final manuscript.

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Data availability

The data is available on demand from the corresponding author: chin@uitm.edu.my

Consent to participate

Verbal informed consent was obtained from all individual participants who participated in the study.

Consent for publication

All individual participants have consented to the submission of the manuscript to the journal.

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