Original Article

Qualitative Analysis of Sanitation Management in Residential Area around Gampong Jawa Landfill in 2021 Based on Fly Distribution Pattern

Muhammad Nur[1], Muhammad Ali Sarong[2], Mudatsir Mudatsir[3], Marlina Marlina[4], Muhammad Sayuthi[5]

[1]Department of Mathematics and Science Application, Syiah Kuala University, Banda Aceh, Indonesia, [2]Department of Marine Science, Faculty of Fisheries and Marine Sciences, Teuku Umar University, West Aceh, Indonesia, [3]Department of Microbiology, Faculty of Medicine, Syiah Kuala University, Banda Aceh, Indonesia, [4]Department of Medical and Surgical Nursing, Faculty of Nursing, Syiah Kuala University, Banda Aceh, Indonesia, [5]Department of Plant Protection, Faculty of Agriculture, Syiah Kuala University, Banda Aceh, Indonesia

Abstract

Aim: Residents are concerned about the presence of flies, especially in areas near landfills, so it is important to study the distribution patterns of fly communities and community responses to the presence of flies. This study focuses on two main topics: fly distribution in various zones and people's perspectives on fly prevention initiatives. **Materials and Methods:** Data were collected by dividing the sampling location into four clusters and collecting data three times per day (morning, noon, and afternoon). Flypaper was used to collect the insects, which were then separated based on their morphology. The data were tabulated and analyzed using the Shannon-Wiener equation for the diversity index, and the Morisita index equation for the distribution pattern. The observation was then continued by asking people about the existence of the fly community. **Results:** Cluster 4 has the strongest dynamics with varying absolute density. The morning has the highest absolute density, with an average of 26.56. The findings of the relative density analysis suggest that *Musca domestica* has the highest percentage, with an average percentage of 74.36%. Only 45% of respondents took actions to combat the presence of flies. The study's findings also revealed that 97% of the population had never been socialized about sanitary management and attempts to control fly communities. **Conclusions:** Community sanitation, the prevalence of trash, and the presence of insects are not successfully regulated. The residential sector of the Gampong Jawa Community, which has the most direct access to the landfill, is at a higher risk of getting affected by hazardous diseases conveyed by flies.

Keywords: Distribution pattern, diversity index, fly population, landfill, pathogen vectors

Introduction

Flies are one types of arthropod belonging to order Diptera.[1] Flies (Diptera) are one of the species that contribute significantly to human health problems. Flies act as mechanical vectors for the spread of disease, especially through the food they infest.[2-4] Different kinds of bacteria can be found in the bodies of flies, such as *Enterobacter aerogenes, Escherichia Coli, Proteus sp., Bacillus sp., Serratia marcescens, Ancylostoma spp., and Trichuris spp.*[5,6] Since flies are dependent on humans for their existence and are drawn to the smell of human blood and waste, they can be found in every home, especially in places near landfills.[7,8] Because flies have a habit of defecating and vomiting on the surface where they land, this is the initial stage of flies contaminating every affected site. Flies ingest organic substances from human and organic waste.[9,10] These practices contribute to the spread of infectious diseases such as typhus, diarrhea, dysentery, and other gastrointestinal illnesses, and some of them can also lead in myasis.[3] The ability of flies to transmit infectious agents to their hosts, commonly referred to as vector competence, determines a major portion of the transmission activity of

Access this article online

Quick Response Code:

Website: https://journals.lww.com/IJEH

DOI: 10.4103/ijehe.ijehe_1_23

Address for correspondence: Dr. Muhammad Sayuthi, Department of Plant Protection, Faculty of Agriculture, Syiah Kuala University, Banda Aceh 23111, Indonesia.
E-mail: say_m2001@unsyiah.ac.id

How to cite this article: Nur M, Sarong MA, Mudatsir M, Marlina M, Sayuthi M. Qualitative analysis of sanitation management in residential area around Gampong Jawa landfill in 2021 based on fly distribution pattern. Int J Env Health Eng 2024;13:4.

Received: 04-01-2023, **Revised:** 16-06-2023, **Accepted:** 11-07-2023, **Published:** 29-02-2024

pathogenic agents from flies to humans.[11,12] Low levels of sanitation contribute to an increase in fly populations, one of the diseases' vectors.[13]

Flies are a source of microbial contamination and carrier of bacterial diseases.[4] According to the research by Stoffolano, The Turkish Coronavirus, the etiologic agent behind acute, intestinal, and highly contagious sickness in Turkey, can be spread by the house fly (*Musca domestica*). In other studies, serological and genomic testing on flies revealed a low prevalence of severe acute respiratory syndrome coronavirus carriage.[14,15] In addition, managers of public health should be more cautious about managing the spread and control of diseases, especially those carried on by flies.[5] The Banda Aceh City, the area of Gampong Jawa, has a high population density and is adjacent to the city's landfill. The integration of biological communities is measured by diversity, which is calculated by taking into account the number of populations that have been incorporated with a relative abundance.[16] The diversity and distribution pattern of flies are important indicators in knowing the pattern of fly community development in Gampong Jawa, which will have an impact on the type of disease and the number of people suffering from the disease in the Gampong. Therefore, this research was conducted with the aim of obtaining information related to the level of diversity of fly species and their distribution patterns so that this research is expected to be the basis for determining the fly population control model to prevent the transmission of diseases caused by flies. This study aimed to determine the level of diversity and distribution patterns of flies in the Gampong Jawa, Banda Aceh City, Indonesia.

Materials and Methods

Research area

The study was conducted in Gampong Jawa area, Banda Aceh City, Indonesia. Detail is illustrated [Figure 1]. This type of this study is quantitative research using a simple *ex post* facto research design.[17] This design is used based on the presence of landfills that affect the fly population.[18-20] There are four clusters (observation points) that are determined based on the distance of clusters to the landfill, each cluster is ± 400 m and consists of three stations with each station divided into three plots. Cluster determination is based on the distance of the landfill to residential areas in Gampong Jawa. The location of Cluster 1 (1201 m − 1600 m) is in Nyak Raden Hamlet, Cluster 2 (801 m − 1200 m) is in Hamzah Yunus Hamlet, Cluster 3 (401 m–800 m) is in Tuan Dibanda Hamlet, and Cluster 4 (0 m–400 m) is in Said Usman and Tgk. Muda.

Data sampling and analyzing

Data collection procedures were carried out at several sampling locations divided into four clusters; data collection was carried out three times a day (morning, noon, and afternoon) and carried out three repetitions of sampling in each cluster. Flies were sampled using flypaper that placed on the ground or a flat

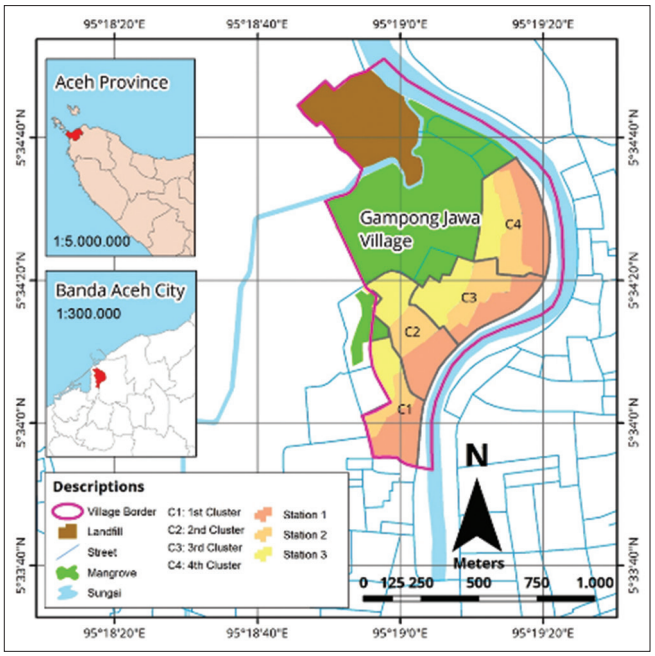

Figure 1: Geographic location of the study area in Gampong Jawa area, Banda Aceh City, Indonesia

surface in each plot that had been determined. The collected samples were sprayed with 70% alcohol and labeled; then, the samples were sorted by morphology and identified. The data obtained were tabulated and analyzed using the Shannon–Wiener equation for the diversity index.[21,22]

The diversity index of flies can be analyzed using the Shannon–Wiener Equation (1).[23]

$$H' = -\sum pi \ln pi \quad (1)$$

Where:

Pi = The proportion of each species in the sample

Diversity index criteria:[24]

- $H' < 1$: Low level of diversity
- H' 1–3: Moderate level of diversity
- $H' > 3$: High level of diversity.

The distribution pattern was determined using the Morisita Index Equation (2).[25]

$$Id = \frac{N \sum X^2 - \sum X}{\left(\sum X\right)^2 - \sum X} \quad (2)$$

Where:

N = Total number of plots

X = Number of species in each plot.

Distribution pattern criteria:[26-28]

- Id < 1: Uniform dispersion
- Id = 1: Random dispersion
- Id > 1: Clumped dispersion.

In addition, data sampling is also carried out with a qualitative approach to obtain information from respondents about sanitation management in the area. A cluster consist of 25 respondents. Approach taken using a questionnaire to respondents and Gampong Jawa stakeholders (Chief Landfill Officer, Village Head, and Health Center Officer), in addition supporting data obtained from the Department of Hygiene and Environment of Banda Aceh City is also used. Interviews conducted to respondents following the question points presented [Table 1].

Results

Nine hundred and seventy samples of flies were collected from all clusters. Information on the quantity of samples dependent on the day and the time of observation [Table 2].

The results shown in each group varied greatly. The level of fly diversity in each cluster shows different results based on the distance of the observation location from the waste processing site. The results of the analysis of the level of diversity of flies [Table 3].

The distance between the location and the waste management site also influences the distribution pattern of flies. Based on the results of the study, the distribution pattern of flies in each cluster generally tends to be uniform, but this pattern will change into groups or vary depending on the environment and food points. The results of this analysis [Table 4].

Table 1: Question points for respondents

Question type	Question
Characteristic of respondents	1. Gender
	2. Education (Leege *et al*., 2021)
	3. Occupation (Illés *et al*., 2021; Sutherland *et al*., 2021)
Sanitation management	1. Type of trash
	2. Availability of trash
	3. Amount of trash
Presence of flies	1. Do flies appear
	2. Are flies bothering you

Table 2: Number of fly samples obtained from each observation cluster

Cluster	1	2	3	4
1st day				
Morning	39	28	34	21
Noon	14	9	29	47
Afternoon	21	8	47	76
2nd day				
Morning	46	34	13	39
Noon	18	10	34	33
Afternoon	15	8	47	63
3rd day				
Morning	17	7	21	24
Noon	14	9	29	20
Afternoon	12	17	29	20

In addition, based on the results of the respondent analysis conducted, the level of education greatly influences the respondent's perspective on how to overcome the problem of flies. This is proven by the level of highly educated people having a good handling attitude so that this cluster can reduce the level of fly presence. 3-day fly findings collected in this investigation in each cluster [Figure 2].

Discussion

Diversity level

According to Shannon–Wiener research, the Gampong Jawa region of Banda Aceh often has low levels of fly variety (H1), especially in Cluster 1. Compared to Cluster 1, the level of diversity in Cluster 2 was comparatively low, but in repeated Clusters 1 and 2, the degree of diversity was moderate (H´1–3) before declining the following day. The location of Cluster 2 in the middle of a residential area that is dispersed into various alleys causes the level of variety there to vary. Cluster 3 was located at the neighborhood processing facility for plastic trash the locals used this location to gather inorganic waste that could still be sold to recyclers. Fly variety in Cluster 3 was typically low, although there was a morning increase to a substantial level. The diversity level reveals the presence of fly species in this region.[16] One of them has a moderate amount of diversity, whereas the others have a low level, similar to the information obtained in Cluster 4, which is 300 m away from the landfill. Illustrates the description of the diversity level in each cluster based on the time of observation [Figure 3].

Distribution pattern

The distribution of flies in Cluster 1, which is the area farthest from the landfill, tended to clumped; however, data showed that, for the third repeat, the distribution pattern shifted to a uniform pattern at midday (0.8571) and in the afternoon (0.8636). Based on the location of cluster 1, it is possible for the distribution of flies because the point of food is only in certain places so that many flies moved toward these points. The importance of the distribution pattern revealed that insects' dispersal plays a significant function in a variety of habitats.[29] According to the results, Cluster 2's fly distribution

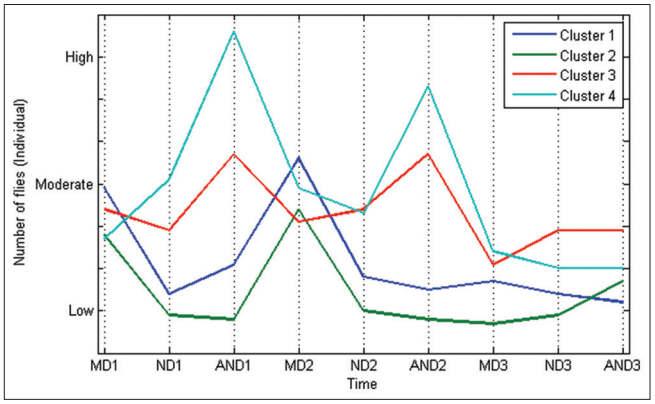

Figure 2: The presence of flies in 3 days of observation, morning (M), noon (N), afternoon (AN), day 1 (D1), day 2 (D2), and day 3 (D3)

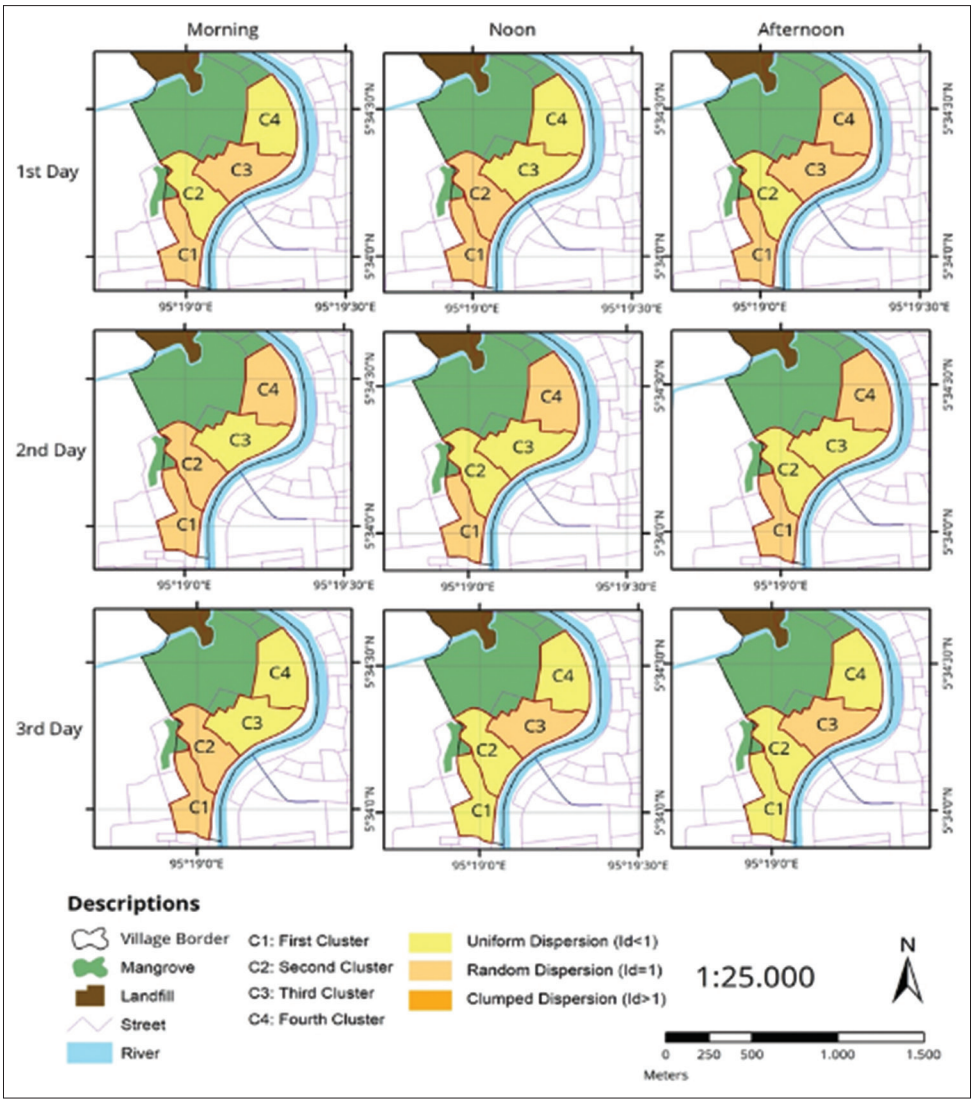

Figure 3: Mapping the level of fly diversity in the observation cluster based on time and day

Table 3: Diversity index of fly

Clusters	Repetition	Observation time		
		Morning	Noon	Afternoon
1	1st day	0.64	0.26	0.85
	2nd day	0.49	0.35	0.68
	3rd day	0.85	0.86	0.98
2	1st day	1.02	0.64	0.74
	2nd day	1.2	0.64	0.66
	3rd day	0.8	0.68	0.47
3	1st day	1.08	0.77	0.44
	2nd day	0.63	0.13	0.18
	3rd day	1.18	0.55	0.33
4	1st day	0.99	0.31	0.54
	2nd day	0.86	0.3	0.76
	3rd day	0.17	1.01	0.83

pattern tended to be uniform, whereas it sometimes changed to a clumped pattern, such as in the morning on the second and third repeats and at midday on the first repeats. The cause of these altered because of Cluster 2's location. Whereas the distribution pattern in Cluster 3 remained constant, the same thing also occurred there, but there were changes throughout a number of repetition and observation intervals. The clumped pattern appeared in the morning and afternoon of the first repetition, but it reappeared in the midday and afternoon of the third repetition. The distribution pattern tended to be regular in cluster 4, according to observation, according to [Figure 3]. The distribution pattern tended to be uniform on the first repeat, but from morning to afternoon on the second repetition, it clumped, and from morning to afternoon on the third repetition, it resumed its varied pattern.

According to this study, observations in many clusters generally showed that the diversity level of flies (Diptera) in Gampong Jawa village, Banda Aceh city, was low about 970 samples. Since different environments and locations can affect how flies grow and develop, they can be used as a separate variable

Table 4: Morisita index of fly

Clusters	Repetition	Observation time		
		Morning	Noon	Afternoon
1	1st day	1.3887	1.8462	1.0857
	2nd day	1.1913	1.0196	1.4000
	3rd day	1.0809	0.8571	0.8636
2	1st day	0.9921	1.0833	0.9643
	2nd day	1.2460	0.8000	0.9643
	3rd day	1.2857	0.7500	0.9924
3	1st day	1.0053	0.9458	1.0019
	2nd day	0.9355	0.9733	0.9907
	3rd day	0.9429	1.0049	1.1675
4	1st day	0.9487	0.9549	1.0600
	2nd day	1.1457	1.0568	1.1167
	3rd day	0.9239	0.9158	0.9947

to determine the degree of fly diversity.[30,31] This study has shown that the distribution pattern of each observed cluster differs because distinct attributes in each cluster led to varied distribution patterns.

Analysis of respondents

Description of education and gender of respondent

Respondents from each cluster have varying degrees of education, according to the interviews. The interviewee's perspective will be considerably influenced by their degree of education.[28] Secondary education is the minimum level of formal education. With 84% of respondents having completed their elementary and secondary school and 16% having attended college, respondents in Cluster 1 were made up of 36% of men and 64% of women. Forty percent of men and 60% of women make up Cluster 2, and some family members have a formal education. Four percent of men and 96% of women make up Cluster 3, and only a small number of family members also hold formal educations. On the other hand, only 96% of the people in Cluster 4 have completed their primary and secondary school, compared to 24% of males and 76% of women. Cluster 2 is a region with a larger population density than the other clusters, which promotes the growth of flies and the effects they have.

Description of responses from respondents

The presence of flies is affected by a number of variables, including the availability of food sources and a breeding area, which can be harmful to the family's hygiene and health. Waste is always created with every activity, whether it takes place inside or outside the home. There are two types of garbage created the most frequently each day, namely, plastic and food waste. The presence of trash cans demonstrates that the neighborhood cares about the environment. Only 4% of residents in the other clusters did not have garbage cans close to their homes, in contrast to Cluster 1, where every respondent's home had its own trash can. Up to 24% of Cluster 1 residents and 48% of Cluster 2 residents, respectively, have taken measures to keep flies away, including using flypapers, applying insecticides, and burning garbage, which is typically where flies breed. Since the majority of responders in each cluster are bothered by the presence of flies, they take this action on their own creativity. Insecticide sprays, baits, controlled aerosols, window traps, window stickers, sticky tubes, adhesive tape, and conventional fly beaters are some fly control methods.[32] It was revealed by the respondents that diarrheal disease is the most prevalent disease suffered by local population, making the socialization of overcoming the existence of fly communities extremely important. In contrast to Clusters 2 and 3, where only 12% of respondents claimed to have received socialization regarding sanitation management and efforts to control the presence of fly communities in their environment, all respondents from Clusters 1 and 4 revealed that they had never been exposed to hygiene management or efforts to control fly colonies in the area. They interact with others through student activities and local medical centers.

Description of responses from stakeholder

According to stakeholder (Chief Landfill Officer, Village Head, and Health Center Officer) interviews in Gampong Jawa, there are no specific waste management programs or activities that the stakeholders are engaging in. The method that the community often manages waste management is by storing rubbish at a location that is given by the government and then having cleaners remove the waste to the landfill. Gampong Jawa's stakeholders have been informed about rubbish banks; however, the program cannott be put into action because of operating issues. In certain cases, local stakeholders utilize fogging to takle the fly population.

Presence of flies in the community

Fly communities were found to be less in Clusters 1 and 2 on observation days 1 and 2. The number of fly communities is about the same in each cluster in the morning, though, which is probably related to the morning and afternoon garbage disposal schedules. There are mangrove ecosystems in Clusters 1 and 2, which has a significant impact on both lowering unpleasant ribs and the prevalence of flies. This is consistent with studies by Membere *et al*. and Hamidou Leyo *et al*., which found that mangroves ecosystem had a major impact on the spread of flies such as *M. domestica*, which can reproduce quickly.[33,34]

Conclusions

The Gampong Jawa Community's residential area, which has the most direct access to the landfill, is at a higher risk of being infected by harmful diseases spread by flies. This complaint corresponds with those expressed by the respondents, who claimed that diarrhea and dysentery are widespread illnesses in the area. The analysis's findings suggested that fly variety was generally modest, but it was still important to plan ahead and create a fly control strategy to stop the transfer of viruses from flies to humans.

Ethics code

The authors approved this study in Ethical Number: 111100040122.

Acknowledgments

The authors thank to the Promoters from University of Syiah Kuala for all their knowledge and support in this process and to stakeholders in Gampong Jawa for their support in the survey and information for this research.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Hodson CN, Ross L. Evolutionary perspectives on germline-restricted chromosomes in flies *(Diptera*). Genome Biol Evol 2021;13:evab072.
2. Issa R. *Musca domestica* acts as transport vector hosts. Bull Natl Res Cent 2019;43:1-5.
3. Pava-Ripoll M, Pearson RE, Miller AK, Ziobro GC. Detection of foodborne bacterial pathogens from individual filth flies. J Vis Exp 2015:e52372.
4. Reuben R, Gyar S, Danladi M. COVID-19: Probable involvement of insects in the mechanical transmission of novel coronavirus (2019-nCoV). Microbes Infect Dis 2020;1:111-7.
5. Bahrndorff S, de Jonge N, Skovgård H, Nielsen JL. Bacterial communities associated with houseflies (*Musca domestica* L.) sampled within and between Farms. PLoS One 2017;12:e0169753.
6. Monyama MC, Onyiche ET, Taioe MO, Nkhebenyane JS, Thekisoe OM. Bacterial pathogens identified from houseflies in different human and animal settings: A systematic review and meta-analysis. Vet Med Sci 2022;8:827-44.
7. Alzahrani SM. Evaluation of triflumuron and pyriproxyfen as alternative candidates to control house fly, *Musca domestica* L. (*Diptera*: *Muscidae*), in Riyadh city, Saudi Arabia. PLoS One 2021;16:e0249496.
8. Tangtrakulwanich K, Albuquerque TA, Brewer GJ, Baxendale FP, Zurek L, Miller DN, *et al*. Behavioural responses of stable flies to cattle manure slurry associated odourants. Med Vet Entomol 2015;29:82-7.
9. Sanchez-Arroyo H, Capinera JL. House Fly, Musca Domestica Linnaeus (*Insecta: Diptera: Muscidae*). Vol 28. Gainesville: IFAS Extension, University of Florida 2013. p. 124-230.
10. Njoku PO, Edokpayi JN, Odiyo JO. Health and environmental risks of residents living close to a landfill: A case study of Thohoyandou landfill, Limpopo province, South Africa. Int J Environ Res Public Health 2019;16:2125.
11. Changbunjong T, Bhusri B, Sedwisai P, Weluwanarak T, Nitiyamatawat E, Chareonviriyaphap T, *et al.* Species identification of horse flies (*Diptera: Tabanidae)* in Thailand using DNA barcoding. Vet Parasitol 2018;259:35-43.
12. Onwugamba FC, Fitzgerald JR, Rochon K, Guardabassi L, Alabi A, Kühne S, *et al.* The role of 'filth flies' in the spread of antimicrobial resistance. Travel Med Infect Dis 2018;22:8-17.
13. Chaiwong T, Srivoramas T, Sueabsamran P, Sukontason K, Sanford MR, Sukontason KL. The blow fly, *Chrysomya megacephala*, and the house fly, *Musca domestica*, as mechanical vectors of pathogenic bacteria in Northeast Thailand. Trop Biomed 2014;31:336-46.
14. Stoffolano JG. Fly foregut and transmission of microbes. Advances in insect physiology, 2019;57:27-95.
15. Ou X, Liu Y, Lei X, Li P, Mi D, Ren L, *et al*. Characterization of spike glycoprotein of SARS-CoV-2 on virus entry and its immune cross-reactivity with SARS-CoV. Nat Commun 2020;11:1-12.
16. Basna M, Koneri R, Papu A. Distribution and Diversity of Soil Insects in Gunung Tumpa Botanical Forest Park, North Sulawesi. J MIPA 2017;6:36-42.
17. Leedy PD, Ormrod JE, Johnson LR. Practical Research: Planning and Design. Boston, MA:Pearson; 2014.
18. Mills GE, Gay LR. Educational Research: Competencies for Analysis and Applications,, 12 edition. New Jersey: Pearson; 2019.
19. Santos RG, Santos RB. Practice-based research: Ex post facto evaluation of evidence-based police practices implemented in residential burglary micro-time hot spots. Eval Rev 2015;39:451-79.
20. Sharma RR. Evolving a model of sustainable leadership: An ex-post facto research. Vision 2019:23:152-69.
21. Rendeková A, Mičieta K, Randáková Z, Miškovic J. Dynamics of the species diversity and composition of the ruderal vegetation of Slovak and Czech cities. Hacquetia 2018;17:171-88.
22. Song Q, Wang B, Wang J, Niu X. Endangered and endemic species increase forest conservation values of species diversity based on the Shannon-Wiener index. Iforest 2016;9:469-74.
23. Shannon CE. A mathematical theory of communication. Bell Syst Tech J 1948;27:623-56.
24. Ortiz-Burgos S. Shannon-weaver diversity index BT. In: Kennish MJ, editor. Encyclopedia of Estuaries. Dordrecht: Springer Netherlands; 2016. p. 572-3.
25. Morisita M. I σ-index, a measure of dispersion of individuals. Res Popul Ecol (Kyoto) 1962;4:1-7.
26. Amaral MK, Péllico Netto S, Lingnau C, Figueiredo Filho A. Evaluation of the Morisita index for determination of the spatial distribution of species in a fragment of araucaria forest. Appl Ecol Environ Res 2015;13:361-72.
27. Golay J, Kanevski M, Orozco CD, Leuenberger M. The multipoint Morisita index for the analysis of spatial patterns. Phys A Stat Mech Appl 2014;406:191-202.
28. Taylor LR. Assessing and interpreting the spatial distributions of insect populations. Annu Rev Entomol 1984;29:321-57.
29. Wardhaugh CW. The spatial and temporal distributions of arthropods in forest canopies: Uniting disparate patterns with hypotheses for specialisation. Biol Rev Camb Philos Soc 2014;89:1021-41.
30. Ihsan IM. Effect of air temperature on preadult development of houseflies (Musca domestica). J Teknol Lingkung 2016; 17: 100-7.
31. Malik A, Singh N, Satya S. House fly *(Musca domestica*): A review of control strategies for a challenging pest. J Environ Sci Health B 2007;42:453-69.
32. Hinkle NC, Hogsette JA. A review of alternative controls for house flies. Insects 2021;12:1042.
33. Membere O, Bawo DD, Onwuteaka J, Ugbomeh AP, Nwosu OR. Abundance and diversity of insects associated with *Rhizophora mangle* and *Avicennia germinans* in Bundu-ama mangrove ecosystem of the Niger Delta, Nigeria. Sci Afr 2021;14:e01058.
34. Hamidou Leyo I, Moussa Ousmane Z, Noël G, Francis F, Caparros Megido R. Breeding enhancement of *Musca domestica* L. 1758: Egg load as a measure of optimal larval density. Insects 2021;12:956.