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Prelimary Studies of Insects Dynamics on Pig Carrion Decomposition in Abakaliki Ebonyi State

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Abstract: The preliminary studies on the insect dynamics associated with pig carrion in Abakaliki was conducted using three healthy pig (*Sus scrofa*) as a model for decomposition to determine the colonization pattern of insects at varying environmental degrees at different stages of decomposition. Adult insects on the carrion were collected using entomological techniques. The study revealed that five orders was collected at their varying degrees of attendance on the carcasses, Coleoptera 78(8.89 %), Diptera 709(80.8 %), Hymenoptera 42(4.8 %), Hemipteran 13(1.5%), Araneae 35(3.9 %) and 14 species namely: *Sacrophaga inzi* 70(8.9%), *Chrysomyia rufifacies* 189(21.6 %), *Musca domestica* 186(21.2 %), *Sarcophaga nodosa* 103(11.7 %), *Necrobia violalea* 63(7.2 %), *Achaeranea* specie 20(2.3 %), *Pheidole* specie 70(8.9 %), *Psuedolucilia* specie 36(4.1 %), *Dolichopus populanis* 18(2.1 %), *Dysdercus* specie 16(1.8 %), *Chrysomyia abiceps* 31(3.5 %), *Chrysomya regalis* 21(2.4 %), *Chrysomya chloropyga* 34(3.9 %) and *Isomyia dubiosa* 20(2.3 %). The flies were attracted to the carrions according to the decomposition stages as follows: *Chrysomyia* sp. and *Sacorphage inzi* in the family Calliphridae and Sarcophagidae were the first insect to arrive and oviposite on the carrion, followed by predators of fly maggots, including beetles and ants arrive later to feed on the maggots. The carrions in the open grassland had faster decomposition than other two sites in the forest which could be observed with limited sunlight. Insects attendance pattern in this study was observed as a measure of information to which and what ways insects could colonize death bodies and so are good indicators of forensic science in suspicious death.

Key words: Insects · Decomposition · Dynamics · Pig Carrion · Abakaliki

INTRODUCTION

Man has continued to encounter insects in his daily living. They are found in almost every habitat. One of such habitats that provide excellent food and breeding resources is a vertebrate corpse. About 400 insects species have been found on a pig cadaver during its various stages of decay [1, 2]. In addition to their ecological importance in decomposition, such insect present important tools for crime investigations allowing the time at which a dead body was colonized to be estimated [3]. In particular, flies of different species especially the flesh fly and the blow fly are among the first colonizers of corpse or carrion and may serve as a biological dock in measuring the time of death up to two or more weeks. Decomposing animal carcasses provide an emphemeral resource as a changing habitat that can support and are exploited by a large number of micro-organism and arthropod communities [4]. The arthropod composition and succession is influenced by the locally available arthropod pool to colonize the cadaver and their respective interactions within and between the necrophagous and predatory species, as well as by many biotic and abiotic factors, including the biogeographical location [5, 6], habitat [7, 8], season [9, 10], local climatic conditions [11, 12], physical state of the remains [13] and the decomposition environment [14]. Insect colonization of carrion is dependent on many

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factors, but one of the most important is the geographical region or biogeoclimatic zone in which the remains are found. The biogeoclimatic zone defines the habitat, vegetation, soil type and meteorological conditions of the area. This obviously has a major impact on the types and species of insects present. It also affects the decomposition of the remains, which in turn impacts the insects that colonize them. Many families of carrion insects are relatively ubiquitous, but the individual species involved in decomposition vary from region to region. Decomposition itself also is quite different in various bioeoclimatic zone [15].

MATERIALS AND METHODS

Study Site: The studies were conducted in the wet season (July – August, 2017) in three different places (forest fringes and grassland) in Abakaliki town. The three selected sites were situated in different types of habitat, located 100 m apart from each other.

Vegetation at the study site and the surrounding were predominantly composed of grasses at the first site (Grassland), *Mimosa pudica, Chromoleana oderata* and *Tridax procubens*, the second site (forest fringe) composed of tress and shrubs, *Cnetus ferruginea, Gmelina arborea, Olax subscorpioidea* and the 3rd site composed of *Panicum maximum, Baphia bracteolate, Sarcosephalus latifulius* and *Phyllathus reticulates*. The identification of these plants was done at the plant Herbarium of the Department of Applied Biology, Ebonyi State University, Abakaliki.

Animal Model: Three healthy pigs (*Sus scrofa*) was used as the animal model because it has been established and characterized as reasonable good surrogate model for human cardavers as described by Rosina *et al.* [16]. The pigs were purchased from a veterinarian farm at Ezamgbo, Ohaukwu L.G.A. They were killed at 12:15 pm and deposition time of the model was 12:45 pm, 12:50 pm, 12:58 pm for grassland, forest and fringes respectively. The pig carrions were guarded against vertebrate scavengers with wire gauze that permits entrance of insects and other arthropods. The wire gauze was used to form a triangular cages (height 3f.t, width 5f.t) supported with cement blocks.

RESULTS

Dynamics of Insects on Pig Carrion: This study examined the insects dynamic with respect to their succession pattern and stages of decomposition for three pig carcasses, in forest fringes and Grassland.

Table 1: Abundance of insects colonizing pig carcasses in grassland (PMGL I) in Abakaliki

Day	Stages of decomposition	Order	Genus	Abundance
	Fresh stage	Diptera	*Sarcophagi inzi*	34
			Chrysomyia rufifacies	45
			Musca domestica	52
	Bloat stage	Diptera Coleooptera	*Sarcophagi nodosa*	25
			Necrobia violacea	16
			Chrysomyia rufifacies	33
			Musca domestica	19
	Active decay	Diptera	*Sarcophaga inzi*	18
			Chrysomyia abiceps	15
			Chysomyia regalis	14
			Chrysomyia chlorophyga	13
			Isomyia dubiosa	17
			Musca domestica	21
	Advance decay	Diptera Coleopteran	*Chrysomyia rufifacies*	17
			Musca domestica	30
			Sarcophaga nodisa	28
			Necrobia violacea	36
	Dry	Diptera	*Chrysomyia rufifacies*	9
			Sarcophagi nodosa	19
			Musca domestica	10
			Sarcophaga nodosa	12
		Hymenoptera Araneae	*Pheidole specie*	15
			Achaearanea species	25
		Coleopteran	*Necrobia violacea*	7

Table 2: Abundance of insects colonizing pig carcasses in forest fringes (PMFL I and II) in Abakaliki

Day	Stages of decomposition	Order	Genus	Abundance for PMFL I and II		Total
	Fresh stage	Diptera	*Sarcophaga inzi*	1	11	12
			Isomyia dubiosa	1	2	3
			Musca domestica	17	6	24
			Chrysomyia chlorophaga	11	10	21
	Bloat stage	Diptera	*Sarcophaga inzi Chrysomyia rufifacies*	19	7	26
			Musca doemstica	22	10	32
				15	2	17
	Active decay	Diptera	*Dolichopus populans*	16	-	16
			Musca domestica	11	1	12
			Chrysomyia abiceps	9	7	16
		Hymenoptera	*Pheidole species*	21	-	21
		Coleopteran	*Necrobia violacea*	14	5	19
	Advance decay	Diptera	*Chrysomyia rufifacies*	15	4	19
			Chrysomyia chlorophaga	20	15	35
			Lucilia species	15	21	36
			Sarcophaga nodosa	17	21	38
		Hymenoptera	*Pheidole specie*	15	10	25
	Dry	Diptera	*Chrysomyia rufifacies*	5	13	18
			Musca domestica	5	17	22
		Araneae	*Achaearanea specie*	1	10	11
		Hemiptera	*Dysderaus specie*	11	2	13
		Hymenoptera	*Pheidole specie*	6	11	17

Table 3: Abundance Pattern of insects orders identified from the study sites

	Sites			
Order	PMFL I	PMFL II	PMGL I	Total number
Diptera	136	137	436	709
Coleoptera	10	9	59	78
Hemiptera	8	5	-	13
Hymenoptera	32	10	-	42
Araneae	4	6	25	35
Total	190	167	520	877

Table 4: Species diversity index of insect in PMGL I

	Stages of diversity				
Insects	F	B	A	Ad	Dd
Sarcophaga inzi	0.260	0.000	0.155	0.000	0.000
Chrysomya rutifaciaes	0.391	0.355	0.000	0.153	0.106
Musca domestica	0.396	0.204	0.181	0.270	0.118
Sarcophagi nodosa	0.000	0.269	0.000	0.252	0.224
Necrobia violacea	0.000	0.172	0.000	0.324	0.081
Chrysomya abiceps	0.000	0.000	0.129	0.000	0.000
Chrysomya regalis	0.000	0.000	0.121	0.000	0.000
Isomyia dubiosa	0.000	0.000	0.147	0.147	0.000
Chrysomya chlorophyga	0.000	0.000	0.112	0.000	0.000
Pheidole specie	0.000	0.000	0.000	0.000	0.124
Achaearanea species	0.000	0.000	0.000	0.000	0.294
Diversity Index	1.047	1.000	0.845	1.146	0.947
Species richness	3	4	4	4	6
Total number of individual	131	93	93	111	85
Shannon-weiner index	0.463	1.348	1.348	0.602	0.687
Species evenness	0.971	0.972	0.972	1.000	0.883

Key Note: F = Fresh stage, B= Bloat stage, A = Advance stage, Ad = Active stage, Dd = Dry decay stage. Species diversity index of insects in PMGL I shows that insect decomposition at the fresh and advance decay stage had the highest diversity index and abundance.

Table 5: Species diversity index of insect in PMFL I and II

Insects	Stages of diversity				
	F	B	A	Ad	Dd
Chrysomyia chlorophaga	0.350	0.000	0.000	0.229	0.000
Chrysomyia abiceps	0.000	0.000	0.191	0.000	0.000
Isomyia dubiosa	0.050	0.000	0.000	0.000	0.000
Chrysomyia rutifaciaes	0.145	0.427	0.000	0.124	0.134
Musca domestica	0.400	0.227	0.144	0.000	0.145
Sarcophaga inzi	0.200	0.347	0.000	0.000	0.000
Dolichopus popylans	0.000	0.000	0.192	0.000	0.000
Pheidole specie	0.000	0.000	0.250	0.163	0.131
Necrobia violacea	0.000	0.000	0.226	0.000	0.000
Lucilia specie	0.000	0.000	0.000	0.235	0.000
Sarcophaga nodosa	0.000	0.000	0.000	0.248	0.000
Achaearanea species	0.000	0.000	0.000	0.000	0.106
Dysderaus specie	0.000	0.000	0.000	0.000	0.115
Diversity Index	1.000	1.001	0.999	1.003	0. 631
Species richness	4	3	5	5	5
Total number of individual	60	75	84	135	81
Shannon-weiner index	0.448	0.441	0.644	0.765	0.631
Species evenness	0.744	0.925	0.921	1.094	0.903

Key Note: F = Fresh stage, B= Bloat stage, A = Advance stage, Ad = Active stage, Dd = Dry decay. Species diversity index insect in PMFL I and II shows that insect decomposition at advance decay stage had the highest diversity index and abundance

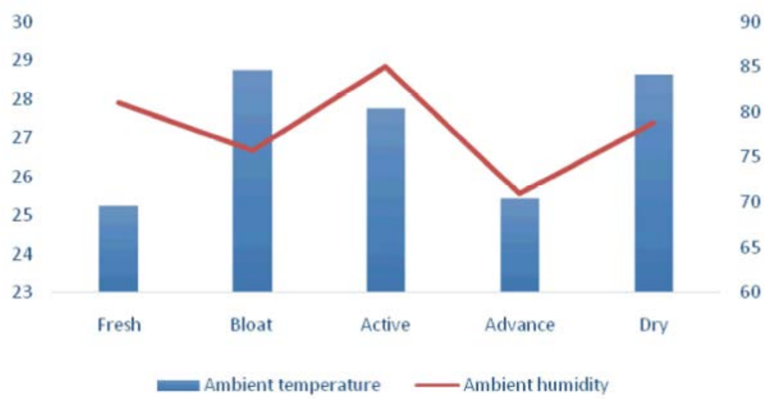

Fig. 1: The range of ambient temperature against ambient humidity for PMFL I

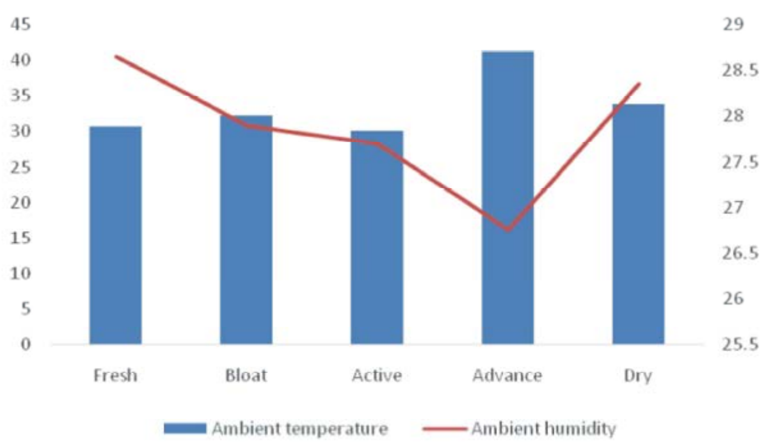

Fig. 2: The range of maximum temperature against minimum humidity for PMFL I

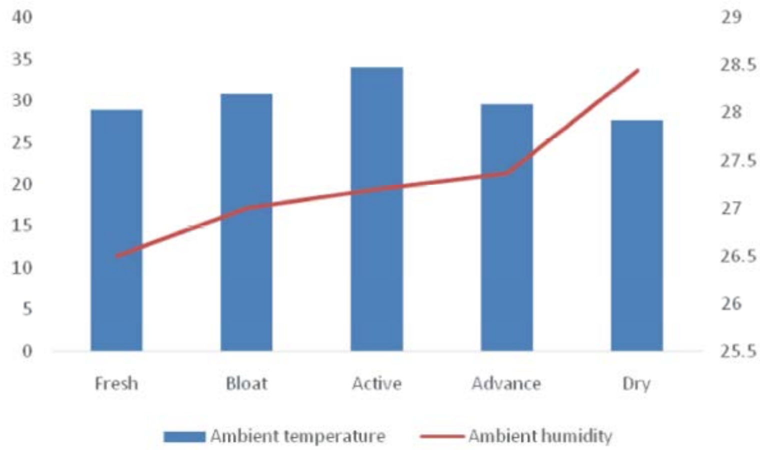

Fig. 3: The range of ambient temperature against ambient humidity for PMFL II

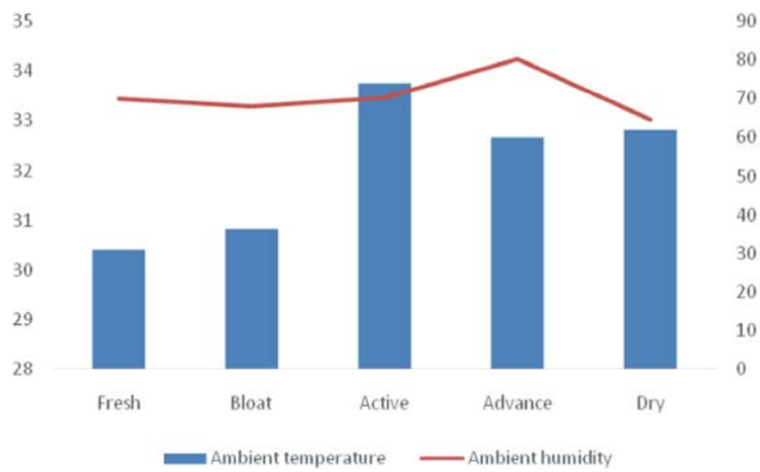

Fig. 4: The range of maximum temperature against minimum humidity for PMFL II

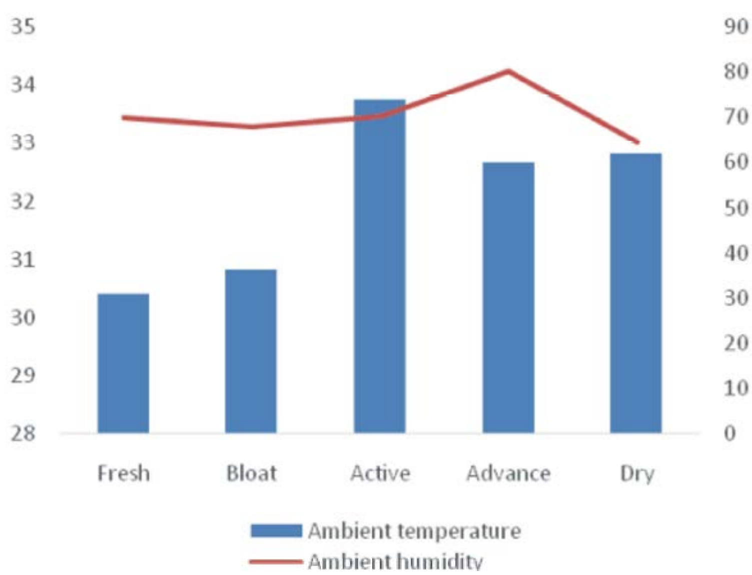

Fig. 5: The range of ambient temperature against ambient humidity for PMGL I

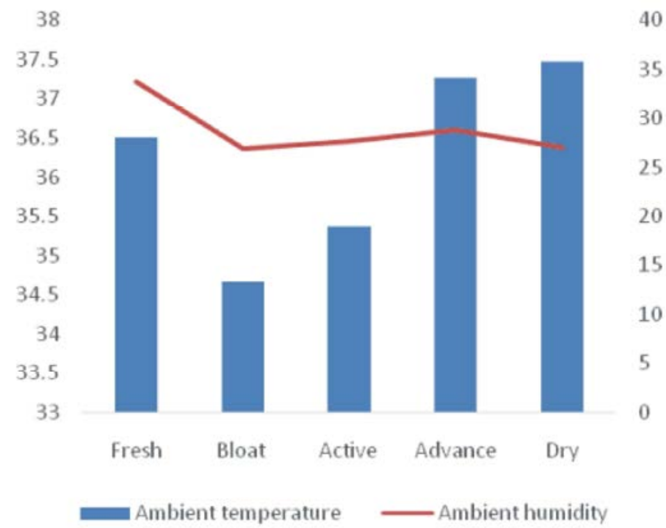

Fig. 6: The range of maximum temperature against minimum humidity for FMGL I

During the study, flies collected from the decomposing pig carrions were categorized into five families (Callipohoridae, Sarcophagidae, Silphidae, formicidae, Muscidae and ten species; namely *Sarcophaga inzi, Chrysomyia rufifacies, Musca domestica, Sarcophaga nodosa, Necrobia violalea, Achaearanea specie, Pheidole specie, Lucilia* species, *Dolichopus populanis, Dysdercus* species as seen in Table 1 and 2 respectively.

The flies were attracted to the carrions, according to the decomposition stages of the pig carrions as follows: *Sarcophaga inzi* was the first fly attracted to the carrions, followed by clusters of *Chrysomya* and *Musca species*, during the fresh stage. They were also observed during the bloating, active, advance and dry decay stages. *Musca domestica*, *Sarcophaga inzi* and *Chrysomyia rufifacia* were observed during the fresh stage were repeatedly collected as seen in Table 2. During the active, advance and dry decay, *Sarcophaga inzi, Chrysomyia abiceps, Chrysomyia regalis, Chrysomyia chlorophaga*, *Isomyia dubiosa, Chrysomyia rufifacies, Necrobia violacea, Achaearanea* species and *Sarcophaga nodosa* while *Musca domestica* and *Chrysomyia rufifacies,* were repeatedly collected in all the stages as seen in Table 1. At the dry decay stage *Dysdercus* specie, *Musca domestica* and *Achaearanea* species were also collected with *Pheidole* specie inclusion.

DISCUSSION

This study examined the insect dynamics associated with pig carrions with respect to their dynamics pattern of insects colonization and environmental impact on carrion. The carrion completely decomposed in 17 and 28 days for the grassland, forest and forest fringes respectively. The number of days recorded for both sites were fewer relative to reported cases elsewhere; Australia, 40 days [17] and Columbia 83 days. However, Tabor, Fell and Brewster [18] reported relatively fewer days to complete decomposition in Malaysia where it took only 14 days for the complete decomposition of pig carrion. In this study, the fly families Calliphoridae, Sarcophagidae and Muscidae are the first forensic insects to arrive and oviposite on the carrion, followed by the predators of fly maggot, including beetles and ants. This is in line with the work of Villet , Richards and Midgley [19] who stated that Calliphridae and Sarcophagidae are the first forensic insects to arrive and oviposite on the corpe. This study has the abundance of Diptera to be 709 (80.84%), coleopteran 78(8.89%), Hemiptera 13(1.48%), Hymenoptera 42(4.78%) and Araneae 35(3.99%) as seen in Table 3.

The study on the abundance of invertebrates colonizing pig carcasses show that the time and stage of attendance of insects determines their pattern of abundance and also the volume of larval emergence and colonization when hatched will bring about the population attendance of the adult insects. The abundance pattern showed that not all the insects that attended at the various stages were capture if so, decomposition would be delayed and PMI will be longer. The collection technique used were pitfall traps and aerial sweep net employed at interval in every visits were used to note the abundance of the insect species in this study.

The study revealed that there were more number of insect species assemblages at the active decay and dry decay stages as shown in table 1 but higher abundance in attendance pattern in fresh stage. This could be ascribe to the fact that carcasses were apparently odourful with high discharge of gases thereby attracting different insects for different purposes most especially the sarcophaga species. There were changes observed with low population attendance among insects colonization in the forest fringe. The study shows that there was decreased species number in assemblage and population abundance in these sites. They were more of five orders with 14 species recorded in this model as seen Table 1 and 2. The population abundance shows that more number of insects were captured in grassland than in two respectively and the highest abundance rate were observed during the active decay stage of decomposition than in other stages of decomposition. The decreased population abundance observed here as against the grassland could be because of reduced environmental impact during the decomposition periods which was greatly reduced as observed than in the forest fringes. It was also observed that the forest fringes had the presence of low land swamp and chains of surface flow of water which may not encourage high abundance of invertebrates and may disfavor insect breeding in the area.

In the geographical impacts however, the carrion in the open grassland heat up more rapidly and decomposing faster than noticed in other two sites. This could be as a result of direct sunlight reaching the carrion. This is in unity with the work of [4, 5] who stated that bodies found in direct sunlight will be warmer, heating up more rapidly and decomposing faster. Higher increase in the Ambient humidity and maximum temperature observed in the grassland than the forest fringes might have helped to keep the carrion in a favourable state for optimum microbe and diptera development and therefore, contributing to the faster rate of degradation observed in the grassland. According to Payn and Rosina *et al.* [15, 16] humid atmosphere promotes decay while a dry one delays it.

Apparently, this season based work was in main period of the wet season and considering that some of the model were set at the forest fringes with surface flow running waters. It was observed that insect development and assemblage at the grassland which was at the open were greatly influenced by the physical variables the rain which dries up shortly after raining and direct sun set at the model. It was also observed that oviposition and insects stage development were rapid in the open grassland than in forest fringes which suffered some cover from tree plants and high retention of moisture and poor temperature storage. This agrees with the report of Davis and Goff [8] which states that rain and humidity in the environment of the carcasses can affect insects development. In most species, large amount of rainfall will indirectly slower he environmental impact and acts as an insulator in the maggot mass and shower decomposition. Eberhardt and Elliot [9] also reported that bodies found exposed to direct sunlight will be warmer, heating more rapidly and decomposing faster. They will loss biomass more rapidly and progress through the decomposition stages faster.

Shannon Weinna index was also used to calculate the diversity of these insects in their different stages of decomposition and observed that advance decay and fresh stage has the highest abundance in grassland and advance decay for forest fringes.

CONCLUSION

A total of 877 species were collected, which include 709 diptera, 78 coleoptera, 13 hemiptera, 42 hymenoptera and 35 araneae as seen in table 3. The dominant species in both sites are the diptera which is also the primary necrophagous colonizers. Most of the species found in the grassland are not found in the forest fringes. It was also observed that different insects colonize the carcass at different stages except for *Chrysomyia rufifacies* and *Musca domestica* which are consistent in all the stages. The pattern of insect succession includes the presence of the necrophagous species which are the first forensic insects to visit the carrion followed by the predators and parasitic insects. Omnivorous and the adventives species e.g spider are the last group of insect to visit the carrion. In the geographical impacts however, the carrion in the open grassland heat up more rapidly and decomposing faster than noticed in other two sites. This could be as a result of direct sunlight reaching the carrion. The difference in these three sites is attributed to the rate of insects attendance and environmental variation.

Recommendation: It is implicit from this study, that flies are important group of insects in the decomposition of carrions. It is however recommended that those insects collected are the best forensic insects in determining the stage of decomposition and PMI of a dead body. Insect management program should be introduced to protect the insects from its natural environment.

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