ESTMATION OF TIME INTERVAL OF THE PIG CARRION BY BEETLE FAUNA SUCCESSION IN SOUTHEAST, NIGERIA

ESTIMAÇÃO DO INTERVALO DE TEMPO DA CARNIÇA DE PORCO PELA SUCESSÃO DA FAUNA DO BESOURO NO SUDESTE, NIGÉRIA

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Artigo recebido em: 03/11/2023 e aceito para publicação em: 10/10/2024.
DOI: https://doi.org/10.14295/holos.v24i1.12500

Abstract: Background: Beetles (Coleoptera) have been recognized as providing significant entomological evidence in the medico-legal field, particularly with reference to dry human remains. The information collected from carrion beetles in Abakaliki will add to the global data base to assist coronary investigators unravel mysteries surrounding suspicious death in Nigeria. A study was carried out to investigate the succession of beetle fauna in a decomposing pig carrion in Abakaliki Ebonyi State. The study was conducted on poisoned pigs using sniper at the pericardium region and beetles were collected using standard entomological methods. Results: The study lasted twenty-two days with notable characteristic changes observed at the five decomposition waves. A total of five families, and twelve species were collected at various succession pattern of decomposition. The results showed that Buphonella species and Necrubia species were recorded at high interval among the decomposition stages, While Dermestidea recorded the highest family observed. The result also revealed that most beetles collected arrived at the dry decay stage with few attendant patterns at earlier stages. Conclusion: However, this study confers the species of Coleopteran insects of forensic importance and gives a background information about their succession in relation to decomposition stages. This could be used to determine the post mortem interval of human corpse based upon knowledge of the fauna.

Keywords: PMI. Succession. Beetle. Pig carrion. Nigeria.

Resumo: Antecedentes: Besouros (Coleoptera) foram reconhecidos como fornecendo evidências entomológicas significativas no campo médico-legal, particularmente no que diz respeito a restos humanos secos. As informações coletadas dos besouros carniceiros em Abakaliki serão adicionadas ao banco de dados global para ajudar os investigadores coronários a desvendar os mistérios que cercam as mortes suspeitas na Nigéria. Um estudo foi realizado para investigar a sucessão da fauna de besouros em uma carniça de porco em decomposição no estado de Abakaliki Ebonyi. O estudo foi realizado em porcos

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envenenados com uso de atirador na região do pericárdio e os besouros foram coletados utilizando métodos entomológicos padrão. Resultados: O estudo durou vinte e dois dias com notáveis mudanças características observadas nas cinco ondas de decomposição. Um total de cinco famílias e doze espécies foram coletadas em vários padrões de sucessão de decomposição. Os resultados mostraram que espécies de Buphonella e espécies de Necrubia foram registradas em intervalos elevados entre os estágios de decomposição, enquanto Dermestidea registrou a maior família observada. O resultado também revelou que a maioria dos besouros coletados chegou ao estágio de decomposição seca, com poucos padrões acompanhantes nos estágios iniciais. Conclusão: No entanto, este estudo confere às espécies de insetos Coleópteros importância forense e fornece informações básicas sobre sua sucessão em relação aos estágios de decomposição. Isto poderia ser usado para determinar o intervalo post mortem de cadáveres humanos com base no conhecimento da fauna.

Palavras-chave: PMI. Sucessão. Besouro. Carniça de porco. Nigéria

1 INTRODUTION

Successional changes in insect fauna on the corpse have been noted and related to the stages of decomposition through which the body passes. Coleopterans are mainly the group of insects that succeed the flies either during the bloating or during the wet and dry decay stages. They usually arrive on the carrions few days after death to feed on the soft and dried tissues of the carrions (Abajue *et al*., 2013) and as well feed on the fly larvae (Grassberger and Frank, 2004). In a predictable, sequential manner, beetles are generally the second group of invertebrates to arrive at a carcass. Carrion beetles (Coleoptera: Silphidae), rove beetles (Coleoptera: Staphylinidae), hister beetles (Coleoptera: Histeridae), and dermestid beetles (Coleoptera: Dermestidae) are the key families colonizing carcasses. Beetles, like flies, are also holometabolous insects. Unlike flies, however, beetle larvae are called grubs.

Depending on the species, beetles have different roles in the carrion food web. Many beetles feed on the remains, some are predators that feed on fly eggs and larvae that have colonized the carcass, and others feed on both. Beetles that feed on the remains are referred to as decomposers, while species that feed across multiple trophic levels (i.e., on the remains and on the other invertebrates) are called omnivores.

According to them Dermestidae (skin beetles) and Cleridae (bone beetles) have been found as the most common types infesting exposed human remains and providing evidence in estimating the minimum post mortem interval (PMI). Major families of beetles which are forensically important are Silphidae, Staphylinidae, Histeridae, Trogidae, Dermestidae, Cleridae, Nitidulidae, Carabidae (Gennard, 2012).

Payne (1965) was amongst the first scientists to design an experiment to relate the stages of body decomposition to insect succession. He also characterized the feeding style

of the species and separated those which actively fed on the corpse from those who were ‘just passing’ and those who were predators on the original specimens. Environmental factors that affect succession include: season (daily temperatures), sun exposure, whether the body was found inside a building, immersed in water or in urban vs. rural area. Bodies that are buried, left in vehicles, found in enclosed spaces, hanged or burnt are also subject to varying insect succession patterns.

The Dermestidae (skin beetles) and Cleridae (bone beetles) have been found as the most common types infesting exposed human remains and providing evidence in estimating the minimum postmortem interval (PMI). This study will enable us know the species of Coleopteran insects of forensic importance.

Bass (1983) showed that information about succession in relation to decomposition could be used to determine the post mortem interval of human corpse. This method of applying succession to determining the post mortem interval is based upon knowledge of the local fauna. The diversity of beetles found on a bodychanges over time and can therefore provide evidence of ecological succession, which provides a second clock. These sources of evidence all require the beetles to be identified, because the growth rates and ecological requirements of each species are different. This is a difficult challenge if they are still eggs, pupae or larvae.

The presence of coleopterans as well as their larvae and their molted skins found on a corpse or exposed animal carcass can offer forensic entomologist the possible estimation time of death or the post mortem interval (PMI) of the carrion. Hence, the need to identify the coleopterans of forensic importance has become inevitable as an entomological tool in estimating PMI in homicide investigations in Nigeria. This will assist law enforcement agencies and medical coroners in consolidating their findings especially when the corpse has taken some days and decomposition stages had advanced beyond the validation of medical pathologists. This study was aimed to determine the coleopteran insects’ succession in Abakaliki, Ebonyi State.

2 METHODS

This project work was carried out at Presco Campus, Ebonyi State University, Abakaliki. Abakaliki is the capital city of the present–day Ebonyi State in Southeastern Nigeria, located 64 kilometres southeast of Enugu. The inhabitants are primarily members

of the Igbo nation. Abakaliki metropolis is located at the latitude of 6.3^{O} E and longitude of 1.8N in the eastern part of the country. Climate is sub-humid tropical and bounded with the raining season between early April and late October. Rainfall patterns is bimodal with two peaks in June and September. Maximum temperature is about 26 ^{O}C, wind Southwest at 6 km/h, 82% humidity with population of 79.28m.

The soil type in the study area is loamy clay with small stones and the floristic composition of the area include two major trees, *Cajanus cajan* and *Ficus carpensis* and grasses found are; *Chromolaena odorata*, *Axonopus compressus*, *Mimosa pudica*, *Miscanthus giganteus* and *Brachiaris mutica*. The surrounding is covered with water, due to the season of the year, with high rainfall pattern but not up to where the carrion was placed.

2.1 The killing method

The killing method started on the 5th of September, 2019 at about 8 O'clock in the morning. 2ml sniper powder (2,3 chlorovinyl dimethyl phosphate DDVP), was injected intramuscularly at the epigastric region and then allowed to lay in a gauzed cage. After 5 minutes, the pig started producing foam from the mouth, struggling, summersaulted, sluggishly and dozed off at about 8:20am, after a while, the legs were stretched, showing that the pig is dead, with the eyes open. This is an exact process to mimic chemical poisoning as it may apply to humans. Complete death was recorded after 37mins of poison administration (8:37 am).

2.2 Measurement of physical variables

- LMT (Larva Mass Temperature); the temperature of the larva cluster as it relates to decay hour or decay time/period was measured and recorded with thermometer reader.
- Soil pig interface temperature; the temperature between the soil and the pig
- Ground temperature; thermometer logger was plugged 3 inches into the ground, to determine the pupation temperature of the insect and the ground influence to the pupation rythme.

2.3 Data analysis

Data was generated from the insect fauna observed from various decomposition stages. Data generated was subjected into ANOVA to test the difference between insect attendance and stages of decomposition.

3 RESULTS

Table 1 - Physical characteristics and time interval of the pig carrion decomposition

S/N	Decomposition stage	Characteristics	Days
1	Fresh stage	• No odour yet but the carrion produced foam from the mouth cavity and orifice protruded due to the administration of the concoction. • Oviposition, temperature falls	0 – 2 days
2	Bloat stage	• Pig carcass swells due to gases produced by bacteria • Temperature rise • Development of eggs to larva • Flies still present (more) • A distinct odour of deposition is present • Veins becomes visible and colour changes • Presence of microorganisms	3 – 5 days
3	Active decay stage	• Decomposition fluid seeps from the body • Flesh becomes creamy in consistency and exposed parts turn black • Body bursts open • Bacteria and maggots break through the skin • Large maggot masses and extreme amounts of fluid • Very strong odour of ammonia is present • Larva begin to pupate • Corpse size reduced a little • Mortality of maggot and flies, due to poison and rainfall • Hair removal.6 – 10 days	6 – 10 days
4	Advanced decay stage	• Pig carcass reduced to hairs • Majority of blow fly larvae have migrated away • Fly population reduced and replaced by some coleopterans and other arthropods • Hide beetles were dominant in dry environments • Mites population equally increased • Increase in odour of strong ammonia • Formation of the skull only	11 – 16 days
5	Dry decay stage	• Hairs are completely out • Less or no colour • Total appearance of skeleton	17 – 22 days

	• Little or no fly • Beetles still present • Skin remains are dried

Table 2 - Checklist of Coleopteran insects associated with pig carrion decomposition in 5 different decomposition stages

Order	Family	Genus/Species	Authority	Year	Percentage insect species
Coleoptera	Chrysomelidae	*Buphonella* sp.	Latreille	1802	36
		Lema affinis	Cik	1798	4
		Buphonella nigraviolacea	All		4
	Staphylinidae	*Philonthus* sp.	Stephens	1832	24
	Dermestidae	*Dermestes maculatus*	De Geer	1774	16
		Dermestes ater	De Geer	1774	4
		Dermestes frischii	Kugelan	1792	12
	Carabidae	*Dichaetochilus politus*	Vagan		18
	Histeridae	*Anlacorycus acciculatus*	Dej		09
		Hister sp.			18
		Necribia sp.			31
		Hypocacculus burqueti	Mars		5

Table 3 - Succession pattern of Coleopteran insects associated with pig carrion decomposition

Family	Species identified	Fresh	Bloat	Active decay	Advance decay	Dry decay
Chrysomelidae	*Buphonella* sp.	-	-	-	-	22
	Lema affinis	-	5	-	-	-
	Buphonella nigraviolacea	-	-	9	-	20
Staphylinidae	*Philonthus* sp.	-	-	10	15	21
Dermestidae	*Dermestes maculatus*	-	-	-	15	19

	Dermestes ater	-	5	-	-	-
	Dermestes frischii	-	-	-	14	20
Carabidae	*Dichaetochilus politus*	-	-	2	6	12
	Anlacorycus acciculatus	-	-1	0	3	5
Histeridae	*Hister* sp.	-	-	-	-	18
	Necribia sp.	-	-	-	-	31
	Hypocacculus burqueti	-	-	-	-	5

Figure 1- The frequency figure of the identified beetle species

4 DISCUSSION

Insects are very important arthropods playing a number of roles, and are almost indispensable to the ecosystem. One of the many roles of insects is their involvement in decay and decomposition of carcasses. Understanding why and how is an area of applied entomology referred to as forensic entomology.

The present study determined the coleopteran insects associated with poisoned pig carrion in Abakaliki. Table 1 showed insects of the coleopteran order that appeared during the pig carrion decomposition. This includes; *Buphonella* sp. (18.62 %), *Philonthus* sp. (24.47 %), *Dermestes maculatus* (18.09 %)*, Dermestes ater* (2.66 %)*, Lema affinis* (2.66 %)*, Buphonella nigraviolacea* (4 %), *Buphonella nigraviola* (15.43 %) and *Dermestes frischii* (18.09 %).

Succession pattern of Coleopteran insects associated with pig carrion decomposition (Table 2) showed a high number of beetles in the dry stage which is the last stage of decomposition, and least in the bloat stage. Some of the beetle families found during the decomposition of the carrion appeared only once, disappeared and come back during another stage of decomposition. *Philonthus* sp. belonging to Calliphoridae family occurred in the highest number.

In this study, decomposition of Pig carrion occurred in five stages (Table 1); fresh, bloated, active, advanced and dry stages. Fresh stage was the first day continued for 0-12 hours after death. In this stage body structure was in original form except of dead and no smell was observed. Temperature falls to that of the ambient temperature. Autolysis, the degradation of complex protein and carbohydrate molecules occur, oviposition started majorly at the mouth, nose, and anus, larviposition and oviposition were recorded at the major orifice. No coleopteran species were observed in this stage.

Bloated stage was second stage recognized that the body of the carrion emitted very distinct smell that was highest than the first day and is the characteristic putrificaction on the lower abdomen with patches of first instar larvae on the lower part. Carcass swells due to gases produced by bacterial, temperature rise of the corpse, more larva deposition recorded on the body of the carcass, insect fauna *Dermestes ater, Lerna affinis* and *Buphonella* sp. were present.

During the active decay (4-8 days), gases subside, decomposition fluids seeps from body, flesh becomes creamy in consistency and exposed parts turn black from aerobic protein degradation (hence, black putrefaction). Bacteria and maggots break through the skin, large maggot masses and extreme amounts of fluid, very strong amount of ammonia is present, larvae beginning to pupate corpse-related to about 20% of its original mass. There was maximum death of insects and maggots probably due to rain and poison. The coleopteran insects found in this stage includes; *Philonthus* sp., *Buphonella nigraviola* and *Buphonella* sp.

In advanced decay or butyric fermentation stage (9-12 days), carcass reduced to hair, skin and bone the majority of blow fly larvae have migrated away to undergo pupation and thus, have left behind a leveled outline of a corpse, fly population reduced and replaced by other arthropod, hide beetles are dominant in dry environment. Mite are predatory beetle population increase odor is of strong ammonia and butyric acid. *Philonthus* sp., *Dermestes maculatus* and *Dermestes frischii* were present during this stage.

Dry (skeletonization) stage is the last stage of carrion decomposition. It is a stage when the whole cycle of insect is expected to be completed and there is decomposition of certain features of animal skeleton.

This is in line with the work of Abajue *et al*. (2015) who reported that the coleopteran insects associated with carrion decomposition include *Dermestes frischii* belonging to the family Dermestidae. The beetles in this family are well known to feed on the dry skin and bones. They are referred to as true carrion feeders, because of the important role they play in carrion degradation. Beetles, are forensically important insects and mostly appear during the late stages of decay. According to Gill (2005), beetles' activity was in actual fact associated with the advanced stages of degradation process causing the drying out of semi liquid soft tissues.

The arrival of beetles to carcasses occurred in a predictable sequence between 3 to 5 days after deposition and this contributed to the high degradation of the carrion bone. Goff (1992) similarly reported that investigations on forensic entomology in criminal cases and estimation of post mortem interval using arthropods development and succession indicates that dermestids have the potential to offer investigators an estimation of the time since death in homicide or questionable cases. Richards and Goff (1997) reported that adult of dermestid beetles generally arrive 5 to 11 days after death. This assertion was in accordance with the report of Ekrakene and Iloba (2011) as they observed arrival time of 5 to 10 days after death in Nigeria.

5 CONCLUSIONS

The findings of the study have led to the conclusion that beetles are important group of insects in the decomposition of carrions. The *Philonthus* sp., *Dermestes maculatus, Dermestes frischii, Buphonella nigraviola* and *Buphonella* sp. collected in this study can

offer forensic investigators on homicides in this region, the estimated time that has elapsed prior to the discovery of a corpse, if the natural decomposition process was not altered as well as offer clue as where the corpse was found or deposited can be used to estimate the post mortem interval of dead cases in this region.

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The five waves of different decomposition stages in carrion observed in pig

Plate 1 - Fresh stage

Plate 2 - Bloat stage

Plate 3 - Active decay state

Plate 4 - Advance decay stage

Plate 5 - Dry decay stage/skeletonisation