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An initial study of insect succession on decomposing rabbit carrions in Harare, Zimbabwe

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PEER REVIEW

Peer reviewer

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Comments

In this research work, authors have demonstrated the importance of establishing the relationship between insects associated with a decomposing dead body.
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ABSTRACT

Objective: To investigate insects visiting sun exposed and shaded decomposing rabbit carcasses and to establish the relationship between insects and carcasses which may be of forensic importance in Harare.

Methods: Two rabbits weighing 2.3 kg and 2.5 kg were killed by sharp blows on the head. One was exposed to the sun while the other was placed under shade. The carcasses were allowed to decompose and insects were collected twice a day for the first week and thereafter once a day up to the end of the 7 weeks. Maggots were also collected from the decomposing carcasses and reared.

Results: Five dipteran families (Calliphoridae, Muscidae, Sarcophagidae, Phoridae and Drosophilidae) were identified from the sun-exposed carcass. Species collected included *Lucilia cuprina* (*L. cuprina*), *Chrysomya albiceps* (*C. albiceps*), *Musca domestica*, *Sarcophaga* sp. and *Drosophila* sp. Four families (Calliphoridae, Muscidae, Phoridae, Anthomyiidae) were identified from the shaded carcass. Representatives of these families included *L. cuprina*, *C. albiceps*, *Musca domestica*, and *Hydrotaea* sp. Three Coleopteran families (Histeridae, Cleridae and Dermestidae) were identified from both carcasses. The observed species were *Saprinus* sp., *Necrobia rufipes* and *Dermestes* sp. Formicidae (Hymenoptera) was represented by only one species (*Pheidole* sp.). Flies which emerged from the rearing units were *L. cuprina*, *Lucilia* sp., *C. albiceps*, *Sarcophaga* sp. and *Sepsis* sp.).

Conclusions: Of the dipteran species collected during the study, *L. cuprina* and *C. albiceps* could be important for further forensic studies since they were collected from the carcasses and also observed from the rearing units.

KEYWORDS

Insect succession, Forensic entomology, Decomposing rabbit carrion

1. Introduction

Forensic entomology is the study of the insects associated with a dead body in an effort to determine elapsed time since death[1]. As the dead body decomposes, it attracts a different group of sarcosaprophagous arthropods, especially insects. Some are attracted to the remains which are used as a medium for oviposition or feeding, while others are attracted by the aggregation of other arthropods that are used as a food source[2]. Insect species associated with carrion and their times of colonization vary according to many factors, one of the most important being the geographic region or biogeoclimatic zone. The biogeoclimatic zone defines the habitat, vegetation, soil type and meteorological conditions of the area that obviously have a major impact on the types and species of insects present, as well as their seasonal availability[3].

The majority of literature in the field of forensic entomology has addressed the corpse fauna of the

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United States, Europe, Britain and Australia, but Africa has generally been neglected[4]. There is relatively little information available regarding insects associated with animal carrion and human corpses in Africa. Few African countries such as Cameroon[5,6], South Africa[7-10], Egypt[11], Ghana[12] and Nigeria[13-15] have studied insects associated with decomposing dead bodies. In Zimbabwe, there are no published records of insects associated with a decomposing dead body. Consequently, forensic entomology has not been incorporated into death investigations, despite numerous homicide and poaching cases being reported almost every week. Therefore, the major objectives of the study were to identify insects visiting decomposing rabbit carcasses and to establish the relationship between insects and carcasses which may be of forensic importance in Harare. The preliminary results of this study could be very useful for further forensic work in Harare.

2. Materials and methods

2.1. Site description

The study was conducted at two sites, 30 m apart from the University of Zimbabwe. The surrounding area was generally bare with short grass.

2.2. Carcasses

Two rabbits from the Animal House, University of Zimbabwe, weighing 2.3 kg and 2.5 kg were killed by sharp blows with a blunt metal object on the head. They were put in separate plastic bags and transported to two separate sites about 30 m walking distance from the Animal House. At site 1, the carcass was exposed to the sun while at site 2, the carcass was placed under shade. Wire cages measuring 160 mm×100 mm×30 mm were placed over the carcasses to protect them from birds and scavengers. The mesh size of the cage, measuring 60 mm×10 mm did not add much to the shading.

2.3. Sampling procedure

Samples were collected twice a day (9:00 and 13:00) for the first week and thereafter once a day for up to the end of the 7 weeks. Sampling started on 1 November 2012 and ended on 19 December 2012. Hand netting (net diameter 330 mm, depth 750 mm, mesh size 5 mm×5 mm) and manual sampling were used to collect flying and crawling insects on the carcasses and the surrounding soil. Operation time at each carcass did not exceed 18 min to ensure uniform and limited disturbance at each site[13]. The collected insects were anesthetized with diethyl ether and preserved in 70% ethanol. However, immature fly samples were kept alive for rearing. A thermometer was held in the cage of each carcass 5 cm above the ground to record the daily ambient temperature.

2.4. Maggot rearing

Two rearing containers, one for each carcass, measuring 205 mm long×195 mm high×160 mm wide were prepared. A layer of sandy soil was placed at the base to provide the maggots with a substrate to burrow into during the pre-pupal stage. A piece of tissue measuring 60 mm×60 mm was dissected from the lateral side of the carcass and placed in the rearing container to feed the maggots. A wire screen with mesh size measuring 2 mm×2 mm for air circulation was put over the rearing container. At Day 8, maggots were collected from each carcass and reared in the separate rearing units. The rearing units were placed under room temperature (27-28 °C) and were checked daily. When the flies emerged, they were killed by placing the rearing containers into a freezer for 15 min. The dead flies were put in labeled vials containing 70% ethanol.

2.5. Sample identification

Adult flies were observed under a dissecting microscope and identified using dichotomous keys[16,17].

3. Results

3.1. Ambient temperature

The minimum recorded temperature on the sun exposed carcass was 27 °C while the maximum recorded was 36 °C. Minimum temperature recorded on the shaded carcass was 26 °C and the maximum was 30 °C.

3.2. Decomposition stages

Three insect orders-Diptera, Coleoptera and Hymenoptera were identified in association with both carcasses during decomposition throughout the study. Four decomposition stages were identified. These were fresh, bloated, decay and post decay stages (Tables 1 and 2). The fresh stage began as soon as the carcasses died up to Day 2. Bloating was observed on Day 3 and both carcasses began to smell and the odour was much more pronounced on the sun exposed carcass. The fifth day marked the decay stage. During this stage, the sun

exposed carcass ruptured whilst the shaded carcass was partially ruptured. By Day 9, both carcasses were showing signs of dryness and this marked the post decay stage.

Table 1

Insect succession and abundance from a sun-exposed rabbit carcass during decomposition stage.

Order	Family	Genus/species	Fresh 0-2 d	Bloat 3-4 d	Decay 5-8 d	Post decay 9-49 d	Total
		L. cuprina (A)	4	2	6	_	12
	Calliphoridae	*C. albiceps* (A)	1	4	8	_	13
		Unidentified (A)	1	1	5	_	7
		Unidentified (I)	_	_	_	37	37
Diptera	Muscidae	*M. domestica* (A)	4	55	47	_	106
		Hydrotaea sp. (A)	_	_	_	8	8
	Phoridae	Unidentified (A)	_	_	1	_	1
	Sarcophagidae	*Sarcophaga* sp. (A)	_	_	1	_	1
	Drosophilidae	*Drosophilia* sp. (A)	_	_	1	_	1
	Histeridae	*Saprinus* sp. (A)	_	_	9	8	17
Coleoptera	Cleridae	*N. rufipes* (A)	_	_	_	9	9
	Dermestidae	*Dermestes* sp. (A)	_	_	18	65	83
Hymenoptera	Formicidae	*Pheidole* sp. (A)	22	29	19	34	104

A-Adult; I-Immature.

Table 2

Insect succession and abundance from a rabbit carrion placed under a shade during decomposition stage.

Order	Family	Genus/Species	Fresh 0-2 d	Bloat 3-4 d	Decay 5-8 d	Post decay 9-49 d	Total
Diptera	Calliphoridae	*L. cuprina* (A)	1	11	1	–	13
		C. albiceps (A)	2	12	1	–	15
		Unidentified (A)	1	27	–	–	28
		Unidentified (I)	–	–	–	17	17
	Muscidae	*M. domestica* (A)	2	276	40	0	318
		Hydrotaea sp. (A)	–	1	1	–	2
	Phoridae	Unidentified (A)	–	–	1	–	1
	Anthomyiidae	Unidentified (A)	–	–	1	–	1
Coleoptera	Histeridae	*Saprinus* sp. (A)	–	–	2	4	6
	Cleridae	*N. rufipes* (A)	–	–	3	8	11
	Dermestidae	*Dermestes* sp. (A)	–	–	31	141	172
Hymenoptera	Formicidae	*Pheidole* sp. (A)	30	14	18	30	92

A-Adult; I-Immature.

3.3. Insect succession

Five dipteran families (Calliphoridae, Muscidae, Sarcophagidae, Phoridae and Drosophilidae) were observed from the sun-exposed carcass (Table 1), whilst four dipetran families (Calliphoridae, Muscidae, Phoridae and Anthomyiidae) were observed from the shaded carcass (Table 2). Early colonizers arriving at both carcasses during the fresh stage were the calliphorids and muscids. The adult calliphorids were observed from the fresh stage up to the decay stage. The species observed were *Lucilia cuprina* (*L. cuprina*) and *Chrysomya albiceps* (*C. albiceps*). Adult *Musca domestica* (*M. domestica*) was also observed from the fresh stage up to the decay stage from the sun exposed carcass, whilst from the shaded carcass, it was observed in all the decomposition stages. Maggots were observed on the fourth day from both carcasses.

The *Hydrotaea* sp. (Muscidae) was observed during the decay stage from the sun exposed carcass, whilst from the shaded carcass it was observed during the bloated and decay stages. Phoridae (unidentified) was observed from both carcasses during the decay stage. Adult *Sarcophaga* sp. and *Drosophilia* sp. were collected from the sun-exposed carcass during the decay stage, whilst adult Anthomyiidae (unidentified) was collected from the shaded carcass during the decay stage. *M. domestica* provided the highest number of flies from both the sun-exposed and the shaded carcasses, followed by the calliphorids. On Day 8, maggots were observed moving away from the carcasses. Between Day 12 and Day 15, immature calliphorids were observed on both carcasses.

Three families of beetles (Coleoptera) were observed during the study. These were the Histeridae, Dermestidae and Cleridae. The *Saprinus* sp. (Histeridae) was the first to arrive at the sun-exposed carcass on Day 6, whilst families Histeridae and Dermestidae were observed from both carcasses during the decay and post decay stages of decomposition. Family Cleridae was collected from the shaded carcass during the decay stage but was not observed during the decay stage from the sun-exposed carcass. The *Dermestes* sp. was the most dominant species from both carcasses.

Ants (Hymenoptera) were observed throughout the decomposition process and only one family, Formicidae (*Pheidole* sp.) was observed. By Day 21, no new insects were observed and from Day 36 up to Day 49 insects were no longer visiting the carcasses except for the ants.

3.4. Flies emerging from the rearing units

The families Calliphoridae (*L. cuprina, Lucilia* sp. and *C. albiceps*), Sarcophagidae (*Sarcophaga* sp.) and Sepsidae (*Sepsis* sp.) emerged from the sun-exposed reared carcass whilst families Calliphoridae (*L. cuprina, Lucilia* sp. and *C. albiceps*) and Sepsidae (*Sepsis* sp.) emerged from the shaded reared carcass. The Calliphorids emerged after 11 d, whilst the Sarcophagid and Sepsids emerged after 15 d.

4. Discussion

Colonization species of greatest importance in the early stages of decomposition usually are those from the three dipteran families: Calliphoridae, Sarcophagidae and Muscidae[18,19]. This was confirmed in the study as the Calliphorids and Muscids were the first to arrive at both carcasses when the carcasses were soft and producing exudes for the flies to feed on. According to a study by Shi *et al.*[20], sarcophgids are the primary colonizers in warmer temperatures and tropical areas. However, in this study, a representative of the Sarcophagidae (*Sarcophaga* sp.)

was observed as a secondary colonizer arriving during the decay stage. However, it was a bit unusual in this study to collect one sample throughout the study compared to studies elsewhere.

Generally, the sequence and duration of insect succession in the sun and shaded sites followed the same general pattern. However, the same study by Okiwelu *et al*. confirmed that the sun exposed carcass decomposed faster than the shaded carcass[13]. Maggots were observed on the fourth day, whilst a study by Dupont *et al*. observed maggots from rats' carcasses on the second day of decomposition[5]. This difference could be attributed to the size of the carcasses[21]. Maggot migration from the carcasses was observed on day 8 and this observation was also confirmed in piglets by Castro *et al*[22]. Immature calliphorids were observed between Day 12 and Day 15 on both the sun-exposed and the shaded carcasses. These immature calliphorids were probably emerging from the pupae whose larvae had burrowed into the soil from the carcasses.

During the post decay stage of decomposition, the carcasses were showing signs of dryness. Hence, the number of flies visiting the carcasses began to decrease. Beetles (Coleoptera) are considered the most common during this stage. *Dermestes* sp. was the dominant species being collected from the decay stage from the sun-exposed carcass. However, other studies have collected this species as early as the bloat stage[23]. According to VanLaerhoven and Anderson[24], the presence of these beetles so early in the decay process might be a function of peak seasonal appearance rather than the decompositional state of the carcass.

Hymenoptera (Formicidae) were observed throughout the decomposition process, and appeared to have no impact on the decomposition process. This is contrary to the observations made by Morreti *et al*. where ants fed on carcasses and maggots[25]. As a result, they categorized them as an important component of the Sarcophagidae community. By Day 21, no new insects were observed, implying that succession was over. From Day 36 to Day 49, no insects were collected, but ants were observed up to Day 49.

At Day 8, maggots were removed from each carcass and reared in separate rearing units. The families Calliphoridae, Sarcaphagidae and Sepsidae emerged from the sun-exposed carcass whilst families Calliphoridae and Sepsidae emerged from the shaded carcass. Immature calliphorids and sarcophagids emerged after 11 d, whilst Sepsids emerged after 15 d. Of note was that Sepsids, which were not observed from both carcasses during the decomposition, were observed from the rearing units. This family may have been missed during the decomposition of the carcasses possibly because of their size since they are small.

From the study, adult *M. domestica* was the most abundant species. However, they were only collected as adults from the decomposing carcasses and were also not observed from the rearing units. This probably indicates that they visited the carcasses to feed and not to breed. Of the dipteran species collected during the study, *L. cuprina* and *C. albiceps* could be important for further forensic studies since they were collected from the carcasses and also observed from the rearing units.

In conclusion, since this was a preliminary study, there is need to repeat and replicate it at different times of the year so as to provide multiple sets of baseline succession data for Harare, encompassing all seasons. However, the information obtained during this study could be useful for providing initial database information as no succession data were previously available in Harare. Furthermore, these results could also possibly stimulate other entomologists in Zimbabwe and initiate future studies.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

The knowledge regarding insect succession on decomposing rabbit carrions is useful for forensic studies. Thus, the current study was conducted as a preliminary study in order to have initial database information in Harare, Zimbabwe, where no study in this field was available.

Research frontiers

The present research work about insect succession on decomposing rabbits in Harare, Zimbabwe was conducted in order to identify insects visiting decomposing rabbit carcasses and to establish insects which may be of forensic importance in Harare.

Related reports

It was known that many insect species colonized animal carrions such as rabbit carcass. The presence of both *L. cuprina*, *C. albiceps* reported in the current study would help to develop forensic entomology in Harare.

Innovations and breakthroughs

Studies on insects associated with a decomposing dead body have already conducted in many African countries. Authors have demonstrated the need to establish this correlation in Zimbabwe, where no study demonstrated this relationship yet.

Applications

From the literature survey, certain arthropods follow a predictable succession sequence. This scientific study supports and suggests the need to carry out further studies in order to define some strategies which allow to easily analyse the arthropod fauna in the time estimating since death.

Peer review

In this research work, authors have demonstrated the importance of establishing the relationship between insects associated with a decomposing dead body.

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