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Research Paper

Studies on the Abundance and Diversity of Necrophagous Arthropods Associated with Decomposition of Vertebrate Carrion Dumped in Madalla Farm Argungu, Kebbi State, Nigeria

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ABSTRACT: *The study of necrophagous arthropods associated with carrion decomposition played a vital role in nutrients cycling in nature as well as in forensic entomology by providing numerous data useful for the sake of knowledge development and applicable in the field of biology, ecology and forensic entomology. This article present experimental data recorded on five vertebrate carrions dumped in Madalla farm during the period of May to June 2021. Five vertebrate carrions representing the locally available carrion in the area namely, goat head, domestic rabbit, fish, chicken and lizard carrion were used. The five vertebrate carrions were humanly killed and observed in separate traps for visiting arthropods. Necrophagous arthropods visiting the carrions were collected and counted daily. Necrophagous arthropods belonging to order diptera, coleoptera, and hymenoptera from eight families were recorded. The results showed that goat head attracted the highest number of arthropods species with a mean of 1016.5 ± 37.68 species, followed by rabbit 632.5 ± 33.71, 768 ± 45.62 on fish, 438.5 ± 38.96 on chicken and 117 ± 26.22 on lizard. The results also indicated a significance difference between the arthropods abundance attracted by five carrions P= 0.285. However, diptera formed the most dominant species of necrophagous insects collected in the area and the distribution of necrophagous arthropods may affected by carrion type.*

KEYWORDS: ***Abundance, Necrophagous, Decomposition, Carrion, Argungu***

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I. INTRODUCTION

Carrion provides habitat ground for necrophagous arthropods activities mainly define by feeding and oviposition for the development of their young. The moment an animal die its body releases chemicals (apeneumones) together with visual cues that attract flies and other arthropods as decomposition proceed (Isaac *et al.*, 2001). The assembly and arrival of the arthropods on dead can be affected by poor chemical cues, location and size of the dead body (Gills, 2007 and Farwig *et al.*, 2014).

Necrophagous arthropods play an important role in nutrients recycling in nature, removal of waste litter in the environment and insects alone can remove large body of vertebrate carrion in few days (Samantha, 2017). In forensic entomology, necrophagous insects are used to analyze the corpse and to explain what has happened during the crime. The study of their succession on corpse makes it possible to calculate the Post-Mortem Interval (PMI) in criminal cases (Dushimiriman, *et al.*, 2021). The larvae of many necrophagous are useful in entomotoxicological studies to explain the causes of death arising from drugs and poisoning. Yet many necrophagous diptera are of medical and veterinary importance as carrier of pathogenic organisms. Larvae of some flies are involved in screw worm infestation (old world) causing human and animal myiasis.

Abeer and Sharooq (2020) study the necrophagous insects in Al-Madinah Al-Munawwarah region of Saudi Arabia using rabbit carcass and recorded insect's species of the order Diptera, Coleopteran and Hymenoptera. Fouzi, *et al.* (2015) reported data on necrophagous Diptera in Sikikda, Algeria and recorded

dipterous insects from the families Calliphoridae, Sarcophagidae, Muscidae and Fannidae. In similar direction Simao *et al.* (2009) observed necrophagous Diptera and Coleoptera as a review of forensically important insect families. Sewyer, (2017) studied the effect of carrion decomposition on arthropods community and recorded a large number of species from 22 families of the order Diptera. Preliminary data on carrion arthropods were reported from Cameroon by Feugang *et al*. (2011). In Nigeria Abajue *et al.* (2016), Ekanem *et al.* (2011), Ado-baba *et al.* (2016), reported preliminary data on carrion associated entomofauna in different region of the country. The present study will be conducted in Argungu town of Kebbi state, Nigeria. The current research will study necrophagous arthropod species associated with some selected vertebrate carrions dumped in the area. The data obtain will be useful for carrion ecologist and forensic scientist in dealing with their daily works. This research will also provide on carrion community structure that can applicable in judicial practise in dealing with rising medico-legal cases and also providing baseline data on forensically significant necrophagous insects.

II. MATERIALS AND METHODS

Study Area

The study was conducted between the month April and June 2021 at Madalla Farm, a private facility own by Alh Bello Umar (fig., 3.1). The farm is about 1.5km away from the Argungu Emirs palace, 968m from Argungu general Hospital and College of Education and is about 100m away from the town grave yard. The farm was completely fenced having an area abou 328m X 289m X 397m X 239m. The farm is made up of poultry houses, fish ponds and orchard with natural growing trees around the place.

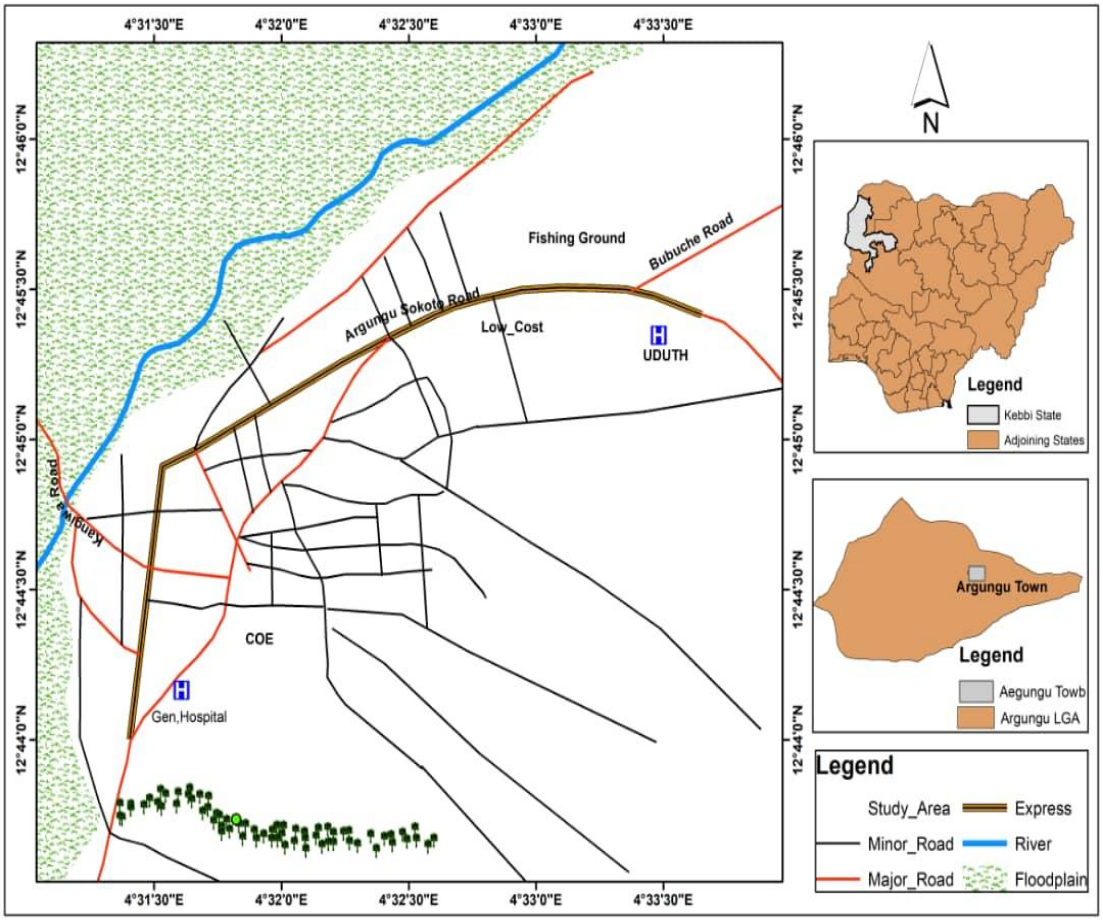
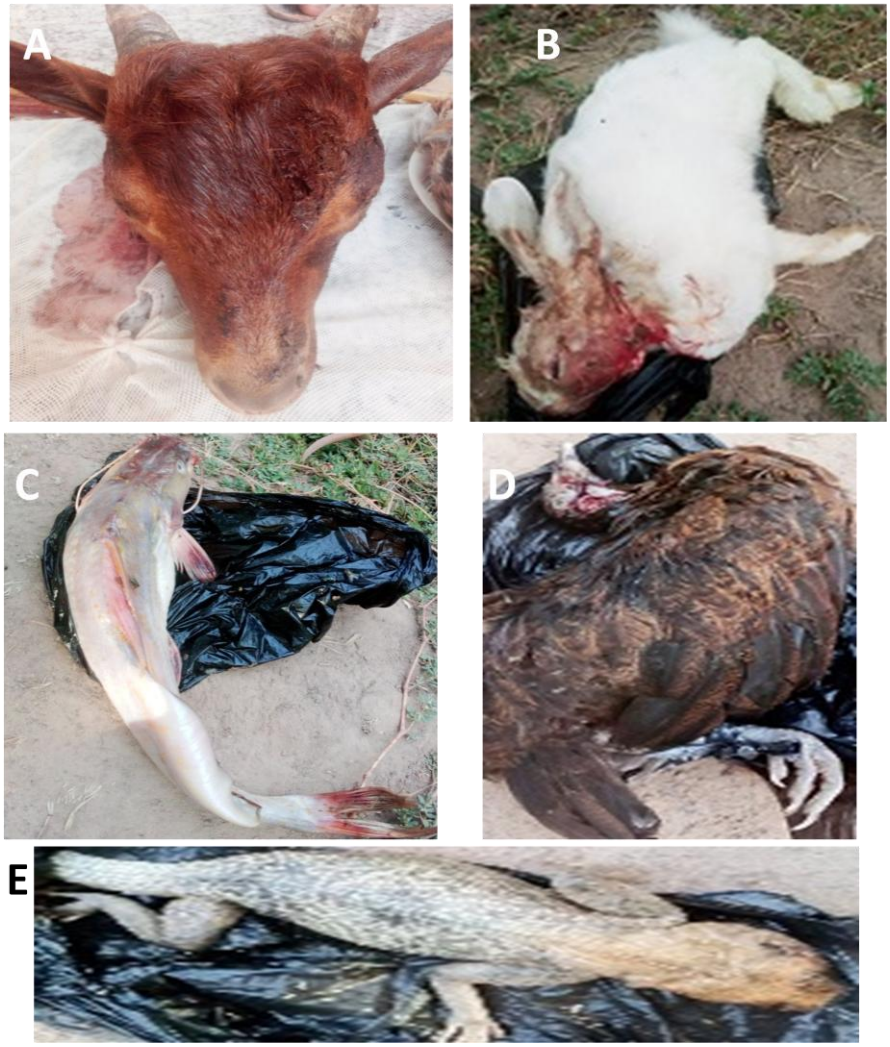


Fig.3.1 Map of Argungu showing the study site.

III. EXPERIMENTAL ANIMAL CARRIONS

For carrying out these studies five (5) vertebrate carrions namely goat head, domestic rabbit, fish, lizard and chicken were used for the experiment. The four of the animals were purchased from Argungu local market while the lizard was hunted and killed instantly. The rabbit and chicken were killed according to the Islamic rule by severing the neck with sharp knife, while fish was allowed to die by removing it from water. The five carrions were transported to the study site in a separate polythene bag immediately after death and were exposed to the study site immediately.



A - Goat head, B - Rabbit, C - Fish, D – Chicken and Lizard
Fig. 3.2 Experimental Animal Carrions

3.3 Experimental Traps

Five (5) wooden cages measuring 100x60x60cm (fig.3.2) were constructed with little modification following Ado-baba *et al*. (2016), Abeer *et al.* (202 and were used during the experiments. The sides and bottom of the trap were covered with a mosquito net while the top was provided with a cover designed in conical shape made from the same mosquito net for opening, closing during sampling. The tip end of the conical cover has a long thread which can tie to a peg few meters away from the trap for opening and closing of the trap without scaring the insects. The bottom of the trap was partially left open for the crawling insects to access the carrion. The design of the traps was made to facilitate easy collection of the sample and better examination of the carcasses without disturbing the carrions.

Fig. 3.3 Experimental traps

3.4 Experimental Set up

To observe and meet all the objectives the following experiments were setup following Ado-baba *et al.* (2016), Abeer *et al.* (2020) with some modifications and observations were made on different required parameters.

Initially five (5) wooden traps measuring 100x60x60cm constructed and treated with termicides were placed on the ground separately at a distance 15m apart to avoid the same insects moving from one trap to other. Fresh carrion of selected vertebebtate animal was then kept directlty on the ground in each of the trap. The traps were so placed that each of them was facilitating the entry of both crawling and flying insects to have access to the carrions throith the top and bottom. Each trap was tied to a peg erected bit away from thr trap to facilitate easy opening and closing of the traps without scaring awaythe insects during carcass examination and sample collections.observations were then made on the types and number of necrophagous arthropods having access to the carions, identifying the associated arthropods, typrs and number of predators feeding on the necrophadois arthropods were recorded. The experiment was repeated twice.

Fig. 3.4 Traps placement

Fig. 3.5 Carrion Placement

3.5 Sample Collection and Carcass Examination

The observations were then made on daily basis on the number and types of necrophagous arthropods having access to different carrion, decomposition of different vertebrate carrion, identifying the associated arthropods, types and number of predators feeding on the necrophagous arthropods was recorded.

Sample collection began the first day of exposure and mark as day 1. The sample were collected two times daily at six hour interval beginning from 8am-4pm to cover day time only when insects diurnal activity should be greatest. The collection period were sometimes changed to cover all day time hours. Flying insects were collected by closing the cover of the trap where all insects within the trap were forced to the tip end of cover. The tip end of this cover was then pushed into the killing jar where the insects were killed (fig. 3.3). Crawling insects, ants, spiders, and other arthropods samples were collected manually by hand picking and killed in a similar way. The number of samples collected was counted and preserved on daily basis up to the end of the experiment. However, only adults samples were collected, eggs and larvae on and around the carrion were only observed not collected to avoid damaging maggots establishing on the carcasses which could consequently interfere with the rate of decomposition process.

***Fig.6* Insects trapped at the Tip end of the trap**

***fig.7* Killing the insects in a killing jar**

3.5 Arthropods Identification

Only arthropods samples which show necrophagous activities were taken to the Insects Museum, Department of Crop Protection, Institute of Agricultural Research (IAR) Ahmadu Bello University Zaria, where they were properly identified and classified to species level by the help of a Taxonomists Mr. Musa I.P. Head of insects Museum, ABU Zaria.

3.6 Data Analysis

Microsoft Excel version 2013 was used in preparation and collating of the data. In order to find the abundance of each of the associated arthropods on all the carrions, the frequency of each of the individual species on particular carrion was counted and expressed in relation to the total number of all species from all the carrions. For comparison of arthropods abundance non parametric analysis in Kruskal Wallis Test (SPSS Version 26) was used to find out the significance differences of arthropods species between the five vertebrates carrion. The result was considered significant at ($P = 0.05$).

IV. RESULTS

Abundance and species richness of arthropods collected on five vertebrate carrions.

Table1. From my investigation I collected a total mean of 2972.5 adult arthropods from the ten carrion types in the decaying stages of decomposion. A total mean of 1016.5 ± 37.68 arthropods were collected on goat head, 632.5 ± 33.71 on rabbit, 768 ± 45.62 on fish, 438.5 ± 38.96 on chicken and 117 ± 26.22 on lizard carrion. However, 20 species were recorded on goat head, 17 on rabbit, 13 on fish 14 on chicken and 9 on lizard carrion. This shows that, there was higher abundance of arthropods on goat head followed by fish, while lizard carrion attracted the least number of arthropods. The result also shows that, there was significance difference of arthropods abundance between the five carrion monitored P= 0.285. However, species richness was higher on goat carrion, Rabbit, chicken and Lizard respectively.

However, the distribution and abundances of individual species on all carrion (table2) indicated that *C. albiceps Musca domestica* were the dominants necrophagous diptera collected all carrions with a total mean of 263.5 and 242.5 on goat head. The second most dominant arthropods recorded has been *Pheidole* Sp with a total mean of 183.5 on goat head. Simpson Index of diversity of arthropods recorded on five carrions indicated a greater diversity of arthropods on all the carrion (table2).

Table1. Number of Carrion (n) monitored and mean of recorded and species richness of arthropods collected on five vertebrate carrions.

Carrion Type	N	Mean of Arthropods ± SD	Total Richness
Goat head	2	950.5 ± 37.68	20
Rabbit	2	589.5 ± 33.71	17
Fish	2	731.5 ± 45.62	13
Chicken	2	398.5 ± 38.96	14
Lizard	2	103.5± 26.22	9
Total	10	P value= 0.285	73

Table2. Mean Number of individual species and species diversity index of necrophagous arthropods on five carrion types.

Arthropod Species	Family	Order	mean number of species on five carrion				
			goat	Rabbit	Fish	chicken	Lizard
Crysomya chloropyga. Wied.	Calliphoridae	Diptera	9.5	2.5	2	0	0
Crysomya regalis. Rob-Desv.	Calliphoridae	Diptera	25.5	16	25.5	48.5	5
Crysomya albiceps. Wied.	Calliphoridae	Diptera	263.5	118	218	38	13.5
Musca domestica. L.	Muscidae	Diptera	242.5	201	190.5	58	13.5
Sarcophaga exuberans. Pand.	Sarcophagidae	Diptera	47.5	5.5	59	30.5	10.5
Incala schoutedeni. Monser.	Scarabaeidae	Coleoptra	2.5	0.5	0	0.5	0
Gymnopleurus Fulgidus. Oliver.	Scarabaeidae	Coleoptra	2	0	0	0	0

Gymnopleurus sp. L.	Scarabaeidae	Coleoptra	1.5	1.5	0	0	0
Caccobius schreberi L.	Scarabaeidae	Coleoptra	1.5	0	0	1.5	0
Hister monotor. Lewis.	Histeridae	Coleoptra	25.5	17.5	17	19	2.5
Hister sp.	Histeridae	Coleoptra	5.5	6	0	0	0
Dermetes maculatus.	Dermestedae	Coleoptra	58.5	22.5	23.5	22.5	4
Dermetes Sp.	Dermestedae	Coleoptra	5.5	3.5	0	0	0
Ormogus procerus.	Trogidae	Coleoptra	24.5	23	47.5	13.5	0
lasius niger . L.	Formicidae	Hymenoptera	*51.5*	50.5	31	40.5	0
Pheidole sp.	Formicidae	Hymenoptera	183.5	121.5	117.5	126	54.5
		Total	950.5	589.5	731.5	398.5	103.5
		Diversity Index (SDI)	***0.167***	***0.184***	***0.179***	***0.137***	***0.24***

V. DISCUSSION

In general a total mean number of (2975) adult insects belonging to 4 insect orders, six families and eight species were found on all the carrions, while nine hundred and twenty eight (928) immature adult flies (imagos) that developed in the carrion traps were also collected. Three insect orders viz, Diptera, Coleoptera and Hymenoptera dominated the carrion communities in the present study. The present was closely related to the work of Sukchit *et al.,* (2015**)** who recorded these orders in addition with hemiptera and isopteran on pig carcasses in Thailand. The five orders recorded in this study are usually carrion invaders reported on most carrion related studies as in Abajue *et al.,* 2016; Sukchit *et al.,* 2015; Azwandi *et al.,* 2013; Ekejiuba *et al.,* 2019 and Mabika *et al,*. 2014. The study revealed that variation existed in the number of different insect orders attracted by the various carrions used in this study. Arthropods families viz, Calliphoridae, Sarcophagidae, Muscidae, Histeridae, Scarabeidae, Dermestidae, Trogidae, Formicidae, Gryllidae, and Areneae were recorded from all the carrions used. Members of these families were regularly reported by many researchers in this field (Rosina *et al.,* 2016 and Mateusz *et al.,* 2020). A total of twenty one species were recorded from all taxa which comprised of *chrysomya chlorophyga, chrysomya regalis, chrysomya albiceps, Sarcophaga exuberans, Musca domestica, Dermestes maculatus, Hister monotor, Hister* Sp. *Incala schoutedeni, Gymnopleurus fulgidus, Gymnopleurus* Sp. *Caccobius schreberi L. Ormogus procerus, lasius niger L. Pheidole* Sp. *Monomorium minimum Buckley and Teleogryllus* Sp., the order coleoptera has the highest species richness represented by eight species from four families which is closely related to the findings of (Kyerematen *et al*., 2012) who recorded ten species from this order on four different baits (pork, beef, chicken and fish). The family formicidae even though, contain only two species but formed the dominant arthropods found on all the carrion. This is similar to the findings of (Azwandi *et al.,* 2013) who recorded about 80% individuals from the family formicidae of the total arthropods collected on three animal carcasses (rat, rabbit and monkey) in Malaysia.

Different factors were known to influence insect's succession on carrion during decomposition as physical position of the carcass, mass and type of carcass, vertebrate scavengers, insect abundance in the area, biology and geographical distribution of the necrophagous insects and season can influence the time of arrival and duration of insects stay on the carrion (Rofela, *et al*. 2017). Carrion related factor with greater influence on decomposition process includes state and size of the carrion (large, small, part or whole body, buried, hanging or ground, wrapped or unwrapped), location of the carrion (urban or rural, submerged or on land, indoors or outdoors, sun exposed or shaded carrion), mode of killing (Slaughtered, stabbed, drowning, gun shut, poisoning, blowing, burning etc), local carrion arthropods in the area, delayed insect access, accessibility of the carrion by necrophages and presence of other vertebrate carrion scavengers (Mabika *et al.,* 2014, Ramón *et al.,* 2015, Rofela *et al.,* 2017 and Matuszewski *et a.,l* 2008).

In this study the effect of carrion type on attraction of necrophagous arthropods has been investigated. It was evident that carcass type can influence the distribution and abundance of necrophagous insects on the carrion. From this investigation goat head attracted the highest number of arthropods than fish, rabbit, chicken and lizard. A significance differences on the number of arthropods recorded between the five carrions was observed. Mashaly *et al*. (2019) studied the distribution and species richness on three animal carcasses in Riyadah Saudi Arabia and recorded large number of insects on Camel than goat and dogs. Kyerematen *et al*., 2012 also observed significance differences in abundance of arthropods Species recorded four different baits (pork, beef, chicken and fish). We opined that the differences in the abundance of arthropods on goat head may be due to it skeletal arrangement which have the ability to maintained carrion body moisture, produce prolongs odor and prevent early disintegration of carcass.

In this study we recorded large number of flies from the family calliphoridae specifically the abundance of *Chrysomya albiceps* comparatively from all carrions and is one of the most common Calliphorids species recorded in most carrion studies. The regular occurrence and abundance of this species has been reported by Nelice *et al*, (2007) from Sao Paulo, Brazil; Mashaly *et al* (2019) from Saudi Arabia; Youmessi *et al* (2011) from Cameroon and. Uhuo, *et al*, (2019), Ado-Baba *et al*, (2016), and Abujue *et al* (2016) from Nigeria. The second most important necrophagous species recorded with higher abundance has been the *Musca domestica* which has also been regularly reported along Calliphorids. The adult are most common at decomposing corpses in the early stage of decomposition when the corpse is moist, especially due to their historic association with human and animal even before dead (Martin, 2010). Other necrophagous species recorded with low abundances includes *C. regalis, C. chloropyga, Sarcophaga exuberans* and other coleoptera from the family Scarabeidae, Histeridae, Dermestidae, Trogidae. Large number of *Lasius niger L.* and *Pheidole* Sp from the family Formicidae. Large number of *Pheidole* Sp. was observed on all the carrion from fresh to dry stage of decomposition mainly feeding on the fluids, blood stains around the slaughter area and tearing of dried flesh. *Lasius niger* was almost exclusively predating on fly larvae. This finding was similar with work of Ado-baba *et al* (2016) who reported that, some members of the family were also seen engaged in asymmetrical interguild predation on insect larvae during the decay stage.

Simpson Index of Diversity was also used to calculate the diversity of these insects from the different carrion and observed that insects diversity was significant from all the carrion in comparison which ranges from 0.137 - 0.243.

VI. CONCLUSION

The composition of necrophagous arthropods on carrions can be influence by carrion type. We observed that the abundance of large number of necrophagous arthropods on goat head and fish may due to its preference by most necrophages. *C. albiceps, Musca domestica* and *Sarcophaga exuberens* (Diptera) as well as *D. maculatus* and *Ormogus procereus* could be important for further forensic research in the area due their presence on carrion at both adult and larval stage and they widely distributed on both carrion.

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