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European Journal of Experimental Biology, 2013, 3(5):106-110

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Arthropod succession on wildlife carcasses in lowland rainforest, Rivers State, Nigeria

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ABSTRACT

The decomposition process and arthropod succession on the carcasses four wildlife species: The Greater Cane Rat, Thyronomys swinderianus ; the Two-Spotted Palm Civet, Nandina binotata, the Mona monkey, Cercopithecus mona, the Maxwell's duiker, Philantomba maxwelli, were observed over a 3-month period during the rainy season in lowland Rainforest, Nigeria. The freshly-killed carcasses were weighed and a carcass of each placed in a cage in open vegetation and the other in a sheltered location. Arthropods were collected with hand nets and crawling species manually and trapping in water. Five stages (fresh, bloated, wet, dry, skeletal) were discernible in the decomposition process. In shade, there was a significant correlation between weight of carcass and duration of decomposition process. The necrophagous dipterans (blowfly, Lucilia serricata; flesh fly, Sarcophaga haemorrhoidalis; house fly, Musca domestica) were the only early arrivals in the fresh stage. These were complemented in the bloated and wet stages by other dipterans (cheese fly, Piophila casei; black soldier fly, Hermetia illucens; green hairy maggot fly, Chrysomya rufifacies), predatory beetles (rove beetle, Octopus species; dermestid beetle, Dermestes maculatus) and formicoids. The major species in the dry stage was Dermestes maculatus. Incidentals such as crickets, spiders, moths, butterflies, and dragon flies appeared in the dry and skeletal stages. Weight and location of carcass (exposed or sheltered) and other prevailing environmental factors affect decomposition rates. Arthropods, acting as necrophages, predators and parasites are important in the decomposition process. As a result of differences in the species composition associated with each decomposition stage, it is possible to estimate Post-Mortem Interval (PMI) of carcasses in late stages of decomposition.

Key Words: Decomposition Stage, Arthropod Colorisation Phases, Post Mortem Interval, Estimation, Omagwa Bushmeat Market

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INTRODUCTION

In ecology, succession refers to the change of a community over time. A pattern of insect succession results as different carrion insects are attracted to the varying biological, chemical and physical changes a carcass undergoes throughout the decay process [1]. A decaying carcass provides a temporary, rapidly changing resource which supports a large, dynamic arthropod community. In forensic studies, investigators recorded more than a century ago, how insects occurred in corpses and carcasses in waves; different types of insects presented at different times [2]. In entomological studies, the commonly described stages of carcass or corpse decomposition are: fresh, bloated, active decay, advanced or post – decay, dry remains [3]. These stages encompass two chemical processes (autolysis and putrefaction) which break down the main components [4]. Understanding the stages of decomposition, the colonization by different arthropod species and factors that may affect decomposition and colonization are key to determining forensically important information on a corpse or carcass [1]. Investigations were conducted into the

decomposition process and arthropod succession on the carcasses of four mammalian wildlife species: the Greater Cane Rat, *Thyronomys swinderianus*; the Two – Spotted Palm Civet, *Nandinia binotata*; the Mona monkey, *Cercopithecus mona*; and Maxwell's duiker, *Philantomba maxwelli*. None of these is listed in Nigeria's endangered species Decree II (1985) [5]

MATERIALS AND METHODS

The freshly-killed, weighed carcasses were kept in separate cages over a 3 – month period August – October, 2011, during the rainy season. Flying insects were collected by the use of nets; crawling insects were manually collected and others in water traps. Adult insects were killed with ethyl acetate and preserved in 70% ethanol. Barber's fluid (40% of 95% ethanol, 40% water, 15% ethyl Acetate, 5% Benzene) was used as relaxer to avoid damage before mounting. Larvae were directly killed in 70% ethanol. Sampling on each carcass took less than an hour. Standard Keys were used for identification [6].

RESULTS

DECOMPOSITION PROCESS

Five stages of decomposition were recognized for all sheltered and field-displayed carcasses: fresh, bloated, wet, dry and skeletal. The fresh stage showed no external signs of physical change and there was no odour. The bloated stage was characterized by an inflated abdomen, ruptured skin, evisceration of furs and a strong distinctive odour. In the active decay (wet) stage, the carcasses were deflated: wetness in the appearance of the carcasses (due to liquefaction of tissues), the flesh around the head and anus was removed, and a pungent odour of putrefaction and disintegration of carcasses. There was a great weight loss in the advanced decay (late wet) stage; most of the flesh was removed from the carcasses, accompanied by diminished putrefaction odour. The dry stage consisted of bones; cartilage and dried skin which were later bleached (Table 1).

Table 1: Duration of Stages in the Decomposition Process

Decomposition stages	Duration of decomposition stage (Days)							
	Civet Cat		Giant Cane Rat		Mona Monkey		Maxwell's Duiker	
	O	**S**	**O**	**S**	**O**	**S**	**O**	**S**
Fresh	1	1	1	1	1	1	1	1
Bloated	4	4	2	3	3	3	5	7
Wet	8	5	4	3	3	6	11	12
Dry	25	25	8	13	18	29	33	33
TPFD	39	36	16	21	29	40	51	54
Skeletal	*	*	*	*	*	*	*	*

O**: Openly displayed; **S**: Sheltered; **: Not determined. **TPFD** = Total period from fresh to dry stage*

DECOMPOSITION PERIODS

There was variation in the decomposition periods (from fresh to the dry stage): 20 – 53 days for openly displayed carcasses and 15 – 50 days for sheltered carcasses. The longest period was in the Duiker and the least in the Greater Cane Rat (Table 2). The correlation of body weight and decomposition periods was significant for the sheltered carcasses (r = 0.8). The differences in the rates of progression through the decomposition stages among carcass species were not significant for the sheltered (F_{cal} = 0.36< F_{tab} at 5%) and openly displayed carcasses (F_{cal} 0.60< F_{tab} at 5%).

Table 2: Weight of carcasses and duration of decomposition

Mammalian species	Location	weight of carcass (kg)	Temperature range (°C)	Duration of stages (days)				
				Fresh	Bloat	Wet	Dry	Total
Duiker	Sheltered	6.25	27 - 38.4	1	7	12	33	53
	Exposed	6.85	29 - 40	1	5	11	33	50
Civet	Sheltered	0.80	27 - 38.5	1	4	5	25	35
Cat	Exposed	1.05	28 - 38.2	1	4	8	25	38
Mona	Sheltered	3.10	29 - 38.6	1	3	6	29	39
Monkey	Exposed	2.30	29 - 36.8	1	3	3	18	25
Greater	Sheltered	2.23	24 - 38.5	1	3	3	13	20
cane rat	Exposed	2.35	29 - 38.6	1	2	4	8	15

ARTHROPOD SUCCESSION

On all mammalian species, blow flies, flesh flies and house flies were the only species recorded in the fresh stage. These dipterans were followed by other dipterans (cheese fly), beetle (particularly rove beetles), ants, and mites in the bloat stage. The wet (active decay) stage retained these earlier-mentioned species. In the dry and skeletal stages, there was a significant reduction in species richness. The dominant species on all carcasses during these terminal

stages was the dermestid beetle, *Dermestes maculatus*. Incidentals such as moths, butterflies, spiders were also encountered during these dry stages (Tables 3, 4, 5, 6).

Table 3: Arthropod succession in Greater Cane rat carcass

Stages of Decomposition	Succession of Arthropod population
Fresh	House fly (Muscidae) Blow fly (Calliphoridae) Flesh fly (Sarcophagidae)
Bloat	House fly (Muscidae) Blow fly (Calliphoridae) Flesh fly (Sarcophagidae) Cheese fly (Piophilidae) Rove beetle (Staphilinidae) Meat eater ant (Formicidae) Cricket (Orthoptera)
Wet	Blow fly (Calliphoridae) House fly (Muscidae) Flesh fly (Sarcophagidae) Rove beetle (Staphilinidae) Black soldier fly (Stratiomyidae) Black blow fly (Calliphoridae) Cheese fly (Piophilidae) Fire ants (Formicidae)
Dry	Cheese fly (Piophilidae) Dermestid beetle (Dermestidae) Fire ants (Formicidae)
Skeletal	Spiders (Araneidae) Dermestid beetle (Dermestidae) Butter fly (Lepidoptera)

Table 4: Arthropod succession in Mona monkey carcass

Stages of Decomposition	Succession of Arthropod population
Fresh	House fly (Muscidae) Blow fly (Calliphoridae) Flesh fly (Sarcophagidae)
Bloat	House fly (Muscidae) Blow fly (Calliphoridae) Flesh fly (Sarcophagidae) Cheese fly (Piophilidae) Rove beetle (Staphilinidae) Black soldier fly (Stratiomyidae)
Wet	Flesh fly (Sarcophagidae) Dragon fly (Odonata) Monopsis moth (Lepidoptera) Rove beetle (Staphilinidae)
Dry	Flesh fly (Sarcophagidae) Monopsis moth (Lepidoptera) Rove beetle (Staphilinidae) Dermestid beetle (Dermestidae)
Skeletal	Fire ants (Formicidae) Spiders (Araneidae) Dermestid beetle (Dermestidae) Monopsis moth (Lepidoptera)

Table 5: Arthropod succession in Two- spotted Palm Civet carcass

Stages of Decomposition	Succession of Arthropod population
Fresh	House fly (Muscidae), Blow fly (Calliphoridae) Flesh fly (Sarcophagidae)
Bloat	House fly (Muscidae) Blow fly (Calliphoridae) Flesh fly (Sarcophagidae) Cheese fly (Piophilidae) Rove beetle (Staphilinidae) *Macrocheles mite* Meat eater ant (Formicidae) Weaver ant (Formicidae) Hister beetle (Histeridae)
Wet	Hister beetle (Histeridae) Rove beetle (Staphilinidae) Hairy maggot fly (Calliphoridae) Cheese fly (Piophilidae) Dermestid beetle (Dermestidae) Bull ant (Formicidae) Monopsis moth (Lepidoptera)
Dry	Rove beetle (Staphilinidae) Dermestid beetle (Dermestidae) Fire ants (Formicidae)
Skeletal	Spiders (Araneidae) Dermestid beetle (Dermestidae)

Table 6: Arthropod succession in Maxwell's duiker carcass

Stages of Decomposition	Succession of Arthropod population
Fresh	House fly (Muscidae), Blow fly (Calliphoridae), Flesh fly (Sarcophagidae)
Bloat	House fly (Muscidae), Blow fly (Calliphoridae), Flesh fly (Sarcophagidae), Cheese fly (Piophilidae), Hister beetle (Histeridae), Rove beetle (Staphilinidae), Cricket (Orthoptera), Dermistid beetle (Dermestidae),
Wet	Hister beetle (Histeridae), Rove beetle (Staphilinidae), Cheese fly (Piophilidae), Dermestid beetle (Dermestidae), Bull ant (Formicidae)
Dry	Blow fly (Calliphoridae), Dermistid beetle (Dermestidae), Dermestid beetle larvae (Dermestidae)
Skeletal	Fire ants (Formicidae), Spiders (Araneidae), Dermestid beetle (Dermestidae), Dermestid beetle larvae (Dermestidae)

DISCUSSION

The entry of the dipterans (blow flies, flesh flies and house flies) confirms earlier records that these are the first set of flies to arrive at a death scene [7, 1]. These are the necrophages that feed on the carcass tissue. Age determination of these insects usually is the basis for making Post-Mortem Interval (PMI) estimations in the early stages of decomposition [8]. The activity of anaerobic bacteria in the abdomen created such gases as hydrogen sulphide, carbon dioxide and methane, which accumulated within the body cavity and caused the distension of the abdomen [9]. The necrophagous dipterans were complemented by rove beetles, ants that also feed on both the carrion and associated fauna. Large populations of these species are known to retard the rate of carrion decomposition by depleting populations of necrophagous species [10]; these species were described as omnivores [7].

The active decay stage was characterised by the period of greatest weight loss, which occurred as a result of both the voracious feeding of the microphages and the oxidation of decomposition fluids into the surrounding environment [9]. The released fluids accumulated around the body, creating a cadaver decomposition island (CDI) [11]. The dry remains stage was characterized by the preponderance of bones, cartilage and bits of dried skin. The dominant species in this stage was the dermestid beetle which normally feeds on dried fish, fur, hide, etc. The dominant necrophages in the earlier stage were absent in the dry stage. The necrophages dispersed from the remains in the dry

stage. Associates of the dermestids in this stage were the incidentals: spiders, mites, etc. Five entomological phases have been described for arthropods associated with carcasses: Exposure phase; Detection phase; Acceptance phase; Consumption phase; and, Dispersal phase [12]. Estimates of post-mortem interval (PMI) in advanced stages of decomposition are usually based on the composition of the arthropod community as it relates to expected successional patterns [13].

CONCLUSION

Location of carcass (exposed or sheltered) and other prevailing environmental factors affect decomposition rates. Arthropods, acting as necrophages, predators and parasites are important in the decomposition process. As a result of differences in the species composition of arthropods associated with each decomposition stage, it is possible to estimate Post Mortem Interval (PMI) of carcasses in late stages of decomposition.

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