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Original Research Article

Estimation of Time Since Death of Bodies Above Soil Surface in A Guinea Forest-Savannah Vegetation of Nigeria Using Visible Post Mortem Changes

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ABSTRACT

Background: Forensic taphonomy is the use of decomposition timeline estimation to unravel mystery behind time of death confirmation in homicide cases involving the law court. The Guinea forest-savannah vegetation is one of the vegetations in Nigeria characterized by short trees, grassland, very hot temperatures almost round the year, speedy wind, etc. It has two distinct seasons – rainy and dry seasons. This study aimed at investigating the visible post mortem changes of domestic pigs (*Sus scrofa domestica*) in a Guinea forest-savannah vegetation of Nigeria so that it can be used to estimate time since death of bodies on the soil surface.

Methods: A stratified random sampling technique was used to select two male and two female matured domestic pigs from a private pig farm located close to the research facility. The visible post mortem changes were observed daily (morning, afternoon and evening) for 49 days.

Results: Four stages of decomposition were identified namely fresh, bloat, active decay, and advanced decay stages. Mummification process started at the sixth day post mortem which slowed the rate of decomposition, and prevented the animals to completely skeletonize within the study period. Extreme atmospheric temperature was the major factor that aided the mummification of the animals.

Conclusions: Decomposition of domestic pigs in this region accelerates at the early hours of post mortem, and subsequently slows down due to extreme climatic conditions. In addition, it takes carcasses on the soil surface more than 49 days to completely skeletonize due to its vegetative factors. This implies that most crime investigations carried out in this region must take into account the climatic conditions before estimating the time of death.

KEYWORDS: Crime investigation, Decomposition timeline estimation, Forensic taphonomy, Mummification, Stages of decomposition, Visible post mortem changes.

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BACKGROUND

The visible post mortem changes of decomposition are a useful tool in estimating the timeline of decomposition and assisting in confirmation of alibi of murder cases [1]. These changes begin to occur few minutes after death. The early signs of the changes are algor mortis, livor mortis, pallor mortis, and rigor mortis [2]. These changes are as a result of breakdown of macromolecules of the body [3].

Decomposition is the breakdown of the body's components immediately after death [4]. The chemical process of decomposition starts immediately after an individual takes his last breath, and this process is controlled by two factors – autolysis and putrefaction. Autolysis refers to the breakdown of tissues by its on enzymes and body internal chemicals [5].

Putrefaction can be defined as the breakdown of body tissues by bacteria [6]. Biswas [7] also noted that putrefaction follows pallor mortis, algor mortis, rigor mortis and livor mortis which are the early activities at death. Autolysis and putrefaction may occur at the same time resulting to different stages of decomposition. Payne [8] identified five stages of decomposition namely fresh, bloat, decay, advanced decay and skeletal. Each of these stages has visible post mortem activities that distinguish them from one another. The changes that occur at these stages can either be accelerated or slowed by certain factors but especially climatic factors; and these factors vary from region or location to the other [9].

In Nigeria, there are seven vegetations namely the Tropical rainforest, Mangrove swamp forest, Fresh water swamp forest, Sahel savannah, Sudan savannah and Guinea forest-savannah, and the Montane land. The Guinea forest-savannah vegetation is found in a region of Nigeria characterised by high-grass savannah. It has two seasons – the dry season and the rainy season. Its annual precipitation is 1000-1400 mm on the average. The grass reaches a great height, in which not only a man, but also a large animal can hide. In the first half of the dry season the savannah looks lifeless; the trees stand bare. In the middle of this season, a smoke screen rises over the savannah: the dry grass burns, which is burned from year to year with the purpose of preparing the land for crops. With the first rains appear juicy shoots of young grass and green leaves. The type of soil in this vegetation varies from loamy, sandy to humus [10].

This study is aimed at investigating the visible post mortem changes that occur from time of death to skeletonization using domestic pigs (*Sus scrofa domestica*). This study also provide a model account of the timeline of decomposition for matured pigs on the soil surface in Nigeria.

MATERIALS AND METHODS

Ethics approval and consent to participate: The ethical approval was obtained from the ethical committee of the Faculty of Basic Medical Sciences, University of Calabar, Calabar (Figure 6). The certification number is 079PHY3321 dated 24th March, 2021. All the authors gave full consent to participate in the study.

Materials for the study: The materials used for this study include Smart 4-in-1 soil survey instrument, Generic Neoteck LCD digital indoor / outdoor thermo-hygrometer, digital body thermometer; Generic AMKOV CD - R2 digital camera, surgical hand gloves, rubber gloves, nose masks, safety rubber boots, laboratory coat, steel tape and stadiometer.

Location of the study: The location was situated at the Taphonomy research facility of the Department of Anatomy and Forensic Anthropology, University of Cross River state, Okuku campus, Yala Local Government Area of Cross River State, Nigeria. The location was mapped and secured using a forensic tape. The soil type predominant in this location are loamy and humus soil.

Animal acquisition: The animals for the study were adult domestic pigs (*Sus scrofa domestica*) weighing between 30kg to 40kg. They were procured from a pig farm located very close to the research location.

Sampling technique / method: The sampling technique used for this study was stratified random sampling. This was achieved via the assistance of the farmer. The farmer identified all matured animals (6 or 7 months in age),and

separated the males from the females.

The male group constituted 11 animals whereas the female constituted 12 animals. Animals in each group were numbered nominally via a neck-tag. Same numbering was assigned and ballots were randomly assigned into groups. Four domestic pigs (two males and two females) were randomly selected via pick and replacement method.

Fig. 1: *Sus scrofa domesticus* immediately after sacrifice (DAY 1 – Fresh Stage). The animal appeared fresh and no sign of decomposition at this stage.

Fig. 2: DAY 2 – Bloat Stage.

Fig. 3: DAY 4 – Active decay stage / early mummification

Fig. 4: DAY 21 – Advanced decay stage / Mummification

Fig. 5: DAY 49 – Advanced decay stage / Mummification

Study design: Animal gender and body statistics (recumbent length, peri-mortem weight, and waist and chest circumference) were recorded. The pre-mortem and post-mortem rectal (body) temperatures of all the pigs were documented. The animals were sacrificed by strangulation so as ensure its forensic importance. Animal death was confirmed when no heart beat was recorded using stethoscope and observation of the pupillary reflex. The exact date and time of death was recorded. The early signs of decomposition (algor, pallor, livor and rigor mortises), marking autolysis were documented. The early signs of decomposition were monitored in a controlled environment where the room temperature was taken note of. The body temperatures of the animals were recorded every 10 minutes for up to six times until an hour. Subsequent hourly temperature changes were recorded for 8 hours. Animal post mortem weight (after 8 hours) was recorded. The body parts where decomposition occurred, and when it occurred was documented. This study also noted the insect activities though proper entomological study was not conducted. The The atmospheric temperature and humidity were recorded twice daily (morning and afternoon).

Animals were immediately moved to the research site at the end of the 8 hours post mortem observation period. Protective cages were used to protect the animals from vertebrate scavengers. Decomposition changes of the animals were observed on day 1, 2, 3, 4, 5, 6, 7, 14, 21, 28, and 49 respectively. The perimeter of the forensic sites (9.39m in length and 3.38m in width) were secured and marked clearly with forensic tape and sign post to avoid any human interference.

Method of data collection for daily climate readings: The thermo-hygrometer was placed in a room (shed), and the wire plug (containing the mercury knob) extended outside the room via its window. The LCD of the equipment was taken far away from sun rays; then the temperature scale was set to Celsius. The time was also set on the equipment to the GMT of our location to ensure accuracy in documenting the readings. The lowest atmospheric temperature of the day was recorded between 3am and 7am; and the highest atmospheric temperature of the day recorded between 11am and 3pm. The lowest humidity of the day was recorded between 11am and 3pm; and the highest humidity of the day recorded between 3am and 7am.

Experimental Control / Precautions: We ensured that the experimental animals were healthy and the food they took two weeks before the experiment did not contain any poisonous or alcoholic substances. Animals were procured from nearby farms to the research facility to ensure that there was no change in body thermal condition. Animals were procured very early in the morning between 5am and 6am, and allowed to rest and acclimatize for a period of 1 hour. The mercury part of the thermometer was cleaned after inserting it inside the anus of the animals with methylated spirit and dry cotton wool so as to ensure accuracy in data collection.

Statistical tool and method of data analysis: Data were analyzed using Statistical Package for Social Science (SPSS) IBM series version 25. The data were descriptively analyzed and represented in tables. The early post-mortem changes of decomposition were descriptively represented in tables and figures. Visible morphological changes of putrefaction were also descriptively represented in figures and tables.

Duration of Research: This study lasted for a period of 49 days (from February 2020 to April, 2020).

RESULTS

Peri-mortem body statistics: The recumbent length, chest circumference, waist circumference, peri-mortem body weight, post mortem body weight, peri-mortem body temperature and post mortem body temperature of the carrions used in the study in Table 1. The peri-mortem body statistics revealed that the experimental animals were fully matured, whose body weight ranged between 30 – 40kg.

Post-mortem body statistics: All the animals struggled for survival (with discharge of faecal matter and urine) during the sacrifice which led to elevated body temperatures at death as shown in Table 2. This increase in body temperature increased the autolytic activity of the pigs.

Visible Post-mortem Changes: The result from the visible changes of the first one hour after death showed that pallor mortis started before algor mortis, and this was followed by livor mortis and rigor mortis simultaneously. The decomposition process kicked off immediately. The visible changes observed after the first one-hour post mortem showed that there were discharge of putrid gases and body fluids from the orifices of the animals. The putrid odour attracted houseflies to the carcasses.

Result from the second day of the study showed that the tongue protruded, the entire body structures bloated, increased intestinal pressure with release of putrid gases, the trunk bloated and purged fluid, the abdomen stretched and marbled then turned green, and there was an increase in fly activities around the oral region. Bloat stage of decomposition was evident on the second day.

The visible changes of decomposition of the fourth day showed that this day was the active decay stage of decomposition. However, active decay started on the third day and progressed rapidly. The visible post mortem changes at the fourth day include increased maggot activities, skin slippage of some of the body structures, less fly activities, less putrid odour, drying of some structures especially head and neck structures, and presence of few ants. The decay process at the fourth day became slower compared to its rate at the first three days of decomposition.

The visible changes of decomposition at the 21st day showed that the body structures were at the advanced decay stage and mummified. The decay process became very slow and almost halted. Some of the bones were visible at this stage but the skin of the animals appeared fresh even though it was discoloured to dark brown and almost black in some animals. These observable changes progressed slowly till the last day of the study even though it appeared almost the same.

Timeline of decomposition: Results from the estimated timeline showed that the first visible change at death was pallor mortis and it started 20 minutes after death and lasted for eight hours. This was immediately followed by algor mortis which started 30 minutes after death and lasted for about eight hours. Rigor and livor mortises started at the same time (50 minutes after death); but rigor mortis lasted for two days whereas livor mortis lasted for six hours.

The fresh stage of decay lasted about nine hours and thirty minutes which was immediately followed by the bloat stage which lasted for an estimated period of three days. The active decay stage started on the third day and lasted for estimated period of 18 days. The advanced decay stage started at the fifth day and proceeded almost at the same time with active decay stage. It continued till the last day of the study.

Table 1: Peri-mortem body statistics of the pigs.

BODY STATISTICS	PIG 1	PIG 2	PIG 3	PIG 4
Weight (Kg)	39.4	32.5	31.5	30
Rectal Temperature (^{0}C)	38	37	38	38.5
Recumbent Length (cm)	112	104	104	99
Chest Circumference (cm)	84	76.5	80	71
Waist Circumference (cm)	79	74	70	59

Table 2: Post-mortem statistics of the pigs.

BODY STATISTICS	PIG 1	PIG 2	PIG 3	PIG 4
Weight after 8 hours (Kg)	39.5	33	32	31
Rectal Temperature at death (^{0}C)	39	38.9	41.4	40.6
Atmospheric Temp. at death (^{0}C)	30	30	30	30
Time of Death	9.12	9.4	9.5	10.18

Table 3a: Day 1 Visible Changes – 10 minutes periodic data after death.

TIME	BT (^{0}C)	AT (^{0}C)	RT (^{0}C)	VISIBLE CHANGES	Insect / Fly Activities
9.22am	39	34	32	**No pupillary reflex.**	Nil
9.32am	39	34	33	**Pallor mortis starts.**	Nil
9.42am	38	34	33.1	**Algor mortis starts.**	Nil
9.52am	37	34	33.2	**Body temperature continues dropping**	Nil
10.02am	37	34	34	**Livor mortis starts; Temperature continues to drop.**	Nil
10.12am	37	34	34	**Rigor mortis starts.**	Nil

BT. Body temperature AT. Atmospheric temperature RT. Room temperature

Table 3b: Day 1 Visible changes – hourly observation.

TIME	BT (^{0}C)	AT (^{0}C)	RT (^{0}C)	VISIBLE CHANGES	Insect / Fly Activities
11.12am	37	40	33	**Pallor, Algor, Livor and Rigor mortises progress.**	Nil
12.12pm	36.4	47	34	**Pallor, Algor, Livor and Rigor mortises progress.**	Nil
1.12pm	36.1	42	35.2	**Pallor, Algor, Livor and Rigor mortises progress.**	Nil
2.12pm	36	42	36.9	**Pallor, Algor, Livor and Rigor mortises progress.**	Nil
3.12pm	35.8	44	37	**Body fluid discharges from nose and oral cavity.**	Nil
4.12pm	35.6	40	37	**Putrid gases discharge from body; Waning of rigor mortis starts; Lividity stops.**	Houseflies at the oral region
5.12pm	35.6	40	36.7	**Waning of rigor mortis progresses with bloating; Body turns completely pale; Algor mortis progresses.**	Fly activities progresses.

Animals were moved to the research site and placed on the soil surface by 5.50pm. Animals started bloating started bloating at the same time by 6.40pm.
BT. Body temperature, AT. Atmospheric temperature, RT. Room temperature

Table 4: Day 2 Visible Changes.

TIME	HEAD & NECK VISIBLE CHANGES	TRUNK VISIBLE CHANGES	LIMBS VISIBLE CHANGES
MORNING (7:01am)	Bloating of the head and neck. Protrusion of the tongue.	Bloating and marbling of the abdomen. Greenish discolouration of the trunk close to the soil surface. Exposure of bloated rectal contents.	Bloating of the limbs with greenish discolouration.
AFTERNOON (2:02pm)	Gross exposure of the tongue attracting flies to the oral region.	Purging of abdominal fluid with increased bloating.	Bloating of the limbs progressed.
EVENING (6:40pm)	Increased fly activity at the oral region.	Purging of fluid increased. Intestinal pressure increased with released of putrid gases. Increased exposure of rectal contents.	Bloating progressed, with discoloured to green.

Table 5: Day 4 Visible Changes.

TIME	HEAD & NECK VISIBLE CHANGES	TRUNK VISIBLE CHANGES	LIMBS VISIBLE CHANGES
MORNING (6:15am)	Whitish fluid substance purging out of the neck with less putrid odour. Increased fly activity on the eye, ear and oral region Sagging and drying of skin of neck and ear.	Skin slippage of the perineal region with maggot activity Presence of maggots at lower lumbar region and abdomen. Presence of ants and few flies. Skin appeared fresh and bloated.	Skin slippage and few maggot activities.
AFTERNOON (12:47pm)	Skin slippage and sagging of the neck. Maggot activities present at the oral region and head structures.	Some structures of the trunk remained bloated with skin slippage of the dorsal trunk.	Active decay stage progressed. Skin slippage of the four limbs. Increased maggot activity at the hind limbs.
EVENING (5:58pm)	Active decay stage progressed. Swarm of maggots present. No fly activity.	Active decomposition progressed. No fly activity. Swarm of maggots on all aspects of the trunk.	Skin slippage progressed. Hind limb bones became more visible. Decreased maggot activity.

Table 6: Day 21 Visible Changes.

TIME	HEAD & NECK VISIBLE CHANGES	TRUNK VISIBLE CHANGES	LIMBS VISIBLE CHANGES
MORNING (6:37am)	Mummification progressed. Body appeared dark-brown. No fly and maggot activity.	Mummification progressed. Body appeared dark-brown. No fly and maggot activity.	Mummification progressed. Body appeared dark-brown. No fly and maggot activity.
AFTERNOON (12:38pm)	No visible changes.	No visible changes.	No visible changes.
EVENING (6:27pm)	No visible changes.	No visible changes.	No visible changes.

Table 7: Day 49 Visible Changes.

TIME	HEAD & NECK VISIBLE CHANGES	TRUNK VISIBLE CHANGES	LIMBS VISIBLE CHANGES
MORNING (6:31am)	Active decay and mummification progressed. Dark-brown discoloration of skin continued. No fly and maggot activity.	Active decay and mummification progressed. Dark-brown discoloration of skin continued. No fly and maggot activity.	Active decay and mummification progressed. Dark-brown discoloration of skin continued. No fly and maggot activity.
AFTERNOON (12:23pm)	No visible changes.	No visible changes.	No visible changes.
EVENING (6:14pm)	No visible changes.	No visible changes.	No visible changes.

Table 8: Estimated timeline of decomposition.

Stage / Period	Timeline	Duration
PALLOR MORTIS	00:20 PMI – 08:00 PMI	8 Hours
ALGOR MORTIS	00:30 PMI – 08:00 PMI	8 Hours
RIGOR MORTIS	00:50 PMI – Day 2	32 Hours
LIVOR MORTIS	00:50 PMI – 07:00 PMI	6 Hours
FRESH	00:00 PMI – 09:28 PMI	9 Hours 30 Minutes
BLOAT	08:30 PMI – Day 4	3 Days
ACTIVE DECAY	Day 3 – Day 21	18 Days
ADVANCED DECAY	Day 5 – Day 49	44 Days
DRY DECAY	Nil	Nil

Table 9: Climatic factors that could affect the rate of decomposition.

DAY	Highest Atmospheric Temperature (^{0}C)	Lowest Atmospheric Temperature (^{0}C)	Highest Humidity (%)	Lowest Humidity (%)
1	47	27	65	24
2	46	26	70	20
3	43	26	84	22
4	39	26	80	24
5	39	26	65	23
6	39	24	97	44
7	41	26	85	25
8	39	25	84	24
9	38	26	82	41
10	39	26	83	46
11	41	27	74	35
12	39	27	83	33
13	38	27	80	44
14	38	27	75	28
15	37	21	75	10
16	40	22	50	25
17	40	23	53	18
18	39	25	69	25
19	40	26	84	24
20	40	27	77	26
21	39	26	81	31
22	37	26	79	34
23	38	26	92	49
24	38	26	75	34
25	36	25	90	50
26	37	26	85	40
27	38	26	90	24
28	36	24	90	27
29	38	26	85	24
30	37	25	90	26
31	38	26	83	35
32	37	26	86	44
33	38	26	86	43
34	34	25	98	25
35	36	26	86	24
36	36	26	92	43
37	36	26	90	42
38	39	26	86	32
39	37	26	82	25
40	39	25	81	33
41	38	26	83	40
42	39	25	86	31
43	39	26	81	31
44	40	26	88	30
45	41	27	81	27
46	41	26	82	26
47	39	26	84	24
48	38	24	90	25
49	39	25	91	26

DISCUSSION

Results from the visible changes of the first eight hours post-mortem revealed that autolysis (pallor, algor, rigor and livor mortises) took place at a faster rate. This could be as a result of the high body temperatures of the carrions. Several authors such as Rao [2], Biswas [7], Finley *et al.* [11], and Hanna and Moyce [12] reported that elevated atmospheric and / or body temperatures increase autolysis and subsequently increase decomposition process. Body cooling started 30 minutes post mortem. This speedy process of body cooling in both study areas also suggest that the strangulation process enhanced the decomposition rate. This is because Hanna and Moyce [12] have reported in their findings that mode of death (such as strangulation) is a factor that accelerates the rate of decomposition. The colour changes (paleness or pallor mortis) of the skin was first observed 20 minutes post-mortem (00:20 PMI). This could be as a result of the high ambient and body temperatures. Muscular rigidity (rigor mortis) was first observed at 00:50 PMI. This early muscular rigidity observed indicates that there was an early speedy decomposition process. This is in line with reports by Hanna and Moyce (2008), which noted that early muscular rigidity after death is one of the first signs of autolysis. Rigor mortis did not last long which could be as a result elevated body temperature of the carrions, which sped-up the decomposition process of the carrions. However, the visible changes observed within the first eight hours would have been different if the first eight hours observations were carried out immediately outside close doors of any room or laboratory so that the animals will immediately have a contact with the floral and faunal communities and climatic factors of the environment. Therefore, this study suggests that further investigations be carried out on the decomposition rate and pattern of matured pigs without concealing the pigs in laboratory or room within the first eight hours of death.

Results from visible post-mortem changes showed that putrefaction phase started towards the end of the autolytic phase (07:00 PMI). The visible changes of decomposition include bloating of body parts especially the trunk, greenish discolouration of skin of the trunk, marbling of skin, degradation of few body parts and dark-brown discolouration of the limbs. Decomposition initially started at a fast rate (during the 8-hour indoor observation), but when the carrions were taken to the research site (outdoor clandestine site), and exposed to very high temperatures, the decomposition rate slowed down and mummification took place. This is because, the extreme temperatures (soil and atmospheric) became very harsh for entomofauna activities to persist on the carrions. This report goes in line with the reports from authors that noted that mummification is a decomposition process that occurs in very hot dry conditions or areas of low humidity causing rapid drying (dehydration and desiccation) of the skin and internal organs [13, 14]. The activities reported in the results obtained from the visible post mortem changes are consistent with the findings reported by Carter *et al*. [15], Forbes *et al.* [16], Janaway *et al*. [17], and Powers [18], but does not corroborate with the putrefaction process reported by Rao [2], Biswas [7], Hanna and Moyce [12], and Hyde *et al.* [19]. The difference in the changes that occurred at the first eight hours and when the animals were exposed to environmental conditions showed that there is need to carry out further studies during the rainy season so as to either corroborate these findings or publish new taphonomic data in the Guinea forest-savannah vegetation.

The decomposition timelines of the animals were deduced from the visible post mortem changes that occurred during autolysis and putrefaction phases. The first sign of decomposition was pallor mortis. Hanna and Moyce [12] also reported that the first sign of decomposition is pallor mortis. Algor mortis started at 00:30 PMI and lasted for a period of 8 hours. Algor mortis was preceded by pallor mortis. The approximate timeline for rigor mortis was 32 hours post-mortem. However, rigor mortis occurred at the same time with body cooling (algor mortis), pallor mortis and livor mortis (lividity). Livor mortis started at about

50 minutes post mortem (00:50 PMI) and lasted for about six hours. The timeline for rigor and livor mortises contradicts the reports on decomposition timeline by Payne [8]. According to Hanna and Moyce [12], Janaway et al. [6] and Payne [8], these early visible changes (pallor, algor, rigor and livor mortises) are notable visible changes of the fresh stage of decomposition.

Bloat stage started at about eight hours post mortem (08:00 PMI), and lasted for a period of about three days. Bloat stage was enhanced by high ambient and body temperatures. This report is supported by the literature documented by Finley et al. [11] which noted that high ambient and body temperatures accelerate autolysis. The approximate timeline of bloat stage is similar to the reports by Hanna and Moyce [12] and Megyesi et al. [20].

The active decay stage started at about third day post mortem (Day 3 PMI), and lasted for a period of about 18 days. This active decay pattern is similar to the reports by Hanna and Moyce [12], and Megyesi et al. [20]. Active decay stage lasted long because of mummification (which was caused by extreme atmospheric and soil temperatures). Mummification process started at about fourth day post mortem (Day 4 PMI) and progressed to the end of the study period (Day 49).

Mummification has been reported as a factor that delayed the rate of decomposition in very hot climates by Carter et al. [15], Forbes et al. [16], Janaway et al. [17], and Schotsmans et al. [21].

The approximate timeline for advanced decay stage of decomposition in the guinea forest-savannah vegetation started at about the 21st day post-mortem (Day 21 PMI), and lasted till the end of the study period. The approximate timeline of advanced decay stage was similar to the reports by Carter et al. [15] and Janaway et al. [17].

Mummification influenced the approximate timeline of advanced decay stage. There was no dry decay (skeletonization) stage. However, for a more robust and accurate decomposition timeline estimation, this study recommends that the Animal Protection Index of Nigeria grants approval for the use of up to 30 matured pigs to carry out this study. This was a limitation to this study.

CONCLUSION

The autolytic phase of decomposition occurs almost at the same time with the putrefactive phase. The Fresh stage of decomposition lasted about 10 hours. The bloat stage of decomposition started on the first day and lasted for three days. Due to mummification, there was no distinction between the active decay stage and advanced stage of decomposition. However, visible changes characteristics with the active decay stage started at the third day and lasted for 18 days; whereas visible changes characteristic with the advanced decay stage started on the fifth day on some of the animals and lasted till the last day of the study. However, the visible changes identified in this study can be used to estimate the timeline of decomposition of a Guinea forest-savannah vegetation of Nigeria; thereby confirming the testimonies of a suspect or an alibi in the law court.

Four stages of decomposition were identified in this study. The decomposition process in the Guinea forest-savannah vegetation of Nigeria is very slow because of extreme temperatures. In addition, there was incomplete skeletonization of the pigs due to mummification. All the animals mummified within the first seven days after death.

Conflicts of Interests:

Authors have declared that no competing interests exist.

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Author Contributions

This work was carried out in collaboration of all authors; and all authors read and approved the final manuscript. Author **Onyejike, Darlington Nnamdi (ODN)** carried out the experiment and wrote the first draft of the manuscript. Author **ODN** also assisted author **EUG** to design the study. Author **Fischer, Victor Adolf (FVA)** reviewed the draft manuscript. Author **Esomonu, Ugochukwu Godwin (EUG)** conceptualized the study, designed the study, and supervised the experimental study. Author **Aguwa, Ugochukwu Samuel (AUS)** curated the data. Author **Ezenwatu,**

Emmanuel Nzube (EEN) assisted author **OIM** to manage the literature searches. Author **Akukwu, Darlington Cyprain (ADC)** assisted author **FVA** to review the draft manuscript. Author **Okeke, Somadina Nnamdi (OSN)** wrote the experimental protocol. Author **Obiesie, Ifechukwu Justicia (OIJ)** assisted author **ODN** to carry out the experiment. Author **Okubike, Emeka Ambrose (OEA)** acquired and managed the animals. Author **Ojemeni, Gloria Chinenye (OGC)** assisted author **AUS** to curate the data. Author **Agulanna, Ambrose Echefulachi (AAE)** assisted authors **AUS and OGC** to curate the data. Author **Onyejike, Ifeoma Miracle (OIM)** managed the literature searches.

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