

Original Article

TAPHONOMIC STUDY OF ADULT *SUS SCROFA DOMESTICA* IN EQUATORIAL CLIMATE IN SARAWAK, MALAYSIA.

Ting Kwong Ing¹, Normaizatul Afizah Ismail*², Zury Azreen Azizul Rahman³, Ab. Halim Mansar⁴.

¹ Forensic Science Programme, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia.

² Kulliyyah of Medicine and Health Sciences, Kolej Universiti INSANIAH, Kedah, Malaysia.

³ Lincoln University College, Petaling Jaya, Malaysia.

⁴ Taylor's University, Subang Jaya, Malaysia.

ABSTRACT

This was the first taphonomic study conducted in Sarawak, Malaysia. In this research, two adults female Sus scrofa domestica weighed 77 kg each were killed by machete at the heart region. In order to mimic a real human body, clothes made of pure cotton was put on the subjects. Pure cotton clothes are mostly worn by Malaysian population due to hot and humid climate. Both the carcasses were placed in separate locations labelled as A and B in a jungle and taphonomic changes were recorded. All stages of decomposition namely the fresh stage, bloated stage, active decay stage, advanced decay stage and remains stage were observed and documented. Daily observation on both the remains was recorded. The ambient temperature, internal body temperature, temperature of larvae mass, body surface temperature, soil surface temperature and humidity of air were recorded daily. Time for each stage of decomposition was determined. During the decomposition process, insects and larvae appeared in each stage of decomposition process were collected and preserved for reference. Photos and videos were taken on each subject throughout the research. The hot and humid climate in Sarawak accelerates the decomposition process. The time taken for both bodies to reach remains stage was nine days. Both the cotton clothes were still preserved until the end of research. In conclusion, it took 9 days for Sus scrofa domestica to be fully skeletonised, on the ground, in an equatorial climate of Sarawak, Malaysia.

Keywords: taphonomic study; *Sus scrofa domestica*; cotton clothes; decomposition process; equatorial climate

INTRODUCTION

Taphonomic study on adult *Sus scrofa domestica* in hot and humid climate in Malaysia was studied to mimic the real human body decomposition. Study on human decomposition is not eligible for ethical approval, therefore an alternative was used for that purpose. In Malaysia, data on taphonomic changes concerning the time range is not available. Most of the research were concentrating on insect succession pattern [1, 2]. Based on that drawback, a research was conducted in Bintingor, Sarawak to find out the decomposition rate for on-the-ground body disposal. It is quite common for murder cases to have the body being dumped in the rural area or open field in the jungle.

This study was the pioneer research on taphonomic study in Sarawak. Sarawak is located in equatorial climate in Malaysia, having a high and stable temperature throughout the year. The annual mean temperature of Malaysia is 27.3 °C except for Genting Highlands and Cameron Highlands which

have lower annual mean temperature of 18.6 °C [3]. In this research model, two female adults *Sus scrofa domestica* weighed 77 kg each was selected due to its size that resembles the adult human body. *Sus scrofa domestica* as a human body surrogates is an acceptable manner for scientific research [4]. It is known that, adults *Sus scrofa domestica* can be used as an analogue for human body due to its characteristic such as lack of fur, having the same weight with a normal human body, and easily obtain from the market [5-7]. Apart from that, the decomposition process for *Sus scrofa domestica* was found to be almost the same with the human body. The decomposition time for each stage was almost the same with human body under the same environmental condition [7].

This taphonomic study can generate a complete set of data which includes pattern of insect succession, post-mortem interval determination based on the decomposition rate, effects of cotton clothes on the decomposition process, effects of equatorial climate on the research study and

comparison of research study between West Malaysia and East Malaysia in the aspects of decomposition rate. The outcome of this study can benefit the enforcement body in the investigation of crime scene involving a human body as well as the researchers in this field.

MATERIALS AND METHOD

This study was conducted in the morning on 26 May 2009. Two adults *Sus scrofa domestica* carcasses with weigh of 77 kg each were used in this study. The subjects were killed by piercing at the heart region with a machete, as advised by the ethical committee. After that, cotton clothes were put onto both the carcasses. Later, the carcasses were transferred into a jungle, on the ground of two different sites labelled as Site A and Site B. The distance of the sites was 400 footsteps away from each other. Fencing (120 cm × 70 cm × 48 cm) was built around the carcasses to protect them from wild animals. In this study, cotton clothes was put onto the adult *Sus scrofa domestica* due to the preference of Malaysian to wear sweat-absorbent material like cotton for daily attire.

Observations were made for 26 days with 3 visits per day except on the first day. The first-day visit was in the morning (0800 hrs), the second visit was in the noon (1200 hrs) and the third visit was in the afternoon (1800 hrs). First day observation was conducted 4 times (1100 hrs, 1300 hrs, 1800 hrs, and 2100 hrs) to evaluate the changes of the carcasses in details. Climatological data such as ambient temperature and humidity were recorded for 26 days by using digital thermometer and hygrometer. Ground temperature, body surface temperature, internal temperature and maggot mass temperature were taken in each visit. Adult flies were caught by using sweep net. Some of the fly larvae were collected using for-

ceps and put into 70% ethyl alcohol for preservation [8]. The specimens were processed for storage and kept as a record in the Forensic Science Department, Faculty of Allied Health Sciences, National University of Malaysia.

RESULTS AND DISCUSSION

The air humidity in the jungle of Bintangor, Sarawak for the 26 days ranged from 69% to 93% (mean 83.54 %, ± 6.21%) at Site A while ranged from 73% to 95% (mean 85.27%, ± 6.00%) at Site B. Three times of raining were recorded during the study (day-1, 9 and 13).

The ambient temperature ranged from 27.1°C to 32.4°C (mean 30.17°C, ± 1.34°C) at Site A while ranged from 27.0°C to 31.9°C (mean 29.85°C, ± 1.32°C) at Site B. Ground surface temperature recorded ranged from 26°C to 28°C (mean 27.38°C, ± 1.32°C) at Site A while ranged from 27°C to 31°C (mean 28.46°C, ± 1.30°C) at Site B. Maggot mass temperature varied from 33°C to 48°C (mean 43.14°C, ± 4.85°C) at Site A while ranged from 28°C to 51°C (mean 42.43°C, ± 7.79°C) at Site B. Internal temperature ranged from 27°C to 50°C (mean 39.23°C, ± 7.34°C) at Site A while ranged from 27°C to 55°C (mean 37.73°C, ± 8.27°C) at Side B.

Five stages of decomposition process were observed in the study. The stages were classified as fresh, bloated, active decay, advanced decay and remains (Table 1). All of the decomposition processes took a certain period of time. From the graph (Figure 1 & 2), there was a higher temperature of maggot mass temperature and internal temperature.

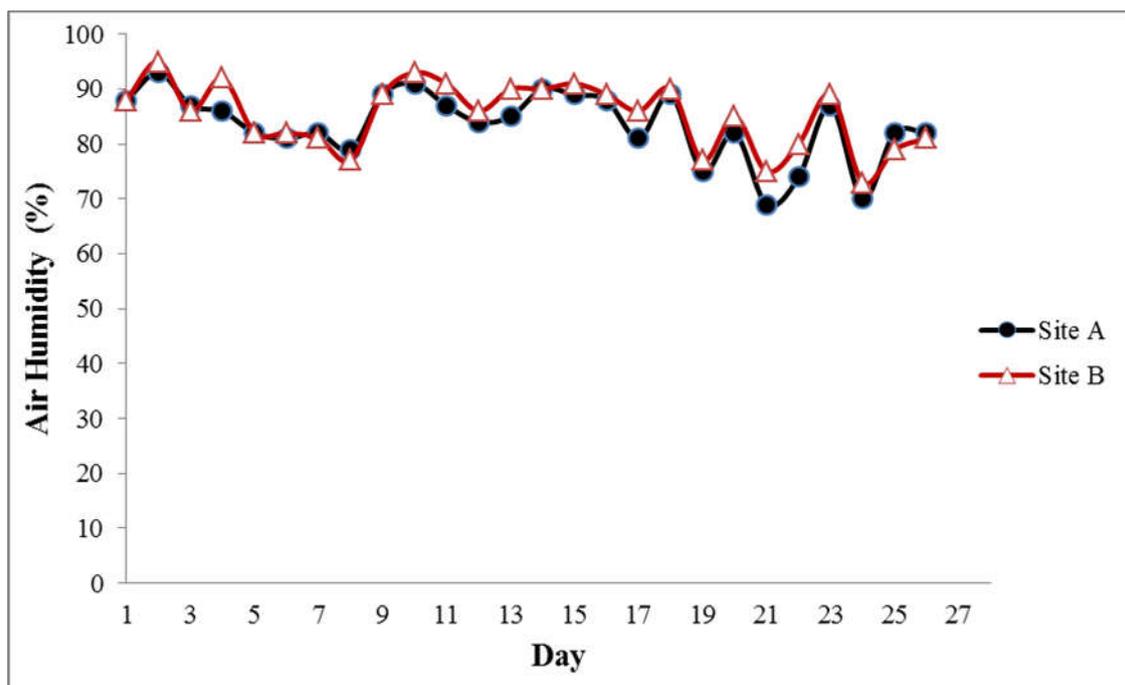


Figure 1: Air humidity in Bintangor, Sarawak

Table 1: Stages of decomposition

Stage	<i>Sus scrofa domestica</i> A	<i>Sus scrofa domestica</i> B
	Day	Day
Fresh	1	1
Bloated	2-3	2-3
Active decay	4-6	4-6
Advanced decay	7-8	7-8
Remains	9-26	9-26

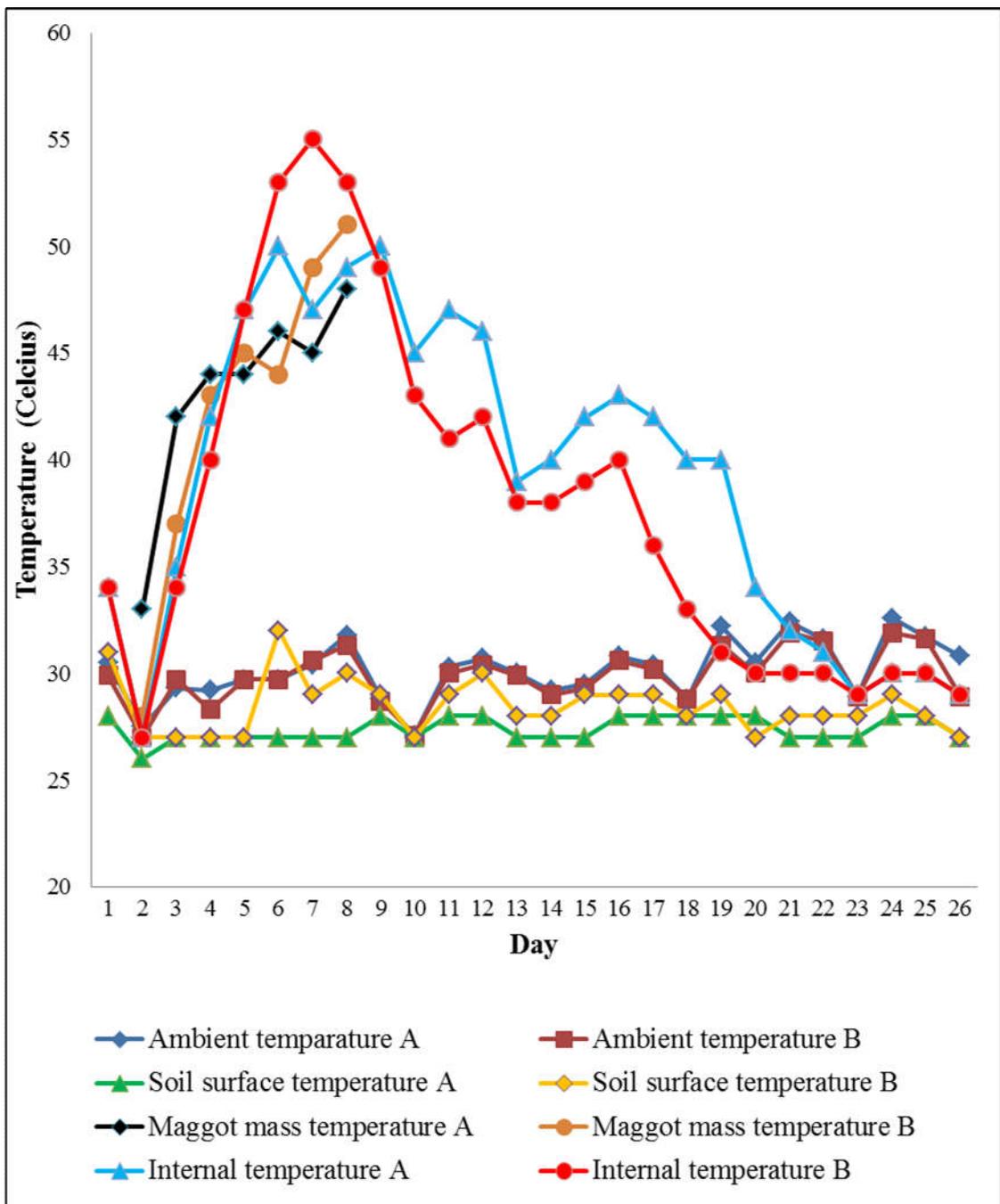


Figure 2: Data from site A and site B

DISCUSSION

In this study, two adults *Sus scrofa domestica* displayed the five stages of the decomposition process namely fresh, bloated, active decay, advanced decay and remains. Each stage had emerged at certain time period as showed in Table 1. The cotton clothes on the carcas had little or no significant effects on the decomposition process. This phenomenon could be explained through the research done in West Malaysia [2]. Only slight colour changes were noted, from original blue to brownish in colour due to contamination by putrefaction fluid. Generally, the textile material would undergo a different rate of decomposition and greatly depends on the composition, colouring, and treatment done on the textile [4]. The cotton clothes cannot withstand the acidic environment. The putrefaction process would alter the surroundings and eventually promote the microorganism activity, increase the pH and redox reactions [9]. The clothes in the study were still well preserved due to the blue synthetic colour used on the clothes. The coloured-synthetic pigment could prevent the clothes from being decomposed [10].

The air humidity in Bintangor, Sarawak is high and always above 65% during the study (Figure 1). Air humidity was higher in the morning and afternoon if compare to noon due to heat from the sun. Since Bintangor in Sarawak displayed Equatorial climate characteristic, it will accelerate the decomposition process of *Sus scrofa domestica*. The carcasses have 60% to 80% water inside their body tissue. During the decomposition process, there was a competition of water between the decomposition and drying process [11]. In an extremely humid condition, decomposition process will slow down due to saturated water in the tissue [12]. On the other hand, humidity was positively correlated with the insect's activity [13]. Further research had proven that rain has little or no effects on the insect's activity [13]. In this study, the adult flies were reduced greatly during the rain but the larvae were still active. During the rain, adult flies were hiding inside the clothes worn by the carcasses and behind the leaves.

The taphonomic study in Bintangor, Sarawak showed the ambient temperature of Site A and Site B were high, stable and displayed same data distribution pattern (Figure 2). Ambient temperature is vital and influential in decomposition process [12, 13]. Thus, faster rate of decomposition was observed in high ambient temperature [14]. The ambient temperature of Bintangor, Sarawak was always over 25°C during the study, thus promoting faster decomposition rate on both the carcasses. The ground surface temperature at both sites did not fluctuate drastically according to the ambient temperature. Generally, the ground surface temperature is always cooler due to shading effect from the surroundings trees. So far there is no research being conducted and proven that there is a correlation between decomposition process and ground surface temperature.

Maggot mass temperature was recorded from the beginnings since the emergence of the first instar larvae which initially feeds on fluid exuded from the carcas. The first instar larvae was usually found at the mouth region which filled with

bloody fluid due to the internal trauma [15]. On the other hand, the maggot mass temperature had no different with the ambient temperature but increased drastically during the emergence of the third instar larvae [14]. The maggot mass temperature of Site A and Site B reached around 50°C (Figure 2) during advanced decomposition stage (Table 1). Maggot mass temperature is always higher than ambient temperature [14]. Increased decomposition rate is directional proportional to the increased temperature [13]. In addition, the clothing worn by the carcas was providing heat to the eggs and larvae [15]. Maggot mass temperature increased drastically due to increased rate of decomposition process and biological activity [16]. Maggot mass temperature started to increase on the second day which was the bloated stage for the remains. No maggot mass temperature was recorded on the ninth day which was the remains stage commenced. This phenomenon was due to depletion of tissue for maggot consumption and all maggots had fully developed into adult flies. New maggot emergence was impossible due to lack of interest of adult flies to lays eggs on the remains.

Apart from that, internal temperature of both *Sus scrofa domestica* was 55°C which was the highest during the advanced decay stage (Figure 2). This temperature was equal to the maggot mass temperature. Thus, the active decomposition process had taken place. Furthermore, increased rate of decomposition and biological activity will directly elevate the temperature [16]. From this study, the internal temperature started to decrease on 9th day (Figure 3) signalling beginning of remains stage and decreased maggot activity. The decomposition process was decreased due to depleted soft tissue for further autolysis. The amount of insect presence was greatly reduced. According to Payne (1965), to determine starting point of remains stage immediately after the advanced decay stage is difficult. However, the starting point of remains can be determined by the surrounding flora or weeds around the carcasses. On the other hand, no growing of flora or weeds was clearly observed in the study conducted in Bintangor, Sarawak. Thus, the guideline of observing the starting point of remains stage cannot be applied in this study. However, the internal temperature and maggot mass temperature are the most appropriate way to determine each of the decomposition stage.

CONCLUSION

In conclusion, the taphonomic study in Bintangor, Sarawak showed that five stages of decomposition (fresh, bloated, active decay, advanced decay and remains) were clearly defined and each of the stage took certain period of time. The cotton clothes had little or no significant effect on the decomposition process as the ambient temperature effect outweighed the clothing effect. The equatorial climate in Bintangor, Sarawak had increased the rate of decomposition process. The decomposition process of carcas in West Malaysia and East Malaysia (Bintangor, Sarawak) is almost the same which took 9 days to skeletonise *Sus Scrota domestica* of 77kg.

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REFERENCES

1. Ahmad, A. and A.H. Ahmad, *A preliminary study on the decomposition and dipteran associated with exposed carcasses in an oil palm plantation in Bandar Baharu, Kedah, Malaysia*. Tropical Biomedicine, 2009. **26**(1): p. 1-10.
2. Heo, et al., *A preliminary study of insect succession on a pig carcass in a palm oil plantation in Malaysia*. Tropical Biomedicine, 2007. **24**(2): p. 23-27.
3. Chong, M.S., *PMR Geografi*. 2007, Selangor: Sasbadi Sdn.Bhd.
4. Haglund, W.D. and M.H. Sorg, *Advances in Forensic Taphonomy : Method, Theory, and Archaeological Perspectives*. 2002, New York: CRC Press
5. Schoenly, K.G., et al., *Using pig carcasses as model corpses to teach concepts of forensic entomology & ecological succession*. American Biology Teacher, 2006. **68**(7): p. 402-410.
6. Anderson, G.S. and V.J. Cervenka, *Insects associated with the body: Their use and analyses*. Advances in Forensic Taphonomy, 2002: p. 173-200.
7. Payne, J.A., *A summer carrion study of the baby pig *Sus scrofa* Linnaeus*. Ecology, 1965. **46**(5): p. 592-602.
8. Haskell, N.H., et al., *Use of aquatic insects in determining submersion interval*. J Forensic Sci, 1989. **34**(3): p. 622-32.
9. Janaway, R.C., *The preservation of organic materials in association with metal artefacts deposited in inhumation graves*. . In Death Decay and Reconstruction : Approaches to Archeology and Forensic Sciences ed. A. Boddington, A.N. Garland, and R.C. Janaway. 1987, Manchester: Manchester University Press.
10. Tibbett, M. and D.O. Carter, eds. *Soil Analysis in Forensic Taphonomy*. Chemical and Biological Effects of Buried Human Remains. 2008, CRC Press: Boca Raton.
11. Aufderheide, A.C., *Soft tissue palaeopathology-an emerging subspecialty*. Human Pathology, 1981. **12**: p. 865-867.
12. Campobasso, C.P., G. Di Vella, and F. Introna, *Factors affecting decomposition and Diptera colonization*. Forensic Science International, 2001. **120**(1-2): p. 18-27.
13. Mann, R.W., W.M. Bass, and L. Meadows, *Time since death and decomposition of the human body: variables and observations in case and experimental field studies*. J Forensic Sci, 1990. **35**(1): p. 103-11.
14. Joy, J.E., N.L. Liette, and H.L. Harrah, *Carrion fly (Diptera : Calliphoridae) larval colonization of sunlit and shaded pig carcasses in West Virginia, USA*. Forensic Science International, 2006. **164**(2-3): p. 183-192.
15. Klotzbach, H., et al., *Information is Everything- A case report demonstrating the necessity of Entomological knowledge at the crime scene*. Journal of Forensic Medicine and Toxicology, 2004. **5**(1): p. 19-21.
16. Carter, D.O., D. Yellowlees, and M. Tibbett, *Cadaver decomposition in terrestrial ecosystems*. Naturwissenschaften, 2007. **94**(1): p. 12-24.

Corresponding author: Normaizatul Afizah Ismail
Email address: maifor@yahoo.com

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