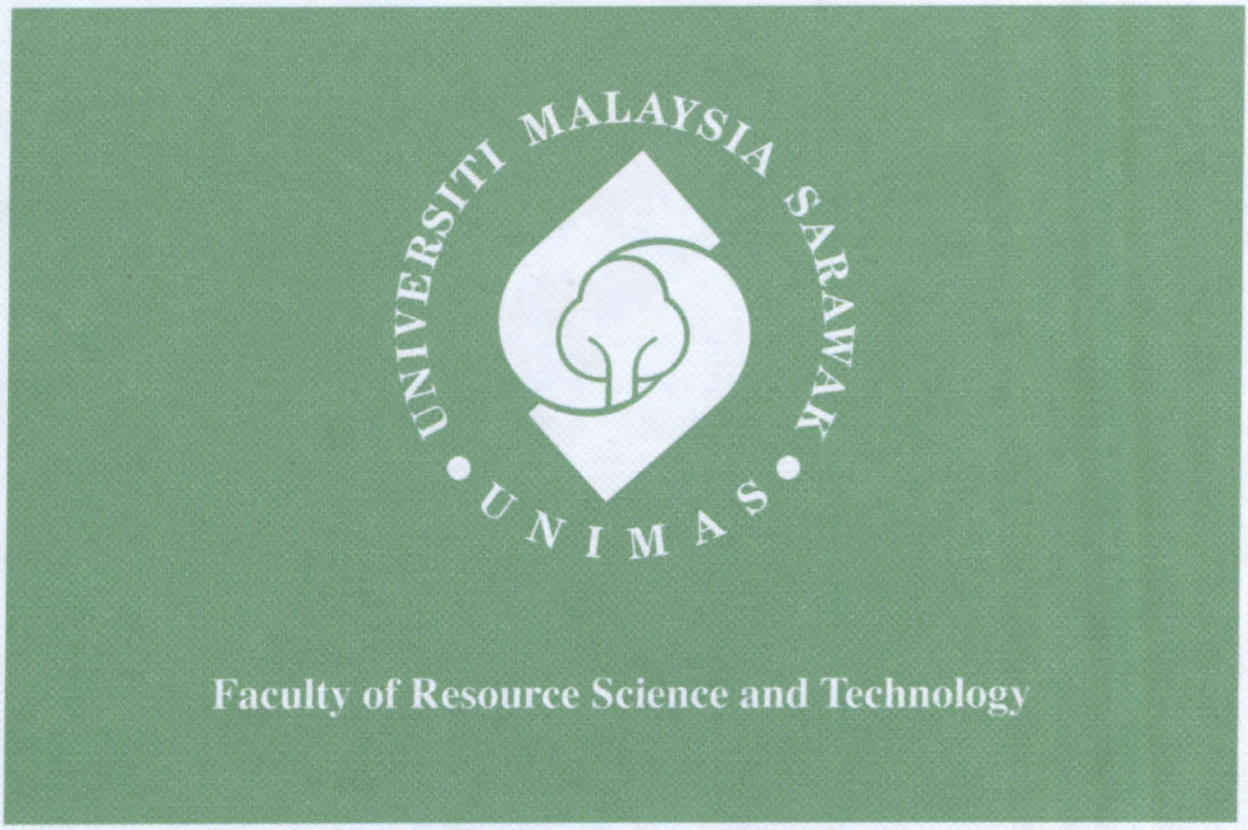

DECOMPOSITION OF TISSUES IN DIFFERENT TYPES OF SOIL

Nur Aina Syahira Binti Zikri

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Bachelor of Science with Honours
(Animal Resource Science and Management)
2015

UNIVERSITI MALAYSIA SARAWAK

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PhD ☐

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DECOMPOSITION OF TISSUES IN DIFFERENT TYPES OF SOIL

NUR AINA SYAHIRA BINTI ZIKRI

This project is submitted in partial fulfillment of the requirement for the Degree of

Bachelor of Science with Honors

(Animal Resource and Science Management)

Department of Zoology

Faculty of Resource Science and Technology

UNIVERSITI MALAYSIA SARAWAK

2015

DECLARATION

I hereby declare that no portion of this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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The project entitled 'Decomposition of tissues in different types of soil' was prepared by Nur Aina Syahira binti Zikri and submitted to the Faculty of Resource Science and Technology in partial fulfillment of the requirements for the Degree of Bachelor of Science (Honours) in Animal Resource and Science Management.

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(Mr Mohd Zacaery Khalik)

Date: _____

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LIST OF ABBREVIATIONS

PMI – Post Mortem Interval

UNIMAS- Universiti Malaysia Sarawak

USDA – United State Department of Agriculture

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Decomposition Of Tissues In Different Types Of Soil

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ABSTRACT

Different types of natural soil have different properties due to the color, composition, texture and consistency. The study was conducted to observe the decomposition stages and the decomposition rate of the samples. In order to investigate soil type effect on decomposition, a study had been conducted by using the head part of fresh domestic chicken carcass (*Gallus gallus*) buried in four different types of soil. Types of soil chosen were laterite, sandy, clay and peat soil. In this study, the soil temperature, relative humidity, moisture, light intensity, pH and rainfall was also observed. The results show that the most rapid decomposition process was in laterite soil while clay soil shows the slowest decomposition. The result also shows that all the physical factors are independent with one another.

Keywords: decomposition stages, soil taphonomy, temperature, humidity.

ABSTRAK

Jenis tanah semula jadi mempunyai ciri-ciri yang berbeza disebabkan oleh warna, komposisi, tekstur dan konsistensi. Kajian ini dijalankan untuk melihat tahap penguraian dan kadar penguraian sampel. Bagi mengkaji kesan jenis tanah pada penguraian, satu kajian telah dijalankan dengan menggunakan bahagian kepala bangkai ayam domestik (Gallus gallus) yang dikebumikan dalam empat jenis tanah yang berbeza.Tanah yang dipilih adalah tanah laterit,, tanah berpasir, tanah liat dan tanah gambut. Dalam kajian ini, suhu tanah, kelengasan, kelembapan, keamatan cahaya, pH dan hujan juga diperhatikan. Hasil kajian menunjukkan bahawa proses penguraian yang paling cepat adalah di dalam tanah laterit, manakala tanah liat menunjukkan penguraian yang paling lambat. Hasil kajian juga mendapati bahawa factor fizikal tidak bergantung kait antara satu sama lain.

Kata kunci: peringkat penguraian, taphonomi tanah, suhu, kelembapan.

1.0 INTRODUCTION

Currently, there is handful information regarding the studies of decomposition on terrestrial ecosystem. However, there is only subtle information regarding buried cadaver in different types of soil while most of the studies usually done above the ground. Oxford Dictionary of Biology (2004) refers decomposition, as a process where decomposer breaks down organic matters chemically, resulting in its very own constituents fractions. The study of Hunter *et al.* (1996) showed that there are many factors affecting the process of decomposition. These include the body condition at burial time, the nature and environment of burial, size of the bones and body, pH of the soil, water content, temperature, and the depth of burial.

Taphonomy is a branch of forensic study that investigate decomposition process of buried carrion over time and the ecology of decomposition sites. It is important in order to get in depth knowledge about the process happened to carrion below ground and the pattern of decomposition; to evaluate the post burial or post mortem interval (PMI) from the processes assisting the cadaver decomposition, determining the cause and aspect of death, locating clandestine graves and distinguish the deceased (Haglund, 2005). Different types of soil have different types of characteristics, color, texture, composition and consistency. Soil provides setting of chemical and physical such as heat, moisture, nutrient and gases. It is generally assumes that these differences of soil characteristics will give different impacts on the decomposition process depends on the condition of burial like depth or physical, biological, and chemical characteristics.

1.1 Background of study

In this experiment, the decomposition rate of domestic chicken head in different types of soil was studied. The samples of twenty domestic chickens (*Gallus gallus*) were

used in this study. *Gallus gallus* is used as a replacement and representative subject for other organisms like rats, bats, and other organisms in decomposition process. It is used because it can be found easily. By using this sample, the freshness of the sample can be standardised, as all samples were available and can be processed at almost the same time.

Most of biological activity productivity depends on the specific properties of soil. Basically, there are four types of soil; peat, clay, sandy and laterite were used in this study. The other researchers in their study used all types of soil except laterite soil which was tested in this study.

1.2 Problem statements

The study of the decomposers in soil and the study of the processes of decomposition in open spaces are often studied but the study of the processes of decomposition in soils is often given scant consideration. In this study, the physical factors such as temperature, humidity, moisture, pH and weather of the study sites were evaluated to see the effects on decomposition processes (Tumer *et al.*, *2012*). On the other hand, finding the right and suitable soil with the most rapid decomposition rate assist in skulling process of multiple samples at a time in order to avoid consuming a long time just to complete a sample.

1.3 Significant of study

The results of this study provide data on the soil that provide the highest decomposition rate which serve as a reference for future taphonomic investigation; and to aid in skulling process especially in preparing museum skull and sketch specimens. Besides, this study will aid in determining the time of decomposition or PMI of animals in such cases or problems like illegal trading, exotic animal consumption and poaching.

1.4 Objective

The specific objectives of this study are;

- to compare the rate of decomposition of *Gallus gallus* skull in different type of soils; and,
- to determine the parameters that affect the decomposition processes; light intensity, temperature, humidity, moisture, rainfall and decomposition processes of carcasses.

1.5 Hypothesis

H_0 : There is no significant difference in decomposition for all types of soil.

H_1 : There are significant differences in decomposition for all types of soil.

2.0 LITERATURE REVIEW

2.1 Taphonomy

Taphonomy is used to infer the decomposition site's ecology; the changes arise on the site ecology when plant or animal remains are introduced; and to what degree the site ecology affects the decomposition of material introduced (Carter & Tibbett, 2008). The objectives of forensic taphonomy are to evaluate the post burial or post mortem interval (PMI) from the processes assisting the cadaver decomposition, determining the cause and aspect of death, locating clandestine graves and distinguish the deceased (Haglund, 2005). The aims of forensic taphonomy; the determination of changes in site ecology and the degree affecting ecology, can be accomplished by determining the ecology of the cadaver decomposition.

Currently there is handful data on cadaver decomposition studies carried on at terrestrial ecosystem. The studies are usually done above the ground, on the soil surface (Rodriguez & Bass, 1983; Vass *et al.*, 1992) and buried in soil (Mant, 1950; Morovic-Budak, 1965; Rodriguez & Bass, 1985; VanLaerhoven & Anderson, 1999). The study of cadaver decomposition has also been done inside structure like cars and buildings (Galloway *et al.*, 1989: Mann *et al.*, 1990;. Galloway 1997) but majority of the studies shine the spotlight on the activity of aboveground insect (Motter, 1898; Reed, 1958; Payne, 1965; VanLaerhoven & Anderson, 1999; Kocárek, 2003) and also scavengers (Galdikas, 1978; Willey & Synder, 1989; Haglund, 1997; Berryman, 2002; DeVault *et al.*, 2003; DeVault *et al.*, 2004).

However, the studies on processes occur in soils regarding cadaver breakdown (grave soil) has less attention (Putman, 1978; Vass *et al.*, 1992; Sagara, 1995; Hopkins *et al.*, 2000; Carter & Tibbett, 2003, 2006; Tibbett *et al.*, 2004). Consequently, the

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understanding of the correlation between soil taphonomy and cadaver decomposition is poorly understood (Carter & Tibbett, 2008).

2.2 Decomposition stages

Cadaver decomposition happens very fast. This process can be divided into three parts; autolysis, putrefaction and decay (Carter & Tibbett, 2008). When the heart stops, the microorganism inside the body suck up the oxygen from the tissue. It can start minutes after death and this cell destruction process indicate the start of autolysis (Gill-King, 1997). Moisture and temperature give significant impact on autolysis (Gill-King, 1997) and can start in a short period after death (Vass *et al.*, 2002). This in concurrent creates an optimal condition for anaerobic microorganisms inside respiratory system and gastrointestinal tract. When the stable environment for anaerobic microorganisms is reached, the cadaver will bloat, change in colour and produce pungent smell due to conversation of organic acids from carbohydrate, proteins and lipids. This process is called putrefaction. In this process, bloated causes rupture and disintegrate of cadaver's skin. This process grant the access of oxygen back into the cadaver which stabilized the aerobic organisms metabolism. In return, the fastest stage of decomposition or known as the decay process, begins (Carter & Tibbett, 2008).

Cadaver contains a concentrated amount of lipid and protein and a high amount of water. Water in a cadaver ranges from 60% to 80% from the total cadaver weight (Swift *et al.*, 1979; Tortora & Grabowski, 2000). There are six other stages of decomposition namely fresh, bloated, active decay, advance decay, dry, and remains stage (Payne, 1965). Temperature is associated with the decomposition stages in cadaveric decay (Carter & Tibbett, 2008). Fresh and bloated stage happen seconds after the time of death up to the phase where the skin starts to disintegrate (Carter, 2005). When anaerobic organisms suck

up the oxygen for metabolism from the cell, it piled up gases that cause the cadaver to bloat. Bloating stage increased the pressure inside the cadaver and caused the fluid oozing out from the cadaver through natural openings like anus, mouth and nose, into the soil. The cadaveric mass loss is the greatest when the liquid has seeped into the soil. This stage is called active decay (Carter & Tibbett, 2008).

The available cadaveric material reduce and drained. Thus, it decelerates the remaining three decomposition stages; advance decay, dry and remains (Carter & Tibbett, 2008). However, at the very last moment of decomposition, it is tough to differentiate the beginning of remains stage and the ends of decay stage (Payne, 1965).

2.3 Factor affecting decomposition

Insect is easily attracted to a cadaver even if it just died a few seconds ago. Most of the decomposition happened by the action of insect and scavengers despite the fact that it is naturally undergo autolysis and putrefaction (Mann *et al.*, 1990). The placement of the cadaver either exposed above ground or buried under ground also affect the decomposition process. In additional, this process is slightly affected by the other physical factors such as soil type, temperature, moisture, and associated materials (Carter & Tibbett, 2008). Many mammals are able to form adipocere in moist and coarse-textured soil due to enough fat and moisture (Forbes *et al.*, 2005).

2.3.1 Temperature

Temperature has an important impact to the exposed cadaveric decomposition process (Rodriguez & Bass, 1983; Mann *et al.*, 1990; Vass *et al.*, 1992). Study shows that temperature plays important roles in decomposition (Mann *et al.*, 1990; Gill-King, 1997). The higher the temperature, the higher the cadaveric decomposition (Rodriguez & Bass,

1983; Mann *et al.*, 1990; Vass *et al.*, 1992) because the escalation on the rate of chemical reaction (Van't Hoff, 1898) and biological activity (Carter & Tibbett, 2006) has a correlation with temperature.

2.3.2 Moisture and humidity

Besides temperature, decomposition process is greatly impacted by soil moisture (Swift *et al.*, 1979). Matric potential is an event which water is adhered between soil particles. The metabolism of decomposer microorganism can be affected by soil moisture by modifying soil texture and matric potential to determine the bioavailable moisture. The breaking down of a cadaver has two tendencies between decomposition and desiccation as cadaver is comprised mostly from water (Aufderheide, 1981). This is a vital correlation because fast desiccation can suppress decomposition and result in natural preservation. In Egypt (Ruffer, 1921) and Peru (Allison, 1979), mummies that undergo natural preservation by desiccation for thousands of years can be observed.

Commonly, intense wet environment caused the formation of adipocere and waterlogging while intense dry environment caused desiccation (Galloway, 1997) whereby both of these factors impede cadaver decomposition process. Other than moisture, cadaveric decomposition process is affected by environment humidity (Campobasso *et al.*, 2001). The cadaveric tissues are saturated with water and ergo, slow down the decomposition. However, the insect activity has a positive relationship with the increasing humidity (Mann *et al.*, 1990). But the following discovery supports the conclusion that rainfall has only a subtle effect on maggot activity (Reed 1958; Mann *et al.*, 1990).

2.3.3 pH factor

Wet condition delayed the increase of soil pH in loamy sand and medium clay

while dry condition increase the soil pH in sandy soil. Plant produced a greater number of tannins in acidic soil (Swift *et al.*, 1979). Tannins combine with proteins and carbohydrate in organic matter and cause the microbial activity to decrease. Thus, acid soil might result in slowing of cadaver decomposition (Carter & Tibbett, 2008).

2.4 Soil Characteristics

Soil is composed of organic matter mineral particles with different size. There are three main mineral particles is soil namely sand, silt and clay. The properties of soil are very complex in many aspects such as biological, chemical, physical and mineralogical and it always change time after time. Soil specific properties determine the diversity, productivity and biological activity of living organism. It aid in heat exchange process for living organisms, at the same time providing physical, biological and chemical setting for nutrient, gases and water. Soils increase the water quality by decreasing contaminants as soil has special natural system that enables it to filter the contaminants and residues out of the water and other resources. Besides, soil plays a vital role in distributing surface water, storage, deep drainage, runoff and infiltration. As a result, soil controls the solute and water flows on the surface of the earth. Soils increase the water quality by decreasing contaminants as soil has special natural system that enable it to filter the contaminants and residues out of the water and other resources. Besides, soil plays a vital role in distributing surface water, storage, deep drainage, runoff and infiltration. As a result, soil controls the solute and water flows on the surface of the earth (Fitzpatrick, 2008).

Soil can be transported from one place to another by many ways like foot, shovel or vehicle. The physical matter could have exchanged when two things came into contact. Given situation of walking criminal in a particular area, the soil in that area might come in contact with his shoes and the physical component exchanged. Soil diversity might help in aiding forensic soil scientist in crime investigation. In order to locate the criminal to the

crime scene, forensic soil scientist or forensic geologist compare the soil found with soil databases. Consequently, the soil will provide an information or evidence linking the criminal to the crime scene (Fitzpatrick, 2008).

Soil horizon is made up of many distinct layer of soil. Each parallel of soil has different profile from the other. For example, the soil on the surface has different profile in characteristics and appearance from the soil below it. This profile changes across landscape due to the fact that the material mix in the upper horizon might have leeched to the lower horizon. The soil profile can also be affected by disturbance, erosion and deposition (Fitzpatrick, 2008). Basically, method for characterizing soil is by dividing it into two categories; morphological and analytical. The most common method used is morphological because it is simpler and easier. The morphology described in this method is color, texture, consistency and structure (Fitzpatrick, 2008)

2.4.1 Color, texture, and consistency of soil

Color is the first descriptor recorded in morphological method. Color determination of the soil is usually done by comparing the color of the soil to Munsell color chart (Munsell, 1994) as color provides the indicator of redox status of the soil. Besides redox status, soil color can also impart the soil aeration and organic matter content (Fitzpatrick *et al.*, 1999). Soil color plays a vital role in soil identification for forensic study (Sugita & Marumo, 1996) the color is determined by three component. The hue, value and chroma.

Hue is the shade or frequency of the color ranges from yellow to red while value is the lighness or tone of the color ranges from white to black. In additional, chroma is the degree of intensity or tone of the colour saturation. The organic matter content and type of iron oxides determine the color of the soil (Bingham & Ciolkosz, 1993). Constant high red chroma and yellow hues denotes the oxidizing condition of the soils while the constant low

chroma colors such as dark gray and blue tints denotes reduced and waterlogged condition. Usually, red soils are better than yellow soils (Veprakas, 1992).

Soil strength and coherence determine the consistency of soil. It is easily observed in the field directly applying a force on a piece of soil in hand and determines the degree of strength needed before the soil break or split. Consistency is frequently decribed as loose, firm, hard and very hard. Apart from that, soil texture is determined by the proportion of sand, silt and clay in soil (USDA, 1993).

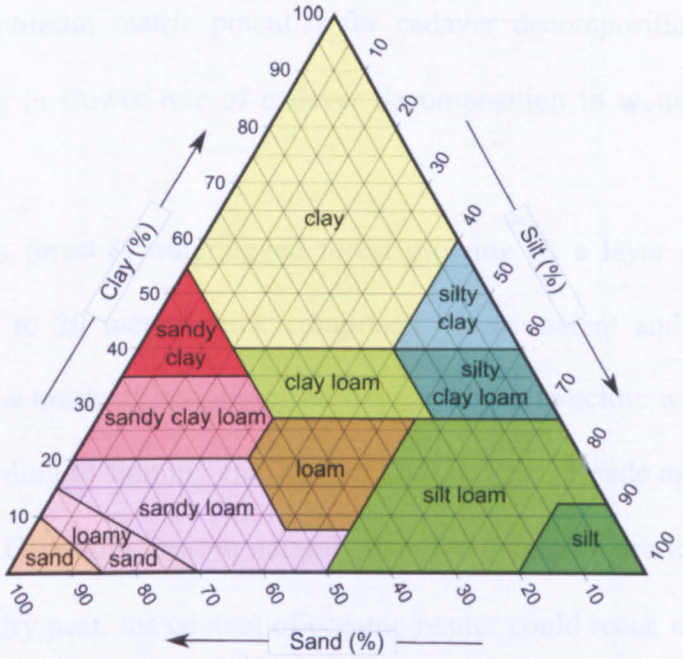

Figure 1: Soil texture classification (Source: USDA, 1993).

2.4.2 Soil types

Laterite soil is generally red in color. Durable weathering thoroughly develops laterite soil. It is semi-permeable, porous and clay-like; which allow it to acts as aquifers in water (Tardy, 1997). However, study on decomposition in laterite soil is subtle.

Sandy soil has granules coarse texture with a large pore sized and usually separated with one another by granules. Coarse-texture or sandy soil have low moisture content usually promotes desiccation (Santarsiero *et al.*, 2000; Fiedler & Graw, 2003) and usually have a high rate of gas diffusion (Moldrup *et al.*,1997) Cadaver decomposition in loamy